

Alien species name Family Order Report describing the impact observation (two (or more) references are given when studies are complementary and have been combined into one impact observation) Year of the report Quotation from the report: rationale for the assigned magnitude (two (or more) quotations are given when studies are complementary and have been combined into one impact observation) Impact mechanism(s) Mechanism type(s) (direct vs indirect) Impacted native species Impacted kindgom(s) Impact score Confidence score Rationale for confidence score: Likelihood of the impact to be higher Rationale of the confidence score: Likelihood of the impact to be lower "Precise location(s) of impact (island, national Park, wood, etc. given in the report)" "Region of impact (district, County, State, Provincia, Archipelago, Departments, etc. of the precise location of impact)" Country of impact Subcontinent Continent Assessor comment Assessor ID Date of assessment Reviewer ID Date of review

Ammotragus lervia Bovidae Cetartiodactyla "Garzón Machado, Víctor, et al. ""Strong negative effect of alien herbivores on endemic legumes of the Canary pine forest."" Biological Conservation 143.11 (2010): 26852694." 2010 "In the absence of herbivores, the number of individuals was significantly greater for all species. These differences in abundance were apparent across all 12 monitoring visits (Fig. 2). [...] For these four species, we conclude that the presence of herbivores, including barbary sheep (Ammotragus lervia), goat (Capra hircus) and European rabbit (Oryctolagus cuniculus), exerts a strong negative effect on plant establishment. [...] Our results indicate that alien herbivores in Caldera de Taburiente (A. lervia, C. hircus and O. cuniculus) have a highly negative impact on the abundance and distribution of the species studied. The highly significant differences between control and exclusion plots and the lack of a correlation between each species' abundance in the exclusion plots and its distribution and abundance under natural conditions suggest that the Canary Islands pineforest understory may be impoverished due to alien herbivores. [...] our results indicate that the Canary pine forest has been severely impoverished by herbivore activity, at least for the legume species studied." Grazing/herbivory/browsing Direct Chamaecytisus proliferus ssp. Proliferus; Teline stenopetala; Spartocytisus filipes; Cicer canariense Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced ungulates present)." La Palma Island Canary IslandsSpain Europe Europe DJ March 2017 LV June 2019

Ammotragus lervia Bovidae Cetartiodactyla "FernándezOlalla, M., et al. ""Threat or opportunity? Browsing preferences and potential impact of Ammotragus lervia on woody plants of a Mediterranean protected area."" Journal of Arid Environments 129 (2016): 915." 2016 "Highly preferred and sparse shrub species might be severely affected by medium to high aoudad densities [...] The aoudad forages on a very wide variety of woody species: from small chamaephytes to trees, although average browsing in tensities are usually moderate. Only 10 species (10.2%) showed average browsing intensity above 3.0, which defines sustainability (see Table 2 and Perea et al., 2014, 2015). However, only four of them were present in more than two surveys, so further research would be needed to provide solid inference on their individual response to aoudad browsing. None of the abundant species (present in>10 surveys) showed unsustainable browsing, and only two of them showed moderate browsing intensity. These results reveal no evidence of major problems regarding actual vegetation structure and composition in our experimental condi tions" Grazing/herbivory/browsing Direct "Rosmarinus officinalis; Pinus halepensis; Juniperus oxycedrus; Thymus vulgaris; Cistus albidus; Quercus coccifera; Staehelina dubia; Cistus clusii Dunal; Pistacia lentiscus; Lithodora fruticosa; Quercus rotundifolia; Dorycnium pentaphyllum; Juniperus phoenicea; Phlomis lychnitis; Rhamnus lycioides; Artemisia campestris L. subsp. glutinosa; Daphne gnidium; Genista valentina; Satureja obovata" Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Sierra Espuña Regional Park Sierra Espuña Regional Park Spain Europe Europe DJ March 2017 LV June 2019

Ammotragus lervia Bovidae Cetartiodactyla "Velamazán, Mario, et al. ""Threatened woody flora as an ecological indicator of large herbivore introductions."" Biodiversity and Conservation 26.4 (2017): 917930." 2017 "The effect of Ammotragus lervia on the threatened woody flora was examined through browsing evidences and rubbing damage. [...] A total of 86 populations of threatened species were examined (Table 1). For each population, 3-5 individuals were randomly selected, recording the following information: plant height, diameter at breast height (dbh), debarking/rubbing damage (presence/absence) and browsing intensity [...] The results reveal that 50% of the threatened plant species showed unsustainable levels of browsing (browsing score C4), with 35.7% of the species under the highest possible level of browsing." Grazing/herbivory/browsing Direct Acer monspessulanum; Coronilla glauca; Cotoneaster granatensis; Erica erigena; Fraxinus angustifolia; Fumana fontanesii; Genista longipes; Phillyrea media; Prunus prostrata; Quercus faginea; Salix pedicellata; Sorbus aria; Thymus serpylloides; Ulmus glabraPlantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Sierra Espuña Regional Park Sierra Espuña Regional Park Spain Europe Europe DJ March 2017 LV June 2019

Axis axis Cervidae Cetartiodactyla "Relva, M. A., & Veblen, T. T. (1998). Impacts of introduced large herbivores on

Austrocedrus chilensis forests in northern Patagonia, Argentina. Forest Ecology and management, 108(1), 27-40." 1998
 "In northern Patagonia, impacts of introduced animals on tree regeneration and understory composition are likely to continue to be a problem for land managers whether the objective of the management be regeneration following timber harvesting or protection of the native flora in parks and reserves. [...] the inhibitory effects of the browsing animals are manifested as stunting and poor form rather than reduced abundance. Heavily browsed *Austrocedrus* saplings typically lose their apical buds and the proliferation of lateral branches creates a shrubby form. Where the land use objective is timber production, this type of animal impact is of substantial economic impact." Grazing/herbivory/browsing Direct
Austrocedrus chilensis Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Isla victoria (Nahuel Huapi National Park) Neuquén Argentina South America
 "Large-scale study (Northern Patagonia) investigating the impact of livestock and game animals. We only recorded the impact of game animals (feral deers on Isla Victoria); The impacts of goats (*Capra hircus*) and sheep (*Ovis aries*) were not assessed, as they are livestock and not feral." LS January 2018 LV 2018
Axis axis Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. Journal of Applied Ecology, 711-724." 1989
 "Deer browsing has nearly eliminated the subcanopy tree, *Aristotelia chilensis*, which otherwise forms dense understoreys and has significantly reduced the abundance of numerous other woody and herbaceous species. [...] The most dramatic difference in the understoreys of the two areas was the dominance on Peninsula Quetrichue by the subcanopy tree *Aristotelia chilensis* compared to its scarcity on Isla Victoria (Tables 3-5)." Grazing/herbivory/browsing Direct *Aristotelia chilensis* Plantae MO Medium
 "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other deer present, and axis deer is scarce)." Isla victoria (Nahuel Huapi National Park) Neuquén Argentina South America
 South America Game animals DJ July 2017 LV June 2019
Axis axis Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. Journal of Applied Ecology, 711-724." 1989
 "*Luma apiculata*, another subcanopy tree species, showed a consistent pattern of greater abundance on Peninsula Quetrichue (Tables 3-5). It was so rare on Isla Victoria that the frequency with which it was browsed was low. Mean maximum heights on the island however, were 19-5 cm (S.E. 6.5) compared to 147 cm (S.E. 30) on the peninsula. This difference suggests that deer have inhibited its growth. [...] The canopy tree *Austrocedrus* was rare in the seedling and sapling size-classes in both areas, making the assessment of deer browsing on its regeneration difficult. Deer, however, browse it intensely and create dwarfed and deformed seedlings. In some stand had a high browse pressure index (Tables 3 and 4). [...] *N. dombeyi* seedlings had a mean height of 73-4 cm (S.E. 9-1; n=49). The relatively high mean susceptibility rating of 1-9 also reflects impairment of *N. dombeyi* regeneration due to deer browsing." Grazing/herbivory/browsing Direct *Luma apiculata*; *Austrocedrus chilensis*; *Nothofagus dombeyi* Plantae MN Medium
 "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (other introduced deer are present, and *Axis* deer is scarce)." Isla victoria (Nahuel Huapi National Park) Neuquén Argentina South America South America Game animals DJ July 2017 LV June 2019
Axis axis Cervidae Cetartiodactyla "Mohanty, N. P., Harikrishnan, S., Sivakumar, K. & Vasudevan, K. Impact of invasive spotted deer (*Axis axis*) on tropical island lizard communities in the Andaman archipelago. Biol. Invasions 18, 9-15 (2016)." 2016
 "We sampled for vegetative cover by holding a white sheet at 1.5 m and positioning a densitometer (Forestry Suppliers, USA) close to the ground. Four equally spaced points in each grid of the densitometer were marked prior to sampling. The number of points covered by vegetation was recorded. [...] As the variables sampled in grids (all except lizard density) within an island were auto correlated, they were averaged to the scale of islands. [...] As expected, vegetative cover decreased with increase in intensity of deer use ($R^2 = 0.667$, $b = -0.835$, $SE = 0.173$, $p < 0.001$) in the islands. [...] Our observations reveal a stark difference in the understory vegetation cover in islands, with and without spotted deer (Table 1).
 " Grazing/herbivory/browsing Direct Vegetation Plantae MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in vegetation in general, making it difficult to understand which species are affected, and how)" "The impact might be lower, because the native population(s) might not be declining (the study did not focus on the species level (vegetation in general), making it difficult to understand which species are affected, and how)" "Alexandra Island, Rutland Island, Hobday Island, Redskin Island, Boat Island, Tarmugli Island, Snob Island, North Cinque Island, South Cinque Island, Bennet Island, Anderson Island, North Andaman Island, South Andaman Island" Andaman islands India South and Southeast Asia Asia DJ July 2017 LV June 2019
Axis axis Cervidae Cetartiodactyla "Mohanty, N. P., Harikrishnan, S., Sivakumar, K. & Vasudevan, K. Impact of invasive spotted deer (*Axis axis*) on tropical island lizard communities in the Andaman archipelago. Biol. Invasions 18, 9-15 (2016)." 2016
 "In this study, we investigated possible indirect pathways of interactions between herbivores and

reptiles (Janzen 1976), and hypothesised that herbivory by spotted deer in the Andaman Islands would reduce vegetative cover and/or depress folivorous arthropod abundance. [...] We considered an island as the experimental unit and sampled for lizard abundance, intensity of deer use, arthropod abundance and understory vegetative cover. We sampled for forest floor and semi arboreal lizards following a modified version of Rodda et al. (2001), a method of total count, in 39 bounded plots of 100 m² each. [...] As we could not obtain density estimates of spotted deer using line transects, due to island size and limited detection, we measured intensity of use. [...] Intensity of spotted deer use was associated with reduced lizard density ($R^2 = 0.393$, $b = -0.669$, $SE = 0.234$, $p = 0.017$). Vegetative cover best explained the variance in overall reptile density as well as in densities of *Coryphophylax subcristatus* and *Lygosoma bowringii* [...] Among species that occurred more than ten times in our samples (Fig. 2), *C. subcristatus* ($R^2 = 0.481$, $b = 0.727$, $SE = 0.217$, $p = 0.007$) and *L. bowringii* ($R^2 = 0.446$, $b = 0.704$, $SE = 0.224$, $p = 0.01$) were positively related to vegetative cover. [...] Among species that occurred more than ten times in our samples, *Coryphophylax subcristatus*, *Cyrtodactylus rubidus* and *Lygosoma bowringii* had greater densities on the island without spotted deer than on islands with spotted deer. "Chemical, physical or structural impact on ecosystems" Indirect *Coryphophylax subcristatus*; *Lygosoma bowringii*; *Cyrtodactylus rubidus* Animalia MO Medium "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (vertical shift in the habitat of the reptiles is speculated)." "Alexandra Island, Rutland Island, Hobday Island, Redskin Island, Boat Island, Tarmugli Island, Snob Island, North Cinque Island, South Cinque Island, Bennet Island, Anderson Island, North Andaman Island, South Andaman Island" Andaman islands India South and Southeast Asia Asia Indirect impact (through impact on vegetation (which is recorded in the database)). LS; DJ January 2018 LV 2018

Axis axis Cervidae Cetartiodactyla "Mohanty, N. P., Harikrishnan, S., Sivakumar, K. & Vasudevan, K. Impact of invasive spotted deer (*Axis axis*) on tropical island lizard communities in the Andaman archipelago. *Biol. Invasions* 18, 9–15 (2016)." 2016 "In this study, we investigated possible indirect pathways of interactions between herbivores and reptiles (Janzen 1976), and hypothesised that herbivory by spotted deer in the Andaman Islands would reduce vegetative cover and/or depress folivorous arthropod abundance. [...] We considered an island as the experimental unit and sampled for lizard abundance, intensity of deer use, arthropod abundance and understory vegetative cover. We sampled for forest floor and semi arboreal lizards following a modified version of Rodda et al. (2001), a method of total count, in 39 bounded plots of 100 m² each. [...] As we could not obtain density estimates of spotted deer using line transects, due to island size and limited detection, we measured intensity of use. [...] Intensity of spotted deer use was associated with reduced lizard density ($R^2 = 0.393$, $b = -0.669$, $SE = 0.234$, $p = 0.017$). Vegetative cover best explained the variance in overall reptile density as well as in densities of *Coryphophylax subcristatus* and *Lygosoma bowringii* [...] Among species that occurred more than ten times in our samples (Fig. 2), *C. subcristatus* ($R^2 = 0.481$, $b = 0.727$, $SE = 0.217$, $p = 0.007$) and *L. bowringii* ($R^2 = 0.446$, $b = 0.704$, $SE = 0.224$, $p = 0.01$) were positively related to vegetative cover. [...] Among species that occurred more than ten times in our samples, *Coryphophylax subcristatus*, *Cyrtodactylus rubidus* and *Lygosoma bowringii* had greater densities on the island without spotted deer than on islands with spotted deer. We infer a significant influence of understory vegetative cover on lizards, in contrast to the indistinct influence of arthropod abundance." "Chemical, physical or structural impact on ecosystems" Indirect Arthropods Animalia MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." "Alexandra Island, Rutland Island, Hobday Island, Redskin Island, Boat Island, Tarmugli Island, Snob Island, North Cinque Island, South Cinque Island, Bennet Island, Anderson Island, North Andaman Island, South Andaman Island" Andaman islands India South and Southeast Asia Asia Indirect impact (through impact on vegetation (which is recorded in the database)). LS; DJ January 2018 LV 2018

Axis axis Cervidae Cetartiodactyla "Ali, R. (2004). The effect of introduced herbivores on vegetation. *Current Science*, 86(8)." 2004 "Browsing might be selectively removing some species allowing the unpalatable ones to dominate [...] The problem seems to be made more acute by the presence of deer, which seriously hamper regeneration of many species. It appears that the spalling densities are lower; however the ones that are not browsed appear to grow faster, and this may explain the similarity in basal areas between the three sites. The effect that deer have on regeneration is shown by the higher number of girths in the 30-60 cm girth class. [...] While it proved possible to census elephants accurately...it did not prove possible to census chital. [...] since animals have been seen crossing between islands, censusing populations was unlikely to give an accurate estimate of population densities over time. Thus, only presence and absence data were considered.

"Grazing/herbivory/browsing Direct Vegetation Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "The impact might be lower, if the performance of native individuals is not decreased (not clear if there has really been an impact on the regeneration, because, for instance, native individuals grow faster) ""Interview Island, Mahatma Gandhi Marine National Park (Alexandra Island, Belle Island, Boat Island, Chester Island, Grub Island, Hobday Island, Jolly Buoy Island,

Malay Island, Pluto Island, Redskin Island, Rifleman Island, Snob Island, Tarmugli Island, Twins Island)" Andaman islands India South and Southeast Asia Asia LS; DJ January 2018 LV 2018

Axis axis Cervidae Cetartiodactyla "Ali R, Pelkey N (2013) Satellite images indicate vegetation degradation due to invasive herbivores in the Andaman Islands. *Curr Sci* 105:209–214" 2013 "The earlier study³ had identified Interview Island as an uninhabited site which has both deer and elephant. Little Andaman has neither, [...] The Mahatma Gandhi Marine National Park (MGMNP) has deer populations on its islands. [...] [Jarawa Reserve] also has deer and their densities appear to be lower here than on Interview Island because of hunting by nontribals at its periphery. [...] To assess the change in vegetation cover across the four sites, a comparison of Normalized Difference Vegetation Index (NDVI) trends between sites over time was made. NDVI values are based on the principle that chlorophyll strongly absorbs visible light but reflects nearinfrared (IR) light. If there is more near-IR reflectance, then the vegetation in that pixel is likely to be dense. [...] For 1986–1995, we used the calibrated vegetation index (CVI) data compiled and mosaicked by the National Institute of Environmental Studies, Japan. [...] Little Andaman has a significantly lower rate of degradation than both Interview Island and Jarawa Reserve for the 1985–1995 data. For the 2001–2005 dataset, Interview Island degraded faster than the Jarawa Reserve–MGMNP cluster, which in turn degraded faster than Little Andaman, and all but one of these comparisons show significant differences. [...] The two deer-only places have a lower rate of degradation since tree damage by elephants does not occur. [...] The answer to this degradation seems to be a combination of chital and elephants. Elephants have damaged the vegetation badly in recent years, and have created a situation where forest regeneration rates are higher than normal. Elephant damage is seen in the form of trees that have been knocked down, or damaged because their bark has been stripped, details are given elsewhere⁴. The chital prevent regeneration by browsing on the seedlings. Besides direct observation on this, there is an abundance of stumps of browsed seedlings that can be seen. To assess the exact quantum of browsing damage would require exclosure studies, which are being undertaken now¹⁷. " Grazing/herbivory/browsing Direct Vegetation Plantae MO Low "The impact might be lower, if no native population(s) is declining (the NDVI method provide information on vegetation in general, and not at the species level; however, it is likely that at least on population declines if the general cover decline); or, if a native population is declining, because the alien might not have caused the observed decline (other stressors: logging, and another introduced herbivor (*Elephas maximus*) (but the impact is more important where both species are present, so the alien seems to increase the impact of *Elephas maximus*)" "Interview Island, Mahatma Gandhi Marine National Park, Jarawa Reserve" Andaman islands India South and Southeast AsiaAsia The observed decline seems to be a combined effect of Axis axis and *Elaphas maximus*. LS January 2018 LV 2018

Axis axis Cervidae Cetartiodactyla "Medeiros AC. 2002. Personal communication. Makawao, Maui (HI): USGeological Survey, Haleakala National Park Field Station. Biologist. In Luna, Tara. "'Fencing is Key to Native Plant Restoration in Hawai 'i.'" *Native plants journal* 4.1 (2003): 4245." 2003 "Deer browsing and girdling of young saplings has had catastrophic effects, with high mortality of some rare and other native plant species of the Pu'uokali lava flows. As a result, construction of deer-proof fencing was required to protect these unique remnant dryland forests (Medeiros 2002)." Grazing/herbivory/browsing Direct Vegetation Plantae MN Low "The impact might be higher, but it is unclear if and how the effect of the alien on the native population size was investigated (personal communication not providing details on the way observations were performed)." "The impact might be lower, if the performance of native individuals is not decreased (personal communication, so no description of how observations were performed)" Hawaii IslandsHawaii IslandsUnited States North America North and Central America DJ July 2017 LV June 2019

Axis axis Cervidae Cetartiodactyla "Mehrhoth, L. (1993). Recovery Plan for the Hawaiian Gardenia. The Service." 1993 "Gardenia brighamii was federally listed as endangered on August 21, 1985 (Herbst 1985). [...] All populations are threatened by alien plant competitors, introduced herbivores, fire, and pathogens. [...] Populations of Axis deer and Mouflon sheep are the major threats to the Lanai populations. Goats, pigs, and cattle have been controlled by the landowner for almost half a century; however, high densities of both Axis deer and Mouflon sheep have not been eliminated. Three fenced, deer-proof exclosures have been erected in the Kanepuu population, each of which protects a single plant. The other 10 to 15 plants on the island are unprotected from intense herbivore pressure." Grazing/herbivory/browsing Direct Gardenia brighamii Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no information on the way the observations were performed, as the data on the current status of the native populations come from personal communications); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the alien is cited as the major threat to the native population(s) but whether the alien played a role in the decline(s) is not clearly mentioned and many other threats are listed (other introduced ungulate (*Ovis orientalis*), fire, pathogens, alien plant competitors))." Lanai'i Island Hawaii IslandsUnited States North America North and Central America "This study does not seem to contain any direct observation, but no reference is cited." LV October 2019 DJ April 2020

Axis axis Cervidae Cetartiodactyla US Fish and Wildlife Service. (1995). Lana'i Plant Cluster Recovery Plan. Lana'i

Plant Cluster Recovery Plan. 1995 "Cattle, sheep, goats, and pigs were eventually eliminated from the island; however, axis deer and mouflon are still numerous and present serious threats to the Lana'i cluster taxa. Only about 10% or less of the island presently remains in native forest or shrubland. [...] The description and taxonomy of each Lana'i cluster plant will be discussed individually. Descriptions are based on the Federal Register documents designating each taxon as endangered (USFWS 1986a, 1986b, 1991; USFWS et al. 1992) . [...] Browsing and trampling by axis deer and mouflon. The habitat of *Santalum freycinetianum* var. *lanaiense* has been severely degraded by grazing and browsing of livestock and exotic game animals. Much of the native vegetation has been removed, increasing wind erosion of the fragile soils. Trampling may directly adversely affect individual *Santalum freycinetianum* var. *lanaiense* plants because of their shallow root systems, or indirectly through destruction of the host plants they depend on. There is a high browse line on the few remaining trees. [...] Browsing and trampling by axis deer and mouflon. The habitat of *Tetramolopium remvi* has been severely degraded by grazing and browsing of livestock and exotic game animals. Much of the native vegetation has been removed, increasing wind erosion of the fragile soils. Axis deer and mouflon are both occasionally present in the vicinity of the only known population of this species. A single incident of grazing or trampling by these animals could easily destroy any or all of the few remaining individuals of this taxon. [...] Browsing and habitat disturbance by axis deer. Deer have not yet fully invaded the current habitat of *Cvrtandra munroi*, though they have directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) contributed to the taxon's decline. Browsing and habitat disturbance by axis deer promise to eliminate *Cvrtandra munroi* if drastic management efforts are not undertaken. [...] Browsing and habitat disturbance by axis deer. Axis deer have invaded the ridgetop habitat of this taxon and directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) pose a threat to the continued existence of the taxon. [...] Browsing and habitat disturbance by axis deer. Axis deer have not yet fully invaded the current habitat of this taxon, though they have directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) contributed to the decline of this taxon. Browsing and habitat disturbance by axis deer promise to eliminate *Phyllostephia lanaiensis* if drastic management efforts are not undertaken. [...] Browsing and habitat disturbance by axis deer. Deer have largely invaded the habitat of this taxon, and have directly (through browsing and trampling) and indirectly (through opening up avenues for invasion of alien plants by their trampling) contributed to the taxon's decline. Browsing and habitat disturbance by axis deer promise to eliminate *Viola lanaiensis* if drastic management efforts are not undertaken." Direct physical disturbance; Grazing/herbivory/browsing; Indirect impact through interaction with other species Direct; Indirect *Santalum freycinetianum* var. *lanaiense*; *Tetramolopium remvi*; *Cyrtandra munroi*; *Gahnia lanaiensis*; *Phyllostephia lanaiensis*; *Viola lanaiensis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no information on the way the observations were performed and the information source is unclear); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the alien is mentioned as one the current threats to the species survival among several threats, such as another alien ungulate (*Axis axis*), fire, alien plants, etc.)." Lanai'i Island Hawaii Islands United States North America North and Central America "This study does not seem to contain any direct observation, but no reference is cited." LV October 2019 DJ April 2020 *Bison bison* Bovidae Cetartiodactyla "Manuwal, Thad, and Rick Sweitzer. ""Browse Impacts of Introduced Mule Deer to Island Scrub Oak Habitats on Santa Catalina Island, California."" Oak Ecosystem Restoration on Santa Catalina Island, California: Proceedings of an On-Island Workshop, February 2–4. Avalon, California: Catalina Island Conservancy, 2007." 2007 "We designed an experiment using a subset of 1600 of the healthiest of these seedlings in which 100 seedlings each were planted in 16 different 30-m X 30-m plots (hereafter seedling plots) in island scrub oak chaparral habitats (3 seedling plots in each of the 5 research focus areas except Twin Rocks, where 4 plots were established; Figure 2). Details on the design of the oak seedling survival experiments follow. [...] The most important mortality factor we identified for oak seedlings on Catalina Island was direct physical disturbance (trampling and wallowing) by bison. In accordance with this result, oak seedling densities along seedling transects were higher in zone 1 (bison not present) than in zones 2 and 3 (bison present)." Direct physical disturbance Direct *Quercus pacifica* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Santa Catalina Island California United States North America North and Central America "Nursery grown oak seedlings; (Report also found under another reference: Manuwal, Thad, and Rick Sweitzer. ""Browse Impacts of Introduced Mule Deer to Island Scrub Oak Habitats on Santa Catalina Island, California."" Oak Ecosystem Restoration on Santa Catalina Island, California: Proceedings of an On-Island Workshop, February 2–4. Avalon, California: Catalina Island Conservancy, 2007.)" DJ December 2017 LV June 2019 *Bos taurus* Bovidae Cetartiodactyla "Malo, J. E., Acebes, P., Giannoni, S. M., & Traba, J. (2011). Feral livestock threatens landscapes dominated by columnar cacti. *Acta oecologica*, 37(3), 249-255." 2011 "[...] our analyses indicate an association between damage to cacti and the abundance of naturalized herbivores, particularly the donkey. Between sites the number and volume of wounds suffered by cacti is significantly positively correlated with the presence of

donkey dung, both for injuries which could be identified as due to herbivores and for all injuries found below 1.75 m. For cows these correlations are only significant in the case of the number of injuries by cactus and (only marginally significant) in the case of volume removed. In contrast, the indicators of cactus damage do not correlate with the presence of guanacos. [...] Physical damage to cacti may lead to increased rates of mortality, though evidences at present are few and come from populations suffering different types of injuries. [...] In our study area it has been shown that flower and fruit production of columnar cacti diminishes as the volume of their injuries increases, with populations more affected reducing more than 10% the flower- and 6% the fruit-output (Peco et al., unpublished data)." Grazing/herbivory/browsing Direct *Echinopsis terscheckii* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only damages on individuals were investigated)." "The impact might be lower, because the performance of native individuals might not be affected (the fact that the performance is affected is inferred from the observation of physical damages, but is not directly tested)." Ischigualasto Talampaya World Heritage Site La Rioja Argentina South America South America LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Peco, B. Borghi, C. E., Malo, J. E., Acebes, P., Almiron, M., & Campos, C. M. Effects of bark damage by feral herbivores on columnar cactus *Echinopsis* (= *Trichocereus*) *terscheckii* reproductive output. J. Arid Environ. 75, 981–985 (2011)." 2011 "[...] due to intrinsic conditions of cacti and their abiotic environs, the results show a significant reduction in reproductive output associated with the presence of trunk damage, which could influence the demography of columnar cacti. A 6e8% decline in the average number of fruits produced by cacti was reflected in a similar decline in the seeds available for regeneration in the most heavily damaged geographic zones, while the loss estimated in the most heavily damaged individuals was estimated to be over 20%." Grazing/herbivory/browsing Direct *Echinopsis terscheckii* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Ischigualasto Talampaya World Heritage Site La Rioja Argentina South America South America LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Berman, D. M. (1991). The ecology of feral horses in central Australia. PhD dissertation. University of New England: Armidale, NSW." 1991 "Results of shrub assessment indicated that mulga (*Acacia anura*) and prickly wattle (*Acacia victoriae*) were damaged more frequently than other trees or shrubs. *Cassia* spp. were least damaged by browsing. Most shrub damage occurred close to watering points in Nineteen Mile valley. There was very little shrub damage in Dry Creek valley [...] The ground was almost bare up to 10 kilometres west of the permanent water (spring) in Nineteen Mile valley, a result of grazing by both horses and cattle which drink at the spring [...] Areas close to water had less herb cover than those more distant because horses and cattle used these areas most intensely. Gully erosion also appeared to be greatest in the areas closest to permanent water [...] This study shows that horses cause considerable direct environmental impact in central Australia and suggests that they also cause significant indirect changes such as accelerated erosion and restriction of suitable habitat for large macropods." Grazing/herbivory/browsing Direct *Acacia anura*; *Acacia victoriae*; herb layer plants (not specified) Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only damages on individuals were investigated)." "The impact might be lower, because the performance of native individuals might not be affected (the fact that the performance is affected is inferred from the observation of physical damages, but is not directly tested)." Kings Canyon Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Munro, N. T., Moseby, K. E. & Read, J. L. The effects of browsing by feral and re-introduced native herbivores on seedling survivorship in the Australian rangelands. Rangel. J. 31, 417–426 (2009)." 2009 "The presence and abundance of seedlings was measured at groves of seven native perennial shrubs over 6 years under four browsing treatments [...] Recruitment of mulga (*Acacia anura* F. Muell. ex Benth.), silver cassia (*Senna artemisioides* subsp. *petiolaris* Randell) and sandhill wattle (*Acacia ligulata* A. Cunn. ex Benth.) was significantly greater in the two browsing regimes inside the Reserve than in the two pastoral regimes. The number of recruits of these three species declined at 'pastoral-destocked' and 'pastoral-stocked' sites but increased at 'reserve-reintroductions' and 'reserve-no browsers' sites from 2001 to 2006. [...] Higher recruitment of mulga occurred in the area browsed by rabbits than where rabbits and cattle were both present (no recruitment at the latter treatment). This could be because the cumulative effects of browsing of mulga by cattle and rabbits are greater than that of rabbits alone, or because forage competition with cattle drives greater consumption of mulga by rabbits. [...] The 'pastoral-stocked' [rabbits and cattle] treatment contained almost no sandhill wattle recruits at monitored sites." Grazing/herbivory/browsing Direct *Acacia anura*; *Acacia ligulata* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (there is no area of land that has not been affected by introduced browsers and therefore no benchmark by which to measure changes since European settlement, however the changes occurring since the settlement of the Reserve allow to infer the changes caused by the alien)." Arid Recovery Reserve South Australia Australia Oceania Oceania "Browsing by feral cattle and rabbits. However, the impact in this treatment is higher than in the treatment where only rabbits are browsing." LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Read, J. L. & Cunningham, R. Relative impacts of cattle grazing and feral

animals on an Australian arid zone reptile and small mammal assemblage. *Austral Ecol.* 35, 314–324 (2010)." 2010
 "Further there was strong evidence of a negative response of mammal captures to abundance of cattle dung (effect -0.026, SE 0.0061, $P < 0.001$), although mammal captures were greater at lightly grazed and grazed sites than ungrazed controls (Fig. 6). [...] Small mammal, principally native rodent, captures were the lowest at heavily grazed sites and the highest in the Arid Recovery Reserve from which exotic herbivores and predators had been removed and kangaroo densities had declined. The dramatic increase in rodent captures within the Arid Recovery Reserve supports findings from an independent dataset (Moseby et al. 2009) that predation pressures are key determinants of terrestrial mammal assemblages in the region. The lower capture rates of small mammals at ungrazed controls compared with lightly grazed or grazed paired sites indicate that suppression of cattle grazing alone was insufficient to facilitate restoration of mammal assemblages."

"Chemical, physical or structural impact on ecosystems" Indirect *Pseudomys bolami*; *Sminthopsis macroura*; *Ctenotus* spp.; *Nephrurus levis* Animalia MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (introduced carnivores are also present)." Roxby Downs South Australia Australia Oceania Oceania LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Liddle, D. T., Brook, B. W., Matthews, J., Taylor, S. M. & Caley, P. Threat and response: A decade of decline in a regionally endangered rainforest palm affected by fire and introduced animals. *Biol. Conserv.* 132, 362–375 (2006)." 2006 "The wild population of the palm *Ptychosperma macarthurii* near Darwin, in monsoonal northern Australia, is regionally endangered and provides a focus to illustrate a range of issues pertinent to conservation of rainforest habitat. [...] In the absence of fire, simulations conducted to explore management options revealed a positive rate of increase with exclusion of introduced animals. [...] The management response required for introduced animals is relatively straight forward. The observed population trends (unburnt few animals $k = 0.9850$; unburnt many animals $k = 0.9584$) support the contention that introduced animals have a significant negative impact on the species (Barrow et al., 1993). There is a need for ongoing control of introduced animals to conserve populations of Darwin Palm, and furthermore, the observed and hypothetical management situations indicate that the more complete the control, the more positive the population response" Direct physical disturbance Direct *Ptychosperma macarthurii* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Darwin Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Munro, N. T., Moseby, K. E. & Read, J. L. The effects of browsing by feral and re-introduced native herbivores on seedling survivorship in the Australian rangelands. *Rangel. J.* 31, 417–426 (2009)." 2009 "The presence and abundance of seedlings was measured at groves of seven native perennial shrubs over 6 years under four browsing treatments [...] Native plum (*Santalum lanceolatum* R.Br.), native apricot (*Pittosporum phylliraeoides* orth. var. DC.) and bullock bush (*Alectryon oleifolius* (Desf.) S.T.Reynolds) exhibited no significant difference in recruitment between the four browsing regimes within the study timeframe." Grazing/herbivory/browsing Direct *Santalum lanceolatum*; *Pittosporum phylliraeoides*; *Alectryon oleifolius* Plantae MC Medium "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (there is no area of land that has not been affected by alien browsers and therefore no benchmark by which to measure changes since European settlement)." Arid Recovery Reserve South Australia Australia Oceania Oceania "Browsing by feral cattle and rabbits. However, the impact in this treatment is higher than in the treatment where only rabbits are browsing." LV March 2019 DJ April 2020

Bos taurus Bovidae Cetartiodactyla "Micol, T., & Jouventin, P. (1995). Restoration of Amsterdam Island, South Indian Ocean, following control of feral cattle. *Biological conservation*, 73(3), 199-206." 1995 "By 1988 the majority of the phyllicas were restricted to a 6-ha area (Fig. 2), protected since the 1970s with fences and introduced *Cupressus* sp; only a few phyllicas survived outside the enclosure. [...] The last fire occurred in 1974 and, in one year, covered the whole island except the western cliffs and the peat-bog causing serious damage to the vegetation, especially to the *Phyllica* forest. Five years after a fire in 1853, von Pelzeln (1861) reported the presence of very thick vegetation which indicated a rapid regeneration of the forest. However, no regeneration occurred after the 1899 fire and Aubert de la Riie (1932) only found grassy turf in the same area. It is likely that at this stage the impact of cattle was more significant and that young trees were browsed or trampled as soon as they appeared. [...] It is particularly illuminating to compare an illustration drawn at the time of the first landing in 1696 with another made in 1875. The first shows a dense forest covering the lowlands (about 1500 ha or 27% of the island's area according to Valentyn, 1726) whereas the second shows only about 250 ha (or 5%; Velain, 1878) of remaining forest (Fig. 2). [...] Vegetation regeneration and its effects on the invertebrate fauna are being monitored (P. Trehen, pers. comm.) in the protected area (without cattle) and the grazed area (with cattle). First results have shown that native plants regressed in favour of introduced ones soon after the culling but are now recovering (Y. Frenot, pers. comm.). In 1989, one year after the first cull, the vegetation was significantly higher than before and native rushes *Scirpus nodosus* were recolonising patchy glades. In 1992, only three years after the complete removal of cattle, the vegetation in previously short meadows was almost 1 m high." Grazing/herbivory/browsing; Direct physical disturbance

Direct Phylica spp. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (impact tested with long-term exclosures, but some information comes from indirect observations (personnal communications, with no description of the way the observations were performed))." Amsterdam Island French Southern Territories French Southern Territories Antarctic Antarctic "In addition to its direct impact, the alien also had an indirect impact (increased the population decline caused by fire)" LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Holdgate, M. W., & Wace, N. M. (1961). The influence of man on the floras and faunas of southern islands. Polar Record, 10(68), 475-493." 1961 "Overgrazing by semi-wild cattle at free range has caused erosion on the southern areas of lowland plain, at Cave Point and Stony Beach, and the areas of unstable sand near the main landing place in the north-west may once have been covered by tussock. The small tussock grass, *Poa flabellata*, does not now occur on Tristan da Cunha, but it is possible it has been eliminated by grazing and formerly grew on the large sections of the main cliff-slopes that now support fern-sward. Higher up the Peak a whole vegetational zone is now dominated by the introduced species *Holcus lanatus* and *Rumex acetosella*, and this too may once have been dominated by native grasses." Grazing/herbivory/browsing Direct *Poa flabellata* Plantae MR Low "The impact might be lower, if the native population(s) is/are not locally extinct (no observational data of the situation before the introduction of cattle - "this may once have been dominated by native grasses"; the information source and the way the observations have been performed is not well described)." Tristan da Cunha "Saint Helena, Ascension and Tristan da Cunha" United Kingdom Europe Europe LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Baldwin, P. H., & Fagerlund, G. O. (1943). The effect of cattle grazing on koa reproduction in Hawaii National Park. Ecology, 24(1), 118-122." 1943 "In the plots upon which cattle grazed the entire time, there were no saplings and only a small number of young suckers. Plots seven and nine represent this condition, and upon their six quadrats were found only 41 suckers. [...] The suppression of reproduction by cattle accounts for the absence of established koa re- production throughout the koa parkland and for the failure of koa reproduction to perpetuate the extensive koa groves which once existed over a large portion of the region. [...] A considerable portion of this region is now open grassland but still has many dead koa trees upon it. The disposition of these relics implies that they once formed large groves of koa similar to those still standing nearby. The cause of death of the old trees may have been fire or some subtle, unrecorded process. However, it is reasonable to attribute to cattle the failure of both seedlings and suckers to perpetuate these groves." Grazing/herbivory/browsing Direct *Acacia koa* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (the impact on the performance has been studied and shown, but only anecdotal observations of a decline have been made by the authors of the study (no quantifiative description of impact))." Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America "The study investigated the mechanism through which the decline happened (impacted regeneration), rather than the decline itself." LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Scowcroft, P. G. Tree Cover Changes in Mamane (*Sophora chrysophylla*) Forests Grazed by Sheep and Cattle. Pacific Sci. 37, 109-119 (1983)." 1983 "Using aerial photographs taken in 1954, 1965, and 1975, percentage of tree cover was determined for three sections of the sheep- and cattlegrazed mdmane (*Sophora chrysophylla*) forest of Mauna Kea, Hawaii. [...] The remnant m?mane forest on Parker Ranch, grazed by cattle, lost one-fifth of its tree cover during the 21-yr period. This loss was the greatest of those measured for the three land divisions." Grazing/herbivory/browsing Direct *Sophora chrysophylla* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (based on a comparison between an area disturbed by the alien and area disturbed by another alien (*Ovis aries*))" Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America LS; DJ January 2018 LV March 2019

Bos taurus Bovidae Cetartiodactyla "Hess, S. C., Banko, P. C., Brenner, G. J., & Jacobi, J. D. (1999). Factors Related to the Recovery of Subalpine Woodland on Mauna Kea, Hawaii 1. Biotropica, 31(2), 212-219." 1999 "We measured mature tree and sapling density, tree associations, crown size, age structure, recovery from ungulate browsing, and grass cover at four study sites in two types of subalpine woodland on Mauna Kea volcano, island of Hawaii. Beginning in 1981, introduced ungulates were reduced in number to allow regeneration of *Sophora chrysophylla* (mamane) in habitat supporting the endangered Hawaiian finch, *Loxioides bailleui* (palila). We found *Sophora* regen- eration at all four study sites, but regeneration was higher in mixed species woodland with codominant *Myoporum sandwicense* (naio) than in areas where *Sophora* dominated. Regeneration of *Myoporum* was uniformly very low in comparison. Invasive grass cover, which suppresses *Sophora* germination, was highest in mid-elevation woodland where *Sophora* dominated. The distribution of mature and sapling *Sophora* were both related to study site, reflecting previous ungulate browsing and uneven recovery due to grasses. Densities of *Sophora* snags were not different among any of the sites, suggesting a more even distribution in the past. Selective browsing before ungulate reduction may have favored *Myoporum* over *Sophora*, leading to high densities of mature *Myoporum* in codominant woodland. After ungulate reduction, however, we found no pattern of competitive inhibition by *Myoporum* on regeneration of *Sophora*. [...] There was no detectable browse damage on *Sophora* on the upper

and mid-elevation sites. In the lower site, 11 of 13 (85%) mature trees and 11 of 13 saplings had browse damage. The bark of many young *Sophora* and *Myoporum* trees was stripped off; there was evidence of browsing on *Sophora* leaves, but no evidence of browsing on *Myoporum* leaves." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Myoporum sandwicense* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (browsing damages have been described (bark removal), which probably lead to a higher susceptibility of individuals to other stressors, but this has not been shown); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (there are four other species of introduced herbivores)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The potential impact on *Loxioides bailleui* has not been recorded. LV October 2019 DJ April 2020

Bos taurus Bovidae Cetartiodactyla "Wood, G. W., Mengak, M. T., & Murphy, M. (1987). Ecological importance of feral ungulates at Shackleford Banks, North Carolina. *American Midland Naturalist*, 236-244." 1987 "Grazing impact was measured by comparing estimated weights of aboveground current annual growth (AGCAG) on grazed and ungrazed plots. AGCAG was defined as aboveground shoots and foliage produced in the current growing season and existent at the time of sampling [...] Three exclosures, each 0.04 ha, were erected in each of the vegetation types in March 1978. [...] All exclosures plus adjacent paired grazed plots were sampled in late August to early September 1978 through 1981. [...] The data obtained in this study indicate that the ungulate populations at their 1978- 1981 levels were interrupting the vegetation dynamics in at least the saltmarsh and grass-shrub communities. Extensive consumption of plant material by large vertebrates is not a natural process in local saltmarsh communities. On the other hand, *Spartina alterniflora* is the climax vegetation of the saltmarsh, and this species has no competitor that might replace it under extreme grazing pressure. In addition, these sites are re- plenished with water and nutrients with each tide; therefore, major deterioration in site potential to support vegetative growth is unlikely. In the grass-shrub community, the primary effect of grazing appears to be a reduction in rate of succession from a grass stage to a *Myrica cerifera* shrub thicket stage. Succession was occurring on both grazed and ungrazed sites, but it was more rapid on the latter. The structural changes occurring in this plant community were not only important in terms of the natural plant dynamics but also in terms of the ability of the island to support grazing animals." Grazing/herbivory/browsing Direct *Andropogon* spp; *Spartina alterniflora*; *Spartina patens*; *Salicornia bigelovii*; *Hydrocotyle bonariensis*; *Uniola paniculata*; *Hydrocotyle bonariensis*; *Myrica cerifera* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (we can not conclude to a decline in the population size from changes in the aboveground biomass in grazed vs ungrazed plots)." "The impact might be lower, because the performance of native individuals might not be affected (contradictory results from 1 year to the other, and from one vegetation type to the other)." North Carolina North Carolina United States North America North and Central America LS January 2018 LV March 2019 *Bubalus bubalis* Bovidae Cetartiodactyla "Liddle, D. T., Brook, B. W., Matthews, J., Taylor, S. M. & Caley, P. Threat and response: A decade of decline in a regionally endangered rainforest palm affected by fire and introduced animals. *Biol. Conserv.* 132, 362–375 (2006)." 2006 "The wild population of the palm *Ptychosperma macarthurii* near Darwin, in monsoonal northern Australia, is regionally endangered and provides a focus to illustrate a range of issues pertinent to conservation of rainforest habitat. [...] In the absence of fire, simulations conducted to explore management options revealed a positive rate of increase with exclusion of introduced animals. [...] The management response required for introduced animals is relatively straight forward. The observed population trends (unburnt few animals $k = 0.9850$; unburnt many animals $k = 0.9584$) support the contention that introduced animals have a significant negative impact on the species (Barrow et al., 1993). There is a need for ongoing control of introduced animals to conserve populations of Darwin Palm, and furthermore, the observed and hypothetical management situations indicate that the more complete the control, the more positive the population response" Direct physical disturbance Direct *Ptychosperma macarthurii* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present and fire events)." Darwin Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Bowman, D. M., Prior, L. D., & De Little, S. C. (2010). Retreating Melaleuca swamp forests in Kakadu National Park: Evidence of synergistic effects of climate change and past feral buffalo impacts. *Austral Ecology*, 35(8), 898-905." 2010 Given the demographic features of *Melaleuca* including rapid seedling regeneration and growth after disturbance (Franklin et al. 2007) the continued contraction signals that the legacy effect of buffalo damage is a proximate and not ultimate cause of the contraction. We suggest that contraction of *Melaleuca* forests is a direct consequence of salinization associated with current sea level rise on low-lying sites (5 m above sea level) that is amplified by past buffalo damage. Before being brought under control in the 1980s large populations of feral buffalo created channels that then allowed ingress of saltwater onto the freshwater flood plains (Stocker 1971; Fogarty 1982; Williams 1984; Knighton et al. 1992; Mulrennan & Woodroffe 1998). Salinization of the flood plains associated with recent

sea level rise has already been reported in KNP (Knighton et al. 1992; Winn et al. 2006). "Chemical, physical or structural impact on ecosystems" Indirect Melaleuca spp. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (analyses are based on aerial photographs, showing changes in the forest cover in general (no monitoring of individual species)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) (the alien density is estimated from paths visible on the aerial photographs)." Kakadu National Park Northern Territory Australia Oceania Oceania The alien is amplifying salinization (indirect impact) LS January 2018 LV February 2019

Bubalus bubalis Bovidae Cetartiodactyla "Braithwaite, R. W., Dudzinski, M. L., Ridpath, M. G., & Parker, B. S. (1984). The impact of water buffalo on the monsoon forest ecosystem in Kakadu National Park. Austral Ecology, 9(4), 309-322." 1984 "Twenty-seven sites were selected randomly within a three-way stratification of Stages I and II of Kakadu National Park (approximately 12 700 km²). [...] A further three sites in the escarpment country were selected to bring a total of 30 sites. [...] Projective foliage cover in strata was measured (Walker & Tunstall 1981) in March 1981 and used to calculate foliage height diversity (MacArthur & MacArthur 1961). Vegetation density (< 3 m) was calculated using the point quadrat method of Braithwaite and Gullan (1978) and indices of leaf shooting in ground (< 1 m), shrub (1-3 m) and tree (> 3 m) strata, and of leaf litter abundance were recorded during each visit. DBH over bark, log dimensions and number of trees (> 10 cm DBH) were measured on sub-sites in June-October 1981. Percentage logs is log volume/basal area of live trees. Floristic data were collected in February-March 1982 (Taylor & Dunlop in press). [...] Buffalo pats were chosen as an index of buffalo usage. [...] However, buffalo appear to knock down many young trees throughout the area, irrespective of forest type. [...] A major effect of trampling is likely to be the supply of water to the trees. Due to impaired infiltration rate the groundwater is not being adequately recharged at the HB sites. The trees appear to have been dying at a faster rate than normal. The dead trees fall and allow more light in through the canopy." Direct physical disturbance Direct Vegetation Plantae MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in the overall vegetation, making it difficult to understand which species are affected, and how); Some of the impact are measured in the field, but other are inferred." "The impact might be lower, if no plant population declines (the study did not focus on the species level, making it difficult to understand which species are affected, and how)" Kakadu National Park Northern Territory Australia Oceania Oceania LS January 2018 LV February 2019

Bubalus bubalis Bovidae Cetartiodactyla "Braithwaite, R. W., Dudzinski, M. L., Ridpath, M. G., & Parker, B. S. (1984). The impact of water buffalo on the monsoon forest ecosystem in Kakadu National Park. Austral Ecology, 9(4), 309-322." 1984 "Twenty-seven sites were selected randomly within a three-way stratification of Stages I and II of Kakadu National Park (approximately 12 700 km²). [...] A further three sites in the escarpment country were selected to bring a total of 30 sites. [...] The 30 sites were visited in August-November (dry season) and January-April (wet season) in 1980-1 and 1981-2. During each site visit of 48 h. the same standard set of observations [...] was taken and the counts used as relative estimates of density. [...] Buffalo pats were chosen as an index of buffalo usage. [...] effects on fauna: nearly three-quarters (72%) of the 74 species have had their densities influenced by buffalo in some way. [...] The density of 8% of species were relatively uniformly depressed (Model 1, Fig. 4). The bird species white-bellied sea-eagle (a), orange-footed scrubfowl (a, $P < 0.01$), pheasant coucal (a), white-gaped honeyeater (b) and mistletoe bird (a); the mammal Sus scrofa (b); the lizard Cryptoblepharus plagioccephalus (b, $P < 0.05$) and the amphibian Cyclorana australis (b) approximated Model 1. With Model 1 the tests of significance are for position differences in the regressions for the LB and HB groups of sites. [...] Other species (8%) were severely depressed at high buffalo density (Model 5, Fig. 4). The bird species emerald dove, large-tailed nightjar and the figbird, the mammals Melomys burtoni and Rattus colletti and the lizard Carlia foliorum conformed to Model 5. None of the species produced regressions with a significant difference in slope. [...] The classification with its six major types of effects is a simplification and the identification of type for some species may change if more data allowed patterns to be perceived more clearly. The listing of species under the various models should be tested experimentally within a park management context. The explanation of why individual species conform to the different patterns observed is beyond the scope of this paper." "Chemical, physical or structural impact on ecosystems" Indirect Haliaeetus leucogaster; Megapodius reinwardt; Centropus phasianinus; Stomiopera unicolor; Dicaeum hirundinaceum; Sus scrofa; Cryptoblepharus plagioccephalus; Cyclorana australis; Chalcophaps indica; Caprimulgus macrurus; Sphecotheres spp.; Melomys burtoni; Rattus colletti; Carlia foliorum Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (only the density of the native population(s) is measured, which, as the native species is/are mobile, might only indicate a local avoidance from the native individuals of the sites disturbed by the alien, and not a decline in the population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Kakadu National Park Northern Territory Australia Oceania Oceania LS January 2018 LV February 2019

Bubalus bubalis Bovidae Cetartiodactyla "Petty, A. M. et al. (2007) Savanna Responses to Feral Buffalo in Kakadu

"At the high population densities seen in the South Alligator River floodplains, buffalo removed most of the surface vegetation, starting with freshwater perennial grasses, including *Hymenachne* and *Phragmites*, then turning to the less palatable but more abundant *Paspalum distichum* L., a salt-tolerant grass which stabilizes tidal levees and is key in preventing the formation of saltwater bearing channels [...] Data on the direct impact of buffalo on woody vegetation of the floodplains has not been reported, although there are numerous photographic records (e.g., Fig. 6; Letts et al. 1979), as well as reports of buffalo eating the seedlings and saplings of the shrub *Cathormion umbellatum* (Vahl) Kosterm (Lucas and Russell Smith 1993). Similarly, contrasting aerial photographs inside and outside of the current buffalo farm (central sector) show a marked decline in woody vegetation inside the boundary of the farm where buffalo graze (Riley 2005; Fig. 6a). In every case, photographic records and other studies show a negative relationship between woody vegetation and buffalo grazing. [...] The total biomass of both herbaceous and woody vegetation on the floodplains increased with the removal of buffalo grazing (Petty et al. 2005; Fig. 5b). Relative abundances of herbaceous species also shifted very rapidly (Minchin and Dunlop 1989). For example, on the South Alligator floodplain in the northern sector, the grass *Hymenachne acutigluma* increased from 1984 to 1988, which in turn increasingly displaced the deep water spike-rush *Eleocharis dulcis* [...] In general, the direct effect of buffalo on ground level vegetation and soils indirectly altered competitive relationships among trees, grass and forbs, as well as produced large changes in fuel loads and fire regimes which, in turn, further altered species composition and overall structure of the savanna. The second cascade, with the reversal in grazing pressure, also included significant hysteresis effects within the vegetation (Werner 2005, Werner et al. 2006) and released resources to other feral animals which then increased in numbers (Corbett 1995)." Grazing/herbivory/browsing Direct *Hymenachne acutigluma*; *Cathormion umbellatum*; *Barringtonia acutangula*; *Strychnos lucida*; *Phragmites* spp.; *Paspalum distichum* Plantae MO Low

"The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) (review of different impact reports, which comes to the conclusion that the alien is a driver of these declines; debate in Bowman et al. (2008) and Bowman et al (2010) on these conclusions)." Kakadu National Park Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Friend, G. R. & Taylor, J. A. Ground surface features attributable to feral buffalo, *Bubalus bubalis*. II Their relationship to the abundance of small animal species. Aust. Wildlife Res. 11, 303–310 (1984)." 1984 "Relationships between ground surface features attributable to feral buffalo (wallows, trails, pug marks and dung pats) and the abundance of 116 small animal species (birds, reptiles, amphibians and orthopterans) were explored by pattern analysis for both dry and wet seasons in a tropical monsoonal area of northern Australia. [...] From the classification, discontinuities in the abundance of 20 (33%) species of birds, seven (58%) species of amphibia, five (39%) species of reptiles and 19 (63%) species of grasshoppers were found to be associated (positively or negatively) with the effects of buffalo measured in one or both seasons. [...] The high proportion (63%) of orthopteran species relating to the effects of buffalo suggests that as a group they are particularly sensitive to differences in ground surface features. This result concurs with Key's (1959) finding of the importance of vegetation structure in determining grasshopper abundance and species composition, since the ground surface features discussed in our study can be considered as further attributes of habitat structure. In particular, the strong relationships shown by *Locusta migratoria* and *Pseudaiolopus keyi* highlight their potential as indicator species of buffalo-induced changes to habitat structure. " "Chemical, physical or structural impact on ecosystems" Indirect "*Colluricincla megarrhyncha*; *Lalage leucomela*; *Melithreptus albogularis*; *Geopelia placida*; *Geopelia humeralis*; *Haliastur sphenurus*; *Haliaeetus leucogaster*; *Wurfia vanica*; *Rhipidura leucophrys*; *Dicrurus hottentottus*; *Halcyon macleayii*; *Myiagra inquieta*; *Ducula spilorrhoa*; *Aprosmictus erythropterus*; *Halcyon sancta*; *Valanga meleager*; *Rectitropis australis*; *Loxilobus* sp.; *Calephorops viridis*; *Stenocatantops angustifrons*; *Rectitropis australis*; *Pardaliparus (limbala)*; *Rectitropis* sp.; *Guslmargus musicus*; *Pseudaiolopus hzyi*; *Froggattinu australis*; *Anidella bilingua*; *Litoria rothi*; *Litoria rubella*" Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (it is not clear if the species do not use the habitat impacted by buffalo (avoidance), or if they decrease in number)." Kapalga (Kakadu National Park) Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Stocker, G.C. 1971. The effects of water buffalo on paperbark forests in the Northern Territory. Australian Forest Research 5: 29–34" 1971 "The Mary River paperbark forest was chosen for examination as an aerial reconnaissance had shown large areas to be dead, dying or with chorotic crowns. In this locality the barriers which normally hold back the spring high tides have been breached, allowing salt water to enter the forested depressions. All the vegetation in severely affected areas has been killed and in marginal areas most damage has occurred at the lowest elevations. [...] Buffaloes graze the sedges and water lilies beneath the paperbarks during the wet season. By the end of the dry season nothing remains except the larger trees, for the rest the vegetation has been trampled into the heavy clay soil." Direct physical disturbance Direct *Melaleuca* spp. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (analyses are based on aerial photographs, showing changes in the forest cover in general (no monitoring of individual species, even though it is likely that individual species decline when the general cover declines)); or, if the native population(s) is/are declining, because the alien might not have

caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (no other stressor is listed in the study, but the fact that overgrazing and trampling by the alien has caused the change in soil property that led to the native population decline(s) is not well demonstrated)." Mary River paperbark forest Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Friend, G. R., Dudzinski, M. L. & Cellier, K. M. *Rattus colletti* (Rodentia: Muridae) in the Australian wet-dry tropics: Seasonal habitat preferences, population dynamics and the effects of buffalo (*Bubalus bubalis*). *Aust. J. Ecol.* 13, 51–66 (1988)." 1988 "Suitable rat habitat is confined to quite limited and specific areas where buffalo grazing pressure is minimal. Without buffalo it is likely that the lower elevation areas supporting *Eleocharis*, *Cyperis* and *Oryza* spp. would be highly favoured by rats in the late dry season. Similarly, in the wet and early dry seasons buffalo may alter vegetation structure and exacerbate the effects of flooding by grazing the wet plains and fringing woodlands, further restricting suitable refuge habitat." "Chemical, physical or structural impact on ecosystems" Indirect *Rattus colletti* Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (the observed changes might be natural fluctuations of the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." South Alligator river (Kakadu National Park) Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Bowman, D. M. J. S., Riley, J. E., Boggs, G. S., Lehmann, C. E. R. & Prior, L. D. Do feral buffalo (*Bubalus bubalis*) explain the increase of woody cover in savannas of Kakadu National Park, Australia? *J. Biogeogr.* 35, 1976–1988 (2008). " 2008 "Feral buffalo built up to high densities in the study area until c. 1985, after which a control programme almost eliminated the animals. From 1990, low densities of managed buffalo were maintained inside an enclosure. We compared trends in woody vegetation when buffalo were high-density feral, low-density managed or absent. [...] The effects of grazers on woody cover are indirect, and largely mediated through reductions in fuel loads and thus fire frequency and intensity, as well as decreased competition (Van Auken, 2000; Asner et al, 2004; Werner, 2005). [...] We analysed sequences of digitized and geo-rectified aerial photographs, acquired in 1964, 1975, 1984, 1991 and 2004, to chart changes in woody cover on the floodplain and in the savanna. On the floodplain we assessed whether trees were present at these times at 14,568 points, and buffalo density was estimated from the density of animal tracks. In the savanna we estimated woody cover at pre-selected sites. [...] To conclude, we found that feral buffalo had little effect on woody vegetation on the floodplains of KNP, a result which suggests that the indigenous trees are resistant to the impacts of these large herbivores. While there is some evidence that tree cover in eucalypt savanna increased in the presence of low densities of managed buffalo, this increase is minor relative to the strong temporal trend of vegetation thickening. Thus our study does not support the hypothesis of Petty et al (2007) that buffalo are a major driver of floodplain and eucalypt savanna dynamics [...] Rather, the observed increase in woody cover in both savanna and flood plains concords with regional trends and may be related to increased atmospheric CO₂, increasing rainfall and changing fire regimes during the study period." "Chemical, physical or structural impact on ecosystems" Indirect *Melaleuca* spp.; *Eucalyptus* spp. Plantae MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated); in addition, there is a controversy with Petty et al. (2010) on the conclusions drawn in this study." Kakadu National Park Northern Territory Australia Oceania Oceania "For the controversy, see also: Petty, A. M., & Werner, P. A. (2010). How many buffalo does it take to change a savanna? A response to. *Journal of Biogeography*, 37(1), 193-195.; Bowman, D. M., Prior, L. D., & Williamson, G. (2010). The roles of statistical inference and historical sources in understanding landscape change: the case of feral buffalo in the freshwater floodplains of Kakadu National Park. *Journal of Biogeography*, 37(1), 195-199." LS January 2018 LV February 2019

Bubalus bubalis Bovidae Cetartiodactyla "Braithwaite, R. W., Dudzinski, M. L., Ridpath, M. G., & Parker, B. S. (1984). The impact of water buffalo on the monsoon forest ecosystem in Kakadu National Park. *Austral Ecology*, 9(4), 309-322." 1984 "Twenty-seven sites were selected randomly within a three-way stratification of Stages I and II of Kakadu National Park (approximately 12 700 km²). [...] A further three sites in the escarpment country were selected to bring a total of 30 sites. [...] The 30 sites were visited in August-November (dry season) and January-April (wet season) in 1980-1 and 1981-2. During each site visit of 48 h. the same standard set of observations [...] was taken and the counts used as relative estimates of density. [...] Buffalo paths were chosen as an index of buffalo usage [...] Only 28% of the classified species seemed unaffected by buffalo. The bird species, rose-crowned fruit-dove, bar-shouldered dove, brush cuckoo, little bronze-cuckoo, azure kingfisher, sacred kingfisher, dollarbird, white-bellied cuckoo-shrike, varied triller, rufous whistler, little shrike-thrush, dusky honeyeater and yellow oriole; the mammals *Isodon macrourus*, *Pteropus scapulatus* plus *P. atactotis* and *Bos taurus*; the reptiles *Ctenotus essingtonii*, *Varanus gouldii* plus *V. panoptes* and *Sphenomorphus crassicaudus*; and the amphibians *Limnodynastes convexiusculus* and *Litoria caerulea*, all seemed unaffected by buffalo." "Chemical, physical or structural impact on ecosystems" Indirect *Ptilinopus regina*; *Geopelia humeralis*; *Cacomantis*

variolosus; Chrysococcyx minutillus; Ceyx azureus; Todiramphus sanctus; Eurystomus orientalis; Coracina papuensis; Lalage leucomela; Pachycephala rufiventris; Colluricincla megarhyncha; Myzomela obscura; Icterus nigrogularis; Isodon macrourus; Pteropus scapulatus; Pteropus atecto; Bos taurus; Ctenopus essingtonii; Varanus gouldii; Varanus panoptes; Sphenomorphus crassicaudus; Limnodynastes convexiusculus; Liioria caerulea Animalia MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Kakadu National Park Northern Territory

Australia Oceania Oceania LV February 2019 DJ April 2020

Bubalus bubalis Bovidae Cetartiodactyla "Corbett, L., Hertog, A. L. & Muller, W. J. An experimental study of the impact of feral swamp buffalo Bubalus bubalis on the breeding habitat and nesting success of magpie geese Anseranas semipalmata in Kakadu National Park. Biol. Conserv. 76, 277–287 (1996)." 1996 "Buffalo trampling and grazing influenced the location of nests but not number. After buffalo were removed, more nests were built in deep water areas at the forest edge of the floodplain. [...] Buffalo were not associated with fluctuations in the numbers of magpie goose nests. It follows, therefore, that buffalo probably also were not associated with fluctuations in hatching success and survival rates of goslings." "Chemical, physical or structural impact on ecosystems" Indirect Anseranas semipalmata Animalia MC Medium The alien might affect the performance of native individuals (the fact that the hatching success and survival rates of the native goslings was not affected by the change in the location of nests caused by the alien has not been directly investigated). Kakadu National Park Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Michels, G. H., Vieira, E. M. & de Sá, F. N. Short- and long-term impacts of an introduced large herbivore (Buffalo, Bubalus bubalis L.) on a neotropical seasonal forest. Eur. J. For. Res. 131, 965–976 (2012)." 2012 "To address these points, we used two distinct approaches in fragments of seasonal forests located in buffalo farms: firstly, by establishing a buffalo-exclusion experiment (over 14 months), and secondly, by comparing areas with three different histories of buffalo occurrence (protected from buffalo encroachment for 3 and 10 years and freely accessed by buffalo). In both approaches, we evaluated the following ecological attributes: plant cover, richness, diversity (Shannon index), biomass and average height. [...] Our study results showed that buffaloes may have an impact on forest plants but that this effect may only be observed after at least 3 years. This conclusion was supported by the evidence of our manipulative experiment, which did not show significant differences in the measured ecological variables, nor in species composition, after 1 year of buffalo exclusion. On the other hand, the observational approach indicated a clear increase in richness and diversity and a decrease in average plant height after 3–10 years of buffalo exclusion. We also observed that the species composition of the studied communities modified during this period." Direct physical disturbance Direct Trixis praestans; Erythroxylum argentinum; Pavonia sepium; Leandra sp.; Miconia pusilliflora; Blepharocalix salicifolius; Myrcia glabra; Myrcia palustris; Myrsine lorentziana; Seguieria sp.; Scutia buxifolia; Fareaea montevidensis; Psychotria cartagenensis; Matayba elaeagnoides; Daphnopsis racemosa Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Sentinela do Sul County Rio Grande Do Sul Brazil South America South America LS January 2018 LV March 2019

Bubalus bubalis Bovidae Cetartiodactyla "Bisaggio, E. L., Alves, S. L., Júnior, C. C. S., & Rocha, C. H. B. (2014). Búfalos Ferais (Bubalus bubalis) em Áreas Protegidas: um estudo de caso na Reserva Biológica do Guaporé, RO. Biodiversidade Brasileira, (2), 243-260." 2014 "Nos campos inundáveis da REBIO Guaporé, as diferenças visuais entre os campos ocupados e os livres de búfalos são notórias. Enquanto os campos livres constituem vastos tapetes homogêneos de gramíneas, os campos ocupados apresentam pouca uniformidade, com variados graus de alterações provocadas pelos búfalos. Nas áreas densamente ocupadas, as gramíneas nativas encontram-se virtualmente ausentes acima da coluna d'água e, quando presentes, se apresentam reviradas e distribuídas de maneira difusa. Outro aspecto que diferencia os campos livres dos ocupados é o fato dos últimos possuírem grandes áreas cobertas por aguapés (Heteranthera spp. e Eichornia spp.), plantas conhecidas por tolerarem ambientes eutrofizados (Kissmann & Groth 1997). Os sub-bosques das Florestas Ombrófilas ocupadas pelos búfalos na REBIO Guaporé parecem ter sido seriamente afetados por estes animais, pois se percebe a completa ausência dos estratos médios e inferiores da vegetação, bem como a ausência de lianas, arbustos e indivíduos jovens das espécies arbóreas (Figura 3C). Os búfalos também causam injúrias em árvores por meio da fricção de seus corpos e chifres nos troncos. É provável que os animais causem a morte de árvores maduras e impeçam o recrutamento e o crescimento de novos indivíduos." Grazing/herbivory/browsing Direct Vegetation Plantae MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in the overall vegetation, making it difficult to understand which species are affected, and how)" "The impact might be lower, if no plant population declines (the study did not focus on the species level, making it difficult to understand which species are affected, and how)" Guaporé Valley Rondônia Brazil South America South America LS January 2018 DJ April 2020

Camelus dromedarius Camelidae Cetartiodactyla "Dörge, B., and Heucke, J. (2003). Demonstration of ecologically sustainable management of camels on aboriginal and pastoral land, Final Report on Project No. 200046,

Natural Heritage Trust (online)." 2003 "While the impact of camels' browsing on the ground vegetation does not contribute to a loss of diversity, their continual browsing can have a serious impact on some shrub- and tree species. According to the palatability index in Table 1 there are 3 tree species recorded so far where camels' browsing is considered to be of serious concern. These are the Curly-pod Wattle *Acacia sessiliceps*, the Bean Tree *Erythrina vespertilio* and the Quandong *Santalum lanceolatum*. Left unprotected inside a camel holding paddock, even with a low density of camels, there will be no regrowth of these species in the long term, as camels regularly revisit the newly grown plants and often completely defoliate them. [...] Inside this paddock the Athel Pine (*Tamarix aphylla*) has virtually no chance to spread any further. All individuals up to the size of 4 meters height were quantitatively killed and no regrowth of this extremely undesired species was recorded. While the Athel Pine outside this paddock was normally distributed in all size classes, inside only individuals higher than 6 meters had survived the 'camel treatment'." Grazing/herbivory/browsing Direct *Acacia sessiliceps*; *Erythrina vespertilio*; *Santalum lanceolatum*; *Tamarix aphylla* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the impact is only observed within inclosures)." "The impact might be lower, because the performance of native individuals might not be affected (the impact is less obvious outside the inclosures)." Experimental mesocosms (Alice Spring) Northern Territory Australia Oceania Oceania "The impact is proven, but it is higher in captivity when compared to free ranging" LS January 2018 DJ; LV March 2019

Camelus dromedarius Camelidae Cetartiodactyla "Box, J.B., McBurnie, G., Strehlow, K., Guest, T., Campbell, M., Bubb, A., McConnell, K., Willy, S., Uluru, R., Kulitja, R. and Bell, B., 2016. The impact of feral camels (*Camelus dromedarius*) on remote waterholes in central Australia. The Rangeland Journal, 38(2), pp.191-200." 2016 "Turbidity was over 16 times higher in springs that were accessible to camels or had been recently visited by camels. This is not surprising, in that camels can cause an increase in water turbidity directly by walking into the water, and indirectly through trampling the surrounding area. Camel dung can also cause nutrient enrichment and subsequent algal blooms (McBurnie et al. 2015), which can also increase turbidity (Croel and Kneitel 2011). Ostracods were missing from sites that were heavily used by camels, and may be particularly sensitive to increases in turbidity caused by erosional sediments (Cohen et al. 1993). Microcrustaceans such as ostracods are considered keystone species in freshwater environments, and have recently been identified as potential sentinel organisms, partly because of their sensitivity to a variety of pollutants (Ruiz et al. 2013). [...] In this study, the percentage of sensitive taxa in springs was significantly lower at both camel-accessible sites and when camels had recently visited, and significantly lower in rockholes that had recent camel visitation. Because the presence of a sensitive species at a site is a strong indicator of good biological condition (US EPA 2002b), their absence suggests that feral camels are a significant biological stressor on both springs and long-lasting rockholes in the KPALT." "Chemical, physical or structural impact on ecosystems" Indirect Ostracods Animalia MR Medium "The impact might be lower, if no local extinction happened (difficult to determine whether each spring constitute one local population)" Uluru-Kata Tjuta National Park (Katiti and Petermann Aboriginal Land Trusts) Northern Territory Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Camelus dromedarius Camelidae Cetartiodactyla "Brim-Box, J., Guest, T., Barker, P., Jambrecina, M., Moran, S., & Kulitja, R. (2010). Camel usage and impacts at a permanent spring in central Australia: a case study. The Rangeland Journal, 32(1), 55-62." 2010 "In long periods with little or no rainfall, camels use X heavily during the day and night and there is little chance for X to re-fill. Consequently, small pools that form when X is full and can be readily accessed by native wildlife, are dry and filled with soil and dung during periods of heavy camel use. This lack of access to an otherwise permanent waterhole may have negative impacts on native animal species that rely on this water. In addition, the low number of macroinvertebrates present during the study period suggests that the aquatic fauna is also negatively impacted by the presence of camels." "Chemical, physical or structural impact on ecosystems" Indirect Macroinvertebrates Animalia MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in macroinvertebrates abundances in general, making it difficult to understand which species are affected, and how)" "The impact might be lower, if no macroinvertebrate population declines (not compared values, just low numbers); or, if a native population is declining, because the alien might not have caused the observed decline (physical modification of the spring have been observed, but the impact on native species is inferred)" Uluru-Kata Tjuta National Park (Katiti and Petermann Aboriginal Land Trusts) Northern Territory Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Camelus dromedarius Camelidae Cetartiodactyla "Brim-Box, J., Guest, T., Barker, P., Jambrecina, M., Moran, S., & Kulitja, R. (2010). Camel usage and impacts at a permanent spring in central Australia: a case study. The Rangeland Journal, 32(1), 55-62." 2010 We noted that the vegetation surrounding X was found to be heavily impacted by camels. Shrubs near X showed signs of heavy browsing and the ground cover became mainly denuded of vegetation due to camel browsing and trampling during dry periods. This could lead to long-term alternations in drainage patterns and erosion of the site. Follow-up vegetation and ground cover surveys are needed to better assess these impacts. Grazing/herbivory/browsing Direct *Eremophila longifolia*; *Ficus platypoda*; *Portulaca* spp. Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only

damages on individuals were investigated)." Uluru–Kata Tjuta National Park (Katiti and Petermann Aboriginal Land Trusts) Northern Territory Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Camelus dromedarius Camelidae Cetartiodactyla "BOX, Jayne Brim, NANO, Catherine EM, MCBURNIE, Glenis, et al. The impact of feral camels (*Camelus dromedarius*) on woody vegetation in arid Australia. The Rangeland Journal, 2016, vol. 38, no 2, p. 181-190." 2016 "Despite the severe browsing effects we observed in areas of high camel density, overall tree mortality from camel impacts remains, for the moment, modest across the region. Specifically, averaged over species, death from browsing was only about 2%. A species that showed notably higher levels of mortality was the palatable shrub, plumbush, which suffered 7% mortality from camel browsing. Its congener, the quandong tree, is also considered to be highly palatable to camels and susceptible to browsing. Camels may have contributed to its recent population declines and threatened status in the NT (Woinarski et al. 2007). However, we do not yet have any scientific studies that have quantified population declines from camel damage in any plant species outside of controlled paddocks, even including species thought to be most vulnerable to camel impacts such as quandong, umbrella wattle and plumbush. [...] Our second major finding was that camel browsing, although resulting in minimal mortality, strongly limits plant growth. Browsing impacts varied greatly across the landscape in direct response to camel density."

Grazing/herbivory/browsing Direct *Acacia ligulata*; *Acacia ramulosa*; *Acacia aneura*; *Acacia paraneura*; *Eremophila longifolia*; *Acacia oswaldii*; *Acacia tetragonophylla*; *Atalaya hemiglauc*; *Codonocarpus cotinifolius*; *Pittosporum angustifolium*; *Santalum lanceolatum* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (even though the alien seems to rarely cause mortality of native trees, studies on its impact on population dynamics would be needed)." It is unlikely that the impact is lower (mortality and limited growth due to browsing by the alien has been shown). "Watarrka & West MacDonnell National Parks (Northern Territory), Petermann ALT (Northern Territory), Simpson Desert (Northern Territory), Karlamilyi National Park (Western Australia), Purni Bore (Southern Australia), APY Lands" South Australia Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Capra hircus Bovidae Cetartiodactyla "Hicks, D. J., & Mauchamp, A. (1995). Size-dependent predation by feral mammals on Galápagos *Opuntias*. *Noticias de Galápagos*, 55, 15-17." 1995 "It is clear that adult *Opuntia* plants are severely damaged by feral animals. [...] Repeated attacks to an *Opuntia* can girdle the trunk and kill the plant. Cladodes of both *Opuntia* species are capable of rooting after such an event. However, vegetative reproduction from fallen cladodes seems to be very rare in *O. galapageia* on Santiago" Grazing/herbivory/browsing Direct *Opuntia echios* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the reproduction and survival of native individuals was investigated)." Santa Cruz Island Galapagos Islands Ecuador South America South America LS January 2018 DJ; LV March 2019

Capra hircus Bovidae Cetartiodactyla "Alves, R. J., Silva, N. G. D., Aguirre-Muñoz, A., Veitch, C., Clout, M., & Towns, D. (2011). Return of endemic plant populations on Trindade Island, Brazil, with comments on the fauna. In *Island invasives: eradication and management. Proceedings of the International Conference on Island Invasives*. Gland, IUCN, Auckland (pp. 259-263)." 2011 "Positive results of the goat eradication include the recovery of endemic plant populations. *Plantago trinitatis* was considered extinct until 1998, and began a slow recovery from the seed bank in the soil when the goat population began to decline. *Peperomia beckeri*, another endemic species known only from the type collection, was rediscovered in December 2009 and is now present as a few individuals. [...] [Table 2]"

Grazing/herbivory/browsing Direct *Peperomia beckeri*; *Plantago trinitatis*; *Psilotum triquetrum* Sw. f. *insularis* Plantae MR Low It is unlikely that the detected local extinction(s) is/are irreversible (all the native populations came back after the alien eradication). "The impact might be lower, if the native population(s) is/are not locally extinct (the way the native population(s) was/were monitored is not described)." Trindade Island Trindade and Martin Vaz Brazil South America South America LV September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Alves, R. J., Silva, N. G. D., Aguirre-Muñoz, A., Veitch, C., Clout, M., & Towns, D. (2011). Return of endemic plant populations on Trindade Island, Brazil, with comments on the fauna. In *Island invasives: eradication and management. Proceedings of the International Conference on Island Invasives*. Gland, IUCN, Auckland (pp. 259-263)." 2011 "The Trindade petrel (*Pterodroma arminjoniana*) is known to breed on Trindade, Round Island (Mauritius), and North Keeling Island (Australia, Cocos Archipelago) in the Indian Ocean. Luigi (1995) found no breeding pairs on Martin Vaz. [...] We have observed a gradual increase in the Trindade population coincident with the cat and goat eradication effort. [...] The boobies, *Sula sula* and *S. leucogaster*, have undergone a gradual global decline although both species are listed as "Least Concern" (Birdlife International 2009a, 2009b). They are not considered threatened in Brazil (not listed by Silveira and Straube 2008). Both are ground-nesting, and their populations on Trindade were under constant pressure from feral goats, which not only trampled their nests, but were recorded eating the eggs (Sergeant Ruy Barreto pers. comm.). Colonies of *S. sula* were recorded on Trindade up to the late 1960s, became very rare on the island by the 1990s, and no nests have been recorded since. On the other hand, the number of nesting *S. leucogaster* multiplied exponentially following cat and goat eradication, and currently covers four times the original territory."

Predation Direct *Sula leucogaster*; *Pterodroma arminjoniana*; *Sula sula* Animalia MO Low "The impact might be

lower, because the native population(s) might not be increasing after the alien eradication (the way the native populations were monitored is not described); or, because the increase in the native population(s) might not be due to the alien eradication (the recovery of the native populations happened after the eradication of both the goat and the cat, and did not happen at all for one of the native populations even after their eradication)." Trindade Island Trindade and Martin Vaz Brazil South America South America LV September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Alves, R. J., Silva, N. G. D., Aguirre-Muñoz, A., Veitch, C., Clout, M., & Towns, D. (2011). Return of endemic plant populations on Trindade Island, Brazil, with comments on the fauna. In *Island invasives: eradication and management. Proceedings of the International Conference on Island Invasives*. Gland, IUCN, Auckland (pp. 259-263)." 2011 "Positive results of the goat eradication include the recovery of endemic plant populations. [...] In 1994, the documented surviving population of *Achyrocline disjuncta* was of 13 individuals, with fewer than 50 individuals estimated for the entire island. [...] [Table 2]" Grazing/herbivory/browsing Direct *Achyrocline disjuncta* Plantae MO Low "The impact might be lower, because the native population(s) might not be increasing after the alien eradication (the way the changes in the native populations were monitored (before and after the alien eradication) is not described)." Trindade Island Trindade and Martin Vaz Brazil South America South America LV September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Simonetti, J. ""Effects of goats upon native rodents and european rabbits in the Chilean matorral."" *Revista Chilena de Historia Natural* 56 (1983): 2730." 1983 "The abundance of native rodents and European rabbits was sampled in two matorral patches subjected to different degrees of disturbance by Spanish goats. [...] From the above evidence, it is plausible to propose that shrub cover reduction due to browsing by goats affects native rodents (decreasing their abundance) and rabbits (increasing it). [...] Rabbits alone or coupled with goats kill a high proportion of seedlings of native shrubs growing both under the canopy and in the open spaces between large shrubs." "Chemical, physical or structural impact on ecosystems" Indirect *Akodon longipilis*; *Akodon olivaceus*; *Phyllotis darwini* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the observed differences might only be natural differences between the area where the alien has been introduced and the area where the alien has not been introduced)." Chilean Matorral Chilean Matorral Chile South America South America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Desender, K., Baert, L., Maelfait, J. P., & Verdyck, P. (2006). Effects of the feral goat population explosion on Alcedo volcano (Isabela, Galapagos) between 1986 and 1996. *Galapagos Research*, 64, 2-7."2006 "During the first week of April 1986, before the overwhelming presence of goats, we sampled terrestrial macroinvertebrates on Alcedo Volcano along an altitudinal transect from the seashore to the top. Vegetation composition and structure at all sampling sites were described and photographs were taken. In 1996, when the Alcedo feral goat population had exploded to an estimated 50,000 to 100,000 and before large scale goat control began, the same transect was resampled and redocumented. In this contribution, site descriptions are summarized, compared between 1986 and 1996 and illustrated with a series of photographs. [...] By coincidence, meteorological conditions during both years appeared similar, especially precipitation, and both 1986 and 1996 could be classified as years with moderate rainfall. Even the timing of heavy rainfall prior to our sampling was more or less comparable: the most recent heavy showers took place about three to four weeks prior to each of the two sampling campaigns. [...] Changes in the vegetation between 1986 and 1996 were not obvious at elevations of 400 m and 600 m (Table 1, Figs 2–3). Changes became apparent from an elevation of about 800 m upwards to the rim: sites 5 and 6 (Fig. 4), both situated on the steepest parts of the volcano slope, appeared more open in 1996; reduction in vegetation appeared to be partially associated with increased erosion. Sites 7 to 9 (rim area, 1000–1060 m altitude) had been much more influenced (Figs 5–7): the evergreen steppe scrub and dense evergreen mossy forest had disappeared in many places, especially around the top (Fig 6) and at the rim (Fig. 7) above the fumarole that was active at the time, and had been replaced, at least during the wet season, by a more or less continuous short-grazed and species-poor meadow. Ferns and especially treeferns on many spots had been mostly destroyed; logs and stumps of dead wood were abundant (Fig. 8). At the rim we witnessed in 1996 the disappearing *Scalesia*, *Tournefortia* and *Zanthoxylum* patches (Fig. 7), bare patches of dying tree ferns (formerly nearly invisible due to luxuriant and dense woodland), increased erosion of the inner caldera slopes as well as a large part of the outer slopes of the volcano. Parts of the area had become dry and dusty during the annual dry season (L. Cayot pers. comm.), where formerly interception of the misty clouds of the garúa by the former woodlands deposited much more moisture on the vegetation of herbs, grasses, trees and shrubs with epiphytic mosses and

lichens." Grazing/herbivory/browsing Direct *Scalesia* spp.; *Tournefortia* spp.; *Zanthoxylum* spp.; Treeferns; Ferns Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (qualitative description of the impact based on photographs, comparison between the situation before/after the alien increases in density) " Alcedo volcano (Isabela Island) Galapagos Islands Ecuador South America South America LV

September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Cruz, Justine B., and Felipe Cruz. ""Conservation of the Darkrumped Petrel *Pterodroma phaeopygia* of the Galápagos Islands, 1982–1991."" Bird Conservation International 6.1 (1996): 2332."

1987 "The effects of predation and habitat deterioration produced by rats, cats, dogs, pigs, goats, burros and cattle, which have been introduced over the last two centuries to the Galapagos archipelago, have reduced the dark-rumped petrel *Pterodroma phaeopygia* population so that it is now in danger of extinction. [...] The habitat in the nesting colony on Floreana was most severely affected by goats. The fragile volcanic scoria was easily broken down by their sharp hooves and these animals were the cause of many rockslides and much erosion. The thin roofs of petrel burrows, which were dug into the gravelly ground, therefore frequently collapsed, often trapping and killing adults and nestlings. On Santiago, goats have completely altered the original habitat and although their elimination is desirable, much more serious threats to the petrel exist in pigs and hawks." Direct physical disturbance Direct *Pterodroma phaeopygia* Animalia MN Low "The impact might be higher, if the alien is playing a role in the observed decline in the size of the native population (the study did not attempt to quantify the impact of the alien species of interest only - combined effect of multiple introduced species)" "The impact might be lower, because the performance of native individuals might not be affected (information source unclear: it is not specified how observations were performed)." Floreana Island; Santiago Island Galapagos Islands Ecuador South America South America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Desender, Konjev, et al. ""Conservation on Volcan Alcedo (Galapagos): terrestrial invertebrates and the impact of introduced feral goats."" Biological Conservation 87.3 (1999): 303310." 1999 "This volcano has recently suffered a population explosion of introduced feral goats, which have transformed large parts of the former forest and scrub into grassland, especially at higher elevations. [...] There was a decrease of high altitude specialist species (including several endemics) and a significant increase of more xerophilic species in overgrazed sites. [...] Only at the rim, in the area most damaged by goats, did we observe, somewhat unexpectedly, an increased species diversity in 1996 as compared to 1986." Grazing/herbivory/browsing Direct Terrestrial invertebrates Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Galapagos Islands Galapagos Islands Ecuador South America South America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Hamann, Ole. ""Vegetational changes in the Galápagos Islands during the period 1966–1973."" Biological Conservation 7.1 (1975): 3759." 1975 "Analysis of 12 permanent sample plots established in the Galápagos showed that introduced mammals have had a destructive influence on the vegetation; closed forest and scrub have been changed into open vegetation. [...] on Pinta, where the number of goats increased dramatically within a few years, almost complete destruction took place in certain areas (plot 1), while others are now in an unbalanced state (plot 2). It seems clear from the evidence presented that the destructive effects of feral goats in the delicate ecosystems of the Galapagos Islands are as serious as previously indicated by more general observations. [...] On the other hand, some species seem to have disappeared completely from one island, e.g. *Ipomoea habeliana* from Pinta (Weber, 1971 and personal observation)." Grazing/herbivory/browsing Direct *Ipomoea habeliana* Plantae MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (browsing by goats was not observed directly and there is no clear evidence showing that goats are the main cause of the change in vegetation, as environmental factors and other introduced species are also playing a role (no enclosure(s), but evolution of permanent plots))." Galapagos Islands Galapagos Islands Ecuador South America South America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Hamann, O. (1993). On vegetation recovery, goats and giant tortoises on Pinta Island, Galápagos, Ecuador. Biodiversity & Conservation, 2(2), 138-151." 1993 "Data on vegetational changes on Pinta Island, Galápagos, collected during the period 1970-1988, show that feral goats have had a destructive impact on the vegetation. Stands of *Scalesia baurii* ssp. *hopkinsii* (Asteraceae) and *Opuntia galapageia* var. *galapageia* (Cactaceae) were close to a complete collapse, while stands of *Bursera graveolens* (Burseraceae) apparently were able to persist for a longer time. After the elimination of large numbers of goats, *Scalesia*, *Opuntia* and *Bursera* were recovering rapidly, but the patterns of regeneration differed in accordance with differences in longevity, growth and seedling establishment. [...] In 1988 an expedition was made to Pinta in order to monitor the vegetational changes taking place after goats had been almost totally eradicated. In 1988 no more goats were present in the vegetated parts on Pinta, where the permanent quadrats are located. The few goats that remained on the island at that time were living close to the barren lava fields in the north-western part of the island (Whelan and Hamann, 1989). [...] In the present paper, data on *Scalesia baurii* ssp. *hopkinsii* generated from permanent quadrat No. 2 is presented. This quadrat was established in 1970 by Tj. de Vries of the CDRS in typical Arid zone vegetation at 125 m (above sea level). [...] In addition, two study areas were selected for measuring populations of *Scalesia baurii* ssp. *hopkinsii*, *Opuntia galapageia* var. *galapageia* and *Bursera graveolens*. One study area was the dry season deciduous steppe forest adjacent to permanent quadrat No. 2 at 125 m a.s.l. (Fig. 2). The other study area was situated at 45 m a.s.l., and was characterized by a more open dry season deciduous steppe forest vegetation with scattered *Bursera* and *Opuntia*, fewer shrubs, very little ground cover and large stretches of lava rock

without vegetation (Fig. 3). In each study area, size was measured on 100 individuals selected at random, and notes were taken on the phenology of the individuals. [...] The data on *Scalesia*, *Bursera* and *Opuntia* on Pinta show that goats had a serious, negative impact on the populations. The stands of *Scalesia* and *Opuntia* had probably been close to a complete collapse, while the stands of *Bursera* apparently were able to survive longer without new recruitment. After the removal of goats, all three species were able to recover. However, the regeneration patterns were different, which reflects the differences between the species in longevity, growth form and habit, and in seed germination and seedling establishment patterns." Grazing/herbivory/browsing Direct *Opuntia galapageia* var. *galapageia*; *Scalesia baurii* ssp. *Hopkinsii*; *Bursera graveolens* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that it they are part of the natural fluctuations of the population(s) (these native populations have been shown to fluctuate naturally)." Pinta Island Galapagos Islands Ecuador South America South America LV August 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Donlan, C. J., Campbell, K., Cabrera, W., Lavoie, C., Carrion, V., & Cruz, F. (2007). Recovery of the Galápagos Rail (*Laterallus spilonotus*) following the removal of invasive mammals. *Biological Conservation*, 138(3), 520-524." 2007 "The changes in rail densities on Santiago Island between 1986/1987 and 2004/2005 are impressive, and a comparison of rail abundance among the three islands surveyed in this study provides inference that these changes are likely attributed to eradication of invasive mammals on Santiago. A total of eighteen rails were detected in 1986/1987 on the island compared to 279 rails in 2004/2005 with similar effort (113 vs. 92 survey plots, respectively). [...] The plant communities on Santiago Island are recovering following pig and goat removal campaigns (Fig. 1; Cruz et al., 2005), following a pattern similar to what has been documented on other Galápagos Islands where goats have been removed " "Chemical, physical or structural impact on ecosystems" Indirect *Laterallus spilonotus* Animalia MO Low "The impact might be lower, if the increase in the native population(s) is not due to the alien eradication (eradication of other introduced herbivores at the same time)." Santiago island Galapagos Islands Ecuador South America South America LS January 2018 DJ; LV March 2019

Capra hircus Bovidae Cetartiodactyla "Gizicki, Z. S., Tamez, V., Galanopoulou, A. P., Avramidis, P., & Foufopoulos, J. (2018). Long-term effects of feral goats (*Capra hircus*) on Mediterranean island communities: results from whole island manipulations. *Biological Invasions*, 20(6), 1537-1552." 2018 "To assess vegetation characteristics we established four 50 m transects, one in each cardinal direction. On the smallest islands (Kisiri, Mikros Ambelas, and North Varvaronissi), which could not accommodate this design, three transects were used. We measured the presence of vegetation along the entire length of each transect and averaged the values for a measure of percent vegetation cover. We also applied this method to assess percent bedrock and bare soil. To determine vegetation height, we measured the height of plants every 2 m along each transect and averaged the values for each island. We sampled vegetation biomass in five randomly placed 80 cm 9 80 cm squares. [...] Plant communities were determined from 80 cm 9 80 cm quadrats placed every 5 m along each established transect; in each quadrat we recorded the identity of all plants present. [...] It is necessary to correct for area effects when making inter-island comparisons because the number of species increases with island size (MacArthur and Wilson 1967). [...] Grazing status of an island significantly affects the estimated plant species density ($p = 0.00676$, $F_{2,13} = 7.521$, ANOVA). Islands with goats removed have significantly fewer species relative to both grazed and ungrazed islands; they have lost 45.4% of their estimated taxa numbers compared to ungrazed islands and 57.9% compared to grazed islands (Fig. 2a). Typical species found on ungrazed islands include *Medicago arborea*, *Matthiola sinuata*, and *Atriplex halimus*. Common plants associated with grazed islands include *Plantago coronopus*, *Tordylium apulum*, and *Phleum arenarium*. [...] Percent vegetation cover is significantly lower ($p = 0.004$, $F_{2,13} = 8.438$, ANOVA) in both grazed (25.96%) and goat-removed (38.56%) islands relative to the ungrazed sample. Plant biomass also decreases significantly ($p = 0.00267$, $F_{2,13} = 9.679$, ANOVA), with grazed islands experiencing a decline to an average of 66.4% of the baseline (Fig. 2c). Mean plant height ($p = 0.013$, $F_{2,13} = 6.174$, ANOVA) is on average 63.64% shorter on grazed islands and 64.85% shorter on goat-removed islands relative to ungrazed islands (Fig. 2d). [...] Plant species composition differed significantly among the islands of different grazing status ($p = 0.005$, $R = 0.357$, ANOSIM). [...] All of our study islands are uninhabited and ecologically similar to each other, with no other known introduced herbivores such as rabbits."

Grazing/herbivory/browsing; Direct physical disturbance Direct *Medicago arborea*; *Matthiola sinuata*; *Atriplex halimus* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant sampling design and spatial scale) and the study only quantified the impact of the alien species (replicated introductions of the alien species)." Cycladic islands Cycladic islands Greece Europe Europe LV July 2018DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Gizicki, Z. S., Tamez, V., Galanopoulou, A. P., Avramidis, P., & Foufopoulos, J. (2018). Long-term effects of feral goats (*Capra hircus*) on Mediterranean island communities: results from whole island manipulations. *Biological Invasions*, 20(6), 1537-1552." 2018 "[...] we established four 50 m transects, one in each cardinal direction. On the smallest islands (Kisiri, Mikros Ambelas, and North Varvaronissi), which could not accommodate this design, three transects were used. [...] Five pitfall traps, used to sample epigeal arthropods, were installed

on each island at randomly chosen locations near each directional transect. [...] Abundance of each species and total number of observed species were recorded for each island. [...] Since the number of species is intrinsically linked to the size of an island (MacArthur and Wilson 1967), we accounted for area by calculating the coefficient C of the species-area relationship, where $C = S/Az$ (Rosenzweig et al. 2011), and thus obtained comparable metrics. [...] Grazing status does not affect significantly estimated arthropod species density ($p = 0.489$, $F_{2,13} = 0.757$, ANOVA), average arthropod biomass/trap/day ($p = 0.611$, $F_{2,13} = 0.511$, ANOVA), or average number of arthropods/trap/day ($p = 0.561$, $F_{2,13} = 0.604$, ANOVA). [...] Grazing has a marginally significant effect on % Hymenoptera ($p = 0.063$, $F_{2,13} = 3.442$, ANOVA) with goat presence resulting in a 53.2% decrease relative to ungrazed islands. [...] All of our study islands are uninhabited and ecologically similar to each other, with no other known introduced herbivores such as rabbits.

" "Chemical, physical or structural impact on ecosystems" Indirect Hymenoptera Animalia MO Medium "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in hymenoptera abundances in general, making it difficult to understand which species are affected, and how)" "It is unlikely that the impact is lower: decline in the general abundance of hymenoptera is well shown (e.g. relevant sampling design and spatial scale), even though the study did not focus on the species level (it is likely that at least one native hymenoptera population declines if the general abundance declines); and only the impact of the alien species of interest is quantified (replicated introductions of the alien species)" Cycladic islands Cycladic islands Greece Europe

Europe LV July 2018DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Gizicki, Z. S., Tamez, V., Galanopoulou, A. P., Avramidis, P., & Foufopoulos, J. (2018). Long-term effects of feral goats (Capra hircus) on Mediterranean island communities: results from whole island manipulations. Biological Invasions, 20(6), 1537-1552." 2018 "Relative abundances of nesting seabirds were obtained during extended single island visits coinciding with the peak of the seabird nesting season (Hilde'n et al. 1995). [...] These estimates are meant to be comparative approximations of resident bird populations and are not true population censuses. [...] Breeding seabirds were flushed upon our arrival on the islands and were counted in the air using binoculars by two independent observers for 15 min. Observation sites were chosen so as to encompass the whole island. The focus seabird species was the yellow-legged gull (Larus michahellis). [...] After estimates were calculated, the values were then divided by island area to account for differences in island size which determined our relative seabird abundances (birds/km²). [...] On grazed islands, we witnessed a trend towards lower seabird populations relative to ungrazed islands; however this effect does not quite reach statistical significance ($p = 0.154$, $F_{2,13} = 2.168$, ANOVA) (see Fig. 2f). [...] The vast majority of nesting seabird species found on the study sites were yellow-legged gulls (Larus michahellis) with occasional European shags (Phalacrocorax aristotelis). [...] All of our study islands are uninhabited and ecologically similar to each other, with no other known introduced herbivores such as rabbits."

"Chemical, physical or structural impact on ecosystems" Indirect Larus michahellis; Phalacrocorax aristotelis Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (even though the replicated design (multiple islands) allows to quantify the impact of the alien and to exclude confounding effects, estimates are used instead of relevant censuses of population sizes, and small differences have been detected between the treatments)." Cycladic islands Cycladic islands

Greece Europe Europe LV July 2018DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Gizicki, Z. S., Tamez, V., Galanopoulou, A. P., Avramidis, P., & Foufopoulos, J. (2018). Long-term effects of feral goats (Capra hircus) on Mediterranean island communities: results from whole island manipulations. Biological Invasions, 20(6), 1537-1552." 2018 "[...] we established four 50 m transects, one in each cardinal direction. On the smallest islands (Kisiri, Mikros Ambelas, and North Varvaronissi), which could not accommodate this design, three transects were used. [...] Five pitfall traps, used to sample epigeal arthropods, were installed on each island at randomly chosen locations near each directional transect. [...] Abundance of each species and total number of observed species were recorded for each island. [...] Since the number of species is intrinsically linked to the size of an island (MacArthur and Wilson 1967), we accounted for area by calculating the coefficient C of the species-area relationship, where $C = S/Az$ (Rosenzweig et al. 2011), and thus obtained comparable metrics. [...] Grazing status does not affect significantly estimated arthropod species density ($p = 0.489$, $F_{2,13} = 0.757$, ANOVA), average arthropod biomass/trap/day ($p = 0.611$, $F_{2,13} = 0.511$, ANOVA), or average number of arthropods/trap/day ($p = 0.561$, $F_{2,13} = 0.604$, ANOVA). [...] Within individual arthropod groups, only the % Diptera is significantly affected by grazing ($p = 0.049$, $F_{2,13} = 3.98$, ANOVA) where we see a 109.25% increase in areas with goats relative to ungrazed islands. [...] The percentages of Arachnids ($p = 0.557$, $F_{2,13} = 0.613$, ANOVA), Coleopterans ($p = 0.146$, $F_{2,13} = 2.235$, ANOVA), Isopods ($p = 0.281$, $v_2(2, n = 16) = 2.541$, Kruskal-Wallis), and Hemipterans ($p = 0.92$, $v_2(2, n = 16) = 0.167$, Kruskal-Wallis) are not affected by grazing. [...] All of our study islands are uninhabited and ecologically similar to each other, with no other known introduced herbivores such as rabbits [...]

" "Chemical, physical or structural impact on ecosystems" Indirect Diptera; Arachnid; Coleoptera; Isopod; Hemiptera Animalia MC Medium "The impact might be higher (relevant sampling design, relevant spatial scale, etc., but the study did not investigate the effect of the alien on the performance of native species individually (order level))"

Cycladic islands Cycladic islands Greece Europe Europe LV July 2018DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Gabay, O., et al. ""Differential effects of goat browsing on herbaceous plant community in a twophase mosaic."" Plant ecology 212.10 (2011): 1643-1653." 2011 "We delineated 10 plots of 1000 m², goats were introduced to five plots and five plots remained without goats [...] Species *Crucinnella macrostachya* and *Plantago cretica* had significant interactions between treatment and patch type (FU6 = 11.97, P = 0.0 for *C. macrostachya* and F1>16 = 4.96, P = 0.0 for *P. cretica*). Both species showed a significantly lower average frequency in browsed plots (0.2 and 0 for *C. macrostachya* and 0.18 and 0.04 for *P. cretica*, control and browsed plots, respectively)."

"Grazing/herbivory/browsing; Chemical, physical or structural impact on ecosystems" Direct; Indirect "*Crucinnella macrostachya*;

Plantago cretica" Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the effects of the alien was studied at a small spatial scale (inclosures))."

Ramat Hanadiv Park Ramat Hanadiv Park Israel West and Central Asia Asia DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Kenji, H. A. T. A., Junichirou Suzuki, and Naoki Kachi. ""Vegetation changes between 1978, 1991 and 2003 in the Nakoudojima island that had been disturbed by feral goats."" Restoring the Oceanic Island Ecosystem. Springer Japan, 2010. 8591." 2010 "Changes in vegetation of the Nakoudojima island between 1978, 1991 and 2003 were quantified with aerial photographs. The island was divided into 9200 plots (10 m × 10 m) on the aerial photographs and the plots were categorized into forest, grassland, bare ground or others. [...] Decreases in the grassland and increases in the bare ground between 1978 and 1991 suggests that large biomass of herbaceous plants were lost by grazing and trampling of feral goats. [...] These changes in vegetation would be due mainly to grazing and trampling, and their termination caused by feral goats. Percentages of the forest decreased from 16.2% to 6.0% for 23 years. Many forests changed into grasslands or bare ground even after the eradication of feral goats, which suggests that canopy trees in the forest died by natural disturbances in addition to the lack of seedlings by the grazing of feral goats."

Grazing/herbivory/browsing; Direct physical disturbance Direct Vegetation Plantae MO Low "The alien might have caused (a) local extinction(s) (even though authors do not talk about species extinction, some wording suggest that it might have happened (linguistic uncertainty))" "The impact might be lower, if the alien did not cause -or contributed to- any decline in the native population size(s) but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (natural disturbance)" Nakoudojima Island Nakoudojima Island Japan East Asia Asia DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Bullock, D. J., S. G. North, M. E. Dulloo, and M. Thorsen. ""The impact of rabbit and goat eradication on the ecology of Round Island, Mauritius."" Turning the tide: the eradication of invasive species (2002): 53-63." 2002 "In this paper, predicted and observed changes are compared using the results of surveys before and after the removal of rabbits and goats [...] In 1975 the most vegetated slopes of Round Island were divided into 12 study Areas (totalling c.102 ha) within which vegetation and reptile populations were recorded. These Areas formed the basis of comparable surveys in subsequent expeditions (1978 - partial surveys only, 1982, 1989 and 1996 [...]) Between 1975 and 1996 the number of Class 1 or equivalent individuals of the three main species declined. However, removal of the mammalian herbivores allowed large pulses of recruitment that are now beginning to replace losses of adult trees. [...] Individual *Latania loddigesii* and *Pandanus vandermeerschii* trees were assigned to one of seven and five size classes respectively where the largest (and presumably oldest) were Class 1 (see Fig. 1 and 2) [...] Were mammalian herbivores still present, *Hyophorbe* would be close to extinction in the wild. [...] In Area 3, total vegetation cover along transects increased between 1975 and 1996, particularly between 1982 and 1989. [...] Five, *Latania*, *Hyophorbe*, *Pandanus*, *Gagnebina pterocarpa* and possibly *Lomatophyllum tormentorii*, increased in response to eradication of the mammalian herbivores." Grazing/herbivory/browsing Direct *Latania loddigesii*; *Pandanus vandermeerschii*; *Hyophorbe lagenicaulis*; *Tylophora coriacea*; *Vetiveria arguata*; *Ipomea pes-caprae*; *Gagnebina pterocarpa*; *Lomatophyllum tormentorii* Plantae MO Medium "The impact might be lower, if the increase in the native population(s) is not due to the alien eradication (eradication of other introduced herbivores)." Round Island Round Island Mauritius Sub-Saharan Africa Africa DJ March 2019 LV June 2019

Capra hircus Bovidae Cetartiodactyla "de la Luz, J. L. L., Rebman, J. P., & Oberbauer, T. (2003). On the urgency of conservation on Guadalupe Island, Mexico: is it a lost paradise?. Biodiversity & Conservation, 12(5), 1073-1082." 2003 "The following is our interpretation of the island's plant communities and their floristic compositions based upon the extant, native plants still found in some areas, various historical references, and aerial surveys of the whole island. [...] Currently, only about 130 old individuals of Guadalupe Island pine (*Pinus radiata* var. *binata*) are remnant evidence of a pine forest that could have covered most of the foggy northern highlands. This number of pines is in a decline from more than 360 trees registered 34 years ago (Libby et al. 1968). Beneath individual pines and in some small groves, a thin layer of litter provides suitable conditions for pine germination and development. In fact, a few seedlings were observed, although they are short-lived due to the effects of goat browse. In most areas, this layer of litter and the associated soils have been completely eroded away between individual trees and small groves. Therefore, the large, older trees seem to act as nurse-plants to the young pine seedlings. Condensation of water droplets on the needles of the older trees during the frequent fogs

facilitates regular watering for any seedlings that grow beneath the larger trees. Absence of these older trees may have an adverse effect on the success of any repopulation efforts for pines. [...] The island oak (*Quercus tomentella*) has similarly suffered a major decline on Guadalupe. Historical accounts from earlier botanists make reference to hundreds of oak trees. However, on our visit we registered only 20 individuals. This number is down from approximately 100 trees reported 50 years ago (Moran 1996). None of the oaks appear to be reproducing and all seem vulnerable to mortality within a relatively short time due to soil erosion and damage to their trunks from goat grazing. [...] An extensive plateau in the northern sector of the island is still occupied by the endemic Guadalupe Island cypress (*Cupressus guadalupensis* var. *guadalupensis*). In the past, an almost monotypic community of this species was much more extensive and probably occupied some of the flatter areas to the south of the plateau. Early records indicate that the trees extended several hundred feet lower in elevation below the east side of the plateau. At present, limited groves of a few thousand individual trees grow in two stands near the highest point on the island. In a manner similar to the other tree species of the island, no tree seedlings escape the goats during their first year. Many of the older trees demonstrated severe damage of their bark and trunks as a result of goat browse." Grazing/herbivory/browsing Direct *Pinus radiata* var. *binata*; *Quercus tomentella*; *Cupressus guadalupensis* var. *guadalupensis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the way the populations were monitored is not described); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (comparison between the situations before/after the introduction of the alien, but no exclusion of confounding effects)." Guadalupe Island Guadalupe Island Mexico Mesoamerica North and Central America LV September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "de la Luz, J. L. L., Rebman, J. P., & Oberbauer, T. (2003). On the urgency of conservation on Guadalupe Island, Mexico: is it a lost paradise?. *Biodiversity & Conservation*, 12(5), 1073-1082." 2003 "The following is our interpretation of the island's plant communities and their floristic compositions based upon the extant, native plants still found in some areas, various historical references, and aerial surveys of the whole island. [...] A community of the endemic palms (*Brahea edulis*) extends from the pine forest at 700–800 m down to 150 m. In the higher parts of this zone, the palms used to grow with oaks and pines, but the oaks and pines have since retreated from most of this area. At present, there are still hundreds of old palms on the island, but recruitment for new generations seems absent since no younger palm trees were seen, again probably due to their consumption by feral goats." Grazing/herbivory/browsing Direct *Brahea edulis* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (comparison between the situation before/after the introduction of the alien, but no exclusion of confounding effects)." Guadalupe Island Guadalupe Island Mexico Mesoamerica North and Central America LV September 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Keitt, Bradford, et al. ""The restoration of Guadalupe Island."" *Fremontia* 33.4 (2005): 2025." 2005 "The first steps in the restoration effort on the island were to inventory existing plant species and build a series of fences (exclosures) to exclude goats from sensitive areas. [...] We have also made exciting discoveries outside of the exclosures. [...] In June 2001 we found *Calamintha* (*Satureja*) *palmeri* in small patches around the north end of the island. This mint family member was first described in 1876 and had not been seen since 1885, leading Moran (1996) to consider it "undoubtedly extinct." Also in June 2001 *Nicotiana attenuata*, a native species last seen in 1898 and considered extinct on the island, was found under the cypress trees at the high north end of the island and protected with a fenced exclosure. The striking "white sage," *Senecio palmeri*, is a Guadalupe endemic that once covered large areas of the island but has not been seen on the island since 1974, and even then was known from only a few individuals in inaccessible cliff areas. To our great delight, in April 2004, we discovered a healthy population of more than 50 *Senecio palmeri* individuals, many in flower, on cliffs along the west side of the island." Grazing/herbivory/browsing Direct *Calamintha* (*Satureja*) *palmeri*; *Senecio palmeri*; *Nicotiana attenuata* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected (even though the native population was thought to be extinct)." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial scale) and the exclosure(s) allowed to quantify the impact of the alien only (the comparison between the situations before/after the reduction of the alien abundance outside the exclosure also confirmed the responsibility of the alien in the observed decline(s))." Guadalupe Island Guadalupe Island Mexico Mesoamerica North and Central America Control programm and eradication programm started in 2004 DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Keitt, Bradford, et al. ""The restoration of Guadalupe Island."" *Fremontia* 33.4 (2005): 2025." 2005 "Goats are especially devastating and are considered "the single most destructive herbivore" of island ecosystems. Because they can survive on almost no water and will eat virtually anything, including bark and roots, goats can kill not only grasses and shrubs, but also adult trees. Their ability to literally strip the landscape bare eventually leads to soil and substrate destruction [...] Giant coreopsis (*Coreopsis gigantea*), common on the offshore islets

of Guadalupe but never reported on the main island, was discovered in spring 2005 at a remote beach area at the south end of the island. Likely a favorite food of goats, this species may have been very common across the south end of the island but disappeared before botanists ever reached the island." Grazing/herbivory/browsing Direct *Coreopsis gigantea* Plantae MO Low "The alien might have caused a local extinction (a native individual has been detected, but it is unclear whether the whole island used to sustain distinct local populations, or if it sustained only one large population)." "The impact might be lower, because the native population(s) might not be declining (the fact that the native species was once abundant on the main island is only a supposition based on the fact that it is common on the offshore islets of Guadalupe, but not an observation; only qualitative descriptions)." Guadalupe Island Guadalupe Island Mexico Mesoamerica North and Central America Control program and eradication program started in 2004 DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Keitt, Bradford, et al. ""The restoration of Guadalupe Island."" *Fremontia* 33.4 (2005): 2025." 2005 "The first steps in the restoration effort on the island were to inventory existing plant species and build a series of fences (exclosures) to exclude goats from sensitive areas. [...] Plant response inside the exclosures was rapid and positive. In January 2002, after only one growing season, 47 seedlings of the endemic pine had sprouted inside one of the exclosures built around nine adult pine trees. It is estimated there are 220 adult pine trees on the island (Rogers et al. 2003), so this one growing season produced a greater than 20% increase in the number of pines on the island. By June 2003, the number of seedlings inside two of the exclosures was up to 231 and by April 2005, about 1,700 young pines had been counted. Perhaps the most amazing discovery inside the exclosures was that of a small *Ceanothus*. Another member of this genus, *C. perplexans*, was collected on the island by early botanical visitors (D. Wilken, pers. comm., 2005) but has not been seen there since the late 1800s. Early examination of this *Ceanothus* seedling indicates that this is a new species for the island, closely resembling *C. arboreus*. However, the leaves on this plant are different enough to suggest that this could possibly be an undescribed endemic subspecies." Grazing/herbivory/browsing Direct *Pinus radiata* var. *binata*; *Ceanothus* sp. Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Guadalupe Island Guadalupe Island Mexico Mesoamerica North and Central America Control program and eradication program started in 2004DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Parkes, J.P. 1984b. Feral goats on Raoul Island. II. Diet and notes on the flora. *New Zealand J. Ecol.* 7:95-101. " 1984 "The distribution of goats has been progressively limited and their density progressively lowered since 1972 when annual hunting expeditions began (Parkes, 1984). This has reduced browsing pressure and has allowed many plant species to regenerate successfully. [...] During an eight day visit to Raoul Island in December 1982, I made qualitative descriptions of the forest vegetation. Rare species and those known to be eaten by goats were particularly noted. These notes, observations made in annual reports submitted by leaders of NZFS hunting expeditions, and previously published descriptions of the effect of goats on the flora are used to describe some of the more obvious changes induced by the reduction in goat numbers. [...] *Coprosma acutifolia*, a major sub-canopy species in 1908 (Oliver, 1910), was eaten out by goats so that Sykes (1969) described it as 'uncommon' but it is now plentiful, at least along the Denham Bay-Smith Bluff faces. [...] The other principal food tree species have also responded to lower browsing pressure. *Tutu*, for example, has formed tall stands on several eroded sites around the crater wall since 1981 (c. F. Buchanan, pers. comm.). [...] In 1908, young plants of the tree ferns (*Cyathea* spp.) were 'extremely rare' (Oliver, 1910), although mature plants were plentiful. In 1966, mature plants were becoming less common and regeneration was still 'virtually absent' (Sykes, 1969). Both authors blamed goats. Since the removal of most of these animals, the 1908 situation has reversed, so that in 1982 young ferns were plentiful but adults were rare. [...] *Homalanthus polyandrus*, classed as 'vulnerable' in the Red Data Book, was reduced to a few trees in the early 1970's (Sykes, 1977), but now forms substantial groves, particularly along the Boat Cove road and in canopy gaps around the island. The endemic tree *Boehmeria australis* var. *dealbata* was also reduced to a few widely scattered individuals by 1966 (Sykes, 1977). Adult trees are still rare, but seedlings and saplings are common in Sunshine Valley (W. Fleury, pers. comm.) and were seen in 1982 along the Prospect-Mahoe ridge. "Grazing/herbivory/browsing Direct *Hebe breviflora*; *Homalanthus polyandrus*; *Boehmeria australis* var. *dealbata*; *Coriaria arborea* var. *kermadecensis*; *Coprosma acutifolia*; *Cyathea* spp. Plantae MO Low "The impact might be lower, because the native population(s) might not have been declining (qualitative description and comparison with qualitative descriptions made by other authors); or because the increase in the native population(s) might not be due to the alien control (no other possible cause are cited, but the impacted native species are not all important constituent of the alien diet, and other species did not recover after the alien has been controlled, indicating that there might be another stressor playing a role)." Raoul Island Kermadec Islands New Zealand Oceania Oceania LV August 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Parkes, J.P. 1984b. Feral goats on Raoul Island. II. Diet and notes on the flora. *New Zealand J. Ecol.* 7:95-101. " 1984 "The distribution of goats has been progressively limited and their density progressively lowered since 1972 when annual hunting expeditions began (Parkes, 1984). This has reduced browsing pressure and has allowed many plant species to regenerate successfully. [...] During an eight day visit to Raoul Island in

December 1982, I made qualitative descriptions of the forest vegetation. Rare species and those known to be eaten by goats were particularly noted. These notes, observations made in annual reports submitted by leaders of NZFS hunting expeditions, and previously published descriptions of the effect of goats on the flora are used to describe some of the more obvious changes induced by the reduction in goat numbers. [...] Pohutukawa regeneration had been limited by 1966 so that Sykes (1969) reported seeing few or no young plants in most areas, and predicted the species eventual disappearance over large parts of the island. In 1982, terrestrial seedlings and young trees were common, particularly in the crater and on cliffs at Denham Bay, and epicormic shoots were abundant on most trunks (Fig. 5). [...] Oliver (1910) thought that *Pseudopanax arboreus* var. *kermadecensis* would become rare or even extinct because of browsing by goats. The species was described as uncommon in 1966 by Sykes (1969), although scattered adult trees were producing seedlings which were eaten by the goats. In 1982, many saplings and seedlings were growing along the Prospect-Mahoe ridge, particularly along south-facing slopes. " Grazing/herbivory/browsing Direct *Metrosideros kermadecensis*; *Pseudopanax arboreus* var. *kermadecensis* Plantae MN Low "The impact might be higher (only regeneration is addressed, but it is not clear if the population size has been studied; lack of detailed description of the impact)" "The impact might be lower, because the performance of native individuals might not be affected (qualitative description of the impact, and comparison with other qualitative descriptions from the literature)." Raoul Island Kermadec Islands New Zealand Oceania Oceania LV August 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama* wallaby) [...] The effects of browsing mammals on the soil microfood web were clearly multitrophic in nature for several locations; populations of microbe-feeding and predaceous nematodes were significantly affected by browsers in both the humus and litter layers in nearly half the site. [...] Effects of browsers on abundances of microarthropods were negative for all but one of the 63 instances in which a significant effect at $P \leq 0.05$ was detected (Fig. 9)." "Chemical, physical or structural impact on ecosystems" Indirect Nematoda; Rotifera; Copepoda; Tardigrada Animalia MO Medium "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in nematode, rotifer, copepod and tardigrad abundances in general, making it difficult to understand which species are affected, and how)" "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population size(s) but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (other deer present)" North Island North Island New Zealand Oceania Oceania "Even though the study was led in the entire country, *Capra hircus* was only browsing on North Island. Indirect impact." DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama* wallaby) [...] In most locations browsing mammals reduced plant diversity (Shannon-Weiner index) in the browse layer; diversity was greater inside the enclosure than outside for all but three locations and for half the locations the effects were significant at $P \leq 0.05$ (Fig. 12). [...] Species that were frequently severely reduced by browsers included *Geniostoma rupestre* J. R. Forst. & G. Forst., *Astelia* spp., *Griselinia littoralis* Raoul, and *Coprosma* spp. (especially *C. grandifolia* Hook. f.)." Grazing/herbivory/browsing Direct *Geniostoma rupestre*; *Astelia* spp.; *Griselinia littoralis*; *Coprosma* spp. (especially *C. grandifolia*) Plantae MN Medium "The impact might be higher (some linguistic ambiguity ""Species that were frequently severely reduced by browsers [...]""), but the effect of the alien on the native population size was not investigated (only the browse- and ground-layer vegetation was investigated)" North Island North Island New Zealand Oceania Oceania "Even though the study was led in the entire country, *Capra hircus* was only browsing on North Island. Therefore, only the impacts observed in North Island have been recorded." DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Turbott, Evan Graham. ""Effect of goats on Great Island, Three Kings, with descriptions of vegetation quadrats."" Records of the Auckland Institute and Museum 3.4/5 (1948): 253272." 1948 "There is a marked contract in the population density of the five other indigenous forest-inhabiting species. *Cyanoramphus novaezelandie* (red fronted parakeet) and *Halcyon sanctus* (kingfisher) occur in moderate numbers only, and *Rhipidura fuliginosa* (fantail) is represented by a small population of probably not more than fifty for the whole island (approximately 1000 acres).* Of the two forest floor species, *Hypotaenidia philippensis* occurs in small numbers, and *Porzana tabuensis* has been recorded only on two occasions. [...] It should be noted that above references to population densities are based on estimates: it was unfortunately not possible to carry out census work which would have permitted of direct comparison with the mainland or other islands (Turbott, 1940). [...] Factors which appear to have controlled the number of species and populations of land birds on Great Island may be stated briefly. The primary influence is considered to have been that of

goats through continued modification of the vegetation. " "Chemical, physical or structural impact on ecosystems" Indirect Cyanoramphus novaezelandiae; Halcyon sanctus; Rhipidura fuliginosa; Hypotaenidia philippensis; Porzana tabuensis Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (the way the native populations were monitored is not described); or because the increase in the native population(s) might not be due to the alien eradication (other stressors are listed)." Great Island Three Kings Islands New Zealand Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Turbott, Evan Graham. ""Effect of goats on Great Island, Three Kings, with descriptions of vegetation quadrats."" Records of the Auckland Institute and Museum 3.4/5 (1948): 253272." 1948 "A brief description of the effect of goats upon the vegetation, and of the vegetation quadrats, is contained in a report which I submitted to the Department of Internal Affairs on my return from the present Expedition (Turbott, 1946). [...] At the time of the destruction of goats it was evident that climax remnants, including both trees and lianes, were of but impermanent status. The following list includes the more important species, given in order of frequency : Metrosideros excelsa Gaertn. (pohutukawa), Meli- cope ternata Forst, (wharangi), Melicytus ramiflorus Forst, (mahoe), Litsaea calicaris (A. Cunn.) Hook. f. (mangeao), and P aratro phis smithii Cheesem. A number of species, including Pittosporum fairchildii Cheesem. and others endemic to the Three Kings, were represented only by a few or by single individuals. [...] Although these were in many cases flowering or fruiting vigorously upon our arrival, seedlings or young plants were entirely absent, except in the case of Melicope ternata , to which reference is made above. Indi- viduals appeared in most cases to be fully mature, and exhibited much dead wood, probably as the result both of extreme age and of direct attack by goats. [...] The following sections of this paper consist of a detailed description, as far as possible in quantitative terms, of the vegetation of three permanent quadrats, which were established to demonstrate the course of potential changes in v the plant covering. [...] The destruction of the goats took place before the complete extinction of the primary forest remnants, and consequently in time to allow of the possibility that a climax forest originating from this stock would replace the widespread Leptospermum ericoides communities. [...] Most species of the climax forest remnants on the quadrat were producing abundant seed during April and May." Grazing/herbivory/browsing Direct Metrosideros excelsa; Melicope ternata; Melicytus ramiflorus; Litsaea calicaris; Paratrophis smithii Cheesem; Pittosporum fairchildii Cheesem Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (unclear description of the experimental design, of the temporal scale, etc.)." Great Island Three Kings Islands New Zealand Oceania Oceania DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Turbott, Evan Graham. ""Effect of goats on Great Island, Three Kings, with descriptions of vegetation quadrats."" Records of the Auckland Institute and Museum 3.4/5 (1948): 253272." 1948 "A number of trees were ring-barked, an arresting example being a large Hiemerliodendron brunoniana (Endl).Skottb.(bird-catching tree), which fel on the northern cliff face during the easterly storm in April. The trunk had been weakened and opened to fungal and insect attack by constant ring-barking, and the surroundin gforest had been thinned so that the tree was open to the full force of the wind. " Direct physical disturbance Direct Hiemerliodendron brunoniana Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Great Island Three Kings Islands New Zealand Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Harlow, Peter S., and Pita N. Biciloa. ""Abundance of the Fijian crested iguana (Brachylophus vitiensis) on two islands."" Biological Conservation 98.2 (2001): 223231." 2001 "Our surveys on Yadua Taba revealed population densities of 196 iguanas per hectare in forest habitat. On the smaller island of Monukiri, where crested iguana sightings were frequent in the early 1980s, the popualtion density estimate was nine iguanas per hectare for the largest stand of forest. The total population estimate for Yadua Taba is > 6000 iguanas, while for Monuriki it is < 100. Vegetation surveys of these islands suggest that the abundance of the herbivorous crested iguana reflects the relative abundance of food trees present, with 63% of forest trees on Yadua Taba being edible species, compared to only 2% on Monuriki. Although both islands are uninhabited and have no introduced predators, Monuriki has been subjected to over three decades of intensive goat grazing and regular dry season burning. The combination of goats and fire may have reduced the survivorship and recruitment of iguana food tree species, several of which are known to be @re sensitive. Selective browsing by goats on the seedlings of palatable tree species on Monuriki has resulted in the competitive release of unpalatable species, inedible to both goats and crested iguana" "Chemical, physical or structural impact on ecosystems" Indirect Brachylophus vitiensis Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial scale) and even if other stressors might be acting on the native population(s), it is likely that the alien is causing at least part of the observed decline(s)." Monukiri Island Mamanuka Islands Fiji Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Harlow, Peter S., and Pita N. Biciloa. ""Abundance of the Fijian crested iguana (Brachylophus vitiensis) on two islands."" Biological Conservation 98.2 (2001): 223231." 2001 "Vegetation

surveys of these islands suggest that the abundance of the herbivorous crested iguana reflects the relative abundance of food trees present, with 63% of forest trees on Yadua Taba being edible species, compared to only 2% on Monuriki. Although both islands are uninhabited and have no introduced predators, Monuriki has been subjected to over three decades of intensive goat grazing and regular dry season burning. The combination of goats and fire may have reduced the survivorship and recruitment of iguana food tree species, several of which are known to be @re sensitive. Selective browsing by goats on the seedlings of palatable tree species on Monuriki has resulted in the competitive release of unpalatable species, inedible to both goats and crested iguana. [...] Beside the *N. oppositifolium* seedlings refered to above, *Hernandia peltata* seedlings accounted for 8.5% of the total number, and 21% of these showed serous grazing or trampling damage by goats." Grazing/herbivory/browsing Direct *Hernandia peltata* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Monukiri Island Mamanuka Islands Fiji Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Gibbons, John. ""Iguanas of the south Pacific."" Oryx 18.2 (1984): 8291." 1984 "The answer lies in looking at the native and introduced animals on a whole series of islands throughout the Fiji Group, including both inhabited and uninhabited ones. In this way, each island becomes an experimental laboratory with variable numbers and kinds of introduced animals. Those that lack introduced animals—a rarity these days—are equivalent to 'controls'. [...] The effects of goats on iguana populations is indirect, but in the long term can be as devastating as that of cats. Goats eat the understorey of a forest, thereby preventing new growth and regeneration. This is particularly marked in drought conditions when there is little grass available and when the population achieves a high density. Removal of ground cover renders juvenile and hatchling iguanas susceptible to predation by hawks and kingfishers. It also leads to increased soil erosion, especially after heavy rain. [...] I consider feral cats the single most important factor responsible for the decline of *Brachylophus* and several other lizard species in Fiji." "Chemical, physical or structural impact on ecosystems" Indirect *Brachylophus fasciatus*; *Brachylophus vitiensis* Animalia MN Medium "The impact might be higher, if the alien is playing a role in the observed decline in the size of the native population (but other stressor(s) seem to be the main cause of this decline)" Devilau Island; Yaqaga Island; Yaduataba Island; Yadua Island; Monuriki Island Devilau Island; Yaqaga Island; Yaduataba Island; Yadua Island; Monuriki Island Fiji Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Coblentz, B. E., & Vuren, D. V. (1987). Effects of feral goats (*Capra hircus*) on Aldabra Atoll. Atoll Research Bulletin." 1987 "We were on Aldabra 30 January through 8 March 1987. [...] Subjective evaluations of goat impacts were made continuously as areas were searched for goats and sign. [...] Feral goats are severely damaging the Grande Terre ecosystem; that was immediately evident to us as we began hiking inland from Bras Cinq Cases on the lagoon side of the island. We noticed that goat sign was abundant well into the mangroves (from the land side), and that a vi rtually continuous browse line nearly 2 m in height was present. Even a considerable amount of *Pemphis acidula* had been completely browsed to this height, and numerous individuals had been killed. [...] Further inland, vi rtual ly al l individuals of favored woody plant species exhibited a hi gh browsel i ne, and regenerat i on of these speci es was simply nonexistent. [...] There have been several explanations offered for the dramatic changes in the flora of Grande Terre, and inexplicably they seem to search for reasons other than the goats. For example, it has been suggested that some high browselines were caused by tortoises pi ling up 2 and 3 layers thick while seeking shade. Presumably in such a situation a tortoise would be able to reach leaves that were not normally available. The death of large numbers of some species, for example, boi s cassant (*Guettarda*) has been attributed both to tortoises abrading the roots while seeking shade, and to salt spray during storms. Perhaps these hypotheses are correct; however, they fail to account for the complete absence of seedl i ng regeneration, and the complete defol i ati on of al l branches less than 2 m high. These trees al l have high browsel i nes caused by goats, and are not repopulati ng because seedl i ngs cannot survi ve, even in areas where tortoises cannot go. Additionally, it seems unlikely that any strand species is intolerant of exposure to salt. We do not propose that goats are solely responsible for major vegetation changes on Grande Terre, but rather that they are one major factor among several possible causes. [...] We bel i eve that the impact of goats on Aldabra is additive to that of the tortoises, and magnifies the ampl i tude of fluctuation in numbers of both plants and tortoises, i ncreasi ng the chances of exti ncti on of the most sensi ti ve endemi cs. [...] Goats represent the only additional major source of herbivory on Grande Terre, and are capable of going where tortoises cannot. It would seem logical to attribute the complete lack of seedling regeneration to them. " Grazing/herbivory/browsing Direct *Pemphis acidula*; *Guettarda* spp.; Vegetation (Other unspecified species) Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the impact on regeneration of native individuals and the death of some individuals have been observed)." "It is unlikely that the impact is lower (even though other causes have been proposed, the arguments given in this article make sense; it seems unlikely that the alien did not contributed at all to the observed impact)" Aldabra Atoll Aldabra Atoll Seychelles Sub-Saharan Africa Africa Additive effect to the native tortoises (*Geochelone gigantea*) LV August 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Coblentz, B. E., & Vuren, D. V. (1987). Effects of feral goats (*Capra hircus*) on Aldabra Atoll. Atoll Research Bulletin." 1987 "We were on Aldabra 30 January through 8 March 1987. [...]"

Perhaps the greatest shock was our observation of hundreds of tortoises in intertidal areas where no herbaceous vegetation was present. At low tide we observed these tortoises to forage on the few leaves that fell to the ground, and to seemingly feed on algae on the surface of the mud. At high tide the tortoises refuted on rocks, mangrove prop roots, and dead limbs, simply to avoid being swept away; many were observed in the red mangrove (*Rhizophora mangle*) zone. It was obvious that this was a marginal, high risk habitat for tortoises, and it seemed likely that resource limitation further inland had probably been the impetus for such extensive utilization of intertidal areas. [...] Tortoises and their forage resource on Aldabra may well fluctuate greatly over time; it will take many years to determine if this is the case. Goats, however, greatly increase total consumption of plant biomass, and compete directly and indirectly with the tortoises for food. [...] By contributing to the accelerated death of trees and shrubs, and preventing all seedling regeneration, goats may be severely limiting the amount of shade available to tortoises. Additionally, as foliar area of a plant is reduced through browsing, the number of tortoises that can refuge under that plant is proportionately reduced; excess tortoises need to find a new source of shade. In some areas, sources of shade are far apart and essentially fully utilized, thus tortoises forced to seek new shade probably have a low probability of survival. The effects of goats upon the shade resource may actually be a greater influence upon tortoise numbers and condition than direct competition for food." Competition Indirect *Geochelone gigantea* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (the fact that the individual performance is affected is inferred from a change to less suitable and more risky habitats)." Aldabra Atoll Aldabra Atoll Seychelles Sub-Saharan Africa Africa LV August 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Beltrán, E., Wildpret, W., León, M. C., García, A., & Reyes, J. (1999). Libro rojo de la flora Canaria contenida en la Directiva-Hábitats Europea. Organismo Autónomo de Parques Nacionales. Ministerio de Medio Ambiente (in Gangoso, Laura, et al. "Contradiction in conservation of island ecosystems: plants, introduced herbivores and avian scavengers in the Canary Islands." *Biodiversity and Conservation* 15.7 (2006): 22312248.)" 2006 "[Gangoso et al. 2006] Overgrazing directly affects plant growth, reproduction and survival, reducing the numbers and quality of individuals and, ultimately, leading to the local disappearance of populations and species. In addition, continuous trampling damages vegetation even more severely than direct grazing. Hooves destroy young plants and the soil becomes exposed, being easily worn away by erosive agents. [...] Food habit studies indicate that goats are directly responsible for the population decrease of endemic Canary plant species (Nogales et al. 1992; Rodríguez-Pinero and Rodríguez-Luengo 1993). The effects of the other introduced herbivores, rabbits and Barbary ground squirrels, are poorly known although it seems reasonable to think that it may be not negligible (Machado 1979; Rodríguez-Pinero and Rodríguez-Luengo 1993). Summarizing (Table 1), 10 insular, 13 Eastern island and 4 Canarian endemic plants are affected by grazing and trampling derived from livestock practices. Of special concern is the critical situation of local endemic species: *Crambe sventenii* (300 individuals), *Argyranthemum winteri* (300 ind.), *Echium handiense* (200 ind.), *Onopordon nogalesii* (100 ind.), and *Salvia herbanica* (50 ind.). Some Canarian endemics with still large populations on other islands (thus, not globally threatened), maintain in Fuerteventura extremely low populations surviving in abrupt slopes: *Convolvulus ?oridus* (50 individuals), *Ceballosia fruticosa* (6 ind.), *Lavatera acerifolia* (4 ind.) and *Bosea yervamora* (2 ind.). The same applies to some Macaronesian endemics, such as *Heberdenia excelsa* (30 ind.), *Rubus bollei* (30 ind.), *Jasminum odoratissimum* (20 ind.), *Visnea mocanera* (10 ind.), *Picconia excelsa* (2 ind.) and *Sideroxylon marmulano* (1 ind.). [From Beltrán et al. 1999, and S. Scholz (unpublished data)]" Grazing/herbivory/browsing; Direct physical disturbance Direct *Crambe sventenii*; *Argyranthemum winteri*; *Echium handiense*; *Onopordon nogalesii*; *Salvia herbanica*; *Convolvulus ?oridus*; *Ceballosia fruticosa*; *Lavatera acerifolia*; *Bosea yervamora*; *Rubus bollei*; *Jasminum odoratissimum*; *Visnea mocanera*; *Picconia excelsa*; *Sideroxylon marmulano*; *Rutheopsis herbanica*; *Ononis christii*; *Ferula lancerottensis*; *Crepis canariensis* Plantae MO Low "The alien might have caused a local extinction, but whether the study design would have allowed to detect it is unclear (unpublished data, so the way the observations were performed, e.g. the spatial or temporal scales of the study, is not described)." "The impact might be lower, because the native population(s) might not be declining (the way the observations were performed is not described (unpublished data)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other stressors are mentioned, such as introduced rabbits and Barbary ground squirrels)." Fuerteventura Canary Islands Spain Europe Europe DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Garzón Machado, Víctor, et al. "Strong negative effect of alien herbivores on endemic legumes of the Canary pine forest." *Biological Conservation* 143.11 (2010): 26852694." 2010 "In the absence of herbivores, the number of individuals was significantly greater for all species. These differences in abundance were apparent across all 12 monitoring visits (Fig. 2). [...] For these four species, we conclude that the presence of herbivores, including barbary sheep (*Ammotragus lervia*), goat (*Capra hircus*) and European rabbit (*Oryctolagus cuniculus*), exerts a strong negative effect on plant establishment. [...] Our results indicate that alien herbivores in Caldera de Taburiente (*A. lervia*, *C. hircus* and *O. cuniculus*) have a highly negative impact on the abundance and distribution of the

species studied. The highly significant differences between control and exclusion plots and the lack of a correlation between each species' abundance in the exclusion plots and its distribution and abundance under natural conditions suggest that the Canary Islands pineforest understory may be impoverished due to alien herbivores. [...] our results indicate that the Canary pine forest has been severely impoverished by herbivore activity, at least for the legume species studied."

Grazing/herbivory/browsing Direct *Chamaecytisus proliferus* ssp. *Proliferus*; *Teline stenopetala*; *Spartocytisus filipes*; *Cicer canariense* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." La Palma Island Canary Islands Spain Europe Europe DJ March 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Coblentz, B. E. (1978). The effects of feral goats (*Capra hircus*) on island ecosystems. *Biological Conservation*, 13(4), 279-286." 1978 "On Santa Catalina Island, I found that the presence of goats had considerable effects upon the total percent cover and species composition of both the herbaceous and shrubby components of brushland areas (Coblentz, in press; Fig. 1). Here, the cover of all vegetation averaged over 50 % more (42 % compared with 27 %) in areas where goats had been eliminated about 15 years earlier. Additionally, California sagebrush (*Artemisia californica*), a favoured food of the goats, and major component of Catalina's shrubland areas, comprised more than one-fifth of the total percent cover in the goat-free areas, but was completely absent in the goat-inhabited area."

Grazing/herbivory/browsing Direct *Artemisia californica* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the way the observations were performed (e.g. spatial scale) is not well described)." Santa Catalina Island California United States North America North and Central America DJ July 2017 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Wood, G. W., Mengak, M. T., & Murphy, M. (1987). Ecological importance of feral ungulates at Shackleford Banks, North Carolina. *American Midland Naturalist*, 236-244." 1987 "Grazing impact was measured by comparing estimated weights of aboveground current annual growth (AGCAG) on grazed and ungrazed plots. AGCAG was defined as aboveground shoots and foliage produced in the current growing season and existent at the time of sampling [...] Three exclosures, each 0.04 ha, were erected in each of the vegetation types in March 1978. [...] All exclosures plus adjacent paired grazed plots were sampled in late August to early September 1978 through 1981. [...] The data obtained in this study indicate that the ungulate populations at their 1978- 1981 levels were interrupting the vegetation dynamics in at least the saltmarsh and grass-shrub communities. Extensive consumption of plant material by large vertebrates is not a natural process in local saltmarsh communities. On the other hand, *Spartina alterniflora* is the climax vegetation of the saltmarsh, and this species has no competitor that might replace it under extreme grazing pressure. In addition, these sites are re- plenished with water and nutrients with each tide; therefore, major deterioration in site potential to support vegetative growth is unlikely. In the grass-shrub community, the primary effect of grazing appears to be a reduction in rate of succession from a grass stage to a *Myrica cerifera* shrub thicket stage. Succession was occurring on both grazed and ungrazed sites, but it was more rapid on the latter. The structural changes occurring in this plant community were not only important in terms of the natural plant dynamics but also in terms of the ability of the island to support grazing animals."

Grazing/herbivory/browsing Direct *Andropogon* spp; *Spartina alterniflora*; *Spartina patens*; *Salicornia bigelovii*; *Hydrocotyle bonariensis*; *Uniola paniculata*; *Hydrocotyle bonariensis*; *Myrica cerifera* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (changes in the aboveground biomass between grazed and ungrazed plots have been detected, but this does not allow to conclude to a decline in the population size)." "The impact might be lower, because the performance of native individuals might not be affected (contradictory results from 1 year to the other, and from one vegetation type to the other)." Shackleford Banks Carolina United States North America North and Central America LS January 2018 LV March 2019

Capra hircus Bovidae Cetartiodactyla "Yocom, Charles F. "Ecology of feral goats in Haleakala National Park, Maui, Hawaii." *American Midland Naturalist* (1967): 418-451." 1967 "I studied the feral goats in Haleakala National Park on the Island of Maui, Hawaii. [...] From 8 July to the end of August, my family and I were on the island of Maui studying feral goats (*Capra hircus*) in Haleakala National Park. Paliku Cabin, near Area One, was used as a center of study for two weeks. Later Holua Cabin was used as a center of operation. The Ranger Station Headquarters was used as a center to work out of while the Kalahaku Pali, Area Four, was observed from the rim. The other areas (Fig. 2) were covered on foot from either Kapalaoa or Paliku Ranger cabins during the rest of the summer [...] I established six geographical areas which I considered to be units used by specific goat populations. [...] found many dead shrubs and evidence of heavy browsing on ohia trees (Fig.4); this damage was done by large populations of feral goats that used this area several years ago. Along the west edge of Kuapo Gap I noted that all the present shrubs, including pukiawe were being heavily utilised by the goats. [...] Even here I found *Vaccinium* plants that had been browsed so much by goats that the plants had died (Fig. 5)." Grazing/herbivory/browsing Direct *Metrosideros polymorpha*; *Styphelia tameiameia*; *Vaccinium reticulatum* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Haleakala National Park (Island of Maui) Hawaii Islands United States North America

North and Central America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Scowcroft, Paul G., and Howard F. Sakai. ""Impact of feral herbivores on mamane forests of Mauna Kea, Hawaii: bark stripping and diameter class structure."" Journal of Range Management (1983): 495-498." 1983 "This study determined the intensity of bark stripping of mamane (*Sophora chrysophylla*), a small endemic leguminous tree, by these animals and assessed the impact of their browsing on the size class structure of mamane stands [...] At higher elevations the distributions indicated that sprout and seedling regeneration have been suppressed, completely so near tree line. Sheep and goats were undoubtedly responsible. [...] In the present case, feral sheep and goats suppress mamane regeneration in some areas of the Mauna Kea Forest Reserve, thus altering the forest structure. Prolonged suppression could further endangering the Palila by reducing the size of the forest." Grazing/herbivory/browsing Direct *Sophora chrysophylla* Plantae MN Medium "The impact might be higher (no decline in the population size was detected, but the alien might be preventing the increase of the native population by preventing its regeneration)" "It is unlikely that the impact is lower (even though there are multiple alien species, it is likely that each of them is affecting the regeneration of the individuals (performance))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America "(The authors compared different levels of grazing intensity, but the differences depended mainly on the number of sheep present (and not on the number of goat present)); *Capra hircus* have been eradicated in 1981 (Scowcroft and Giffin 1983)" DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Hess, S. C., Banko, P. C., Brenner, G. J., & Jacobi, J. D. (1999). Factors Related to the Recovery of Subalpine Woodland on Mauna Kea, Hawaii 1. *Biotropica*, 31(2), 212-219." 1999 "We measured mature tree and sapling density, tree associations, crown size, age structure, recovery from ungulate browsing, and grass cover at four study sites in two types of subalpine woodland on Mauna Kea volcano, island of Hawaii. Beginning in 1981, introduced ungulates were reduced in number to allow regeneration of *Sophora chrysophylla* (mamane) in habitat supporting the endangered Hawaiian finch, *Loxioides bailleui* (palila). We found *Sophora* regeneration at all four study sites, but regeneration was higher in mixed species woodland with codominant *Myoporum sandwicense* (naio) than in areas where *Sophora* dominated. Regeneration of *Myoporum* was uniformly very low in comparison. Invasive grass cover, which suppresses *Sophora* germination, was highest in mid-elevation woodland where *Sophora* dominated. The distribution of mature and sapling *Sophora* were both related to study site, reflecting previous ungulate browsing and uneven recovery due to grasses. Densities of *Sophora* snags were not different among any of the sites, suggesting a more even distribution in the past. Selective browsing before ungulate reduction may have favored *Myoporum* over *Sophora*, leading to high densities of mature *Myoporum* in codominant woodland. After ungulate reduction, however, we found no pattern of competitive inhibition by *Myoporum* on regeneration of *Sophora*. [...] There was no detectable browse damage on *Sophora* on the upper and mid-elevation sites. In the lower site, 11 of 13 (85%) mature trees and 11 of 13 saplings had browse damage. The bark of many young *Sophora* and *Myoporum* trees was stripped off; there was evidence of browsing on *Sophora* leaves, but no evidence of browsing on *Myoporum* leaves." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Myoporum sandwicense* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (browsing damages have been described (bark removal), which probably lead to a higher susceptibility of individuals to other stressors, but this has not been shown); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (there are four other species of introduced herbivores)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The potential impact on *Loxioides bailleui* has not been recorded. LV October 2019 DJ April 2020

Capra hircus Bovidae Cetartiodactyla "Spatz, Gunter, and Dieter MuellerDombois. ""The influence of feral goats on koa tree reproduction in Hawaii Volcanoes National Park."" *Ecology* 54.4 (1973): 870-876." 1973 "Most of the few trees of this height found outside the fenced area were dying or dead, showing that the current goat pressure is so high that the replacement cycle of koa is nearly disrupted [...] The methods used in the present study include, first, the quantitative analysis of koa reproduction in a 100 m by 10 m goat enclosure and in its surrounding area; and second, the structural analysis of six unfenced koa tree colonies in the mountain parkland ecosystem. [...] However, the goat pressure has become so strong locally that suckers cannot grow beyond a 10-cm height. If goats are allowed to increase, they can cause the extinction of koa trees in the mountain parkland on Mauna Loa." Grazing/herbivory/browsing; Direct physical disturbance Direct *Acacia koa* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only reproduction was investigated)." "It is unlikely that the impact is lower (there are evidences that the alien is affecting the reproduction through the use of enclosures). Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Worthington, David J., et al. ""Abundance and management of Mariana fruit bats and feral ungulates on Anatahan, Mariana Islands."" *Pacific Conservation Biology* 7.2 (2001): 134-142." 2001 "A survey of Mariana Fruit Bats *Pteropus mariannus* and feral ungulates was conducted on Anatahan, Mariana Islands, in July

1995. We estimated that a population of 1 902-2 136 bats persists on the island, based on a combination of direct colony counts, departure counts, and station counts of non-colonial animals. Our data suggest that bat numbers have declined since the last surveys were made in 1983 and 1984. [...] Goats were first introduced to Anatahan in the late 1950s or 1960, when an island resident released as many as 40 animals from Sarigan (Reichel et al. 1988; Rice 1992). Our estimated herd size of 5 000-6 000 animals is considerably larger than an estimate of 3 000-4 000 goats made in 1988 (Reichel et al. 1988), but neither estimate is based on rigorous surveys, nor should a population trend necessarily be inferred. However, Lemke (in litt.) did not note significant erosion or large numbers of goats on Anatahan in the early 1980s, suggesting that the present severe damage on Anatahan has been rapid, possibly due to a sharp increase in the feral ungulate population. [...] The most likely causes for a decrease in fruit bat abundance on Anatahan during the past decade involve mortality from chronic illegal hunting and declining food resources induced by goat and pig damage to the island's forests. Although the extent of hunting losses are unknown, human visitation to the island has expanded significantly since 1984 and has probably been accompanied by a commensurate increase in the take of bats. However, without simultaneous counts on the islands north of Anatahan, emigration cannot be excluded as an additional contributing factor in the population's apparent decline."

Competition Indirect Pteropus mariannus Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (chronic illegal hunting)." Anatahan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Worthington, David J., et al. "Abundance and management of Mariana fruit bats and feral ungulates on Anatahan, Mariana Islands." Pacific Conservation Biology 7.2 (2001): 134-142." 2001

"Heavy browsing and grazing by Feral Goats and Feral Pigs has depleted the forest understorey at many locations and caused severe erosion on some steep slopes. [...] Browsing was evident on many plant species, including Premna and Pandanus. Goats were occasionally sighted browsing in treetops 3 m or more off the ground, as well as in tree ferns. Plants not eaten sometimes succumbed to erosion." Grazing/herbivory/browsing Direct Premna obtusifolia; Pandanus tectorium Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only damages on individuals were investigated)." Anatahan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania DJ July 2017LV June 2019

Capra hircus Bovidae Cetartiodactyla "Kessler, C. C. "Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands." Turning the tide: the eradication of invasive species (2002): 132-141." 2002 "The native forest on Sarigan was in an advanced state of decline due to the presence of feral goats (Capra hircus) and pigs (Sus scrofa). [...] Vegetation monitoring before and after eradication shows an increase in plant species richness, an increase in tree seedlings, and the rapid expansion of the introduced vine Operculina ventricosa. [...] The vegetation responded immediately to the removal of ungulates. The total number of plant species found in all 13 plots has increased from seven in 1997 to 17 in 1998, 22 in 1999, and 25 in 2000. [...] Tree species have increased from a total of four in 1997 to nine in 2000 (Fig. 4) and have shown a steady increase in the number of seedlings on the plots. These tree species are Aglaia mariannensis, Artocarpus mariannensis, Cocos nucifera, Erythrina variegata, Hibiscus tiliaceus, Neisosperma oppositifolia, Trema orientalis, Premna obtusifolia, and Carica papaya. [...] All are native species to the Marianas, except for C. papaya, which is from the Americas but considered naturalised (Raulerson and Rinehart 1991). [...] The subsequent loss of soil through erosion kills the trees. The eating of new growth by ungulates suppresses any regeneration capabilities of the forest. The result is a steady decline of forest habitat whether it is native or coconut forest." "Grazing/herbivory/browsing; Chemical, physical or structural impact on ecosystems" Direct; Indirect Aglaia mariannensis; Artocarpus mariannensis; Cocos nucifera; Erythrina variegata; Hibiscus tiliaceus; Neisosperma oppositifolia; Trema orientalis; Premna obtusifolia Plantae MO Low "The impact might be lower, if the increase in the native population(s) is not due to the alien eradication (eradication of other introduced ungulates)." Sarigan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania DJ March 2019 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Kessler, C. C. "Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands." Turning the tide: the eradication of invasive species (2002): 132-141." 2002 "The native forest on Sarigan was in an advanced state of decline due to the presence of feral goats (Capra hircus) and pigs (Sus scrofa). [...] During January and February 1998, 68 pigs and 904 goats were removed by helicopter shooting, ground shooting, trapping, and tracking with dogs. [...] Glueboard traps were used for catching lizards. A line of 12 traps, with 5 m spacings was set in the morning and picked up in the afternoon. [...] Catch rates for blue-tailed skinks (Eumeces caeruleocauda) and the endemic Slevin's skink (Eumeces slevini) have greatly increased (Fig. 5) [...] The most rapid change of any wildlife species is the increase of skinks, mostly due to their high reproductive rate. The combination of an enlargement in forage area (increased vegetation) and the removal of a direct predator (the pig) has seemingly benefited these lizards." "Chemical, physical or structural impact on ecosystems" Indirect Eumeces caeruleocauda; Eumeces slevini Animalia MO Medium "The impact might be lower, if the increase in the native population(s) is not due to the alien eradication (eradication of other introduced ungulates)." Sarigan Island Northern

Mariana Islands Northern Mariana Islands Oceania Oceania "The absence of changes detected in bird populations (Megapodius laperouse; Pteropus mariannus; Rattus exulans; Halcyon chloris; Aplonis opaca; Myzomela rubrata; Megapodius laperouse) have not been recorded as an absence of impact, because the authors of the study do not consider that the temporal scale was relevant to detect changes in bird populations." DJ March 2019 LV June 2019

Capra hircus Bovidae Cetartiodactyla "Mueller-Dombois, Dieter, and Gunter Spatz. ""The influence of feral goats on the lowland vegetation in Hawaii Volcanoes National Park."" (1972)." 1972 "One area was the coastal Im-Jland in ""tvhich feral goats are known to roam year-round in great numbers. In August 1968, a 7 by 100 m enclosure was built south of Kukalauula Pali (at 300 m elevation) in the predominantly annual grassland of Eragrostis tenella (love grass). [...] Two more exclosures (a 10 by 90 m and a 100 by 100 m enclosure) were built in August 1971 on Puu Kaone, south of Hilina Pali (also at 300 ill elevation) in a perennial grassland [...] By examining the outside trends, it can be seen that Eragrosti senella decreased in quantity over the year, from 30 to 20iH As expected, however, it was present with a higher quantity during the latter part of the wet season in March,with 34%. Cynodon dactylon remained rather stable, showing nearly the same cover in July 1971 (31%) as in July 1972 (33%). Its cover was reduced during the wet season, when Eragrostis was more abundant." Grazing/herbivory/browsing Direct Eragrostis tenella; Cynodon dactylon Plantae MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Volcanoes National Park (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America DJ March 2019 LV June 2019

Cervus canadensis Cervidae Cetartiodactyla "Rose, A. B., & Platt, K. H. (1987). Recovery of northern Fiordland alpine grasslands after reduction in the deer population. New Zealand journal of ecology, 10, 23-33." 1987 "The frequency of Ourisia macrophyllala. macrocarpa was lowest in 1975, possibly reflecting depletion by deer between 1969-1975 and subsequent recovery [...] The main feature of the 55 transects measured in all three surveys was a large increase between 1969 and 1984 in the frequencies of the large-leaved herbs Anisotome haastii, Celmisia verbascifolia, Gentiana spp., and Senecio lyallii/S. scorzoneroide (Table 4). [...] Most of the largest increases occurred between 1975 and 1984, the period when deer numbers declined to near zero." Grazing/herbivory/browsing Direct Ourisia macrophyllala Macrocarpa; Anisotome haastii; Celmisia verbascifolia; Gentiana spp.; Senecio lyallii; Senecio scorzoneroide; Chionochloa pallens; Chionochloa flavescens; Celmisia verbascifolia Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the increase(s) in the native population(s) after the alien control is/are well shown (e.g. relevant spatial scale)." Fiordland National Park South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus canadensis Cervidae Cetartiodactyla "Rose, A. B., & Platt, K. H. (1987). Recovery of northern Fiordland alpine grasslands after reduction in the deer population. New Zealand journal of ecology, 10, 23-33.; Kean, R.I. 1956. Notornis faeces as evidence on foods as a factor in chick rearing success. Notornis 6: 229-31,237-40.; Mills, J. A., & Mark, A. F. (1977). Food preferences of takahe in Fiordland National Park, New Zealand, and the effect of competition from introduced red deer. The Journal of Animal Ecology, 939-958." 1987 "[Rose and Platt 1987] The takahe (Notornis mantelli), an endangered rail, was once widespread in the study area, but is currently almost totally restricted to the Murchison Mountains to the south (Lavers et al., 1980; Fig. I). [...] Competition from deer for food, particularly snow tussocks (Chionochloa spp.), was first implicated by Kean (1956) as contributing to the takahe's demise. [...] Chionochloa pallens and Chionochloa flavescens are the staple food resources for takahe in the Wapiti Area, and type PC grasslands would be among the most preferred and productive takahe habitat (Lavers et al., 1980). Results of this study support the contention that high deer numbers seriously depleted this resource, contributing to the decline of the takahe (Kean, 1956; Williams et al., 1976; Mills and Mark, 1977; Mills et al., 1984). Other, lesser, components of takahe diet may also have been depleted (e.g., Celmisia petriei), but most were too infrequent to show clear trends on the plots." Competition; Indirect impacts through interactions with other species Indirect Porphyrio hochstetteri (syn. Notornis mantelli) Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (the references cited as the ones describing the decline (Lavers et al. 1980, Kean 1956 and Williams 1960) are not accessible); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the implication of the alien in the decline has not been directly tested: it is inferred from the observed changes in native vegetation due to the alien (Rose and Platt 1987), or from food preference (Mills and Mark 1977))." Fiordland National Park South Island New Zealand Oceania Oceania "Kean (1956): First implication of the competition with the alien in this decline; Rose and Platt (1987), Mills and Mark (1977): Investigation of the mechanism (competition for food and decline in the food abundance)" DJ July 2017LV June 2019

Cervus canadensis Cervidae Cetartiodactyla "Stewart, G. H., Wardle, J. A., & Burrows, L. E. (1987). Forest understorey changes after reduction in deer numbers, northern Fiordland, New Zealand. New Zealand journal of ecology, 10, 35-42." 1987 "A resurvey of the Wapiti, Doon, and Glaisnock catchments in 1984/85 showed that densities of woody plants in the forest understorey had increased on average by at least 75% after a c. 80% reduction in deer numbers

since earlier surveys (1969 and 1975). Woody food plants highly preferred by deer were rare in most forest types in 1969, but were present in all types by 1984 and had increased in density by as much as 300-400%. However, recovery was still largely confined to understorey tiers < 75 cm high and most of the recovery had occurred since 1975. [...] Mean stem density in the Wapiti/Doon/Glaisnock seral and silver beech forests (high altitude silver beech forests, C1, C2) did not change significantly from 1969 to 1984 (Table 3). However, stem density increased significantly in mountain beech types (M1, M2, M3) and included the appearance of, or marked increases in, highly preferred species (e.g., *Pseudopanax crassifolius*, *P. colensoi*; Table 3). Highly preferred species, notably *Pseudopanax crassifolius*, *P. colensoi*, and *Griselinia littoralis*, also appeared in type C3 (silver beech-pepperwood-*Blechnum* forest). The high altitude communities (C1 and C2) and the seral community (P2) showed the least change. [...] Thirty-seven of the 40 species in the 16-135 cm tiers, increased markedly in density, e.g., *Pseudopanax simplex* from 496 to 3245 stems/ha (550% increase), *Hoheria glabrata* from 68 to 437 (540%), *Griselinia littoralis* from 90 to 345 (280%), and *Coprosma foetidissima* from 2164 to 3982 (85%). *Aristotelia serrata*, *Fuchsia excorticata*, *Schefflera digitata* and a number of other species not recorded in the 16-135 cm tiers in 1975 were present in 1984. Some of the least preferred species also increased, but proportional increases were not as much as for preferred species, e.g., *Pseudowintera colorata* increased from 2728 to 3521 stems/ha (29%). [...] Thirty-six of the 38 woody plant species in the < 15 cm tier showed frequency increases of c. 80-400%, e.g., in the <15 cm tier *Griselinia littoralis* increased from 7 to 31%, *Hoheria glabrata*, 9 to 20%, *Pseudopanax simplex*, 14 to 26%, and *Coprosma foetidissima* 16 to 30%. In comparison, the least preferred species *Pseudowintera colorata* increased slightly from 10 to 13%. Some herbs and ferns (e.g., *Polystichum vestitum*) that were present only in the < 15 cm tier in 1969 had not changed in their frequency of occurrence but had increased in height to be present in the 16-135 cm tiers in 1984."

Grazing/herbivory/browsing Direct *Pseudopanax simplex*; *Hoheria glabrata*; *Griselinia littoralis*; *Coprosma foetidissima*; *Aristotelia serrata*; *Fuchsia excorticata*; *Schefflera digitata*; *Polystichum vestitum*; *Pseudopanax crassifolius*; *Pseudopanax colensoi* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated (browse tier))." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this decreased performance (other introduced deer species are present)." Fiordland National Park South Island New Zealand Oceania Oceania LV September 2019 DJ April 2020 *Cervus canadensis* Cervidae Cetartiodactyla "Stewart, G. H., Wardle, J. A., & Burrows, L. E. (1987). Forest understorey changes after reduction in deer numbers, northern Fiordland, New Zealand. *New Zealand journal of ecology*, 10, 35-42." 1987 "A resurvey of the Wapiti, Doon, and Glaisnock catchments in 1984/85 showed that densities of woody plants in the forest understorey had increased on average by at least 75% after a c. 80% reduction in deer numbers since earlier surveys (1969 and 1975). Woody food plants highly preferred by deer were rare in most forest types in 1969, but were present in all types by 1984 and had increased in density by as much as 300-400%. However, recovery was still largely confined to understorey tiers < 75 cm high and most of the recovery had occurred since 1975. [...] Mean stem density in the Wapiti/Doon/Glaisnock seral and silver beech forests (high altitude silver beech forests, C1, C2) did not change significantly from 1969 to 1984 (Table 3). However, stem density increased significantly in mountain beech types (M1, M2, M3) and included the appearance of, or marked increases in, highly preferred species (e.g., *Pseudopanax crassifolius*, *P. colensoi*; Table 3). Highly preferred species, notably *Pseudopanax crassifolius*, *P. colensoi*, and *Griselinia littoralis*, also appeared in type C3 (silver beech-pepperwood-*Blechnum* forest). The high altitude communities (C1 and C2) and the seral community (P2) showed the least change. [...] Thirty-seven of the 40 species in the 16-135 cm tiers, increased markedly in density, e.g., *Pseudopanax simplex* from 496 to 3245 stems/ha (550% increase), *Hoheria glabrata* from 68 to 437 (540%), *Griselinia littoralis* from 90 to 345 (280%), and *Coprosma foetidissima* from 2164 to 3982 (85%). *Aristotelia serrata*, *Fuchsia excorticata*, *Schefflera digitata* and a number of other species not recorded in the 16-135 cm tiers in 1975 were present in 1984. Some of the least preferred species also increased, but proportional increases were not as much as for preferred species, e.g., *Pseudowintera colorata* increased from 2728 to 3521 stems/ha (29%). [...] Thirty-six of the 38 woody plant species in the < 15 cm tier showed frequency increases of c. 80-400%, e.g., in the <15 cm tier *Griselinia littoralis* increased from 7 to 31%, *Hoheria glabrata*, 9 to 20%, *Pseudopanax simplex*, 14 to 26%, and *Coprosma foetidissima* 16 to 30%. In comparison, the least preferred species *Pseudowintera colorata* increased slightly from 10 to 13%. Some herbs and ferns (e.g., *Polystichum vestitum*) that were present only in the < 15 cm tier in 1969 had not changed in their frequency of occurrence but had increased in height to be present in the 16-135 cm tiers in 1984."

Grazing/herbivory/browsing Direct *Pseudopanax simplex*; *Hoheria glabrata*; *Griselinia littoralis*; *Coprosma foetidissima*; *Aristotelia serrata*; *Fuchsia excorticata*; *Schefflera digitata*; *Polystichum vestitum*; *Pseudopanax crassifolius*; *Pseudopanax colensoi* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated (browse tier))." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this decreased performance (other introduced deer species are present)." Fiordland National Park South Island New Zealand Oceania Oceania LV September 2019 DJ April 2020 *Cervus canadensis* Cervidae Cetartiodactyla "Wardle, J., Hayward, J., & Herbert, J. (1971). Forests and scrublands of

northern Fiordland. New Zealand Journal of Forest Science, 1(1), 80-115." 1971 "The susceptibility of the larger ferns, shrub and tree species has been derived from tier analysis of the plots which showed evidence of red deer or wapiti presence in the form of browsing, tracking, or pellets. Vegetation in the 1ft to 6ft tier is nearly always available for browsing by red deer or wapiti while at least some of the vegetation in the less than 1ft and 6ft to 15ft tiers is outside the normal browse range as it is either too close to the ground or too high. The frequency of a species is thus likely to become reduced by browsing in the 1ft to 6ft tier long before it becomes affected in the less than 1ft or 6ft to 15ft tiers. Browse susceptible species are likely to suffer greater reduction within the 1ft to 6ft tier relative to outside it than those which are more tolerant. This relationship of frequency of a plant species inside the 1ft to 6ft tier relative to outside it has been used to determine the relative susceptibility or susceptibility ratings (SR) for each of the major species. [...] Those with the highest ratings, such as fuchsia, broadleaf, putaputaweta, wineberry, lacebark, and Asplenium bulbiferum, show a marked regeneration gap and are expected to be eliminated from many of the areas they now occupy if animal pressure is maintained at the present level." Grazing/herbivory/browsing Direct "Fuchsia excorticata; Griselinia littoralis; Carpodetus serratus; Aristotelia serrata; Hoheria glabrata; Asplenium bulbiferum" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (since the regeneration has been shown to be affected, the population size might be declining, but the way the study was led did not allow to detect such decline(s))." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this decreased performance (other introduced deer species are present, and no comparison with a situation without the alien)." Fiordland National Park South Island New Zealand Oceania Oceania LV September 2019 DJ April 2020

Cervus canadensis Cervidae Cetartiodactyla "Smith, D. S., Lamit, L. J., Lau, M. K., Gehring, C. A., Shuster, S. M., & Whitham, T. G. (2015). Introduced elk alter traits of a native plant and its plant-associated arthropod community. Acta Oecologica, 67, 8-16." 2015 "Here, we combined observational ?eld surveys, an exclosure experiment, network analysis and structural equation modeling to examine the direct and indirect effects of an introduced species on native communities. Specifically, we investigated how introduced elk indirectly impact the composition and co-occurrence patterns within a community of plant-associated arthropods by directly altering the phenotype of a native plant, Solidago velutina. Surveying the arthropods associated with the plant's in?orescence, two main patterns emerged. i) Using ?eld observations across 500 km² and an exclosure experiment, S. velutina growing in the presence of elk had 67e90% fewer ?owering ramets, 15e85% lower percentage of ?owering ramets, 33e45% fewer ?orets per in?orescence and 25e45% lower sexual ramet biomass. [...] Using observational data across 19 sites we found a negative relationship between elk scat counts and S. velutina traits. As elk scat increased, the number of ?orets per sexual ramet (F₁, 17 ¼ 6.66, P¼0.019, R²¼0.28; Fig. 1A), the number of sexual ramets per genet (F₁, 17 ¼ 5.57, P¼0.030, R²¼0.25, Fig. 1B), the percent of sexual ramets per genet (F₁, 17 ¼ 7.34, P¼0.015, R²¼0.30, Fig. 1C) and the biomass of sexual ramets (F₁, 15 ¼ 6.27, P¼0.024, R²¼0.29, Fig. 1D) all decreased. Also, trait variability was lowest at sites with high elk scat counts (Fig. 1), suggesting that elk are removing trait variation from S. velutina. [...] Experimental data from the exclosures corroborated our observational data. For all measured traits, values were significantly lower outside of exclosures, in the presence of elk, relative to inside the exclosures (Fig. 2AeD, Table 1)."

Grazing/herbivory/browsing Direct Solidago velutina Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Coconino National Forest Arizona United States North America North and Central America LV September 2019 DJ April 2020

Cervus elaphus Cervidae Cetartiodactyla "Barrios-Garcia, M. N., Relva, M. A., & Kitzberger, T. (2012). Patterns of use and damage by exotic deer on native plant communities in northwestern Patagonia. European journal of wildlife research, 58(1), 137-146." 2012 "Browsing was the most extensive and intensive damage on native plant communities. Deer browsed most of the 30 woody species recorded in this study; however, deer browsed more than expected on two evergreen species (A. chilensis and S. patagonicus) and two spinescent species (C. hystrix and D. diacanthoides). [...] The observed damage is the result of two different deer species with overlapping ranges. Pooling the impact of red and fallow deer could be problematic; however, in this system it is not possible to differentiate them based on the indicators we used. Because bite size is similar for both species and pellet sizes also overlap for most of their lifetime, the identification of browsing patterns by individual deer species is possible only through direct observation, when the two species occupy similar but non-overlapping ranges, or by use of stomach content analyse." Grazing/herbivory/browsing Direct Austrocedrus chilensis; Schinus patagonicus; Colletia hystrix; Dasyphyllum diacanthoides Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the regeneration (saplings) was investigated)." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (two species of introduced deer are present, so they might each feed on some specific species)." Isla victoria (Nahuel Huapi National Park) Neuquén Argentina South America South America DJ July 2017 LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Relva, M. A., & Veblen, T. T. (1998). Impacts of introduced large herbivores on Austrocedrus chilensis forests in northern Patagonia, Argentina. Forest Ecology and management, 108(1), 27-40." 1998 "In northern Patagonia, impacts of introduced animals on tree regeneration and understory composition are likely to continue to be a problem for land managers whether the objective of the management be regeneration following timber harvesting or protection of the native flora in parks and reserves. [...] the inhibitory effects of the browsing animals are manifested as stunting and poor form rather than reduced abundance. Heavily browsed Austrocedrus saplings typically lose their apical buds and the proliferation of lateral branches creates a shrubby form. Where the land use objective is timber production, this type of animal impact is of substantial economic impact." Grazing/herbivory/browsing Direct Austrocedrus chilensis Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Cervus elaphus Cervidae Cetartiodactyla "Relva, M. A., Nunez, M. A., & Simberloff, D. (2010). Introduced deer reduce native plant cover and facilitate invasion of non-native tree species: evidence for invasional meltdown. Biological Invasions, 12(2), 303-311." 2010 "The largest population of red deer (Cervus elaphus) in Europe is found in Scotland. However, human impacts through hunting and introduction of foreign deer stock have disturbed the population's genetics to an unknown extent. In this study, we analysed mitochondrial control region sequences of 625 individuals to assess signatures of human and natural historical influence on the genetic diversity and population structure of red deer in the Scottish Highlands. Genetic diversity was high with 74 haplotypes found in our study area (115 87 km). Phylogenetic analyses revealed that none of the individuals had introgressed mtDNA from foreign species or subspecies of deer and only suggested a very few localized red deer translocations among British localities. [...] The study area comprised 14 open hill estates distributed across a 115 87 km area in the Scottish Highlands (Figure 1). Samples consisted of an ear tip or a sample of jaw muscle from a total of 625 legally shot red deer (345 males and 280 females). [...] Although possible hybridization events in our study area involving non-native male deer will remain undetected because of the maternal inheritance of mtDNA, we would expect that owing to the strongly polygynous mating system characteristic of red deer, breeding success of introduced females must have been higher than that of introduced males. Considering the large number of samples included in our study, if past introductions had been extensive and successful in our study area this would have been reflected in the mtDNA diversity, structure and phylogenetic analyses." Grazing/herbivory/browsing Direct Austrocedrus chilensis Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the individual growth was investigated)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Cervus elaphus Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. Journal of Applied Ecology, 711-724." 1989 "Deer browsing has nearly eliminated the subcanopy tree, Aristotelia chilensis, which otherwise forms dense understoreys and has significantly reduced the abundance of numerous other woody and herbaceous species. [...] The most dramatic difference in the understoreys of the two areas was the dominance on Peninsula Quetihue by the subcanopy tree Aristotelia chilensis compared to its scarcity on Isla Victoria (Tables 3-5)." Grazing/herbivory/browsing Direct Aristotelia chilensis Plantae MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected (there is some linguistic ambiguity, e.g. "[...] deer browsing has nearly eliminated the subcanopy tree, Aristotelia chilensis, [...]]", but the native species was still found on Isla Victoria)." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America DJ July 2017 LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. Journal of Applied Ecology, 711-724." 1989 "Luma apiculata, another subcanopy tree species, showed a consistent pattern of greater abundance on Peninsula Quetihue (Tables 3-5). It was so rare on Isla Victoria that the frequency with which it was browsed was low. Mean maximum heights on the island however, were 19-5 cm (S.E. 6.5) compared to 147 cm (S.E. 30) on the peninsula. This difference suggests that deer have inhibited its growth. [...] The canopy tree Austrocedrus was rare in the seedling and sapling size-classes in both areas, making the assessment of deer browsing on its regeneration difficult. Deer, however, browse it intensely and create dwarfed and deformed seedlings. In some stand had a high browse pressure index (Tables 3 and 4). [...] N. dombeyi seedlings had a mean height of 73-4 cm (S.E. 9-1; n=49). The relatively high mean susceptibility rating of 1-9 also reflects impairment of N. dombeyi regeneration due to deer browsing." Grazing/herbivory/browsing Direct Luma apiculata; Austrocedrus chilensis; Nothofagus domeyi Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (even though the rarity of the seedlings and saplings in both area render the assessment of the effect of browsing difficult, impaired regeneration due to browsing has been observed)." Isla victoria (Nahuel Huapi National Park)

Neuquén ArgentinaSouth America South America DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Bowman, F. (2014). A pilot study examining the ecological and human dimensions of wild deer management, Nariel Valley Victoria. B. Sc.(Hons) Thesis, University of Canberra, Canberra." 2014 "Damage to vegetation and soil from deer was estimated at each faecal pellet survey site (i.e. 20 transects per EVC, 600 plots). Each plot was searched for signs of deer damage. Evidence of deer damage was classified into the following categories: browsed vegetation, formation of trails, trampled or thrashed vegetation, hoof prints, wallows, and tree rubs. Extensive reconnaissance was also undertaken throughout the native vegetation in the vicinity of the transects to detect damage by deer to vegetation and soils. Observations were made opportunistically between May to August, 2014 and were confined to the native vegetation within 200 m distance from cleared land. [...] Antler damage to the bark of trees and saplings was observed throughout the study area. In particular, it was common to observe removal, damage and scattered remains of bark at the base of trees, which appeared to be related to damage caused by antler rubbing. [...] Antler rubbing was found to be extensive within the forest and woodland areas, with damage to some trees and saplings so significant that it had resulted in mortality of some individual plants, particularly saplings. Antler rubbing was observed on a variety of tree species and of varying sizes in the study area (Figure 3.8). Damage was frequently observed on Cherry Ballart (*Exocarpus cupressiformis*) and Brittle Gum (*Eucalyptus mannifera*) trunks. [...] A few Cherry ballart trees were found to have died as a result of antler rubbing in this study. [...] Understory vegetation was significantly reduced along game trails and in encampment areas. [...] Observed structural damage included creation of opened up areas, and the death or reduced fitness of individual plants. [...] While the results of this study only detected minimal damage by thrashing and trampling (2% of survey plots), observations indicated that deer were causing significant damage through this behaviour." Grazing/herbivory/browsing; Direct physical disturbance Direct "Exocarpus cupressiformis; Eucalyptus mannifera; undefined ("variety of tree species"; "understorey vegetation")" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the authors mentioned that what they observed in the plots was not fully representative of what they observed at a larger scale)." "The impact might be lower, because the performance of native individuals might not be affected (the authors mention that browsing may cause the death of individuals or affect their fitness, but it is not clear if they directly observed it in this study, and how they define an effect on the fitness of the native individuals)." Nariel Valley Victoria Australia Oceania Oceania LV January 2018 DJ April 2020

Cervus elaphus Cervidae Cetartiodactyla "Husheer, Sean W., Q. W. Hansen, and Stephen C. Ulrich. "Effects of red deer on tree regeneration and growth in Aorangi Forest, Wairarapa." New Zealand Journal of Ecology (2005): 271277." 2005 "This study uses data from paired fenced and unfenced plots established at seven sites in Aorangi Forest between 1981 and 1987, and remeasured in 2004, to show the effects of ungulates on tree (? 2 cm diameter at breast height) regeneration and growth. [...] Our results show that browsing by red deer has prevented regeneration of kanono (*Coprosma grandifolia*), a highly palatable, fastgrowing subcanopy hardwood tree. Deer reduced the growth of mahoe (*Melicytus ramiflorus*) trees, probably by directly browsing epicormic shoots. [...] This study has shown a rapid increase in the tree stem density of kanono in fenced deer exclosure plots that was not observed in paired unfenced plots, providing evidence that browsing by red deer has prevented regeneration of kanono at Aorangi Forest over the past two decades." Grazing/herbivory/browsing Direct *Coprosma grandifolia*; *Melicytus ramiflorus* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Aorangi Forest North Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Husheer, Sean W. "Introduced red deer reduce tree regeneration in Pureora Forest, central North Island, New Zealand." New Zealand Journal of Ecology (2007): 7987." 2007 "This study uses data from repeatedly measured forest monitoring plots (20 × 20 m) (n = 32) and nine ungulate exclosures (paired fenced and unfenced plots; 20 × 20 m) to show the effects of introduced ungulates on tree regeneration in Pureora Forest Park, central North Island, between 1974 and 2002. [...] Fences surrounding one of the paired plots at each of the nine sites were designed to exclude deer and goats, while at most only deterring the access of smaller browsers (<30 cm high) such as brushtail possums and pigs. [...] Changes were mostly due to increases in densities of six deer-palatable hardwood species: *Coprosma grandifolia*, *Elaeocarpus dentatus*, *Griselinia littoralis*, *Melicytus rami orus*, *Sscheffera digitata* and *Weinmannia racemosa* in all nine of the fenced plots. [...] Changes in overstorey species composition also varied significantly between fenced and unfenced plots between 1984 and 2002 (? = 0.12, F = 2.7, P = 0.005). In fenced plots, mean *Coprosma grandifolia* tree stem density increased by an average of 126 times (F_{2,16} = 4.1, P = 0.037), *Schefflera digitata* 22 times (F_{2,16} = 3.7. P = 0.047) and *Weinmannia racemosa* by 27% (F_{2,16} = 8.0, P = 0.004) between 1984 and 2002. In adjacent unfenced plots there was no change in stem density of *C. grandifolia*, a doubling of *S. digitata* density, and a 22% decline in *W. racemosa* stem density. [...] Red deer are most likely to be responsible for the suppression of palatable tree recruitment in Pureora Forest, because unlike other ungulates present, red deer were not substantially reduced in density during the study. [...] It is unlikely that feral goat or pig browsing had a major influence on results because intensive culling throughout the study reduced pig populations, and nearly eliminated goats from northern Pureora Forest Park (Clegg 1987; Broome &

Clegg 1990)." Grazing/herbivory/browsing Direct Coprosma grandifolia; Schefflera digitata; Weinmannia racemosa Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Pureora Forest North Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Husheer, Sean W. ""Introduced red deer reduce tree regeneration in Pureora Forest, central North Island, New Zealand."" New Zealand Journal of Ecology (2007): 7987." 2007 "This study uses data from repeatedly measured forest monitoring plots (20 × 20 m) (n = 32) and nine ungulate exclosures (paired fenced and unfenced plots; 20 × 20 m) to show the effects of introduced ungulates on tree regeneration in Pureora Forest Park, central North Island, between 1974 and 2002. [...] Fences surrounding one of the paired plots at each of the nine sites were designed to exclude deer and goats, while at most only deterring the access of smaller browsers (<30 cm high) such as brushtail possums and pigs. [...] Changes were mostly due to increases in densities of six deer-palatable hardwood species: Coprosma grandifolia, Elaeocarpus dentatus, Griselinia littoralis, Melicytus rami orus, Sschef era digitata and Weinmannia racemosa in all nine of the fenced plots. [...] Red deer are most likely to be responsible for the suppression of palatable tree recruitment in Pureora Forest, because unlike other ungulates present, red deer were not substantially reduced in density during the study. [...] It is unlikely that feral goat or pig browsing had a major in uence on results because intensive culling throughout the study reduced pig populations, and nearly eliminated goats from northern Pureora Forest Park (Clegg 1987; Broome & Clegg 1990)." Grazing/herbivory/browsing Direct Elaeocarpus dentatus; Griselinia littoralis; Melicytus ramiflorus Plantae MN Medium "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (exclusion of several species and not only of the one of interest)." Pureora Forest North Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Allen, R. B., I. J. Payton, and J. E. Knowlton. ""Effects of ungulates on structure and species composition in the Urewera forests as shown by exclosures."" New Zealand journal of ecology (1984): 119130." 1984 "Despite the large reduction in ungulate numbers throughout Urewera forests introduced browsing animals, particularly deer, still affect the structure and composition of most fore types [...] The distributions presented for hangehange (Geniostoma ligustnfolium) (Fig. 2a) represent the first type of pattern, also shown by Coprosma australis, C. lucida, C. robusta, C. tenuifolia, Pseudopanax arboreus, lancewood (P. crassifolius), P. simplex and pate (Table 1). These species were absent, or nearly so, in both the tree and sapling tiers outside the exclosures." Grazing/herbivory/browsing Direct Geniostoma ligustnfolium; Coprosma australis; Coprosma lucida; Coprosma robusta; Coprosma tenuifolia; Pseudopanax arboreus; Pseudopanax crassifolius; Pseudopanax simplex; Schefflera digitata Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other alien ungulates present, but Cervus elaphus is the most widespread and abundant)." Urewera forests North Island New Zealand Oceania Oceania DJ July 2017 LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Allen, R. B., I. J. Payton, and J. E. Knowlton. ""Effects of ungulates on structure and species composition in the Urewera forests as shown by exclosures."" New Zealand journal of ecology (1984): 119130." 1984 "Despite the large reduction in ungulate numbers throughout Urewera forests introduced browsing animals, particularly deer, still affect the structure and composition of most fore types [...] The second type of pattern (Fig. 2b) was shown by mahoe, which was more numerous in the sapling tier inside the exclosures than in the control plots, but showed no difference in the tree tier (Table 1). Rewarewa, putaputaweta, mapau (Myrsine australis) and Pittosporum tenuifolium showed similar trends (Table 1). Rewarewa was present in the main canopy but the others were sub-canopy species. All are longer lived than those included in the first group with hangehange, and only the smaller size-classes showed a difference. [...] Seedlings of the canopy forming species rewarewa and tawa were less frequent in the 15-140 cm height class (Table 3) in the control plots than in the exclosure plots. [...] Seedlings of the following sub canopy tree and shrub species were also less frequent in the 15-140 cm height class in the control plots than in the exclosures: Coprosma australis, mahoe, mapau, lancewood and pate. The fern Asplenium bulbiferum and the liane supplejack (Ripogonum scandens) followed this pattern also. However, none of these seven species showed differences between exclosure and control plots in the less than 15 cm height class. This indicates that their seedlings were present outside the exclosures, but height growth is being restricted by browsing." Grazing/herbivory/browsing Direct Melicytus ramiflorus; Knightia excelsa; Carpodetus serratus; Myrsine australis; Pittosporum tenuifolium; Asplenium bulbiferum; Ripogonum scandens; Beilschmiedia tawa Plantae MN Medium "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (other introduced deer are present, but Cervus elaphus is the most widespread)." Urewera forests North Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was C. elaphus, with several locations supporting C. hircus, and with the dominant browser in some areas being Dama dama L. (fallow deer), Odocoileus virginianus Zimmerman (white tailed deer), or Macropus eugenii Desmarest (Dama wallaby) [...] The effects of browsing mammals on the soil microfood web were clearly multitrophic in nature for several locations; populations of microbe-feeding and predaceous nematodes were significantly affected by browsers in both the humus and litter layers in nearly half the site. [...] Effects of browsers on abundances of microarthropods were negative for all but one of the 63 instances in which a significant effect at P 5 0.05 was detected (Fig. 9)." "Chemical, physical or structural impact on ecosystems" Indirect Nematoda; Rotifera; Copepoda; Tardigrada Animalia MO Medium "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in nematod, rotifer, copepod and tardigrad abundances in general, making it difficult to understand which species are affected, and how)" "It is unlikely that the impact is lower (other herbivores present which might have partly caused the impact, however, the alien species of interest is the main species in most locations)" North Island; South Island North Island; South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was C. elaphus, with several locations supporting C. hircus, and with the dominant browser in some areas being Dama dama L. (fallow deer), Odocoileus virginianus Zimmerman (white tailed deer), or Macropus eugenii Desmarest (Dama wallaby) [...] In most locations browsing mammals reduced plant diversity (Shannon-Weiner index) in the browse layer; diversity was greater inside the exclosure than outside for all but three locations and for half the locations the effects were significant at P 5 0.05 (Fig. 12). [...] Species that were frequently severely reduced by browsers included Geniostoma rupestre J. R. Forst. & G. Forst., Astelia spp., Griselinia littoralis Raoul, and Coprosma spp. (especially C. grandifolia Hook. f.)." Grazing/herbivory/browsing Direct Geniostoma rupestre; Astelia spp.; Griselinia littoralis; Coprosma spp. (especially C. grandifolia) Plantae MN Medium "The impact might be higher (some linguistic ambiguity ""Species that were frequently severely reduced by browsers [...]""), but the effect of the alien on the native population size was not investigated (only the browse- and ground-layer vegetation has been investigated)" North Island; South Island North Island; South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Jane, G. T. ""The impact of browsing animals on the stand dynamics of monotypic mountain beech (Nothofagus solandri) forests in Canterbury, New Zealand."" Australian journal of botany 42.2 (1994): 113124." 1994 "Red deer (Cewus elaphus) have been the main browsing mammal in the forests of Canterbury, although on the lower altitude forest fringes domestic sheep and cattle were also present [...] The most serious aspect of the impact of deer is the longterm effect on stand structure. It takes several decades for the lack of recruitment into the tree sizeclasses to become apparent and this depression in the smaller tree sizeclasses persists for several decades after seedling recovery becomes apparent [...] Deer and other browsing animals have had a marked impact on the regeneration in mountain beech forests of Canterbury and this effect will persist for many decades, even if the last animal is removed. The period of impact has only been brief. Deer numbers peaked in the 1930s or perhaps even later and were declining by the 1960s with a sharp increase in the decline beginning by 1965 when commercial deer recovery began in Canterbury. As a result, severe impact on the vegetation probably lasted for less than 25 years, less than the normal interval between disturbance events and scarcity of sufficient duration to affect more than pole sized recruitment, as shown in the Puketeraki area where impact was probably more prolonged. The effect of this browsing impact would have been to prevent casual replacement of trees, such as in small canopy gaps, and enhance the peak in any 1930s to 1960s cohort size-class distribution. The arrival of the helicopter-based hunting and venison recovery industry in the 1960s and the consequent substantial fall in deer densities has resulted in a marked rejuvenation in the wet climate forests and a slower one in dry climate forests, but even at current densities, recovery at high altitudes is slow and in several areas seedling regeneration is still very limited (Jane 1987)." Grazing/herbivory/browsing Direct Fuscospora cliffortioides Plantae MN Medium "It is unlikely that the impact is higher (it is mentioned in the article that alien deer population has been decreased through hunting and that ""a more prolonged influence [of the alien deer] may have had far greater repercussions and have led to gradual conversion of forest to savannah and perhaps to its final demise. The only thing preventing this has been the frequent episodic massed mortality through snow damage, wind or insect epidemics that allowed massed regeneration.""")" "It is unlikely that the impact is lower (meta-analysis using different reports on the impact of Cervus elaphus in the forest of Cantebury, on a long temporal scale)." Canterbury South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Batcheler, C. L. ""Preliminary observations of alpine grasshoppers in a habitat modified by deer and chamois."" Proceedings of the New Zealand Ecological Society. Vol. 14. 1967." 1967 "Modification of the habitat because of grazing and trampling by the introduced ungulates is also believed to have favoured

grasshoppers, particularly in more dense grasslands. Small juveniles have often been observed in the vicinity of soil which has been left denuded by the death of individual plants. Common examples of this include occurrence of instars I and II on soil exposed by the death of small patches of prostrate *Dracophyllum uniflorum* killed by deer: where individual broadleaved snowgrass tussocks (*C. flavescens*) in a matrix of the less palatable mid ribbed snowgrass (*C. palens*) have been killed; and in the runnels which have developed along animal trails in carpet grass (*C. australis*) associations."

Grazing/herbivory/browsing Direct *Chionochloa flavescens*; *Dracophyllum uniflorum* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size."

Cupola Basin South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Rose, A. B., & Platt, K. H. (1987). Recovery of northern Fiordland alpine grasslands after reduction in the deer population. New Zealand journal of ecology, 10, 23-33." 1987 "The frequency of *Ourisia macrophylla*. *macrocarpa* was lowest in 1975, possibly reflecting depletion by deer between 1969-1975 and subsequent recovery [...] The main feature of the 55 transects measured in all three surveys was a large increase between 1969 and 1984 in the frequencies of the large-leaved herbs *Anisotome haastii*, *Celmisia verbascifolia*, *Gentiana* spp., and *Senecio lyallii*/*S. scorzonoides* (Table 4). [...] Most of the largest increases occurred between 1975 and 1984, the period when deer numbers declined to near zero." Grazing/herbivory/browsing Direct *Ourisia macrophylla*

Macrocarpa; *Anisotome haastii*; *Celmisia verbascifolia*; *Gentiana* spp.; *Senecio lyallii*; *Senecio scorzonoides*; *Chionochloa pallens*; *Chionochloa flavescens*; *Celmisia verbascifolia* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the increase(s) in the native population(s) after the alien control is/are well shown (e.g. relevant spatial scale)." Fiordland National Park South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Rose, A. B., & Platt, K. H. (1987). Recovery of northern Fiordland alpine grasslands after reduction in the deer population. New Zealand journal of ecology, 10, 23-33.; Kean, R.I. 1956. *Notornis* faeces as evidence on foods as a factor in chick rearing success. *Notornis* 6: 229-31, 237-40.; Mills, J. A., & Mark, A. F. (1977). Food preferences of takahe in Fiordland National Park, New Zealand, and the effect of competition from introduced red deer. *The Journal of Animal Ecology*, 939-958." 1987 "[Rose and Platt 1987] The takahe (*Notornis mantelli*), an endangered rail, was once widespread in the study area, but is currently almost totally restricted to the Murchison Mountains to the south (Lavers et al., 1980; Fig. I). [...] Competition from deer for food, particularly snow tussocks (*Chionochloa* spp.), was first implicated by Kean (1956) as contributing to the takahe's demise. [...] *Chionochloa pallens* and *Chionochloa flavescens* are the staple food resources for takahe in the Wapiti Area, and type PC grasslands would be among the most preferred and productive takahe habitat (Lavers et al., 1980). Results of this study support the contention that high deer numbers seriously depleted this resource, contributing to the decline of the takahe (Kean, 1956; Williams et al., 1976; Mills and Mark, 1977; Mills et al., 1984). Other, lesser, components of takahe diet may also have been depleted (e.g., *Celmisia petriei*), but most were too infrequent to show clear trends on the plots." Competition; Indirect impacts through interactions with other species Indirect *Porphyrio hochstetteri* (syn. *Notornis mantelli*)

Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (the references cited as the ones describing the decline (Lavers et al. 1980, Kean 1956 and Williams 1960) are not accessible); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the implication of the alien in the decline has not been directly tested: it is inferred from the observed changes in native vegetation due to the alien (Rose and Platt 1987), or from food preference (Mills and Mark 1977))." Fiordland National Park South Island New Zealand Oceania Oceania "Kean (1956): First implication of the competition with the alien in this decline; Rose and Platt (1987), Mills and Mark (1977): Investigation of the mechanism (competition for food and decline in the food abundance)" DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Tanentzap, Andrew J., et al. "Landscape?level vegetation recovery from herbivory: progress after four decades of invasive red deer control." *Journal of Applied Ecology* 46.5 (2009): 1064-1072." 2009 "We report long-term vegetation changes in permanent plots located in forest, shrubland and grassland communities across a mountain range in southern New Zealand. We test whether c. 92% reduction in the population of invasive non-indigenous red deer *Cervus elaphus* since 1964 has led to the recovery of deer-preferred species. [...] Our results suggest that after nearly four decades, even low densities of introduced herbivores may restrict ecosystem recovery, and therefore, restoring herbivore-disturbed ecosystems by solely manipulating herbivore population numbers may require a long-term perspective [...] Between 1976 and 2008, 17 species were significantly more abundant, and two significantly less abundant, with a greater percentage of highly preferred and preferred species increasing in abundance compared with less preferred species"

Grazing/herbivory/browsing Direct *Chionochloa rigida*; *Dolichoglottis scorzonoides* Plantae MO Medium "The impact might be lower, if there is no increase in the native population(s) due to the control of the alien (small spatial scale, and the authors mention that the studied area is not a good representation of what happens at the whole forest level)." Fiordland National Park South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Wardle, J., Hayward, J., & Herbert, J. (1971). Forests and scrublands of northern Fiordland. New Zealand Journal of Forest Science, 1(1), 80-115." 1971 "The susceptibility of the larger ferns, shrub and tree species has been derived from tier analysis of the plots which showed evidence of red deer or wapiti presence in the form of browsing, tracking, or pellets. Vegetation in the 1ft to 6ft tier is nearly always available for browsing by red deer or wapiti while at least some of the vegetation in the less than 1ft and 6ft to 15ft tiers is outside the normal browse range as it is either too close to the ground or too high. The frequency of a species is thus likely to become reduced by browsing in the 1ft to 6ft tier long before it becomes affected in the less than 1ft or 6ft to 15ft tiers. Browse susceptible species are likely to suffer greater reduction within the 1ft to 6ft tier relative to outside it than those which are more tolerant. This relationship of frequency of a plant species inside the 1ft to 6ft tier relative to outside it has been used to determine the relative susceptibility or susceptibility ratings (SR) for each of the major species. [...] Those with the highest ratings, such as fuchsia, broadleaf, putaputaweta, wineberry, lacebark, and Asplenium bulbiferum, show a marked regeneration gap and are expected to be eliminated from many of the areas they now occupy if animal pressure is maintained at the present level." Grazing/herbivory/browsing Direct "Fuchsia excorticata; Griselinia littoralis; Carpodetus serratus; Aristotelia serrata; Hoheria

glabrata; Asplenium bulbiferum" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (since the regeneration has been shown to be affected, the population size might be declining, but the way the study was led did not allow to detect such decline(s))." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this decreased performance (other introduced deer species are present, and no comparison with a situation without the alien)." Fiordland National Park South Island New Zealand Oceania Oceania LV September 2019 DJ April 2020

Cervus elaphus Cervidae Cetartiodactyla "Mark, A. F. ""Responses of indigenous vegetation to contrasting trends in utilization by red deer in two southwestern New Zealand National Parks."" New Zealand Journal of Ecology (1989): 103114." 1989 "This paper documents observations made over the last 20 years on contrasting trends in vegetation condition and flora associated with differences in density of red deer in two national parks in southwestern New Zealand. [...] In Mt Aspiring National Park (2872 km'), a reconnaissance vegetation survey in the late 1960's showed early signs of an improving trend (Mark 1977) following drastic reductions of the large deer population by commercial hunters using helicopters. [...] After the 1967-69 vegetation survey (Mark 1977), 68 permanently marked photographic points were installed in February 1970 and 20 more in February 1973. These were distributed among five major vegetation types as follows: forest (13), subalpine scrub (3), valley grassland (7), low-alpine snow tussock grassland (53) and high-alpine fellfield-snowbank (12). [...] The one site in the West Matukituki Valley (518 m) has shown only slight recovery in regeneration of Nothofagus fusca (red beech); in the numbers and sizes of most shrub and small tree species (Coprosma foetidissima, C. propinqua and Griselinia littoralis); and of Polystichum vestitum in the herb layer. [...] Chionochloa flavescens and C. conspicua plus the woody species Coprosma propinqua, C. pseudocuneata and Hoheria glabrata have increased in both size and density." Grazing/herbivory/browsing Direct Nothofagus fusca; Coprosma foetidissima; Coprosma propinqua; Griselinia littoralis; Nothofagus menziesii; Polystichum vestitum; Pseudopanax simplex; Coprosma pseudocuneata; Coprosma parviflora; Chionochloa flavescens; Chionochloa conspicua; Coprosma pseudocuneata; Hoheria glabrata; Podocarpus nivalis; Coprosma rugosa; Pseudopanax colensoi Plantae MO Medium "The impact might be lower, if the increase in the native population(s) is not due to the alien control (the quantification of the impact is only based on the comparison of the situation before/after the control of the alien (no exclusion of confounding effects); but browsing by the alien still appears to be the main cause of the decline)." Mt Aspiring National Park South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Mark, A. F. ""Responses of indigenous vegetation to contrasting trends in utilization by red deer in two southwestern New Zealand National Parks."" New Zealand Journal of Ecology (1989): 103114." 1989 "This paper documents observations made over the last 20 years on contrasting trends in vegetation condition and flora associated with differences in density of red deer in two national parks in southwestern New Zealand. Secretary Island (80 km') in Fiordland National Park was initially designated a Special Area to recognise its almost unique virgin (i.e. deer-free) state. However, the condition of the vegetation has declined since 1965 when the first clear signs of deer browsing were noted (Mark and Baylis 1975). [...] These included an 80 m2 permanent quadrat to follow effects of selective browsing on the stem apices of juvenile lancewood (Pseudopanax crassifolius), two 500 m2 permanent quadrats to assess the impact of antler rubbing on celery pine (Phyllocladus aspleniifolius var. alpinus); a 200 m2 permanent quadrat to study responses in four herbaceous species, two obviously palatable (Asplenium bulbiferum and Dicksonia squarrosa) and two apparently non- palatable (Blechnum discolor and Cyathea smithii); and one permanently marked site to follow the fate of Asplenium bulbiferum and Cyathea smithii using oblique and vertical photography. [...] The increase in 'juvenile' plants of Dicksonia (for size class definitions see Mark and Baylis 1982) has been at the expense of 'immature' plants in which severe browsing has reduced the size and number of fronds. While mature Dicksonia plants have increased from 16 to 27, only those which exceed 2m tall remain unbrowsed. Most are now classed as severely browsed. [...] With Asplenium

bulbiferum both juvenile and adult plants declined and all four of the latter were severely browsed by 1987. [...] The general cover at this site was little different in 1987 when it was measured again by the quarter method of plotless sampling. The density of herbs had decreased only slightly (from 32,580 plants ha⁻¹ in 1981 to 31,830 in 1987). However, the proportion of *Asplenium* had dropped from 77% to 65% of plants in the herb layer (>30 cm tall) or from 25,100 to 20,700 plants ha⁻¹." Grazing/herbivory/browsing Direct *Dicksonia squarrosa*; *Asplenium bulbiferum* Plantae MO Medium "The impact might be lower, if the increase in the native population(s) is not due to the alien control (the quantification of the impact is only based on the comparison of the situation before/after the control of the alien (no exclusion of confounding effects); but browsing by the alien still appears to be the main cause of the decline)." Secretary Island (Fiordland National Park) South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Mark, A. F. "Responses of indigenous vegetation to contrasting trends in utilization by red deer in two southwestern New Zealand National Parks." New Zealand Journal of Ecology (1989): 103114." 1989 "This paper documents observations made over the last 20 years on contrasting trends in vegetation condition and flora associated with differences in density of red deer in two national parks in southwestern New Zealand. Secretary Island (80 km²) in Fiordland National Park was initially designated a Special Area to recognise its almost unique virgin (i.e. deer-free) state. However, the condition of the vegetation has declined since 1965 when the first clear signs of deer browsing were noted (Mark and Baylis 1975). [...] These included an 80 m² permanent quadrat to follow effects of selective browsing on the stem apices of juvenile lancewood (*Pseudopanax crassifolius*), two 500 m² permanent quadrats to assess the impact of antler rubbing on celery pine (*Phyllocladus aspleniifolius* var. *alpinus*); a 200 m² permanent quadrat to study responses in four herbaceous species, two obviously palatable (*Asplenium bulbiferum* and *Dicksonia squarrosa*) and two apparently non-palatable (*Blechnum discolor* and *Cyathea smithii*); and one permanently marked site to follow the fate of *Asplenium bulbiferum* and *Cyathea smithii* using oblique and vertical photography. [...] On Secretary Island the most palatable species have continued to decline. Woody plants are debarked by chewing or antler rubbing, and herbs are grazed. Accessible parts of palatable trees and shrubs continue to be heavily browsed, while stems of some species continue to be distorted because lateral buds substitute for removed terminal shoots. Some unpalatable species have increased. [...] Both the subalpine shrub *Pseudopanax linearis* and juvenile stems of the lowland small tree *P. crassifolius* continue to have a high proportion of their stem apices removed by deer" Grazing/herbivory/browsing Direct "Pseudopanax colensoi (var. *ternatum* and var. *fiordensis*); *Pseudopanax linearis*; *Pseudopanax crassifolius*; *Phyllocladus aspleniifolius*; *Griselinia littoralis*; *Coprosma lucida*; *Coprosma foetidissima*; *Coprosma colensoi*" Plantae MN Medium "The impact might be higher ("On Secretary Island the most palatable species have continued to decline."), but the dynamics of the native populations have not been studied." "The impact might be lower, because the performance of native individuals might not be affected (the effect on the performance of native individuals is not directly measured, but inferred from observed damages)." Secretary Island (Fiordland National Park) South Island New Zealand Oceania Oceania DJ July 2017 LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Wilson, Deborah J., et al. "An experimental study of the impacts of understorey forest vegetation and herbivory by red deer and rodents on seedling establishment and species composition in Waitutu Forest, New Zealand." New Zealand Journal of Ecology (2006): 191207." 2006 "Ungulates significantly delayed the recovery of vegetation within 2 years after disturbance by experimental clearing of the forest understorey. They slowed the establishment of seedlings ? 10 cm tall and reduced the similarity of reestablishing vegetation to its prior species composition. [...] We consider that most of the ungulate effects observed in this study were due to deer, but pigs may have contributed, although they disturbed the soil of only one subplot during the 2 years of the project." Grazing/herbivory/browsing Direct *Aristotelia serrata*; *Coprosma foetidissima*; *Elaeocarpus hookerianus*; *Griselinia littoralis*; *Ripogonum scandens*; *Schefflera digitata*; *Weinmannia racemosa*; *Fuchsia excorticata*; *Pennantia corymbosa*; *Raukawa simplex* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the recovery of vegetation after an artificial disturbance was investigated)." "It is unlikely that the impact is lower (even though pigs may have contributed to the impact on the performance of native individuals, the main disturbance seems to come from deer)." Waitutu Forest (Fiordland National Park) South Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Cervus elaphus Cervidae Cetartiodactyla "Husheer, Sean W., Q. W. Hansen, and Stephen C. Urlich. "Effects of red deer on tree regeneration and growth in Aorangi Forest, Wairarapa." New Zealand Journal of Ecology (2005): 271277." 2005 "This study uses data from paired fenced and unfenced plots established at seven sites in Aorangi Forest between 1981 and 1987, and remeasured in 2004, to show the effects of ungulates on tree (? 2 cm diameter at breast height) regeneration and growth. [...] The regeneration of other less palatable sub-canopy trees (e.g. *porokaiwhiri*, *Hedycarya arborea*), and slower-growing canopy species (e.g. *hinau*, *Elaeocarpus dentatus* and *rewarewa*, *Knightia excelsa*) appears to have been unaffected by deer browsing." Grazing/herbivory/browsing Direct *Hedycarya arborea*; *Knightia excelsa*; *Elaeocarpus dentatus* Plantae MC High It is unlikely that the impact is higher (the study did not detect any impact of the regeneration or growth of these native individuals). Aorangi Forest North Island New Zealand Oceania

- Cervus nippon* Cervidae Cetartiodactyla "Bartos, L., Hyánek, J., & Zirovnický, J. I. R. I. (1981). Hybridization between red and sika deer. II Phenotype analysis. *Zoologischer Anzeiger*, 207(56), 271287." 1981 "A questionnaire survey provided information from 3 preserves and 9 regions where feral sika and red deer occur, from 4 zoological gardens and from the Woburn Deer Park (Bartos and Zirovnický 1981). Evidence cards were prepared. The description of basic data (sex, species, age, weight, locality, hunter) and questions of "yes or no" type of 14 different phenotype elements in 44 different possibilities were involved. The cards were sent to 15 localities in Bohemia and Moravia. After the end of the hunting seasons 1978/79 and 1979/80 the cards were obtained back and analysed. [...] 586 of filled in evidence cards were obtained (84.4% of red deer; 15.6% of sika deer) [...] Higher or lower hybrid trait occurrence was found in all the examined localities. Within the examined populations of red deer, the tail/ear length ratio (it means the tail longer or of the same length as the ear) was the most frequent hybrid trait. Also colouration of tail and hock gland seemed to be a significant indicator of hybridization. [...] The present results indicate the widespread occurrence of hybridization between red and sika deer within the examined localities in Czechoslovakia." Hybridisation Direct *Cervus elaphus* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (i.e. very low frequency of hybrids in some populations (but it is not specified which localities have a high or low frequency) and identification of hybrids based on phenotypic characteristics and not on genetic analyses)" "10 localities of West Bohemia region, 3 localities of Central Bohemia region and 1 locality of South Bohemia region (unspecified)" Bohemia Czech Republic Europe Europe LV March 2018 DJ April 2020
- Cervus nippon* Cervidae Cetartiodactyla "Macháček, Z., Dvořák, S., Ježek, M., & Zahradník, D. (2014). Impact of interspecific relations between native red deer (*Cervus elaphus*) and introduced sika deer (*Cervus nippon*) on their rutting season in the Doupovské hory Mts. *J. For. Sci.*, 60, 272280." 2014 "Research and monitoring were carried out in the Doupovské hory Mts., north-western Bohemia, Czech Republic. [...] Since establishment of the hunting ground in 1953, hunting operations and game population management have been carried out by the Karlovy Vary division of the state enterprise Vojenské lesy a statky České republiky, státní podnik (hereinafter referred to as Military Forestry and Lands). [...] Based on direct observations and evaluation of data on male kills, we used adult male kills as the basic variable determining the peak and timing of the rut. [...] Visual observations available from the study area suggest gradual changes in the rutting behaviour of both the sika and red deer, especially at sites with increased population densities of the two species. It is often possible to observe a sika deer that does not refrain from vocalizing in the vicinity of a rutting red deer in mid-September. [...] Rutting vocalizations of the sika deer have also undergone a significant change over the decades. [...] The mating seasons of the two species thus converge at the mean rate of 0.62 day per year. [...] Our results thus indicate not only a change in genes (which was demonstrated in similar sympatric populations of the sika and red deer in Poland, Biedrzycka et al. 2012), but also a change in behaviour of the two species. [...] This is an indirect evidence of extensive hybridization between the native red deer and the introduced sika deer. No direct proof of this phenomenon is available from the area under study, but we can assume that mutual cross breeding occurs there as well." Hybridisation Direct *Cervus elaphus* Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (no genetic analyses, but measures of the timing of the rutting seasons (based on many inferences))." Doupovské hory Mountains Bohemia Czech Republic Europe Europe LV March 2018 DJ April 2020
- Cervus nippon* Cervidae Cetartiodactyla "Bartos, L., Hyánek, J., & Zirovnický, J. I. R. I. (1981). Hybridization between red and sika deer. II Phenotype analysis. *Zoologischer Anzeiger*, 207(56), 271287." 1981 "The Janovice game preserve in East Bohemia was chosen for the direct study of the phenotypes of the mixed population of red deer and sika deer throughout the year. Both deer species have been kept in this preserve since the 1920'. The observation was performed mainly in 1977 and 1978. [...] The occurrence of a high percentage of phenotypic traits which are regarded as traits of the hybridization of red and sika deer, together with Lowe's finding (1978, personal communication) that 75% of the mathematically demonstrated hybrids carried no hybrid traits, supports the assumption that the population studied throughout the year in the Janovice game preserve is probably at a 100% rate hybridized." Hybridisation Direct *Cervus elaphus* Animalia MR Low "The detected local extinction(s) might be irreversible, if no recolonisation from the meta-population is possible (e.g. if the entire meta-population of the native species is hybridised)." "The impact might be lower, if the native population(s) is/are not locally extinct (i.e. if pure native individuals are still present: poor sample size (N=2) for genetic analyses and the effects on the whole population are inferred)." The Janovice game preserve Bohemia Czech Republic Europe Europe LV March 2018 DJ April 2020
- Cervus nippon* Cervidae Cetartiodactyla "Ferté, H., Cléva, D., Depaquit, J., Gobert, S., & Léger, N. (2000). Status and origin of *Haemonchiae* (Nematoda: Trichostrongylidae) in deer: a survey conducted in France from 1985 to 1998. *Parasitology research*, 86(7), 582587." 2000 "[Transcript] Kotrla and Kotrly (1973) have mentioned the presence of *A. sidemi* in sika deer and, later, in red deer and moufflon sympatric with sika deer (Kotrla et al. 1976). Thus, the presence of *A. sidemi* in roe and red deer in France suggests the possibility of the parasitic transfer from introduced sika deer suggested by Kostyaev (1969) and Ryskoskii (1986) in Russia and by Kotrla and Kotrly (1977) in Czechoslovakia. [...] We examined

294 abomasa of wild roe deer and 25 abomasa of wild red deer between 1985 and 1998. [...] In all, 17 samples were taken from animals found dead (Seine-et-Marne, Haut-Rhin, and Aube). The prevalence of *Ashworthius* was 22% (65/294) in roe deer and 40% (10/25) in red deer. [...] Currently, the effect of parasitism by *Ashworthius* on the physical condition of wild animals cannot be exactly assessed. Nevertheless, the discovery of many of these bloodsucking worms in roe deer found dead indicates that their pathogenicity is comparable with that of *H. contortus* in sheep." Transmission of diseases Indirect

Capreolus capreolus Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (too small sample sizes at each location)." "The impact might be lower, because the performance of native individuals might not be affected (conclusions are only based on anecdotal evidences, there has been no investigation of the effect of the transmitted parasite, *A. sidemi*, on the performance of the native individuals)." "Ille-et-Vilaine, Côtes d'Armor, Morbihan, Loire-Atlantique (Bretagne); Seine-et-Marne, Essonne (Ile de France); Marne, Aisne, Aube, Ardennes, Meuse (Champagne); Haut-Rhin, Bas-Rhin (Alsace)" Bretagne; Ile de France; Champagne; Alsace France Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Perrin, P. M., Mitchell, F. J. G. & Kelly, D. L. Longterm deer exclusion in yewwood and oakwood habitats in southwest Ireland: Changes in ground flora and species diversity. For. Ecol. Manage. 262, 2328–2337 (2011)." 2011 "Changes in ground flora were monitored over a 32-year period in deer exclosures in a yew-wood and a neighbouring oakwood in Killarney National Park, southwest Ireland [...] Four deer-proof exclosures were established in the winter of 1969–70 [...] three further exclosures (C2–C4) were added in 1974–75. [...] A base-line survey of the vascular ground flora in exclosures R1–R3 and C1 was conducted prior to fencing in 1969, and these exclosures were subsequently resurveyed at irregular intervals until 1997 (Table 2). [...] In summer 2001, to permit a comparison of grazed and ungrazed woodland, an unfenced plot was established adjacent to each exclosure (Table 1). [...] In the oakwood, *Luzula sylvatica* and *Vaccinium myrtillus* expanded their cover in one exclosure with cover in ferns declining, but in other exclosures where dense holly thickets developed, it was instead *R. fruticosus* and *H. helix* that became more abundant within the fences than outside. [...] Overall, longterm fencing has caused a shift from vegetation characterised by woodland specialist to woodland generalist species and there are indications of a longterm decline in diversity. We conclude that chronic heavy grazing in these woodlands has strongly influenced the overall abundance and composition of the ground flora, but that complete exclusion of grazing is also undesirable due to potential declines in diversity of woodland specialists. [...] The central management issue concerning this site is heavy grazing, partly by native *Cervus elaphus* (red deer) but largely by nonnative *Cervus nippon* (sika deer) that were introduced to the area in 1865 and have bred extremely successfully (Whitehead, 1964)." Grazing/herbivory/browsing Direct *Luzula sylvatica*; *Vaccinium myrtillus* Plantae MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, because the native population(s) might not be declining (there might have been a subjective placement of the measured plots, small size of exclosures, low numbers of replicate exclosures, relatively small area sampled, and variability in the results (abundance really increased only in one exclosure), so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." "Camillan Wood (Muckross Peninsula, Killarney National Park)" County Kerry Ireland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Cross, J. R. (1981). The establishment of *Rhododendron ponticum* in the Killarney oakwoods, SW Ireland. The Journal of Ecology, 807-824." 1981 "The effects of grazing have been assessed in more detail within two exclosures erected within the woods, one of 750 m² in Camillan Wood, erected in 1969, and the other of 1.2 ha in Tomies Wood, erected in 1972 (Fig. 1). Both sites were similar, with a canopy of mature *Quercus petraea* and occasional *Betula pubescens*, and an understorey of *Ilex aquifolium*. [All data for Camillan Wood and that for Tomies Wood in 1979 obtained using twenty 1 m² quadrats placed at random; remaining data for Tomies Wood from fifty 8 m² plots arranged in a grid; data for 1969, 1972 and 1974 from Kelly (1975)]. Table 1 gives details of changes in the cover of the herb layer within the exclosures, and includes comparison with the cover outside the exclosures in 1979. A slow but steady increase in the cover of the field layer has occurred within the exclosures, whilst grazing pressure has remained high outside (Plate 2). In the Tomies exclosure large numbers of *Ilex aquifolium* seedlings have become established, and in both exclosures *Luzula sylvatica* and *Vaccinium myrtillus* flower and fruit and the ferns produce fertile fronds. There is, however, considerable variation in cover within the exclosures, with dense swards of *Luzula sylvatica* under a thin canopy, but where light is limiting, as for example under the dense canopy of *Ilex aquifolium*, there is still virtually no herb layer. [...] The woods have been subject to almost continuous human disturbance and to grazing for at least four centuries, [...] However, it is very probable that a combination of grazing and burning has reduced the area of the woods." Grazing/herbivory/browsing Direct *Luzula sylvatica*; *Vaccinium myrtillus* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (there is high variation in the recovery of the native species in the exclosures and since these results are using data from Kelly (1975) and that we could not access this study, some information on the experimental design (e.g. size of the exclosures, ...) is missing)." "Camillan Wood (Muckross Peninsula, Killarney National Park), Tomies Wood (Killarney National Park)" County Kerry Ireland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Perrin, P. M., Mitchell, F. J. G. & Kelly, D. L. Longterm deer exclusion in yewwood and oakwood habitats in southwest Ireland: Changes in ground flora and species diversity. For. Ecol. Manage. 262, 2328–2337 (2011)." 2011 "Changes in ground flora were monitored over a 32-year period in deer exclosures in a yew-wood and a neighbouring oakwood in Killarney National Park, southwest Ireland [...] Four deer-proof exclosures were established in the winter of 1969–70 [...] three further exclosures (C2–C4) were added in 1974–75. [...] A base-line survey of the vascular ground flora in exclosures R1–R3 and C1 was conducted prior to fencing in 1969, and these exclosures were subsequently resurveyed at irregular intervals until 1997 (Table 2). [...] In summer 2001, to permit a comparison of grazed and ungrazed woodland, an unfenced plot was established adjacent to each exclosure (Table 1). [...] In the yewwood exclosures, total ground flora cover increased markedly during the period of deer exclusion, the main species to increase in abundance being *Rubus fruticosus* agg. and *Hedera helix*. Herbaceous species increased initially in frequency but subsequently declined; herbaceous species had higher total cover in unfenced plots than in fenced plots at the end of the study. [...] As in Reenadinna, [in Camillan] *L. periclymenum* increased gradually in frequency following fencing. [...] Overall, longterm fencing has caused a shift from vegetation characterised by woodland specialist to woodland generalist species and there are indications of a longterm decline in diversity. We conclude that chronic heavy grazing in these woodlands has strongly influenced the overall abundance and composition of the ground flora, but that complete exclusion of grazing is also undesirable due to potential declines in diversity of woodland specialists. [...] The central management issue concerning this site is heavy grazing, partly by native *Cervus elaphus* (red deer) but largely by nonnative *Cervus nippon* (sika deer) that were introduced to the area in 1865 and have bred extremely successfully (Whitehead, 1964)." Grazing/herbivory/browsing Direct *Rubus fruticosus* agg.; *Hedera helix*; *Lonicera periclymenum* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower (even though the study mentions that there might have been a subjective placement of the exclosures, that exclosures are small, that there was a low number of replicates, and that the sampled area was small, it is likely that the alien caused a decline in the native population(s), because it was a long-term study which showed clear differences between the inside and outside of the exclosures)." "Camillan Wood and neighbouring Reenadinna Wood (Muckross Peninsula, Killarney National Park)" County Kerry Ireland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Bartoš, L. (2009). Sika deer in continental Europe. In *Sika Deer* (pp. 573594). Springer Japan." 2009 "In 1994, we visited Killarney National Park for other purposes and observed various hybrid signs especially in the local red deer population. We even videorecorded a young red deer stag flicking his extraordinary elongated tail in a way characteristic for sika." Hybridisation Direct *Cervus elaphus* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (no information on the proportion of hybrids in the population is provided)." "The impact might be lower, because the performance of native individuals might not be affected (i.e. the presumed hybrids might not be actual hybrids, because no genetic analyses has been performed, and the conclusions are only based on individuals showing hybrid signs)." Killarney National Park County Kerry Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Cross, J. R. (1981). The establishment of *Rhododendron ponticum* in the Killarney oakwoods, SW Ireland. *The Journal of Ecology*, 807-824." 1981 "The effects of grazing have been assessed in more detail within two exclosures erected within the woods, one of 750 m² in Camillan Wood, erected in 1969, and the other of 1.2 ha in Tomies Wood, erected in 1972 (Fig. 1). Both sites were similar, with a canopy of mature *Quercus petraea* and occasional *Betula pubescens*, and an understorey of *Ilex aquifolium*. [All data for Camillan Wood and that for Tomies Wood in 1979 obtained using twenty 1 m² quadrats placed at random; remaining data for Tomies Wood from fifty 8 m² plots arranged in a grid; data for 1969, 1972 and 1974 from Kelly (1975)]. Table 1 gives details of changes in the cover of the herb layer within the exclosures, and includes comparison with the cover outside the exclosures in 1979. A slow but steady increase in the cover of the field layer has occurred within the exclosures, whilst grazing pressure has remained high outside (Plate 2). In the Tomies exclosure large numbers of *Ilex aquifolium* seedlings have become established, and in both exclosures *Luzula sylvatica* and *Vaccinium myrtillus* flower and fruit and the ferns produce fertile fronds. There is, however, considerable variation in cover within the exclosures, with dense swards of *Luzula sylvatica* under a thin canopy, but where light is limiting, as for example under the dense canopy of *Ilex aquifolium*, there is still virtually no herb layer. [...] The woods have been subject to almost continuous human disturbance and to grazing for at least four centuries, [...] However, it is very probable that a combination of grazing and burning has reduced the area of the woods. "

Grazing/herbivory/browsing Direct *Ilex aquifolium* Plantae MN Medium "It is likely that the impact is higher (it is mentioned in the introduction that overgrazing reduced the area of the woods), but the effect of the alien on the size of the native population was not observed or investigated (only recruitment was investigated)." It is unlikely that the impact is lower (direct relevant observational evidence to support the assessment). Tomies Wood (Killarney National Park) County Kerry Ireland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Kelly, D. L. (2002). The regeneration of *Quercus petraea* (sessile oak) in southwest Ireland: a 25year experimental study. *Forest Ecology and Management*, 166(1), 207226." 2002 "[Transcript]

A breach of the enclosure occurred as a result of a tree falling across the fence in the second winter (January 1974). A number of sika deer ranged through the enclosure over a period of about 2 days (P. Moriarty, personnel communication), concentrating their activity in the clearing. [...] Oak seedlings did not exceed 0.3 m high, yet in the clearing 30% were browsed; about half of the shoot was removed in most cases. Seven (4%) died as a direct result, having been more or less uprooted. In the weeded plots, 49% of the oak seedlings were browsed, but only 11% in the unweeded plots [...] The 2day breach of the fence in the second winter of the experiment provided striking evidence of the partiality of sika deer for oak seedlings." Grazing/herbivory/browsing Direct *Quercus petraea* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Tomies Wood (Killarney National Park) County Kerry Ireland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, S. L., Carden, R. F., Coad, B., Birkitt, T. & Pemberton, J. M. A survey of the hybridisation status of *Cervus* deer species on the island of Ireland. *Conserv. Genet.* 15, 823–835 (2014)." 2014 "On the other hand, there was no evidence for nuclear or mitochondrial introgression from Japanese sika into red deer in samples obtained from the North West or, more remarkably, Co. Kerry. [...] In the North West of Ireland, conclusions regarding the extent of red-sika hybridisation are tentative due to small sample sizes. [...] Whilst all our samples from counties Donegal, Tyrone, Sligo, Mayo and Galway typed as 'pure' sika and 'pure' red deer, these counties should continue to be monitored for hybridisation." Hybridisation Direct *Cervus elaphus* Animalia MC Medium "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (very small sample size)." County Donegal; County Tyrone; County Sligo; County Mayo; County Galway County Donegal; County Tyrone; County Sligo; County Mayo; County Galway Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Long, A. M., Moore, N. P., & Hayden, T. J. (1998). Vocalizations in red deer (*Cervus elaphus*), sika deer (*Cervus nippon*), and red× sika hybrids. *Journal of Zoology*, 244(1), 123134." 1998 "In addition, recordings were made of the feral hybrid population in Wicklow National Park (WNP), Co. Wicklow (53°00'N, 06°30'W), an area where complete introgression of the 2 species is believed to have occurred (Harrington, 1973). [...] In addition, significant vocal changes occur as a result of hybridization between red and sika deer in both captive and feral situations. [...] This broad range of call types observed in the Wicklow population indicates that complete introgression between the two parent species has occurred. [...] The calls observed from both captive and feral hybrids may be demonstrating an ability of deer to mimic the calls of other species of deer in close proximity. [...] If deer too were to exhibit such a tendency, one might well expect that an exchange of specific calls might result between such closely-related species. The Killarney deer populations of red and sika have been sympatric for over 130 years, yet the results of this study show that there is no tendency by either deer species to attempt vocal mimicry of the other." Hybridisation Direct *Cervus elaphus* Animalia MR Low "The impact might be lower, if the native population(s) is/are not locally extinct (i.e. if pure native individuals are still present: no genetic analyses and detection of hybrids only based on vocal changes)." Wicklow National Park County Wicklow Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Lowe, V. P. W., & Gardiner, A. S. (1975). Hybridization between red deer (*Cervus elaphus*) and sika deer (*Cervus nippon*) with particular reference to stocks in NW England. *Journal of Zoology*, 177(4), 553566." 1975 "On a recent visit to the Wicklow Mountains in Ireland with Mr Harrington of the Department of Lands, it was interesting to note the great range of variation exhibited by the deer in an entirely hybrid population, and, amongst the forms seen, a number of them fitted very closely to the descriptions of the different mainland and the Foimosan subspecies given in the literature. It is not difficult, therefore, to understand how Delap (1968) came to confuse hybrids such as that in Plate I(b) with the Manchurian race of Sika, as this is the commonest form of hybrid when Sika characters are dominant." Hybridisation Direct *Cervus elaphus* Animalia MR Low "The impact might be lower, if the native population(s) is/are not locally extinct (i.e. if pure native individuals are still present: it is not specified how the authors or the study determined that the population was entirely composed of hybrids, but probably based on hybrid phenotype (and not on genetic analyses))." Wicklow National Park County Wicklow Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, S. L., Carden, R. F., Coad, B., Birkitt, T. & Pemberton, J. M. A survey of the hybridisation status of *Cervus* deer species on the island of Ireland. *Conserv. Genet.* 15, 823–835 (2014)." 2014 "Here, 374 individuals were genotyped at a panel of 22 microsatellites and at a single mtDNA marker that are highly diagnostic for red deer and Japanese sika. [...] Samples were obtained from seven counties in the Republic of Ireland and a single county in Northern Ireland covering the major red deer and Japanese sika populations (Carden et al. 2011). [...] Most samples obtained from Co. Kerry, Co. Cork and Co. Wicklow were shot during the 2011–2012 season; the remaining samples, collected from all eight counties, were sampled between 2006 and 2012. [...] In this study 80 out of 197 (41 %) of the deer sampled from Co. Wicklow were hybrids based on either their nuclear genotype or mitochondrial haplotype, whilst 7 out of 15 (47 %) of those sampled from Co. Cork were also hybrids. [...] Our study suggests that there are no pure red deer

left in Co. Wicklow and it seems likely hybridisation has played a role in this extinction." Hybridisation Direct Cervus elaphus Animalia MR High "It is unlikely that the detected local extinction(s) is/are irreversible (pure red deer still exist in the meta-population and could recolonize the place). "It is unlikely that the impact is lower (the local extinction has been well shown, with genetic analyses and on a large sample size)." County Wicklow; County Cork County Wicklow; County Cork Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "McDevitt, A. D., Edwards, C. J., O'Toole, P., O'Sullivan, P., O'Reilly, C., & Carden, R. F. (2009). Genetic structure of, and hybridisation between, red (Cervus elaphus) and sika (Cervus nippon) deer in Ireland. Mammalian Biology/Zeitschrift für Säugetierkunde, 74(4), 263-273." 2009 "Bi-parental (microsatellites) and maternally-inherited (mitochondrial DNA) genetic markers were utilised that allowed comparisons between 85 red deer from six localities and 47 sika deer from 3 localities in Ireland. [...] Tissue samples from males and females were collected throughout 2007 and 2008 from legally culled deer. [...] All hybrid deer (red/sika) found in this study were found in Wicklow, Galway and Mayo where the 'red-like' deer exhibited sika deer alleles/haplotypes, and vice versa in the case of Wicklow. [...] A total of eight red deer individuals (9.4%) were identified as interspecific hybrids (0.01 to 0.989). [...] Six interspecific hybrids were found in individuals identified as red deer and five individuals identified as sika deer in the Wicklow region (Fig. 2B). A further two red deer individuals from Cos. Mayo and Galway were identified as hybrids. [...] Hybridisation in wild, freeranging red and sika deer still appears to be a rare event and based on the results of this study and contrary to popular belief, it is doubtful that all, or even most, of the deer in Wicklow are hybrids." Hybridisation Direct Cervus elaphus Animalia MN Low "It is likely that the impact is higher, but the effect of the alien on the size of the native population was not investigated (larger sample size would be needed in order to estimate the real extent of hybridisation -for example, in Mayo, 1 out of the 3 sampled individuals were hybrid: it is therefore likely that the impact is higher)" It is unlikely that the impact is lower (detection of hybrids based on genetic analyses). County Wicklow; County Galway; County Mayo County Wicklow; County Galway; County Mayo Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, S. L., Carden, R. F., Coad, B., Birkitt, T. & Pemberton, J. M. A survey of the hybridisation status of Cervus deer species on the island of Ireland. Conserv. Genet. 15, 823–835 (2014)." 2014 "On the other hand, there was no evidence for nuclear or mitochondrial introgression from Japanese sika into red deer in samples obtained from the North West or, more remarkably, Co. Kerry. [...] As a result of their Neolithic introduction to Ireland, and perhaps due to bottlenecks since, the Co Kerry red deer are not only genetically divergent from other red deer in the rest of Ireland (Carden et al. 2012) but also low in genetic diversity. Using eight nuclear markers McDevitt et al. (2009) concluded that mtDNA nucleotide and haplotype diversity in Co Kerry was up to ten times lower than in other parts of Ireland. Therefore, their longstanding isolation, restricted genetic diversity and the process of genetic drift may have caused the Co. Kerry red deer to diverge from other red deer populations to the extent that they have become less genetically and phenotypically compatible with the sika they are now in sympatry with, compared to those that originally resided in Co. Wicklow." Hybridisation Direct Cervus elaphus Animalia MC High "It is unlikely that the impact is higher (no hybrid was detected in a representative sample of the population, based on genetic analyses)." County Kerry County Kerry Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Long, A. M., Moore, N. P., & Hayden, T. J. (1998). Vocalizations in red deer (Cervus elaphus), sika deer (Cervus nippon), and red× sika hybrids. Journal of Zoology, 244(1), 123-134." 1998 "In Killarney, there is a strong consensus, borne out by a number of studies, that these two species have remained genetically intact since the introduction of sika deer to the Killarney area in 1865 (Lowe & Gardiner, 1989; Linnell & Cross, 1991; Murphy, 1995). In this study, the complete absence of the range of call types produced by hybrid deer in the populations of Killarney reinforces the earlier findings that, within this area, hybridization has not yet arisen." Hybridisation Direct Cervus elaphus Animalia MC Low "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (no genetic analyses, and the absence of hybrids has only been concluded from the absence of vocal changes in the native population)." Killarney National Park County Kerry Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "McDevitt, A. D., Edwards, C. J., O'Toole, P., O'Sullivan, P., O'Reilly, C., & Carden, R. F. (2009). Genetic structure of, and hybridisation between, red (Cervus elaphus) and sika (Cervus nippon) deer in Ireland. Mammalian Biology/Zeitschrift für Säugetierkunde, 74(4), 263-273." 2009 "Bi-parental (microsatellites) and maternally-inherited (mitochondrial DNA) genetic markers were utilised that allowed comparisons between 85 red deer from six localities and 47 sika deer from 3 localities in Ireland. [...] Tissue samples from males and females were collected throughout 2007 and 2008 from legally culled deer. [...] All hybrid deer (red/sika) found in this study were found in Wicklow, Galway and Mayo where the 'red-like' deer exhibited sika deer alleles/haplotypes, and vice versa in the case of Wicklow." Hybridisation Direct Cervus elaphus Animalia MC Medium "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (very small sample size)." County Kerry; County Down; County Donegal County Kerry; County Down; County Donegal Ireland Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Husheer, S. W., Allen, R. B., & Robertson, A. W. (2006). Suppression of regeneration in New Zealand mountain beech forests is dependent on species of introduced deer. *Biological Invasions*, 8(4), 823-834." 2006 "Plot data were used to compare mountain beech (*Nothofagus solandri* var. *cliffortioides*) regeneration between a region with sika deer, and four regions without sika deer. All regions surveyed had red deer present. In the region where sika deer had been present for more than a decade, there was evidence of poor mountain beech seedling regeneration. In the four regions without sika deer, there was evidence of a strong regenerative response at stands with low occupancy by trees. [...] Where sika deer had colonised mountain beech seedling abundance was low at all plots, and did not increase with low basal area. Differences in the level of regeneration between areas with and without sika deer were so profound on a landscape scale that the impacts of sika deer appear to be the most plausible explanation for the suppressed mountain beech regeneration observed throughout the Kaimanawa region." Grazing/herbivory/browsing Direct *Nothofagus solandri* var. *cliffortioides* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (even though there has been only one region with the alien against four without, the study is led on a large spatial scale, a relevant temporal scale, and with a relevant sampling design)." Kaimanawa region North Island New Zealand Oceania Oceania LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Demiaszkiewicz, A. W., Kuligowska, I., Lachowicz, J., Pyziel, A. M., & Moskwa, B. (2013). The first detection of nematodes *Ashworthius sidemi* in elk *Alces alces* (L.) in Poland and remarks of ashworthiosis foci limitations. *Acta parasitologica*, 58(4), 515-518." 2013 "Ashworthius sidemi, a nematode belonging to the family of Trichostrongylidae, is a primary parasite of Asiatic cervides, mostly sika deer (*Cervus nippon*), with which it has been introduced to Ukraine, as well as Slovakia, the Czech Republic and France (Ferte and DuretteDeset 1989; Kotrla and Kotrly 1973, 1977; Ovcharenko 1968). Migrating red deer carried this parasite to neighboring countries as well as to Polish territory, namely the Bieszczady Mountains [...] Parasitological examinations were done on 10 digestive tracts from elk hunted in November 2010 under the authorization of the Minister of Environment for scientific purposes in the Augustowska Forest and the Biebrza Marshes. [...] Two out of 10 examined elk were infected with the *Ashworthius sidemi* nematodes, giving an invasion extensiveness of this nematode 20%. [...] *A. sidemi* is a typical parasite of cervides. The invasion occurs in not more than a few hundred nematodes, and seems not to be pathogenic in this case." Transmission of diseases Indirect *Cervus canadensis* Animalia MC Low "The impact might be higher, if the study did not allow to detect an impact on the performance of native individuals (very small sample size and no investigation of the effect of the parasite transmitted by the alien on the performance of the native individuals - "it seems not to be pathogenic")." Augustowska Forest; Biebrza Marshes Augustowska Forest; Biebrza Marshes Poland Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Biedrzycka, A., Solarz, W., & Okarma, H. (2012). Hybridization between native and introduced species of deer in Eastern Europe. *Journal of Mammalogy*, 93(5), 1331-1341." 2012 "Muscle samples of both species were collected between 2005 and 2009 from legally hunted deer. [...] A total of 176 red deer and 50 sika deer were collected from 5 loosely defined populations or regions. We sampled 49 red deer in Pszczyna forest (Polish southern population), 41 red deer in Kadyny forest (Polish northern population), 18 red deer in Kaliningrad District (Russia), and 39 red deer in Lithuania (Fig. 1). In all of these places, red deer and sika deer co-occur. Additionally, we sampled 29 red deer in an area located about 200 km southeast from the northern Polish sika location (Piska forest), because there were several observations of sika stags migrating in that direction. Sika deer samples come from one region in Poland (Kadyny forest, 46 individuals), and from Kaliningrad District (Russia, 4 individuals). [...] Our analysis of 14 hypervariable, unlinked microsatellite loci and an mtDNA marker in a sample of 225 red and sika deer from 5 different regions in Poland, Kaliningrad District, and Lithuania revealed ongoing hybridization between these 2 species across a large geographical scale. [...] We found a total of 35 (15.5%) hybrid individuals in all regions studied, including the region where no sika deer population is established. [...] Taking into account that our sample size was much smaller than in the Scottish study, finding a high number of 1st or 2nd generation hybrids suggests that hybridization events are frequent and that crosses between hybrids occur." Hybridisation Direct *Cervus elaphus* Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the (pure) native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (high percentage of hybrids detected in a relatively small sample size, relevant spatial scale, genetic analyses)." Pszczyna forest; Kadyny forest and Piska forest (Poland); Kaliningrad District (Russian Federation); Lithuania Poland; Russian Federation; Lithuania Poland; Russian Federation; Lithuania Europe; Asia LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Goodman, S. J., Barton, N. H., Swanson, G., Abernethy, K., & Pemberton, J. M. (1999). Introgression through rare hybridization: a genetic study of a hybrid zone between red and sika deer (genus *Cervus*) in Argyll, Scotland. *Genetics*, 152(1), 355-371." 1999 "This article describes an extension of the genetic analysis on the sika and red deer samples collected by Abernethy (1994a,b) between 1991-92. [...] Nine loci, in addition to the two selected by Abernethy (BOVIRBP and OarFCB193; Abernethy 1994b), were identified as being diagnostic because, in a larger test panel of 44 sika and 44 red of diverse geographic origins, no alleles were shared between the taxa.

[...] Our analysis of 11 unlinked microsatellite loci and of the mitochondrial DNA shows that all 246 deer sampled in the Kintyre transect fall into two classes, which correspond to their sika- or red-like phenotype. However, many individuals carry alleles typical of the opposite population at one or more loci. This pattern might be due either to hybridization between red and sika since their recent contact or to polymorphism within the ancestral populations. Three arguments suggest that the former process best accounts for most introgressed alleles. First, the distribution of allele sizes in sika consists of one predominant allele plus several rare alleles, each of which is common in the red-like population (Table 2). [...] Second, the frequency of alleles typical of sika within the red-like population increases markedly to the south, where sika are common (Figure 5b). [...] Finally, three individuals carry 5 apparently introgressed alleles, typical of the opposite race, out of 23 alleles sampled per individual; these are probably first- or second-generation backcrosses. [...] Red-sika hybrids in captive herds do not show any reproductive difficulties (Harrington 1979), and our data show that F1's in the wild must also breed successfully, because otherwise, more would be required to account for the presence of later generations of hybrids. [...] Introgression is rare at any one locus, but where the taxa overlap up to 40% of deer carry apparently introgressed alleles. While most putative hybrids are heterozygous at only one locus, there are rare multiple heterozygotes, reflecting significant linkage disequilibrium within both sika and redlike populations. The rate of backcrossing into the sika population is estimated as $H = 0.002$ per generation and into red, $H = 0.001$ per generation."

Hybridisation Direct Cervus elaphus Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the (pure) native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (relevant spatial scale, genetic analyses, large sample size)."

Argyll Argyll (Scotland) United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Swanson, Graeme Mackie. ""Genetic and phenotypic consequences of translocations of deer (Genus Cervus) in Scotland."" (1999)." 1999 "Intensive Argyll Study - In Argyll, an intensive study was carried out across most of the area, collecting samples from the majority of FE [Forest Enterprise] properties. [...] Across the Argyll study area, 23 distinct Forest Enterprise owned areas were identified as sample sites which corresponded to general deer management areas, 12 in W. Argyll District, 7 in Lome District and 4 in Cowal District (Figure 2.1). [...] Tissue samples were collected by FE ranger staff from shot deer during normal culling operations over the winter cull [season] 1996-97. A small additional set of sixteen samples was collected from the Loch Avich population at the start of the following winter cull due to the rare occurrence of several phenotypic hybrids in the area. [...] A total of 1313 tissue samples were collected from Argyll during this study, with corresponding phenotypic material and larder data. [...] A similar pattern to the Scotland wide study emerged, in which recent hybridisation was rare (except at site 10, Loch Avich) and introgression more extensive in sika like deer (62% of samples) than red-like deer (33%). [...] The Loch Avich population provided the best evidence for recent hybridisation with 14 (32%) samples having hybrid indices between 0.2 and 0.8, four of which were identified as phenotypic hybrids. [...] The results concur with previous data from this area (Goodman, et al., 1999) showing rare introgression at individual loci, but locally high proportions of the population carrying introgressed alleles." Hybridisation Direct Cervus elaphus Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the (pure) native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (relevant spatial scale, genetic analyses, and even though some sites have small sample size, a high percentage of hybrids has been detected at these sites)" Argyll Argyll (Scotland) United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, Stephanie L., et al. ""Introgression of exotic Cervus (nippon and canadensis) into red deer (Cervus elaphus) populations in Scotland and the English Lake District."" Ecology and Evolution (2018)." 2018 "From Kintyre, Argyll, we included genotype data at the study loci from the previous study of Senn and Pemberton (2009) (n = 735 individuals) and we collected additional samples, specifically from WLA and South Kintyre (SK) in 2008- 11, bringing the total number of animals sampled from Kintyre to 1,054. [...] We included samples from 727 animals from eight Hebridean islands collected in 2009-2010. For this study, 570 individuals from 18 Forestry Commission Scotland management units across the North Highlands were sampled in 2009-2011. Samples obtained from the Central Highlands included a set from in and around the Cairngorms National Park and the Loch Lomond and the Trossachs National Park (n = 171 individuals, collected 2008-2012) and a set from open hill estates across the Central Highlands from the study of Pérez- Espona et al. (2008) (n = 235, collected 2003-2004) giving a total of 406 animals sampled. Finally, 137 samples were obtained from the English Lake District via Eleni Socratous, University of Leicester. These samples were collected during 2008-2010 and mostly came from Grizedale. [...] Specifically, within two regions of Kintyre, WLA [West Loch Awe] and SK [South Kintyre], 45% and 55%, respectively, of the individuals analyzed were nuclear hybrids. Sites adjacent to these two main areas of introgression also returned substantial numbers of hybrids (Figures 3 and S6). [...] While the hybrid swarm at WLA [West Loch Awe] has been documented previously (Senn & Pemberton, 2009), the extensive hybridization found at SK [South Kintyre] has only become apparent with the additional samples collected for this study." Hybridisation Direct Cervus elaphus Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower,

because the decline(s) in the native population(s) is/are well shown (relevant spatial scale, genetic analyses, large sample size and high frequency of hybrids detected)." Kintyre Peninsula Argyll (Scotland) United Kingdom Europe

Europe LV July 2019DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Diaz, A., Pinn, E., & Hannaford, J. (2005). 14. Ecological impacts of Sika Deer on Poole Harbour saltmarshes. *Proceedings in Marine Science*, 7, 175188." 2005 "Where grazing was severe, there was an almost total loss of vegetation cover. [...] The creation of bare patches in saltmarshes can lead to the development of hypersaline conditions due to increased surface evaporation in the absence of vegetation cover (Bertness, 1991). This may have contributed to the development of lower saltmarsh communities, able to tolerate high levels of salinity during the summer, dominated by *Salicornia ramosissima*, in the intensively grazed areas of the higher marsh positions at Arne. [...] In this study, grazed plots regained the species composition typical of ungrazed plots within 4 years." Grazing/herbivory/browsing Direct Saltmarsh flora Plantae MO Medium "Impact might be higher and have led to the extinction of native plant species (the study investigated changes in saltmarsh flora in general, making it difficult to understand which species are affected, and how)" "It is unlikely that the impact is lower (direct relevant observational evidence to support the assessment, and even though the study did not focus on the species level, it is likely that at least one native population declines if the whole cover declines)" Arne RSPB reserve (Purbeck) Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Hannaford, J., Pinn, E. H., & Diaz, A. (2006). The impact of sika deer grazing on the vegetation and infauna of Arne saltmarsh. *Marine pollution bulletin*, 53(1), 5662." 2006 "During the summer of 2002, a survey of Arne saltmarsh was undertaken to assess the general extent of deer grazing at Arne. [...] 50 plots were established in three different locations: 20 in grazed areas, 20 in ungrazed areas and 10 fenced enclosures. [...] Each plot measured 2 m · 2 m and were marked out using bamboo canes to enable repeat sampling. The fenced plots were sited within heavily grazed areas and were set-up in 1989 as part of a previous study at Arne. [...] The impact of deer grazing was investigated using a standard vegetation survey within each plot to determine species composition and abundance. [...] Grazing appeared to have an impact on vegetation diversity and abundance. *S. anglica* was much less abundant in grazed areas whilst *S. ramosissima* and *P. maritima* were more abundant (Fig. 2(b)). In contrast, *S. maritima* and *H. portulacoides* were more abundant in ungrazed and fenced areas (Fig. 2(b)) whilst *P. coronopus* and *T. maritima* only occurred in ungrazed areas (Fig. 2(b)). In addition, bare mud was more common in the grazed areas (Fig. 2(b)). The grazing regime did not appear to affect the abundance of *Limonium* spp. (Fig. 2(b)) but this result may simply reflect the low abundance of this species in the experimental area. [...] The findings of this study indicated that deer grazing at Arne had a significant impact on the saltmarsh flora and fauna, but that this impact was localised. Where grazing was severe, there was a decrease in vegetation height and diversity." Grazing/herbivory/browsing Direct *Spartina anglica*; *Suaeda maritima*; *Halimione portulacoides*; *Plantago coronopus*; *Triglochin maritima* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (difficult to conclude to a general decrease in the populations from this experimental design (no monitoring of the native population(s)))." Arne RSPB reserve (Purbeck) Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Hannaford, J., Pinn, E. H., & Diaz, A. (2006). The impact of sika deer grazing on the vegetation and infauna of Arne saltmarsh. *Marine pollution bulletin*, 53(1), 5662." 2006 "During the summer of 2002, a survey of Arne saltmarsh was undertaken to assess the general extent of deer grazing at Arne. [...] 50 plots were established in three different locations: 20 in grazed areas, 20 in ungrazed areas and 10 fenced enclosures. [...] Each plot measured 2 m · 2 m and were marked out using bamboo canes to enable repeat sampling. The fenced plots were sited within heavily grazed areas and were set-up in 1989 as part of a previous study at Arne. [...] The abundance of the macro-infauna of the saltmarsh was also assessed using the augur drill. [...] A 20 cm diameter augur drill was used to obtain three core samples to a depth of 10 cm. [...] The cores collected were sieved through a 0.5 mm sieve and the retained invertebrate fauna were identified to species level. [...] In addition, *H. ulvae* dominated the fauna of the grazed plots whilst *Gammarus* spp. was proportionally more abundant in the ungrazed areas (Fig. 4(c))." "Chemical, physical or structural impact on ecosystems" Indirect *Gammarus* spp. Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale which might not be relevant for evaluating the impact on the native population(s): it might only be an avoidance behavior from the native population(s))." Arne RSPB reserve (Purbeck) Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "House, C., May, V. & Diaz, A. 15. Sika Deer trampling and saltmarsh creek erosion: Preliminary investigation. *Proc. Mar. Sci.* 7, 189–193 (2005)." 2005 "The study site was an area of saltmarsh between Shipstal Point and Gold Point, Arne. Creek sections crossed by deer were located by following deer tracks across the marsh. Fifteen 1 m sections of creek crossed by deer and 15 control sections (i.e. not crossed by deer) were chosen at random from areas across the study site. [...] The percentage cover of each plant species within the 1 m x 1 m areas immediately either side of each creek-crossing was recorded in February 1999 and February 2000. [...] Creek sections crossed by deer were found to be significantly more eroded than control creeks ($t = 3.40$, $P = 0.002$). [...] Creek sections crossed by deer were significantly less vegetated than control creeks ($t = -7.49$, $P < 0.001$) (Figure 2). Further analysis

showed that, at the level of individual plant species in creeks crossed by deer, the loss of cover of *Puccinellia maritima* was significantly correlated with increased erosion (Spearman rank $r = -0.527$, $P = 0.043$)."

Direct *Puccinellia maritima* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only small areas were sampled)." It is unlikely that the impact is lower (the loss of cover means that native individuals are susceptible to erosion). Arne RSPB reserve (Purbeck) Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Uzal Fernandez, A. The interaction of Sika deer (*Cervus nippon* Temminck 1838) with lowland heath mosaics. Analysis 1–190 (2010)." 2010 "A total of 90 sampling points ('sites') were placed at random locations on lowland heath in the two study areas, 60 in Arne and 30 in Hartland, following two restrictions: i) a minimum distance between sites of 25 m; ii) the random sites were divided equally between dry and wet heath as they are the main two habitats on lowland heath in the study areas. [...] The animal survey was based on the use of pitfall traps to collect surface-active invertebrates. [...] At each site, two invertebrate pitfalls were installed. [...] Traps were set for 100 continuous days from May to September 2008 and were visited every 20 days to collect the invertebrates and refill the traps with preservative. [...] The three taxonomic levels considered were i) order level; ii) families within the order Coleoptera (beetles) and iii) detailed classification of the family Carabidae into species. [...] Despite the lack of a strong trend in the relationship between the diversity of surface-active invertebrates and the local density of Sika deer on lowland heath, results of this research showed some evidence that the composition of communities of surface-active invertebrates on dry heath was related to the composition of the vegetation community. This relationship between the composition of communities of surface-active invertebrates on dry heath and the composition of the vegetation community can be considered as an indirect effect of the local density of deer as results showed a significant relationship between the local density of Sika deer on dry heath and the composition of plant communities. [...] On wet heath the composition of communities of surface-active invertebrates were directly related to the local density of Sika deer. [...] Sites with the presence of *C. problematicus* and *A. parallelepipedus* were found in areas of higher local density of deer, while sites with presence of *Nebria brevicollis* and *P. minor* were found in areas of lower local density of deer. However, the weakness of this relationship might indicate that, in fact, this result might be a statistical artefact." "Chemical, physical or structural impact on ecosystems" Indirect *Nebria brevicollis*; *Prerostichus minor* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (very weak negative correlation between the abundance of the alien and the abundance of the native, which might just consist in a statistical artefact); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (no exclusion of confounding effects)." "Arne RSPB reserve, Hartland Moore National Nature Reserve (Purbeck)" Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Uzal Fernandez, A. The interaction of Sika deer (*Cervus nippon* Temminck 1838) with lowland heath mosaics. Analysis 1–190 (2010)." 2010 "A total of 90 sampling points ('sites') were placed at random locations on lowland heath in the two study areas, 60 in Arne and 30 in Hartland, following two restrictions: i) a minimum distance between sites of 25 m; ii) the random sites were divided equally between dry and wet heath as they are the main two habitats on lowland heath in the study areas. [...] Surveys of both the communities of plant and surface-active invertebrates were conducted at each site. The vegetation survey was conducted on four plots of 2m x 2m placed at random around each signed post marking the site [...] Plant community surveys were carried out from February to November 2008 and classified into four seasons: winter (February), spring (May), summer (August) and autumn (November 2008). To determine the species composition of the plant community and the percentage of cover of each species, a vegetation survey was carried out within each plot. [...] In particular, higher local density of deer was related to the decline in quality of dry heath plant communities. This decline in quality was chiefly due to a reduction in total vegetation volume, particularly the abundance of *C. vulgaris*; an increase in bare ground, dead vegetation and disturbed areas; the establishment of opportunistic species (i.e. *P. aquilinum*, lichens and bryophytes). By contrast, on wet lowland heath, only a decrease in the abundance of *M. caerulea* and an enhancement of plant diversity were related to higher local density of Sika deer." Grazing/herbivory/browsing; Direct physical disturbance Direct *Calluna vulgaris*; *Molinia caerulea* Plantae MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." "Arne RSPB reserve, Hartland Moore National Nature Reserve (Purbeck)" Dorset (England) United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Gill, R. M. A., & Morgan, G. (2010). The effects of varying deer density on natural regeneration in woodlands in lowland Britain. *Forestry*, 83(1), 53-63." 2010 "To explore the full range of effects that deer have on forests, 15 sites were selected with the primary objective of embracing a range of deer densities and therefore included areas with few or no deer (e.g. the Isle of Wight) as well as areas known to have high densities. [...]"

Within each block, between 1 and 19 stands (satisfying the constraints mentioned above), were randomly selected (Table 2). [...] Normally, 10 plots were sampled per stand, although this was increased or reduced in a few of the largest and smallest stands, respectively. [...] Within the blocks, impacts were assessed on advance regeneration in mature stands containing mainly broadleaved tree species (85 per cent of basal area). [...] Among seedlings, the most prevalent species were ash (22 per cent), sycamore *Acer pseudoplatanus* (12 per cent), oak (12 per cent), holly *Ilex aquifolium* (12 per cent) and hawthorn *Crateagus monogyna* (10 per cent). [...] In each plot, the number of naturally regenerating tree seedlings and number damaged by deer were counted in each of two height classes. Trees 0 – 30 cm tall were recorded in a circular plot of 200 cm radius and trees 30 – 150 cm tall in a plot of 350 cm radius. [...] The results show that higher deer densities were associated with higher rates of browsing and reduced seedling densities across the range of sites that were sampled. These results are broadly typical of many other investigations of ungulates in woodlands, which reveal a marked reduction in seedling density with increased browsing pressure." Grazing/herbivory/browsing Direct *Acer pseudoplatanus*; *Quercus* sp.; *Ilex aquifolium*; *Crateagus monogyna* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)."

"West Oxfordshire; Mundford (Thetford Forest Park, Suffolk); King's Forest (Thetford Forest Park, Suffolk); Chilterns; West Midlands; Alice Holt (Hampshire); Cotswolds; Lower Woods (Gloucestershire); Dean; High Meadow (Surrey); Chiddingfold (Surrey) (England); Breiddens (Powys, Wales); Nash Wood (England/Wales)" England United Kingdom Europe Europe LV January 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, Stephanie L., et al. ""Introgression of exotic *Cervus* (*nippon* and *canadensis*) into red deer (*Cervus elaphus*) populations in Scotland and the English Lake District."" Ecology and Evolution (2018)." 2018 "From Kintyre, Argyll, we included genotype data at the study loci from the previous study of Senn and Pemberton (2009) (n = 735 individuals) and we collected additional samples, specifically from WLA and South Kintyre (SK) in 2008- 11, bringing the total number of animals sampled from Kintyre to 1,054. [...] We included samples from 727 animals from eight Hebridean islands collected in 2009–2010. For this study, 570 individuals from 18 Forestry Commission Scotland management units across the North Highlands were sampled in 2009–2011. Samples obtained from the Central Highlands included a set from in and around the Cairngorms National Park and the Loch Lomond and the Trossachs National Park (n = 171 individuals, collected 2008–2012) and a set from open hill estates across the Central Highlands from the study of Pérez- Espona et al. (2008) (n = 235, collected 2003—2004) giving a total of 406 animals sampled. Finally, 137 samples were obtained from the English Lake District via Eleni Socratous, University of Leicester. These samples were collected during 2008–2010 and mostly came from Grizedale. [...] We have also demonstrated that in scattered parts of the North Highlands, there are small numbers of individuals which look like red deer or sika but they have introgressed genes from the other species, while in the Lake District, very few phenotypically red deer carry traces of sika. The Hebrides populations of red deer appear free of sika introgression to date."Hybridisation Direct *Cervus elaphus* Animalia MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected (very low frequency of hybrids detected in a large sample size)." It is unlikely that the impact is lower (detection of hybrids based on genetic analyses). Lake District (England); North Highlands (Scotland) England; Scotland United Kingdom Europe Europe LV July 2019DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. *Ibis*, 149(s2), 119-127." 2007 "To address this need, one of us (R.M.A.G.) surveyed 13 mature woodland sites, assessing both deer population density and understorey vegetation density in late winter or early spring 2002 and 2003. [...] Foliage density was measured by recording the visibility of a 0.5 × 0.5-m frame from 10 m at four compass directions at ten plots in each stand. This was repeated at successive 0.5-m height intervals between ground level and 3.5 m. Visibility was recorded in three 'intensities' (0, entirely visible; 1, partially obscured; 2, totally obscured) and expressed as a percentage of the maximum possible score (8). Canopy cover was recorded by estimating overhead cover in 5% cover classes. [...] The experiment consists of eight plots of uniform coppice age of mean size 1.1 ha (range 0.8–1.5 ha). Half of each plot was fully protected from deer browsing immediately after felling and removal of the cut underwood by the erection of a 1.8-m steel deer fence. The remaining area was surrounded by a dead hedge. The experiment therefore compared total exclusion of deer with shortterm exclusion. [...] Bramble cover, canopy cover, low vegetation cover, field layer density and shrub layer density tended to be higher within the fenced subplots. Grass cover, however, was higher outside the fences. In the case of Bramble and field layer, the effect of fence was only apparent in the interaction with plot. [...] The results indicate a marked reduction in foliage density with increasing deer density (Fig. 1; Table 2), reducing the foliage density score by up to 92% of the zero deer density score. The reduction was greatest (and statistically more significant) at the height at which deer forage (below 1.5 m), and greater for larger deer species (at a given density) than smaller species. The effects of deer were significant after including canopy cover as a variable in all the models." Grazing/herbivory/browsing Direct Bramble; Canopy; Low vegetation; Shrub layer; Field layer Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the overall visibility and density of the vegetation was measured)." "Hereford, Gloucestershire, Oxfordshire, Surrey, Norfolk (England); Powys (Wales)" England; Wales United Kingdom Europe Europe LV March

2019 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Putman, R. J. Grazing in temperate ecosystems: large herbivores and the ecology of the New Forest. (1986)." 1986 "The patchy turf of Forest grasslands boasts no plant material higher than a few millimetres - apart from the occasional stem of ragwort! (Plate 14). Such grasslands clearly lack many of the possible structural layers of mature, ungrazed grasslands. On heathlands, too, the effects of heavy grazing are clear in their reduction of structural diversity. [...] New Forest woodlands virtually lack any ground flora or shrub layer. The woodland floor is essentially bare, and indeed the whole structural 'layer' between ground level and 1.8 m - the extent of a pony's reach - is missing: most of the Forest woodlands display a marked browse line at this level (Plate 15). Under continuous browsing pressure, palatable shrubby species such as hawthorn, blackthorn and hazel are eliminated and fail to regenerate. Even species relatively resistant to grazing, such as holly or gorse, are heavily used: taller holly trees are thoroughly browsed up to the 1.8-m browse line and have little vegetation below this level; shrubs of both holly and gorse which fall entirely within the reach of the herbivores are severely stunted and 'hedged' by the continuous browsing (Plate 16). At the ground level, brambles, ivy and other low vegetational species are completely eliminated; the only species which gives any structure at this level is bracken (*Pteridium*), which, although eaten by the ponies at certain times of year, is not particularly palatable. [...] Fifteen years after fencing, there were shown to be 35 times as many trees in the ungrazed pen as in the pen still grazed by fallow deer, although the difference between the compounds is not significant until the regenerating trees are included in the analysis. [...] Results from this study highlight the differences in vegetational composition and structure between woodland areas free of grazing animals and those maintaining a high density of large herbivores. Differences in structure - and actual vegetational bulk in terms of pure biomass or bulk of material - are apparent both in the ground flora and in the woody vegetation. Much of the difference between the grazed and ungrazed area results from the massive regeneration of tree species which has occurred in the area free of grazing; results emphasise the lack of such regeneration in grazed areas. This suppression of regeneration may have a direct effect on physical structure of the vegetation, but in the long term has an even more significant effect - on the population age structure of the Forest trees." Grazing/herbivory/browsing Direct *Fagus sylvatica*; *Quercus* sp.; *Pinus sylvestris*; *Larix* sp.; *Betula* sp.; *Pseudotsuga menziesii*; *Ulex europaeus*; *Ilex aquifolium*; *Crataegus monogyna*; *Prunus spinosa*; *Salix* sp.; *Calluna* sp.; *Erica* sp.; *Agrostis setacea*; *Leontodon autumnalis*; *Trifolium repens*; *Trifolium pratense*; *Vulpia bromoides*; *Cerastium holosteoides*; *Leontodon autumnalis*; *Sagina procumbens* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (some impacts are directly measured, some a just reviewed); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other introduced herbivores are excluded by the enclosures, and Sika deer is not representing a main part of the guild)." New Forest Hampshire (England) United Kingdom Europe Europe LS January 2018 DJ April 2020 *Cervus nippon* Cervidae Cetartiodactyla "Lowe, V. P. W., & Gardiner, A. S. (1975). Hybridization between red deer (*Cervus elaphus*) and sika deer (*Cervus nippon*) with particular reference to stocks in NW England. *Journal of Zoology*, 177(4), 553-566." 1975 "Using multivariate methods of analysis on a range of skull measurements (see page 556) obtained from samples of both species and their hybrids, an attempt was made to find some means of distinguishing the hybrids from the species irrespective of the extent to which introgression had occurred. [...] Only the skulls from Witherslack, supplied by Mr R. H. Bradley, which were collected whenever an opportunity occurred to shoot itinerant parties of deer, provided us with anything approaching a random sample. Using these skulls in conjunction with samples of Sika and Red deer skulls, we have tried to devise a method of analysing the skull measurements which would distinguish all hybrids from either of the parent species and also measure the degree of introgression. [...] At least 36 deer with obvious hybrid characters are known to have been shot in the region. In addition a further nine deer were shot or found dead, none of which appeared to be of hybrid origin, but all of which were subsequently found to have skulls hybrid in character. Of these we have been able to examine, measure and use 19, see Appendix 1. [...] More recently, however, hybrid stags have been seen and collected very much further to the west and north, one in Holker Park (H in Fig. 4), near Cark-in-Cartmel, another in the northern section of Grizedale Forest (G in Fig. 4) near Hawkshead and two to the east of Thirlmere. It appears, therefore, that they are continuing to extend their range westwards and northwards and are now mixing with populations of native Red deer. It will be interesting to see if hybridization now extends to these native animals also, which is at least suggested by the two stags from the east side of Thirlmere. [...] It appeared from these analyses that all the Red deer blood in the hybrids in the Cartmel Fell area was of park origin. Hybridization probably occurred on Middleton Fell in the 1920s and has subsequently spread westwards and northwards. Today it seems unlikely that there are any Red deer left in this area. All the present stock possess to some degree hybrid characteristics. [...] This may explain why no hybrids have arisen among the Japanese Sika deer in the Bowland area, and may also explain why, in both Wicklow (Ireland) and in the Cartmel Fell area, we are now left with a situation in which introgression with Red deer (of park origin) is complete, and the species lost, whilst the Sika deer have remained unaffected." Hybridisation Direct *Cervus elaphus* Animalia MR Low "The impact might be lower, if the native population(s) is/are not locally extinct (i.e. if pure native individuals are still present: small sample size, detection of hybrids only based on skull characteristics, the purpose of the study was not to

investigate the extent of introgression and therefore the impact at the population level is inferred)." Cartmel Fell Lake District (England) United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Delap, P. (1968). Observations on deer in north-west England. Journal of Zoology, 156(4), 531-533." 1968 "This south-east corner of the Lake District holds a rather isolated nucleus of some 30 Red deer, previously of quite normal appearance. From 1961 unusual young deer began to appear within this herd. By 1966 at least eight such animals had been studied in the field, all displaying strong Sika characteristics. During the October rut in 1965, 1966 and 1967 a mature stag was observed with the main Cartmel hind nucleus, who was obviously the sire of these youngsters. The Forestry Commission, on whose land the rut takes place, decided to shoot these hybrid beasts to prevent deterioration of the fine native Red deer. Just before he was shot the old male was pursuing one of the spotted hybrid hinds and was heard to utter a repeated hoarse squeal-the typical Sika rutting-cry. The Red stag, of course, roars on these occasions. This animal weighed 194 stone and his teeth-wear corresponded to an age of about 12 years. In appearance and in antler style he was intermediate between the two species. There seems no doubt that this animal was a Red deer/Manchurian half-breed and that he was fertile : indeed successful backcrossing was taking place and where his own quarter-bred hinds were involved the F 2 generation were so strongly Sika as to suggest pure-bred animals to one expert observer. Intervention by the Forestry Commission has probably forestalled the production of a "hybrid swarm".

Hybridisation Direct Cervus elaphus Animalia MN Medium It is unlikely that the impact is higher (hybrids individuals have directly been removed from the native population). "The impact might be lower, because the performance of native individuals might not be affected (i.e. the presumed hybrids might not be actual hybrids, because no genetic analyses has been performed, and the conclusions are only based on phenotypical observations)." Lake District Lake District (England) United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Swanson, Graeme Mackie. "Genetic and phenotypic consequences of translocations of deer (Genus Cervus) in Scotland." (1999)." 1999 "Extensive Scotland wide survey - In the other areas, sampling was aimed at collecting representative samples from any surviving sika populations, as well as any neighbouring red deer populations which could potentially have hybridised. [...] In total 670 deer (phenotypically 336 red, 326 sika & 8 hybrid; of both sexes as available) were sampled across Scotland as part of the extensive study (Table 2.2). In addition, 325 samples from phenotypically red deer collected from several parts of Scotland in 1991-1992 by the British Deer Society were made available by Dr Mike Bruford, Institute of Zoology, London. [...] Small numbers of hybrids were found in all phenotypically red populations except Helmsdale." Hybridisation Direct Cervus elaphus Animalia MC Medium "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (very small sample size)." Helmsdale Helmsdale (Scotland) United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Swanson, Graeme Mackie. "Genetic and phenotypic consequences of translocations of deer (Genus Cervus) in Scotland." (1999)." 1999 "Extensive Scotland wide survey - In the other areas, sampling was aimed at collecting representative samples from any surviving sika populations, as well as any neighbouring red deer populations which could potentially have hybridised. [...] In total 670 deer (phenotypically 336 red, 326 sika & 8 hybrid; of both sexes as available) were sampled across Scotland as part of the extensive study (Table 2.2). In addition, 325 samples from phenotypically red deer collected from several parts of Scotland in 1991-1992 by the British Deer Society were made available by Dr Mike Bruford, Institute of Zoology, London. [...] Samples with several introgressed alleles at different loci provided strong evidence for hybridisation since introduction in Argyll, Galloway and Sutherland and Ross-shire, but different patterns of introgression emerged. [...] In Galloway a number of early generation hybrids were identified. In Sutherland and Ross-shire, introgression was common (>75% of individuals) in sika-like deer at 5 of the 10 micro satellite loci but almost absent at the other loci, suggesting a hybridisation event(s) several generations ago followed by backcrossing and strong assortative mating. [...] The evidence from this study suggests that hybridisation does tend to occur in these circumstances as all three newly hybridised populations identified across Scotland (Argyll, Easter Ross and Borders) are at the leading edge of sika colonisation into resident red deer areas." Hybridisation Direct Cervus elaphus Animalia MN Medium "The impact might be higher, if the hybridisation is more frequent than the results suggest (large sample size: small proportion of hybrids in red-like populations, but higher proportions of hybrids in sika-like populations)" It is unlikely that the impact is lower (detection of hybrids based on genetic analyses). "Sutherland, Easter Ross, Borders" Scotland United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. Ibis, 149(s2), 119-127." 2007 "In each year since 1999, the distribution of bird territories was established through territory mapping, with up to 15 visits in the period April to early June (Bibby et al. 2000). [...] However, there is much that remains unclear about how deer are affecting British woodland bird populations. Apart from our results using fenced enclosures in Bradfield Woods, direct evidence of a link between deer numbers and songbirds is still lacking. It is still not entirely clear to what extent recent declines in woodland songbird populations have been caused by deer or whether they simply coincide temporally with a general increase in deer numbers. Nonetheless, the

Bradfield Woods results do suggest that, at least at a local scale, reductions in some species may be associated with increased pressure from deer. [...] These results lend support to the hypothesis that deer are at least partly responsible for causing declines in some British bird populations, but they do not eliminate the possibility that increased shading is also responsible for changes in woodland structure." "Chemical, physical or structural impact on ecosystems" Indirect
Sylvia communis; *Sylvia borin*; *Sylvia atricapilla*; *Phylloscopus collybita*; *Phylloscopus trochilus*; *Luscinia megarhynchos*; *Prunella modularis*; *Turdus merula* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (Bibby et al. 2000 observed a general decline in woodland birds in Britain, but no decline of these specific local native populations have been shown, except regarding *Luscinia megarhynchos* (Fuller et al. 2001)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other bird species are also declining nationally because of other stressors, it might be the case for this species as well; in addition, other introduced deer species are present, increased shading might also play a role, and the study only establishes the responsibility of the alien in the decline(s) by showing a potential indirect mechanism)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Cervus nippon Cervidae Cetartiodactyla "Pérez-Espona, S., Pérez-Barbería, F. J., Goodall-Copestake, W. P., Jiggins, C. D., Gordon, I. J., & Pemberton, J. M. (2009). Genetic diversity and population structure of Scottish Highland red deer (*Cervus elaphus*) populations: a mitochondrial survey. *Heredity*, 102(2), 199." 2009 "The largest population of red deer (*Cervus elaphus*) in Europe is found in Scotland. However, human impacts through hunting and introduction of foreign deer stock have disturbed the population's genetics to an unknown extent. In this study, we analysed mitochondrial control region sequences of 625 individuals to assess signatures of human and natural historical influence on the genetic diversity and population structure of red deer in the Scottish Highlands. Genetic diversity was high with 74 haplotypes found in our study area (115–87 km). Phylogenetic analyses revealed that none of the individuals had introgressed mtDNA from foreign species or subspecies of deer and only suggested a very few localized red deer translocations among British localities. [...] The study area comprised 14 open hill estates distributed across a 115–87 km area in the Scottish Highlands (Figure 1). Samples consisted of an ear tip or a sample of jaw muscle from a total of 625 legally shot red deer (345 males and 280 females). [...] Although possible hybridization events in our study area involving non-native male deer will remain undetected because of the maternal inheritance of mtDNA, we would expect that owing to the strongly polygynous mating system characteristic of red deer, breeding success of introduced females must have been higher than that of introduced males. Considering the large number of samples included in our study, if past introductions had been extensive and successful in our study area this would have been reflected in the mtDNA diversity, structure and phylogenetic analyses." Hybridisation Direct *Cervus elaphus* Animalia MC High "It is unlikely that the impact is higher, as genetic analyses on a large sample size showed that no hybridisation is occurring between the native and alien populations." Central Highlands Scotland United Kingdom Europe Europe LV July 2019 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Swanson, Graeme Mackie. "Genetic and phenotypic consequences of translocations of deer (Genus *Cervus*) in Scotland." (1999)." 1999 "Extensive Scotland wide survey - In the other areas, sampling was aimed at collecting representative samples from any surviving sika populations, as well as any neighbouring red deer populations which could potentially have hybridised. [...] In total 670 deer (phenotypically 336 red, 326 sika & 8 hybrid; of both sexes as available) were sampled across Scotland as part of the extensive study (Table 2.2). In addition, 325 samples from phenotypically red deer collected from several parts of Scotland in 1991–1992 by the British Deer Society were made available by Dr Mike Bruford, Institute of Zoology, London. [...] Introgression was uncommon in the remaining sika-like populations (<20% of individuals) and rare in red-like populations (<5%), but most red-like populations contained rare alleles whose origins were difficult to interpret. [...] In the first group of populations identified above, the presence of rare alleles typical of the opposite taxon does not alone provide sufficient evidence for hybridisation, as these alleles may represent ancient polymorphism within the parental populations (Goodman et al., 1999). [...] These alleles may represent polymorphism, introgression from unreported sika introductions or introgression from introduced wapiti (*C. canadensis* L. 1758)." Hybridisation Direct *Cervus elaphus* Animalia MC Low "The impact might be higher (if the hybridisation with the alien is the reason of the introgression - "the presence of rare alleles typical of the opposite taxon does not alone provide sufficient evidence for hybridisation")." "Great Glen, Loch Morar, Angus, Fife" Scotland United Kingdom Europe Europe LV March 2018 DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Smith, Stephanie L., et al. "Introgression of exotic *Cervus* (*nippon* and *canadensis*) into red deer (*Cervus elaphus*) populations in Scotland and the English Lake District." *Ecology and Evolution* (2018)." 2018 "From Kintyre, Argyll, we included genotype data at the study loci from the previous study of Senn and Pemberton (2009) (n = 735 individuals) and we collected additional samples, specifically from WLA and South Kintyre (SK) in 2008–11, bringing the total number of animals sampled from Kintyre to 1,054. [...] We included samples from 727 animals from eight Hebridean islands collected in 2009–2010. For this study, 570 individuals from 18 Forestry Commission Scotland management units across the North Highlands were sampled in 2009–2011. Samples obtained from the Central

Highlands included a set from in and around the Cairngorms National Park and the Loch Lomond and the Trossachs National Park (n = 171 individuals, collected 2008–2012) and a set from open hill estates across the Central Highlands from the study of Pérez- Espona et al. (2008) (n = 235, collected 2003—2004) giving a total of 406 animals sampled. Finally, 137 samples were obtained from the English Lake District via Eleni Socratous, University of Leicester. These samples were collected during 2008–2010 and mostly came from Grizedale. [...] The Hebrides populations of red deer appear free of sika introgression to date. [...] In the Central Highlands, samples obtained from in and around the national parks (n = 171) were free from hybridization as were the wider sample of deer from upland estates throughout the Central Highlands (n = 233) (Q ? 0.99, Figures 3 and S6)."Hybridisation Direct Cervus elaphus Animalia MC High "It is unlikely that the impact is higher, as genetic analyses on a large sample size showed that no hybridisation is occurring between the native and alien populations." Hebridean Islands; Central Highlands Scotland United Kingdom Europe Europe LV July 2019DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Feldhamer G.A., Chapman J.A. and Miller R.L. (1978) Sika Deer and WhiteTailed Deer on Maryland's Eastern Shore. 30, 585–593.; Keiper, R. R. (1985). Are sika deer responsible for the decline of white-tailed deer on Assateague Island, Maryland?. Wildlife Society Bulletin (1973-2006), 13(2), 144-146." 1978 "[Feldhamer et al. 1978] For the years 1973-77, deer possession tags obtained from hunters at various check stations were examined for Dorchester, Wicom- ico and Worcester counties, Maryland. Prior to 1973, no differentiation between sika and white-tailed deer could be recorded on the tags. Beginning in 1973, space was provided to indicate which species of deer was killed. The species and sex of each deer killed were recorded relative to county election districts in order to enhance determination of trends. [...] large numbers of sika deer currently exist and where the number of sika deer killed each year since 1973 has also steadily in- creased. During this time, an average of 63.4% of the county deer harvest has come from these election districts, and more sika deer than white-tailed deer were harvested for the first time in 1976 from this portion of the county. [...] In both instances, the success of the sika deer was attributed to their more diverse and adaptable feeding habits, especially in over-browsed habitat, as opposed to any overtly aggressive behavioral traits. This process may be operating in sympatric populations of sika deer and white-tailed deer in Maryland and is currently being investigated. Another possible reason for the observed trend in harvest data is that sika deer are rath- er diminutive animals, smaller than white- tails, and are generally less preferable as game animals. It is quite possible, therefore, that differential hunting pressure befalls white-tails, either because they are more eas- ily seen or simply preferred by hunters."

Competition Indirect Odocoileus virginianus Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (data are based on harvested densities (records from hunters) instead of a population monitoring (however, since Odocoileus virginianus is apparently preferred as game animal, the fact that the number of killed individuals is decreasing suggests that the population is indeed declining), and the impact is measured over a small temporal scale, what could only show natural fluctuations of the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (preference of hunters for the native species)." "Dorchester County, Wicomico County, Worcester County" Maryland United States North America North and Central America "Feldhamer et al. (1978) showed the decline of the native white-tailed deer concomitant with the increase of the sika deer; Keiper (1985) showed that the diet of the two species overlap, to show competition between the two species and explain why the decline occurred (mechanism)" LV February 2018DJ April 2020

Cervus nippon Cervidae Cetartiodactyla "Armstrong, W. E., & Harmel, D. E. (1981). Exotic mammals competing with the natives. Texas Parks and Wildlife Department." 1981 "Production and survival studies on axis, sika and white-tailed deer also were started in 1971 in three 96-acre, deer-proof pastures on the Kerr Wildlife Management Area. All grazing animals were removed from the pastures for three years prior to the study to allow for recovery of preferred deer foods. In January 1971, six sika deer (two bucks and four does) and a similar herd of six whitetails were trapped and transplanted onto one 96-acre pasture. [...] No hunting was permitted and animals were allowed to increase and compete for available food supplies. Biologists made weekly checks during fawning seasons to determine fawn production. Extensive observations were made during extremely dry periods and other stressful conditions to determine deaths of the three species. [...] From January 1971 through April 1974, the whitetail population increased to 15 and the sika herd increased to 16. Competition for available food became severe between the two species. This competition, combined with a drought in the summer of 1975, resulted in severe white-tailed deer food shortages, and the whitetail population dropped to six deer by the end of 1976. During this same period, the sika deer population increased to 32 animals. In December 1979, three whitetails and 62 sika deer were present in the pasture. The remaining three whitetails died in February 1980."

Competition Indirect Odocoileus virginianus Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the effects of the alien was studied at a small spatial scale (inclosures)).""The impact might be lower, because the performance of native individuals might not be affected (the experimental conditions might not representative of what happens in the wild, if, for instance, the alien and native individuals avoid each others in the wild)." Kerr Wildlife Management Area Texas United States North America North and Central America LV January 2018 DJ April 2020

Dama dama Cervidae Cetartiodactyla "Barrios-Garcia, M. N., Relva, M. A., & Kitzberger, T. (2012). Patterns of use and damage by exotic deer on native plant communities in northwestern Patagonia. *European journal of wildlife research*, 58(1), 137-146." 2012 "Browsing was the most extensive and intensive damage on native plant communities. Deer browsed most of the 30 woody species recorded in this study; however, deer browsed more than expected on two evergreen species (*A. chilensis* and *S. patagonicus*) and two spinescent species (*C. hystrix* and *D. diacanthoides*). [...] The observed damage is the result of two different deer species with overlapping ranges. Pooling the impact of red and fallow deer could be problematic; however, in this system it is not possible to differentiate them based on the indicators we used. Because bite size is similar for both species and pellet sizes also overlap for most of their lifetime, the identification of browsing patterns by individual deer species is possible only through direct observation, when the two species occupy similar but non-overlapping ranges, or by use of stomach content analyse." Grazing/herbivory/browsing Direct *Austrocedrus chilensis*; *Schinus patagonicus*; *Colletia hystrix*; *Dasyphyllum diacanthoides* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (other introduced deer are present)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Relva, M. A., & Veblen, T. T. (1998). Impacts of introduced large herbivores on *Austrocedrus chilensis* forests in northern Patagonia, Argentina. *Forest Ecology and management*, 108(1), 27-40." 1998 "In northern Patagonia, impacts of introduced animals on tree regeneration and understory composition are likely to continue to be a problem for land managers whether the objective of the management be regeneration following timber harvesting or protection of the native flora in parks and reserves. [...] the inhibitory effects of the browsing animals are manifested as stunting and poor form rather than reduced abundance. Heavily browsed *Austrocedrus* saplings typically lose their apical buds and the proliferation of lateral branches creates a shrubby form. Where the land use objective is timber production, this type of animal impact is of substantial economic impact." Grazing/herbivory/browsing Direct *Austrocedrus chilensis* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Relva, M. A., Nunez, M. A., & Simberloff, D. (2010). Introduced deer reduce native plant cover and facilitate invasion of non-native tree species: evidence for invasional meltdown. *Biological Invasions*, 12(2), 303-311." 2010 "Introduced deer had an important negative effect on height growth of both the dominant native and the main exotic tree species. However, the impact is stronger for native *Austrocedrus* than for exotic *P. menziesii*. [...] Even though the mean height of native and exotic tree saplings in our study site is within the range of deer browse, it is much lower for *Austrocedrus* (26 cm, ± 2.9) than for *P. menziesii* (103 cm, ± 11.05). In light of the limited ability of *Austrocedrus* to compensate for loss of tissue (Relva and Sancholuz 2000), deer browsing can significantly lengthen the time required for this native species to reach a height threshold to escape from browsing. Our results may thus support the invasional meltdown hypothesis, as the net effect of exotic deer was more negative on native trees than on exotic trees, therefore facilitating the exotics. [...] There is no statistical difference in the cover of exotic species after deer exclusion; however, there is a trend for a reduction in the cover of exotics and an increase in the cover of natives. Although 32% of recorded species were exotics, they are not as important as natives in terms of abundance and richness." Grazing/herbivory/browsing Direct *Austrocedrus chilensis* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the individual growth was investigated)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. *Journal of Applied Ecology*, 711-724." 1989 "The most dramatic difference between understoreys with and without exotic deer in the *Nothofagus-Austrocedrus* forests studied was the scarcity of the subcanopy tree *Aristotelia chilensis* in the deer-affected area. The drastic reduction in the abundance of *A. chilensis* on Isla Victoria is consistent with the near elimination of this species over a 4-year period at a site with a dense red deer population in a Chilean rain forest (Ramirez et al. 1981). Similarly, in New Zealand forests which share many genera with south Andean forests, the most severe impacts of exotic deer have been on subcanopy tree and shrub species (Veblen & Stewart 1982). The results of our quantitative comparison of the vegetation of an area with high deer densities with an area lacking deer are consistent with earlier qualitative observations of deer influences on the vegetation of Isla Victoria" Grazing/herbivory/browsing Direct *Aristotelia chilensis*Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other introduced deer are present)." Isla victoria

(Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Veblen, T. T., Mermoz, M., Martin, C., & Ramilo, E. (1989). Effects of exotic deer on forest regeneration and composition in northern Patagonia. *Journal of Applied Ecology*, 711-724." 1989 "Luma apiculata, another subcanopy tree species, showed a consistent pattern of greater abundance on Peninsula Quetihue (Tables 3-5). It was so rare on Isla Victoria that the frequency with which it was browsed was low. Mean maximum heights on the island however, were 19-5 cm (S.E. 6 5) compared to 147 cm (S.E. 30) on the peninsula. This difference suggests that deer have inhibited its growth. [...] The canopy tree Austrocedrus was rare in the seedling and sapling size-classes in both areas, making the assessment of deer browsing on its regeneration difficult. Deer, however, browse it intensely and create dwarfed and deformed seedlings. In some stand had a high browse pressure index (Tables 3 and 4). [...] N. dombeyi seedlings had a mean height of 73-4 cm (S.E. 9-1; n=49). The relatively high mean susceptibility rating of 1-9 also reflects impairment of N. dombeyi regeneration due to deer browsing." Grazing/herbivory/browsing Direct Luma apiculata; Austrocedrus chilensis; Nothofagus domeyi Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (even though the rarity of the seedlings and saplings in both area render the assessment of the effect of browsing difficult, impaired regeneration due to browsing has been observed)." Isla victoria (Nahuel Huapi National Park) Neuquén ArgentinaSouth America South America DJ July 2017LV March 2019

Dama dama Cervidae Cetartiodactyla "Bowman, F. (2014). A pilot study examining the ecological and human dimensions of wild deer management, Nariel Valley Victoria. B. Sc.(Hons) Thesis, University of Canberra, Canberra." 2014 "Damage to vegetation and soil from deer was estimated at each faecal pellet survey site (i.e. 20 transects per EVC, 600 plots). Each plot was searched for signs of deer damage. Evidence of deer damage was classified into the following categories: browsed vegetation, formation of trails, trampled or thrashed vegetation, hoof prints, wallows, and tree rubs. Extensive reconnaissance was also undertaken throughout the native vegetation in the vicinity of the transects to detect damage by deer to vegetation and soils. Observations were made opportunistically between May to August, 2014 and were confined to the native vegetation within 200 m distance from cleared land. [...] Antler damage to the bark of trees and saplings was observed throughout the study area. In particular, it was common to observe removal, damage and scattered remains of bark at the base of trees, which appeared to be related to damage caused by antler rubbing. [...] Antler rubbing was found to be extensive within the forest and woodland areas, with damage to some trees and saplings so significant that it had resulted in mortality of some individual plants, particularly saplings. Antler rubbing was observed on a variety of tree species and of varying sizes in the study area (Figure 3.8). Damage was frequently observed on Cherry Ballart (*Exocarpus cupressiformis*) and Brittle Gum (*Eucalyptus mannifera*) trunks. [...] A few Cherry ballart trees were found to have died as a result of antler rubbing in this study. [...] Understory vegetation was significantly reduced along game trails and in encampment areas. [...] Observed structural damage included creation of opened up areas, and the death or reduced fitness of individual plants. [...] While the results of this study only detected minimal damage by thrashing and trampling (2% of survey plots), observations indicated that deer were causing significant damage through this behaviour." Grazing/herbivory/browsing; Direct physical disturbance Direct "Exocarpus cupressiformis; Eucalyptus mannifera; undefined ("variety of tree species"; "understorey vegetation")" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the authors mentioned that what they observed in the plots was not fully representative of what they observed at a larger scale)." "The impact might be lower, because the performance of native individuals might not be affected (the authors mention that browsing may cause the death of individuals or affect their fitness, but it is not clear if they directly observed it in this study, and how they define an effect on the fitness of the native individuals)." Nariel Valley Victoria Australia Oceania Oceania LV January 2018 DJ April 2020

Dama dama Cervidae Cetartiodactyla "Ferretti, F., Sforzi, A., & Lovari, S. (2011). Behavioural interference between ungulate species: roe are not on velvet with fallow deer. *Behavioral Ecology and Sociobiology*, 65(5), 875-887." 2011 "In the whole study area, the summer density of roe deer decreased by 24.0% from 2007 (10.7 ind/100 ha±4.9 ind/100 ha; 0.90 confidence intervals) to 2009 (8.2 ind/100 ha±3.4 ind/100 ha; 0.90 confidence intervals; Fig. 5b). In contrast, the summer density of fallow deer increased by 12.9% from 2007 (14.4 ind/100 ha±2.8 ind/100 ha; 0.90 confidence intervals) to 2009 (16.3 ind/100 ha± 2.7 ind/100 ha; 0.90 confidence intervals; Fig. 5b). [...] Our data showed that fallow deer can actively exclude roe from feeding sites. Not surprisingly, presence and density of roe deer have been shown to be negatively affected by high fallow deer densities (Focardi et al. 2006; our data). [...] Could interference by fallow negatively affect the numbers of roe deer? Inverse numerical trends have been reported for roe and fallow deer, with decreasing roe numbers (Batcheler 1960; Putman and Sharma 1987; Focardi et al. 2006). These trends may be interpreted as independent reactions of roe and fallow deer to a third factor (Putman 1996; e.g. habitat modification, Batcheler 1960). We observed a reduction of roe deer and an increase of fallow deer numbers in our study area. Number of sightings in all observation sites also followed the same pattern. In our study area, with the sampling strategy adopted, the faecal accumulation rate (Mayle et al. 1999) has been shown to be reliable to estimate deer densities (Fattorini et al. 2010), suggesting that our estimates actually

reflected a reduction of roe deer density and an increase of fallow deer numbers, at the population scale." Competition Indirect *Capreolus capreolus* Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Maremma Regional Park Central Italy Italy Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Focardi, S., Aragno, P., Montanaro, P., & Riga, F. (2006). Inter-specific competition from fallow deer *Dama dama* reduces habitat quality for the Italian roe deer *Capreolus capreolus italicus*. *Ecography*, 29(3), 407-417.; Focardi, S., Montanaro, P., Isotti, R., Ronchi, F., Scacco, M., & Calmanti, R. (2005). Distance sampling effectively monitored a declining population of Italian roe deer *Capreolus capreolus italicus*. *Oryx*, 39(4), 421-428." 2006 "[Focardi et al. 2005] Monitoring rare species of wild ungulates is critical for their conservation management. The Italian roe deer *Capreolus capreolus italicus* was recently confirmed to be a subspecies in Mediterranean habitats of central and southern Italy. We have monitored this subspecies at Castelporziano, near Rome, since 1988, and detected an abrupt population decline in 2001. [...] A general count of ungulates was made in the second half of March each year (Focardi et al., 1996; Focardi et al., 2002b). Animals were observed from a variable number of positions throughout the study area. In open areas we used 5-m high observation towers. This method allowed us to record group size and composition (Focardi et al., 1996, 2002b).; [Focardi et al. 2006] The roe deer of Mediterranean habitats in the central and southern parts of Italy has recently been recognised as a distinct subspecies, *Capreolus capreolus italicus*. A population of this endangered subspecies has been monitored in the Preserve of Castelporziano, near Rome, since 1988. We observed an abrupt population decline in 2000, which may severely threaten the sustainability of this population. We evaluated the hypothesis that competition by fallow deer may be a principal cause of this decline. By a new and innovative methodology, we modelled the spatial distribution of fallow deer density (FDD) in the study area to show that 1) habitat quality for roe deer was an inverse function of FDD, 2) habitat apportionment between fallow and roe deer increased as a function of FDD and by applying structural equation modelling 3) FDD was superior to habitat composition in explaining observed variations in home range size and probably in habitat quality for roe deer. This analysis is the first to document that inter-specific competition may influence the spatial behaviour of a deer species leading to poor phenotypic performance in the inferior competitor. We conclude that the conservation of this relict population would benefit by reducing fallow deer numbers at Castelporziano and from other measures aimed to decrease the level of inter-specific competition. [...] Our analysis strongly supports the hypothesis that competitive interactions with fallow deer are a significant contributing factor in the decline of this roe deer population. Two points are especially relevant: 1) habitat separation between the 2 species increased as a function of the fallow deer density and 2) fallow deer density explained home range variation of roe deer _ and thus the poor phenotypic traits shown by several individuals _ better than did habitat composition. Maximum likelihood analyses also suggested that models of roe deer performance based on fallow deer distribution and density alone, or at least FDD combined with aspects of habitat quality, were statistically the most likely of alternative explanations." Competition Indirect *Capreolus capreolus* Animalia MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The decline is well shown (in Fuller et al. 2005), but the impact might be lower, if the alien did not cause the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Preserve of Castelporziano Preserve of Castelporziano Italy Europe Europe Focardi et al. (2006) tested the mechanism (competition) through which the alien could negatively impact the native roe deer population and could cause the decline observed in Focardi et al. (2005). LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Imperio, S., Focardi, S., Santini, G., & Provenzale, A. (2012). Population dynamics in a guild of four Mediterranean ungulates: density-dependence, environmental effects and inter-specific interactions. *Oikos*, 121(10), 1613-1626.; Focardi, S., Franzetti, B., Ronchi, F., Imperio, S., Montanaro, P., Aragno, P., & Toso, S. (2015). Monitoring populations of a guild of ungulates: implications for the conservation of a relict Mediterranean forest. *Rendiconti Lincei*, 26(3), 535-544." 2012 "[Imperio et al. 2012] Here we studied the population dynamics of four wild ungulate species in the Castelporziano Preserve near Rome, Italy, as obtained from detailed bag counts from hunting drives during the period 1878–1986: the Italian roe deer *Capreolus capreolus italicus*, the Maremma wild boar *Sus scrofa majori* (both endemic to Italy), the native red deer *Cervus elaphus*, and the alien fallow deer *Dama dama*. We also considered the effects of the presence of another alien ungulate, the nilgai *Boselaphus tragocamelus*. [...] Population density estimates are obtained from the data base of bag records described by Imperio et al. (2010). Data are available for the period 1878 to 1986 (records are missing in nine out of 109 years, mostly during the two World Wars, thereafter WWI and WWII) and are shown in Fig. 1 (upper panel). [...] Perhaps the most relevant impact was that of fallow deer on the dynamics of roe deer, which, however, was only evident during preremoval sub-period B, presumably as a consequence of the very high fallow deer density at that time. Results of the SEM model suggest that the observed inverse correlation between fallow and roe deer densities was not a side effect of spurious correlations with unknown variables but, instead, was due to a direct

competition between the two species (Putman 1996). This finding is consistent with the available information on inter-specific competition in Mediterranean environments (Focardi et al. 2006, Ferretti et al. 2008); [Focardi et al. 2015] We reconstructed the variations in populations of ungulates for the period 1878–1986, using calibrated harvest data (Imperio et al. 2010), and we tested several hypotheses about factors driving the fluctuations of these populations thanks to a complete set of habitat and climate data (Imperio et al. 2012). [...] Both intra- and inter-specific competition appeared to have a stronger effect than habitat and climate on the growth rates of the three studied species. Although these populations were mainly regulated by density dependence, inter-specific relationships also appeared to play an important role, especially for roe deer which suffered from fallow deer competition. [...] Apparently, the reduction in the fallow deer population after 2005 has produced a slow increase in the roe deer population; the same pattern was seen with hunting bag records showing that the increase of the fallow deer population in the years 1908–1915 preludes to the crash of the roe deer population in 1918–1920. " Competition Indirect Capreolus capreolus Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects; however, the results of the SEM indicate that the decline in the native population(s) is directly due to competition with the alien and the analyses of Focardi et al. 2015 support this conclusion (competition appeared to have a stronger effect than habitat and climate on the growth rates))." Preserve of CastelporzianoPreserve of Castelporziano Italy Europe Europe Imperio et al. (2012) and Focardi et al. (2015) showed that the dynamic in the population of the alien influenced the dynamic of the native population over 109 years. LS

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Dama dama Cervidae Cetartiodactyla "Smale, M. C., Hall, G. M. J., & Gardner, R. O. (1995). Dynamics of kanuka (*Kunzea ericoides*) forest on South Kaipara spit, New Zealand, and the impact of fallow deer (*Dama dama*). *New Zealand Journal of Ecology*, 131-141." 1995 "The mahoe population also increased significantly inside the exclosure (a fivefold increase in seedling numbers), but not outside. Amongst understorey species in Lookout Bush, coastal karamu (*Coprosma macrocarpa* Cheeseman) and to a small extent kawakawa, invaded the exclosure, but remained absent outside (Table 4). Hangehange invaded both plots, but the exclosure much more abundantly. There was a highly significant decline in small-leaved coprosmas inside the exclosure, and a significant decline in prickly heath outside. [...] Two markedly different successional pathways are evident. Within the exclosure (i.e., in the absence of deer), kanuka and its associated subcanopy species are being replaced by mahoe and another generation of houpara, and outside by another generation of both kanuka and houpara - an example of a partially "stalled succession" (Connell and Slatyer, 1977). Mapou seems likely to be but a minor component of any future canopy [...] The continuing impact of fallow deer is still considerable, altering the composition not only of the current understorey, but also of the future canopy." Grazing/herbivory/browsing Direct *Coprosma* spp.; *Melicytus ramiflorus*; *Myrsine australis* Plantae MN Low "It is likely that the impact is higher (very important increase of the native species within the exclosure), but the study did not allow to detect the effect of the alien on the native population size (focused on saplings)." Woodhill Forest North Island New Zealand Oceania Oceania

LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" *Ecological monographs* 71.4 (2001): 587-614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama* wallaby) [...] The effects of browsing mammals on the soil microfood web were clearly multitrophic in nature for several locations; populations of microbe-feeding and predaceous nematodes were significantly affected by browsers in both the humus and litter layers in nearly half the site. [...] Effects of browsers on abundances of microarthropods were negative for all but one of the 63 instances in which a significant effect at $P \leq 0.05$ was detected (Fig. 9)." "Chemical, physical or structural impact on ecosystems" Indirect Nematoda; Rotifera; Copepoda; Tardigrada Animalia MO Medium "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in nematode, rotifer, copepod and tardigrad abundances in general, making it difficult to understand which species are affected, and how)" "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population size(s) but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (other deer present)" Woodhill Forest North Island New Zealand Oceania Oceania

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Dama dama Cervidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" *Ecological monographs* 71.4 (2001): 587-614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama* wallaby) [...] In most locations browsing mammals reduced plant diversity (Shannon-Weiner index) in the browse layer; diversity was greater inside the exclosure than outside for all but three locations and for half the locations the effects were significant at $P \leq 0.05$ (Fig. 12). [...] Species that were frequently

severely reduced by browsers included *Geniostoma rupestre* J. R. Forst. & G. Forst., *Astelia* spp., *Griselinia littoralis* Raoul, and *Coprosma* spp. (especially *C. grandifolia* Hook. f.)." Grazing/herbivory/browsing Direct *Geniostoma rupestre*; *Melicytus ramiflorus* Plantae MN Medium "It is likely that the impact is higher, but the study did not allow to detect the effect of the alien on the native population size (only investigated the density of the species in the browse layer (0-2m height), which is rather a measure of the performance (regeneration))." Woodhill Forest North Island New Zealand Oceania Oceania DJ July 2017LV June 2019

Dama dama Cervidae Cetartiodactyla "Husheer, S. W., & Frampton, C. M. (2005). Fallow deer impacts on Wakatipu beech forest. *New Zealand Journal of Ecology*, 83-94." 2005 "This study provides circumstantial evidence of poor regeneration of two deer-palatable subcanopy hardwood species in Wakatipu Forest between 1976 and 1999, and does not show increases in the density of deer-palatable species following the introduction of restricted recreational hunting in 1981. Instead, it appears that browsing by fallow deer has prevented recruitment of seedlings of the palatable *G. littoralis* (broadleaf) into the sapling and tree tiers. Sapling density of the palatable *R. simplex* (three finger) was lower than its tree stem density, also suggesting suppression of regeneration. [...] This study provides little evidence that browsing by fallow deer induced large changes in the structure and composition of Wakatipu beech forests over the last two decades. The limited compositional changes that were detected could be due to natural successional processes, or to the legacy of high fallow deer densities prior to plot establishment, as much as to contemporary effects of fallow deer browsing on the remaining palatable species" Grazing/herbivory/browsing Direct "*Griselinia littoralis*; *Nothofagus menziesii*; *Carpodetus serratus*; *Raukaua simplex*" Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." It is unlikely that the impact is lower (the effects on the performance of native individuals have been tested with enclosure). Wakatipu Forest South Island New Zealand Oceania Oceania LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Lecomte, X., Fedriani, J. M., Caldeira, M. C., Clemente, A. S., Olmi, A., & Bugalho, M. N. (2016). Too many is too bad: Long-term net negative effects of high density ungulate populations on a dominant Mediterranean shrub. *PloS one*, 11(7), e0158139." 2016 "Our study showed that high density populations of ungulate herbivores can have a drastic negative effect on plant size and number of *C. ladanifer* flower-buds produced thus, limiting the availability of ripe fruits holding fully developed seeds that could be disseminated into the soil seed bank. The effects of such dramatic decline of shrub reproductive structures, translated along the plant reproductive cycle and led to reduced fruit set, limited soil seed bank, ultimately affecting the population density of *C. ladanifer*. The long-term net balance between ungulate herbivory and its effects on number of flower buds and potential seed dispersal was thus highly negative for the plant, as illustrated by the strong decrease of *C. ladanifer* density after 12 years. These results highlight the potential of high density ungulate populations, favored by habitat management practices such as limited culling policies and food supplementing, to alter the nature of species interactions " Grazing/herbivory/browsing Direct *Cistus ladanifer* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (the experimental design might not be ideal for monitoring the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other introduced deer species are present)." Tapada Real de Vila Viçosa (Tapada de Baixo) Tapada Real de Vila Viçosa (Tapada de Baixo) Portugal Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Joys, A. C., Fuller, R. J., & Dolman, P. M. (2004). Influences of deer browsing, coppice history, and standard trees on the growth and development of vegetation structure in coppiced woods in lowland England. *Forest Ecology and Management*, 202(1), 23-37." 2004 "According to the Kolmogorov–Smirnov test statistic on the distribution of the coppice compartments, the vegetation structure is significantly different between low and high deer browsing. The exception being cover of bramble and overstorey canopy cover. [...] Overall, vegetation development was delayed by deer browsing as found in English coppice (Fuller, 2001) and European woodlands (Peterken and Jones, 1989; Berquist et al., 1999; Kirby, 2001). " Grazing/herbivory/browsing Direct *Fraxinus excelsior*; *Corylus avellana*; *Salix* spp.; *Betula* spp.; *Alnus glutinosa* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth of individuals was investigated)." "Treswell Wood (Nottinghamshire, England); Foxley Wood, Ashwellthorpe Wood, Wayland Wood (Norfolk, England); Gamlingay Wood, Hayley Wood (Cambridgeshire, England); Bradfield Wood, Groton Wood, Bonny Wood, Priestley/Swingens Wood, Wolves Wood (Suffolk, England)" England United Kingdom Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Gill, R. M. A., & Morgan, G. (2010). The effects of varying deer density on natural regeneration in woodlands in lowland Britain. *Forestry*, 83(1), 53-63." 2010 "To explore the full range of effects that deer have on forests, 15 sites were selected with the primary objective of embracing a range of deer densities and therefore included areas with few or no deer (e.g. the Isle of Wight) as well as areas known to have high densities. [...] Within each block, between 1 and 19 stands (satisfying the constraints mentioned above), were randomly selected (Table 2

). [...] Normally, 10 plots were sampled per stand, although this was increased or reduced in a few of the largest and smallest stands, respectively. [...] Within the blocks, impacts were assessed on advance regeneration in mature stands containing mainly broadleaved tree species (85 per cent of basal area). [...] Among seedlings, the most prevalent species were ash (22 per cent), sycamore *Acer pseudoplatanus* (12 per cent), oak (12 per cent), holly *Ilex aquifolium* (12 per cent) and hawthorn *Crateagus monogyna* (10 per cent). [...] In each plot, the number of naturally regenerating tree seedlings and number damaged by deer were counted in each of two height classes. Trees 0 – 30 cm tall were recorded in a circular plot of 200 cm radius and trees 30 – 150 cm tall in a plot of 350 cm radius. [...] The results show that higher deer densities were associated with higher rates of browsing and reduced seedling densities across the range of sites that were sampled. These results are broadly typical of many other investigations of ungulates in woodlands, which reveal a marked reduction in seedling density with increased browsing pressure." Grazing/herbivory/browsing Direct *Acer pseudoplatanus*; *Quercus* sp.; *Ilex aquifolium*; *Crateagus monogyna* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "West Oxfordshire; Mundford (Thetford Forest Park, Suffolk); King's Forest (Thetford Forest Park, Suffolk); Chilterns; West Midlands; Alice Holt (Hampshire); Cotswolds; Lower Woods (Gloucestershire); Dean; High Meadow (Surrey); Chiddingfold (Surrey) (England); Breiddens (Powys, Wales); Nash Wood (England/Wales)" England United Kingdom Europe Europe LV January 2018 DJ April 2020

Dama dama Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. *Ibis*, 149(s2), 119-127." 2007 "To address this need, one of us (R.M.A.G.) surveyed 13 mature woodland sites, assessing both deer population density and understorey vegetation density in late winter or early spring 2002 and 2003. [...] Foliage density was measured by recording the visibility of a 0.5 × 0.5-m frame from 10 m at four compass directions at ten plots in each stand. This was repeated at successive 0.5-m height intervals between ground level and 3.5 m. Visibility was recorded in three 'intensities' (0, entirely visible; 1, partially obscured; 2, totally obscured) and expressed as a percentage of the maximum possible score (8). Canopy cover was recorded by estimating overhead cover in 5% cover classes. [...] The experiment consists of eight plots of uniform coppice age of mean size 1.1 ha (range 0.8–1.5 ha). Half of each plot was fully protected from deer browsing immediately after felling and removal of the cut underwood by the erection of a 1.8-m steel deer fence. The remaining area was surrounded by a dead hedge. The experiment therefore compared total exclusion of deer with shortterm exclusion. [...] Bramble cover, canopy cover, low vegetation cover, field layer density and shrub layer density tended to be higher within the fenced subplots. Grass cover, however, was higher outside the fences. In the case of Bramble and field layer, the effect of fence was only apparent in the interaction with plot. [...] The results indicate a marked reduction in foliage density with increasing deer density (Fig. 1; Table 2), reducing the foliage density score by up to 92% of the zero deer density score. The reduction was greatest (and statistically more significant) at the height at which deer forage (below 1.5 m), and greater for larger deer species (at a given density) than smaller species. The effects of deer were significant after including canopy cover as a variable in all the models." Grazing/herbivory/browsing Direct Bramble; Canopy; Low vegetation; Shrub layer; Field layer Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the overall visibility and density of the vegetation was measured)." "Hereford, Gloucestershire, Oxfordshire, Surrey, Norfolk (England); Powys (Wales)" England; Wales United Kingdom Europe Europe LV March 2019 DJ April 2020

Dama dama Cervidae Cetartiodactyla "Putman, R. J. Grazing in temperate ecosystems: large herbivores and the ecology of the New Forest. (1986)." 1986 "The patchy turf of Forest grasslands boasts no plant material higher than a few millimetres - apart from the occasional stem of ragwort! (Plate 14). Such grasslands clearly lack many of the possible structural layers of mature, ungrazed grasslands. On heathlands, too, the effects of heavy grazing are clear in their reduction of structural diversity. [...] New Forest woodlands virtually lack any ground flora or shrub layer. The woodland floor is essentially bare, and indeed the whole structural 'layer' between ground level and 1.8 m - the extent of a pony's reach - is missing: most of the Forest woodlands display a marked browse line at this level (Plate 15). Under continuous browsing pressure, palatable shrubby species such as hawthorn, blackthorn and hazel are eliminated and fail to regenerate. Even species relatively resistant to grazing, such as holly or gorse, are heavily used: taller holly trees are thoroughly browsed up to the 1.8-m browse line and have little vegetation below this level; shrubs of both holly and gorse which fall entirely within the reach of the herbivores are severely stunted and 'hedged' by the continuous browsing (Plate 16). At the ground level, brambles, ivy and other low vegetational species are completely eliminated; the only species which gives any structure at this level is bracken (*Pteridium*), which, although eaten by the ponies at certain times of year, is not particularly palatable. [...] Fifteen years after fencing, there were shown to be 35 times as many trees in the ungrazed pen as in the pen still grazed by fallow deer, although the difference between the compounds is not significant until the regenerating trees are included in the analysis. [...] Results from this study highlight the differences in vegetational composition and structure between woodland areas free of grazing animals and those maintaining a high density of large herbivores. Differences in structure - and actual vegetational bulk in terms of pure biomass or bulk of material - are apparent both in the ground flora and in the woody vegetation. Much of the difference between the grazed and ungrazed area results from the massive regeneration of

tree species which has occurred in the area free of grazing; results emphasise the lack of such regeneration in grazed areas. This suppression of regeneration may have a direct effect on physical structure of the vegetation, but in the long term has an even more significant effect - on the population age structure of the Forest trees." Grazing/herbivory/browsing Direct *Fagus sylvatica*; *Quercus* sp.; *Pinus sylvestris*; *Larix* sp.; *Betula* sp.; *Pseudotsuga menziesii*; *Ulex europaeus*; *Ilex aquifolium*; *Crataegus monogyna*; *Prunus spinosa*; *Salix* sp.; *Calluna* sp.; *Erica* sp.; *Agrostis setacea*; *Leontodon autumnalis*; *Trifolium repens*; *Trifolium pratense*; *Vulpia bromoides*; *Cerastium holosteoides*; *Leontodon autumnalis*; *Sagina procumbens* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced deer present)." New Forest Hampshire (England) United Kingdom Europe Europe LS January 2018 DJ April 2020 *Dama dama* Cervidae Cetartiodactyla "Putman, R. J., Edwards, P. J., Mann, J. C. E., How, R. C., & Hill, S. D. (1989). Vegetational and faunal changes in an area of heavily grazed woodland following relief of grazing. *Biological Conservation*, 47(1), 13-32." 1989 "Two 5""6 ha inclosures were established in 1963 within an area of heavily grazed deciduous woodland in the New Forest, Hampshire. In one, a constant grazing pressure was maintained (at c. 1 fallow deer ha⁻¹); the other was kept free of all large herbivores. The vegetation of both was surveyed 6 years, 14 years and 22 years after inclosure. [...] Since 1963 the plot in which deer have been kept appears in practice to have sustained more intensive browsing than the vegetation outside, and this is reflected in the shrub and herb layers. The deer have prevented any tree regeneration, and have eliminated almost all holly, hawthorn and other understorey, even where these persist in the general forest woodlands beyond the plots. Gorse, where it persists within the plot, is severely 'hedged'." Grazing/herbivory/browsing Direct *Betula* spp.; *Fagus sylvatica*; *Ilex aquifolium*; *Larix decidua*; *Pinus sylvestris*; *Pseudotsuga menziesii*; *Quercus robur*; *Salix atrocinerea* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." New Forest Hampshire (England) United Kingdom Europe Europe LS January 2018 LV March 2019 *Dama dama* Cervidae Cetartiodactyla "Putman, R. J., Edwards, P. J., Mann, J. C. E., How, R. C., & Hill, S. D. (1989). Vegetational and faunal changes in an area of heavily grazed woodland following relief of grazing. *Biological Conservation*, 47(1), 13-32." 1989 "Two 5""6 ha inclosures were established in 1963 within an area of heavily grazed deciduous woodland in the New Forest, Hampshire. In one, a constant grazing pressure was maintained (at c. 1 fallow deer ha⁻¹); the other was kept free of all large herbivores. The vegetation of both was surveyed 6 years, 14 years and 22 years after inclosure. [...] A regular routine of small mammal trapping was carried out in each plot by S. D. Hill from February 1983 until June 1984. Traps were positioned in pairs at 15 m intervals in a 7 x 7 grid [...] A survey of ground invertebrates was carried out in August and September 1985, using pitfall traps (e.g. Gist & Crossley, 1973; Luff, 1975). Twenty traps were positioned in each plot. [...] Three species of small mammals (*Apodemus sylvaticus*, *Clethrionomys glareolus*, *Sorex araneus*) were regularly recorded throughout the trapping period in the ungrazed plot, with a further two species recorded only occasionally (*Apodemus flavicollis* and *Sorex minutus*). In the grazed area *A. sylvaticus* alone was recorded and consistently at lower densities than in the ungrazed site. [...] Amongst the beetles the most clear-cut differences emerged as greater abundance of rove beetles (*Staphylinidae*) in the grazed plot, with a greater number of ground beetles (*Carabidae*) in the ungrazed area. [...] Indeed amongst the *Coleoptera* only one species, *Abax parallelepipedus*, was markedly more frequent in collections in the ungrazed site. [...] No species occurred only in the ungrazed area, but flies of all groups were more abundant there than in the grazed pen, as were harvestmen (*phalangids*). "Chemical, physical or structural impact on ecosystems" Indirect *Apodemus sylvaticus*; *Clethrionomys glareolus*; *Sorex araneus*; *Abax parallelepipedus*; *Diptera*; *Phalangiidae* Animalia MO Low "It is unlikely that the alien caused a local extinction ("No species occurred only in the ungrazed area, [...]")." "The impact might be lower, because the native population(s) might not be declining (what happens in the inclosure might not be representative of the effect of the alien on the native populations outside the inclosures)" New Forest Hampshire (England) United Kingdom Europe Europe LS January 2018 LV March 2019 *Dama dama* Cervidae Cetartiodactyla "Morecroft, M. D., Taylor, M. E., Ellwood, S. A., & Quinn, S. A. (2001). Impacts of deer herbivory on ground vegetation at Wytham Woods, central England. *Forestry*, 74(3), 251-257." 2001 "Between 1974 and 1992 there were declines in bramble (*Rubus fruticosus* agg.) and several woodland forbs and an increase in grasses at Wytham Woods. These changes have been explained as effects of increasing deer populations. We set out to test this by establishing exclosure experiments in the summer of 1997. [...] Some decline in bramble was probably inevitable in the years following 1974, although the extent of the decline must have been increased by deer grazing. [...] This study has added to the weight of evidence that rising deer populations have been changing the ground vegetation of British woodlands in recent decades. It has, however, also demonstrated that interactions with other factors such as site management and the availability of grassland may play an important role in determining outcomes of grazing at particular sites." Grazing/herbivory/browsing Direct *Rubus fruticosus* agg.; Forbs (herbaceous dicotyledons) Plantae MO Medium "The impact might be lower, if the alien did not cause any decline in the native population size(s) but that the

other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (other deer present)"
Wytham Woods Oxfordshire (England) United Kingdom Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Perrins, C. M., & Overall, R. (2001). Effect of increasing numbers of deer on bird populations in Wytham Woods, central England. *Forestry*, 74(3), 299-309." 2001 "The species which have shown the most marked declines on the CBC plot, namely blackbird, song thrush, dunnoek and bullfinch, plus the four warblers are generally typical of this sort of woodland and their decline/disappearance require an explanation. Although the four warblers are migrants, the other four species are largely resident. The single feature which all these eight species have in common and which contrasts with the species which have not declined, is that they most commonly nest in low vegetation such as brambles. [...] The impact of deer on the vegetation in Wytham probably has had a deleterious effect on the bird population. [...] Habitat damage by deer seems at best an incomplete explanation for such changes. [...] In addition to deer browsing, the canopy closure might also be causing the decline in bramble (the main species in which these birds nest)." "Chemical, physical or structural impact on ecosystems" Indirect Sylvia borin; Phylloscopus trochilus; Phylloscopus collybita; Sylvia atricapilla; Pyrrhula phyrula; Turdus merula; Turdus philomelus; Prunella modularis Animalia MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (two introduced species are present and no exclusion of confounding effects (negative correlation between the abundance of the alien species and the abundance of the native species))." Wytham Woods Oxfordshire (England) United Kingdom Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Fuller, R. J. (2001). Responses of woodland birds to increasing numbers of deer: a review of evidence and mechanisms. *Forestry*, 74(3), 289-298.; Holt, C. A., Fuller, R. J., & Dolman, P. M. (2010). Experimental evidence that deer browsing reduces habitat suitability for breeding Common Nightingales *Luscinia megarhynchos*. *Ibis*, 152(2), 335-346." 2001 "[Fuller 2001] Pressure from roe deer increased in Bradfield Woods throughout the 1980s and muntjac deer colonized the wood in the early 1990s. In 1989 moderate deer-culling and temporary protection of freshly cut coupes with dead hedges (brush-wood fences) were initiated. [...] Vegetation structure was re-measured in 1994 and migrant birds were re-surveyed in 1995, both using exactly the same methods as in 1987. [...] The breeding birds were resurveyed in 1995 (Table 1). The survey concentrated on migrant species because these were found to be dependent on areas with a dense shrub layer in 1987, particularly coppice of 3-8 years of growth (Fuller and Henderson, 1992). There had been no major change in the management of the wood over this period, [...] In contrast, nightingales had declined by >80 per cent. Unlike warblers, nightingales forage mainly on sparsely vegetated areas of ground yet they require dense low vegetation for cover. Proliferation of coarse grasses in the field layer of 6-7 year coppice may have reduced the availability of suitable feeding sites. It is also possible that low vegetation structures have altered in ways that are especially deleterious to nightingales, for once the deer breach the dead hedges (usually within 2 years) they tend to browse out the low growth (Fuller et al., 1999). [...] These results show that populations of some shrub-nesting species can persist in areas with moderately high densities of deer providing that actions are taken to minimize deer impacts on vegetation structure.; [Holt et al. 2010] Since the 1980s, deer numbers have increased markedly at Bradfield Woods and in the surrounding landscape (Fuller 2001), typifying the wider regional situation (Ward 2005, Davey & Aebischer 2006). [...] Nightingales showed a strong preference for younger coppice without deer compared with paired plots that were browsed by deer. This suggests that increasing deer pressure is likely to be one of the factors contributing to declines in Nightingales and perhaps other woodland bird species dependent on dense understorey habitats (Fuller et al. 2005, Hewson et al. 2007). We stress that the status of the species is also affected by a range of other potential factors operating on the breeding grounds, on migration, and in winter (Fuller et al. 2005). Furthermore, it is unclear whether deer have similar impacts on habitat quality in non-coppice woodland environments and scrub." "Chemical, physical or structural impact on ecosystems" Indirect Luscinia megarhynchos Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (the way of monitoring the birds might not have been fully adequate (13 visits in the wood and visual observations)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other bird species are also declining nationally because of other stressors, it might be the case for this species as well)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe Fuller (2001): Observed the decline in the native population and established the link between this decline and the increase in alien deers; Holt et al. (2010): Investigated the mechanism through which the alien could have caused this decline (tested how the alien influences local habitat preference of the native) LV January 2018 DJ April 2020

Dama dama Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. *Ibis*, 149(s2), 119-127." 2007 "In each year since 1999, the distribution of bird territories was established through territory mapping, with up to 15 visits in the period April to early June (Bibby et al. 2000). [...] However, there is much that remains unclear about how deer are affecting British woodland bird populations.

Apart from our results using fenced enclosures in Bradfield Woods, direct evidence of a link between deer numbers and songbirds is still lacking. It is still not entirely clear to what extent recent declines in woodland songbird populations have been caused by deer or whether they simply coincide temporally with a general increase in deer numbers. Nonetheless, the Bradfield Woods results do suggest that, at least at a local scale, reductions in some species may be associated with increased pressure from deer. [...] These results lend support to the hypothesis that deer are at least partly responsible for causing declines in some British bird populations, but they do not eliminate the possibility that increased shading is also responsible for changes in woodland structure." "Chemical, physical or structural impact on ecosystems" Indirect Sylvia communis; Sylvia borin; Sylvia atricapilla; Phylloscopus collybita; Phylloscopus trochilus; Luscinia megarhynchos; Prunella modularis; Turdus merula Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (Bibby et al. 2000 observed a general decline in woodland birds in Britain, but no decline of these specific local native populations have been shown, except regarding Luscinia megarhynchos (Fuller et al. 2001)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other bird species are also declining nationally because of other stressors, it might be the case for this species as well; in addition, other introduced deer species are present, increased shading might also play a role, and the study only establishes the responsibility of the alien in the decline(s) by showing a potential indirect mechanism)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe LS January 2018 LV March 2019

Dama dama Cervidae Cetartiodactyla "Holt, C. A., Fuller, R. J., & Dolman, P. M. (2011). Breeding and post-breeding responses of woodland birds to modification of habitat structure by deer. Biological conservation, 144(9), 2151-2162.; Fuller, R. J., Noble, D. G., Smith, K. W., & Vanhinsbergh, D. (2005). Recent declines in populations of woodland birds in Britain. British Birds, 98, 116-143." 2011 "[Fuller et al. 2005] Experimental evidence that deer can alter woodland bird communities is currently lacking in Britain, but is available from two North American studies in which densities of White-tailed Deer Odocoileus virginianus were manipulated (deCalesta 1994; McShea & Rappole 2000).; [Holt et al. 2011] In lowland Britain for example, four of the six extant deer species are particularly widespread and increasing: red deer (Cervus elaphus), roe deer Capreolus capreolus), fallow deer (Dama dama) and Reeves' muntjac (Muntiacus reevesi) (Ward, 2005). This issue has been suggested as a contributory factor in the population declines of several woodland bird species in Britain (Fuller et al. 2005) and North America (Alloberet et al., 2005a). [...] Effects of deer browsing are reported from a replicated split-plot exclusion experiment in English coppiced woodland. [...] At the species level, especially pronounced negative effects were evident for dunnoek (Prunella modularis) and garden warbler (Sylvia borin) [...] We also detected negative responses to browsing by nightingale (Luscinia megarhynchos) and long-tailed tit (Aegithalos caudatus). [...] Fewer dunnoeks were captured in the control plots than in the exclosures throughout the coppice cycle of two to eight years re-growth studied. Dunnoeks require a combination of dense understorey for nesting and bare ground for foraging (Bishton, 1986), habitat characteristics that tend to be compromised by deer activity. [...] A negative response to deer by garden warbler, also in decline nationally (Hewson et al., 2007), was detected only within youngest re-growth. Hewson and Fuller (2005) suggested that a temporal shift to increased proportional use of edge habitat by long-tailed tits within woodlands in southern England may be attributable to increased grazing pressure within woodland interiors. None of the 16 species examined responded positively to deer browsing." "Chemical, physical or structural impact on ecosystems" Indirect Prunella modularis; Sylvia borin; Luscinia megarhynchos; Aegithalos caudatus Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (Marchant 1990 (inaccessible) showed a large decline in the breeding populations and contractions of breeding range in several woodlands birds in Britain in recent decades, but the decline of these specific local native populations have not been shown (except regarding Luscinia megarhynchos (Fuller et al. 2001)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects; in addition, other bird species are also declining nationally because of other stressors, it might be the case for this species as well)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe Fuller et al. (2005) hypothesised that the alien is partly responsible in the declines observed in Marchant (1990); Holt et al. (2011): Showed that alien influenced local habitat use by the native species (mechanism) LS January 2018 LV March 2019

Elephas maximus Elephantidae Proboscidea "Ali R, Pelkey N (2013) Satellite images indicate vegetation degradation due to invasive herbivores in the Andaman Islands. Curr Sci 105:209–214" 2013 "The earlier study3 had identified Interview Island as an uninhabited site which has both deer and elephant. Little Andaman has neither, [...] The Mahatma Gandhi Marine National Park (MGMNP) has deer populations on its islands. [...] [Jarawa Reserve] also has deer and their densities appear to be lower here than on Interview Island because of hunting by nontribals at its periphery. [...] To assess the change in vegetation cover across the four sites, a comparison of Normalized Difference Vegetation Index (NDVI) trends between sites over time was made. NDVI values are based on the principle that chlorophyll strongly absorbs visible light but reflects nearinfrared (IR) light. If there is more near-IR reflectance, then the vegetation in that pixel is likely to be

dense. [...] For 1986–1995, we used the calibrated vegetation index (CVI) data compiled and mosaicked by the National Institute of Environmental Studies, Japan. [...] Little Andaman has a significantly lower rate of degradation than both Interview Island and Jarawa Reserve for the 1985–1995 data. For the 2001–2005 dataset, Interview Island degraded faster than the Jarawa Reserve–MGMNP cluster, which in turn degraded faster than Little Andaman, and all but one of these comparisons show significant differences. [...] The two deer-only places have a lower rate of degradation since tree damage by elephants does not occur. [...] The answer to this degradation seems to be a combination of chital and elephants.

Elephants have damaged the vegetation badly in recent years, and have created a situation where forest regeneration rates are higher than normal. Elephant damage is seen in the form of trees that have been knocked down, or damaged because their bark has been stripped, details are given elsewhere⁴. The chital prevent regeneration by browsing on the seedlings. Besides direct observation on this, there is an abundance of stumps of browsed seedlings that can be seen. To assess the exact quantum of browsing damage would require exclosure studies, which are being undertaken now¹⁷. "

Grazing/herbivory/browsing; Direct physical disturbance Direct Vegetation Plantae MO Low "The impact might be lower, if no native population(s) is declining (the NDVI method provide information on vegetation in general, and not at the species level; however, it is likely that at least on population declines if the general cover declines); or if the alien did not cause the decline (other stressors: logging, and another introduced herbivore (*Axis axis*) is also present in Interview Island (but the impact is more important where *Elephas maximus* is present than where only *Axis axis* is present, so the alien seems to increase the impact of *Axis axis*)" Interview Island Andaman Islands India South and Southeast Asia Asia LV August 2019 DJ April 2020

Elephas maximus Elephantidae Proboscidea "Ali, R. (2004). The effect of introduced herbivores on vegetation. Current Science, 86(8)." 2004 "Vegetation sampling was carried out in three areas in the Andaman Islands, India to study the impact of introduced elephant and chital. One area (Interview Island) had both, the second area (MGMNP) had chital and the third, Little Andaman, had neither. [...] Vegetation sampling: Belt transects were laid out on Interview Island in February and March 2001. [...] Five transects were done on Interview Island, two and a half each in logged and unlogged areas. [...] Each transect was further subdivided into 10 plots of 50 m X 5 m. [...] The species and girth of each plant sampled were noted. [...] The vegetation plots on Interview Island did not have any cane (*Calamus* spp.), bamboo or screwpine (*Pandanus* spp.). Canes and screwpine were only seen on some steep and rocky slopes near the shore. The understory was missing from most places. In similar topography in other parts of the Andamans, canes are abundant. [...] Elephants food choices appear to have changed. Sivaganesan (unpublished report) noted a number of species that he did not record as being damaged by elephants. There are being browsed now. He had recorded that cane, bamboo and *Pandanus*, all favoured by elephants, were getting scarce. These have disappeared from the transects chosen, and were only seen on steep rocky hill slopes that were inaccessible to elephants. Since the cut-off girths for the trees sampled is not given by him, direct comparisons for other plant species are difficult. The drop in elephant populations, combined with the changes in food, indicate that the population may be facing a food shortage. The problem seems to be made more acute by the presence of deer, which seriously hamper regeneration of many species. [...] Comparing groups indicated that large trees were significantly lesser on Interview Island. This confirms the possibility that saplings do not tend to survive on Interview Island. " Grazing/herbivory/browsing; Direct physical disturbance Direct *Calamus* spp.; *Pandanus* spp.; Bambusoideae Plantae MO Medium It is unlikely that the alien caused (a) local extinction(s) (individuals are still observed on some steep and rocky slopes) "The impact might be lower, because the native population(s) might not be declining (no real monitoring of the populations (small number of transects and small transects))" Interview Island Andaman Islands India South and Southeast Asia Asia LV August 2019 DJ April 2020

Elephas maximus Elephantidae Proboscidea "Ali, R. (2004). The effect of introduced herbivores on vegetation. Current Science, 86(8)." 2004 "Vegetation sampling was carried out in three areas in the Andaman Islands, India to study the impact of introduced elephant and chital. One area (Interview Island) had both, the second area (MGMNP) had chital and the third, Little Andaman, had neither. [...] Vegetation sampling: Belt transects were laid out on Interview Island in February and March 2001. [...] Five transects were done on Interview Island, two and a half each in logged and unlogged areas. [...] Each transect was further subdivided into 10 plots of 50 m X 5 m. [...] The species and girth of each plant sampled were noted. [...] Large trees of *Sterculia campanulata*, *Pterocarpus dalbergoides* and *Manilkara littoralis* were found debarked or otherwise damaged. [...] Debarking also resulted in the death of trees. [...] Twenty-two species were found with damage by elephants." Grazing/herbivory/browsing; Direct physical disturbance Direct *Sterculia campanulata*; *Pterocarpus dalbergoides*; *Manilkara littoralis*; Other unspecified species Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (species richness was measured, but changes in individual species populations were not studied)." "The impact might be lower, if the performance of native individuals is not decreased (it is mentioned that debarking resulted in the death of trees, but the effect of debarking on each species individually is not precisely described)" Interview Island Andaman Islands India South and Southeast Asia Asia LV August 2019 DJ April 2020

Equus asinus Equidae Perissodactyla "Hicks, D. J., & Mauchamp, A. (1995). Size-dependent predation by feral mammals on Galápagos *Opuntias*. Noticias de Galápagos, 55, 15-17." 1995 "It is clear that adult *Opuntia* plants are severely

damaged by feral animals. [...] Repeated attacks to an *Opuntia* can girdle the trunk and kill the plant. Cladodes of both *Opuntia* species are capable of rooting after such an event. However, vegetative reproduction from fallen cladodes seems to be very rare in *O. galapageia* on Santiago" Grazing/herbivory/browsing Direct *Opuntia echios* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only small areas were sampled)." Santa Cruz Island Galapagos Islands Ecuador South America South America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Peco, B. Borghi, C. E., Malo, J. E., Acebes, P., Almiron, M., & Campos, C. M. Effects of bark damage by feral herbivores on columnar cactus *Echinopsis* (= *Trichocereus*) *terscheckii* reproductive output. J. Arid Environ. 75, 981–985 (2011)." 2011 "[...] due to intrinsic conditions of cacti and their abiotic environs, the results show a significant reduction in reproductive output associated with the presence of trunk damage, which could influence the demography of columnar cacti. A 68% decline in the average number of fruits produced by cacti was reflected in a similar decline in the seeds available for regeneration in the most heavily damaged geographic zones, while the loss estimated in the most heavily damaged individuals was estimated to be over 20%." Grazing/herbivory/browsing Direct *Echinopsis terscheckii* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the fruit production (performance) was investigated)." Ischigualasto Talampaya World Heritage Site La Rioja Argentina South America South America LS; DJ January 2018 LV March 2019

Equus asinus Equidae Perissodactyla "Douglas CL, Norment C (1977) Habitat damage by feral burros in Death Valley. Desert Bighorn Council transactions 21:23–25" 1977 "The results of the browse impact survey in Wildrose Canyon are presented in Table 1, which lists number and percentage of total individuals examined in each browse impact category for each species. The sample sizes for *Acamptopappus shochleyi* and *Ambrosia dumosa* are large enough to indicate that these species are threatened with removal from the area, while *Artemisia spinescens* and *Daicæ fremontii* may also be significantly affected. [...] Of all shrubs examined in Wildrose Canyon, 45.7% exhibited some evidence of having been browsed; the largest percentage of browsed shrubs found in any other area was 26.2 in Skidoo. Percentage of shrubs in the b1 category remained relatively constant in all four localities, with most of the variation occurring in the b2 and b3 categories. This is important, since the presence of large numbers of plants in the two latter classes indicate that burros may be affecting the structure of the plant community and certain species may be in danger of being removed from the area entirely. [...] Our data show that feral burros are having a substantial impact upon vegetation in Wildrose Canyon. Our study does not clarify the extent of damage caused by trailing, which may be as significant as that caused by browsing." Grazing/herbivory/browsing Direct "*Ambrosia dumosa*; *Acamptopappus shochleyi*; *Artemisia spinescens*; *Daicæ fremontii*" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance." Atacama desert Atacama desert Chile South America South America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Bowers, J. E. (1997). Demographic patterns of *Ferocactus cylindraceus* in relation to substrate age and grazing history. Plant Ecology, 133(1), 37–48." 1997 "Three subpopulations of *Ferocactus cylindraceus*, a short-columnar cactus of the Sonoran and Mojave deserts, were sampled in Grand Canyon, Arizona, USA, at sites representing a range of substrate ages and different grazing histories. [...] Although the data are pseudoreplicated, confounding site with topography and grazing history, it is possible to draw some cautious conclusions about the effect of grazing on *F. cylindraceus* establishment. As noted above, feral burros in Grand Canyon demonstrably accelerated turnover of several dominant shrubs and were implicated in the near extirpation of *Ambrosia dumosa* at Indian Canyon (Webb & Bowers 1993). Nurse plants such as *A. dumosa* facilitate seedling survival by moderating soil and air temperatures, by hiding plants from herbivores, and by preventing excess transpiration (Turner et al. 1966; Nobel 1984, 1989; McAuliffe 1988). The disappearance of *A. dumosa* from Indian Canyon was no doubt a serious loss for *F. cylindraceus*, which establishes best under the canopies of nurse plants (Nobel 1984, 1989). By eliminating many potential nurse plants, grazing at Indian Canyon also eliminated many potential establishment sites, making it difficult for seeds to respond to germinating rains and for seedlings to survive between rains." Grazing/herbivory/browsing Direct *Ferocactus cylindraceus* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the establishment was investigated)." "The impact might be lower, if the alien did not cause any impact on the performance of the native individuals, but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decreased performance (there are other climatic factors that act on seedling survival)." Galapagos Islands Galapagos Islands Ecuador South America South America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Hanley, T. A., & Brady, W. W. (1977). Feral burro impact on a Sonoran Desert range. Journal of Range Management, 374–377." 1977 "Burro impact on the study area was most pronounced in the secondary wash communities. The magnitude of impact can be evaluated by comparing cover and density values (Table 2)

for the Secondary Wash, *Cercidium-Ambrosia* type (low utilization) and the Secondary Wash, *Cercidium-Larrea* type (heavy utilization). Over-utilization resulted in a great reduction in density and size of white bursage and a general reduction in density and canopy cover of nearly all species. There appeared to be no species acting as increasers or invaders under heavy burro utilization pressure. That burros have had a substantial impact on the vegetation of this area is evident. However, assessment of the impact is complicated by the unavailability of data concerning the time required and the numbers of burros responsible for the differences observed in community structure." Grazing/herbivory/browsing Direct *Cercidium microphyllum*; *Ambrosia dumosa*; *Larrea tridentata*; *Lycium andersonii*; *Krameria grayi*; *Opuntia* spp. Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Galapagos Islands Galapagos Islands Ecuador South America South America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Fowler de Neira, L. E., & Roe, J. H. (1984). Emergence success of tortoise nests and the effect of feral burros on nest success on Volcan Alcedo, Galapagos. *Copeia*, (3), 702-707." 1984 "The south caldera floor nesting area is always occupied by burros; bi-monthly burro counts ranged from two to 39 animals per count (Fowler, 1983). Burros broke into 32.1% of the 28 south floor nests monitored in 1980. Two were completely destroyed and five others produced young at a lowered emergence success. At the north nesting area, less frequented by burros but heavily used for nesting, 11.7% of 60 nests were damaged by burros. Therefore, of 88 *G. e. vandenburghi* nests monitored on Alcedo, 18.2% were damaged. Clutches of 4.5% were completely destroyed and the remaining 13.7% produced some young at a lowered emergence success (36%) or were left incubating, the extent of damage unknown. [...] Comparing the contents of undisturbed and disturbed nests, and the percentages in each category, it is evident that, in addition to broken eggs, there were more stranded live young and dead young in burro damaged nests" Direct physical disturbance Direct *Geochelone elephantopus vandenburghi* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the individual mortality and reproduction rate was investigated)." Havasu Resource Area Arizona United States North America North and Central America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Malo, J. E., Acebes, P., Giannoni, S. M., & Traba, J. (2011). Feral livestock threatens landscapes dominated by columnar cacti. *Acta oecologica*, 37(3), 249-255." 2011 "The results show the existence of high damage levels to cacti and strongly suggest that naturalized herbivores, and donkeys in particular, are the main responsible. This finding may have important implications for such environments given that columnar cacti play important ecological and physiognomical roles in them and that the population dynamics of these plants are strongly dependent on the longevity of mature individuals. [...] Firstly, we must highlight the finding that the damage levels detected in the study area are strong and may affect the population dynamics of the columnar cacti in the medium term. At some sites the cacti suffer on average damage equivalent to the loss of more than 1000 cm² of cortical surface and of 5000 cm³ of tissue" Grazing/herbivory/browsing Direct *Echinopsis terscheckii* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Ischigualasto Provincial Park (Death Valley National Monument) California United States North America North and Central America LS january 2018 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Marshall, J. P., Bleich, V. C., & Andrew, N. G. (2008). Evidence for interspecific competition between feral ass *Equus asinus* and mountain sheep *Ovis canadensis* in a desert environment. *Wildlife Biology*, 14(2), 228-237." 2008 "We analysed data from aerial surveys conducted during 1993-2003 to look for evidence of an effect of feral ass abundance on mountain sheep demography. [...] Annual survey flights (\bar{x} =9.0 hours; range: 8.0-10.2 hours) occurred over two consecutive days in late September or early October. [...] For abundance, we calculated mountain sheep observed per hour (sheep/hour) and feral ass observed per hour (ass/hour) from the total number of each species observed during each annual survey divided by the amount of time flown for that survey. We calculated an index of population exponential rate of change (r) by taking the natural logarithm of sheep/hour, and estimating successive differences between each year. [...] We used two indices of reproduction: the number of young-of-the-year (both sexes) observed per 100 adult females, and the proportion of young-of-the-year (both sexes) out of all observed sheep. We used two indices of juvenile recruitment: the number of yearlings (both sexes) observed per 100 adult females, and the proportion of yearlings (both sexes) out of all observed sheep. [...] Although reproduction and juvenile recruitment did not appear to be influenced by either forage availability (as indexed by rainfall) or abundance of feral ass, there was strong evidence that those factors influenced abundance and r of the mountain sheep population (Table 2). There was an interactive effect of rainfall and feral ass abundance on mountain sheep abundance, such that there was a negative association between ass/hour and sheep/hour when rainfall was low, but the association became positive with increasing rainfall (Fig. 2). [...] Whether mountain sheep abandoned localized areas (e.g. in the vicinity of water sources) is uncertain; nevertheless, the existence of a clearly negative relationship between indices of abundance of the two species suggests that some interaction existed." Competition Indirect *Ovis canadensis* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (it might only be an avoidance behavior from the native population(s) that has been detected (relatively small spatial scale and no impact on the reproduction or juvenile recruitment

has been detected, but an impact on the population size does not necessarily occurs through reproduction as the alien could be decreasing the resistance of individuals to other stressors, such as droughts)." Sonoran Desert California United States North America North and Central America LV September 2019 DJ April 2020

Equus asinus Equidae Perissodactyla "Yancey MJ, Douglas CL (1983) Burro-small vertebrate interactions in Death Valley National Monument, California. Desert Bighorn Council Transactions 27:17–24 " 1983 "These heavily used perennials appear to be browsed in Nemo and Wildrose when they are readily accessible. Many are small volume plants that may occur within larger shrubs (Tables 3-5). Thus, *Ambrosia dumosa* was either exploited or left alone. This was also true of *Stipa speciosa*, which was more abundant between shrubs in Nemo than in Wildrose. Such accessible plants may not appear in browse impact data if entire individuals were removed. This is probably also the case in other moderately to heavily browsed areas. The local increased use of *Coleogyne ramosissima*, *Ephedra nevadensis*, and *Grayia spinosa* could be related to the steady decrease in availability of heavily used species, such as *Artemisia spinescens*. Reddick (1981) also noted this possibility. A decline in the usage of *Acamptopappus shockleyi*, the dominant shrub in both sites, cannot be explained without further studies.[...] few shrubs showed a volumetric difference between moderately to heavily grazed plots and lightly to non-grazed plots. This suggests that plant composition affects total plant volume more than variations in individual species. Therefore, although individual species were on the average smaller in Wildrose than Nemo (Tables 3-5), Wildrose still had a greater overall volume. The robust Shannon Diversity Index did not reflect proportional variations between the two sites.[...] Wildrose had a greater total plant volume than Nemo. Nemo had many small volume species that were heavily browsed, where less used, larger volume shrubs were more prominent in Wildrose. Both canyons had significant site-species interactions, indicating a positive correlation between species and site in affecting plant volume. The basis for this correlation was burro impact." Grazing/herbivory/browsing Direct *Ambrosia dumosa*; *Stipa speciosa*; *Artemisia spinescens* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only damages on individuals were investigated)." "The impact might be lower, because the performance of native individuals might not be affected (short temporal scale, so the observed effects might only be temporary)." Wildrose and Nemo canyons (Death Valley National Monument) California United States North America North and Central America LS January 2017 DJ; LV March 2019

Equus asinus Equidae Perissodactyla "Yancey MJ, Douglas CL (1983) Burro-small vertebrate interactions in Death Valley National Monument, California. Desert Bighorn Council Transactions 27:17–24 " 1983 "From June 1981 through August 1982, rodents were live- trapped to compare Nemo and Wildrose Canyon populations. [...] Pitfalls and transects were combined to compare lizard populations between Nemo and Wildrose Canyon [...] Numbers of *Cnemidophorus tigris* and *Uta stansburiana* were tested separately between sites. Data from *Coleonyx variegatus*, *Crotaphytus collaris*, *C. wislizenii*, *Phrynosoma platyrhinos*, and *Sceloporus graciosus* were combined. The assessment lines were not run often enough to provide reliable statistical results [...] Lizards were not significantly affected by burro activity; whereas, at least some rodent species were [...] There would be no variations in any of the small vertebrate species. Neither site has had irreparable range damage caused by the burros. Threatened plants have been removed, but many individuals remain undamaged while growing in shrubs. These provide a continuous seed source. Plant diversity has also been enhanced by trampling and droppings. " "Chemical, physical or structural impact on ecosystems" Indirect *Ammospermophilus leucurus*; *Dipodomys merriami*; *Dipodomys microps*; *Neotoma lepida*; *Perognathus formosus*; *Perognathus longimembris*; *Peromyscus crinitus*; *Peromyscus maniculatus*; *Cnemidophorus tigris*; *Uta stansburiana*; *Coleonyx variegatus*; *Crotaphytus collaris*; *Crotaphytus wislizenii*; *Phrynosoma platyrhinos*; *Sceloporus graciosus* Animalia MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Wildrose and Nemo canyons (Death Valley National Monument) California United States North America North and Central America LS January 2018 DJ; LV March 2019

Equus caballus Equidae Perissodactyla "De Villalobos, A. E., & Zalba, S. M. (2010). Continuous feral horse grazing and grazing exclusion in mountain pampean grasslands in Argentina. *Acta Oecologica*, 36(5), 514-519." 2010 "Specific and functional richness, diversity, evenness, spatial heterogeneity and above-ground biomass were compared between areas subjected to ten years of intensive grazing by horses and exclosures of the same age. Forbs, shrubs and rosettes were more abundant after ten years of grazing, while the spatial heterogeneity of perennial grasses was higher in long-term grazed areas. Nevertheless, grasslands showed good recovery after horse removal, with greater species diversity and evenness, higher abundance of perennial grasses, greater above-ground biomass and lower percentages of exotic species. [...] There was a negative effect of continuous feral horse grazing on the species richness of mountain grasslands. Out of a total of 130 plant species that were recorded during this study, 57 species had been recorded in 1993 in areas grazed by feral horses. In 2003, 53 species were detected in the grazed areas, whereas 67 species were associated with ungrazed areas. Thirty species were only detected in the exclosures and 10 species were exclusive to the grazed areas. [...] We also documented a significant recovery of grassland structure and an increase in species richness after seven years of horse exclusion." Grazing/herbivory/browsing Direct *Piptochaetium leopodium*; *Piptochaetium hackelii*; *Stipa juncooides*; *Stipa neesiana*; *Stipa tenuis* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to

detect it." Ernesto Tornquist Provincial Park Buenos Aires ArgentinaSouth America South America LS
January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Zalba, S. M., & Cozzani, N. C. (2004). The impact of feral horses on grassland bird communities in Argentina. *Animal Conservation*, 7(1), 35-44." 2004 "In Tornquist Park this results in great changes in vegetation structure, which, in extreme cases turns into grassy meadows 15 cm high in contrast to grasslands free from exotic herbivores that are over 1 m high. These variations reflect on the richness and diversity of birds, which are greatest in areas subject to moderate levels of grazing, slightly lower in the enclosures and much lower under high grazing pressure, coinciding with changes in the diversity of habitats. In particular it is interesting that the richness and diversity of species are slightly greater in areas of moderate grazing than in the enclosures, as predicted by the theory of intermediate disturbance. [...] The presence of feral horses was associated with an increase in the rate of predation of eggs which varied from 12.5% within the enclosures to 70% in grazed areas. It is suggested that the increase in predation rate was due to the increased visibility of the nests and an increase in the density of opportunist carnivores. [...] Our work suggests that there are consistent differences in the composition of bird communities according to grazing intensity, with some species preferring areas of intense grazing and others found exclusively, or more abundantly, in areas with a low density of feral horses." "Chemical, physical or structural impact on ecosystems" Indirect *Anthus* spp.; *Sicalis luteola*; *Sturnella loyca*; *Embernagra platensis* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Ernesto Tornquist Provincial Park Buenos Aires ArgentinaSouth America South America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Loydi, A., Zalba, S. M., & Distel, R. A. (2012). Viable seed banks under grazing and exclosure conditions in montane mesic grasslands of Argentina. *Acta oecologica*, 43, 8-15." 2012 "The species richness in the exclosed and grazed areas was not consistent with the proposed hypothesis of higher richness in grazed areas. Seed density also remained the same. Grazing does not affect, or even reduce, seed species richness. This is contrary to what happens in the established vegetation, where species richness was increased by grazing (Loydi and Distel, 2010). However, when we considered different components of the vegetation, we found that there was a higher density and richness of grass seeds in the exclosures." Grazing/herbivory/browsing Direct *Briza subaristata*; *Nassella melanosperma*; *Piptochaetium hackelii* Plantae MC Low "The impact might be higher, if the study did not allow to detect an impact on the performance of native individuals." Ernesto Tornquist Provincial Park Buenos Aires ArgentinaSouth America South America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Dyring, J. (1990). The impact of feral horses (*Equus caballus*) on sub-alpine and montane environments in Australia. MSc dissertation, University of Canberra." 1990 "There were significantly more herbaceous than woody plants in the Centre zone, compared with the Edge and Untrampled zones (Fig 5.4). More woody plants grew towards the Un trampled zones ($x^2 = 54.431$, $df = 2$, $P < 0.005$). [...] Species with low occurrence indices - *Podolepis robusta* (0.0). *Eucalyptus dalrympleana* (0.0). *Epacris microphylla* (0.1) and *Leucopogon montanus* (0.1) were not found in the Centre zone. All but *Podolepis robusta* are artificially classified as woody species (although *P. robusta* has a tough woody rootstock) and perhaps because of their brittleness and upright growth form. fail to tolerate trampling. Alternatively. because of their taller growth form. horses may either walk around these plants or avoid areas where these plants are abundant. Plants with occurrence indices of 0.5 or less (excluding *P. robusta*. *Helichrysum acuminatum*. and *Oreomyza ciliata*) were all woody species that did not survive well in the more trampled Centre and Edge zones. The upright form of *Helichrysum acuminatum* suggests its susceptibility to trampling. and *Oreomyza ciliata* is characteristic of wetter sites which were very susceptible to trampling impacts (Chappell et al. 1971. Marshall & Holmes 1979. Lance et al. 1989). Overall. significantly less woody species were found in the Centre zone compared -with non-woody species. The total numbers of species in each catchment decreased significantly towards the tracks [...] Trampling is seen as an important environmental factor in vegetation gradients across tracks. However. other intrinsic factors (eg. soil characteristics) and extrinsic factors, such as increased nutrient status (via horse and other animal excrement. leaching onto the track etc.) and microclimatic variations. are likely to maintain vegetation differences once tracks are formed." Direct physical disturbance Direct *Acacia obliquinerva*; *Helichrysum acuminatum*; *Acaena anseritifolia*; *Eucalyptus* spp.; *Olearia* spp.; *Oxylobium* spp.; *Plantago alpestris*; *Podolepis robusta*; *Epacris microphylla*; *Pratia surrepens*; *Richea continentis*; *Syridium graminifolium*; *Wahlenbergia* spp.; *Bossiaea foliosa*; *Epacris microphylla*; *Leucopogon montanus* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Southern Snowy Mountains New South Wales Australia Oceania Oceania LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Berman, D. M. (1991). The ecology of feral horses in central Australia. PhD dissertation. University of New England: Armidale, NSW." 1991 "The ground was almost bare up to 10 kilometres west of the permanent water (spring) in Nineteen Mile valley, a result of grazing by both horses and cattle which drink at the spring [...] Areas close to water had less herb cover than those more distant because horses and cattle used these areas most intensely. Gully erosion also appeared to be greatest in the areas closest to permanent water [...] This study shows that horses cause considerable direct environmental impact in central Australia and suggests that they also cause significant

indirect changes such as accelerated erosion and restriction of suitable habitat for large macropods. "

Grazing/herbivory/browsing Direct Herbaceous vegetation Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the study did not focus at the species level, although it is likely that if the general cover declines, at least one native population declines); or if the alien did not cause the decline (not possible to disentangle the impact of horses and cattle)" Kings Canyon Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Berman, D. M. (1991). The ecology of feral horses in central Australia. PhD dissertation. University of New England: Armidale, NSW." 1991 Results of shrub assessment indicated that mulga (*Acacia anura*) and prickly wattle (*Acacia victoriae*) were damaged more frequently than other trees or shrubs. *Cassia* spp. were least damaged by browsing. Most shrub damage occurred close to watering points in Nineteen Mile valley. There was very little shrub damage in Dry Creek valley [...] This study shows that horses cause considerable direct environmental impact in central Australia and suggests that they also cause significant indirect changes such as accelerated erosion and restriction of suitable habitat for large macropods. Grazing/herbivory/browsing Direct *Acacia anura*; *Acacia victoriae* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only damages on individuals were investigated)." "The impact might be lower, because the performance of native individuals might not be affected (it is not clear how the performance of native individuals was affected by the physical damages)." Kings Canyon Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Prober, S. M., & Thiele, K. R. (2007). Assessment of impacts of feral horses (*Equus caballus*) in the Australian Alps. An experimental monitoring program in the Cobberas-Tingaringy Unit of the Alpine National Park: Progress 1999 to 2005. A report to Parks Victoria" 2007 "Results to date show that exclosure from horse grazing has not had striking effects on vegetation composition at either site. While some minor effects were becoming apparent by 2005, they were still weaker than natural local variation at the site, e.g. as observed between the north and south creekbanks. [...] Nevertheless, there was some evidence that vegetation change is beginning to occur with exclosure from horse grazing. The most significant effect of exclosure at both sites was an increase in the height of the vegetation. Concomitant with this was a reduction in point-scale species richness reflecting a decline in abundance of some species, particularly native forbs. [...] It is notable that there was no significant change in weed richness/abundance as a result of exclosure. [...] At Native Cat Flat, the effects of exclosure were stronger than at Cowombat Flat ($R_{max} = 0.84$, $P = 0.001$; ANOSIM $P < 0.001$), with all fenced plots grouping together at the top left of the ordination (Fig. 4). The relationship between the effect of exclosure and of sampling year was less pronounced than at Cowombat Flat, probably because feral horse grazing levels at Native Cat Flat had been higher than at Cowombat Flat since the fires. Nevertheless, *Stellaria angustifolia* (a scrambling herb) and *Isolepis aucklandica* (a sedge of low stature) declined, and the tall herb *Veronica* aff. *gracilis* increased, in association with both exclosure and year. Other changes related to exclosure included a decline in *Lilaeopsis polyantha* and *Hydrocotyle algida* on fenced plots (herbs of low stature, Appendix 3a). Other effects included a decline in the herbs *Hypoxis hygrometrica*, *Euchiton involucreatum* and *Gonocarpus micranthus* from 1999 to 2005 and an increase in the exotic grass *Holcus lanatus* over the same period (Appendix 3b). [...] Landscape scale effects that might occur if feral horses are excluded from the entire region, such as changes in broad-scale hydrology and changes to populations of other grazers, may not occur under the conditions of the experiment. Conversely, localised effects observed in this study may not translate across the landscape." Grazing/herbivory/browsing Direct Vegetation Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))."

Alpine National Park Victoria Australia Oceania Oceania LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Freedman, B., Catling, P. M., & Lucas, Z. (2011). Effects of feral horses on vegetation of Sable Island, Nova Scotia. The Canadian Field-Naturalist, 125(3), 200-212." 2011 "We studied the three plant communities (Marram grassland, mature heath, and Marram-heath transitional) in a total of nine stands in six exclosures. [...] The largest and most consistent effect of horse grazing that we observed on vegetation of the major terrestrial communities of Sable Island was a decrease in the biomass of standing litter in all habitats and a decrease in live Marram Grass in grassland. [...] The average cover of Marram Grass was less outside the three Marram grassland exclosures, significantly so in two of them (Table 3). The average cover of Marram Grass was less outside two of the three Marram-heaths sampled, but the differences were not significant. Marram Grass had significantly less cover outside the single heath exclosure than inside. [...] there was significantly less cover of *Poa pratensis* L. (Kentucky Bluegrass) and *Solidago sempervirens* L. on the outside of one grassland exclosure than on the inside [...]" Grazing/herbivory/browsing Direct *Ammophila breviligulata*; *Poa pratensis* L.; *Solidago sempervirens* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (low number of replicates, differences between grazed and ungrazed area are detected, but are sometimes contradictory or small)." Sable Island Nova Scotia Canada North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Kuiters, A. T., Van der Sluijs, L. A. M., & Wytema, G. A. (2006). Selective

bark-stripping of beech, *Fagus sylvatica*, by free-ranging horses. Forest ecology and management, 222(1), 1-8." 2006
 "We found stem damage to be dependent on size. The smaller size-classes (<40 cm DBH) were preferentially debarked by the horses, apparently tending to select stems that were growing rapidly and had a smooth structure. [...] Although the horses were already introduced in Veluwezoom National Park in 1986, it was not until 2002 that largescale debarking was observed by the site managers. [...] It is expected that damage rates will further increase in the near future, which will finally have its impact on tree survival, especially in the case of ringbarking. Particularly in the higher damage categories, wounds of damaged stems were infected already by wood-decomposing fungi." Grazing/herbivory/browsing Direct
Fagus sylvatica Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (the debarking might not affect the survival of native individuals)." Veluwezoom National Park
 Veluwezoom National Park Netherlands Europe Europe LS January 2018 LV March 2019
Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The impact of horses was assessed from an existing network of permanent grassland plots and three ungulate exclosure plots established in 1982 to assess vegetation condition and the impact of large grazing herbivores. [...] [Permanent grassland plots] A large number of permanent grassland plots (Allen, Rose and Evans, 1983) were established by staff of the New Zealand Forest Service (B. Fleury, pers. comm.) in the southern Kaimanawa Mountains. Nine of these plots, where horses were the only major grazing influence, were remeasured in 1989 (Fig. 1). [...] Between 1982 and 1989, the mean frequency of seven small prostrate species declined significantly (Table 2). [...] Observation suggested that concentrated browsing and trampling of *Nothofagus* saplings on the margins of the forest appears to have prevented forest expanding into the bordering grassland. [...] There were no significant changes in the cover of any species, although that for *Chionochloa pallens* came close to a significant change (Fig. 3). There was, however, a highly significant decrease in mean height of *C. pallens* (mean height in 1982=33.8cm, mean height in 1989=11.2cm, Student's t-test, paired sample, $P<0.001$). No *C. pallens* seedlings were seen." Grazing/herbivory/browsing; Direct physical disturbance Direct
Anisotome aromatica; *Euphrasia cuneata*; *Gentiana bellidifolia*; *Hypnum cupressiforme*; *Luzula migrata*; *Nothofagus solandri* var. *cliffortioides*; *Chionochloa pallens* Plantae MO Low
 "The impact might be lower, because the native population(s) might not be declining (the impact was observed in an enclosure experiment (large enclosure), so the whole native populations might not be declining)." Kaimanawa Mountains North Island New Zealand Oceania Oceania LV March 2019 DJ April 2020
Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The impact of horses was assessed from an existing network of permanent grassland plots and three ungulate exclosure plots established in 1982 to assess vegetation condition and the impact of large grazing herbivores. [...] [Permanent grassland plots] A large number of permanent grassland plots (Allen, Rose and Evans, 1983) were established by staff of the New Zealand Forest Service (B. Fleury, pers. comm.) in the southern Kaimanawa Mountains. Nine of these plots, where horses were the only major grazing influence, were remeasured in 1989 (Fig. 1). [...] Between 1982 and 1989, the mean frequency of seven small prostrate species declined significantly (Table 2). [...] [Fenced exclosure plots] Three fenced exclosure plots, 20 x 20m, were established in 1982 at Motumatai (Fig. 1), two in mountain beech (*Nothofagus solandri* var. *cliffortioides*) forest, and one in hard tussock grassland. Equivalent unfenced control plots were located within twenty metres of each exclosure. [...] In the control plot, continued grazing pressure led to a significant decline in individuals of the highly palatable grass, hair fescue, and also in *Festuca nigrescens*, *Geranium sessiliflorum*, Yorkshire fog, *Rytidosperma gracile*, *Stackhousia minima*, and *Wahlenbergia albomarginata*." Grazing/herbivory/browsing; Direct physical disturbance Direct
Geranium sessiliflorum; *Wahlenbergia albomarginata* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (low numbers of exclosures and of subplots sampled, and small spatial scale); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (quantification of the alien is based on changes over time in grazed plots)" Kaimanawa Mountains North Island New Zealand Oceania Oceania LS January 2018 LV March 2019
Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The impact of horses was assessed from an existing network of permanent grassland plots and three ungulate exclosure plots established in 1982 to assess vegetation condition and the impact of large grazing herbivores. [...] [Fenced exclosure plots] Three fenced exclosure plots, 20 x 20m, were established in 1982 at Motumatai (Fig. 1), two in mountain beech (*Nothofagus solandri* var. *cliffortioides*) forest, and one in hard tussock grassland. Equivalent unfenced control plots were located within twenty metres of each exclosure. [...] After grazing ceased in the exclosure, the frequency of the dominant inter-tussock grass, hair fescue increased significantly (Table 4). [...] In the control plot, continued grazing pressure led to a significant decline in individuals of the highly palatable grass, hair fescue, and also in *Festuca nigrescens*, *Geranium sessiliflorum*, Yorkshire fog, *Rytidosperma gracile*, *Stackhousia minima*, and *Wahlenbergia albomarginata*. [...] There appeared to be an increase in *Griselinia littoralis* seedlings in both exclosures, and an increase in *Poa anceps* in the forest pocket exclosure. [...] The recruitment of red

tussock was substantially reduced by grazing. There was no silver tussock in the control plot, probably because it had been browsed out." Grazing/herbivory/browsing; Direct physical disturbance Direct Festuca tenuifolia; Festuca nigrescens; Rytidosperma gracile; Stackhousia minima; Holcus lanatus; Poa anceps; Chionochloa rubra; Poa cita Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (low number of exclosures and of subplots sampled, small spatial scale)." Kaimanawa Mountains North Island New Zealand Oceania Oceania LV March 2019 DJ April 2020

Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The presence of all the biogeographically important plant species and their habitats in the wild horse range were recorded. The impact of grazing and trampling upon the plant habitats was assessed qualitatively. [...] Another species of restricted distribution in the North Island, Deschampsia caespitosa, may have been browsed out by horses because it has not been recorded in recent surveys." Grazing/herbivory/browsing; Direct physical disturbance Direct Deschampsia caespitosa Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it (no real monitoring of the native population, only 40 m transects)." "The impact might be lower, because the native population(s) might not be declining (the species has not been recorded during recent surveys, but the species has not well been monitored (only 40 m transects)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s)" Kaimanawa Mountains North Island New Zealand Oceania Oceania LV March 2019 DJ April 2020

Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The impact of horses was assessed from an existing network of permanent grassland plots and three ungulate exclosure plots established in 1982 to assess vegetation condition and the impact of large grazing herbivores. [...] [Fenced exclosure plots] Three fenced exclosure plots, 20 x 20m, were established in 1982 at Motumatai (Fig. 1), two in mountain beech (Nothofagus solandri var. cliffortioides) forest, and one in hard tussock grassland. Equivalent unfenced control plots were located within twenty metres of each exclosure. [...] The small number of subplots sampled and the lack of true replication (because of the limited number of exclosures) made statistical testing for differences between exclosures and control plots uninformative. There appeared to be an increase in Griselinia littoralis seedlings in both exclosures, and an increase in Poa anceps in the forest pocket exclosure." Grazing/herbivory/browsing; Direct physical disturbance Direct Griselinia littoralis Plantae MN Low "The impact might be lower, because the native population(s) might not be declining (low number of exclosure and of subplots sampled, small spatial scale)" Kaimanawa Mountains North Island New Zealand Oceania Oceania LV March 2019 DJ April 2020

Equus caballus Equidae Perissodactyla "Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. New Zealand journal of ecology, 49-64." 1991 "The presence of all the biogeographically important plant species and their habitats in the wild horse range were recorded. The impact of grazing and trampling upon the plant habitats was assessed qualitatively. [...] Some species suffered grazing and trampling damage; for instance, Agrostis imbedlla, Carex berggrenii, Gnaphalium ensifer, Koelaria sp., and Rytidosperma pumilum. [...] Trampling damage is particularly severe in fragile, high-nutrient flushes, thereby threatening Carex berggrenii." Grazing/herbivory/browsing; Direct physical disturbance Direct Agrostis imbedlla; Carex berggrenii; Gnaphalium ensifer; Koelaria sp.; Rytidosperma pumilum Plantae MN Low "The impact might be lower, because the performance of native individuals might not be affected (it is not clear how the performance of native individuals was affected by the physical damages)." Kaimanawa Mountains North Island New Zealand Oceania Oceania LV March 2019 DJ April 2020

Equus caballus Equidae Perissodactyla "De Stoppelaire, G. H., Gillespie, T. W., Brock, J. C., & Tobin, G. A. (2004). Use of remote sensing techniques to determine the effects of grazing on vegetation cover and dune elevation at Assateague Island National Seashore: impact of horses. Environmental Management, 34(5), 642-649." 2004 "Colorinfrared imagery from 1998 and field measurements from 2001 indicated that there was a significant difference in vegetation cover between the fenced and unfenced plotpairs over the study period. Fenced plots contained a higher percentage of vegetation cover that was dominated by American beachgrass (Ammophila breviligulata). [...] Field measurements of vegetation cover from 2001 showed fenced plots averaging between 25% and 50% vegetation cover, whereas unfenced plots contained between 1% and 5% vegetation cover [...]" Grazing/herbivory/browsing Direct Ammophila breviligulata Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Assateague Island Assateague Island United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Furbish, C. E., & Albano, M. (1994). Selective Herbivory and Plant Community Structure in a Mid-Atlantic Salt Marsh. Ecology, 75(4), 1015-1022." 1994 "While this study showed that it is possible that a selective grazing pressure can influence a competitive relationship between the grasses, it does not

prove that selective grazing is the only factor determining the relative coverages of the grasses. Other factors, such as National Park Service and Maryland State Parks manipulations of the island's geomorphological processes by building artificial dunes, may be contributing or primary factors. [...] Evidence of selective grazing upon *S. alterniflora* over *D. spicata* was found when examining grazing sign in the salt marshes. Horse behavior and fecal analysis indicated that *S. alterniflora* is an often consumed and desirable forage, but *D. spicata* is avoided. Therefore, the feral horses are prime candidates for exerting a preferential grazing pressure in the low salt marshes" Grazing/herbivory/browsing Direct *Spartina alterniflora* Plantae MN Low "The impact might be higher, if a decline in the native population size has not been detected (too small spatial scale) and that the alien is causing this decline (but other stressors are cited as being the contributing or main factors)." Some measures of the native plants eaten by the alien were performed in captivity. Assateague Island Assateague Island United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Seliskar, D. M. (2003). The response of *Ammophila breviligulata* and *Spartina patens* (Poaceae) to grazing by feral horses on a dynamic mid-Atlantic barrier island. American Journal of Botany, 90(7), 1038-1044." 2003 "Ammophila breviligulata, American beachgrass, and *Spartina patens*, salt meadow hay, have been grazed by feral horses on the dunes of Assateague Island for hundreds of years; however, because of a significant increase in the horse population since the 1960s, overgrazing and dune erosion have become problems. Grazing was assessed on foredunes of four different morphologies along a 21-km stretch of the Maryland portion of the island using 17 enclosure plot pairs. In addition to decreased cover and biomass of the two species, plant structure was significantly affected by grazing. Leaf length and width, stem diameter, and stem density of *A. breviligulata* and stem diameter of *S. patens* were reduced in the grazed plots. Especially sensitive to grazing were reproductive characteristics. Percentage of plants in flower, height of flowering stems, and inflorescence length were all significantly reduced by grazing (nongrazed individuals measured). Species composition was not affected by horse accessibility." Grazing/herbivory/browsing Direct *Ammophila breviligulata*; *Spartina patens* Plantae MO Medium "The alien might have caused a local extinction, but the study design does not allow to detect it." Assateague Island Assateague Island United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Sturm, M. (2008). Assessing the effects of ungulates on natural resources at Assateague Island National Seashore. Park Science, 25, 44-49." 2008 "Horse herbivory was similarly found to be influencing the growth and development of maritime forest and shrub habitats. For example, horses significantly reduced overall species diversity during the summer in forest understory habitats. This is likely the result of foraging combined with other destructive behaviors such as trampling and rubbing. In areas of the forest understory where horses were excluded, plant diversity quickly increased regardless of whether deer were present; however, we found the highest plant species diversity in forest treatments where both horses and deer were excluded. This research also confirmed the finding of Seliskar (1997) and De Stoppelaire (2002) that horse herbivory reduces American beachgrass abundance. Understanding this aspect of the influence of horse herbivory is key because of the important role American beachgrass plays in dune development and maintenance " Grazing/herbivory/browsing; Direct physical disturbance Direct *Hudsonia tomentosa*; *Ammophila breviligulata*; *Chasmanthium laxum*; *Fimbristylis castanea* Plantae MO Low "The alien might have caused a local extinction, but whether the study design would have allowed to detect it is unclear (not enough information is provided on the way the observation were performed)." "The impact might be lower, because the native population(s) might not be declining (no information is provided on the way the observation were performed)." Assateague Island Assateague Island United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Ostermann-Kelm, S. D., Atwill, E. A., Rubin, E. S., Hendrickson, L. E., & Boyce, W. M. (2009). Impacts of feral horses on a desert environment. BMC ecology, 9(1), 22." 2009 "Trails were characterized as having significantly compacted soil, low plant cover, a high percentage of bare ground, and low species diversity (Table 5). In contrast, areas adjacent to trails (0-0.4 m) had increased plant diversity and lower soil strength." Direct physical disturbance Direct Vegetation Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the direct damages on native individuals were observed)." Coyote Canyon (Anza-Borrego Desert State Park) California United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Porter, K. M., DePerno, C. S., Krings, A., Krachey, M., & Braham, R. (2014). Vegetative impact of feral horses, feral pigs, and white-tailed deer on the Currituck National Wildlife Refuge, North Carolina. Castanea, 79(1), 8-17." 2014 "Overall, horses were responsible for 83% (n=72) of all documented disturbances, white-tailed deer were responsible for 9% (n=8), and 8% (n=7) were due to unknown sources. We detected a significant effect of treatments on plant growth where horses were present ($F_{1/4} 5.14$, $df = 2,421$ $p = 0.0063$); the raised enclosure ($p = 0.004$) and the complete enclosure ($p < 0.04$) were significantly different from the control, the complete enclosure was similar to the raised enclosure ($p = 0.60$). No differences were detected where horses were excluded ($F = 1.11$, $df = 2,406$, $p = 0.33$) (Figure 3). The total length reduction for *S. pungens* was 4.43 m and the range of reduction was between

39.4% and 100% loss in biomass (Smith 2002). We detected a total length reduction of 0.59 m for *Vaccinium* spp., which indicated a biomass loss between 2.4% to 12.5% [...] Our study demonstrated a marked increase in disturbances where horses were present compared to areas where they were excluded. [...] Additionally, horses may have been responsible for six of the seven disturbances in the excluded area due to a two-week power outage. We detected few disturbances from white-tailed deer and none from feral pigs. Our results indicated that treatment had a positive effect on growth of vegetation on the side of the fence where horses were present. [...] Despite the short time period between the end of the fence construction and the start of our sampling, we documented significant differences in plant growth between treatments in areas where horses were present. This is remarkable because the vegetation in horse-excluded sections likely had not fully recovered when sampling began. Additionally, our exclosure plots accounted for less than 1% of the entire refuge"

Grazing/herbivory/browsing Direct *Schoenoplectus pungens*; *Vaccinium* spp Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth of individuals was investigated)." Currituck National Wildlife Refuge Carolina United States North America

North and Central America LS January 2018 LV March 2019

Equus caballus Equidae *Perissodactyla* "Levin, P. S., Ellis, J., Petrik, R., & Hay, M. E. (2002). Indirect effects of feral horses on estuarine communities. *Conservation Biology*, 16(5), 1364-1371." 2002 "We selected as our study sites six marsh islands of about 10 km

2 each that were adjacent to Shackleford Banks. Three of these islands were accessible to horses [...] Three islands were not visited by horses because of deeper water that deterred horses. [...] To document bird usage and density on each island, we performed scan samples using binoculars from a stationary boat. [...] Using conical, galvanized-steel, wire-mesh minnow traps (42 cm long, 22.5 cm maximum diameter, 3.5 cm entrance diameter), we sampled fish at the marsh surface. [...] Fish abundance and species richness were significantly higher in ungrazed marshes than in grazed marshes (Fig. 2). Two fish species, mummichogs and pinfish, dominated our samples (18% and 76%, respectively). Adult mummichog abundance averaged 14 times higher in ungrazed than in horse-grazed marshes (Fig. 2), although juvenile mummichogs were captured only in ungrazed marshes ($x=1.11$ per pit trap; $SE = 0.56$). Similarly, pinfish were completely absent from grazed marshes (Fig. 2). [...] Laughing Gulls (*Larus atricilla*) and Forster's Terns (*Sterna forsteri*) nested in great abundance in ungrazed marshes and dominated the avian assemblage there (96% of the total). However, Laughing Gulls were virtually absent and Forsters' Terns significantly reduced in numbers on marshes grazed by horses (Table 2; Fig. 1). [...] Experiments manipulating marsh vegetation indicated that the potential for predation on fishes in ungrazed marshes was higher than in grazed marshes. [...] Thus, it appears that when horses remove the shelter provided by *Spartina*, mummichogs seek shelter in the burrows of xanthid crabs and then become easy prey for the crabs. We did not investigate the mechanisms by which grazing affected pinfish abundance, although it is conceivable that the same processes affecting mummichogs affect pinfish."

"Chemical, physical or structural impact on ecosystems" Indirect *Fundulus heteroclitus*; *Lagodon rhomboides*; *Larus atricilla*; *Sterna forsteri* Animalia MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the

decline(s) in the native population(s) is/are well shown (relevant spatial scale, not relevant temporal scale but reliable rescaling, good experimental design) and because no other stressor is likely to have caused the observed decline(s) and that the mechanism through which the alien is causing the decline(s) has been shown." Shackleford Banks Carolina United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae *Perissodactyla* "Wood, G. W., Mengak, M. T., & Murphy, M. (1987). Ecological importance of feral ungulates at Shackleford Banks, North Carolina. *American Midland Naturalist*, 236-244." 1987 "Grazing impact was measured by comparing estimated weights of aboveground current annual growth (AGCAG) on grazed and ungrazed plots. AGCAG was defined as aboveground shoots and foliage produced in the current growing season and existent at the time of sampling [...] Three exclosures, each 0.04 ha, were erected in each of the vegetation types in March 1978. [...] All exclosures plus adjacent paired grazed plots were sampled in late August to early September 1978 through 1981. [...] The data obtained in this study indicate that the ungulate populations at their 1978- 1981 levels were interrupting the vegetation dynamics in at least the saltmarsh and grass-shrub communities. Extensive consumption of plant material by large vertebrates is not a natural process in local saltmarsh communities. On the other hand, *Spartina alterniflora* is the climax vegetation of the saltmarsh, and this species has no competitor that might replace it under extreme grazing pressure. In addition, these sites are re- plenished with water and nutrients with each tide; therefore, major deterioration in site potential to support vegetative growth is unlikely. In the grass-shrub community, the primary effect of grazing appears to be a reduction in rate of succession from a grass stage to a *Myrica cerifera* shrub thicket stage. Succession was occurring on both grazed and ungrazed sites, but it was more rapid on the latter. The structural changes occurring in this plant community were not only important in terms of the natural plant dynamics but also in terms of the ability of the island to support grazing animals." Grazing/herbivory/browsing Direct *Andropogon* spp; *Spartina alterniflora*; *Spartina patens*; *Salicornia bigelovii*; *Hydrocotyle bonariensis*; *Uniola paniculata*; *Hydrocotyle bonariensis*; *Myrica cerifera* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (changes in the aboveground biomass between grazed and ungrazed plots have been detected, but this does

not allow to conclude to a decline in the population size)." "The impact might be lower, because the performance of native individuals might not be affected (contradictory results from 1 year to the other, and from one vegetation type to the other)." Shackleford Banks Carolina United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Turner, M. G. (1987). Effects of grazing by feral horses, clipping, trampling, and burning on a Georgia salt marsh. *Estuaries*, 10(1), 54-60." 1987 "This study suggests that trampling may be the more destructive component of grazing by large ungulates in the marsh. Horses have a strong impact on large portions of the high marsh. Horse grazing pressure is not uniform, but varies from intense near the upland to light further into the marsh. The upland area of marsh is by far the area most severely affected. Some heavily grazed areas are already withstanding very intense grazing pressures. In these areas, standing stocks of live biomass never exceed 40 g m⁻² dry mass. Heavily grazed marshes may be more susceptible to erosion and storm damage, since accretion of sediment in marshes is a function of the density of grasses present to trap particles (Gleason et al. 1979). [...] Control plots generally contained higher live rhizome biomass than moderately perturbed plots (i.e., grazed, clipped or trampled) [...] Standing stocks of live *Spartina* biomass reached annual maxima during late summer (Fig. 2) and peak standing dead occurred in early winter, as is typical (Gallagher et al. 1980; Giurgevich and Dunn 1982). All experimental perturbations caused a decline in the peak value, with the clipping + trampling combinations causing the greatest decline. Effects due to clipping alone and trampling alone were similar. Moderately intense horse grazing reduced peak biomass by 29% in 1984. Mean standing stocks of aboveground biomass and standing dead generally decreased from control to most disturbed (Table 1)." Grazing/herbivory/browsing Direct *Spartina alterniflora* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only small areas were sampled)." "The impact might be lower, because the performance of native individuals might not be affected (variation in the results)." Cumberland Island Georgia United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Turner, M. G. (1987). Effects of grazing by feral horses, clipping, trampling, and burning on a Georgia salt marsh. *Estuaries*, 10(1), 54-60." 1987 "This study suggests that trampling may be the more destructive component of grazing by large ungulates in the marsh. Horses have a strong impact on large portions of the high marsh. Horse grazing pressure is not uniform, but varies from intense near the upland to light further into the marsh. The upland area of marsh is by far the area most severely affected. Some heavily grazed areas are already withstanding very intense grazing pressures. In these areas, standing stocks of live biomass never exceed 40 g m⁻² dry mass. Heavily grazed marshes may be more susceptible to erosion and storm damage, since accretion of sediment in marshes is a function of the density of grasses present to trap particles (Gleason et al. 1979). [...] Densities of the salt marsh periwinkle (*Littorina irrorata*) were highly variable among experimental plots. The south plots contained higher densities of snails than did the north plots; in fact, densities were too low in the north for treatment effects to be observed. Snails on the south plots responded to perturbations, but only during the second growing season. The trend was similar to that seen in the aboveground vegetation." "Chemical, physical or structural impact on ecosystems" Indirect *Littorina irrorata* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only small areas were sampled)." "The impact might be lower, because the performance of native individuals might not be affected (variation in the results)." Cumberland Island Georgia United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Hess, S. C., Banko, P. C., Brenner, G. J., & Jacobi, J. D. (1999). Factors Related to the Recovery of Subalpine Woodland on Mauna Kea, Hawaii 1. *Biotropica*, 31(2), 212-219." 1999 "We measured mature tree and sapling density, tree associations, crown size, age structure, recovery from ungulate browsing, and grass cover at four study sites in two types of subalpine woodland on Mauna Kea volcano, island of Hawaii. Beginning in 1981, introduced ungulates were reduced in number to allow regeneration of *Sophora chrysophylla* (mamane) in habitat supporting the endangered Hawaiian finch, *Loxioides bailleui* (palila). We found *Sophora* regeneration at all four study sites, but regeneration was higher in mixed species woodland with codominant *Myoporum sandwicense* (naio) than in areas where *Sophora* dominated. Regeneration of *Myoporum* was uniformly very low in comparison. Invasive grass cover, which suppresses *Sophora* germination, was highest in mid-elevation woodland where *Sophora* dominated. The distribution of mature and sapling *Sophora* were both related to study site, reflecting previous ungulate browsing and uneven recovery due to grasses. Densities of *Sophora* snags were not different among any of the sites, suggesting a more even distribution in the past. Selective browsing before ungulate reduction may have favored *Myoporum* over *Sophora*, leading to high densities of mature *Myoporum* in codominant woodland. After ungulate reduction, however, we found no pattern of competitive inhibition by *Myoporum* on regeneration of *Sophora*. [...] There was no detectable browse damage on *Sophora* on the upper and mid-elevation sites. In the lower site, 11 of 13 (85%) mature trees and 11 of 13 saplings had browse damage. The bark of many young *Sophora* and *Myoporum* trees was stripped off; there was evidence of browsing on *Sophora* leaves, but no evidence of browsing on *Myoporum* leaves." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Myoporum sandwicense* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of

the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (browsing damages have been described (bark removal), which probably lead to a higher susceptibility of individuals to other stressors, but this has not been shown); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (there are four other species of introduced herbivores)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 DJ April 2020

Equus caballus Equidae Perissodactyla "Fahnestock, J. T., & Detling, J. K. (1999). The influence of herbivory on plant cover and species composition in the Pryor Mountain Wild Horse Range, USA. *Plant Ecology*, 144(2), 145-157." 1999 "Cover of *P. spicata* in grazed sites was 12% in 1993 and 3% in 1994 (Table 2). In contrast, cover of *P. spicata* in ungrazed sites was 24% and 12% in 1993 and 1994, respectively ($P < 0.05$; Table 2). [...] Differences in plant cover patterns in the PMWHR were substantially greater between years than between grazed and ungrazed sites. [...] In contrast to these differences between years, plant cover across all grazed sites (61%) was not significantly different from plant cover at ungrazed sites (58%). While these results do not preclude the possibility of a grazing effect in ungrazed sites prior to the erection of exclosures, they do suggest that plant community dynamics in the PMWHR are influenced more by abiotic variables, especially by interannual differences in growing season precipitation, than by wild horse grazing [...]"

Grazing/herbivory/browsing Direct *Pseudoroegneria spicata* Plantae MN Low "The impact might be higher, if a decline in the native population size has not been detected (small spatial scale)." "The impact might be lower, because the performance of native individuals might not be affected (no decline in the native population(s) was detected in the study, but whether the alien affected the performance of native individuals was not investigated)." Pryor Mountain Wild Horse Range Montana/Wyoming United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Beever, E. A., & Brussard, P. F. (2000). Examining ecological consequences of feral horse grazing using exclosures. *Western North American Naturalist*, 236-254." 2000 "At the plot level, areas around horse excluded springs had approximately 6-18 times greater vegetative cover than horse grazed areas. We observed no plant species along the water's edge at spring B and only 2 at spring A which contrasts strongly with the increased plant richness found at the aquatic-terrestrial boundary inside the exclosures. In general the only vegetation that remained in spring A plot was vegetation that was sheltered from trampling by large rocks [...] Horse-excluded areas exhibited 3.3 times greater total species richness than did horse-grazed plots (mean 24.5 versus 7.5 species) [...] strong differences in vegetation and qualitative differences in small mammals activity can be observed between horse-excluded and horse-occupied areas. Although comparisons for individual species are not presented here, strong treatment differences in percent cover and abundance were observed for nearly all plant species at Clan Alpine springs" Grazing/herbivory/browsing Direct Vegetation Plantae MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in vegetation abundance in general, making it difficult to understand which species are affected, and how)" "The impact might be lower, if no native population(s) is declining (not relevant spatial scale; paired sites not always presenting similar characteristics)" Clan Alpine Mountains Nevada United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Beever, E. A., & Brussard, P. F. (2000). Examining ecological consequences of feral horse grazing using exclosures. *Western North American Naturalist*, 236-254." 2000 "Exclosure plots near springs on average had 6 times more small mammal burrow entrances than did horse-grazed plots [...] In addition to tallying burrow entrances, we also observed pocket gopher (*Thomomys* sp.) tunnels in both spring C and spring D plots, but not in either of the horse-grazed plots. [...] During live-mammal trapping for 3 consecutive nights at 6 plots (288 total trap nights), we captured 21 individuals of 4 rodent species and had 13 recaptures. Meadow pairs exhibited higher species richness and higher capture rates in ungrazed grids, but the sagebrush pair exhibited higher species richness and abundance of small mammals in the grazed grid." "Chemical, physical or structural impact on ecosystems" Indirect *Peromyscus maniculatus*; *Microtus longicaudatus*; *Lemmys curtatus*; *Tamias* spp.; *Thomomys* sp. Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (a decline in the native population(s) has been inferred from a decrease in the number of burrows of native rodents (but small spatial scale, contradictory results, paired sites not always presenting similar characteristics))." Clan Alpine Mountains Nevada United States North America North and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Beever, E. A., & Brussard, P. F. (2004). Community-and landscape-level responses of reptiles and small mammals to feral-horse grazing in the Great Basin. *Journal of Arid Environments*, 59(2), 271-297." 2004 "For small mammals, although simple species richness suggested that horseoccupied and horse-removed sites were faunally similar, RRR (Realized richness of rodents) was significantly greater at horse-removed sites in both years. [...] Few species of small mammals exhibited significant differences in abundance between horse-occupied and horse-removed sites. This lack of difference was often due to low capture numbers, which led to low statistical power to detect significant differences in abundance. [...] Our finding of lower absolute squamate species diversity and a trend

toward lower abundance of many reptile species at horse-grazed sites agrees with other studies of reptiles experiencing disturbance." "Chemical, physical or structural impact on ecosystems" Indirect *Reithrodontomys megalotis*; *Ammospermophilus leucurus*; *Microtus longicaudus*; *Dipodomys merriami*; *Gambelia wislizenii*; *Cnemidophorus tigris*; *Phrynosoma platyrhinos*; *Sceloporus graciosus*; *Uta stansburiana*; *Callisaurus draconoides*; *Sceloporus occidentalis* Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (very small spatial scale, so it might only be an avoidance behavior from the native population(s) that has been detected, or natural differences)." Great Basin Nevada United States North America North and Central America LS January 2018 LV March 2019 *Equus caballus* Equidae Perissodactyla "Beever, E. A., & Herrick, J. E. (2006). Effects of feral horses in Great Basin landscapes on soils and ants: direct and indirect mechanisms. *Journal of Arid Environments*, 66(1), 96-112." 2006 "In our research, we observed notable differences in ant mounds and soil-surface penetration resistance between sites grazed by horses and sites from which horses had been removed for 10–14 years, when comparing sites at the landscape scale. Results of our analyses suggest that these apparent ecosystem alterations are likely due to a combination of direct and indirect effects (Fig. 1). [...] First, soil surfaces at horse-occupied sites exhibited significantly higher penetration resistance than did those at horse-removed sites, in both 1997 and 1998 [...] We found greater abundance of ant mounds at horse-removed as compared to horseoccupied sites in both 1997 and 1998, with 2.2–4.0 times more mounds at high-elevation sites, and 3.6–8.4 times more mounds at low-elevation sites " "Chemical, physical or structural impact on ecosystems" Indirect *Formica* sp. Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (a decline in the native population(s) has been inferred from a decrease in the number of ant mounds, but it might not be representative of the whole population size)." Great Basin Nevada United States North America North and Central America LS January 2018 LV March 2019 *Equus caballus* Equidae Perissodactyla "Beever, E. A., Tausch, R. J., & Thogmartin, W. E. (2008). Multi-scale responses of vegetation to removal of horse grazing from Great Basin (USA) mountain ranges. *Plant Ecology*, 196(2), 163-184." 2008 "We compared characteristics of vegetation at 19 sites in nine mountain ranges of the western Great Basin; sites were either grazed by feral horses (*Equus caballus*) or had had horses removed for the last 10–14 years. [...] In order to characterize structure, cover, diversity, and composition of vegetation, we used four 50 m line-intercept transects (Bonham 1989) per site. [...] We recorded the species and length of intercept of each plant (including perennials and annuals) under the 50 m line. [...] We recorded the number of individuals from each vegetation class (grass, forb, and shrub) intersected on each 50 m transect as an estimate of frequency, and averaged counts across the four transects within each site. [...] To investigate richness at a broader scale than transects, cumulative lists of plants at each site ("site species richness") were created by adding all species from transects and other plants encountered in and immediately adjacent to (within 10 m of) the samplingstation grid (see Beever 1999 for plant species lists). [...] During 1997 and 1998, line-intercept transects randomly located within sites revealed that horse-removed sites exhibited 1.1–1.9 times greater shrub cover, 1.2–1.5 times greater total plant cover, 2–12 species greater plant species richness, and 1.9–2.9 times greater cover and 1.1–2.4 times greater frequency of native grasses than did horse-occupied sites. In contrast, sites with horses tended to have more grazing resistant forbs and exotic plants. [...] Because horses primarily consume graminoids (Hanley and Hanley 1982; McInnis and Vavra 1987), our findings of lower frequency and percent cover of grasses at horse-occupied sites (Table 2) as well as strong variable weight for presence of horses in information-theoretic analyses of these two response variables (Table 3) is not surprising." Grazing/herbivory/browsing Direct Grass Plantae MO Low Great Basin Nevada United States North America North and Central America LS January 2018 LV March 2019 *Equus caballus* Equidae Perissodactyla "Beever, E. A., Tausch, R. J., & Thogmartin, W. E. (2008). Multi-scale responses of vegetation to removal of horse grazing from Great Basin (USA) mountain ranges. *Plant Ecology*, 196(2), 163-184." 2008 "We compared characteristics of vegetation at 19 sites in nine mountain ranges of the western Great Basin; sites were either grazed by feral horses (*Equus caballus*) or had had horses removed for the last 10–14 years. [...] In order to characterize structure, cover, diversity, and composition of vegetation, we used four 50 m line-intercept transects (Bonham 1989) per site. [...] We recorded the species and length of intercept of each plant (including perennials and annuals) under the 50 m line. [...] We recorded the number of individuals from each vegetation class (grass, forb, and shrub) intersected on each 50 m transect as an estimate of frequency, and averaged counts across the four transects within each site. [...] Although there was no difference in the frequency (i.e., stem count) of sagebrush shrubs in either year, percent cover of sagebrush was significantly (1.1– 2.2 times) higher at horse-removed than at horseoccupied sites during 1998 but not during 1997 (1.1–2.1 times higher, but more variable among sites within treatments; Table 2). [...] If transition thresholds (Laycock 1991) are not crossed, current grazing can influence foliar cover without directly affecting species frequency, whereas changes in density often reflect longer-term impacts on the plant community." Grazing/herbivory/browsing Direct *Artemisia tridentata* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (a decrease in the performance of the native individuals has been inferred from a decrease in the foliar cover)." Great Basin Nevada United States North America North

and Central America LS January 2018 LV March 2019

Equus caballus Equidae Perissodactyla "Davies, K. W., Collins, G., & Boyd, C. S. (2014). Effects of feral free? roaming horses on semi?arid rangeland ecosystems: an example from the sagebrush steppe. *Ecosphere*, 5(10), 1-14." 2014 "Our results suggest that feral horse grazing can affect some aspects of semi-arid ecosystems. [...] At higher levels of horse use there was about half the perennial grass cover in grazed compared to ungrazed exclosures; however, herbaceous cover and density were generally not different between horse grazed and ungrazed areas in our study [...] In contrast to the lack of measured effects of feral horse grazing exclusion on herbaceous vegetation abundance, sagebrush density was two-fold higher in horse exclosures suggesting sagebrush recruitment may be limited by feral horses, probably though physical damage of sagebrush. [...] Our results suggest effects of feral horses on species richness and diversity may vary by plant community and site characteristics (grazingplant coevolution, climate, soils, etc.). Plant species diversity was greater in exclosures than feral horse grazed areas in our study. "Direct physical disturbance Direct *Artemisia* spp. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Sheldon National Wildlife Refuge Nevada United States North America North and Central America LS January 2018 LV March 2019

Hemitragus jemlahicus Bovidae Cetartiodactyla "Caughley G (1970) Eruption of ungulate populations, with emphasis on Himalayan thar in New Zealand. *Ecology* 51:53–72" 1970 "The most con- spicuous difference was in the density of snow tussocks (*Chionochloa* spp.) which often formed an almost continuous cover where thar were absent (e.g. Fox Valley) but were invariably scattered or uncommon where thar were numerous (e.g. Douglas Valley). The presence of dead stumps of snow tussock in these depleted areas argued that tussock had previously been more abundant there. [...] If the casual observations relating to the effect of grazing on snow tussocks are accurate, they sug- gest a relationship between percentage cover and length of time thar have been present in an area. The following hypothesis was erected: on a tran- sect from the edge of breeding range to the point of liberation the density of snow tussocks should decrease, the decline being steepest between the area where thar have recently established and the area holding a population in the stage of initial stabilization. [...] The species to be considered are *Chionochloa flavescentis*, *C. pallens* and *C. rigida*, [...] An index of percentage cover of grasses and herbs normally growing above 30 cm was calcu- lated over April and May 1967 for each area containing one of the four study populations east of the divide. [...] Table 11 shows that all species or groups had significant variation between sites within areas, but that only the snow tussocks and *Poa colensoi* could be shown as differing significantly between areas. The snow tussocks conformed to hypothesis by exhibiting a trend of decreasing per cent cover from the edge of the range to its center. " Grazing/herbivory/browsing Direct *Chionochloa pallens*; *Chionochloa flavescentis*; *Chionochloa rigida* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (comparison of the situations before/after the introduction of alien, but no exclusion of confounding effects)." Southern Alp South island New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Hemitragus jemlahicus Bovidae Cetartiodactyla "Cruz, J., Thomson, C., Parkes, J. P., Gruner, I., & Forsyth, D. M. (2017). Long-term impacts of an introduced ungulate in native grasslands: Himalayan tahr (*Hemitragus jemlahicus*) in New Zealand's Southern Alps. *Biological Invasions*, 19(1), 339-349." 2017 "The range of Himalayan tahr in the Southern Alps is dominated by grasslands of snow tussocks including *Chionochloa pallens*, *C. flavescentis* and *C. rigida*; [...] Himalayan tahr had significant impacts on total vegetation cover and tussock height. The forms of the relationships differed, being linear (non-threshold) for tussock height and non-linear (threshold) for vegetation cover. [...] The overall relationship between tussock height and tahr activity showed a negative linear decline in tussock height with increasing tahr activity, which was termed 'proportionate' by Norbury et al. (2015). [...] More generally, total vegetation cover appears to still be recovering from the high tahr densities that occurred prior to the advent of helicopter based commercial harvesting." Grazing/herbivory/browsing Direct *Chionochloa pallens*; *Chionochloa flavescentis*; *Chionochloa rigida*; *Chionochloa crassiuscula*; *Chionochloa macra* Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Southern Alp South island New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Hemitragus jemlahicus Bovidae Cetartiodactyla "Parkes, J. P.; Thomson, C. 1999: Impact of Himalayan thar (*Hemitragus jemlahicus*) on snow tussock in the Southern Alps. *Science for Conservation* 132: 1-46." 1999 "Changes in the indices of tussock biomass (percent cover, height, basal area, and plant density) were generally consistent with changes in thar densities and their absolute number. In the Hooker Valley, where thar always remained at low densities, all indices improved or remained the same, with significant increases in the percent cover and density of *Chionochloa pallens* (Table 2). In North Branch, where thar numbers increased between the surveys and were always above the intervention density, all indices decreased, with height and percent cover showing significant reductions. In the

Whymper, where the numbers increased slightly but remained at modest densities, there were no consistent trends or significant changes in the indices "Grazing/herbivory/browsing Direct *Chionochloa pallens* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Southern Alp South island New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Lama guanicoe Camelidae Cetartiodactyla "Armstrong, P. H. (1994). Human impact on the Falkland Islands environment. The Environmentalist, 14(3), 215-231." 1994 "Guanaco (*Lama guanicoe*) were first brought in around 1860 and small numbers still persisted in 1871. In the early 1930s, they were again introduced by the John Smith estate to Staats Island in the Weddell Group. They increased quite rapidly into a herd of several hundred, severely damaging the tussac grazing." Grazing/herbivory/browsing Direct *Poa flabellata* Plantae MN Low "The alien might have caused a decline in the native population size (linguistic ambiguity: "'severely damaging the tussac grazing'" implies at least a reduction in the performance of individuals, but too ambiguous to imply a reduction in the population size); No information on how the impact was measured/observed and unclear whether it consists in a direct observation." "The impact might be lower, because the performance of native individuals might not be affected (no information on how the impact was measured/observed and unclear whether it consists in a direct observation)" Staats Island Falkland Islands (Malvinas) Falkland Islands (Malvinas) South America South America MS; LV September 2017 DJ April 2020

Lama guanicoe Camelidae Cetartiodactyla "Franklin, unpublished data (in: Franklin, W. L., & Grigione, M. M. (2005). The enigma of guanacos in the Falkland Islands: the legacy of John Hamilton. Journal of biogeography, 32(4), 661-675.)" 2005 "Beginning in the mid-1950s, an organized effort was made to exterminate the guanacos of Staats Island, because of the poor state of the animals and overgrazing that had occurred on the island. [...] While tussac grass and native boxwood (*Hebe eliptica*) have nearly disappeared from Staats Island due to fire and overgrazing by cattle, sheep and guanacos (Strange, 1987; Franklin, unpubl. data) and there are areas of sheet erosion on some steep slopes, the vegas continue to be in good condition, supporting a guanaco population in good physical condition (Franklin, 2004)." Grazing/herbivory/browsing Direct *Poa flabellata*; *Hebe eliptica* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no information on how the impact was measured/observed); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (other stressors, such as fire and other herbivores)" Staats Island Falkland Islands (Malvinas) Falkland Islands (Malvinas) South America South America MS; LV September 2017 DJ April 2020

Muntiacus reevesi Cervidae Cetartiodactyla "Cooke AS (2006) Monitoring Muntjac Deer *Muntiacus Reevesi* and Their Impacts in Monks Wood National Nature Reserve, 172 pp. English Nature Research Report 681, Peterborough, UK." 2006 "In the early 1970s, dog's mercury was widespread, carpeting about 34% of the ground (Steele & Welch 1973; Cooke and others 1995), equivalent to 53 ha. By the 1990s, the main stands in the south west corner of the woods were reduced to about 1ha. [...] Between 1998 and 2005, the area of the stands has in the south west had increased to about 2.5ha. [...] Because of the recent spread of *Brachypodium sylvaticum* in particular, it is possible that the reduction of dog's mercury may not be fully reversible, even if muntjac could be eliminated from the wood. [...] The change from the early 1970s to the late 1990s was profound. Deer browsing, with a contribution with increased shading, caused the tickets to die back until no significant areas remained. In addition, browsing suppressed seedling growth. Bramble was still abundant in the late 1990s but plants failed to develop into tall, mature bushes. Monitoring since 2000 has shown some recovery in bramble height, but extensive thickets have not yet developed" Grazing/herbivory/browsing Direct *Mercurialis perennis*; *Rubus fruticosus* agg. Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Monks Wood National Nature Reserve Cambridgeshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Cooke AS (2006) Monitoring Muntjac Deer *Muntiacus Reevesi* and Their Impacts in Monks Wood National Nature Reserve, 172 pp. English Nature Research Report 681, Peterborough, UK." 2006 "Grazing on inflorescences will of course have had an immediate impact on numbers of intact bluebells, while grazing on leaves will have reduced their vigour. [...] In 2005, although grazing levels were similar in both woods, leaves were on average 16% shorter in Monks Woods, inflorescence height was reduced by an average of 11% and there was a 30% reduction in the number of flowers per inflorescence. [...] When grazing pressure is relaxed, vigour recovers so that previously dormant plants begin to flower (again), but it can be some time before size fully recovers. [...] The extent to which bluebells have recovered in recent years confirms that muntjac had major impact on this species. However changes in distribution noted between 1957 and 1973 and between 1973 and 2002 demonstrated that bluebells were also affected by other factors. [...] Results from the enclosure study showed that browsing during 1993-2003 affected tree regeneration in compartment 27c. [...] failure to find any unprotected ash in the height range 20-130 cm during the search in 2005 indicated

that regeneration had not recovered despite the reduction in deer density since stalking began in 1998/9. [...] Given the fact that regrowth of hazel and other trees, including ash, was still being heavily browsed in parts of Monks Wood in 2005, it should be not surprising to learn that ash regeneration was still affected. [...] As tree may live for 200 years (Rackam 2003), so it is debatable whether reduced tree regeneration since 1985 is important in Monks Wood." Grazing/herbivory/browsing Direct Hyacinthoides non-scripta; Fraxinus excelsior; Corylus avellana Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only individual vigor for bluebells (leave size, height and number of flowers per inflorescence) and regeneration for trees were investigated)." Monks Wood National Nature Reserve Cambridgeshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Cooke, A. S. (1997). Effects of grazing by muntjac (Muntiacus reevesi) on bluebells (Hyacinthoides non-scripta) and a field technique for assessing feeding activity. Journal of Zoology, 242(2), 365-369." 1997 "Bluebell plants were not significantly more abundant inside the 1978 exclosures. Domin scores ranged from 2-9 in the exclosures and from 4-8 in the control plots, while frequency of occurrence of plants was similar inside and out (Table I). Leaves, however, were significantly shorter outside the exclosures in both April and May (Table I). Inside exclosures erected in 1993, leaf length had recovered significantly in two years " Grazing/herbivory/browsing Direct Hyacinthoides non-scripta Plantae MN Medium "The impact might be higher, if a decline in the population size has not been detected (the experimental design might not have allowed to detect a decline)." "The impact might be lower, because the performance of native individuals might not be affected (a decrease in the performance of the native individuals has been inferred from a change in the leave sizes)." Monks Wood National Nature Reserve Cambridgeshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Pollard, E., & Cooke, A. S. (1994). Impact of muntjac deer Muntiacus reevesi on egg-laying sites of the white admiral butterfly Ladoga camilla in a Cambridgeshire wood. Biological Conservation, 70(2), 189-191." 1994 "The measurements of egg-heights of the white admiral and of the browse-line of honeysuckle show that the pattern of egg-laying in Monks Wood has been significantly changed by browsing. Honeysuckle leaves trailing down close to the ground have been eaten by the deer and are unavailable to the butterflies. [...] The Monks Wood population has declined, but the wider comparison shows that this decline is not significantly greater than elsewhere (unpublished data from the Monitoring Scheme). Thus there is no evidence that the deer have had an additional adverse effect on the Monks Wood population. It remains possible that the Monks Wood population has been affected by the browsing, but the monitoring data are not adequate to demonstrate the effect " "Chemical, physical or structural impact on ecosystems" Indirect Ladoga camilla Animalia MN Low "The impact might be higher, if the detected decline is at least partly caused by the alien (the monitoring data are not adequate to test whether the alien is causing some decline in the population, but the decline in the Monks Wood population does not seem to be greater than elsewhere)." "The impact might be lower, because the performance of native individuals might not be affected (too short temporal scale, so the detected effect might only be a temporary effect of the alien)." Monks Wood National Nature Reserve Cambridgeshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Gill, R. M. A., & Morgan, G. (2010). The effects of varying deer density on natural regeneration in woodlands in lowland Britain. Forestry, 83(1), 53-63." 2010 "The results show that higher deer densities were associated with higher rates of browsing and reduced seedling densities across the range of sites that were sampled. [...] The decline in seedling density with increasing deer density was steepest at relatively low deer densities than higher, as indicated by the linear relationship with log seedling abundance. This suggests that seedlings are particularly sensitive to deer browsing, being among the most preferred food sources. [...] The relatively limited number of sites available in this study made it difficult to investigate the effects of deer while controlling for the influence of other variables. Within the sample of sites used in this study, the majority had an intermediate deer density (10 – 20 km⁻² in woodlands). This meant that there were not many sites at high and low densities, which would have helped to bring the differences between deer species, and the effect of relative use of fields, into sharper focus. Secondly, the results also reveal considerable variation in seedling density between sites, some of which can be accounted for by stand and site characteristics, such as soil quality and stand characteristics — a few of the sites sampled had low deer densities and low numbers of seedlings or vice versa. " Grazing/herbivory/browsing Direct Acer pseudoplatanus; Quercus sp.; Ilex aquifolium; Cateagrus monogyna Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "West Oxfordshire; Mundford (Thetford Forest Park, Suffolk); King's Forest (Thetford Forest Park, Suffolk); Chilterns; West Midlands; Alice Holt (Hampshire); Cotswolds; Lower Woods (Gloucestershire); Dean; High Meadow (Surrey); Chiddingfold (Surrey) (England); Breiddens (Powys, Wales); Nash Wood (England/Wales)" England United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. Ibis, 149(s2), 119-127." 2007 "To address this need, one of us (R.M.A.G.) surveyed 13 mature woodland sites, assessing both deer population density and understorey vegetation density

in late winter or early spring 2002 and 2003. [...] Foliage density was measured by recording the visibility of a 0.5 × 0.5-m frame from 10 m at four compass directions at ten plots in each stand. This was repeated at successive 0.5-m height intervals between ground level and 3.5 m. Visibility was recorded in three 'intensities' (0, entirely visible; 1, partially obscured; 2, totally obscured) and expressed as a percentage of the maximum possible score (8). Canopy cover was recorded by estimating overhead cover in 5% cover classes. [...] The experiment consists of eight plots of uniform coppice age of mean size 1.1 ha (range 0.8–1.5 ha). Half of each plot was fully protected from deer browsing immediately after felling and removal of the cut underwood by the erection of a 1.8-m steel deer fence. The remaining area was surrounded by a dead hedge. The experiment therefore compared total exclusion of deer with shortterm exclusion. [...] Bramble cover, canopy cover, low vegetation cover, field layer density and shrub layer density tended to be higher within the fenced subplots. Grass cover, however, was higher outside the fences. In the case of Bramble and field layer, the effect of fence was only apparent in the interaction with plot. [...] The results indicate a marked reduction in foliage density with increasing deer density (Fig. 1; Table 2), reducing the foliage density score by up to 92% of the zero deer density score. The reduction was greatest (and statistically more significant) at the height at which deer forage (below 1.5 m), and greater for larger deer species (at a given density) than smaller species. The effects of deer were significant after including canopy cover as a variable in all the models." Grazing/herbivory/browsing Direct Bramble; Canopy; Low vegetation; Shrub layer; Field layer Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the overall visibility and density of the vegetation was measured)." "Hereford, Gloucestershire, Oxfordshire, Surrey, Norfolk (England); Powys (Wales)" England; Wales United Kingdom Europe Europe LV March 2019 LS February 2020

Muntiacus reevesi Cervidae Cetartiodactyla "Putman, R. J. Grazing in temperate ecosystems: large herbivores and the ecology of the New Forest. (1986)." 1986 "The patchy turf of Forest grasslands boasts no plant material higher than a few millimetres - apart from the occasional stem of ragwort! (Plate 14). Such grasslands clearly lack many of the possible structural layers of mature, ungrazed grasslands. On heathlands, too, the effects of heavy grazing are clear in their reduction of structural diversity. [...] New Forest woodlands virtually lack any ground flora or shrub layer. The woodland floor is essentially bare, and indeed the whole structural 'layer' between ground level and 1.8 m - the extent of a pony's reach - is missing: most of the Forest woodlands display a marked browse line at this level (Plate 15). Under continuous browsing pressure, palatable shrubby species such as hawthorn, blackthorn and hazel are eliminated and fail to regenerate. Even species relatively resistant to grazing, such as holly or gorse, are heavily used: taller holly trees are thoroughly browsed up to the 1.8-m browse line and have little vegetation below this level; shrubs of both holly and gorse which fall entirely within the reach of the herbivores are severely stunted and 'hedged' by the continuous browsing (Plate 16). At the ground level, brambles, ivy and other low vegetational species are completely eliminated; the only species which gives any structure at this level is bracken (*Pteridium*), which, although eaten by the ponies at certain times of year, is not particularly palatable. [...] Fifteen years after fencing, there were shown to be 35 times as many trees in the ungrazed pen as in the pen still grazed by fallow deer, although the difference between the compounds is not significant until the regenerating trees are included in the analysis. [...] Results from this study highlight the differences in vegetational composition and structure between woodland areas free of grazing animals and those maintaining a high density of large herbivores. Differences in structure - and actual vegetational bulk in terms of pure biomass or bulk of material - are apparent both in the ground flora and in the woody vegetation. Much of the difference between the grazed and ungrazed area results from the massive regeneration of tree species which has occurred in the area free of grazing; results emphasise the lack of such regeneration in grazed areas. This suppression of regeneration may have a direct effect on physical structure of the vegetation, but in the long term has an even more significant effect - on the population age structure of the Forest trees." Grazing/herbivory/browsing Direct *Fagus sylvatica*; *Quercus* sp.; *Pinus sylvestris*; *Larix* sp.; *Betula* sp.; *Pseudotsuga menziesii*; *Ulex europaeus*; *Ilex aquifolium*; *Crataegus monogyna*; *Prunus spinosa*; *Salix* sp.; *Calluna* sp.; *Erica* sp.; *Agrostis setacea*; *Leontodon autumnalis*; *Trifolium repens*; *Trifolium pratense*; *Vulpia bromoides*; *Cerastium holosteoides*; *Leontodon autumnalis*; *Sagina procumbens* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (some impacts are directly measured, some are just reviewed); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (other herbivores present)" New Forest Hampshire (England) United Kingdom Europe Europe LV March 2019 LS January 2018 LS February 2020

Muntiacus reevesi Cervidae Cetartiodactyla "Joys, A. C., Fuller, R. J., & Dolman, P. M. (2004). Influences of deer browsing, coppice history, and standard trees on the growth and development of vegetation structure in coppiced woods in lowland England. *Forest Ecology and Management*, 202(1), 23-37." 2004 "According to the Kolmogorov–Smirnov test statistic on the distribution of the coppice compartments, the vegetation structure is significantly different between low and high deer browsing. The exception being cover of bramble and overstorey canopy cover. [...] However, they all had an understorey of native deciduous trees, consisting of ash (*Fraxinus excelsior*), hazel (*Corylus avellana*), willow (*Salix* spp.), birch (*Betula* spp.), and alder (*Alnus glutinosa*) (Stace, 1997). [...] Overall, vegetation development was delayed by deer browsing as found in English coppice (Fuller, 2001) and European woodlands (Peterken and Jones, 1989; Berquist et al.,

1999; Kirby, 2001). " Grazing/herbivory/browsing Direct Fraxinus excelsior; Corylus avellana; Salix spp.; Betula spp.; Alnus glutinosa Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "Treswell Wood (Nottinghamshire); Foxley Wood, Ashwellthorpe Wood, Wayland Wood (Norfolk); Gamlingay Wood, Hayley Wood (Cambridgeshire); Bradfield Wood, Groton Wood, Bonny Wood, Priestley/Swingsens Wood, Wolves Wood (Suffolk)" "Nottinghamshire, Norfolk, Cambridgeshire, Suffolk (England)" United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Morecroft, M. D., Taylor, M. E., Ellwood, S. A., & Quinn, S. A. (2001). Impacts of deer herbivory on ground vegetation at Wytham Woods, central England. Forestry, 74(3), 251-257." 2001 "Some decline in bramble was probably inevitable in the years following 1974, although the extent of the decline must have been increased by deer grazing. [...] This study has added to the weight of evidence that rising deer populations have been changing the ground vegetation of British woodlands in recent decades. It has, however, also demonstrated that interactions with other factors such as site management and the availability of grassland may play an important role in determining outcomes of grazing at particular sites. " Grazing/herbivory/browsing Direct Rubus fruticosus agg.; Forbs (herbaceous dicotyledons) Plantae MO Medium "The impact might be lower, if the alien did not cause any decline in the native population size(s) but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (other deer present)" Wytham Woods Oxfordshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Perrins, C. M., & Overall, R. (2001). Effect of increasing numbers of deer on bird populations in Wytham Woods, central England. Forestry, 74(3), 299-309." 2001 "The species which have shown the most marked declines on the CBC plot, namely blackbird, song thrush, dunnoek and bullfinch, plus the four warblers are generally typical of this sort of woodland and their decline/disappearance require an explanation. Although the four warblers are migrants, the other four species are largely resident. The single feature which all these eight species have in common and which contrasts with the species which have not declined, is that they most commonly nest in low vegetation such as brambles. [...] The impact of deer on the vegetation in Wytham probably has had a deleterious effect on the bird population. [...] Habitat damage by deer seems at best an incomplete explanation for such changes. [...] In addition to deer browsing, the canopy closure might also be causing the decline in bramble (the main species in which these birds nest)" "Chemical, physical or structural impact on ecosystems" Indirect Sylvia borin; Phylloscopus trochilus; Phylloscopus collybita; Sylvia atricapilla; Pyrrhula pyrrhula; Turdus merula; Turdus philomelos; Prunella modularis Animalia MO Medium "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." Wytham Woods Oxfordshire (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Fuller, R. J. (2001). Responses of woodland birds to increasing numbers of deer: a review of evidence and mechanisms. Forestry, 74(3), 289-298.; Holt, C. A., Fuller, R. J., & Dolman, P. M. (2010). Experimental evidence that deer browsing reduces habitat suitability for breeding Common Nightingales Luscinia megarhynchos. Ibis, 152(2), 335-346." 2001 "[Fuller 2001] Pressure from roe deer increased in Bradfield Woods throughout the 1980s and muntjac deer colonized the wood in the early 1990s. In 1989 moderate deer-culling and temporary protection of freshly cut coupes with dead hedges (brush-wood fences) were initiated. [...] Vegetation structure was re-measured in 1994 and migrant birds were re-surveyed in 1995, both using exactly the same methods as in 1987. [...] The breeding birds were resurveyed in 1995 (Table 1). The survey concentrated on migrant species because these were found to be dependent on areas with a dense shrub layer in 1987, particularly coppice of 3-8 years of growth (Fuller and Henderson, 1992). There had been no major change in the management of the wood over this period, [...] In contrast, nightingales had declined by >80 per cent. Unlike warblers, nightingales forage mainly on sparsely vegetated areas of ground yet they require dense low vegetation for cover. Proliferation of coarse grasses in the field layer of 6-7 year coppice may have reduced the availability of suitable feeding sites. It is also possible that low vegetation structures have altered in ways that are especially deleterious to nightingales, for once the deer breach the dead hedges (usually within 2 years) they tend to browse out the low growth (Fuller et al., 1999). [...] These results show that populations of some shrub-nesting species can persist in areas with moderately high densities of deer providing that actions are taken to minimize deer impacts on vegetation structure.; [Holt et al. 2010] Since the 1980s, deer numbers have increased markedly at Bradfield Woods and in the surrounding landscape (Fuller 2001), typifying the wider regional situation (Ward 2005, Davey & Aebischer 2006). [...] Nightingales showed a strong preference for younger coppice without deer compared with paired plots that were browsed by deer. This suggests that increasing deer pressure is likely to be one of the factors contributing to declines in Nightingales and perhaps other woodland bird species dependent on dense understorey habitats (Fuller et al. 2005, Hewson et al. 2007). We stress that the status of the species is also affected by a range of other potential factors operating on the breeding grounds, on migration, and in winter (Fuller et al. 2005). Furthermore, it is unclear whether deer have similar impacts on habitat quality in non-coppice woodland environments and scrub." "Chemical, physical or structural impact on

ecosystems" Indirect *Luscinia megarhynchos* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (the way of monitoring the birds might not have been fully adequate (13 visits in the wood and visual observations)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other bird species are also declining nationally because of other stressors, it might be the case for this species as well)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe Fuller (2001): Observed the decline in the native population and established the link between this decline and the increase in alien deers; Holt et al. (2010): Investigated the mechanism through which the alien could have caused this decline (tested how the alien influences local habitat preference of the native) LV January 2018 LS February 2020

Muntiacus reevesi Cervidae Cetartiodactyla "Gill, R., & Fuller, R. J. (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. *Ibis*, 149(s2), 119-127." 2007 "In each year since 1999, the distribution of bird territories was established through territory mapping, with up to 15 visits in the period April to early June (Bibby et al. 2000). [...] However, there is much that remains unclear about how deer are affecting British woodland bird populations. Apart from our results using fenced enclosures in Bradfield Woods, direct evidence of a link between deer numbers and songbirds is still lacking. It is still not entirely clear to what extent recent declines in woodland songbird populations have been caused by deer or whether they simply coincide temporally with a general increase in deer numbers. Nonetheless, the Bradfield Woods results do suggest that, at least at a local scale, reductions in some species may be associated with increased pressure from deer. [...] These results lend support to the hypothesis that deer are at least partly responsible for causing declines in some British bird populations, but they do not eliminate the possibility that increased shading is also responsible for changes in woodland structure." "Chemical, physical or structural impact on ecosystems" Indirect *Sylvia communis*; *Sylvia borin*; *Sylvia atricapilla*; *Phylloscopus collybita*; *Phylloscopus trochilus*; *Luscinia megarhynchos*; *Prunella modularis*; *Turdus merula* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (Bibby et al. 2000 observed a general decline in woodland birds in Britain, but no decline of these specific local native populations have been shown, except regarding *Luscinia megarhynchos* (Fuller et al. 2001)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (other bird species are also declining nationally because of other stressors, it might be the case for this species as well; in addition, other introduced deer species are present, increased shading might also play a role, and the study only establishes the responsibility of the alien in the decline(s) by showing a potential indirect mechanism)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Holt, C. A., Fuller, R. J., & Dolman, P. M. (2011). Breeding and post-breeding responses of woodland birds to modification of habitat structure by deer. *Biological conservation*, 144(9), 2151-2162.; Fuller, R. J., Noble, D. G., Smith, K. W., & Vanhinsbergh, D. (2005). Recent declines in populations of woodland birds in Britain. *British Birds*, 98, 116-143." 2011 "[Fuller et al. 2005] Experimental evidence that deer can alter woodland bird communities is currently lacking in Britain, but is available from two North American studies in which densities of White-tailed Deer *Odocoileus virginianus* were manipulated (deCalesta 1994; McShea & Rappole 2000).; [Holt et al. 2011] In lowland Britain for example, four of the six extant deer species are particularly widespread and increasing: red deer (*Cervus elaphus*), roe deer *Capreolus capreolus*), fallow deer (*Dama dama*) and Reeves' muntjac (*Muntiacus reevesi*) (Ward, 2005). This issue has been suggested as a contributory factor in the population declines of several woodland bird species in Britain (Fuller et al. 2005) and North America (Alloberet et al., 2005a). [...] Effects of deer browsing are reported from a replicated split-plot exclusion experiment in English coppiced woodland. [...] At the species level, especially pronounced negative effects were evident for dunnoek (*Prunella modularis*) and garden warbler (*Sylvia borin*) [...] We also detected negative responses to browsing by nightingale (*Luscinia megarhynchos*) and long-tailed tit (*Aegithalos caudatus*). [...] Fewer dunnocks were captured in the control plots than in the exclosures throughout the coppice cycle of two to eight years re-growth studied. Dunnocks require a combination of dense understorey for nesting and bare ground for foraging (Bishton, 1986), habitat characteristics that tend to be compromised by deer activity. [...] A negative response to deer by garden warbler, also in decline nationally (Hewson et al., 2007), was detected only within youngest re-growth. Hewson and Fuller (2005) suggested that a temporal shift to increased proportional use of edge habitat by long-tailed tits within woodlands in southern England may be attributable to increased grazing pressure within woodland interiors. None of the 16 species examined responded positively to deer browsing." "Chemical, physical or structural impact on ecosystems" Indirect *Prunella modularis*; *Sylvia borin*; *Luscinia megarhynchos*; *Aegithalos caudatus* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (Marchant 1990 (inaccessible) showed a large decline in the breeding populations and contractions of breeding range in several woodlands birds in Britain in recent decades, but the decline of these specific local native populations have not been shown (except regarding *Luscinia megarhynchos* (Fuller et al. 2001)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no

exclusion of confounding effects; in addition, other bird species are also declining nationally because of other stressors, it might be the case for this species as well)." Bradfield Woods Suffolk (England) United Kingdom Europe Europe
 Marchant (1990): Showed large decline in the breeding populations and contractions of breeding range in several woodland birds in Britain in recent decades (cited in Fuller et al. (2005)); Fuller et al. (2005): Hypothesised that the alien is partly responsible for these declines (no direct observations); Holt et al. (2011): Showed that alien influenced local habitat use by the native species; Marchant (1990) is inaccessible. LS January 2018 DJ; LV March 2019

Muntiacus reevesi Cervidae Cetartiodactyla "Chapman, N. G., Claydon, K., Claydon, M., Forde, P. G., & Harris, S. (1993). Sympatric populations of muntjac (*Muntiacus reevesi*) and roe deer (*Capreolus capreolus*): a comparative analysis of their ranging behaviour, social organization and activity. *Journal of Zoology*, 229(4), 623-640." 1993 "A comparison of the spatial organization of the two species showed that there was a high degree of overlap, although there were significant differences in temporal changes in home-range size and position [...] Thus there is no evidence that interspecific competition has shaped the ranging behaviour or activity patterns of muntjac and roe deer in the King's Forest. [...] These differences would suggest that, in the event of limited resource availability, roe deer rather than muntjac would move to exploit new habitats. This is borne out by events subsequent to the study; from February 1987 to February 1991 the muntjac population rose by 68% to 62 animals, the roe deer population fell by 17% to 20 animals. Allowing for some animals using the study area for only part of the time, population densities were 25.2 and 8.4 animals/km², respectively. The muntjac continued to centre their activity in the same parts of the study area, and the decline in roe numbers was most evident in these areas. Pellet counts indicated that in one such block muntjac use increased by 62% between July 1989 and March 1991 ; roe use decreased by 39% over the same time." Competition Indirect *Capreolus capreolus* Animalia MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (negative correlation between the abundance of the alien and the abundance of the native species, but no exclusion of confounding effects)." King's Forest (Thetford Forest Park) Suffolk (England) United Kingdom Europe Europe LS January 2018 DJ; LV March 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Allombert, S., Gaston, A. J., & Martin, J. L. (2005). A natural experiment on the impact of overabundant deer on songbird populations. *Biological Conservation*, 126(1), 1-13." 2005 "We used a group of islands in the Haida Gwaii archipelago (British Columbia, Canada), where islands without deer co-exist near islands with deer, as a natural experiment to test if the dependence of each species on understorey vegetation was a good predictor of deer impact. Forest bird assemblages were compared on six islands that either had no deer, had deer for less than 20 years or for more than 50 years, and on an enlarged set of 31 islands for which vegetation data and an index of deer impact were available. In the six islands data-set, songbird abundance on islands browsed for more than 50 years was 55–70% lower than on deer-free islands. [...] Two common species with a high dependence on understorey vegetation, the fox sparrow (*Passerella iliaca*) and the rufous hummingbird (*Selasphorus rufus*), common on deer-free islands, were totally missing on islands with a long browsing history (see Table 3). Two other species with a high dependence on understorey vegetation common on islands without deer, the song sparrow (*Melospiza melodia*) and the orange-crowned warbler (*Vermivora celata*), were present in only one of the islands with a long browsing history and then only at a low density. The winter wren (*Troglodytes troglodytes*, high dependence species) and the golden-crowned kinglet (*Regulus satrapa*, lower dependence species) were also less abundant on islands with a long-browsing history than on deer-free islands. [...] For both census methods, when significant effects of browsing history occurred, values for islands with a short-browsing history were always intermediate between those from islands without deer and those from islands with a long browsing history." "Chemical, physical or structural impact on ecosystems" Indirect *Passerella iliaca*; *Selasphorus rufus*; *Melospiza melodia*; *Vermivora celata*; *Troglodytes troglodytes*; *Regulus satrapa*; *Catharus ustulatus*; *Certhia americana* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (first, the observed differences between the compared islands might only be natural variation, and secondly, there are exchanges of the native species across islands, so the whole population(s) might not be declining)." Haida Gwaii British Columbia Canada North America North and Central America LV July 2019 LS February 2020

Odocoileus hemionus Cervidae Cetartiodactyla "Allombert, S., Stockton, S., & Martin, J. L. (2005). A natural experiment on the impact of overabundant deer on forest invertebrates. *Conservation Biology*, 19(6), 1917-1929." 2005 "In large parts of North America and Europe, deer overabundance threatens forest plant diversity. Few researchers have examined its effects on invertebrate assemblages. In a natural experiment on Haida Gwaii (British Columbia, Canada), where Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) were introduced, we compared islands with no deer, with deer for fewer than 20 years, and with deer for more than 50 years. We sampled invertebrates in three habitat categories: forest edge vegetation below the browse line, forest interior vegetation below the browse line, and forest interior litter. In forest edge vegetation, invertebrate abundance and species density decreased with increasing length of browsing history. In forest interior vegetation, decrease was significant only on islands with more than 50 years of browsing. Insect abundance in the vegetation decreased eightfold and species density sixfold on islands browsed for more than 50 years compared with islands without deer. Primary consumers were most affected. Invertebrates from the litter showed little or no variation related to

browsing history. We attributed the difference between vegetation-dwelling and litter-dwelling invertebrates to differences in the effect of browsing on their habitat. In the layer below the browse line deer progressively removed the habitat. The extent of litter habitat was not affected, but its quality changed. We recommend more attention be given to the effect of overabundant ungulates on forest invertebrate conservation with a focus on edge and understory vegetation in addition to litter habitat. [...] All groups decreased in abundance with increasing browsing history (Fig. 1a). [...] The only variation related to browsing history, although not significant statistically, was observed in gas-tropods. Their abundance was 8.4 times lower on islands with a long browsing history than on islands without deer." "Chemical, physical or structural impact on ecosystems" Indirect Diptera; Hymenoptera; Homoptera; Coleoptera; Heteroptera; Gastropod Animalia MO Low "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in abundances in general (order level), making it difficult to understand which species are affected, and how)" "The impact might be lower, because the native population(s) might not be declining (the observed differences between the compared islands might only consist in natural differences) and order level" Haida Gwaii British Columbia Canada North America North and Central America LV July 2019 LS February 2020 *Odocoileus hemionus* Cervidae Cetartiodactyla "Chollet, Simon, et al. ""Long-term consequences of invasive deer on songbird communities: Going from bad to worse?."" Biological invasions 17.2 (2015): 777-790. APA " 2015 "Initial data consist of vegetation plots and songbird point-counts on 57 islands in Haida Gwaii (British Columbia, Canada) taken in 1989 when the impacts of introduced deer lacking predators had already developed for [50 years. Twenty years later, we surveyed these islands using the same methods. To isolate the effects of deer, we compare results to nearby islands never colonized by deer and assess how canopy birds have fared relative to understory birds. [...] Bird species richness and abundance on the islands more recently colonized by deer were high at the outset of the study with a marginal trend of decrease over time. On islands with deer for more than 50 years in 1989 species richness and abundance of the understory-dependent species was dramatically lower than on the islands known to have been colonized less than 20 years before and values were lowest in 1999 and 2007. [...] We examined this alternative of long term decline versus achieving a new stable state on the remote island archipelago of Haida Gwaii where Sitka black-tailed deer *Odocoileus hemionus* were introduced at the end of the nineteenth century." "Chemical, physical or structural impact on ecosystems" Indirect "Selasphorus rufus; Vermivora celata; Troglodytes troglodytes; Passerella iliaca; Melospiza melodia; Catharus ustulatus; Catharus guttatus; Ixoreus naevius

" Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s)" Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Gaston, Anthony J., et al. ""Reduction in deer numbers on Reef island and Sgang Gwaay: progress, results, and vegetation changes."" Lessons from the Islands (2008): 103." 2008 "To understand the effects on vegetation of a reduction in deer numbers, we removed deer and monitored the recovery of the vegetation on Reef Island and S'Gang Gwaay, Haida Gwaii (Queen Charlotte Islands, British Columbia). [...] Considering only species averaging >0.5% cover in 1997, the greatest percent increases in cover on Reef Island at 0–5 cm occurred for shrubs: false azalea, salal, salmonberry *Rubus spectabilis*, and red huckleberry, all of which increased in cover by more than 300% (Fig. 7a). The only other species to increase by >300% was the sword fern *Polystichum munitum*. Increases were similar in the 5- to 15-cm and 15- to 25-cm strata, with the addition of spiny wood fern *Dryopteris expansa*, which showed a roughly 500% increase in both strata. Red huckleberry showed the greatest increase in the stratum above 50 cm (nearly 2000%), where it was virtually absent in 1997. This shrub was present in 1997 as remnant overmature individuals, and some of the increase in cover in this stratum represents shooting from the base of elderly stems (see Vila and Martin this volume). [...] Western hemlock and Sitka spruce showed lower increases in cover in all strata (above 5 cm, <150%). Nootka reed-grass showed slight decreases in all strata except 50–100 cm" Grazing/herbivory/browsing Direct *Rubus spectabilis*; *Polystichum munitum*; *Dryopteris expansa*; *Lysichiton americanum*; *Streptopus amplexifolius*; *Tiarella trifoliata*; *Stachys colleyae* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale and exchanges of species across islands, so the observed decline(s) might only be localised effects and not a general decline in the native population(s)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (comparison between the situations before/after the removal of the alien)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Gaston, Anthony J., Stephen A. Stockton, and Joanna L. Smith. ""Species-area relationships and the impact of deer-browse in the complex phytogeography of the Haida Gwaii archipelago (Queen Charlotte Islands), British Columbia."" Ecoscience 13.4 (2006): 511-522." 2006 "Vegetation surveys on the study islands were carried out as part of a project to monitor the impact of introduced deer and the vegetation recovery following culling of the deer population on Reef Island (see Stockton et al., 2005; Gaston et al., 2006 [...] Species found on at least two deer-free islands but on none of the smaller islands with deer were the shrub *Rubus parviflorus* and the

wildflowers *Heracleum lanatum*, *Barbarea orthoceras*, *Claytonia sibirica*, and *Tellima grandiflora*. Species missing from the heavily deer-affected small islands (Haswell, West Limestone) but found on other small islands were all wildflowers: *Sedum divergens*, *Epilobium angustifolium*, *Fragaria chiloensis* and *Mimulus guttatus*. A comparison of all the small islands (< 25 ha) shows that wildflowers were the group most affected by deer (Figure 4). Heavily deer-affected islands supported a mean of 20.0 ± 1.0 (SE) wildflower species, whereas those only moderately affected or without deer supported 30.2 ± 2.0 species ($t_5 = 3.07$, $P = 0.03$)."

Grazing/herbivory/browsing Direct *Rubus parviflorus*; *Heracleum lanatum*; *Barbarea orthoceras*; *Claytonia sibirica*; *Tellima grandiflora*; *Sedum divergens*; *Epilobium angustifolium*; *Fragaria chiloensis*; *Mimulus guttatus* Plantae MO Medium

"The impact might be lower, because the native population(s) might not be declining (very small islands with exchanges of the native species across islands, so the whole population(s) might not be declining)." Haida Gwaii British Columbia Canada North America North and Central America

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Odocoileus hemionus Cervidae Cetartiodactyla "Gaston, Anthony J., Stephen A. Stockton, and Joanna L. Smith.

"Species-area relationships and the impact of deer-browse in the complex phylogeography of the Haida Gwaii archipelago (Queen Charlotte Islands), British Columbia." *Ecoscience* 13.4 (2006): 511-522." 2006 "Vegetation surveys on the

study islands were carried out as part of a project to monitor the impact of introduced deer and the vegetation recovery following culling of the deer population on Reef Island (see Stockton et al., 2005; Gaston et al., 2006 [...]) Although the moderately deer-affected islands were similar in species richness to deer-free islands, they showed substantial effects of deer browsing in the form of dead and dying shrubs, especially *Vaccinium parvifolia*, *Symphoricarpos albus*, and the fern *Polystichum munitum*. This die-back proceeded visibly during the period of the study, so that few *Polystichum munitum* (a large fern forming clumps including several years' growth) remained alive by 2003."

Grazing/herbivory/browsing Direct *Vaccinium parvifolium*; *Symphoricarpos albus*; *Polystichum munitum* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected."

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Odocoileus hemionus Cervidae Cetartiodactyla "Martin, Jean-Louis, and Tanguy Daufresne. "Introduced species and their impacts on the forest ecosystem of Haida Gwaii." Proceedings of the Canada-British Columbia South Moresby

Forest Replacement Account, Victoria, BC Edited by G. Wiggins. Canada-British Columbia South Moresby Forest Replacement Account, BC Ministry of Forests, Victoria, BC. 1999." 1999 "[...] we censused the number of bird

species and the number of individuals per bird species on deer-free Low Island and compared it to data from an equal area on deer-infested Reef Island. [...] Population densities of bird species that forage or breed in shrubs, such as Rufous

Hummingbird (*Selasphorus rufus*), Swainson's Thrush (*Catharus ustulatus*), Orange-crowned Warbler (*Vermivora celata*), Fox Sparrow (*Passerella iliaca*), and Song Sparrow (*Melospiza melodia*) were 3-7 times lower on deer-infested islands than on deer-free islands (Table 4)." "Chemical, physical or structural impact on ecosystems" Indirect *Selasphorus rufus*; *Catharus ustulatus*; *Vermivora celata*; *Passerella iliaca*; *Melospiza melodia* Animalia MO Low

"The impact might be lower, because the native population(s) might not be declining (the temporal scale might be too short (overestimation of the impact), or the differences between the compared islands might only be due to natural variation); or, if the native

population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (no description of the survey methods)." Haida Gwaii British Columbia Canada North America North and

Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Martin, Jean-Louis, and Tanguy Daufresne. "Introduced species and their impacts on the forest ecosystem of Haida Gwaii." Proceedings of the Canada-British Columbia South Moresby

Forest Replacement Account, Victoria, BC Edited by G. Wiggins. Canada-British Columbia South Moresby Forest Replacement Account, BC Ministry of Forests, Victoria, BC. 1999." 1999 "[...] In 1993 and 1994 we surveyed islands

that cover the entire range of island area found within Juan Perez Sound and Laskeek Bay, on the east coast of Moresby Island: Lost Island (5.3 ha), Tar Island (6 ha), Low Island (9.6 ha), Agglomerate Island (20 ha), East Limestone Island (48

ha), Reef Island (250 ha), Ramsay Island (4557 ha), and two areas on the large main islands: the De la Beche Inlet area on Moresby Island and an area near Haswell Point on Louise Island. [...] Impacts on shrubs—We focused on the two

commonest shrubs, salal (*Gaultheria shallon*) and huckleberry (*Vaccinium* spp.). Plants were divided into two categories: well-developed shrubs (height ? 0.5 m, with several stems or main branches) and shoots (height < 0.5 m, with only one

stem). [...] Vegetation cover on deer-infested islands differs dramatically from that on deer-free islands (Table 2): • the cover of salal, huckleberry, and ferns is reduced to a tiny fraction, compared to that on deer-free islands; • the other shrubs

usually found in the understory are completely missing from the samples on deer-infested islands (they are statistically extinct), whereas they are common and widespread on deer-free islands; • conversely, the cover of young spruce and

hemlock is increased in the shrub layer on deer-infested islands [...]" Grazing/herbivory/browsing Direct *Gaultheria shallon*; *Vaccinium* spp; Ferns Plantae MO Medium

"The impact might be lower, because the native population(s) might not be declining (the temporal scale might not be too short (overestimation of the impact), or the differences between the compared islands might only be due to natural differences or other stressors might be causing these

differences). Temporal scale is also quite short: it is unclear if populations would increase or stabilise over a longer period

of time." Haida Gwaii British Columbia Canada North America North and Central America DJ
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Odocoileus hemionus Cervidae Cetartiodactyla "Martin, Jean-Louis, and Tanguy Daufresne. ""Introduced species and their impacts on the forest ecosystem of Haida Gwaii."" Proceedings of the Canada–British Columbia South Moresby Forest Replacement Account, Victoria, BC Edited by G. Wiggins. Canada–British Columbia South Moresby Forest Replacement Account, BC Ministry of Forests, Victoria, BC. 1999." 1999 "[...] In 1993 and 1994 we surveyed islands that cover the entire range of island area found within Juan Perez Sound and Laskeek Bay, on the east coast of Moresby Island: Lost Island (5.3 ha), Tar Island (6 ha), Low Island (9.6 ha), Agglomerate Island (20 ha), East Limestone Island (48 ha), Reef Island (250 ha), Ramsay Island (4557 ha), and two areas on the large main islands: the De la Beche Inlet area on Moresby Island and an area near Haswell Point on Louise Island. [...] Impact on tree regeneration—The impact of deer on tree seedlings (young trees between 0.1 and 0.5 m high) was also quantified. There were three target species: Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and redcedar (*Thuja plicata*). [...] conversely, the cover of young spruce and hemlock is increased in the shrub layer on deer-infested islands; and • redcedar is missing in the shrub layer on the deer-infested islands." Grazing/herbivory/browsing Direct *Thuja plicata* Plantae MN Medium "The impact might be lower, because the performance of native individuals might not be affected (short temporal scale, which might have overestimated the effect on the regeneration; the differences observed between islands where the alien has been introduced and islands where the alien has not been introduced might only be natural differences); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (no exclusion of confounding effects)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Martin, Jean-Louis, et al. ""Top-down and bottom-up consequences of unchecked ungulate browsing on plant and animal diversity in temperate forests: lessons from a deer introduction."" Biological Invasions 12.2 (2010): 353-371." 2010 "We studied plant communities in forest interior and shoreline, on seven small islands of varying browse history. Three islands were untouched by deer, deer had been resident for about 15 years on two, and on another two deer had been present for more than 50 years. Without deer, vegetation in the understorey and/or shrub layer was dense or very dense. Structure and composition varied markedly within and between shoreline and interior communities. Without deer, shoreline communities were dominated by species absent from islands with deer. [...] On islands where deer had been present for[50 years vegetation below the browse line was extremely simplified, converging in both forest interior and shoreline towards an open assemblage of a few deer-tolerant species, basically two coniferous trees. [...] Of the 26 species retained in the analysis of shoreline plots, the guild attributions (see Fig. 2) of 16 had significant differences in the average cover/plot below 150 cm among island categories (ANOVA analysis, see Table 1)" Grazing/herbivory/browsing Direct *Gaultheria shallon*; *Rosa nutkana*; *Lonicera involucrata*; *Rubus spectabilis*; *Epilobium angustifolium*; *Maianthemum dilatatum*; *Vicia gigantea*; *Angelica lucida*; *Heracleum lanatum*; *Ranunculus occidentalis*; *Conioselinum pacificum*; *Fritillaria camschatcensis*; *Elymus mollis*; *Festuca rubra*; *Rubus parviflorum*; *Symphoricarpos albus*; *Vaccinium parvifolium*; *Polysticum munitum* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (the observed differences between the compared islands might only be natural variation)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Martin, Jean-Louis, et al. ""Top-down and bottom-up consequences of unchecked ungulate browsing on plant and animal diversity in temperate forests: lessons from a deer introduction."" Biological Invasions 12.2 (2010): 353-371." 2010 "We studied plant communities in forest interior and shoreline, on seven small islands of varying browse history. Three islands were untouched by deer, deer had been resident for about 15 years on two, and on another two deer had been present for more than 50 years. [...] Cover of young Sitka spruce and western hemlock was highest on islands with deer <20 years and similar in the two other island categories. Cover of deciduous trees was reduced on islands with deer. [...] In our study, Sitka spruce under 1.5 m, occurred often in bonsai form in the presence of deer, especially when growing in good light conditions, with a dense foliage within a layer of protruding dead branches. However, browsing did not seem to significantly affect their cover over time and many young spruce and hemlock attained escape height and resumed normal growth (Vila et al. 2002). Although uncommon on the islands we studied, the third dominant conifer on Haida Gwaii, western redcedar, *Thuja plicata*, was recorded below 150 cm only on islands without deer." Grazing/herbivory/browsing Direct *Alnus crispa sinuata*; *Malus fusca*; *Thuja plicata*; *Picea sitchensis* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the browsing layer (<150cm) was investigated)." Haida Gwaii British Columbia Canada North America North and Central America LV October 2019 LS February 2020

Odocoileus hemionus Cervidae Cetartiodactyla "Pojar, J., et al. ""Relationships between introduced black-tailed deer and the plant life in the Queen Charlotte Islands, British Columbia."" Unpublished report, BC Ministry of Forests, Smithers, BC (1980)." 1980 "Recent field work involving sampling of vegetation and soils throughout the Charlottes has

provided evidence of a virtual epidemic of deer. The severe browsing has drastically changed the plant life of the Islands. The structure of many plant associations has been radically altered, and preferred forage species have been nearly eliminated or greatly reduced in many areas. *Thuja plicata* has been seriously depleted and sometimes eliminated as regeneration in mature forests as well as on logged-over sites. *Chamaeyparis nootkatensis*, *Picea sitchensis* and *Tsuga heterophylla* have also suffered from overbrowsing. There has been a dramatic reduction in the shrub and herb layers of many forest ecosystems. Serious silvicultural impacts of continued overbrowsing include the probable elimination of *T. plioata* and *C. nootkatensis* as commercial timber species on the Queen Charlottes, and increasing damage to young *Picea sitchensis* and *Teuga heterophylla*. Deer overbrowsing has also a compounded problems of slope stability. [...] The old observations of Gregg, Hall and Hopkinson, and the more recent observations of Calder and Taylor, suggest that devil's club was an important component of a dense underbrush in the Queen Charlotte mature forest, especially on alluvial sites. This is certainly not the case today. We have seen. only a few survivors - some scattered in roadside ditches on the east coast, most as depauperate individuals clinging to inaccessible cliff faces or sides of ravines, or perched atop root platforms of windthrown trees. [...] Salmonberry in undisturbed coastal forests prefers habitats similar to those of devil's club, i.e., moist rich often partially open alluvial and seepage sites. Salmonberry also appears to have declined from previous abundance on the Queen Charlotte Islands. It is now similarly uncommon, and usually found in the same sort of deer inaccessible spots as devil's club. [...] The declines in *Oplopanax horridus* and *Rubus spectabilis* are among the most dramatic impacts of overbrowsing on alluvial forest ecosystems. [...] There is a notable lack of ferns such as *Athgrium filix-femina*, *Dryopteris assimiiis*, *Ggmnocarpium dryopteris*, *Polystichum munitum* and *Adiantum pedatum*. [...] *Vaccinium* - dominated shrub stratum (Fig. 29), lead us to the conclusion that overbrowsing by deer is largely responsible for the present. scarcity of shrubs in the zonal forests of the Islands (of. Hatter and Steiger 1974). Through-out the Charlottes one encounters scattered tall old individuals of *vaccinium*, *Menziesia*, and *Gaultheria*, bare of foliage save for a terminal spray beyond the reach of deer. [...] On the Charlottes, it appears that deer and black bear have reduced the abundance of these ferns. (Table 1)"

Grazing/herbivory/browsing Direct *Oplopanax horridus*; *Rubus spectabilis*; *Athyrium filix-femina*; *Dryopteris assimiiis*; *Ggmnocarpium dryopteris*; *Polystichum munitum*; *Adiantum pedatum*; *Vaccinium alaskanese*; *Vaccinium ovalifolium*; *Vaccinium parvifolium* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Haida Gwaii British Columbia Canada North America North and Central America DJ February 2018 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Pojar, J., et al. ""Relationships between introduced black-tailed deer and the plant life in the Queen Charlotte Islands, British Columbia."" Unpublished report, BC Ministry of Forests, Smithers, BC (1980)." 1980 "Recent field work involving sampling of vegetation and soils throughout the Charlottes has provided evidence of a virtual epidemic of deer. The severe browsing has drastically changed the plant life of the Islands. The structure of many plant associations has been radically altered, and preferred forage species have been nearly eliminated or greatly reduced in many areas. *Thuja plicata* has been seriously depleted and sometimes eliminated as regeneration in mature forests as well as on logged-over sites. *Chamaeyparis nootkatensis*, *Picea sitchensis* and *Tsuga heterophylla* have also suffered from overbrowsing. There has been a dramatic reduction in the shrub and herb layers of many forest ecosystems. Serious silvicultural impacts of continued overbrowsing include the probable elimination of *T. plioata* and *C. nootkatensis* as commercial timber species on the Queen Charlottes, and increasing damage to young *Picea sitchensis* and *Teuga heterophylla*. Deer overbrowsing has also a compounded problems of slope stability. [...] The demise of western red cedar is probably the most noticeable and, in combination with the effects of modern industrial logging, the most ecologically and economically significant result of overbrowsing [...] Our observations on red cedar regeneration agree with those of Calder and Taylor (1968) that, in most areas of the Queen Charlotte Islands, ""the-establishment of seedlings is greatly retarded or eliminated because of severe browsing by the large population of deer..."". [...] Those few young cedars that can be found in heavily utilized areas have usually been repeatedly browsed down to bushy juveniles merely 5 to 10 cm tall (Fig. 6). [...] Both species are still common but occur with much reduced cover and vigor (see Table 1). Frequently they can be found only as depauperate individuals, nibbled down to stubs or puny rosettes, or as epiphytic or epixylic Plants (Fig. 32)." Grazing/herbivory/browsing Direct *Thuja plicata*; *Gaultheria shallon*; *Blechnum spicant* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (it is difficult to evaluate whether the spatial scale of the study is relevant)." Haida Gwaii British Columbia Canada North America North and Central America DJ February 2018 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Stroh, Noemie, Christophe Baltzinger, and Jean-Louis Martin. ""Deer prevent western redcedar (*Thuja plicata*) regeneration in old-growth forests of Haida Gwaii: Is there a potential for recovery?"" Forest Ecology and Management 255.12 (2008): 3973-3979." 2008 The lack of recruitment in western redcedar (*Thuja plicata*) in old-growth forests has been attributed to deer. The objectives of this study were to (1) experimentally confirm that deer browsing causes a lack of western redcedar recruitment [...] Our experiment was designed to characterize the impact of deer on forest understorey vegetation and to monitor the changes following deer exclusion. [...] Initial redcedar cover was low in both the enclosures and unfenced areas. In the unfenced plots redcedar cover decreased

over time (Fig. 1a). We observed significant differences in redcedar cover percentage inside and outside of the enclosures in the lower stratum at the three dates tested Grazing/herbivory/browsing Direct Thuja plicata Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Vila, B., Torre, F., Guibal, F., & Martin, J. L. (2004). Can we reconstruct browsing history and how far back? Lessons from *Vaccinium parvifolium* Smith in Rees. Forest Ecology and Management, 201(2-3), 171-185." 2004 "We assessed the impact of browsing by black-tailed deer (*Odocoileus hemionus sitkensis*) on a common long-lived shrub(the red huckleberry, *Vaccinium parvifolium*) on Haida Gwaii (British Columbia, Canada). We studied how deer impact canbe used as a marker of deer abundance and fluctuation and a means to reconstruct the recent history of deer browsing over asignificant section of the archipelago. We compared islands with and without deer to understand processes involved in thesechanges. We compared shrub features such as number of stems and regenerating sprouts, age and height of stems and stemage-structures between deer-free and deer-affected islands and analysed their spatial and temporal variation. Deer, bybrowsing regenerating sprouts, stopped stem replacement. On deer-affected islands the number of stems per individual shrubwas 2–4 times lower than on deer-free islands. The number of regenerating sprouts was 8–15 times higher. Stems were, onaverage, 2–3 times older. There was no variation in these characteristics among deer-free islands." Grazing/herbivory/browsing Direct *Vaccinium parvifolium* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth of individuals was investigated)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Vila, Bruno, et al. ""Response of young *Tsuga heterophylla* to deer browsing: developing tools to assess deer impact on forest dynamics."" Trees 17.6 (2003): 547-553." 2003 "Our objectives were (1) to link tree shape to browsing history, (2) to assess the effect of deer browsing on growth indices and tree height by comparing browsed and non-browsed trees, and (3) to use these results to assess delay in tree recruitment caused by browsing and discuss mechanisms that could explain spatial variation in this delay. [...] Non-browsed trees had large sized branches all along the trunk (Fig. 2). Escaped trees had a shrubby stunted shape under the browse line and a normal shape above it. [...] Mean annual height growth was 4- to 10-fold higher in non-browsed trees than in stunted trees or in escaped trees under the browse line (Table 2). In escaped trees mean annual height growth was twice as high above than under the browse line." Grazing/herbivory/browsing Direct *Tsuga heterophylla* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected (no mention of loss of individuals)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Vila, Bruno, Frédéric Guibal, and Jean-Louis Martin. ""Impact of browsing on forest understory in Haida Gwaii: A dendro-ecological approach."" Laskeek Bay Research 10 (2001): 62-73." 2001 "We assessed the impact of introduced deer on understory vegetation in some islands of Haida Gwaii by studying affected and control individuals of Salal, Red Huckleberry and Sitka Spruce. We analysed how browsing influences architecture, growth in diameter and the occurrence of traumatic anatomical features on cross-sections. For shrubs, a classical dendrochronological assessment of deer impact on growth has limited value because of high inter-shrub variance in ring-width series. [...] In spruce, severe browsing causes a shrubby growth form, with an overbranched crown and narrow growth rings. Browsing significantly decreases apical growth. When an individual tree becomes released from browsing, a sudden change in ring growth occurs. " Grazing/herbivory/browsing Direct *Gaultheria shallon*; *Picea sitchensis* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth of individuals was investigated)." Haida Gwaii British Columbia Canada North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Manuwal, Thad, and Rick Sweitzer. ""Browse Impacts of Introduced Mule Deer to Island Scrub Oak Habitats on Santa Catalina Island, California."" Oak Ecosystem Restoration on Santa Catalina Island, California: Proceedings of an On-Island Workshop, February 2–4. Avalon, California: Catalina Island Conservancy, 2007." 2007 "Our objectives here are to investigate the impacts of introduced mule deer on island scrub oak (*Quercus pacifica*) habitats; more specifically, to (1) determine seasonal mule deer diets, (2) estimate browse use of two rare endemic trees/shrubs [...] In August 2005, we altered the fences at three of the exclosures to experimentally assess browse impacts of mule deer on two species of endemic shrubs. Portions of the exclosures were altered so that several individuals each of felt leaf ceanothus (N = 3) and island bush poppy (N = 4) were exposed to mule deer (experimentals), and the same number of each remained protected inside the fence (controls). [...] Our results suggest deer select for forbs and grasses during the annual wet season and rely on woody browse during the annual dry season. Mule deer dramatically reduce available current annual growth twigs of rare island endemic shrubs [...] Among the most compelling and dramatic results of this study was the heavy browsing on two species of Catalina Island endemic shrubs (*D. harfordii*, *C. arboreus*) after we altered several exclosures in the Goat Harbor area to expose a fixed number of them to deer

browsing. These two endemic shrubs experienced heavy foraging pressure, which resulted in mortality of one *C. arboreus* tree 15 months after exposure to mule deer. All five of the other *C. arboreus* and *D. harfordii* trees in treatment plots were entirely devoid of leaves below 2.0 m." Grazing/herbivory/browsing Direct *Dendromecon harfordii*; *Ceanothus arboreus* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Santa Catalina Island California United States North America North and Central America DJ February 2018 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Ramirez, A. R., et al. ""Exotic deer diminish post-fire resilience of native shrub communities on Santa Catalina Island, southern California."" Plant Ecology 213.6 (2012): 1037-1047." 2012 "Browsing by exotic mule deer on Santa Catalina Island (SCI) off the coast of southern California may diminish the post-fire resilience of native shrublands. To assess this, deer exclosures were established following a wildfire to monitor post-fire recovery of three dominant, native shrub species (*Heteromeles arbutifolia*, *Rhus integrifolia*, and *Rhamnus pirifolia*). [...] We chose to focus our study on one of the dominant, native shrubs, *Heteromeles arbutifolia* (Lindley) Roemer (Rosaceae), as an indicator of shrub recovery. We chose *H. arbutifolia* because it was the most abundant and conspicuous resprouting shrub inside the exclosures and provided the best opportunity to compare recovery between treatments [...] Our results suggest that deer browsing is associated with increased mortality of *H. arbutifolia* resprouts (88 % mortality of browsed resprouts compared to 11 % of non-browsed resprouts) [...] The population of unprotected *H. arbutifolia* has been effectively extirpated from the burn area. The exclosures are protecting roughly 25 % of the sampled population, yet the portion of the population that was unprotected and lost may not recover" Grazing/herbivory/browsing Direct *Heteromeles arbutifolia* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the regeneration of individuals (in the presence of the alien) after fire events was investigated)." Santa Catalina Island California United States North America North and Central America DJ December 2017 LV June 2019

Odocoileus hemionus Cervidae Cetartiodactyla "Manuwal, Thad, and Rick Sweitzer. ""Browse Impacts of Introduced Mule Deer to Island Scrub Oak Habitats on Santa Catalina Island, California."" Oak Ecosystem Restoration on Santa Catalina Island, California: Proceedings of an On-Island Workshop, February 2–4. Avalon, California: Catalina Island Conservancy, 2007." 2007 "Our objectives here are to investigate the impacts of introduced mule deer on island scrub oak (*Quercus pacifica*) habitats; [...] We used experiments with nursery grown oak seedlings to examine the effects of ungulates and other environmental factors on seedling survival. [...] At the outset of the study in December 2004, we identified five general study areas where habitats were dominated by island scrub oak (Figure 2). [...] These five research focus areas were targeted for oak seedling plot survival plots and assessing oak regeneration potential. [...] The most common type of disturbance was browsing by deer: twenty-six percent (426) of the seedlings were browsed over the duration of the study. An average of $4.7\% \pm SE 0.4$ of the 1600 planted seedlings had evidence of browsing during each monitoring period (Figure 6). [...] However, physical damage to oak seedlings by bison (*Bos bison*) and competition from non-native grasses appears more important for reduced seedling survival than browsing by mule deer [...] Browsing by mule deer was not identified as a major mortality factor for oaks in seedling plots, at least at this young stage. However, results from diet analyses indicated that we underestimated mule deer foraging on island scrub oak based on their focus on leaves of oaks instead of stems.

" Grazing/herbivory/browsing Direct *Quercus pacifica* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Santa Catalina Island California United States North America North and Central America DJ July 2018 LV June 2019

Odocoileus virginianus Cervidae Cetartiodactyla "Casabon, C., & Pothier, D. (2007). Browsing of tree regeneration by whitetailed deer in large clearcuts on Anticosti Island, Quebec. Forest Ecology and Management, 253(1), 112119." 2007 "Browsing by the substantial population of white-tailed deer (*Odocoileus virginianus* Zimmermann) on Anticosti Island hampers the regeneration of balsam fir (*Abies balsamea* (L.) Mill.), which is both the deer's preferred food and shelter. The island's original fir stands have gradually been replaced by stands of white spruce (*Picea glauca* (Moench) Voss), as this species is rarely browsed by the deer. This project assesses the impact on the regeneration of balsam fir and companion species by large clearcuts performed using cutting with protection of regeneration and soils (CPRS). To this end, fenced-off areas adjacent to unfenced areas were established in 1995 and 1996 in large CPRS clearcuts. The results show that the distance from forest edge does not influence the stocking, number and height of seedlings, while browsing does reduce these variables in the case of fir and paper birch (*Betula papyrifera* Marsh.). However, stocking, number and height of white spruce seedlings were unaffected by both deer browsing and distance from forest edge. Woody debris seemed to protect balsam fir seedlings from browsing 8 years after cutting, but this protection should likely stop when seedlings will outgrow woody debris. It thus appears that large CPRS clearcuts will not permit the regeneration of balsam fir on a level sufficient for re-establishing fir stands on Anticosti Island. [...] The impact of deer is quite marked even at significant distances from the forest edge. Deer browsing has had the effect, on the one hand, of limiting regeneration and the growth of fir and paper birch, and, on the other, of encouraging the growth of white spruce. "

Grazing/herbivory/browsing Direct *Betula papyrifera* Marsh.; *Abies balsamea* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Chouinard, A., & Filion, L. (2001). Detrimental effects of whitetailed deer browsing on balsam fir growth and recruitment in a secondgrowth stand on Anticosti Island, Québec. *Ecoscience*, 8(2), 1992-2010." 2001 "On Anticosti Island, fir is browsed by deer throughout the year (Potvin et al., 1998). It is especially used in winter, being the most abundant forage species apart from white spruce (*Picea glauca* [Moench] Voss), a less palatable species which is only occasionally browsed (Pimlott, 1963; Huot, 1982). [...] Repeated browsing by white-tailed deer significantly delayed balsam fir development. As a result, species recruitment into the canopy has been prevented and the stand structure was altered after the 1959 disturbances (clearcut and surface fire). Most of the fir stems were maintained in a stunted, non-reproductive sapling state, at height < 3 m and diameter rarely > 50 mm at the root collar (Figure 3). [...] Although deer browsing likely had little direct influence on the total density of fir stems (Table I), it has resulted in severe stem deformation, growth anomalies and reduced vigor. Browse-related fir mortality was rarely observed at the study site and was limited to small stems (< 75 cm). [...] By retarding fir growth (Table IV, Figure 7) and maturation, intense browsing has considerable effects on fir regeneration, as well as on the stand structure. Preferential browsing on fir favors white spruce, increasing its relative abundance within the tree layer (Figure 3b). Fir will remain a minor component of the stand, since only a few individuals were able to grow above maximum browsing height (Table II, Figure 4a). The results from this site may not represent the state of balsam fir and white spruce on the whole island, as the spatial and vegetational context may have influenced deer frequentation and involved some site-specific browsing."

Grazing/herbivory/browsing Direct *Abies balsamea* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Chouinard, A., & Filion, L. (2005). Impact of introduced white-tailed deer and native insect defoliators on the density and growth of conifer saplings on Anticosti Island, Quebec. *Ecoscience*, 12(4), 506-518." 2005 "In this study, browsing negatively affected size and vertical and radial growth of both fir and white spruce seedlings. In addition, heavily browsed fir in open stands rarely exceeded 60 cm, and their radial growth was one third that of unbrowsed white spruce. Light browsing had little or no impact on fir growth, with lightly browsed fir saplings having a size comparable to that of fir from the control stands. [...] Browsing severity was extreme (SBI 1) in stands with low density of fir saplings. However, no sapling mortality was found (Table III). [...] However, widespread fir sapling mortality in the 1980s and early 1990s was likely due to severe deer browsing, since mature trees are more susceptible to defoliation by spruce budworm than saplings are (Blais, 1958; Martineau, 1985) and high sapling mortality was found where tree damage was minimal. [...] Tree-ring analysis was used to differentiate the influence of deer browsing from the possible effects of past insect activity on conifer species. Periods of radial growth reduction coincided with documented spruce budworm (*Choristoneura fumiferana*) and hemlock looper (*Lambdina fuscicornis*) infestations during the 20th century. The combined influence of insect defoliation and deer browsing on fir was evidenced by contrasted patterns in stem growth above and below browsing height. [...] Hare browsing can be differentiated from deer browsing by the clear diagonal cut on ends of browsed shoots (Sinclair et al., 1993). At our study stands, hare browsing was light (Chouinard & Filion, 2001)." Grazing/herbivory/browsing Direct *Abies balsamea*; *Picea glauca* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV December 2017 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Hébert, C., & Jobin, L. (2001). Impact du cerf de Virginie sur la biodiversité des forêts de l'île d'Anticosti. *Le Naturaliste Canadien*, 125(3)." 2001 "[Transcrit] Au début du XXe siècle, les sapinières dominaient largement le paysage forestier de l'île (40% de la surface totale). [...] Cependant, la moitié des sapinières sont aujourd'hui disparues (Potvin et al., 2000), incapables de se régénérer à cause du broutement intensif qu'exerce le cerf de Virginie. [...] En absence de prédateurs, la population de cerfs a proliféré au point où l'animal a profondément transformé la forêt d'Anticosti. Les sapinières, qui n'occupent plus que 20% du territoire, ont été graduellement remplacées par des pessières blanches pures (Potvin et al., 2000). Ce fut le cas sur presque tout le territoire affecté par une importante pullulation de l'arpenteuse de la pruche, *Lambdina fuscicornis* (Guen.) au début des années 1970 (Jobin, 1980). [...] nous aborderons l'impact de la transformation des sapinières anciennes en pessières blanches ainsi que celui de l'appauvrissement des strates arbustives et herbacées au sein même des sapinières anciennes. [...] En 1993, le piège Luminoc (Jobin et Coulombe, 1992; Hébert et Jobin 1995) a été utilisé pour caractériser les communautés de lépidoptères de quatre peuplements forestiers d'Anticosti (figure 1). Un piège fut installé dans deux sapinières anciennes (secteurs Jupiter et Macdonald; figure 3-A) et deux pessières blanches, une de 20 ans (secteur Chicotte; figure 5) et une de 60 ans (secteur Pointe Sud-Ouest) issues de pullulations d'arpenteuse de la pruche en 1972 et en 1935 respectivement. Les pièges ont

fonctionné de façon continue entre le 9 juin et le 18 août, les insectes étant récoltés toutes les semaines. Les résultats montrent une abondance et une richesse spécifique plus grande, et de façon très marquée, dans les sapinières anciennes comparativement aux pessières blanches, et ce pour la plupart des familles de lépidoptères, sauf les *Pyrilidae* et la *Tortricidae* (tableau 1). [...] Des espèces communes pour le nord-est du Québec (Handfield, 1999) ont pratiquement disparu dans les pessières blanches issues d'épidémies. C'est le cas de la noctuelle *Xestia mixta* Hbn. (12 individus dans chaque sapinière, mais un seul dans la pessière blanche de 60 ans) et des géométrides *Xanthorhoe ferrugata* Cl. (huit et 11 individus dans les deux sapinières, mais aucun dans les pessières blanches) et *Cyclophora pendulinaria* Gn. (20 individus dans chaque sapinière, mais un seul dans la pessière blanche de 60 ans), toutes des espèces associées à des feuillus ou à des plantes herbacées. " "Chemical, physical or structural impact on ecosystems" Indirect *Xestia mixta*; *Xanthorhoe ferrugata* Cl.; *Cyclophora pendulinaria* Gn. Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (the observed differences between the compared islands might only be natural variation, few replicates and small sampling effort)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Hébert, C., & Jobin, L. (2001). Impact du cerf de Virginie 1 sur la biodiversité des forêts de l'île d'Anticosti. *Le Naturaliste Canadien*, 125(3)." 2001 "[Transcrit] Au début du XXe siècle, les sapinières dominaient largement le paysage forestier de l'île (40% de la surface totale). [...] Cependant, la moitié des sapinières sont aujourd'hui disparues (Potvin et al., 2000), incapables de se régénérer à cause du broutement intensif qu'exerce le cerf de Virginie. [...] En absence de prédateurs, la population de cerfs a proliféré au point où l'animal a profondément transformé la forêt d'Anticosti. Les sapinières, qui n'occupent plus que 20% du territoire, ont été graduellement remplacées par des pessières blanches pures (Potvin et al., 2000). Ce fut le cas sur presque tout le territoire affecté par une importante pullulation de l'arpenteuse de la pruche, *Lambdina fiscellaria* (Guen.) au début des années 1970 (Jobin, 1980). [...] nous aborderons l'impact de la transformation des sapinières anciennes en pessières blanches ainsi que celui de l'appauvrissement des strates arbustives et herbacées au sein même des sapinières anciennes. [...] En 1998, le piège Luminoc a été utilisé comme piège fosse (Hébert et al., 2000) dans neuf peuplements forestiers d'Anticosti pour caractériser les communautés de Carabidae et de Staphylinidae, deux importantes familles de coléoptères du sol. Trois des peuplements étaient situés dans la sapinière ancienne du secteur Jupiter, trois autres dans la pessière blanche du secteur Chicotte et les trois derniers dans la sapinière ancienne du secteur Vauréal (figure 1). Trois pièges ont été disposés dans chaque peuplement étudié. Le même dispositif a été utilisé dans le cadre d'une autre étude réalisée dans des sapinières anciennes de la Gaspésie (Despôts et al., 2000) dans trois peuplements dans des sapinières anciennes de type futaie, c'est-à-dire avec peu d'ouvertures créées par la chute d'arbres morts. Enfin, trois pièges fosses lumineux furent aussi installés dans chacun de trois peuplements anciens localisés sur des îles de la Minganie, (une sapinière sur chacune des îles suivantes: Niapiskau, Fantôme et Quarry). L'abondance moyenne des Carabidae s'est avérée beaucoup plus grande dans les forêts anciennes de la Gaspésie et des îles de la Minganie que dans celles de l'île d'Anticosti (figure 8). De plus, la jeune pessière blanche issue de la pullulation de l'arpenteuse de la pruche en 1972 (secteur Chicotte) a montré des captures trois à quatre fois moins importantes que celles des sapinières anciennes d'Anticosti. Par ailleurs, alors qu'on observe une moyenne d'environ dix espèces de Carabidae par site en Gaspésie et sur les îles de la Minganie, seulement 8,3 et 6,3 espèces ont été capturées en moyenne dans les sapinières anciennes d'Anticosti et 5,7 dans la jeune pessière blanche du secteur Chicotte. [...] La jeune pessière blanche du secteur Chicotte abrite encore une fois le plus pauvre de tous les peuplements inventoriés avec près de deux fois moins d'espèces [de Staphylinidae] que dans les sapinières anciennes d'Anticosti, trois fois moins qu'en Minganie, et cinq fois moins qu'en Gaspésie." "Chemical, physical or structural impact on ecosystems" Indirect Carabidae; Staphylinidae Animalia MO Medium The alien might have caused (a) local extinction(s) (lower species richness; but it is difficult to conclude that the alien has caused local extinctions of species (because study did not make the analyses at the species level) "The impact might be lower, because the native population(s) might not be declining (the observed differences between the compared islands might only consist in natural differences)" Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "MOORE, JeanDavid, POTHIER, David, et POTVIN, François. Expérimentation de coupes de grande superficie pour régénérer le sapin baumier à l'île d'Anticosti en présence de densités élevées de cerf de Virginie. Ministère des ressources naturelles, de la faune et des parcs, Direction de la recherche forestière, 2004." 2004 "Concernant l'impact du broutement du cerf sur la régénération de toutes tailles, une interaction triple statistiquement significative a été constatée entre les espèces, la protection des parcelles (présence ou absence d'exclos) et le temps, dans les coupes de 1995 ($P = 0,024$) et celles de 1996 ($P = 0,014$) (Tableaux 5a,b). En tenant compte de la mortalité non attribuable au cerf telle qu'observée dans les exclos, l'analyse de cette interaction fait ressortir que le broutement du cerf contribue à une mortalité additionnelle des semis de sapin de près de 9 % en trois ans (Figure 5). D'autre part, si l'on compare les parcelles accessibles au cerf à celles clôturées, on observe alors une baisse de 70 % du nombre de semis de sapin trois ans après les coupes de 1995 ($P = 0,028$). Cet effet est particulièrement marqué pour la classe de hauteur de 5 à 30 cm ($P < 0,001$)." Grazing/herbivory/browsing Direct *Abies balsamea* Plantae

MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F. & Poirier, S. (2004). L'île d'Anticosti, un paradis? L'influence du cerf de Virginie sur la végétation des sapinières. Le naturaliste canadien, vol. 128 (1), 5260." 2004 "[Transcript] Notre dispositif expérimental comprend 5 sapinières à maturité sur drainage mésique, comptant chacune deux sites. A chaque site, une parcelle clôturée de 2 x 2 m (clôture de 1,2 m de hauteur) est appariée à une parcelle identique non clôturée, distante de 2 m (figure 2). Le dispositif a été mis en place en 1996 et mesuré en 1996, 1998 et 2001. [...] Des mesures de végétation ont été prises sur la régénération forestière et sur l'ensemble des strates muscinales, herbacée et arbustive. [...] En 1998 et 2001, entre la fin de juillet et le début d'août, nous avons procédé à l'inventaire de l'ensemble de la végétation en estimant visuellement le recouvrement par espèce dans chaque parcelle. [...] Il y avait fort peu de différences entre les parcelles clôturées et non clôturées en ce qui concerne l'occurrence, les mêmes espèces se retrouvant dans les deux groupes de parcelles avec des taux quasi identiques. Par contre, la plupart d'entre elles avaient un pourcentage de recouvrement largement supérieur dans les parcelles clôturées (figure 6). En 2001, la mitrelle nue (*Mitella nuda*), le cornouiller du Canada, le maianthème du Canada et les prêles (*Equisetum* sp.) avaient un recouvrement trois à sept fois plus grand dans les parcelles clôturées." Grazing/herbivory/browsing Direct *Equisetum* sp.; *Cornus stolonifera*; *Maianthemum canadense*; *Mitella nuda* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (difficult to conclude to a general decrease in the native population(s) from the study design - 2 replicates of an exclosure cage (2 by 2 m) associated with a control plot, in 5 different balsam fir stands)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F. & Poirier, S. (2004). L'île d'Anticosti, un paradis? L'influence du cerf de Virginie sur la végétation des sapinières. Le naturaliste canadien, vol. 128 (1), 5260." 2004 "[Transcript] Notre dispositif expérimental comprend 5 sapinières à maturité sur drainage mésique, comptant chacune deux sites. A chaque site, une parcelle clôturée de 2 x 2 m (clôture de 1,2 m de hauteur) est appariée à une parcelle identique non clôturée, distante de 2 m (figure 2). Le dispositif a été mis en place en 1996 et mesuré en 1996, 1998 et 2001. [...] Des mesures de végétation ont été prises sur la régénération forestière et sur l'ensemble des strates muscinales, herbacée et arbustive. [...] En 1998 et 2001, entre la fin de juillet et le début d'août, nous avons procédé à l'inventaire de l'ensemble de la végétation en estimant visuellement le recouvrement par espèce dans chaque parcelle. [...] A noter aussi que le framboisier (*Rubus idaeus*) était présent uniquement dans les parcelles protégées." Grazing/herbivory/browsing Direct *Rubus idaeus* Plantae MO Low "The alien might have caused a local extinction (the impacted native species is/are only found in the exclosures), but the study design would not have allowed to detect it." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (the impacted native species is/are only found in the exclosure(s)) and the exclosure(s) allowed to quantify the impact of the alien only." Anticosti Island Quebec Canada North America North and Central America LV July 2017 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F. & Poirier, S. (2004). L'île d'Anticosti, un paradis? L'influence du cerf de Virginie sur la végétation des sapinières. Le naturaliste canadien, vol. 128 (1), 5260." 2004 "[Transcript] Notre dispositif expérimental comprend 5 sapinières à maturité sur drainage mésique, comptant chacune deux sites. A chaque site, une parcelle clôturée de 2 x 2 m (clôture de 1,2 m de hauteur) est appariée à une parcelle identique non clôturée, distante de 2 m (figure 2). Le dispositif a été mis en place en 1996 et mesuré en 1996, 1998 et 2001. [...] Des mesures de végétation ont été prises sur la régénération forestière et sur l'ensemble des strates muscinales, herbacée et arbustive. Les semis des espèces arborescentes ont été dénombrés en 1996 (dans les parcelles clôturées seulement), 1998 et 2001 (parcelles clôturées et non clôturées). [...] Les écarts étaient encore plus marqués pour la strate arbustive, le bouleau à papier et le sapin baumier ayant littéralement explosé après cinq ans d'exclusion du cerf. Profitant de l'ouverture partielle des sapinières causée par le chablis et la mortalité par pied d'arbre, le peuplier faux-tremble et le framboisier se sont aussi installés dans les parcelles clôturées, mais sont restés pratiquement ou totalement absents des parcelles accessibles aux cerfs." Grazing/herbivory/browsing Direct *Abies balsamea*; *Betula papyrifera*; *Populus tremuloides* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Breton, L. (1992). Impact du cerf sur la succession végétale après coupe à Anticosti: suivi d'un ensemble d'exclos de 1984 à 1989. Direction de la gestion des espèces et des habitats, Direction générale de la ressource faunique, Ministère du loisir, de la chasse et de la pêche." 1992 "À l'automne 1983, 28 petits exclos (2 x 2 m) et un grand exclos (30 x 30 m) furent érigés dans une sapinière déboisée 4 ans plus tôt. Un nombre iden-tique de parcelles non clôturées (2 x 2 m) ont été localisées comme témoins à proximité des petits exclos. [...] Les exclos ont été établis dans un bûché de 9,2 ha situé dans la sapinière ouest, sur le chemin du lac Cailloux. Ce milieu supporte une densité évaluée à près de 10 cerfs/km², comparativement à 15 pour l'ensemble de l'île

(Potvin et al., 1991). [...] La position des 28 petits exclos fut fixée aléatoirement dans l'ensemble du bûché alors que le grand exclos fut érigé à un endroit jugé représentatif. [...] L'exclusion du cerf a aussi entraîné des effets sur la strate herbacée (tableaux 5 et 6). L'épilobe (*Epilobium angustifolium*) était plus largement distribuée et plus abondante dans les exclos ($P < 0,05$) ainsi que, de manière moins évidente, la maïentème (*Maïenthenum canadense*). le fraisier (*Fragaria virginiana*) et le framboisier (*Rubus idaeus*)."

Grazing/herbivory/browsing Direct *Epilobium angustifolium*; *Maïenthenum canadense*; *Fragaria virginiana*; *Rubus idaeus* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial and temporal scales, appropriate experimental design) and the exclosure(s) allowed to quantify the impact of the alien only." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Breton, L. (1992). Impact du cerf sur la succession végétale après coupe à Anticosti: suivi d'un ensemble d'exclos de 1984 à 1989. Direction de la gestion des espèces et des habitats, Direction générale de la ressource faunique, Ministère du loisir, de la chasse et de la pêche." 1992 "À l'automne 1983, 28 petits exclos (2 x 2 m) et un grand exclos (30 x 30 m) furent érigés dans une sapinière déboisée 4 ans plus tôt. Un nombre iden-tique de parcelles non clôturées (2 x 2 m) ont été localisées comme témoins à proximité des petits exclos. [...] Les exclos ont été établis dans un bûché de 9,2 ha situé dans la sapinière ouest, sur le chemin du lac Cailloux. Ce milieu supporte une densité évaluée à près de 10 cerfs/km², comparativement à 15 pour l'ensemble de l'île (Potvin et al., 1991). [...] La position des 28 petits exclos fut fixée aléatoirement dans l'ensemble du bûché alors que le grand exclos fut érigé à un endroit jugé représentatif. [...] Nos résultats démontrent de façon éloquente que l'absence presque complète d'une strate arbustive et la faible régénération du sapin ne proviennent pas de facteurs écologiques particuliers à Anticosti. Il a suffi d'exclure le cerf durant trois saisons de végétation pour obtenir des semis de sapin atteignant environ 40 cm, des bouleaux à papier de 1 m et des diervilles chèvrefeuilles de 50 cm. À l'inverse, ces mêmes essences ne dépassaient pas 20 à 25 cm dans les parcelles non clôturées."

Grazing/herbivory/browsing Direct *Abies balsamea*; *Betula papyrifera*; *Diervilla lonicera* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Laprise, G. (2002). Suivi de la banque de semis de sapin baumier sur l'île d'Anticosti en relation avec le broutement du cerf. Société de la faune et des parcs du Québec." 2002 "Balsam fir (*Abies balsamea*) stands on Anticosti Island contain numerous fir seedlings near the ground (>100 000 seedlings/ha on average) but almost no regeneration above 30 cm. Whitetailed deer (*Odocoileus virginianus*) browsing in summer is probably responsible for that situation. In order to understand what was the process involved, we individually tagged 1800 seedlings that were checked over three years from May to November. Our design involved two habitats, mature balsam fir stands (forest) and large recently clear-cut blocks (3 km²), with five replicates. [...] Each year, deer browsed on average 26 % of the seedlings in forest and 48 % of the seedlings in the clear-cut blocks. The combined effect of seedling recruitment, natural mortality and deer browsing resulted in a net loss of 42 % in forest over three years."

Grazing/herbivory/browsing Direct *Abies balsamea* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (even though the quantification of the effect of browsing on the regeneration might be overestimated since all seedlings that were browsed were considered as dead even though they might have survived (2/3 of the seedlings were not completely browsed and might have survived), it is unlikely that the alien is not impacting the regeneration of the native individuals at all)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Société de la faune et des parcs du Québec. Direction de la faune et des habitats. (2000). Le cerf et les sapinières de l'île d'Anticosti. Québec: Direction de la faune et des habitats, Société de la faune et des parcs du Québec." 2000 "En 1995 et 1996, sept blocs de 3 km² chacun ont été coupés dans des sapinières, dans le cadre d'un projet expérimental (Potvin et al. 1998) (figure 2). Deux dispositifs installés dans ces blocs permettent d'apprécier l'impact à très court terme (trois dernières années) du cerf sur la végétation. Le premier dispositif est constitué de 52 sites sur lesquels deux superficies circulaires de 5 m de rayon ont été établies côte à côte, soit une superficie clôturée immédiatement après coupe (exclos) et une superficie demeurée accessible aux cerfs. Ce dispositif permet de mesurer l'effet du cerf en comparant les parcelles clôturées et non clôturées. Dans chacune de ces superficies circulaires, une grappe de 10 placettes de 4 m² a été installée pour effectuer le suivi de la régénération (nombre de semis par essence) et de la végétation (% de recouvrement par espèce). [...] L'impact du cerf est aussi très évident sur l'ensemble de la végétation trois ans après la coupe (figure 6). Même si exclos et parcelles accessibles comptent à peu près le même nombre d'espèces (76 contre 71), 18 d'entre elles sont significativement plus abondantes dans les sites clôturés. La différence la plus remarquable concerne l'épilobe (13% de recouvrement dans les exclos contre moins de 1% dans les parcelles accessibles)." Grazing/herbivory/browsing Direct *Epilobium angustifolium*; *Cornus canadensis*; *Rubus idaeus*; *Maïenthenum canadense*; *Fragaria* sp.; *Rubus pubescens*; *Trientalis borealis*; *Prunus*

pennsylvanica; *Dryopteris spinulosa*; *Linnea borealis*; *Equisetum* sp.; *Senecio* sp.; *Galium* sp.; *Ribes* sp.; *Streptopus roseus*
 Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial and temporal scales, appropriate experimental design) and the enclosure(s) allowed to quantify the impact of the alien only." Anticosti Island Quebec Canada North America North and Central America
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Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Société de la faune et des parcs du Québec. Direction de la faune et des habitats. (2000). Le cerf et les sapinières de l'île d'Anticosti. Québec: Direction de la faune et des habitats, Société de la faune et des parcs du Québec." 2000 "Pour décrire la composition de la forêt avant l'introduction du cerf et son évolution par la suite, nous avons examiné l'âge de 1568 arbres étudiés lors du sondage terrestre. Compte tenu que seuls les arbres hauts de 7 m et plus sont sondés dans l'inventaire forestier, nous avons utilisé une autre méthode pour évaluer la situation dans les peuplements de moins de 20 ans. La régénération forestière de ces jeunes peuplements a été décrite à partir des sapinières affectées par l'épidémie d'arpenteuse de 1971-1973, perturbation qui a causé une mortalité massive sur 1428 km² (figure 1). Lors du sondage terrestre de l'inventaire forestier, 15 parcelles circulaires de 40 m² ont été distribuées dans ce milieu pour y dénombrer les tiges de 1 à 9 cm au DHP (diamètre mesuré à hauteur de poitrine, soit à 1,3 m). [...] D'après l'âge des arbres sondés lors de l'inventaire forestier de 1987, le sapin baumier dominait largement les forêts qui se sont établis jusqu'en 1920 (figure 4). La forte proportion d'épinette blanche parmi les arbres les plus vieux n'est qu'un reflet de la plus grande longévité de cette espèce par rapport au sapin. Un changement drastique est survenu à partir de 1930, alors que le sapin est devenu marginal et a été presque complètement remplacé par l'épinette blanche. [...] À l'aide du plus récent inventaire forestier et en assumant que les types écologiques normalement associés au sapin étaient à l'origine dominés par cette essence, on estime que la proportion occupée par les sapinières à l'île était de 40% au moment de l'introduction du cerf (figure 10). En 1999, cette proportion a chuté à 20%. [...] La situation ne s'est pas améliorée au cours des 20 dernières années, si l'on se base sur la régénération forestière présente dans les sapinières affectées par l'épidémie d'arpenteuse de 1971-1973. Dans ce milieu, la régénération (tiges de 1 à 9 cm au DHP) est largement dominée par l'épinette blanche (1300 tiges/ha) et l'épinette noire (600 tiges/ha), alors que la présence du sapin reste très marginale (30 tiges/ha). Les deux premières essences se rencontrent dans 80 et 53% des parcelles, respectivement, contre seulement 13% pour le sapin." Grazing/herbivory/browsing Direct
Abies balsamea Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (even though it is based on inferred data) and because no other stressor is likely to have caused the observed decline(s)." Anticosti Island Quebec Canada North America North and Central America
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Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., & Société de la faune et des parcs du Québec. Direction de la faune et des habitats. (2000). Le cerf et les sapinières de l'île d'Anticosti. Québec: Direction de la faune et des habitats, Société de la faune et des parcs du Québec." 2000 "En 1995 et 1996, sept blocs de 3 km² chacun ont été coupés dans des sapinières, dans le cadre d'un projet expérimental (Potvin et al. 1998) (figure 2). Deux dispositifs installés dans ces blocs permettent d'apprécier l'impact à très court terme (trois dernières années) du cerf sur la végétation. Le premier dispositif est constitué de 52 sites sur lesquels deux superficies circulaires de 5 m de rayon ont été établies côte à côte, soit une superficie clôturée immédiatement après coupe (exclos) et une superficie demeurée accessible aux cerfs. Ce dispositif permet de mesurer l'effet du cerf en comparant les parcelles clôturées et non clôturées. Dans chacune de ces superficies circulaires, une grappe de 10 placettes de 4 m² a été installée pour effectuer le suivi de la régénération (nombre de semis par essence) et de la végétation (% de recouvrement par espèce). [...] Avant coupe, la régénération était comparable entre les exclos et les parcelles accessibles (figure 5). Le sapin était alors présent dans plus de 90% des parcelles et on comptait en moyenne 100 000 semis/ha. Par contre, la situation trois ans après coupe est toute autre. Le coefficient de distribution du sapin se situe alors à 47% et la densité à 5 600 semis/ha dans les sites accessibles au cerf, contre un coefficient de 68% et près de 20 000 semis/ha dans les exclos." Grazing/herbivory/browsing Direct
Populus tremuloides; *Betula papyrifera* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America
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Odocoileus virginianus Cervidae Cetartiodactyla "Potvin, F., Beaupré, P., & Laprise, G. (2003). The eradication of balsam fir stands by whitetailed deer on Anticosti Island, Québec: a 150year process. *Ecoscience*, 10(4), 487-495." 2003 "White-tailed deer (*Odocoileus virginianus*) were introduced 100 y ago on Anticosti, a 7,943-km² island located in the Gulf of St. Lawrence, Québec. The forest of the island is typically boreal and, at the time of the introduction, was dominated by balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), and black spruce (*P. mariana*). Since then, the vegetation has been modified as a result of high deer density (16 deer·km⁻²) and heavy browsing. The most important change is the progressive decline of balsam fir stands, formerly the prevalent forest type. [...] We also estimated that fir stands, which now cover 20% of the island, occupied about 40% of the total area initially. [...] On an intermediate scale (1,200 km², 30 y), we examined

the natural regeneration established after an insect outbreak that took place in 1971/1972 and massively killed predominantly balsam fir forests. In that area, white spruce regeneration now largely replaces that of balsam fir. [...] On a finer scale (< 1 km², 3 y), we monitored 1,800 balsam fir seedlings (25 cm high) individually tagged. Seedlings were browsed throughout the snowfree season, and the annual browsing incidence in forest was estimated at 26%."

Grazing/herbivory/browsing Direct *Abies balsamea* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (even though some information is inferred) and even if other stressors might be acting on the native population(s), it is likely that the alien is causing at least part of the observed decline(s)." Anticosti Island Quebec Canada North America North and Central America LV July 2017 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "TREMBLAY, J. P., Huot, J., & Potvin, F. (2007). Density?related effects of deer browsing on the regeneration dynamics of boreal forests. *Journal of Applied Ecology*, 44(3), 552-562." 2007 "In the balsam fir forest–white-tailed deer system of Anticosti Island, selective browsing at high deer density is the main source of mortality of advance regeneration. As balsam fir seedlings resume their growth following a stand-replacing disturbance, their height and survival increase exponentially with decreasing deer densities. Although growth suppression in shaded understorey prevents seedling growth and thus reduces their apparency (Palmer & Truscott 2003), the mortality of seedlings is also related to deer density in forest. The demographic responses are mirrored by an exponential increase in the abundance of balsam fir saplings with decreasing deer density. We conclude that selective browsing at high deer densities over an extended period of time sets the conditions for recruitment failure of preferred species following a stand-replacing disturbance. [...] Browsing from snowshoe hares *Lepus americanus* Erxleben can be discerned from that of white-tailed deer by the nature of the browsing scar (cut vs. chewed) but no sign of hare browsing was found. Snowshoe hare abundance was low based on pellet counts ($Y_2 + Y_3 \pm SE$ in clearcut = 0.3 ± 0.1 pellets m⁻², n = 145 and in forest = 1.3 ± 0.4 pellets m⁻², n = 146). The only other species of forest small mammal present on the island is the deer mouse *Peromyscus maniculatus* Wagner whose diet is mainly composed of seeds, berries and invertebrates. Moose are also present on Anticosti Island but at very low density (Rochette, Gingras & Potvin 2003)." Grazing/herbivory/browsing Direct *Abies balsamea* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Tremblay, J. P., Thibault, I., Dussault, C., Huot, J., & Côté, S. D. (2005). Longterm decline in whitetailed deer browse supply: can lichens and litterfall act as alternative food sources that preclude densitydependent feedbacks. *Canadian Journal of Zoology*, 83(8), 1087-1096." 2005 "A comparison of two browse surveys conducted 25 years apart showed a strong decline in browse availability. [...] Annual browse surveys were conducted by Huot (1982) between 1975 and 1978 (hereinafter 1975) in forest stands representative of key deer habitat types (Table 1). We repeated the surveys in 2001–2002 (hereinafter 2001) in the same stands (n = 13). The position of sample plots (29–32) within stands was randomly determined in both periods. [...] We counted all stems (individual saplings or trees) with at least one twig between 25 and 225 cm from the ground, and all twigs >5 cm from those stems, for balsam fir, paper birch, and other deciduous species, including American mountain ash (*Sorbus americana* Marsh.), balsam poplar (*Populus balsamifera* L.), quaking aspen (*Populus tremuloides* Michx.), northern bush honeysuckle (*Diervilla lonicera* P. Mill.), chokecherry (*Prunus virginiana* L.), pin cherry (*Prunus pensylvanica* L. f.), squashberry (*Viburnum edule* (Michx.) Raf.), serviceberry (*Amelanchier* spp.), and wil-lows (*Salix* spp.). Browse below 25 cm was regarded as unavailable in winter because of snow cover, while twigs at a height of over 225 cm were considered to be out of deer reach (Huot 1982). [...] Deciduous browse species, including serviceberries, northern bush honeysuckle, balsam poplar, pin cherry, chokecherry, willows, American mountain ash, and squashberry were already scarce in 1975 and continued to decline until they were almost completely eradicated by 2001. Balsam fir, paper birch, and quaking aspen, three common species in the canopy of boreal forests (Grondin et al. 1996), are now either absent or at very low density in the winter feeding stratum of most stands where they were more abundant 25 years ago and before. [...] The observed decline in browse availability could also be partially explained by mechanisms other than deer browsing, including canopy closure during the stem-exclusion phase of forest succession (Table 1). [...] However canopy closure cannot explain the absence of balsam fir browse in overmature stands with good shrub stocking (e.g., stands 16 and 20 in Table 1; see also McLaren and Janke 1996). We conclude that the observed decline in browse availability is a direct result of chronic heavy browsing pressure by white-tailed deer." Grazing/herbivory/browsing Direct *Abies balsamea*; *Betula papyrifera* Marsh.; *Populus tremuloides* Michx.; *Amelanchier* spp.; *Diervilla lonicera* P. Mill.; *Populus balsamifera* L.; *Prunus pensylvanica* L. f.; *Prunus virginiana* L.; *Salix* spp.; *Sorbus americana* Marsh.; *Viburnum edule* (Michx.) Raf. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (the measured variable, browsing stratum, might not provide a representative sample of the whole population size)." Anticosti Island Quebec Canada North America North and Central America LV July 2017 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "TREMBLAY, JeanPierre, HUOT, Jean, et POTVIN, François.

Divergent nonlinear responses of the boreal forest field layer along an experimental gradient of deer densities. *Oecologia*, 2006, vol. 150, no 1, p. 7888." 2006 "The dominant relationships are exponential increase in most of the field layer plant reproductive and productivity indicators with decreasing deer density, especially in cutover. These relationships are characterized by fast recovery at local deer densities lower than 7.515 deer km⁻² and the suppression of growth or reproduction at higher density levels. The steepness of the recovery generally increased with subsequent years. On the other hand, the abundance of browsetolerant grasses increased with increasing deer density. [...] We conclude that at an early successional stage following timber harvesting, the negative impact of deer on the field layer plant communities is present, even at the low browsing pressure in our system." Grazing/herbivory/browsing Direct *Anaphalis margaritacea*; *Aster* spp.; *Clintonia borealis*; *Conioselinum chinense*; *Epilobium angustifolium*; *Hieracium* spp.; *Maienthemum canadense*; *Prenanthes* spp.; *Ranunculus acris*; *Senecio* spp.; *Streptopus roseus*; *Rubus idaeus*; *Rubus* spp.; *Trientalis borealis*; *Vaccinium* sp. Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Viera, V. (2003). Effets à long terme du cerf de Virginie (*Odocoileus virginianus*) sur les communautés végétales de l'île d'Anticosti (Doctoral dissertation, Université Laval)." 2003 "[Transcript] Field surveys were conducted from late June to late August 2001 in the western part of Anticosti and on five islands of the Mingan Archipelago (île du Havre, île du Fantôme, île Niapiskau, île Quarry, Grande île) selected for their large size, their similarities with Anticosti in terms of forest composition and their accessibility (Fig. 1). We separated our sampling effort among four natural habitats of different ecological value for deer on Anticosti [...] We sampled three or four replicates for each of these habitats in each site (Anticosti and Mingan). [...] We randomly selected the habitats to survey among a series of easily accessible potential sites which had the required characteristics. In each of the selected site, we randomly positioned 20 sample points [...] At each sampling point, we determined the species composition and relative abundance of woody and herbaceous vegetation including mosses and lichens. [...] As in mature fir stands, some herb species were found only on Anticosti (*Cirsium arvense*, *Urtica* sp., *Rumex acetosella*, *Cerastium vulgare*) whereas other herb species were found only on Mingan (*Clintonia borealis*, *Solidago* sp., *Aralia nudicaulis*) (Table 4). [...] Species such as *Taxus canadensis*, *Acer spicatum*, *A. rubrum* and *Sorbus americanus*, which are common on Mingan, have been extirpated or were severely reduced on Anticosti." Grazing/herbivory/browsing Direct *Clintonia borealis*; *Solidago* sp.; *Aralia nudicaulis*; *Acer spicatum*; *Acer rubrum* Plantae MR Medium "The detected local extinction(s) might be irreversible (because the extinction happened on an island), but the reversibility of the changes has not been tested." "The impact might be lower, if the native population(s) is/are not locally extinct (no transects for detecting native individuals (more difficult to conclude to local extinction(s)), and the detected differences might consist in natural differences between the two islands)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Viera, V. (2003). Effets à long terme du cerf de Virginie (*Odocoileus virginianus*) sur les communautés végétales de l'île d'Anticosti (Doctoral dissertation, Université Laval)." 2003 "[Transcript] Field surveys were conducted from late June to late August 2001 in the western part of Anticosti and on five islands of the Mingan Archipelago (île du Havre, île du Fantôme, île Niapiskau, île Quarry, Grande île) selected for their large size, their similarities with Anticosti in terms of forest composition and their accessibility (Fig. 1). We separated our sampling effort among four natural habitats of different ecological value for deer on Anticosti [...] We sampled three or four replicates for each of these habitats in each site (Anticosti and Mingan). [...] We randomly selected the habitats to survey among a series of easily accessible potential sites which had the required characteristics. In each of the selected site, we randomly positioned 20 sample points [...] At each sampling point, we determined the species composition and relative abundance of woody and herbaceous vegetation including mosses and lichens. [...] [Results of vegetation survey in the exclosures on Anticosti] *Cirsium* sp. and grasses were recorded only in browsed plots of Anticosti where as *Taxus canadensis* and *Goodyera* sp. (Orchidaceae) were found only in Mingan. [...] Species found in Mingan but that did not recover inside the exclosures may not be definitively extirpated on Anticosti. Due to its slow growth rate, *Taxus canadensis* may require longer periods of time to reestablish (Allison 1990). The absence of rare species such as *Goodyera* sp. in the exclosures may be explained by its natural scarcity." Grazing/herbivory/browsing Direct *Taxus canadensis*; *Goodyera* sp. Plantae MR Low The detected local extinction(s) might be irreversible (the short temporal scale of the study compared to the slow growth rate of the native species and the natural scarcity of the species prevent us to conclude to irreversible local extinction(s)). "The impact might be lower, if the native population(s) is/are not locally extinct (no transects for detecting native individuals (more difficult to conclude to local extinction(s)), and the detected differences might consist in natural differences between the two islands)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Viera, V. (2003). Effets à long terme du cerf de Virginie (*Odocoileus virginianus*) sur les communautés végétales de l'île d'Anticosti (Doctoral dissertation, Université Laval)." 2003 "[Transcript] Field surveys were conducted from late June to late August 2001 in the western part of Anticosti

and on five islands of the Mingan Archipelago (île du Havre, île du Fantôme, île Niapiskau, île Quarry, Grande île) selected for their large size, their similarities with Anticosti in terms of forest composition and their accessibility (Fig. 1). We separated our sampling effort among four natural habitats of different ecological value for deer on Anticosti [...] We sampled three or four replicates for each of these habitats in each site (Anticosti and Mingan). [...] We randomly selected the habitats to survey among a series of easily accessible potential sites which had the required characteristics. In each of the selected site, we randomly positioned 20 sample points [...] At each sampling point, we determined the species composition and relative abundance of woody and herbaceous vegetation including mosses and lichens. [...] Even if the occurrence of *Cornus canadensis* in the sample plots did not differ between the two sites (Table 2), ground coverage of the species was higher in Mingan ($P = 0.04$). [...] We did not detect differences in height and cover of all herb species present in both sites except for *Linnaea borealis* and *Cornus canadensis* for which ground coverage was higher on Mingan ($t = 3.95$, $P < 0.01$ and $t = -2.94$, $P = 0.02$) [...] Finally, ground cover of lichens was greater in bogs of Mingan compared to Anticosti (50% and 17%, $t = 3.21$, $P = 0.04$). [...] Browsing by deer was easily distinguished from the sharp, angled cut browsing by the snowshoe hare (*Lepus americanus*), the only other browser inhabiting the study sites."Grazing/herbivory/browsing Direct *Cornus canadensis*; *Ribes* spp.; *Potentilla fruticosa*; *Linnaea borealis*; lichens Plantae MO Medium

"The impact might be lower, because the native population(s) might not be declining (no quantitative data on the situation before the introduction of alien)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Viera, V. (2003). Effets à long terme du cerf de Virginie (*Odocoileus virginianus*) sur les communautés végétales de l'île d'Anticosti (Doctoral dissertation, Université Laval)." 2003

"[Transcript] Field surveys were conducted from late June to late August 2001 in the western part of Anticosti and on five islands of the Mingan Archipelago (île du Havre, île du Fantôme, île Niapiskau, île Quarry, Grande île) selected for their large size, their similarities with Anticosti in terms of forest composition and their accessibility (Fig. 1). We separated our sampling effort among four natural habitats of different ecological value for deer on Anticosti [...] We sampled three or four replicates for each of these habitats in each site (Anticosti and Mingan). [...] We randomly selected the habitats to survey among a series of easily accessible potential sites which had the required characteristics. In each of the selected site, we randomly positioned 20 sample points [...] At each sampling point, we determined the species composition and relative abundance of woody and herbaceous vegetation including mosses and lichens. [...] [Results of vegetation survey in the exclosures on Anticosti] Species such as *Abies balsamea*, *Rubus idaeus*, *Sorbus americanus* recovered within five years when protected from deer browsing (Table 8). Indeed, while these species were not found in the control plots accessible to deer, all were found in the fir stands of Mingan." Grazing/herbivory/browsing Direct *Abies balsamea*; *Rubus idaeus*; *Sorbus americanus* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Anticosti Island Quebec Canada North America North and Central America LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Bellingham, P. J., & Allan, C. N. (2003). Forest regeneration and the influences of whitetailed deer (*Odocoileus virginianus*) in cool temperate New Zealand rain forests. *Forest Ecology and Management*, 175(1), 7186." 2003 "[Transcript] The forests were sampled with permanent 20 m X 20 m plots (methods of Allen, 1993). [...] First, to determine the effects of removing deer on forest regeneration, we examined vegetation inside long-term fenced exclosure plots [established in 1979]. [...] Against this benchmark of absolute exclusion of deer, we then assessed forest change over a larger area with greater numbers of permanent plots located more objectively. [...] We assessed the occurrence of deer at or near the widespread plots using measurements of deer dung, which has been shown in other studies to accord with deer abundance (e.g. Marques et al., 2001). [...] In summary, whitetailed deer can affect densities of seedlings and saplings in Stewart Island forests, but of nine common tree and shrub species, only one (*B. rotundifolia*) showed clear indications that its longterm maintenance may be threatened by continued deer browsing. [...] there was evidence at a wider scale than the exclosure plots to suggest that survivorship of another highly palatable species, *B. rotundifolia*, was reduced substantially by deer. Soon after poisoning of deer in eastern Stewart Island forests in early 1981, there was a substantial increase in seedling density of *B. rotundifolia*, as was also reported by Stewart and Burrows (1989), as *S. reinoldii*. This seedling cohort grew to become a substantial part of the forest basal area in the Eastern plots by 2000 (Fig. 4b), whereas, previously, *B. rotundifolia* had been nearly absent. This increase in seedling density was not maintained until 2000 (Fig. 4d) and this may be due to recovery of the deer population in the eastern coastal forests to densities that inhibited its continued regeneration; indeed deer densities appear to be higher in this area than elsewhere in the areas studied." Grazing/herbivory/browsing Direct *Brachyglottis rotundifolia* (syn. *Senecio reinoldii*) Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (relevant spatial scale, temporal scale) and the exclosure(s) and the gradient of alien density allowed to show the responsibility of the alien in the observed decline(s). Even though only seedlings have been investigated (and no mature individuals), it is mentioned that the [seedling cohort grew to become a substantial part of the forest basal area]." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February

Odocoileus virginianus Cervidae Cetartiodactyla "Bellingham, P. J., & Allan, C. N. (2003). Forest regeneration and the influences of whitetailed deer (*Odocoileus virginianus*) in cool temperate New Zealand rain forests. *Forest Ecology and Management*, 175(1), 7186." 2003 "[Transcript] First, to determine the effects of removing deer on forest regeneration, we examined vegetation inside long-term fenced enclosure plots [established in 1979]. [...] Against this benchmark of absolute exclusion of deer, we then assessed forest change over a larger area with greater numbers of permanent plots located more objectively. [...] We assessed the occurrence of deer at or near the widespread plots using measurements of deer dung, which has been shown in other studies to accord with deer abundance (e.g. Marques et al., 2001). [...] We report changes in various life stages of common canopy tree species; three angiosperms: *G. littoralis* (Cornaceae), *M. umbellata* (Myrtaceae) and *W. racemosa* (Cunoniaceae), and three conifers: *D. cupressinum*, *Podocarpus hallii* and *Prumnopitys ferruginea* (all Podocarpaceae). [...] We also report changes in three understorey angiosperm shrubs: *Brachyglottis rotundifolia* (Compositae, previously referred to *Senecio reinoldii*), *Coprosma foetidissima* (Rubiaceae) and *P. colorata* (Winteraceae) [...] The density of seedlings of all woody species in the deer exclosures increased significantly between 1979 and 2000 (paired t-test, $t_4 = 3.24$, $P = 0.032$, Fig. 2), in contrast to the adjacent control plots where there was no change in density (paired t-test, $t_4 = 1.35$, $P = 0.25$). [...] For some of the other species, observed increases in densities of seedlings and saplings over 20 years were better predicted by stand structural attributes, surrogates for seed availability, and distance from the coast than they were by indices of deer frequency. Furthermore, deer pellet frequency indices alone were very poor predictors of seedling density, when not included in models along with stand structural attributes, suggesting deer browsing and stand structure have interactive effects on regeneration [...] On the other hand, population size structures of most dominant canopy and understorey shrubs showed no evidence of lack of past recruitment for any species except *M. umbellata*, a species that does not feature prominently in deer diets on Stewart Island (Nugent and Challies, 1988), and which has a similar size structure in the absence of deer populations (e.g. Veblen and Stewart, 1980). Since a majority of stems of most species were in smaller size classes (Fig. 3) there was no evidence of past regeneration failure of any of the eight widespread canopy species we considered, given that deer had been present for at least 80 years beforehand."

Grazing/herbivory/browsing Direct *Dacrydium cupressinum*; *Metrosideros umbellata*; *Weinmannia racemosa*; *Griselinia littoralis*; *Podocarpus hallii*; *Prumnopitys ferruginea*; *Coprosma foetidissima*; *Pseudowintera colorata* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected (the impacted regeneration was found to be not limiting the recruitment on the long-term)." Stewart Island/Rakiura

Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Stewart, G. H., & Burrows, L. E. (1989). The impact of whitetailed deer *Odocoileus virginianus* on regeneration in the coastal forests of Stewart Island, New Zealand. *Biological conservation*, 49(4), 275293." 1989 "The impact of white-tailed deer *Odocoileus virginianus* Zimmermann on regeneration

patterns in the coastal conifer-broadleaved hardwood forests of Stewart Island was monitored for 6 years. Permanent 20 × 20 m quadrats, established in 1979 on deer-free Bench Island, inside deer exclosures on Stewart Island, and in an area subject to deer browsing on Stewart Island, were remeasured in 1985. [...] In the Stewart Island areas two types of sites were investigated: non-excluded sites where deer numbers had been reduced by a poisoning operation in 1981 (New Zealand Forest Service, 1984) but were now expanding again, and fenced exclosures from which deer had been excluded since 1979. [...] The numbers of treeferns (primarily *Dicksonia squarrosa*) in the subplots were recorded in height classes (height taken to highest point of the crown) of 0.3-2.0, 2-5 and 5-12m. [...] When deer were excluded, the amount of bare ground/litter declined in all vegetation types, coinciding in each with a marked increase in fern cover (primarily *Dicksonia squarrosa*, Table 3). [...] The number of treeferns in exclosures in all vegetation types increased about 135% from 1979 to 1985 (Table 6), but proportions in different height classes changed. In 1979 most were 2-5 m tall, but by 1985 most were in the 0.3-2 m height class, reflecting the proliferation of suckers after the removal of browsing and trampling pressure. The number of treeferns 2-5 m declined markedly from 1979 to 1985, and many had collapsed and died (also see Table 5). [...] The number of treeferns in all vegetation types increased by about 50% from 1979 to 1985, a lesser increase than in the exclosures (Table 6). Changes in the proportions of treeferns in different height classes were similar to those in the exclosures (also see Table 5), but fewer entered the 0.3-2 m tier because of increasing browsing and trampling pressure after the initial poisoning operation." Grazing/herbivory/browsing; Direct physical disturbance Direct *Dicksonia squarrosa* Plantae MO High

"It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial and temporal scales) and the exclosure(s) allowed to quantify the impact of the alien only." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV January 2018 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Stewart, G. H., & Burrows, L. E. (1989). The impact of whitetailed deer *Odocoileus virginianus* on regeneration in the coastal forests of Stewart Island, New Zealand. *Biological conservation*, 49(4), 275293." 1989 "The impact of white-tailed deer *Odocoileus virginianus* Zimmermann on regeneration patterns in the coastal conifer-broadleaved hardwood forests of Stewart Island was monitored for 6 years. Permanent 20 ×

20 m quadrats, established in 1979 on deer-free Bench Island, inside deer exclosures on Stewart Island, and in an area subject to deer browsing on Stewart Island, were remeasured in 1985. [...] In the Stewart Island areas two types of sites were investigated: non-excluded sites where deer numbers had been reduced by a poisoning operation in 1981 (New Zealand Forest Service, 1984) but were now expanding again, and fenced exclosures from which deer had been excluded since 1979. [...] The total number of species and the number of species present in the browse height tier (0.3-2 m) were recorded on 'recce' plots (Allen & McLennan, 1983) located in each permanent quadrat or inside each exclosure. [...] The diameters of all trees (stems >2.5cm dbh) in each subplot were measured and tagged, and the numbers of saplings (<2.5cm dbh but > 1m tall) were counted. [...] The frequency of small seedlings (< 15 cm tall) and the numbers of tall seedlings (16-135cm) and saplings were recorded in 24 systematically located and permanently marked 0-75m² understorey plots [...] After deer exclusion many seedlings in these areas were of deer-preferred species such as *Griselinia littoralis*, *Weinmannia racemosa*, *Pseudopanax simplex*, and *Coprosma foetidissima*. [...] Highly preferred food species such as *Griselinia littoralis*, *Pseudopanax crassifolius*, and *Myrsine australis* were rare or absent [on non-excluded quadrats]. [...] and saplings of several species (e.g. *Carpodetus serratus* and *Senecio reinoldii*) were recorded for the first time (Table 4). [...] Seedlings of highly preferred species that had appeared in the exclosures (e.g. *Griselinia littoralis* and *Coprosma lucida*) were still rare or absent. There were very few seedlings and saplings of preferred subcanopy hardwoods such as *Pseudopanax simplex* and *Carpodetus serratus*. Even though some seedlings were establishing they were being impeded from further height growth by browsing. [...] *Coprosma areolata* was almost absent in 1979 but increased significantly in types affected by almost total dieback by 1985 (Fig. 2)." Grazing/herbivory/browsing; Direct physical disturbance

Direct *Griselinia littoralis*; *Weinmannia racemosa*; *Pseudopanax simplex*; *Coprosma foetidissima*; *Pseudopanax crassifolius*; *Myrsine australis*; *Coprosma lucida*; *Senecio reinoldii*; *Carpodetus serratus*; *Coprosma areolata* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "It is unlikely that the impact is lower (study led at a large spatial scale, on different vegetation types, at relevant temporal scale for regeneration, etc.)." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Veblen, T. T., & Stewart, G. H. (1980). Comparison of forest structure and regeneration on Bench and Stewart Islands, New Zealand. New Zealand journal of ecology, 5068." 1980

"Tree diameters at breast height (dbh) of all individuals 5 cm dbh were measured and numbers of saplings (trees < 5 cm dbh and 1.4 m tall) counted in two 0.39 ha plots (54 72 m) each on Bench and Stewart Islands. [...] The understorey vegetation in each 0.39 ha plot was sampled in a restricted random lay-out using three types of plots. [...] In contrast to the similar size-class compositions shown by the dominant tree species on both islands, important differences are evident for the sub-canopy tree species. *Pseudopanax simplex*, which is the most abundant sub-canopy tree species in all stands, is markedly underrepresented in the sapling size-class on Stewart Island, whereas on Bench Island saplings are abundant (Fig. 3a). Similarly, *Pseudopanax crassifolius*, *Myrsine australis*, and *Griselinia littoralis* as well as the combined less common species (*Melicytus lanceolatus*, *Fuchsia excorticata*, *Pseudopanax colensoi*, *Carpodetus serratus*, *Schefflera digitata*, *Senecio reinoldii*, and *Pittosporum colensoi*), are all represented by abundant saplings on Bench Island but not on Stewart Island (Fig. 3). In addition to the underrepresentation in the sapling size-class, the total numbers of these species are also generally less on Stewart Island. These differences in the abundance and size-class distributions of sub-canopy tree species on the two islands are taken as evidence that browsing has significantly retarded their regeneration on Stewart Island. [...] Given the less dense main canopy on Stewart Island and hence higher light levels, the reduced numbers of both sub-canopy tree species and 0.5-2 m tall tree ferns are most logically attributed to browsing. While on Bench Island canopy gaps created by tree falls are quickly filled by sub-canopy tree species and tree ferns, canopy gaps on Stewart Island remain unoccupied due to the inhibitory effects of browsing. [...] Similarly, Cockayne (1909a) lists *Pseudopanax edgerleyi* and *P. simplex* as abundant and *P. colensoi*, *Myrsine australis*, *Coprosma lucida*, *C. rotundifolia* and *Pittosporum colensoi* as common in the rata-kamahi-rimu forests of Stewart Island. Today these species are relatively scarce on Stewart Island although all are present and most are abundant on Bench Island. [...] Several palatable species such as *Kirkophytum lyallii*, *Asplenium bulbiferum*, *Coprosma lucida*, and *Phymatosorus diversifolius* previously abundant on Stewart Island (Cockayne, 1909a) and presently abundant on Bench Island, are now rare or absent on Stewart Island. [...] Given the lesser canopy densities, and hence higher light levels, the reduced understorey cover on Stewart Island is likely to be the consequence of severe browsing pressure. [...] A major difference between the understorey vegetation of the two islands is the abundance of the fern *Phymatosorus diversifolius* on Bench Island and its scarcity on Stewart Island; on all three types of site it is by far the most frequent species on Bench Island. Cockayne (1909a) described *P. diversifolius* as abundant on the ground on Stewart Island when he studied the vegetation soon after the liberation of deer. Now, the only site in the Stewart Island plots in which *P. diversifolius* exceeds a frequency of 5 % is on the tree fern trunks where it is often above the browse-height of deer. [...] Thus, on Stewart Island a reduced main canopy and understorey permits more frequent establishment but browsing prevents the development in height of these plants. [...] However, on Stewart Island browsing animals are the likely explanation for the poor forest recovery following die-back and for the tendency towards forest replacement by fern and graminoids." Grazing/herbivory/browsing Direct *Pseudopanax simplex*; *Pseudopanax*

crassifolius; *Myrsine australis*; *Griselinia littoralis*; *Melicactus lanceolatus*; *Fuchsia excorticata*; *Pseudopanax colensoi*; *Carpodetus serratus*; *Schefflera digitata*; *Brachyglottis rotundifolia* (syn. *Senecio reinoldii*); *Pittosporum colensoi*; *Pseudopanax edgerleyi*; *Coprosma lucida*; *Coprosma rotundifolia*; *Kirkophytum lyallii*; *Asplenium bulbiferum*; *Phymatosorus diversifolius*; *Coprosma foetidissima* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (e.g. relevant spatial scale) and even if other stressors might be acting on the native population(s), it is likely that the alien is causing at least part of the observed decline(s)." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Veblen, T. T., & Stewart, G. H. (1980). Comparison of forest structure and regeneration on Bench and Stewart Islands, New Zealand. New Zealand journal of ecology, 5068." 1980 "Tree diameters at breast height (dbh) of all individuals 5 cm dbh were measured and numbers of saplings (trees < 5 cm dbh and 1.4 m tall) counted in two 0.39 ha plots (54 72 m) each on Bench and Stewart Islands. [...] On both Bench and Stewart Islands the sizeclass distributions of the main canopy tree species are similar; thus, it is unlikely that browsing animals on Stewart Island have greatly affected the population structure of the main canopy tree species. However, the dearth of tree seedlings > 15 cm tall in contrast to the abundance of seedlings "" 15 cm tall indicates that on Stewart Island browsing impedes seedling development which, in the longterm, will endanger maintenance of the main canopy tree populations. [...] Considering the large percentages of the tree saplings and stems > 5 cm dbh established on logs, the lack of individuals > 15 cm tall on logs of species such as *G. littoralis*, *P. simplex*, and *W. racemosa* has serious implications for the future regeneration of these tree species under intense browsing pressure on Stewart Island. [...] Therefore, even over large areas of forest the size-class distributions of the main canopy species do not conform to the ideal expected for a continuously regenerating population. [...] However, on Stewart Island browsing animals are the likely explanation for the poor forest recovery following die-back and for the tendency towards forest replacement by fern and graminoids." Grazing/herbivory/browsing Direct *Metrosideros umbellata*; *Dacrydium cupressinum*; *Podocarpus ferrugineus*; *Podocarpus hallii*; *Weinmannia racemosa* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected (study led at a large spatial scale, etc.)." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Veblen, T. T., & Stewart, G. H. (1980). Comparison of forest structure and regeneration on Bench and Stewart Islands, New Zealand. New Zealand journal of ecology, 5068." 1980 "All *Dicksonia squarrosa* (the only tree fern species present in the stands sampled) > 0.5 m tall were counted in each 0.39 ha plot [two on each Bench and Stewart islands] and classified into height classes of 0.5-2 m and > 2 m. [...] Relative to Bench Island, the proportions as well as absolute numbers of the tree fern *Dicksonia squarrosa* in the 0.5-2 m height class are low on Stewart Island (Table 3) which is a direct consequence of the deer browsing the new tree fern shoots. As a consequence of epiphytic tree seedling establishment on the tree fern stems, the inhibition of tree fern regeneration may also affect the rate of tree seedling establishment. The relative abundance of tree ferns > 2 m tall is substantially greater on Stewart Island than on Bench Island (Table 3). This may be due to the higher light levels beneath the main canopies, as discussed below, or may be related to less competition for other resources from the much reduced populations of sub-canopy species on Stewart Island. [...] Given the less dense main canopy on Stewart Island and hence higher"" light levels, the reduced numbers of both sub-canopy tree species and 0.5-2 m tall tree ferns are most logically attributed to browsing. While on Bench Island canopy gaps created by tree falls are quickly filled by sub-canopy tree species and tree ferns, canopy gaps on Stewart Island remain unoccupied due to the inhibitory effects of browsing. [...] However, on Stewart Island browsing animals are the likely explanation for the poor forest recovery following die-back and for the tendency towards forest replacement by fern and graminoids." Grazing/herbivory/browsing Direct *Dicksonia squarrosa* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected (study led at a large spatial scale, etc.)." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Wardle, David A., et al. ""Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences."" Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama wallaby*) [...] The effects of browsing mammals on the soil microfood web were clearly multitrophic in nature for several locations; populations of microbe-feeding and predaceous nematodes were significantly affected by browsers in both the humus and litter layers in nearly half the site. [...] Effects of browsers on abundances of microarthropods were negative for all but one of the 63 instances in which a significant effect at $P \leq 0.05$ was detected (Fig. 9)." "Chemical, physical or structural impact on ecosystems" Indirect Nematoda; Rotifera; Copepoda; Tardigrada Animalia MO Medium "The alien might have caused (a) local extinction(s), but the study did not focus on the species level (the study investigated changes in nematode, rotifer, copepod and tardigrad abundances in general,

making it difficult to understand which species are affected, and how)" "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population size(s) but that the other stressor(s) acting on the native population is/are alone the cause(s) of this/these decline(s) (other deer present)" Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania DJ July 2017LV June 2019

Odocoileus virginianus Cervidae Cetartiodactyla "Wardle, David A., et al. "Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences." Ecological monographs 71.4 (2001): 587614." 2001 "The main browsing mammal in most locations was *C. elaphus*, with several locations supporting *C. hircus*, and with the dominant browser in some areas being *Dama dama* L. (fallow deer), *Odocoileus virginianus* Zimmerman (white tailed deer), or *Macropus eugenii* Desmarest (*Dama wallaby*) [...] In most locations browsing mammals reduced plant diversity (Shannon-Weiner index) in the browse layer; diversity was greater inside the enclosure than outside for all but three locations and for half the locations the effects were significant at $P \leq 0.05$ (Fig. 12). [...] [Fig. 4]"

Grazing/herbivory/browsing Direct *Coprosma foetidissima*; *Dicksonia squarrosa* Plantae MN Medium "It is likely that the impact is higher, but the study did not allow to detect the effect of the alien on the native population size (only investigated the density of the species in the browse layer (0-2m height), which is rather a measure of the performance (regeneration))." "The impact might be lower, because the performance of native individuals might not be affected (an impact on the performance of these species has only been found in one enclosure out of three)." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV June 2019 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Bellingham, P. J., & Allan, C. N. (2003). Forest regeneration and the influences of whitetailed deer (*Odocoileus virginianus*) in cool temperate New Zealand rain forests. Forest Ecology and Management, 175(1), 7186." 2003 "[Transcript] The forests were sampled with permanent 20 m X 20 m plots (methods of Allen, 1993). [...] In each plot, 24, 0.75 m² subplots were permanently marked on a regular grid, each 5 m apart (Allen, 1993). [...] In each subplot, the presence of ferns [*Cyathea smithii* and *Dicksonia squarrosa*] between 0.15 and 1.35 m tall was also recorded. [...] First, to determine the effects of removing deer on forest regeneration, we examined vegetation inside long-term fenced enclosure plots [established in 1979]. [...] Tree fern (*C. smithii* and *D. squarrosa*) stem densities and basal areas, measured only in 2000, did not differ between enclosures and controls (485 +/- 240 stems/ha in enclosure versus 410 +/- 201 stems/ha in control; 5.76 +/- 2.21 m²/ha in enclosure versus 3.18 +/- 1.31 m²/ha in control; paired t-tests, both $P > 0.37$)." Grazing/herbivory/browsing Direct *Cyathea smithii*; *Dicksonia squarrosa* Plantae MC Medium "The impact might be higher, if the study did not allow to detect an impact on the performance of native individuals (the purpose of the study was not to investigate the impact on ferns, so the absence of an impact of browsing by the alien was only concluded from the enclosure experiment (which might not have allowed to detect all impacts on the performance))." Stewart Island/Rakiura Stewart Island/Rakiura New Zealand Oceania Oceania LV January 2018 LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Bélanger L., Martin J.L., Michalet J., Said S., Tremblay J.P., 2008. Rapport de mission sur l'état des bois de l'archipel de Saint-Pierre-et-Miquelon, présenté au Conseil territorial de Saint-Pierre-et-Miquelon, à la Direction de l'Agriculture et de la Forêt et à l'Office National de la Chasse et de la Faune Sauvage." 2008 "Afin d'émettre des avis circonstanciés, des prospections faunistiques et floristiques de terrain ont été réalisées par les membres de la mission en compagnie de chasseurs et de naturalistes locaux. [...] Nous avons effectué sept parcours qui nous ont permis de prendre connaissance de l'état des secteurs boisés de St-Pierre (Anse à Dinan, Anse St-Pierre), de Miquelon (secteurs du Cap et du bois Mirande, Sylvain et Grande Bouillée) et de Langlade (secteurs de Cuquemel et ruisseau Debond, de Tête pelée et de l'Anse aux Soldats et de la Maquine – Cap au Renard ; Figure 5). [...] L'état de santé des boisés de l'archipel a été évalué en analysant l'état de trois strates de l'écosystème forestier : 1. la régénération basse de moins de 50 cm de hauteur, soit celle plus basse que les fougères et graminées 2. la régénération haute, soit celle que l'on estime en mesure de supporter la compétition des herbacés et qui est moins sensible aux abrouissements 3. la canopée constituée par les arbres matures. [...] Malgré une grande variabilité dans le couvert et la régénération haute, nous avons constaté que l'ensemble des sapinières hautes à bouleau visitées se trouvait au niveau 3 de dégradation, c'est-à-dire se caractérise par la disparition de la haute régénération des feuillus et du sapin. Les peuplements visités à la Grande Bouillée et à l'Anse aux Soldats comptaient également de grandes trouées de mortalités au stade 6 de conversion en landes à herbacées. [...] Traces d'abrouissement très présentes identifiant le gibier (cerf de Virginie et lièvre d'Amérique) comme la cause de l'absence de régénération bien établie (mais la banque de semis existe souvent)." Grazing/herbivory/browsing Direct *Abies balsamea*; *Betula papyrifera*; *Sorbus americana*; *Sorbus decora* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the regeneration was investigated)." It is unlikely that the impact is lower (direct observations of browsing traces suggest that the alien is one cause of the impact on the regeneration). Langlade Island; Miquelon Island Saint Pierre and Miquelon Saint Pierre and Miquelon Europe Europe LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Michallet, J., Letournel, B., & Jougllet, M. (2009). Analyse des données «relation fauneflore» relevées sur les îles de Miquelon et Langlade. Rapport technique. ONCFS, CNERA Cervidés Sanglier, Direction régionale Outre Mer." 2009 Le cerf a un impact plus important sur les semis de sapin baumier de

Langlade alors que le lièvre a un effet plus marqué sur les semis de bouleau à papier des sites de Miquelon et Langlade. Pour les autres essences la valeur de l'abroustissement dévolu aux cerfs et lièvres est identique. Malgré le faible recul du jeu de données (1 année seulement) nous pouvons retenir que lièvres et cerfs ont un impact non négligeable sur les semis en particulier des essences feuillus. La différence de densité entre les semis de faible hauteur (moins de 70 cm) et ceux dépassant cette limite est importante. Ce déficit en semis « matures » risque de remettre localement en cause l'avenir des peuplements feuillus. Pour ce qui concerne les essences résineuses (sapin et épinettes) la densité en semis peut être jugée comme relativement importante localement et ce malgré l'absence de données (difficulté d'apprécier la part des « semis » issus d'une reproduction végétative et ceux issus d'une reproduction sexuée. Grazing/herbivory/browsing Direct

Abies balsamea; *Betula papyrifera*; *Sorbus americana*; *Picea mariana*; *Picea glauca* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." Langlade Island; Miquelon Island Saint Pierre and Miquelon Saint Pierre and Miquelon

Europe Europe LV July 2017LS February 2020

Odocoileus virginianus Cervidae Cetartiodactyla "Muller, S., Sibley, J.P., Horellou, A., Simian, G. (2008). Rapport de mission ""biodiversité"" SaintPierre & Miquelon 3 14 juin 2008. Ministère de l'Ecologie, de l'Energie, du Développement Durable et de l'Aménagement du Territoire. Muséum National d'Histoire Naturelle, Service du Patrimoine Naturel.

Université Paul Verlaine Metz." 2008 "Sur la carte cidessus, les zones coloriées en vert sombre correspondent à des espaces qui apparaissaient boisés en 1952 sur les photos aériennes et ne le sont plus en 2005. Ces espaces représentent 37 % des surfaces boisées de 1952, qui ont donc été perdus au cours de la deuxième moitié du 20ème siècle ! Ces expertises confirment les constats que nous avons déjà réalisés au cours des missions précédentes. Ils mettent directement en cause l'impact du cerf de Virginie, introduit dans l'archipel en 1953." Grazing/herbivory/browsing Direct *Abies balsamea*; *Taxus canadensis*; *Trientalis borealis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (even though relevant spatial scale for the impacted native species, the native populations are not monitored independently but as a whole (the habitat ""boreal forest""), which reduces the confidence in the impact on individual species); or, if some native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (based on a comparison before/after the introduction of the alien)"

Langlade Island; Miquelon Island Saint Pierre and Miquelon Saint Pierre and Miquelon Europe Europe LV July 2017LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Reed, D. F. (2001). A conceptual interference competition model for introduced mountain goats. The Journal of wildlife management, 125-128." 2001 "I conducted censuses from an 8-km alpine walking route southeast of Goliath Peak, then to above Lincoln Lake, and finally encircling Rogers Peak and Mount Warren. I walked routes weekly or 2-3 times/month from 1981 through 1986 and recorded numbers of animals, group sizes, sex and age classes, locations, and inter- and intraspecific interactions. [...] I observed 107 direct interactions between mountain goats and mountain sheep. The intensity of these interactions ranged from neutral (i.e., no overt response) to moderate or intense flight reaction. Fifty-nine interactions were neutral, 39 resulted in apparent deterrence of sheep from some resource (i.e., mineral licks and foraging and resting areas), 8 resulted in slight to moderate flight reaction in mountain goats from the presence of sheep, and 1 resulted in a sheep following several mountain goats with no apparent response by the mountain goats (considered positive interaction). Mountain goats initiated most of the observed interspecific behaviors resulting in negative effects on mountain sheep (n = 39; Table 1). These data suggested that 36.5 % (39 of 107) of mountain goat-mountain sheep interactions resulted in sheep yielding space or other resources. [...]

Minimum population curves of the 2 species have been estimated from annual ground counts since 1978 (Reed and Green 1994:141). Most of these counts were single counts, and therefore, confidence intervals could not be calculated. Over time the 2 population curves diverged as mountain goats decreased (from about 125 to 90) due to increased hunting pressure, and mountain sheep increased (from about 160 to 210) from 1990 through 1993 (Reed and Green 1994). It is attractive to infer cause and effect (i.e., less displacement of mountain sheep through interference competition, exploitation competition, or both, equals changes in distribution and-or greater numbers of mountain sheep), but other variables such as increased survival due to possible milder winters and changes in immunity can not be ruled out." Transmission of

diseases; Competition Indirect *Ovis canadensis* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (the population estimates have been shown to be not always accurate (Reed and Green, 1994)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (there are other possible explanations to this negative correlation between the native and the alien populations (e.g. milder winters and changes in immunity))" Mount Evans area Colorado United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Pfitsch, W. A., & Bliss, L. C. (1985). Seasonal forage availability and potential vegetation limitations to a mountain goat population, Olympic National Park. American Midland Naturalist, 109-121."1985 "Twenty plots (10x10 m) were located for analysis of floristics, grazing, and plant production in the Klahhane Ridge area in 1979. [...] An enclosure (10 x 10 m), placed adjacent to each of five vegetation plots sampled in 1979, was constructed within 10 days after snowmelt in 1980. [...] In 1981, three quadrats (1 m2) were sampled for plant

cover within each of five ex- closures (4 x 4 m) constructed in 1976 in a S-facing meadow. Five quadrats were sampled in a stratified random design within an adjacent plot (5 x 10 m) outside of the above exclosures. One 5 x 10 m plot adjacent to two exclosures served as the outside control for both exclosures. [...] Areas in CT 1 from which mountain goats had been excluded for 5 years had the same species density (# spp m⁻²) in 1981 than did adjacent unexclosed plots (Table 2). The cover of *Festuca idahoensis* was higher ($t = 5.8$; $P < 0.001$) and that of *Phlox diffusa* slightly lower within the exclosures, while total plant cover was the same. [...] The most preferred species ($SAGI > 1.7$) include *Festuca idahoensis*, *Aster paucicapitatus*, *Hedysarum occidentale*, *Poa incurva*, and *Carex spectabilis*." Grazing/herbivory/browsing Direct *Festuca idahoensis* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (only five exclosures, sampled only once)." Klahhane Ridge (Olympic National Park) Washington United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Schreiner, E.G., Woodward, A., 1994, Responses of vegetation to reductions in goat density In: Schreiner, E.G., Moorhead, B.B., eds., Mountain Goats in Olympic National Park: Biology and Management of an Introduced Species: Scientific Monograph NPS/NROLYM/NRSM-94/25, Denver, CO, US Department of the Interior, National Park Service, Natural Resources Publication Office, p. 129-138." 1994 "We established permanent plots in three areas of mountain goat summer range to evaluate plant responses to different levels of goat herbivory¹⁴ (Table 29). Each study area had relatively high initial goat density but differed in annual precipitation and the composition of plant communities. The three areas also differed physiographically: Klahhane Ridge extends east-west with mainly north and south exposures, Mount Dana is an isolated peak with all exposures, and Avalanche Canyon is a north-south valley with east- and west-facing exposures. We reduced each goat subpopulation and simultaneously measured vegetation to test the null hypothesis that reducing mountain goat density would not affect the relative abundance of plant species. [...] Plant cover and grazing levels were estimated on randomly located 1- x 1-m quadrats ($n = 6-12$) in each plot (Appendix A1). [...] Mean cover of selected plant species was 9.0% and 29.7% for plots receiving (respectively) high and low initial levels of goat use. In contrast, nonselected plant species cover was 11.3% in plots with high levels of goat use and 11.0% in plots with low goat use. As goat density was reduced, cover of selected plant species in areas originally having high levels of goat use increased at a significantly faster rate (i.e., greater slope of regression) than cover of selected plant species in areas originally having low goat use ($P = 0.0667$; Fig. 36A; Table 30). Selected plant species cover also increased faster than that of nonselected plant species in plots with high initial levels of goat use ($P = 0.1667^*$ [special instance described in third paragraph above]) but not in plots receiving low initial levels of goat use ($P = 0.3143$). Total plant cover increased in plots with high initial levels of goat use and decreased in plots with low initial levels of use ($P = 0.0667$). [...] Total plant cover and cover of nonselected plant species were not significantly different between those plots with high and those with low initial goat use. [...] *Festuca idahoensis* increased in plots where goat use was originally high and decreased in plots where use was originally low (significantly different slopes at $P = 0.0667$; Fig. 38). *Achillea millefolium* decreased in plots with high initial goat use but not in low initial use plots ($P = 0.0667$). [...] The relative abundance of plant species at Klahhane Ridge changed over time in plots receiving high initial goat use but not in those receiving low initial use. For example, the disturbance-oriented *A. millefolium* dominated a high initial use plot (~10% cover) in 1983 and *Cirsium edule* and *Phlox diffusa* codominated with about 6% cover each. By 1990, *Cirsium* and *Phlox* shared dominance (~9% cover) and *F. idahoensis* had ~7% cover; *Achillea* had decreased to about 6%. [...] For example, three selected forage species (*Carex spectabilis*, *Juncus parryi*, and *Aster paucicapitatus*) occurred in three different communities and each increased in mean cover." Grazing/herbivory/browsing Direct *Festuca idahoensis*; *Carex spectabilis*; *Juncus parryi*; *Aster paucicapitatus*; *Cirsium edule*; *Phlox diffusa* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (sites were selected for high alien density and small sampling quadrats, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Klahhane Ridge; Mount Dana; Avalanche Canyon (Olympic National Park) Washington United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Schreiner, E.G., Gracz, M.B., Kaye, T.N., Woodward, A., Buckingham, N.M., 1994, Rare plants In: Schreiner, E.G., Moorhead, B.B., eds., Mountain Goats in Olympic National Park: Biology and Management of an Introduced Species: Scientific Monograph NPS/NROLYM/NRSM-94/25, Denver, CO, US Department of the Interior, National Park Service, Natural Resources Publication Office, p. 173-185." 1994 "Permanent plots showed that *Astragalus* plants were injured (grazed or trampled) by goats. Injury was sporadic but sometimes intense (Fig. 43). Some injuries were obviously caused by goats (i.e., abundant goat sign adjacent to grazed or trampled *Astragalus* plants), but the cause of other injuries could not be determined. Goat wallowing in three plots was responsible for four dead plants in 1986. Extensive grazing and trampling of plants at Unicorn Peak in 1987 were entirely attributable to mountain goats. In the plots where most of the injuries took place, 26 of 50 subplots contained goat tracks, Grazing was evident on 72% (89) of the individuals in the plots—most were noted as 76-100% grazed. Goats evidently moved through the area and stopped to graze and wallow in the *Astragalus*. [...] Blue Mountain plots contained an average of 3 times more *Astragalus* plants per square meter than did plots representing Mount Angeles subpopulations (1.01 vs. 0.31; $P < 0.01$, Mann-Whitney U-test). The logistic regression equation describing *Astragalus* habitat characteristics was

used to test the hypothesis that habitat differences were responsible for different densities of plants between the two areas. Based on habitat characteristics, the equation predicted that the mean probability of a plot containing *Astragalus* at Blue Mountain was 0.47 and 0.53 at Mount Angeles ($P = 0.40$, Mann-Whitney U-test). The major difference between the two areas was the historical density of mountain goats (much greater on Mount Angeles) rather than habitat characteristics. [...] Circumstantial evidence from habitat analysis suggested that goat herbivory may have reduced plant densities on Mount Angeles compared to Blue Mountain. [...] One or 2 years of successful seedling establishment means little to the persistence of a subpopulation or to species survival because of high mortality. Considerably longer study will be required to determine population trends. Goat effects on *Astragalus* were sporadic, sometimes intense, and had unknown long-term consequences to the survival of the species. " Grazing/herbivory/browsing; Direct physical disturbance Direct *Astragalus australis* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (short temporal scale and the observed differences between the compared sites might only be natural variation). The performance of the native individuals has been shown to be affected by the alien." Mount Angeles (Olympic National Park) Washington United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Schreiner, E. G. and Burger, J. E. (1994). Photographic comparisons: a qualitative appraisal of the influence of climate and disturbances on vegetation, 1915-1990. Mountain Goats in Olympic National Park: biology and management of an introduced species. United States Department of the Interior Scientific Monograph NPS/NROLYM/NRSM-94/25, 139-172." 1994 "Photographs taken before goats were introduced compared with repeat photographs taken later allowed us to extend the evaluation of vegetation in relation to mountain goat herbivory further back in time—albeit qualitatively. We report results from an ongoing study of long-term changes in subalpine vegetation; photographs from Klahhane Ridge are presented because we have not completed work elsewhere in the park. [...] We compared general features, including aspect, type of view (distant, moderately distant, close), plant community type(s), and noted whether or not the scene was the same as that shown in other pairs. Differences (if any) in each community were described and then tallied as increases, decreases, or no changes in vegetation, amount of exposed soil, and goat sign (Appendix A1). [...] Forces driving changes included goats, humans, fire, and climate change, or combinations thereof. Interpretations are conservative; unless a single cause of change was clearly identifiable (e.g., fire), all contributing factors were considered. [...] Increased cover on this site occurred sooner than other, more preferred, sites. This outcrop was evidently among the first to be abandoned by goats as densities were lowered, hence the rapid recovery. Species exhibiting increased cover included *Artemisia ludoviciana* and *Bromus sitchensis*. Changes in which major plant community components such as *Artemisia ludoviciana* were greatly reduced or eliminated by herbivory are best illustrated by Plate 9 beginning in 1970. [...] Photographs from before, during, and after the peak of goat density in the late 1970's exhibit trends in plant cover consistent with this hypothesis. Plant species such as *Festuca idahoensis*, a bunchgrass often consumed by goats, decreased as goat density increased and then increased as goat density decreased." Grazing/herbivory/browsing Direct *Festuca idahoensis*; *Artemisia ludoviciana*; *Bromus stichensis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (conclusions about the changes in the native population(s) are based on photographs, but the population(s) have not been monitored in the field)." Olympic National Park Washington United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Kaye, T. N. (1989). Autecology, reproductive ecology, and demography of *Astragalus australis* var. *olympicus* (Fabaceae)." 1989 "In 1985, three permanent plots were established near the population center at Unicorn Peak, two at Blue Mountain summit, and three at Blue Mountain NE buttress. Two plots were placed at Hurricane Hill in 1986. [...] Through 1986 the number of *Astragalus australis* var. *olympicus* plants in each subplot was counted in July. [...] In 1987 and 1988 individual plants were mapped to scale in July and September, their reproductive status was noted, and a thorough search was made for seedlings. [...] In all years, damage to plants by mountain goats was noted. Grazing in 1987 and 1988 was categorized into classes of plant tissue removed: 1-5%, 5-25%, 25-50%, 50-75%, and 75-100%. Wilcoxon signed-rank test was used to test the null-hypothesis that the number of non-seedling plants per plot and over all plots pooled remained the same from the year of plot establishment to 1988. [...] The effect of mountain goats on plant survival depended on whether plants were grazed or trampled in goat wallows. In 1987, 78.8% of the non-seedling plants monitored in plots 101 and 102 at Unicorn Peak were grazed to some degree. This had little effect on plant survival, however. In fact, more ungrazed plants (16.7%) were dead in 1988 than grazed plants (4.5%) (Table IV.1). On the other hand, many (25.5%) reproductive plants that were grazed in 1987 resprouted as vegetative plants in 1988, but no ungrazed reproductive plants regressed in this way (Table IV.1). Goat wallows, though less common, were more likely than grazing to kill *Astragalus australis* var. *olympicus* plants. In 1986, goat wallows were found in three permanent plots. Two wallows at Blue Mountain NE buttress were responsible for two plant deaths, one in plot 6, subplot #13, and the other in plot 114, subplot #11. At Unicorn Peak, a wallow overlapping plot 102 killed two plants in subplot #10. No other wallows were observed inside permanent plots, but during a 1987 census of goat wallows in and within 50 meters of *Astragalus australis* var. *olympicus* populations, I located 129 wallows at Blue Mountain NE buttress, none at

Blue Mountain summit, 39 at Unicorn Peak, and none at Hurricane Hill." Grazing/herbivory/browsing; Direct physical disturbance Direct *Astragalus australis* Plantae MN High "It is unlikely that the impact is higher, because no decline in the native population(s) was/were detected." It is unlikely that the impact is lower (individual survival is shown to be affected by wallowing by the alien). Unicorn Peak; Blue Mountain (Olympic National Park) Washington United States North America North and Central America LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Cobb, M. A., Helling, H. E. I. D. I., & Pyle, B. I. L. L. (2012). Summer diet and feeding location selection patterns of an irrupting mountain goat population on Kodiak Island, Alaska. In Biennial Symposium of the Northern Wild Sheep and Goat Council (Vol. 18, pp. 122-135)." 2012 "We visited each study site twice in 2011, during the growing season: once in the early summer (June–early July) and once in the late summer (late July–August). During each sampling occasion, we collected fresh mountain goat pellets and compared vegetation diversity and abundance between locations where goats were observed feeding ("feeding locations") and randomly selected areas in the alpine ("available locations"). [...] Forage cover and habitat predictors differed between study sites, according to Mann-Whitney U tests (Table 3). Hidden Terror (introduction site) had lowest forage diversity ($P < 0.01$) and the least long-awned sedge, moss, grass, fern, and moss cover. Alternatively, Uyak (highest mountain goat densities) had the highest forage diversity ($P = 0.01$) and the most long-awned sedge cover ($P < 0.01$). Hepburn (lowest mountain goat densities and most recently colonized) had more moss cover than other study sites ($P = 0.02$). [...] Although the irruptive growth of Kodiak's goats may have led to the observed differences in forage, as documented in introduced ungulate populations elsewhere (Caughley 1970), we cannot completely rule out that observed differences in vegetation diversity and cover among study sites may have existed prior to the arrival of goats because the composition of plant communities prior to goat colonization is unknown. The study site with the highest mountain goat density on Kodiak (Uyak) also had the highest forage diversity and the most forage cover, for all forage classes except mosses and rushes." Grazing/herbivory/browsing Direct *Carex macrochaeta*; *Carex stylosa*; *Geranium erianthum*; *Lupinus nootkatensis*; *Juncus* spp.; *Luzula* spp.; *Alopecurus* spp.; *Calamagrostis* spp.; *Poa* spp.; *Hordeum* spp.; *Hierochloa* spp.; *Phleum* spp.; Ferns Plantae MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated). The study might also not have allowed to detect an impact on the native population (there might have been initial differences between the different sites, which would not have allowed to detect a decline)." Kodiak Island Kodiak Archipelago (Alaska) United States North America North and Central America "No impact has been reported on the native plant species listed as being part of the alien diet (this only shows potential for impact, but we cannot infer that the individuals are suffering from being grazed)." LV August 2019 LS February 2020

Oreamnos americanus Bovidae Cetartiodactyla "Flesch, E. P. (2013). Population trends of bighorn sheep and mountain goats in the Greater Yellowstone Area. In MSU Student Research Celebration 2012." 2013 "We used the historical data to determine if ln-linear regression results supported the hypothesis that sympatry of mountain goats with bighorn sheep adversely affects bighorn sheep herd growth rates. Since the mean of sympatric bighorn sheep herd growth rates ($\bar{x} = 1.05$, $\text{stdev} = 0.08$, $n = 16$) was similar to and higher than that of allopatric herds ($\bar{x} = 0.99$, $\text{stdev} = 0.06$, $n = 10$), individual herd ln-linear regression results did not support this hypothesis. The aggregation of sympatric and allopatric counts to estimate an overall growth rate for each herd type also did not provide conclusive evidence for lower sympatric growth rates. The aggregated growth rate of sympatric herds, 1.05 (95% C.I. = 1.03, 1.06; $P < 0.01$), was higher than the growth rate of allopatric herds during a similar time period, $\bar{x} = 1.02$ (95% C.I. = 1.00, 1.03; $P < 0.05$). The difference in growth rates is in the opposite direction than predicted by the competition hypothesis. These results are likely not a result of sympatry, but are due to other factors that influence large herbivore ecology and are confounded by geographic clustering of allopatric and sympatric herds. These factors might include regional differences in weather/climate conditions, geology, and soil fertility. The necessity to incorporate interpolations in growth rate estimations is a limitation to this analysis, but similarity between the mean individual herd growth rates and the aggregated growth rate for each herd type suggests this method produced reasonable results." Transmission of diseases; Competition Indirect *Ovis canadensis* Animalia MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Greater Yellowstone Area Wyoming United States North America North and Central America LV August 2019 LS February 2020

Oryx gazella Bovidae Cetartiodactyla "Bender, L.C., Li, H., Thompson, B.C., Morrow, P.C., Valdez, R., 2003. Infectious disease survey of gemsbok in New Mexico. *Journal of Wildlife Diseases* 39 (4), 772–778.; Burkett, D.W., Valdez, R., Thompson, B.C., Boykin, K.G., 2002. Gemsbok: the management challenge of an exotic ungulate in the American Southwest. In: Ebedes, H., Reilly, B., van Hoven, W., Penzhorn, B. (Eds.), *Sustainable Utilization Conservation in Practice. Proceedings of the Fifth Wildlife Ranching Symposium*. South African Game Rancher's Organization, Pretoria, South Africa, pp. 166–171.; Hoenes, B. D., & Bender, L. C. (2010). Relative habitat-and browse-use of native desert mule deer and exotic oryx in the greater San Andres Mountains, New Mexico. *Human–Wildlife Interactions*, 4(1), 4." 2003 "[Bender et al. 2003] Concurrent with expansion of gemsbok was a decline in native ungulates, particularly desert

mule deer (*Odocoileus hemionus crooki*) and the state-designated en-dangered desert bighorn sheep (*Ovis can-adensis mexicana*) (Burkett et al., 2002). [...] Anecdotal evidence suggests that dramatic population declines coincided with large increases in gemsbok population densities and expansion of gemsbok range. [...] We surveyed gemsbok in 2001 for exposure to a variety of diseases potentially important for native ungulates. High seroprevalence was found for malignant catarrhal fever virus (49 [98%] of 50 sera; 43 [96%] of 45 plasma samples), blue-tongue virus (48 [96%] of 50), bovine respiratory syncytial virus (33 [66%] of 50), and parainfluenza-3 virus (10 [20%] of 50). Low numbers of *Nematodirus* spp. eggs in a few individuals were the only parasites detected in gemsbok. Exposure to the above diseases in gemsbok is of interest to managers because of potential implications for recovery of desert bighorn sheep (*Ovis canadensis mexicana*) and desert mule deer (*Odocoileus hemionus crooki*) in the White Sands area because each has been implicated in mortality in these species either in the White Sands area or elsewhere in the western/southwestern United States.; [Hoenes and Bender 2010] Of concern to local managers were declines in desert mule deer (*Odocoileus hemionus crooki*; Figure 2) during this same time period and whether declines were related to the increase of oryx (*P. Morrow*, WSMR, personal communication). [...] Although declines in mule deer numbers paralleled increases in the number of oryx, a cause-and-effect relationship associated with competitive exclusion given present distribution of the 2 species was not supported based on relative patterns of habitat-use or browse levels of key species in the San Andres Mountains, which were low (<4%). This did not preclude a competitive impact in the past, although we feel that this was unlikely because the higher elevation habitat types most used by deer in the San Andres Mountains were the last colonized by oryx. Oryx in these higher elevation areas had only recently (i.e., after the significant declines in mule deer) become abundant. However, other factors, such as persistent drought and disease (Bender et al. 2006), may have negatively affected mule deer but not oryx. [...] oryx-use accounted for the majority of browse-use in 2 of 3 habitat types that had a significant browse component, indicating that oryx and mule deer may compete for similar resources, especially because key browse species are relatively rare in the San Andres Mountains (Hoenes 2008).]" Competition Indirect *Odocoileus hemionus crooki*; *Ovis canadensis mexicana* Animalia MO Low "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, because the native population(s) might not be declining (no decline in the native population was observed in this article and we could not access the primary source reporting the decline (Burkett et al. 2002)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (transmission of the viruses/parasites found in alien individuals to native individuals has not been shown (Bender et al. 2003), and interference competition is not likely to occur (Hoenes and Bender 2010))" White Sands Missile Range New Mexico United States North America North and Central America Burkett et al. (2002): Described the negative correlation between the alien and native populations; Bender et al. (2003): Testing the mechanism through which the alien could have lead to the decline of the native (transmission of disease); Hoenes and Bender 2010: Testing the mechanism through which the alien could have lead to the decline of the native (interference competition); Burkett et al. (2002) is inaccessible. LV July 2019 LS February 2020

Oryx gazella Bovidae Cetartiodactyla "Cain III, J. W., Avery, M. M., Caldwell, C. A., Abbott, L. B., & Holechek, J. L. (2017). Diet composition, quality and overlap of sympatric American pronghorn and gemsbok. Wildlife Biology, wlb-00296." 2017 "Severe drought occurred between 2010 and 2011, which allowed us to evaluate drought impacts on diet composition, quality, and overlap. Using feces collected from each species, we assessed diet composition and overlap with microhistological analysis and diet quality using fecal nitrogen (FN) and fecal 2,6-diaminopimelic acid (FDAPA). [...] Diet quality for pronghorn decreased significantly during summer drought (i.e. FN and FDAPA decreased 26% and 27%), yet drought had little effect on dietary quality for gemsbok. In addition, diet overlap was substantially higher than previously reported, particularly during the summer drought period. [...] Unlike the results of Smith et al. (1998), we found overlap was 0.44–0.49 between these two ungulates, a level we considered biologically meaningful for pronghorn. [...] Diet quality is an important indicator of the health of wildlife populations that can be monitored through fecal indices (Gates and Hudson 1981, Holechek et al. 1982b, Robinson et al. 2001). During the warm–dry season of 2010, FN and FDAPA values in the pronghorn diet was likely related to the consumption of forbs. McDonald (2005) compared dietary quality of pronghorn throughout similar environments in the southwestern US and reported FN values (0.86–1.60%) similar to those reported in this study (0.31–1.99%). In contrast, McDonald (2005) reported FDAPA values that were substantially higher (0.82–1.80 mg g⁻¹) than ours (0.31–0.44 mg g⁻¹) which were below values deemed necessary to support reproduction in pronghorn." Competition Indirect *Antilocapra americana* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (the impact on the reproduction has not been directly observed, but inferred from FDAPA (fecal 2,6-diaminopimelic acid) values of the diet of the native species)." White Sands Missile Range New Mexico United States North America North and Central America The study did not allow to know whether an impact occurred on the plant species composing the diet of the alien (so no impact through grazing has been recorded). LV July 2019 LS February 2020

Ovis aries Bovidae Cetartiodactyla "Harrington, G. (1979). The effects of feral goats and sheep on the shrub

[weed] populations in a semi-arid woodland [Queensland, New South Wales]. Australian Rangeland Journal (Australia).1(4):334-345." 1979 "These results confirm that shrubs are still increasing in density in the Cobar region of New South Wales, even where shrub densities are as high as 6000/ha. In this experiment moderate sheep grazing only significantly reduced the establishment of *A. aneura* and *D. viscosa*; all other species were either unaffected or, as in the case of *G. parviflora* and *E. bowmanii*, actually increased. As *G. parviflora* is a small tree with dense foliage the recorded increase of 27/ha would have considerable implications for future competition with herbage species. [...] Sheep browsed only lightly during the experimental period (Harrington 1978) and confined their attentions to *A. aneura* and *D. viscosa*. They were not apparently responsible for the death of any bushes nor did they greatly affect the overall leaf biomass of shrubs." Grazing/herbivory/browsing Direct *Acacia aneura*; *Dodonaea viscosa* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration and adult survival were investigated)." New South Wales Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Walter, H. S., & Levin, G. A. (2008). Feral sheep on Socorro Island: facilitators of alien plant colonization and ecosystem decay. Diversity and Distributions, 14(2), 422-431." 2008 "We visited Socorro Island on 10 different occasions between 1987 and 1996 [...] The Socorro parakeet (*Aratinga brevipes*) has declined, and four small songbirds have disappeared or declined in sheep-impacted habitats. [...] The population decline of the Socorro mockingbird (*Mimus graysoni*) is perhaps the best example of a species increasingly stressed by Socorro's ecosystem degradation. To persist over evolutionary time, its population must have numbered in the thousands. It was still an abundant species in 1954 (Medina, 1978) and 1958 (Villa, 1960). Some human trapping and the sheep-induced landscape alteration appear to have eliminated this endemic taxon from the entire southern third of Socorro. In July 1988, a small remnant population was discovered in the forest groves near the trailhead at 500 m elevation (Wehtje et al, 1993). This population gradually diminished during our observation period (1988-96) as its habitat continued to deteriorate under a steady impact of sheep presence: lack of ground cover, deadwood, and absence of shrubs and young trees with their flowers, seeds, and insects created unsuitable structural and functional ecological niche factors (pers. obs.). By 1996, all *Mimus graysoni* had vanished from these mid-elevation groves. A significant but small breeding population of this characteristic bird of Socorro remains in the sheep-free dwarf forests of Cerro Evermann and in the matorral thickets of the northern slopes (Ceballos & Márquez-Valdelamar, 2000, J. Martínez-Gómez, pers. comm.)." "Chemical, physical or structural impact on ecosystems" Indirect *Mimus graysoni*; *Aratinga brevipes* Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (human activities and cat predation)" Socorro Island Revillagigedo Islands Mexico Mesoamerica North and Central America "The impact of the sheep as facilitators of alien plant colonization has not been classified, as the effect of this on native biota has not been investigated in this study." LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Walter, H. S., & Levin, G. A. (2008). Feral sheep on Socorro Island: facilitators of alien plant colonization and ecosystem decay. Diversity and Distributions, 14(2), 422-431." 2008 "Significant parts of the south-eastern half of Socorro (Fig. 3) have been transformed into savanna and prairie-like open habitats that are covered by a mix of native and exotic vegetation today (see Fig. S4b in Supplementary Material) surrounded by severe sheet and gully erosion. [...] Aerial and ground surveillance of the island terrain have documented the presence of large barren hilltops and slopes of brown soil and dark rock substrate. Ground surveys and regular in situ observations of sheep grazing and browsing [...] The majority of the remaining woody areas on the south-eastern half surveyed by us exhibited severe sheep impact beneath the canopy: there was a definite browse line where branches and aerial shoots and roots had been bitten off (see Fig. S4a in Supplementary Material) and there were many dead trees. [...] The sheep cleared the dense understorey herb layer of the endemic *Acalypha umbrosa* Brandege, then nibbled at roots, aerial shoots, the bark of stems, and even litter and deadwood (see Fig. S4a in Supplementary Material). [...] The final transects were censused in woodland dominated by *Ficus cotinifolia* (transect 12) and a rocky scrub dominated by *Dodonaea angustifolia* (Benth.) Sherff (transect 13). The former had been badly damaged by the sheep, allowing the establishment of many invasive plants.

" Grazing/herbivory/browsing Direct *Ficus cotinifolia*; *Bumelia socorrensis*; *Guetterda insularis*; *Acalypha umbrosa*; *Dodonaea angustifolia* Plantae MN Medium The alien might cause a decline in the native population size (it is not clear if the alien is causing local disturbance or general disturbance). Socorro Island Revillagigedo Islands Mexico Mesoamerica North and Central America "The impact of the sheep as facilitators of alien plant colonization has not been classified, as the effect of this on native biota has not been investigated in this study." DJ March 2019 LV June 2019

Ovis aries Bovidae Cetartiodactyla "Jehl, J.R. Jr & Parkes, K.C. (1983) 'Replacements' of landbird species on Socorro Island, Mexico. The Auk, 100,551-559." 1983 "Sheep were introduced on Socorro in 1869 and are still abundant. Although parts of the island appear severely overgrazed, creating new, open field environments that were probably not present a century ago, the impact of the sheep on the endemic avifauna has been minimal, as there was no apparent

change in either abundance or wariness of birds from Grayson's time through 1958. Soldiers are permitted to hunt feral sheep in many parts of the island, even to the crest of Mount Evermann, but do not disturb birds during their hunting trips, and we certainly have no reason to implicate either the sheep or their hunters in the decline of the dove and the mockingbird. [...] On Socorro, as we have shown, reduction of the endemic avifauna is not related to the limited habitat disturbance created by sheep. On the other hand, both the Northern Mockingbird and Mourning Dove chiefly inhabit those areas that have been most heavily grazed. Thus, the sheep may have created suitable habitat for the invaders, resulting in additions to the avifauna but without any correlated loss." "Chemical, physical or structural impact on ecosystems"

Indirect *Mimus graysoni*; *Zenaidura macroura* Animalia MC Low "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (the absence of a decline in the native population(s) was inferred and not directly tested, and whether the alien population impacted the performance of native individuals was not investigated)." Socorro Island Revillagigedo Islands Mexico Mesoamerica North and Central America LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. *Biological Conservation*, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The 'akiap'au (*Hemignathus munroi*), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i 'amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual m'mane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect *Hemignathus virens virens* Animalia MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis aries Bovidae Cetartiodactyla "Van Vuren, D. H. (2013). Avian response to removal of feral sheep on Santa Cruz Island, California. *The Wilson Journal of Ornithology*, 125(1), 134-139." 2013 "I censused birds in an open shrub/grassland habitat on Santa Cruz Island, California, in 1980 and again in 2008, 24 years after feral sheep were removed, in order to assess avian responses to vegetation changes resulting from sheep removal. [...] Density of overstory shrubs had increased dramatically, the browse-line was gone, and low-growing shrubs were common, including some species that were rare or absent in 1980 such as Santa Cruz Island buckwheat (*Eriogonum arborescens*) and deerweed (*Acmispon dendroideus*). Shrubs that had germinated since 1980 had reached 2–3 m in height."

Grazing/herbivory/browsing Direct *Eriogonum arborescens*; *Acmispon dendroideus* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it (anecdotal evidence, no monitoring of the native population)." "The impact might be lower, because the native population(s) might not be declining (anecdotal evidence: the aim of the study was not to investigate the impact on the shrub populations)" Santa Cruz Island California United States North America North and Central America DJ March 2019 LV June 2019

Ovis aries Bovidae Cetartiodactyla "Van Vuren, D. H. (2013). Avian response to removal of feral sheep on Santa Cruz Island, California. *The Wilson Journal of Ornithology*, 125(1), 134-139." 2013 "I censused birds in an open shrub/grassland habitat on Santa Cruz Island, California, in 1980 and again in 2008, 24 years after feral sheep were removed, in order to assess avian responses to vegetation changes resulting from sheep removal. [...] Four species increased in density in both lightly and moderately impacted areas. Hutton's Vireos (*Vireo huttoni*), Orange-crowned Warblers (*Oreothlypis celata*), and Spotted Towhees (*Pipilo maculatus*) were not detected in 1980, and Blue-gray Gnatcatchers (*Poliophtila caerulea*) were present then at low densities, but by 2008 these four species included some of the more common species in the study. Three species increased in density, but only in one portion of the study area. Bushtits (*Psaltir- parus minimus*) and Lazuli Buntings (*Passerina amoena*) were not detected in 1980 but were common in the light-impact area in 2008. Barn Swallows (*Hirundo rustica*) increased in density in 2008 but only in the moderate-impact area. [...] Rufous-crowned Sparrows declined substantially in the light-impact area from 1980–2008, and increased to a modest density in the moderate-impact area in 2008 after not being detected there in 1980. [...] Growth of vegetation 24 years after removal of feral sheep resulted in substantial changes to habitat structure in the study area. [...] In general, birds seemed to respond accordingly. Species richness remained the same in the light- impact area but more than doubled in the moderate-impact area, probably reflecting the greater degree of habitat recovery there. However, both lightly and moderately impacted areas showed substantial changes in the bird community between 1980 and 2008. Several species appeared to

benefit from vegetation recovery." "Chemical, physical or structural impact on ecosystems" Indirect *Pipilo maculatus*; *Vireo huttoni*; *Oreothlypis celata*; *Polioptila caerulea*; *Psaltiripatus minimus*; *Passerina amoena*; *Hirundo rustica*; *Aimophila rustica* Animalia MO Medium "The impact might be lower, because the native population(s) might not be declining (the density of native birds is studied in a small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Santa Cruz Island California United States North America North and Central America LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Van Vuren, D. H. (2015). Shrub regeneration after removal of feral sheep from Santa Cruz Island, California. California fish and game, 100(3), 396-403." 2015 "All short-stature shrubs increased in density, especially island deerweed (*Acmispon dendroideus*) and Santa Cruz Island buckwheat (*Eriogonum arborescens*). Most tall-stature shrubs showed major increases in density as well, especially island big- pod ceanothus, mountain mahogany, island redberry (*Rhamnus pirifolia*), and lemonade berry, but some shrubs did not. [...] Island deerweed and northern island hazardia (*Hazardia datonsa*) were two other short-stature shrubs that were absent in transects in 1980 but present or even abundant in 2013 [...] In contrast, Santa Cruz Island buckwheat (*Eriogonum arborescens*) and coastal sagebrush (*Artemisia californica*), two species considered vulnerable to sheep grazing (Coblentz 1978, Brumbaugh 1980, Minnich 1980), increased from absent to abundant on one or both transects. [...] Results from the two strip transects were generally consistent. During the 29 years after removal of feral sheep, total density of shrubs increased dramatically, from 210-246/ ha in 1980 to 666-1148/ha in 2013. Species richness increased as well, from 8 species in each transect in 1980 to 14-15 species in 2013 (Table 1). These data do not include shrub seedlings <1 m tall, which were largely absent in transects in 1980 and too abundant to count in 2013. [...] My results indicate that 29 years after sheep removal, shrubs on Santa Cruz Island have shown remarkable regeneration, with a three- to four-fold increase in total density and a near-doubling of species richness. Further, many of the shrubs that increased are insular endemic taxa (Junak et al. 1995), which are of conservation concern. " Grazing/herbivory/browsing Direct *Cercocarpus betuloides*; *Rhus integrifolia*; *Hazardia detonsa*; *Eriogonum arborescens*; *Artemisia californica*; *Acmispon dendroideus*; *Ceanothus megacarpus insularis*; *Rhamnus pirifolia* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Santa Cruz Island California United States North America North and Central America LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Van Vuren, D., & Coblentz, B. E. (1987). Some ecological effects of feral sheep on Santa Cruz Island, California, USA. Biological conservation, 41(4), 253-268." 1987 "Avian density and species richness in a lightly impacted chaparralgrassland community were more than twice as high as in an adjacent, moderately impacted area (Table 3). These differences were reflected in a greater bird species diversity in the lightly impacted area. Fifteen of 18 species identified during censuses were recorded in higher numbers in the lightly impacted area. Six species are insular endemics; sheep grazing was associated with an average 63% reduction in their densities. Sheep probably affected birds by altering plant community structure through depletion of the herbaceous layer, defoliation of the lower branches of shrubs, and reduction of shrub density. This assertion is supported by densities of ground-nesting species, which averaged 134 birds km⁻² in the area of light sheep impact but were completely absent in the adjacent area of moderate sheep impact. " "Chemical, physical or structural impact on ecosystems" Indirect *Aphelocoma coerulescens insula*; *Aimophila ruficeps obscura*; *Spizella passerina*; *Pipilo erythrophthalmus megalonyx*; *Thryomanes bewickii nesophilus*; *Calypte anna*; (other insular endemic birds (6 taxa-not specified) and ground nesters (4 taxa not specified)) Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (too small spatial and temporal scales); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (only the negative correlation of abundances is used to infer a causal effect)" Santa Cruz Island California United States North America North and Central America LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Van Vuren, D., & Coblentz, B. E. (1987). Some ecological effects of feral sheep on Santa Cruz Island, California, USA. Biological conservation, 41(4), 253-268." 1987 "Exclusion of sheep from a *Prunus ilicifolia* shrub for 3 months resulted in a dense growth of basal sprouts, some more than 30cm long [...] 42% of shrubs browsed bipedally were insular endemics (*Rhamnus pirifolia*, *Ceanothus megacarpus insularis*) which comprised only 16% of 231 shrubs counted in strip transects. [...] A severely impacted grassland community was characterised by reduced herbaceous cover and increased exposure of soil. [...] A reduction in height and upper-layer cover of grasses, coupled with an increase in upper-layer cover but no change in height of forbs, suggests that heavy grazing removed grasses and exposed lower-growing forbs beneath. [...] The combined effects of defoliation and trampling damage has resulted in moderate to severe impact of about one-half of the island. Sheep altered a grassland community by reducing the cover of herbaceous vegetation, denuding the soil, altering community structure, and reducing the litter which promotes subsequent growth (Table 2). These effects were probably even more pronounced during the dry season. Sheep changed growth form of at least one shrub by consuming all foliage within reach, an impact which was worsened by their ability to browse on their hind legs. Long-term implications of complete defoliation of low-growing shrubs and the prevention of regeneration

through seedlings and basal sprouts are serious. " Grazing/herbivory/browsing Direct Grasses and forbs (not specified); *Prunus ilicifolia*; *Rhamnus pirifolia*; *Ceanothus megacarpus insularis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (too small spatial and temporal scales, and the study did not focus on the species level (grasses and forbs in general), making it difficult to understand which species are affected, and how)) " Santa Cruz Island California United States North America North and Central America LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Wood, G. W., Mengak, M. T., & Murphy, M. (1987). Ecological importance of feral ungulates at Shackleford Banks, North Carolina. *American Midland Naturalist*, 236-244." 1987 "Grazing impact was measured by comparing estimated weights of aboveground current annual growth (AGCAG) on grazed and ungrazed plots. AGCAG was defined as aboveground shoots and foliage produced in the current growing season and existent at the time of sampling [...] Three exclosures, each 0.04 ha, were erected in each of the vegetation types in March 1978. [...] All exclosures plus adjacent paired grazed plots were sampled in late August to early September 1978 through 1981. [...] The data obtained in this study indicate that the ungulate populations at their 1978- 1981 levels were interrupting the vegetation dynamics in at least the saltmarsh and grass-shrub communities. Extensive consumption of plant material by large vertebrates is not a natural process in local saltmarsh communities. On the other hand, *Spartina alterniflora* is the climax vegetation of the saltmarsh, and this species has no competitor that might replace it under extreme grazing pressure. In addition, these sites are re- plenished with water and nutrients with each tide; therefore, major deterioration in site potential to support vegetative growth is unlikely. In the grass-shrub community, the primary effect of grazing appears to be a reduction in rate of succession from a grass stage to a *Myrica cerifera* shrub thicket stage. Succession was occurring on both grazed and ungrazed sites, but it was more rapid on the latter. The structural changes occurring in this plant community were not only important in terms of the natural plant dynamics but also in terms of the ability of the island to support grazing animals." Grazing/herbivory/browsing Direct *Andropogon* spp; *Spartina alterniflora*; *Spartina patens*; *Salicornia bigelovii*; *Hydrocotyle bonariensis*; *Uniola paniculata*; *Hydrocotyle bonariensis*; *Myrica cerifera* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (changes in the aboveground biomass between grazed and ungrazed plots have been detected, but this does not allow to conclude to a decline in the population size)." "The impact might be lower, because the performance of native individuals might not be affected (contradictory results from 1 year to the other, and from one vegetation type to the other)." Shackleford Banks Carolina United States North America North and Central America LS January 2018 LV March 2019

Ovis aries Bovidae Cetartiodactyla "Scowcroft, P. G., & Giffin, J. G. (1983). Feral herbivores suppress mamane and other browse species on Mauna Kea, Hawaii. *Journal of Range Management*, 638-645." 1983 "Abundance, survival, and growth of *Mamane* (*Cycosphylla*) regeneration were determined inside and outside sheep exclosures located in heavily browsed portions of the mamane forest of Mauna Kea, Hawaii. [...] Hawaiian bent (*Agrostis sandwicensis*), he'u-pueo (*Trisetum glomeratum*), and *Deschampsia australis*, an endemic shrub-aheahea (*Chenopodium oahuense*), and an introduced forb-gosmore (*Hypochoeris radicata*)-were susceptible to browsing. [...] Results indicate that feral sheep browsing suppresses regeneration of mamane. Three other endemic species, Hawaiian bent, he'u-pueo, and aheahea, are also suppressed. Other preferred browse species were either not significantly affected by browsing or the data for them were inadequate to evaluate. [...] After 15 years, more mamane plants were growing inside the exclosures than outside. In 1979, 886 individual mamane plants were growing within the Puu Nanaha and 588 within the Puu Kale exclosure. Outside, the tallies were 24 mamane for Puu Nanaha and 93 for Puu Kale, excluding pre-exclosure trees. Of the mamane outside, 33% for Puu Nanaha and 71% for Puu Kale were recent emergents and never browsed. Inside Puu Nanaha and Puu Kale, the mamane height class distributions displayed the characteristic reverse-J shape of an actively reproducing stand (Fig. 2). Outside, only two disjunct classes were represented-less than 0.6 m and greater than 2.6 m tall. The small size class included new emergents and suppressed plants hidden among rock rubble. The large size class included only old pre-exclosure trees. At Kaluamakani, 785 individual mamane were growing inside, but only 10 outside in 1981. All individuals outside were preexclosure trees. Of the mamane that had developed inside since fencing, 47% were seedlings <0.1 m tall. All of these seedlings were found in leaf litter under pre-exclosure trees. The height class distributions were similar to those at Puu Nanaha and Puu Kale." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Agrostis sandwicensis*; *Trisetum glomeratum*; *Deschampsia australis*; *Chenopodium oahuense* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America "The same native population as in Scowcroft and Sakai (1983) is studied, but differently." LS January 2018 DJ; LV March 2019

Ovis aries Bovidae Cetartiodactyla "Scowcroft, Paul G., and Howard F. Sakai. "Impact of feral herbivores on mamane forests of Mauna Kea, Hawaii: bark stripping and diameter class structure." *Journal of Range Management* (1983): 495-498." 1983 "This study determined the intensity of bark stripping of mamane (*Sophora chrysophylla*), a small endemic leguminous tree, by these animals and assessed the impact of their browsing on the size class structure of

mamane stands [...] At higher elevations the distributions indicated that sprout and seed ling regeneration have been suppressed, completely so near tree line. Sheep and goats were undoubtedly responsible. [...] In the present case, feral sheep and goats suppress mamane regeneration in some areas of the Mauna Kea Forest Reserve, thus altering the forest structure. Prolonged suppression could further endangering the Palila by reducing the size of the forest." Grazing/herbivory/browsing Direct *Sophora chrysophylla* Plantae MN Medium "The alien might cause a decline in the native population size, by preventing its regeneration (no declining trend of the native population size was detected, but the alien might be preventing the increase of the native population by preventing its regeneration)." "It is unlikely that the impact is lower (even though there are multiple alien species, it is likely that each of them is affecting the regeneration of the individuals (performance))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America "The same native population as in Scowcroft and Giffin (1983) is studied, but differently." DJ July 2017 LV June 2019

Ovis aries Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. *Biological Conservation*, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The ?akiap?l?au (Hemignathus munroi), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i ? amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual m?mane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect Hemignathus munroi Animalia MR Low "The detected local extinction(s) might be irreversible, but the reversibility of the changes has not been tested." "The impact might be lower, if the native population(s) is/are not locally extinct (trends in the species populations are well monitored, but it is difficult to be sure of the local extinction with this experimental setup); if the alien did not cause the detected local extinction(s) (it is the effect of the droughts that is mainly tested and not the effect of browsing by the alien; and it is not clear which alien is present (it is only mentioned ""sheep""))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The alien is increasing the impact of droughts (combination of the two stressors). LV October 2019 LS February 2020

Ovis aries Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. *Biological Conservation*, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The ?akiap?l?au (Hemignathus munroi), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i ? amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual m?mane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect *Loxioides bailleui*; *Chasiempis sandwichensis*; *Himatione sanguinea*; *Vestiaria coccinea* Animalia MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (it is the effect of the droughts that is mainly tested and not the effect of browsing by the alien)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The alien is increasing the impact of droughts (combination of the two stressors). LV October 2019 LS February 2020

Ovis aries Bovidae Cetartiodactyla "Hess, S. C., Banko, P. C., Brenner, G. J., & Jacobi, J. D. (1999). Factors Related to the Recovery of Subalpine Woodland on Mauna Kea, Hawaii 1. *Biotropica*, 31(2), 212-219." 1999 "We measured mature tree and sapling density, tree associations, crown size, age structure, recovery from ungulate browsing, and grass cover at four study sites in two types of subalpine woodland on Mauna Kea volcano, island of Hawaii. Beginning in 1981, introduced ungulates were reduced in number to allow regeneration of *Sophora chrysophylla* (mamane) in habitat supporting the endangered Hawaiian finch, *Loxioides bailleui* (palila). We found *Sophora* regen- eration at all four study sites, but regeneration was higher in mixed species woodland with codominant *Myoporum sandwicense* (naio) than in areas

where *Sophora* dominated. Regeneration of *Myoporum* was uniformly very low in comparison. Invasive grass cover, which suppresses *Sophora* germination, was highest in mid-elevation woodland where *Sophora* dominated. The distribution of mature and sapling *Sophora* were both related to study site, reflecting previous ungulate browsing and uneven recovery due to grasses. Densities of *Sophora* snags were not different among any of the sites, suggesting a more even distribution in the past. Selective browsing before ungulate reduction may have favored *Myoporum* over *Sophora*, leading to high densities of mature *Myoporum* in codominant woodland. After ungulate reduction, however, we found no pattern of competitive inhibition by *Myoporum* on regeneration of *Sophora*. [...] There was no detectable browse damage on *Sophora* on the upper and mid-elevation sites. In the lower site, 11 of 13 (85%) mature trees and 11 of 13 saplings had browse damage. The bark of many young *Sophora* and *Myoporum* trees was stripped off; there was evidence of browsing on *Sophora* leaves, but no evidence of browsing on *Myoporum* leaves." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Myoporum sandwicense* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (browse damages have been described (bark removal), which probably lead to a higher susceptibility of individuals to other stressors, but this has not been shown); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (there are four other species of introduced herbivores)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The potential impact on *Loxioides bailleui* has not been recorded. LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. *Biological Conservation*, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The 'akiap'au (*Hemignathus munroi*), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i 'amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual m'mane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect *Hemignathus virens virens* Animalia MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Powell, E. A. (1992). Population Size and Frequency of Branching in the Eke Silversword, *Argyroxiphium caliginis* (Asteraceae), on Eke Crater, West Maui, Hawaii." 1992 "The largest Ka'u silversword population, which is located on Kahuku Ranch, Hawaii Island, has declined rapidly from a "magnificent colony" of "several thousand plants" in 1974 (Degener et al. 1976) to an estimated population size of less than 2000 individuals in 1984 (unpublished data). This species has suffered greatly from browsing by mouflon sheep and has been proposed for listing as an endangered species (U.S. Fish and Wildlife Service 1990)." Grazing/herbivory/browsing Direct *Argyroxiphium kauense* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the description of the effect on the native population is based on unpublished data and on an inaccessible source (Degener 1976), so we have no information on the way the observations were performed); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (no information on how the responsibility of the alien in the decline has been established: the alien is cited as one of the stressor causing the decline, but no direct quantification of the impact of the alien has been done)" Island of Hawai'i Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Robichaux, R., Bergfeld, S., Bruegmann, M., Canfield, J., Moriyasu, P., Rubenstein, T., ... & Warshauer, F. (2001). Reintroducing Hawaii's silverswords. *Endangered Species Update*, 18(3), S22-S22." 2001 "The Mauna Loa silversword (*Argyroxiphium kauense*) suffered a similar fate. Historically, this species was common in moist to wet ecosystems between 5,000 and 8,900 feet (1,500 and 2,700 m) on Mauna Loa and Hualalai volcanoes. Following the introduction and spread of pigs, mouflon sheep, and other alien ungulates, however, the Mauna Loa silversword suffered a severe decline. The surviving individuals, numbering fewer than 1,000 plants, are confined to three small natural populations widely scattered across Mauna Loa. In addition to direct threats from alien ungulates, Mauna Kea and Mauna Loa silverswords may face serious indirect threats from alien insects, especially ants and wasps.

These alien predators have the potential to decimate populations of native bees and moths that serve as pollinators, thereby greatly limiting seed set in silverswords. [...] The major threat to the recovery of silverswords (and many other endangered plant species in Hawaii) continues to be alien ungulates. Even at low numbers, these animals can have severe impacts. On the upper slopes of Mauna Kea, for example, where alien ungulate populations have been greatly reduced by a court-ordered removal program, browsing still caused significant seedling mortality, and serious damage to adult silverswords, at some of the outplanting sites in 1999." Grazing/herbivory/browsing Direct *Argyroxiphium kauense*; *Argyroxiphium sandwicense* ssp. *Sandwicense* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the information source is unclear and the experimental design is not described); or, of the native population(s) is/are declining, because the alien might not be the cause of the decline(s) (the alien is mentioned as one the current threats to the species survival among several threats, such as another alien ungulate, fire, alien plants, etc.);" Island of Hawai'i Hawaii Islands United States North America North and Central America "This study does not seem to contain any direct observation, but no reference is cited." LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Scott, J. M., Mountainspring, S., Ramsey, F. L., & Kepler, C. B. (1986). Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies in avian biology, (9)." 1986 "The limiting factors of Hawaiian forest birds fall into these general categories: habitat modification, predation, disease, interspecific competition, and major environmental perturbations. Aside from these, pesticide contamination from agricultural practices is a potential problem for Hawaiian Hawks, Short-eared Owls, and possibly Hawaiian Crows and waterbirds. The relative impact of different stresses varies among areas and species, and is conceptually depicted in Figure 319 for typical passerines on windward Hawaii (Fig. 320). [...] On Mauna Kea, mouflon extensively overbrowse mamane, especially at timberline, and have a damaging effect on native vegetation similar to that of feral sheep (Giffin 1982). Palila, Akiapolaau, Elepaio, and Common Amakihi populations on Mauna Kea are thus threatened with an uncertain future until mouflon are controlled, or preferably removed. In Kau the damage caused to native vegetation near timberline by a growing population of mouflon and other feral ungulates threatens the survival of the Akepa, which reaches its greatest densities in the ecotone between subalpine ohia woodland and alpine scrub. The Hawaiian Goose and Hawaii Creeper may also be adversely affected in this area." "Chemical, physical or structural impact on ecosystems" Indirect *Loxops coccineus* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (no long-term monitoring of the native populations (one time point); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the alien is mentioned as a threat to the native populations, but it is unclear how this has been established (probably direct observation of the alien browsing on the native species), and if it means that the alien is responsible of a decline in the population or in a potential future threat)" Kau (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Mehrhoff, L. (1993). Recovery Plan for the Hawaiian Gardenia. The Service." 1993 "Gardenia brighamii was federally listed as endangered on August 21, 1985 (Herbst 1985). [...] All populations are threatened by alien plant competitors, introduced herbivores, fire, and pathogens. [...] Populations of Axis deer and Mouflon sheep are the major threats to the Lanai populations. Goats, pigs, and cattle have been controlled by the landowner for almost half a century; however, high densities of both Axis deer and Mouflon sheep have not been eliminated. Three fenced, deer-proof exclosures have been erected in the Kanepuu population, each of which protects a single plant. The other 10 to 15 plants on the island are unprotected from intense herbivore pressure." Grazing/herbivory/browsing Direct *Gardenia brighamii* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no information on how the observations were performed: data on the current status of the native species populations obtained from personal communications); ; or, of the native population(s) is/are declining, because the alien might not be the cause of the decline(s) (the alien is cited as the major threat to the native species populations but whether the alien caused a decline is not clearly mentioned, many other threats are playing a role (other introduced ungulate, fire, pathogens, alien plant competitors))" Lanai'i Island Hawaii Islands United States North America North and Central America "This study does not seem to contain any direct observation, but no reference is cited." LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla US Fish and Wildlife Service. (1995). Lana'i Plant Cluster Recovery Plan. Lana'i Plant Cluster Recovery Plan. 1995 "Cattle, sheep, goats, and pigs were eventually eliminated from the island; however, axis deer and mouflon are still numerous and present serious threats to the Lana'i cluster taxa. Only about 10% or less of the island presently remains in native forest or shrubland. [...] The description and taxonomy of each Lana'i cluster plant will be discussed individually. Descriptions are based on the Federal Register documents designating each taxon as endangered (USFWS 1986a, 1986b, 1991; USFWS et al. 1992) . [...] Browsing and trampling by axis deer and mouflon. The habitat of *Santalum freycinetianum* var. *lanaiense* has been severely degraded by grazing and browsing of livestock and exotic game animals. Much of the native vegetation has been removed, increasing wind erosion of the fragile soils. Trampling may directly adversely affect individual *Santalum freycinetianum* var. *lanaiense* plants because of their shallow root systems, or indirectly through destruction of the host plants they depend on. There is a high browse line on the few

remaining trees. [...] Browsing and trampling by axis deer and mouflon. The habitat of *Tetramolopium remvi* has been severely degraded by grazing and browsing of livestock and exotic game animals. Much of the native vegetation has been removed, increasing wind erosion of the fragile soils. Axis deer and mouflon are both occasionally present in the vicinity of the only known population of this species. A single incident of grazing or trampling by these animals could easily destroy any or all of the few remaining individuals of this taxon." Direct physical disturbance; Grazing/herbivory/browsing; Indirect impact through interaction with other species Direct; Indirect *Santalum freycinetianum* var. *lanaiense*; *Tetramolopium remvi* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the information source is unclear and the way the observations were performed is not described); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the alien is mentioned as one the current threats to the species survival among several threats, such as another alien ungulate (*Axis axis*), fire, alien plants, etc.)" Lanai'i Island Hawaii IslandsUnited States North America North and Central America "This study does not seem to contain any direct observation, but no reference is cited." LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Scott, J. M., Mountainspring, S., Ramsey, F. L., & Kepler, C. B. (1986). Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies in avian biology, (9)." 1986 "The limiting factors of Hawaiian forest birds fall into these general categories: habitat modification, predation, disease, interspecific competition, and major environmental perturbations. Aside from these, pesticide contamination from agricultural practices is a potential problem for Hawaiian Hawks, Short-eared Owls, and possibly Hawaiian Crows and waterbirds. The relative impact of different stresses varies among areas and species, and is conceptually depicted in Figure 319 for typical passerines on windward Hawaii (Fig. 320). [...] On Mauna Kea, mouflon extensively overbrowse mamane, especially at timberline, and have a damaging effect on native vegetation similar to that of feral sheep (Giffin 1982). Palila, Akiapolaau, Elepaio, and Common Amakihi populations on Mauna Kea are thus threatened with an uncertain future until mouflon are controlled, or preferably removed. In Kau the damage caused to native vegetation near timberline by a growing population of mouflon and other feral ungulates threatens the survival of the Akepa, which reaches its greatest densities in the ecotone between subalpine ohia woodland and alpine scrub. The Hawaiian Goose and Hawaii Creeper may also be adversely affected in this area." "Chemical, physical or structural impact on ecosystems" Indirect *Loxioides bailleui*; *Chasiempis sandwichensis*; *Hemignathus munroi*; *Hemignathus virens* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (no long-term monitoring of the native populations (one time point)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the alien is mentioned as a threat to the native populations, but it is unclear how this has been established (probably direct observation of the alien browsing on the native species))" Mauna Kea volcano (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Scowcroft, P. G., & Conrad, C. E. (1992). Alien and native plant response to release from feral sheep browsing on Mauna Kea. Alien Plant Invasions in Native Ecosystems of Hawai'i: Management and Research, 625-665." 1992 "Data from Wailuku indicate that a similar native vegetation response can be expected on that side of the mountain if mouflon are eliminated. Both mamane and *Agrostis sandwichensis* reestablished at Wailuku in the absence of grazing and browsing. Neither species establishes where mouflon sheep can get to them. On the basis of these results and those of Scowcroft and Giffin (1983), we conclude that maintenance of mouflon sheep at 1986 population levels will prevent recovery of native species in those portions of the Mauna Kea Forest Reserve where the animals concentrate." Grazing/herbivory/browsing Direct *Agrostis sandwichensis*; *Sophora chrysophylla* Plantae MN Medium "The impact might be higher, if the alien is preventing the increase of the native population (it is not clear if the alien is currently preventing the increase of the native population, or if it might in the future (i.e. potential future threat))." Mauna Kea volcano (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America "This study is a follow-up study of the study from Scowcroft and Giffin (1983) (looking at the same exclosures, but later)" LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Scowcroft, P. G., & Giffin, J. G. (1983). Feral herbivores suppress mamane and other browse species on Mauna Kea, Hawaii. Journal of Range Management, 638-645." 1983 "Mouflon and goats are found primarily above 1,800 m, but damage has been limited because of their recent establishment in the forest and small populations (200 to 300 mouflon and 150 to 200 goats). [...] Browsing by feral sheep at Puu O Kauha, and by both feral and Mouflon sheep at Wailuku, was responsible for the reduced growth of unprotected sprouts. Similar comparisons for seedlings at these sites were not possible because none of the unprotected ones survived. [...] Another threat may interfere with the ultimate recovery of the mamane forest-Mouflon sheep and feral-Moutlon hybrids. These animals are being retained as a game species on Mauna Kea. Their food preferences are similar to those of feral sheep, with mamane being one of the most important items in their diet (Giffin 1981). The 2 species are also alike in their herding, behavior, and habitat use patterns. The Mouflon population density has increased to a point where mamane reproduction is being severely suppressed, especially in the area of tree-line. This problem can only be alleviated by drastically reducing herd size. The

number of Mouflon that can be managed without habitat damage has yet to be determined." Grazing/herbivory/browsing
 Direct *Sophora chrysophylla* Plantae MN Medium "The alien might cause a decline in the native population size, by preventing its regeneration (no declining trend of the native population size was detected, but the alien might be preventing the increase of the native population by preventing its regeneration)." It is unlikely that the impact is lower (the alien has been observed to affect the individual performance (regeneration) of native individuals). Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America "The same native population as in Scowcroft and Sakai (1983) is studied, but differently." LV October 2019 LS February 2020
Ovis orientalis Bovidae Cetartiodactyla "Scowcroft, Paul G., and Howard F. Sakai. "Impact of feral herbivores on mamane forests of Mauna Kea, Hawaii: bark stripping and diameter class structure." Journal of Range Management (1983): 495-498." 1983 "This study determined the intensity of bark stripping of mamane (*Sophora chrysophylla*), a small endemic leguminous tree, by these animals and assessed the impact of their browsing on the size class structure of mamane stands [...] At higher elevations the distributions indicated that sprout and seedling regeneration have been suppressed, completely so near tree line. Sheep and goats were undoubtedly responsible. [...] In the present case, feral sheep and goats suppress mamane regeneration in some areas of the Mauna Kea Forest Reserve, thus altering the forest structure. Prolonged suppression could further endangering the Palila by reducing the size of the forest." Grazing/herbivory/browsing
 Direct *Sophora chrysophylla* Plantae MN Medium "The alien might cause a decline in the native population size, by preventing its regeneration (no declining trend of the native population size was detected, but the alien might be preventing the increase of the native population by preventing its regeneration)." "It is unlikely that the impact is lower (even though there are multiple alien species, it is likely that each of them is affecting the regeneration of the individuals (performance))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America "(The authors compared different levels of grazing intensity, but the differences depended mainly on the number of sheep present (and not on the number of goat or mouflon present)). The same native population as in Scowcroft and Giffin (1983) is studied, but differently." LV October 2019 LS February 2020
Ovis orientalis Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. Biological Conservation, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The 'akiapuaea (*Hemignathus munroi*), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i 'amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual mamane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect *Hemignathus munroi* Animalia MR Low "The detected local extinction(s) might be irreversible, but the reversibility of the changes has not been tested." "The impact might be lower, if the native population(s) is/are not locally extinct (trends in the species populations are well monitored, but it is difficult to be sure of the local extinction with this experimental setup); if the alien did not cause the detected local extinction(s) (it is the effect of the droughts that is mainly tested and not the effect of browsing by the alien; and it is not clear which alien is present (it is only mentioned "sheep"))." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The alien is increasing the impact of droughts (combination of the two stressors). LV October 2019 LS February 2020
Ovis orientalis Bovidae Cetartiodactyla "Banko, P. C., Camp, R. J., Farmer, C., Brinck, K. W., Leonard, D. L., & Stephens, R. M. (2013). Response of palila and other subalpine Hawaiian forest bird species to prolonged drought and habitat degradation by feral ungulates. Biological Conservation, 157, 70-77." 2013 "Surveys of passerines during 1998–2011 in subalpine woodland habitat on Mauna Kea Volcano, Island of Hawai'i, revealed that the abundance of the critically endangered palila (*Loxioides bailleui*), a seed specialist, declined by 79% after 2003. The 'akiapuaea (*Hemignathus munroi*), an endangered specialist insectivore, was not detected in the survey area after 1998. The Hawai'i 'amakihi (*Hemignathus virens virens*), a generalist feeder and the most abundant species on Mauna Kea, was the only native species to maintain a stable population. The Japanese white-eye (*Zosterops japonicus*), a well-entrenched generalist and one of the three most common introduced species, declined. Drought prevailed in 74% of months during 2000–2011, and dry conditions contributed to the recent decline of the palila by reducing the annual mamane (*Sophora chrysophylla*) seed pod crop, which influences palila breeding and survival. Sustained browsing by introduced ungulates also lowered habitat carrying capacity, and their elimination should reduce the effects of drought and promote forest restoration. [See Table 1 for all the native impacted species]" "Chemical, physical or structural impact on ecosystems" Indirect *Loxioides bailleui*; *Chasiempis sandwichensis*; *Himatione sanguinea*; *Vestiaria coccinea* Animalia MO Low "The impact might be lower,

if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (it is the effect of the droughts that is mainly tested and not the effect of browsing by the alien). Unclear which alien is present (only mentioned ""sheep""). Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The alien is increasing the impact of droughts (combination of the two stressors). LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Hess, S. C., Banko, P. C., Brenner, G. J., & Jacobi, J. D. (1999). Factors Related to the Recovery of Subalpine Woodland on Mauna Kea, Hawaii 1. *Biotropica*, 31(2), 212-219." 1999 "We measured mature tree and sapling density, tree associations, crown size, age structure, recovery from ungulate browsing, and grass cover at four study sites in two types of subalpine woodland on Mauna Kea volcano, island of Hawaii. Beginning in 1981, introduced ungulates were reduced in number to allow regeneration of *Sophora chrysophylla* (mamane) in habitat supporting the endangered Hawaiian finch, *Loxioides bailleui* (palila). We found *Sophora* regeneration at all four study sites, but regeneration was higher in mixed species woodland with codominant *Myoporum sandwicense* (naio) than in areas where *Sophora* dominated. Regeneration of *Myoporum* was uniformly very low in comparison. Invasive grass cover, which suppresses *Sophora* germination, was highest in mid-elevation woodland where *Sophora* dominated. The distribution of mature and sapling *Sophora* were both related to study site, reflecting previous ungulate browsing and uneven recovery due to grasses. Densities of *Sophora* snags were not different among any of the sites, suggesting a more even distribution in the past. Selective browsing before ungulate reduction may have favored *Myoporum* over *Sophora*, leading to high densities of mature *Myoporum* in codominant woodland. After ungulate reduction, however, we found no pattern of competitive inhibition by *Myoporum* on regeneration of *Sophora*. [...] There was no detectable browse damage on *Sophora* on the upper and mid-elevation sites. In the lower site, 11 of 13 (85%) mature trees and 11 of 13 saplings had browse damage. The bark of many young *Sophora* and *Myoporum* trees was stripped off; there was evidence of browsing on *Sophora* leaves, but no evidence of browsing on *Myoporum* leaves." Grazing/herbivory/browsing Direct *Sophora chrysophylla*; *Myoporum sandwicense* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (browsing damages have been described (bark removal), which probably lead to a higher susceptibility of individuals to other stressors, but this has not been shown); or, if the performance of the native individuals is affected, because other stressor(s) might alone be the cause(s) of this/these decreased performance (there are four other species of introduced herbivores)." Mauna Kea volcano (Island of Hawai'i) Hawaii Islands United States North America North and Central America The potential impact on *Loxioides bailleui* has not been recorded. LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Belfield, T. R., & Pratt, L. W. (2002). Rare plants of the Mauna Loa Special Ecological Area, Hawai'i Volcanoes National Park." 2002 "Phyllostegia racemosa was not known from HAVO until one plant was found along a Mauna Loa SEA transect (transect 16) during a 1987 forest bird census. The plant was sighted again in 1991 and persisted through 1993, when it was noted on transect during the SEA rare plant survey. The site is within Kipuka Mauna'iu near 1,800 m (5,900 ft) elevation in an *Acacia koa* grove with a ground cover of alien *Ehrharta stipoides* or meadow ricegrass (Fig. 1). Subsequent searches of the area in 1997 and 1998 failed to find the known individual or any additional plants, and the species may have been lost from the Park. Between 1997 and 2000, mouflon sheep were present within the upper Mauna Loa SEA, and they may have browsed or killed any remaining *Phyllostegia* plants." Grazing/herbivory/browsing Direct *Phyllostegia racemosa* Plantae MR Low "The impact might be lower, if the native population(s) is/are not locally extinct (the way the species was monitored is not well described and the study might just have failed to detect the species); or if the alien did not cause the detected local extinction(s) (the alien is cited as a possible explanation, and this is only based on the fact that they have been present at the location when the extinction happened)." Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Belfield, T. R., & Pratt, L. W. (2002). Rare plants of the Mauna Loa Special Ecological Area, Hawai'i Volcanoes National Park." 2002 "Three other common Hawaiian species had very low numbers within the SEA. *Rubus hawaiiensis* ('akala) was noted only near the Mauna Loa Road in the upper unit and at one site near a rock wall in Kipuka Mauna'iu of the alpine unit. The rarity of this species as well as that of the palatable herb *Pseudognaphalium sandwicense* ('ena'ena) and the dwarf shrub *Tetramolopium humile* may indicate the impact of browsing by mouflon sheep in the SEA. [...] The few individuals of *Pseudognaphalium sandwicense* ('ena'ena), *Tetramolopium humile*, and *Rubus hawaiiensis* ('akala) encountered in the study area suggest that feral animals continue to deplete palatable herb and shrub species. In particular, the disparity in number of *Pseudognaphalium* and *Geranium* between the two kipuka may be an indicator of greater browsing pressure on favored species in the more remote Kipuka Mauna'iu." Grazing/herbivory/browsing Direct *Tetramolopium humile*; *Pseudognaphalium sandwicense*; *Rubus hawaiiensis* Plantae MO Low "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (it is not

mentioned clearly how the responsibility of the alien in the rarity of the impacted native species has been established)." Volcanoes National Park (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Belfield, T. R., & Pratt, L. W. (2002). Rare plants of the Mauna Loa Special Ecological Area, Hawai'i Volcanoes National Park." 2002 "In 1992, the *S. hawaiiensis* population at the Central Lava Flow site had supported 548 relatively scattered plants and a concentrated group of 614 individuals. When the population was re-visited in 1997, *S. hawaiiensis* had been severely browsed by mouflon sheep, and the 614 clumped plants (group 73) had been decimated and reduced to a few small individuals. [...] Browsing by mouflon changed the size class distribution of the population and reduced the mean height and width of plants by approximately 70% between 1992 and 1998. [...] While mouflon were implicated in the loss of many plants due to severe browsing and trampling, a more significant impact of browsing was the suppression of reproduction. If repeated browsing events continue, the *S. hawaiiensis* population of Mauna Loa may be severely reduced or even extirpated. Twenty randomly selected *S. hawaiiensis* plants were enclosed in wire- mesh cages in 1998, and their mortality, growth, and phenology was compared with that of 20 nearby, unprotected plants. Mortality over two years was slightly higher among unprotected plants; losses were attributed to drought conditions. Mean growth was slightly greater in caged plants, but differences were not significant. Phenology of the two groups differed greatly throughout the two-year study; 77% of caged plants were observed bearing flowers or fruits, while only 7% of unprotected plants were fertile. [...] A second *S. hawaiiensis* population on the Ke'omoku Lava Flow at 1,710 m elevation was also monitored in 1994 and 1999. No browsing damage was detected at this site, but mortality was very high over the five-year period with the loss of 71% of tagged plants. Losses were distributed over all four of the measured height classes. Mean height and width decreased over the five years, but the decline was not extreme. Thirty-three percent of plants were fertile in 1994, and only 15% bore flowers or fruits in 1999. [...] Browsing appears a greater detriment to *S. hawaiiensis* populations than drought, as sustained browsing events are more likely to directly eliminate populations and suppress reproduction." Grazing/herbivory/browsing Direct *Silene hawaiiensis* Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (another population of the native species is also declining, without being browsed by the alien; however, it has been shown in the study that the impact of the alien on the native population is at least MN, because the impact on the individual performance has been investigated)" Volcanoes National Park (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Belfield, T. R., & Pratt, L. W. (2002). Rare plants of the Mauna Loa Special Ecological Area, Hawai'i Volcanoes National Park." 2002 "In 1953-54, *Argyroxiphium sandwicense* var. *macrocephalum*, the threatened Haleakala silversword, was out-planted within the Mauna Loa SEA at several sites from the end of the Mauna Loa Road to Pu'u 'Ula'ula. A decade later, only three stunted individuals remained at the site near the Mauna Loa Road (Morris 1967), and these had disappeared by 1974 (National Park Service 1974). An unknown number of Haleakala silverswords survived at introduction sites above the current study area. In 1973, *Argyroxiphium sandwicense* var. *sandwicense*, the critically endangered Mauna Kea silversword, was out-planted at four sites in the Mauna Loa Strip, including the end of the Mauna Loa Road, two goat exclosures at elevations of 2,260 m (7,400 ft) and 2,470 m (8,100 ft), and Pu'u 'Ula'ula. These Mauna Kea plants survived only within the two exclosures (National Park Service 1974). A population of silverswords southwest of Pu'u 'Ula'ula has not been identified to species, but probably represents progeny of earlier out-plantings of Haleakala silversword. There were approximately 40 plants at this site when it was discovered in 1990. By 1998 only 12 plants remained, and no plants were found when the site was revisited in 2000 (Tim Tunison, pers. comm. 2000). [...] In 1996, more than 200 Ka'ala silverswords from this source were planted at a site below the cross fence in the Upper Unit east of the previous out-planting above the end of the Mauna Loa Road. These plants were later depredated by mouflon sheep, which had moved downslope from the unprotected upper reaches of the Mauna Loa Strip and had crossed the fence into the upper unit of the SEA. Browsing damage, coupled with dry conditions, resulted in the loss of nearly all out-planted individuals. Subsequently an exclosure of about 4 ha (10 acres) was created just below the cross fence, and an additional area of the alpine unit was enclosed, incorporating remaining plants of the Kipuka Kua'ali'oli *Plantago* population. [...] Since then, 2,500 silverswords from Kapapala Forest Reserve seed stock have been successfully planted within the two exclosures (Fig. I), and survival has been excellent (>90%)." Grazing/herbivory/browsing Direct *Argyroxiphium sandwicense* (var. *macrocephalum* and *sandwicense*) Plantae MO Medium "The alien might have caused a local extinction, but it is unclear whether the different studied sites sustain distinct local populations, or if they are all part of one large population." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown and it is likely that the alien is causing at least part of the observed decline(s)." Volcanoes National Park (Island of Hawai'i) Hawaii IslandsUnited States North America North and Central America Out-planted native populations LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Benitez, D. M., Belfield, T., Loh, R., Pratt, L., & Christie, A. D. (2008).

Inventory Vascular Plants of the Kahuku Addition, Hawaii Volcanoes National Park." 2008 "'h? wai was documented in three sites at Kahuku. [...] The areas of Kahuku where 'h? wai were observed had extensive damage from pig activity and either feral cattle or mouflon browsing; and no terrestrial individuals were observed. Protection of the Kahuku/Ka` Forest population is important to the conservation of this species in the southernmost portion of its range. [...] The low number of sites supporting Hawaiian catchfly at Kahuku was surprising, since suitable habitat apparently was extensive throughout the subalpine zone of the eastern survey region. However, signs of long-term ungulate browsing were evident throughout this region, and mouflon sheep are known to seek out this plant. The plant located during the survey appeared to be re-sprouting leaf growth after having been browsed by mouflon sheep. The older sections of HAVO include important habitat for Hawaiian catchfly that are protected from goats and mouflon by fences. A large population of perhaps 5,000 plants is known from the K?lauea caldera area, and a scattered population of ca. 1,500-2,000 plants has been reported within the Mauna Loa SEA (Belfield and Pratt 2002). Protection of subalpine habitat by fencing at Kahuku may result in the reappearance of Hawaiian catchfly there. If natural recovery does not occur, there will be many potential sites for re-introduction of this species to Kahuku. A small out-planting of this species is currently underway within the new silversword enclosure; the seed source was the Mauna Loa population of Hawaiian catchfly. [...] A small population of *Sanicula sandwicensis*, an herb with no common name, was found in Kahuku's western survey region. Less than 20 plants were found in native subalpine shrubland along the edge of a small k?puka at 1,850 m elevation, on soil substrate over old p?hoehoe. Fruits were observed on some plants, indicating some level of reproduction. However, browsing pressure by mouflon sheep was high in this area, and plants were growing only within the cover of p?kiawe patches or in rocky areas where animals could not reach them." Grazing/herbivory/browsing Direct *Clermontia lindseyana*; *Silene hawaiiensis*; *Sanicula sandwicensis* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no long-term monitoring, but punctual surveys); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the responsibility of the alien in the small population sizes is only inferred from direct observations of damages caused by alien on native individuals)" Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Benitez, D. M., Belfield, T., Loh, R., Pratt, L., & Christie, A. D. (2008). Inventory Vascular Plants of the Kahuku Addition, Hawaii Volcanoes National Park." 2008 "Two subspecies of nohoanu or native geranium were observed at Kahuku. Subspecies *cuneatum* was found rarely in Kahuku's western survey region, whereas subspecies *hypoleucum* was more frequently noted in the eastern survey region. Subsp. *hypoleucum* occurred at 43 sites along transects 9, 18, 21, 24, and 42 in 'hi'a woodland on substrates of old weathered 'a and p?hoehoe dating from 750 to 3,000 years old. No plant taller than 10 cm was observed along the survey transects. Both subspecies appeared to be aggressively browsed by mouflon sheep. This species was also present in the silversword enclosure where it was observed growing to its full height, flowering, fruiting, and reproducing. This suggests that intense browsing pressure is limiting populations of nohoanu in Kahuku's 'hi'a woodlands and subalpine communities." Grazing/herbivory/browsing Direct *Geranium cuneatum* Plantae MN Medium "The alien might cause a decline in the native population size (since the alien affects the reproduction of the native individuals), but the study did not allow to detect the effect of the alien on the native population size (only an effect on the performance of native individuals is described)." Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Ovis orientalis Bovidae Cetartiodactyla "Belfield, T. R., & Pratt, L. W. (2002). Rare plants of the Mauna Loa Special Ecological Area, Hawai'i Volcanoes National Park." 2002 "When the dramatic decline in the *Plantago* population at Kipuka Kulalio was detected two years after its discovery, browsing by mouflon sheep (or possibly goats) was feared even though there had been no obvious sign of animal damage within the kipuka. Sheep are known to browse preferentially on some native tree species, such as msmane, but also adversely affect native herbaceous species (Scowcroft and Giffin 1982). Browsing became less likely as a factor in the loss of the Kipuka Kulalio plants after the population at Kipuka Mauna'iu was revisited and found to be intact despite visible signs of sheep presence, including feces. Some minor browsing was observed on *Plantago* leaves and a few common plants. The Kipuka Mauna'iu site is farther from human activity along the Mauna Loa trail, and at the time the alpine unit was unenclosed and both sites were open to access by feral animals. [...] Potential threats to *A. fragile* are browsing by feral goats and mouflon sheep. Predation of the fern has been reported at Pohakuloa (U. S. Fish and Wildlife Service 1998), but we found no evidence of animal damage to the species in Mauna Loa SEA" Grazing/herbivory/browsing Direct *Plantago hawaiiensis*; *Asplenium fragile* Plantae MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated). The study might also not have allowed to detect an impact of the alien on the native population." Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LV October 2019 LS February 2020

Rangifer tarandus Cervidae Cetartiodactyla "LeaderWilliams, N., RI Lewis Smith, and P. Rothery. ""Influence of introduced reindeer on the vegetation of South Georgia: results from a longterm exclusion experiment."" Journal of Applied

Ecology (1987): 801822." 1987 "[...] reindeer (*Rangifer tarandus* L.) introduced to different areas of the island in 1911 and 1925 have had a serious impact on the vegetation [...] (2) Experimental exclosures and cages were established in various plant communities in 1973-74, and changes in floristic composition and vegetation cover have been recorded for 12 years. [...] Recovery of vegetation in exclosures showed that the native grass *Poa flabellata* and the dwarf shrub *Acaena magellanica* increased in cover in response to removal of grazing pressure. In contrast, the introduced grass *Poa annua* and, to a lesser extent, the moss *Polytrichum* and bare ground decreased in cover in response to exclusion [...] The major exception is macrolichens, notably of the genus *Cladonia*, which will probably take several decades to recover. [...] in some localized areas such as raised beaches and ridgetops, *P. flabellata* has been eradicated and replaced either by moss banks or by *P. annua*. Closed swards of *A. magellanica* no longer occur in the reindeer areas, whilst inflorescences are absent from, and leaf size is considerably reduced in *A. magellanica* growing in other communities." Grazing/herbivory/browsing Direct Deschampsia antarctica; Acaena magellanica; Polytrichum; Poa flabellata; Tortula robust; Cladonia spp. Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Stromness Bay South Georgia Island United Kingdom Europe Europe DJ July 2017LV June 2019

Rangifer tarandus Cervidae Cetartiodactyla "LeaderWilliams, N., Tessa A. Scott, and R. M. Pratt. ""Forage selection by introduced reindeer on South Georgia, and its consequences for the flora."" Journal of Applied Ecology (1981): 83106." 1981 "Reindeer recently have overgrazed extensive stands of tussock grassland; in some localized areas such as ridgetops and coastal flats, *P. flabellata* has been eradicated (Plate 2(b)) and replaced by moss banks [...] However, closed swards of *A. magellanica* no longer occur on the Barff Peninsula and in much of the Busen area, having been replaced usually by moss banks" Grazing/herbivory/browsing Direct Poa flabellata; Acaena magellanica Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no information on how the impact was measured/observed: it might be at a very small spatial scale or very localised disturbance, which might not have caused any decline in the populations)" Stromness Bay South Georgia Island United Kingdom Europe Europe DJ July 2017LV June 2019

Rangifer tarandus Cervidae Cetartiodactyla "Vogel, Michael, Herman Remmert, and Ron I. Lewis Smith. ""Introduced reindeer and their effects on the vegetation and the epigeic invertebrate fauna of South Georgia (subantarctic)."" Oecologia 62.1 (1984): 102109." 1984 "Exclosure experiments in areas where the reindeer were introduced have resulted in a dramatic change in the composition of the protected vegetation. *Poa flabellata* (the major winter food) and *Acaena magellanica* (a major summer food) have recovered to their former status inside the exclosures, [...] *Poa flabellata* (major winter food) is abundant only inside the exclosure at Royal Bay [...] In the reindeer areas *Acaena magellanica* (major summer food) has been almost eradicated except within the exclosures. [...] Exclosure 10, 8 m above sea level, is located on a dry raised beach in a reindeer-devasted stand of *Poa flabellata*. Within the fenced area *Poa flabellata* has regenerated extensively" Grazing/herbivory/browsing Direct Poa flabellata; Acaena magellanica Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Stromness Bay South Georgia Island United Kingdom Europe Europe DJ July 2017LV June 2019

Rangifer tarandus Cervidae Cetartiodactyla "Klein, David R. ""Vegetation recovery patterns following overgrazing by reindeer on St. Matthew Island."" Journal of Range Management (1987): 336338." 1987 "Vegetation plots established on St. Matthew Island in 1957 disclosed that by 1963, when the peak population of reindeer existed on the island, the lichen mat in sites favorable for the growth of lichens had been greatly reduced (Table 1). [...] Grasses, willows, and forbs also increased in the plots from 1957 to 1963. [...] On plots established on a dry ridge 60m above sea level *Oxytropis nigrescens* increased from 0.6% (+0.2 SE) ground cover in 1957 to 12.3% (?3.5 SE) in 1985. Similarly, *Pedicularis sudetica* which is known to be a preferred summer forage of reindeer (Wright 1979), appeared to be much more abundant on St. Matthew Island in 1985 than in 1957, 1963, and 1966. The expanding reindeer population was, therefore, exploiting a finite forage resource, only a fraction of which could be replaced through annual growth. " Grazing/herbivory/browsing Direct Oxytropis nigrescens; Pedicularis sudetica Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (some information is inferred)" St. Matthew Island Alaska United States North America North and Central America DJ July 2017LV June 2019

Rusa timorensis Cervidae Cetartiodactyla "Keith, David, and Belinda Pellow. ""Effects of Javan rusa deer (*Cervus timorensis*) on native plant species in the JibbonBundeena area, Royal National Park, New South Wales."" (2005): 99." 2005 "Extensive reconnaissance was undertaken throughout the native vegetation and the suburban area to observe deer behaviour and movement, record plant species consumed or damaged by deer and effects of deer on the structure of vegetation and soils. Observations were made opportunistically between 1999 and 2003. [...] Of 78 native plant species examined during the survey, only nine showed no evidence of vertebrate herbivory or physical damage and the majority of these plants were ferns and sedges. The other 69 species showed effects that included defoliation (young and/or old leaves), removal of shoots, bark-stripping, stem breakages and destruction or consumption of reproductive material. Cese effects

varied in severity between species and from place to place, and were inferred to have been caused by deer based on the local abundance of deer droppings, footprints and the scarcity of other vertebrate herbivores in the area."

Grazing/herbivory/browsing Direct *Acmena smithii*; *Cissus antarctica*; *Clerodendrum tomentosum*; *Rapanea howittea*; *Syzygium paniculatum*; *Doryanthus excelsa*; *Xanthorrhoea resinifera*; *Phyllanthus gunnii*; *Corymbia gummifera*; *Syzygium paniculatum* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Gibbon Bundeena area (Royal National Park) New South Wales Australia Oceania Oceania DJ July 2017 LV June 2019

Rusa timorensis Cervidae Cetartiodactyla "Bouchet, Philippe, Tanguy Jaffré, and JeanMarie Veillon. "Plant extinction in New Caledonia: protection of sclerophyll forests urgently needed." Biodiversity and Conservation 4.4 (1995): 415-428." 1995 "In this paper we highlight the problems of the sclerophyll forests, the most threatened of terrestrial biomes in New Caledonia, and document the extinction of a species of *Pittosporum* in a protected area. [...] The sclerophyll forest patch on Lepredour Island where the extinct *Pittosporum tanianum* occurred. The absence of regeneration because of grazing by introduced deer and rabbits is evident from the ground bare on most of the island, a 'protected' area [...] When *Pittosporum tanianum* was discovered on Lepredour in July 1988, only two specimens were found. No other specimens have been found on the island or other localities despite intensive searches. Their botanical interest was immediately noticed, and propagation was attempted by cuttings, but this failed. During a later visit to Lepredour in 1992, it was found that one plant had died as soil had eroded away around the tree. The second plant died between June 1992 and July 1993 from unknown causes. [...] As a database we have used the 19 published volumes of Flore de Nouvelle-Calédonie et Dépendances, covering critically approximately 55% of the 3000 native phanerogam species. "

Grazing/herbivory/browsing Direct *Pittosporum tanianum* Plantae MR Low "The detected local extinction(s) might be irreversible, but the reversibility of the changes has not been tested (the possibility of native individuals recolonizing the area is not addressed)." "The impact might be lower, if the alien did not cause the detected local extinction(s) (many other stressors, such as fire, land clearing and grazing by cattle)." Léprédour Island New Caledonia New Caledonia Oceania Oceania DJ February 2018 LV June 2019

Rusa timorensis Cervidae Cetartiodactyla "Bouchet, Philippe, Tanguy Jaffré, and JeanMarie Veillon. "Plant extinction in New Caledonia: protection of sclerophyll forests urgently needed." Biodiversity and Conservation 4.4 (1995): 415-428." 1995 "The extensive grassland and niaouli savannas, which today seem so typical of the nature of New Caledonia, have replaced much of the original sclerophyll forest. This is the result of a combination of two factors: (i) fire; and (ii) agricultural activities (clearing and grazing by introduced hooved mammals). [...] In addition, the Indonesian deer *Cervus timorensis* was introduced in the 1880s and has adapted extremely well to the conditions of New Caledonia. An estimated 105000-110000 animals are in the wild (Chardonnet and Lartiges, 1992), and much higher population levels seem to have existed in the 1920-1930s. Grazing and tramping by cattle and deer prevent regeneration of the sclerophyll forests, whose remnants now consist of old trees without any understorey (Fig. 2). [...] Formally established under that name in 1980, this reserve [Réserve Spéciale de Faune de l'Île Leprédour (560 ha)] had already been made a hunting reserve in 1941 for the then Governor of New Caledonia. Access to the island is by permit only, but no staff are employed there. This is a reserve by name only as it is plagued with deer (currently about 500 heads) and rabbits. Goats were present until eradicated in ca 1980. The botanical interest of this limestone island lies in three small disjunct patches of dry forest occupying a total of ca 5 ha, plus scattered isolated trees. These patches suffer from overgrazing by deer which has destroyed the understorey (Fig. 4) and regeneration ability of the forest. Most trees are probably 100 years old. Much of the island is covered by grassland with obvious signs of erosion (Fig. 3). Despite disturbances and their very small area, these small forest patches contain the only populations of two plant species: *Pittosporum tanianum* and *Leptostylis* sp. In addition, *Austromyrtus* sp., *Oxanthera* sp., and *Planchonea* sp. are known only from Lepredour Island and nearby (unprotected) Montagne Peninsula on the mainland. [...] As a database we have used the 19 published volumes of Flore de Nouvelle-Calédonie et Dépendances, covering critically approximately 55% of the 3000 native phanerogam species."

Grazing/herbivory/browsing Direct *Terminalia cherrieri* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no direct observational evidence, only inferred data); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the impact of the alien on the native species has not been tested (just evolution over time), and many other stressors: fire, land clearing and grazing by cattle)" New Caledonia New Caledonia New Caledonia Oceania Oceania "Several other species have probably declined as well, but it is not easy to identify which ones." DJ February 2018 LV June 2019

Rusa timorensis Cervidae Cetartiodactyla "Stronach, Neil. "Fire in the TransFly savanna, Irian Jaya/PNG." ACIAR PROCEEDINGS. ACIAR; 1998, 1999." 1998 "In conjunction with heavy grazing by rusa deer, burning has eliminated dense *Phragmites* reedbeds, setting in train a number of major ecological changes which lead to the widespread encroachment of seasonal swamp grassland by *melaleuca* woodland and forest. [...] Fire is also implicated in changes in grassland, notably in conjunction with grazing by rusa deer. The people of the coastal plains indicate that in living memory, and coinciding with the establishment of the rusa deer, there have been major changes in the swamps and grasslands. Robust swamp grasses, notably *Phragmites karka*, have declined. Seasonal inundation has been neither so deep nor so long.

Large areas of grassland and seasonal swamp have been encroached mostly by *Melaleucaspp.* (Stronach 1995; Kitchener 1997). " Grazing/herbivory/browsing Direct *Phragmites karka* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (no quantified changes, but qualitative descriptions by people of the coastal plains); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the impact of the alien on the native species has not been tested, but based on a comparison between the situations before/after the introduction of the alien)" Papua New Guinea Papua New Guinea Oceania Oceania DJ July 2017LV June 2019

Rusa unicolor Cervidae Cetartiodactyla "Peel, B., Bilney, R. J., & Bilney, R. J. (2005). Observations of the ecological impacts of Sambar *Cervus unicolor* in East Gippsland, Victoria, with reference to destruction of rainforest communities. The Victorian Naturalist, 122(4), 189-200." 2005 "Sambar damage was noted in 74 sites (gulies, crceks and coastal areas) visited by the authors between 2002-2005 in East Gippsland, Victoria. [...] When damage to a certain individual plant was identified as being caused by Sambar, the species and particular type or damage, including the extent and severity were noted, along with the plant community in which it was growing. [...] The most severe and obvious impacts of Sambar are related to browsing. causing death or reducing the litness of individual plants. This is usually done by removing stems, shoots and leaves (see Fig. 1), which reduces the plant's growth rate, resulting in shorter plants that remain reachable to Sambar for longer periods, eventually leading to understorey stunning and elimination. Reproductive output of certain species can also be reduced due to consumption of flowers, fruits, seeds and seedlings (e.g. Yellow Milk Vine *Marsdenia flavescens*, Prickly Currant-bush *Coprosma quadrifida* and Muttonwood *Rapanea howittiana*). [See Table 2]"

Grazing/herbivory/browsing; Direct physical disturbance Direct *Lysimachia japonica*; *Cyathia australis*; *Cyathia leichardtiana*; *Rubus mollocanus*; *Rubus parviflorus*; *Rubus rosifolius* Plantae MO Low "It is unlikely that the alien caused a local extinction, because the authors mention that it is only a matter of time before local extinctions take place (suggesting that no extinction happened yet)." "The impact might be lower, because the native population(s) might not be declining (the way the declines in these native populations were investigated is not explained (no spatial scale given, no quantified decline, etc))" East Gippsland Victoria Australia Oceania Oceania See Table 2 (the fact that declines in these populations were observed is not clear from the quotation) LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Peel, B., Bilney, R. J., & Bilney, R. J. (2005). Observations of the ecological impacts of Sambar *Cervus unicolor* in East Gippsland, Victoria, with reference to destruction of rainforest communities. The Victorian Naturalist, 122(4), 189-200." 2005 "Sambar damage was noted in 74 sites (gulies, crceks and coastal areas) visited by the authors between 2002-2005 in East Gippsland, Victoria. [...] When damage to a certain individual plant was identified as being caused by Sambar, the species and particular type or damage, including the extent and severity were noted, along with the plant community in which it was growing. [...] The most severe and obvious impacts of Sambar are related to browsing. causing death or reducing the litness of individual plants. This is usually done by removing stems, shoots and leaves (see Fig. 1), which reduces the plant's growth rate, resulting in shorter plants that remain reachable to Sambar for longer periods, eventually leading to understorey stunning and elimination. Reproductive output of certain species can also be reduced due to consumption of flowers, fruits, seeds and seedlings (e.g. Yellow Milk Vine *Marsdenia flavescens*, Prickly Currant-bush *Coprosma quadrifida* and Muttonwood *Rapanea howittiana*). [See Table 2]"

Grazing/herbivory/browsing; Direct physical disturbance Direct *Acacia mearnsii*; *Acacia melanoxylon*; *Acmena smithii*; *Acronychia oblongifolia*; *Pittosporum undulatum*; *Rapanea howittiana*; *Banksia integrifolia*; *Exocarpos cupressiformis*; *Gynatrix macrophylla*; *Monotoca elliptica*; *Myoporum insulare*; *Pomaderris aspera*; *Solanum aviculare*; *Symplocos thwaitesii*; *Zieria smithii*; *Celastrus australis*; *Cissus hypoglauca*; *Clematis glycinoides*; *Eustrephus latifolius*; *Geitonoplesium cymosum*; *Marsdenia flavescens*; *Marsdenia rostrata*; *Sarcopetalum harveyanum*; *Smilax australis*; *Adiantum formosum*; *Athyrium australe*; *Blechnum nudum*; *Dicksonia antarctica*; *Doodia aspera*; *Hypolepis glandulifera*; *Lastreopsis acuminata*; *Polystichum proliferum* Plantae MN Medium "It is unlikely that the impact is higher: whether the effect on the native population size was investigated or not is not clear (but it is likely, since they found some population decline for other species)." "The impact might be lower, because the performance of native individuals might not be affected (the methods are not described, and it is unclear how a reduced growth was observed)." East Gippsland Victoria Australia Oceania Oceania "Other species can be found in Table 2: for these, it is only mentioned ""Plants browsed"", so we cannot infer a decrease in their fitness." LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Bowman, F. (2014). A pilot study examining the ecological and human dimensions of wild deer management, Nariel Valley Victoria. B. Sc.(Hons) Thesis, University of Canberra, Canberra." 2014 "Damage to vegetation and soil from deer was estimated at each faecal pellet survey site (i.e. 20 transects per EVC, 600 plots). Each plot was searched for signs of deer damage. Evidence of deer damage was classified into the following categories: browsed vegetation, formation of trails, trampled or thrashed vegetation, hoof prints, wallows, and tree rubs. Extensive reconnaissance was also undertaken throughout the native vegetation in the vicinity of the transects to detect damage by deer to vegetation and soils. Observations were made opportunistically between May to August, 2014 and were confined to the native vegetation within 200 m distance from cleared land. [...] Antler damage to the bark of trees and saplings was observed throughout the study area. In particular, it was common to observe removal, damage and

scattered remains of bark at the base of trees, which appeared to be related to damage caused by antler rubbing. [...] Antler rubbing was found to be extensive within the forest and woodland areas, with damage to some trees and saplings so significant that it had resulted in mortality of some individual plants, particularly saplings. Antler rubbing was observed on a variety of tree species and of varying sizes in the study area (Figure 3.8). Damage was frequently observed on Cherry Ballart (*Exocarpus cupressiformis*) and Brittle Gum (*Eucalyptus mannifera*) trunks. [...] A few Cherry ballart trees were found to have died as a result of antler rubbing in this study. [...] Understorey vegetation was significantly reduced along game trails and in encampment areas. [...] Observed structural damage included creation of opened up areas, and the death or reduced fitness of individual plants. [...] While the results of this study only detected minimal damage by thrashing and trampling (2% of survey plots), observations indicated that deer were causing significant damage through this behaviour." Grazing/herbivory/browsing; Direct physical disturbance Direct "Exocarpus cupressiformis; Eucalyptus mannifera; undefined ("variety of tree species"; "understorey vegetation")" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (the authors mentioned that what they observed in the plots was not fully representative of what they observed at a larger scale)." "The impact might be lower, if the performance of native individuals is not decreased (the authors did not describe how they define a decrease in the fitness of the vegetation (they mention that browsing may cause the death of individuals or affect their fitness, but did not show it in this study))" Nariel Valley Victoria Australia Oceania Oceania All the impacted plant species were not specified. LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Bilney, R. J. (2013). Antler rubbing of yellow-wood by Sambar in East Gippsland, Victoria. Victorian Naturalist, The, 130(2), 68." 2013 "Surveys of 49 Warm Temperate Rainforest gullies in East Gippsland identified discrete populations of Yellowwood *Acronychia oblongifolia* in 34 gullies. Antler rubbing of Yellow-wood by Sambar *Cervus unicolor* was obvious and widespread in all 34 gullies. Eight gullies were randomly selected to assess the extent of antler rubbing to 100 Yellow-wood plants in each gully (50 plants close to two randomly generated locations). Across all eight gullies an average of 64.6% (± 17.7 sd; range 36-92%) of Yellow-wood individuals were antler rubbed, with 51.0% (± 17.8 sd; range 18-80%) subjected to severe rubbing (>50% ringbarking), with mortality recorded at 30.3% (± 14.0 sd; range 6-52%). Yellow-wood with stems in the range 30-150 mm diameter at breast height (DBH) were subjected to the highest rates of antler rubbing (73-81%), with smaller stems (10-16 mm DBH) suffering the highest rates of mortality. Sambar represent a major threat to the long-term persistence of Yellowwood and rainforest communities in East Gippsland. [...] Despite the high levels of mortality that are occurring, Yellow-wood trees often re-sprout from stems below antler rubs and/or sucker from roots. Yellow-wood therefore has the potential to persist in areas subjected to high levels of adult stem mortality; however, the regeneration is often subjected to antler rubbing once it reaches suitable size (Fig. 4), so the plant has a limited capacity to reach maturity. Therefore, the short-term ability for Yellow-wood to persist at sites with continued antler rubbing is high, but the long-term survival of Yellowwood is in doubt given that its primary regenerative mechanism for the renewal of the stand and individual is dramatically affected." Direct physical disturbance Direct *Acronychia oblongifolia* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (although a 30% mortality rate suggests a reduction in the population size, the second half of the quote brings into question their definition of "mortality" and suggests that populations are not currently declining but are likely to in the future)." It is unlikely that the impact is lower (relevant sample size and study led at a large spatial scale). Victoria Victoria Australia Oceania Oceania "They only exclude the other herbivores, but do not mention other deer species (except if it is the only deer species in Victoria, it could as well be due to another species (at least partly))." LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Bennett, A. (2009). The impacts of sambar (*Cervus unicolor*) in the Yarra Ranges National Park. Chapter 5: The impacts of sambar on forest understoreys. University of Melbourne, Department of Zoology & Department of Forest and Ecosystem Science." 2009 "Through the use of selective exclosures, this study aimed to investigate the browsing impacts of sambar on forest understoreys in the Upper Yarra catchment, Yarra Ranges National Park. [...] This study was conducted in four forest types [Shrubby Foothill Forest, Damp Forest, Wet Forest and Riparian Forest] that occur throughout the park and were selected to investigate the impacts of sambar on forest understoreys because they are located adjacent to The Flats, where there is a high sambar density (Chapter 2). [...] A total of 41 exclusion units (123 plots) were established between October and December 2005: 35 were located in the Upper Yarra catchment and six in the O'Shannassy catchment. [...] Privet mock-olive (*Notelea ligustrina*) and Victorian Christmas bush (*Prostanthera lasianthos*) were found only in exclusion units located in areas of low sambar density and were highly browsed." Grazing/herbivory/browsing Direct *Notelea ligustrina*; *Prostanthera lasianthos* Plantae MO Low "The alien might have caused a local extinction (the impacted native species is/are only found in the exclosures), but the study design would not have allowed to detect it." "It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown (the impacted native species is/are only found in the exclosure(s)) and the exclosure(s) allowed to quantify the impact of the alien only." Yarra Ranges National Park Victoria Australia Oceania Oceania LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Bennett, A. (2009). The impacts of sambar (*Cervus unicolor*) in the Yarra

Ranges National Park. Chapter 5: The impacts of sambar on forest understoreys. University of Melbourne, Department of Zoology & Department of Forest and Ecosystem Science." 2009 "Through the use of selective exclosures, this study aimed to investigate the browsing impacts of sambar on forest understoreys in the Upper Yarra catchment, Yarra Ranges National Park. [...] This study was conducted in four forest types [Shrubby Foothill Forest, Damp Forest, Wet Forest and Riparian Forest] that occur throughout the park and were selected to investigate the impacts of sambar on forest understoreys because they are located adjacent to The Flats, where there is a high sambar density (Chapter 2). [...] A total of 41 exclusion units (123 plots) were established between October and December 2005: 35 were located in the Upper Yarra catchment and six in the O'Shannassy catchment. [...] During the first survey, Winter 2006, a maximum of 20 understorey plants were selected in each plot if available and marked at the base with tie wire and a numbered aluminium tag. These understorey plants encompassed a variety of understorey shrubs, tree-ferns, ground ferns and on occasion juvenile trees. A maximum of 5 individuals for a single species within each plot were included in the survey. Species surveyed were replicated if available in all treatment plots within a given unit and between units. [...] For each tagged individual, the total height was measured with a 2-m ruler, together with signs of old and new browsing, rubbing and stem breakage, which were all noted as presence or absence. [...] On each tagged plant individual, 1 – 3 branches were selected and marked with tie wire and a coloured bead that corresponded to a height range (Figure 5.6b). [...] Plants in the understorey were more frequently and intensely browsed in areas of high sambar density. Three species were browsed to a significantly greater extent by sambar than native herbivores: hazel pomaderris (*Pomaderris aspera*), prickly tea-tree (*Leptospermum continentale*) and prickly bush-pea, (*Pultenaea juniperina*). Sambar significantly reduced plant biomass in forest understoreys where they occur in high densities. [...] There was no significant variation in height between surveys for plants subject to sambar browsing, indicating that browsing by sambar in the forest understorey will generally prevent plants from exceeding the observed mean height of around 110 cm." Grazing/herbivory/browsing Direct *Pomaderris aspera*; *Leptospermum continentale*; *Pultenaea juniperina*; other undefined Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth of individuals was investigated)." "The impact might be lower, because the performance of native individuals might not be affected (the performance of the native individuals is only estimated by plant height, growth rate, branch volume, and browsing signs: for the majority of these characteristics, results are pooled for all the studied plant species, preventing us to conclude much on the change in the performance of the different species)." Yarra Ranges National Park Victoria Australia Oceania Oceania LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Bennett, A., & Coulson, G. (2010). The impacts of sambar *Cervus unicolor* on the threatened shiny nematolepis *Nematolepis wilsonii*. Pacific Conservation Biology, 16(4), 251-260." 2010 "Shiny nematolepis is a small understorey tree endemic to Victoria. This species is listed as a threatened taxon in Victoria under the Flora and Fauna Guarantee Act 1988 and as vulnerable under Commonwealth's Environment Protection and Biodiversity Conservation Act 1999. This status reflects the species' limited distribution and low abundance, as the sole known population of less than 500 mature individuals is found within a small (approximately 4 ha) area, in the O'Shannassy catchment, Yarra Ranges National Park (YRNP). [...] Four paired-plot exclosures (10 x 10 m) (Figure 3.3) were constructed in October 2006 and March 2007 for this study. Each pair or 'unit' consisted of a fenced and an open plot [...] The health assessment was an estimation of relative percentage foliage cover present on the individual, visually estimated in comparison to an individual of optimum health (100%), illustrated by Lorimer and Lorimer (2005). [...] Sambar significantly decreased relative foliage cover of shiny nematolepis (*Nematolepis wilsonii*), a threatened understorey tree, through their antler rubbing activities. Thrashing of shiny nematolepis saplings also significantly decreased relative foliage cover, with sambar selecting saplings with a larger stem diameter from those available. Rubbed trees and thrashed saplings experienced damage to, on average, over half the stem circumference. [...] Sambar rubbing activities, likely to be caused over several years of repeated rubbing, may ringbark shiny nematolepis individuals and cause death, which was noted as the apparent cause of death for several individuals in 2005 (Lorimer and Lorimer 2005) and for seven dead individuals in this study, which all had 100% of circumference rubbed. [...] Storm damage at the site demonstrated that a single natural event can kill numerous trees. [...] Selective exclosures effectively differentiated the offtake of forage by sambar from that of native herbivores. [...] Native herbivores reduced branch volume by 38.4%, while sambar reduced branch volume a further 41.4%. [...] This study indicates that the presence of damage by both cockatoos and sambar each independently increased the susceptibility of mature trees to death by storm damage. " Direct physical disturbance Direct *Nematolepis wilsonii* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only 400 mature individuals of *Nematolepis wilsonii* existed at the time of the study and death of individuals is described, so there might be an impact on the population)." Yarra Ranges National Park Victoria Australia Oceania Oceania LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Murphy, A. H., White, M., & Downe, J. M. (2006). National Recovery Plan for the Shiny Nematolepis *Nematolepis wilsonii*. Department of Sustainability and Environment." 2006 "The single known population of *Nematolepis wilsonii* contains about 500 plants, including numerous seedlings, scattered over an area of about 5 ha (Walsh & Albrecht 1988). [...] As there is no other information on past distribution or abundance, and no

evidence of any declines in existing populations, it is not possible to determine if the species has suffered any decline in range and/or abundance. [...] The greatest threat is the damage caused by the introduced Sambar Deer *Cervis unicolor*. Deer use the trees to remove the velvet on their antlers, leading to the loss of cambium from the trunk and effectively ringbarking trees. Trampling by deer has also been observed and is likely to threaten the population by inhibiting regeneration."

Direct physical disturbance Direct *Nematolepis wilsonii* Plantae MN Low "The alien might cause a decline in the native population size ("The greatest threat is the damage caused by the introduced Sambar Deer *Cervis unicolor*"), but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (no details on how these observations were performed is given, and it is unclear if it consists in a direct observation or not)." Yarra Ranges National Park Victoria Australia Oceania Oceania LV January 2018 LS February 2020

Rusa unicolor Cervidae Cetartiodactyla "Mungall, E. C. 2007. Exotic animal field guide: nonnative hoofed mammals in the United States. Texas A&M University Press, College Station." 2007 "By 1940, sambar numbers hit a high of several hundred, then fell to less than fifty during World War II when there was intensive logging. After being sold in 1968, the island passed into the national wildlife refuge system. All remaining exotics except the wily sambar were removed. An uproar from the mainland ensued. The sambar were given permission to stay provided that ecological study could demonstrate no detrimental effect to the island's natives like the white-tailed deer. A University of Georgia team found that the overlap in food selections was mainly in highly abundant browse species and that the sambar favored the marshes while the whitetails concentrated on the uplands. [...] There are also several hunting days a year in order to limit sambar numbers to the seventyfive to one hundred range. At this level, sambar and white-tailed deer coexist easily on the island. If larger numbers were to prompt sambar to strike out for any of the extensive timber tracts across the bay, the more uniform habitat could put sambar in more direct competition with their native relatives." Competition Indirect *Odocoileus virginianus* Animalia MC Low "The impact might be higher, if the study did not allow to detect an impact on the native performance or population size (no methods explained, no direct observations but no references provided)." Saint Vincent Island Saint Vincent Island Saint Vincent and the Grenadines Caribbean Islands North and Central America Hunting days are controlling the alien population. LV January 2018 LS February 2020

Sus scrofa Suidae Cetartiodactyla "Cuevas, M. F., Mastrantonio, L., Ojeda, R. A. & Jaksic, F. M. (2012). Effects of wild boar disturbance on vegetation and soil properties in the Monte Desert, Argentina. *Mammalian Biology* 77: 299–306." 2012 "Undisturbed patches systematically presented a higher cover of plant species, which suggests that rooting activity has a negative effect on the cover of perennial grasses, shrubs and annual herbs. Only the annual herb *Pitraea cuneato-ovata* cover was higher in disturbed patches during the wet season, as previously reported by Cuevas et al. (2010), benefiting from wild boar disturbance. We found six species of grasses (*Digitaria californica*, *Pappophorum* sp., *Stipa* sp., *Setaria* sp., *Trichloris crinita* and *Sporobolus criptandrus*), six species of annual herbs (*Baccharis angulata*, *Conyza* sp., *Glandularia mendocina*, *Heliotropium mendocinum*, *Sphaeralcea miniata* and *Plantago patagonica*), and three species of shrubs (*Acantholippia seriphioides*, *Larrea cuneifolia* and *Lycium* sp.) that were negatively affected by rooting behavior; and thus were responsible for the decreased richness and diversity immediately after wild boar disturbance that we found. All these plant species are native." Direct physical disturbance Direct *Baccharis angulata*; *Conyza* sp.; *Glandularia mendocina*; *Heliotropium mendocinum*; *Sphaeralcea miniata*; *Digitaria californica*; *Pappophorum* sp.; *Setaria* sp.; *Sporobolus criptandrus*; *Plantago patagonica*; *Stipa* sp.; *Trichloris crinita*; *Acantholippia seriphioides*; *Larrea cuneifolia*; *Lycium* sp Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the direct physical damages on individuals were investigated)." Man and Biosphere Reserve of Nacunán (Monte Desert) Mendoza ArgentinaSouth America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Cuevas, M.F., Novillo, A., Campos, C., Dacar, M.A. & Ojeda R.A. (2010) Food habits and impact of rooting behavior of the invasive wild boar, *Sus scrofa*, in a protected area of the Monte Desert, Argentina. *Journal of Arid Environments* 74: 1582–1585." 2010 "We recorded 15 rooting sites and 45 plant species at the sites. Only the cover of two plant species showed significant differences between rooted and non-rooted areas: *Lycium* sp. (*Solanaceae*) and *P. cuneato ovata*. Cover of *Lycium* sp. was higher in non-rooted areas during the dry season. *P. cuneato-ovata* showed a significantly higher cover in rooted areas during the wet season (Table 2). [...] Disturbance produced by soil rooting of wild boars significantly reduced the cover of perennial species such as *Lycium* sp. On the other hand, the wild boar exhibited a close relationship with the annual plant *P. cuneato-ovata*, whose bulbs constituted 21% of the animal diet. *P. cuneato-ovata* dominated the rooted areas where soil moisture lasts much longer than in areas where the soil remains intact (Cuevas et al., unpublished data). In this sense, the wild boar is behaving as an ecological engineer, creating conditions (e.g. higher water retention in rooted soil) for the establishment of certain plant species." Direct physical disturbance Direct *Lycium* sp Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the direct physical damages on individuals were investigated)." Man and Biosphere Reserve of Nacunán (Monte Desert) Mendoza ArgentinaSouth America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Sanguinetti, J. & Kitzberger, T. (2010). Factors controlling seed predation by rodents and non-native *Sus scrofa* in *Araucaria araucana* forests: potential effects on seedling establishment. *Biological Invasions*, 12: 689–706." 2010 "In our study area, although rodents were the main seed eaters, introduced *S. scrofa* consumed an important proportion of the total seeds, especially outside dense understory vegetation and close to seeding trees, where wild boar predation was higher than 30%, equivalent to that of rodents.[...] In our study area, wild boar reduced significantly the amount of surviving seeds during mast year but this effect did not alter seedling establishment, suggesting that other factors related with recruitment limitation may be acting on this conifer. [...] This non-native ungulate may only be affecting *A. araucana* seed survivorship and seedling regeneration at the individual level but may not affect the tree population as a whole. [...] However, although wild boar affected seed survivorship at the study site, considering the small sample size these results cannot yet be generalized and more studies are needed to determine the real extent of wild boar impact on *Araucaria* forests." Grazing/herbivory/browsing Direct *Araucaria araucana* Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (even though the predation by the alien does not seem to affect the seedling establishment at the study site, it has been shown to affect the seed survivorship at the individual level; studies performed on a larger sample size would be needed to conclude anything at the population level)." Lanín National Park Neuquén ArgentinaSouth America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Barrios-García, M. N., Classen, A. T. & Simberloff, D. (2014). Disparate responses of above- and belowground properties to soil disturbance by an invasive mammal. *Ecosphere*, 5(4): 1-13." 2014 "To explore how introduced wild boar might alter forested ecosystems, we conducted a large-scale wild boar exclusion experiment in three different forest types (*Austrocedrus chilensis* forest, *Nothofagus dombeyi* forest, and shrublands). Wild boar presence altered plant composition and structure, reducing plant biomass 3.8-fold and decreasing both grass and herb cover relative to areas where wild boar were excluded. [...] Although wild boar were introduced relatively recently, their activity has shifted the abundance and community composition in Patagonia forests. Boar rooting reduced plant biomass 60% relative to unrooted areas. Interestingly and unexpectedly, there was no interaction between boar activity and forest type. Also, in spite of their significant soil disturbance, boar had minimal impacts on the soil system after three years of exclusion. [...] grasses and herbs were the most impacted by disturbance." Direct physical disturbance Direct Vegetation Plantae MO Low The alien might have caused (a) local extinction(s) (it is not possible to understand if the change in composition is associated with a decline or extinction of native species) "The impact might be lower, because the native population(s) might not be declining (the study did not focus on the species level (vegetation in general), making it difficult to understand which species are affected, and how)" Nahuel Huapi National Park Neuquén ArgentinaSouth America South America "Comparison of three habitat *Austrocedrus chilensis* forest, *Nothofagus dombeyi* forest, and shrublands" LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Miller, B., & Mullette, K. J. (1985). Rehabilitation of an endangered Australian bird: the Lord Howe Island woodhen *Tricholimnas sylvestris* (Sclater). *Biological Conservation*, 34(1), 55-95." 1985 "The pigs wrought extensive damage to the forest floor; some areas on the northern slopes of Mt Gower looked like a ploughed field, with ferns and seedlings uprooted. Each autumn pigs concentrated their activity higher up, just below the upper cliffs of Gower, where they excavated nesting providence petrels from their burrows. [...] A comparison of pig and woodhen distributions showed that the two did not overlap, but (Little Slope apart) fitted together very neatly. In several places the distributions were separated by only a low rock face. For example, pigs frequently foraged to the base of the Get-Up-Place (10 m cliff) which they could not scale, while woodhen regularly ranged to the top of it, but not below, even though they could easily scramble down. This situation was repeated on Mt Lidgbird (the Round Face) and on the uppermost ledge of Big Slope, providing strong circumstantial evidence that pigs were a major determinant of the woodhens' confinement. [...] In December 1981 a pair of woodhen was recorded from a new territory situated immediately below the Get-Up-Place (territory A in Fig. 2), an area until recently visited by pigs. This is the first documented instance of woodhen occurring below the northern Gower cliffline since 1936 (Hindwood, 1940). Forty-one ascents of Gower were made in search of woodhen between 1971 and 1979 (Disney & Fullagar, 1981) and birds below the section of the plateau are unlikely to have escaped notice. This was further evidence that up to the time of their removal pigs had been preventing expansion of the woodhen population." Direct physical disturbance Direct *Tricholimnas sylvestris* Animalia MN Low "It is likely that alien has caused a decline in the native population size ("This was further evidence that up to the time of their removal pigs had been preventing expansion of the woodhen population."), but the study did not allow to detect the effect of the alien on the native population size." Lord Howe Island New South Wales Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Miller, B., & Mullette, K. J. (1985). Rehabilitation of an endangered Australian bird: the Lord Howe Island woodhen *Tricholimnas sylvestris* (Sclater). *Biological Conservation*, 34(1), 55-95." 1985 "Further circumstantial evidence for the restrictive influence of pig predation on the woodhen population comes from an examination of the distribution of petrel breeding colonies. These followed the same pattern as that of the woodhen, but with two major exceptions: a large breeding concentration on Little Slope (pig free) and a smaller colony at Little

Island, where nests were situated in crevices between huge boulders and were inaccessible to pigs. Predation by pigs apparently explained the disjunct breeding distribution of this petrel [...] Vertebrate remains (rat and petrel) were recorded from 25 of the stomachs (58 ~o), and were frequently the major component of the contents. One stomach contained the remains of three rats and one petrel. It is unlikely that much of the vertebrate material was obtained as carrion, since corpses were seldom encountered, even in areas free of pig." Predation Direct Pterodroma solandri Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "It is unlikely that the impact is lower (according to the authors, it is unlikely that the alien is feeding on carrions instead of preying on living individuals)." Lord Howe Island New South Wales Australia Oceania Oceania LS March 2017 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Liddle, D. T., Brook, B. W., Matthews, J., Taylor, S. M. & Caley, P. Threat and response: A decade of decline in a regionally endangered rainforest palm affected by fire and introduced animals. Biol. Conserv. 132, 362–375 (2006)." 2006 "The wild population of the palm Ptychosperma macarthurii near Darwin, in monsoonal northern Australia, is regionally endangered and provides a focus to illustrate a range of issues pertinent to conservation of rainforest habitat. [...] In the absence of fire, simulations conducted to explore management options revealed a positive rate of increase with exclusion of introduced animals. [...] The management response required for introduced animals is relatively straight forward. The observed population trends (unburnt few animals $k = 0.9850$; unburnt many ani- mals $k = 0.9584$) support the contention that introduced ani- mals have a significant negative impact on the species (Barrow et al., 1993). There is a need for ongoing control of introduced animals to conserve populations of Darwin Palm, and furthermore, the observed and hypothetical manage- ment situations indicate that the more complete the control, the more positive the population response" Direct physical disturbance Direct Ptychosperma macarthurii Plantae MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Darwin Northern Territory Australia Oceania Oceania LS January 2018 LV March 2019

Sus scrofa Suidae Cetartiodactyla "Fordham, D., Georges, A., Corey, B., & Brook, B. W. (2006). Feral pig predation threatens the indigenous harvest and local persistence of snake-necked turtles in northern Australia. Biological Conservation, 133(3): 379-388." 2006 "Pigs were the main predator. Recorded tracks and disturbance in aestivation plots indicate that pigs were the cause of 27 of 28 recorded deaths (96%). [...] Pigs provide a steady predation pressure on C. rugosa during the final draw down period. Predation is alleviated only when the billabong dries and pigs disperse to the surrounding savannah.[...] In 11 out of the 27 cases of pig predation (41%), pigs specifically located and dug up the aestivating turtle, leaving the remainder of the 1m2 plot undisturbed. This indicates that pigs actively seek out and prey on aestivating turtles. [...] The present study shows that C. rugosa populations can potentially persist despite episodes of heavy pig predation if wet years are frequent, providing annual persistence of water at seasonal billabongs, since survival rates remain high in the absence of drying. [...] Our research spawns an interesting question. Do pigs prey upon a proportion of the turtle population that would other-wise be doomed as a result of customary harvesting? Evi-dence suggests that C. rugosa achieve relatively high survivorship rates in the absence of high pig densities (Ken-nett, 1994). As such, it is logical to assume that this would in turn convert to increased harvest efficiency, especially since harvest efficiency rises when feral animals are absent or in low density during the draw down period (Fordham, unpublished data). Therefore, it is probable that harvesting would have otherwise sealed the fate of a proportion of the turtles preyed by pigs at Gid-da-della.

However, the poten-tial threat pigs pose to C. rugosa populations in Arnhem Land is not necessarily lessened by the fact that pig predation, to an extent, replaces Aboriginal harvesting." Predation Direct Chelodina rugosa Animalia MN Low "It is likely that the impact is higher, but the study did not allow to detect changes at the population level (predation events have been observed: on 38 individuals, 27 died because of predation by pigs; however, it seems that the heavy predation by pigs leads to a decrease in the harvesting pressure, so the net effect on the dynamic of the native population might still be neutral)." It is unlikely that the impact is lower (predation events have been observed). Gid-da-della billabong Northern Territory Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Whytlaw, P. A., Edwards, W., & Congdon, B. C. (2013). Marine turtle nest depredation by feral pigs (Sus scrofa) on the Western Cape York Peninsula, Australia: implications for management. Wildlife Research, 40(5), 377-384." 2013 "The west coast of the Cape York Peninsula (CYP) is a major nesting ground for three species of threatened marine turtle, namely, the flatback (Natator depressus), olive ridley (Lepidochelys olivacea) and hawksbill (Eretmochelys imbricata). [...] The overall level of nest mortality was 40.2%. Depredation was responsible for 93% of nest losses. Pig predation was high, accounting for 89.6% of all mortality. Depredation occurred equally across nests of all three turtle species. Although nests were laid uniformly in both time and space, pig depredation was significantly clustered. [...] In contrast, depredation was responsible for 93.1% of all nest mortality observed in the present study. This was clearly the most important process affecting nest survivorship on Pennefather beach. [...] human depredation was also a relatively minor contributor to the total nest loss (10.4%). Pig depredation, in contrast, was high, accounting for 89.6% of all instances of nest mortality and nests of all species were equally affected. Total nest mortality caused by pigs (33.5%) was substantially lower than that reported in 2004–05 (70%) (J. Doherty, unpubl. data) and 2006

(65%) (CYPDA, unpubl. data), and also substantially lower than the levels observed in other parts of the world."

Predation Direct Natator depressus; Lepidochelys olivacea; Eretmochelys imbricata Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only mortality events in nests were observed)." Cape York Peninsula Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Mitchell, J., Dorney, W., Mayer, R., & McIlroy, J. (2008). Ecological impacts of feral pig diggings in north Queensland rainforests. Wildlife Research 34(8): 603-608." 2008 "At the end of the study period, there were 31% more living seedlings within the protected exclosures than in the unprotected controls. There was a strong general trend of more seedlings surviving in the absence of pig diggings: four of the six exclosures in the dry stratum and five of the six exclosures in the wet stratum had an overall greater mean number of alive seedlings in the exclosures than in the controls. The difference in the number of seedlings between the exclosures and controls was more pronounced as the protection time increased. " Direct physical disturbance Direct Vegetation (complex notophyll vine forest with emergent Eucalyptus grandis) Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only seedling density was investigated)." Cardwell Range Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Webber, B. L., Norton, B. A., & Woodrow, I. E. (2010). Disturbance affects spatial patterning and stand structure of a tropical rainforest tree. Austral Ecology, 35(4), 423-434." 2010 "We predict that relative to less disturbed sites, the impact of these two novel human-induced disturbance regimes on R. kurrangii will produce characteristic changes in population stand dynamics and spatial patterning [...] Noticeable pig damage only affected the CC site [...] The CC population had the lowest levels of seedling recruitment, despite having the highest density of reproductively mature trees (i.e. the highest reproductive potential). This finding suggests that pigs may be causing the disruption of R. kurrangii seedling recruitment at the CC site." Direct physical disturbance Direct Ryparosa kurrangii Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only recruitment was investigated)." "The impact might be lower, because the performance of native individuals might not be affected (the recruitment of the native species is compared between one disturbed site and several undisturbed sites, what limits the conclusions on the effect of the alien on the recruitment of the native species)." "Crystal Creek, Webber Creek, Little Cooper Creek (Daintree region)" Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Taylor, D. L., Leung, L. P. & Gordon, I. J. (2011). The impact of feral pigs (Sus scrofa) on an Australian lowland tropical rainforest. Wildlife Research 38(5): 437-445." 2011 "In 2006, feral pigs had caused significant declines in seedling density, soil macroinvertebrate density and leaf litter cover, but not in soil pH, soil conductivity, invertebrate diversity, vegetation diversity, tree density, canopy cover or fallen log cover. [...] Four 1-m² quadrats in each plot were randomly selected for soil biota sampling. From the centre of each quadrat, a block of soil 25cm wide, 60cm long and 15cm deep (including leaf litter) was removed using a shovel and placed in a white, plastic tray. [...] There was a large difference in the mean density of macroinvertebrates between the fenced and unfenced plots in both seasons, indicating that the disturbance and predation by feral pigs during the exclosure period markedly reduced the density of macroinvertebrates. [...] the damage caused by feral pigs before the exclosure period caused long-term suppression of the density of macroinvertebrates, and that 12 years was not sufficient time for pre-fencing damage to recover. In the dry season, there was a significant effect of fencing on the mean Shannon–Wiener index of macroinvertebrate diversity. [...] however, this effect was, again, mediated by season and was not significant in the wet season." Direct physical disturbance Direct Macroinvertebrates Animalia MN Low "The impact might be higher (the abundance of macroinvertebrates was assessed at damaged sites in comparison to undamaged sites at a small spatial scale, which does not allow to conclude much about the impact at the population level (avoidance))" "The impact might be lower, if the performance of native individuals is not decreased (the effect on the performance of native individuals has not really been tested)" Daintree National Park Queensland Australia Oceania Oceania LV May 2019 LS February 2020

Sus scrofa Suidae Cetartiodactyla "Taylor, D. L., Leung, L. P. & Gordon, I. J. (2011). The impact of feral pigs (Sus scrofa) on an Australian lowland tropical rainforest. Wildlife Research 38(5): 437-445." 2011 "In 2006, mean seedling density in the fenced plots was more than two times higher than that in the unfenced plots, indicating a positive effect of feral pig exclusion by fencing. The extremely low densities of seedlings in the unfenced plots suggest that seedlings are extremely vulnerable to feral pig disturbance. [...] Our data showed that feral pigs had no negative impacts on plant diversity during the 12-year study period. [...] It is possible that, in the future, the density of trees may be affected by feral pig damage because a reduction of seedling density may translated into reduced numbers of seedlings reaching maturity. [...] The number of plots and the size of the plots used in the study might have been too small to detect such impacts. Many species were found in more than one plot; however, the numbers of individuals of these species differed greatly from plot to plot." Direct physical disturbance Direct Archontophoenix alexandrae; Atractocarpus sessilis; Calamus sp; Calophyllum australianum; Connarus conchocarpus; Flindersia bourjotiana; Guioa acutifolia; Synima

macrophylla Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only seedling density was investigated)." Daintree National Park Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Mitchell, J., Dorney, W., Mayer, R., & McIlroy, J. (2008). Ecological impacts of feral pig diggings in north Queensland rainforests. Wildlife Research 34(8): 603-608." 2008 "The quantity of litter biomass remained relatively consistent between the exclosures and controls but fluctuated between sampling events due to seasonal effects. [...] No overall relationship between earthworm biomass and pig diggings could be found in this study [...] Pig diggings appear to have no impact on the amount of litter, root mass, earthworm populations, or soil moisture levels in this rainforest study site" "Chemical, physical or structural impact on ecosystems" Indirect Lumbricus sp. Animalia MC Medium "The alien might affect the performance of native individuals (no decline in the native population size -biomass of earthworms- was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Cardwell Range Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Doupé, R. G., Schaffer, J., Knott, M. J., & Dicky, P. W. (2009). A description of freshwater turtle habitat destruction by feral pigs in tropical north-eastern Australia. Herpetological Conservation and Biology 4(3), 331-339" 2009 "They are about 0.5 ha in size, saucer-like in shape, and contain similar aquatic macrophyte communities, being predominated by Giant Water Lily (Nymphaea gigantea) and Spiny Mudgrass (Pseudoraphis spinescens). [...] In the absence of pre-invasion data, this study nevertheless demonstrates that the foraging activities of feral pigs in these floodplain lagoons disrupt their physical, chemical and biological environments. Pig-mediated disturbance in the unfenced lagoons significantly affected their optical properties by dramatically increasing turbidity. The degree to which this may have altered primary productivity is unknown, however pig foraging is clearly linked to the destruction of aquatic macrophytes, and the proliferation of bare ground and open water in the lagoons. In contrast to other studies (e.g. Kotanen 1995; Arrington et al. 1999), we have found no evidence that feral pig rooting has affected either the number or diversity of plant species and nor have we found evidence for the invasion of exotic vegetation types as a consequence of pig disturbance." Direct physical disturbance Direct Nymphaea gigantea; Pseudoraphis spinescens Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Lakefield National Park Queensland Australia Oceania Oceania Transect and plot with repeated measures of macrophytes abundance LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Taylor, D. L., Leung, L. P. & Gordon, I. J. (2011). The impact of feral pigs (Sus scrofa) on an Australian lowland tropical rainforest. Wildlife Research 38(5): 437-445." 2011 "This study aimed to determine the impact of feral pigs on soil, soil biota and vegetation in a lowland tropical rainforest in Daintree, north-eastern Australia, and the recovery following exclusion of feral pigs for 12 years. [...] Three types of plots were established in 1994: damaged plots were fenced in areas where severe damage had already occurred ('fenced damaged'); undamaged plots were fenced in areas showing no evidence of damage ('fenced undamaged'); and unfenced plots were randomly placed and remained at risk of damage ('unfenced'). [...] Our results indicated that disturbance and predation by feral pigs during the exclosure period did not affect the density of earthworms in the dry or wet seasons [...] "Predation Direct Earthworms Animalia MC Low "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Daintree National Park Queensland Australia Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Hegel, C. G. Z., & Marini, M. A. (2013). Impact of the wild boar, Sus scrofa, on a fragment of Brazilian Atlantic Forest. Neotropical Biology and Conservation 8(1): 17-24." 2013 "Among the forests, there was a preference for the less conserved forest (F5) and the most conserved forest (F1), followed by a marginally significant preference for the second type of most conserved forest (F2) [...] The vegetation where the boars foraged was almost completely destroyed. Seedlings, young plants and roots of trees were uprooted, broken and chewed within the forest patches and the herbaceous vegetation and grass were affected in the clearings, secondary vegetation and wetlands. Aside from the excavation to search for food, nest building, wallowing (in the wetland areas) and trampling of the vegetation in muddy areas also caused damage to the vegetation. The estimate of the total biomass impacted by the wild boar at the sampled points was 56,186 kg, and of this 40,085 kg (71.3%) was in the most conserved forest. [...] The two more conserved forests, aside from presenting a high impact in about 30% of the sampled points, were the two vegetation types with the highest average area of impacted patches, further increasing the concern in relation to the conservation of these forests" Direct physical disturbance Direct Vegetation Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the direct damages on individuals were investigated)." Ecological Station Aracuri (Muitos Capões) Rio Grande Do Sul Brazil South America South America The article refers to type of habitat or vegetation communities (i.e. Achyrocline and Trichocline dominated vegetation; Cichorium dominated vegetation; Araucaria forest with ferns and tree ferns; Araucaria forest with bracken fern) LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "MacFarland, C. G., Villa, J. & Toro, B. (1974). The Galapagos giant tortoise, *Geochelone elephantopus*, Part I: Status of the surviving populations. *Biological Conservation*, 6, 118-133." 1974
 "This paper (Part I) briefly summarizes previous information and reports recent findings on (1) the sizes, sex and size-class structures, reproductive potential and mortality rates of the tortoise populations, and (2) the current threats to the tortoises posed by introduced mammals and human exploitation. Part II will evaluate the conservation methods currently being applied to the tortoise populations. [...] Wherever present, pigs destroy the vast majority of nests (Fig. 2), and also kill large numbers of young tortoises, up to at least 35-40 cm in curved carapace length (see Van Denburgh, 1914, for definition) or approximately 4-6 years in age (Fig. 3)." Predation Direct *Geochelone elephantopus* Animalia MN Medium
 "The alien might cause a decline in the native population size, as the study showed a significant reduction in survival of young as well as nest destruction, but the study did not allow to detect the effect of the alien on the native population size." Galapagos Islands Galapagos Islands Ecuador South America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Harris, M. P. (1970). The biology of an endangered species, the Dark-rumped Petrel (*Pterodroma phaeopygia*), in the Galapagos Islands. *The Condor*, 72(1), 76-84." 1970 "Among the other introduced animals, pigs are probably the greatest threat to the petrels, as they eat both the adults and young and destroy the burrows. Pigs were introduced onto Santa Cruz about 1927, and by 1935 were abundant in many areas. [...] Whatever the causes, all the settlers agree that there has been a spectacular decline in the numbers of the petrels, at least on Santa Cruz, and this is still continuing." Predation Direct *Pterodroma phaeopygia* Animalia MN Low "The impact might be higher, if the alien is at least partially causing the observed decline (even if the cause of this decline is not clear (habitat destruction by humans and by the climatic conditions of Galapagos), pigs might be one of the causes of this decline)." It is unlikely that the impact is lower (predation events have been observed). Santa Cruz Island Galapagos Islands Ecuador South America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Cruz, Justine B., and Felipe Cruz. "Conservation of the Dark-rumped Petrel *Pterodroma phaeopygia* of the Galapagos Islands, 1982-1991." *Bird Conservation International* 6.1 (1996): 2332." 1987 "The effects of predation and habitat deterioration produced by rats, cats, dogs, pigs, goats, burros and cattle, which have been introduced over the last two centuries to the Galapagos archipelago, have reduced the dark-rumped petrel *Pterodroma phaeopygia* population so that it is now in danger of extinction. [...] Petrel nests on uninhabited Santiago were scattered in small clusters over approximately 35 km² of the highlands (400-900 m). We followed the history of 205 nests from February to August and October 1985. During a 14-day visit in June 1986, we monitored 50 nests: this coincided with a pig-control campaign by GNPS. Their programme included hunting and poisoning with 1080 (sodium monofluoroacetate) and was aided by a severe drought. [...] On Santiago we found that pigs and hawks were the principal predators of adult and nestling petrels, with 55% of monitored adult birds (n = 510) being killed in one season. Our best estimate is that there were less than 500 (\pm 200) breeding pairs of petrels in 1985. A reduction in the pig population by 80% (L. Calvopina and H. Ochoa, verbally) may have been reflected in the low incidence of predation found in 1986, when we recovered only six dead petrels. [...] On Santiago, goats have completely altered the original habitat and although their elimination is desirable, much more serious threats to the petrel exist in pigs and hawks." Predation; Direct physical disturbance Direct *Pterodroma phaeopygia* Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (many other stressors, such as hawks)." Santa Cruz Island; Santiago Island Galapagos Islands Ecuador South America South America LV July 2019 LS February 2020

Sus scrofa Suidae Cetartiodactyla "Donlan, C. J., Campbell, K., Cabrera, W., Lavoie, C., Carrion, V., & Cruz, F. (2007). Recovery of the Galapagos Rail (*Laterallus spilonotus*) following the removal of invasive mammals. *Biological Conservation*, 138(3), 520-524." 2007 "The changes in rail densities on Santiago Island between 1986/1987 and 2004/2005 are impressive, and a comparison of rail abundance among the three islands surveyed in this study provides inference that these changes are likely attributed to eradication of invasive mammals on Santiago. A total of eighteen rails were detected in 1986/1987 on the island compared to 279 rails in 2004/2005 with similar effort (113 vs. 92 survey plots, respectively). [...] The plant communities on Santiago Island are recovering following pig and goat removal campaigns (Fig. 1; Cruz et al., 2005), following a pattern similar to what has been documented on other Galapagos Islands where goats have been removed." Predation Direct *Laterallus spilonotus* Animalia MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Santiago island Galapagos Islands Ecuador South America South America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Howell, S.N.G., Webb, S., (1990). The seabirds of Las Islas Revillagigedo. *Wilson Bulletin* 102, 140-146." 1990 "Townsend's Shearwater (*Puffinus auricularis*). [...] On land, all nesting sites were marked by severe pig rooting, and numerous shearwater remains littered the destroyed burrows. We found no occupied burrows. [...] The population on Clarion has never been censused, and its existence there is threatened by pigs." Predation Direct *Puffinus auricularis* Animalia MN Low "The alien might cause a decline in the native population size,

as the study showed a significant reduction in survival of young, but the study did not allow to detect the effect of the alien on the native population size." "It is unlikely that the impact is lower (even though predation by the alien on nests is not directly observed, it can be inferred from rooting marks next to destroyed burrows)." Revillagigedo Islands Revillagigedo Islands Mexico Mesoamerica North and Central America LS March 2017 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Campbell, D. J., & Rudge, M. R. (1984). Vegetation changes induced over ten years by goats and pigs at Port Ross, Auckland Islands (Subantarctic). New Zealand Journal of Ecology, 103-118." 1984 "We watched pigs rooting up tussocks of *Carex* and *Chionochloa*, and pig rooting can be seen in all habitats including the open moorland. On Ranui Peninsula especially, *Chionochloa* is prominent in their faeces. [...] It is clear that pigs have been making use of *Chionochloa* at least during the 10-year period that our plots have been measured. Considering the amount of *Chionochloa* available on McCormick Peninsula in 1972-73, and that pigs pull the tillers out completely, pigs alone may have been able to bring about much of the observed decline. There is no doubt that pigs and goats together will completely eliminate *Chionochloa* from low altitudes." Direct physical disturbance Direct *Chionochloa antarctica* Plantae MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (no other stressor is mentioned as a potential cause of the decline, but the conclusion that the alien is causing the decline is only based on the observation that the alien is making use of the native species)." Auckland Island Auckland Islands New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Flux, I. A. (2002). New Zealand white-capped mollymawk (*Diomedea cauta steadi*) chicks eaten by pigs (*Sus scrofa*). Notornis, 49(3), 175-176." 2002 "In February 2000 Josh Kemp, Department of Conservation (pers. comm.) reported seeing pigs in the white-capped mollymawk colony at Southwest Cape. When we visited this colony a year later (1 March 2001) we saw at least 7 pigs, including 3 piglets. One sow came towards us with the head of a freshly killed mollymawk chick hanging from her mouth, while a piglet with her was chewing on a mollymawk chick's foot. Another sow was disturbed snuffling around several freshly destroyed nest mounds and a large boar was seen in another part of the colony where there were destroyed nests. [...] Over time, predation by pigs has probably progressively altered the distribution of nests at Southwest Cape and reduced the colony size. The fact that the colony persists is probably attributable to the longevity of adults and the inaccessibility of some nest sites to pigs." Predation Direct *Diomedea cauta steadi* Animalia MN Low "It is likely that the alien caused a decline in the native population size, but it is unclear if and how a decline has been observed ("Over time, predation by pigs has probably progressively altered the distribution of nests at Southwest Cape and reduced the colony size")." It is unlikely that the impact is lower (predation events have been observed). Auckland Island Auckland Islands New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Coleman, M. C., Parkes, J. P., & Walker, K. J. (2001). Impact of feral pigs and other predators on macro-invertebrates, D'Urville Island. Department of Conservation." 2001 "The effect of the exclosures appeared to be largely on juvenile recruitment of snails, as adult numbers remained similar inside and outside the fences throughout the study, but there was a marked increase in juvenile snails inside the fences. [...] Before the exclosures were erected, 139 empty snail shells were removed from the plots in 1996: 24 from the northern sites and 115 from the southern site. Of these, 61% had been killed by pigs, 21% by weka, 12% were intact but empty, and 6% were so old or fragmentary that we could not determine the cause of death. After the exclosures were erected, these proportions remained similar for the plots outside the fences; of the 33 snails that died over the 3 years, 73% were killed by pigs, 12% by weka, 6% by thrushes, 6% were intact, and 3% died of unknown causes. [...] Pigs can kill snails of all sizes, although they apparently swallow smaller ones whole, as we found few small shells typically crushed by pigs. we could detect only weak effects of excluding the two predators (pigs and weka) that contributed 82% of the observed predation outside the fences. There was some evidence that the recruitment of young snails was enhanced by excluding pigs and weka, whether by reducing predation or by reducing the effects of soil disturbance by rooting, but that many of these were then eaten by thrushes." Predation Direct *Powelliphanta hochstetteri obscura* Animalia MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only recruitment was investigated)." It is unlikely that the impact is lower (the effects on the performance of native individuals have been tested with exclosure). D'Urville Island D'Urville Island New Zealand Oceania Oceania LS January 2018 LS February 2020

Sus scrofa Suidae Cetartiodactyla "Krull, Ch., Choquenot, D., Burns, B. & Stanley, M. (2013). Feral pigs in a temperate rainforest ecosystem: disturbance and ecological impacts. Biological Invasions 15: 2193-2204." 2013 "To study the impacts of feral pig disturbance and its recovery, areas of feral pig freshly disturbed ground and visually undisturbed controls were fenced off at 12 sites to exclude feral pigs. [...] There were several species that showed a gradient of increased abundance (some species more than doubled in abundance) with distance from disturbance, these included; *K. excelsa*, *K. ericoides*, *H. arborea*, *C. lucida*, *Ripogonum scandens* and *Leucopogon fasciculatus*, which was not recorded in the disturbed plots. [...] Another group of species were at highest abundances in the 1 m exclosures but decreased in the disturbed and 10 m exclosures, these included *Pseudopanax crassifolius*, *Rhopalostylis sapida*, *Geniostoma rupestre* and

Clematis spp. [...] Two of the large podocarp species, *A. australis* and *D. cupressinum* were at lowest abundance in the disturbed plots but were found at similar abundance in the 1 and 10 m plots. A similar pattern was also seen in *Myrsine australis*. Our study showed a difference in plant species composition in the disturbed plots when compared with the visually undisturbed. " Direct physical disturbance Direct "Dacrydium cupressinum; *Agathis australis*; *Knightia excelsa*; *Hedycarya arborea*; *Kunzea ericoides*; *C. lucida*; *Ripogonum scandens*; *Leucopogon fasciculatus*; *Pseudopanax crassifolius*; *Rhopalostylis sapida*; *Geniostoma rupestre*; *Clematis* spp; *Myrsine australis*

" Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." Waitakere Ranges North Island New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Medway, D. (2001). Pigs and petrels on the Poor Knights islands. New Zealand Natural Sciences 26: 87-90." 2001 "When Falla (1924) visited the group in December 1923, and there discovered the breeding place of Buller's shearwater (*Puffinus bulleri*), he found that only Aorangi supported a "few" wild pigs which took a heavy toll of young petrels. He found wings and other parts of Buller's shearwaters among the remains of birds which the pigs had rooted out of their burrows. He also found Fairy prions (*Pachyptila turtur*) which had been preyed upon by the pigs. During several hours on the island, no living petrels of any kind were found, and all the burrows examined were empty. On nearby Tawhiti Rahi "free from all danger of pigs, the birds were nesting undisturbed". Oliver (1925), who visited Aorangi in November - December 1924, considered that: "[...] The rare Buller's shearwater and other petrels are practically extinct on the southern islet, but abundant on other islets of the group". Pigs were eradicated from Aorangi in 1936 (Wilson 1959). [...] A remarkable improvement was noticeable when Buddle and others visited Aorangi in November - December 1940 (Buddle 1941). Among other things, petrels had extended their range and were found in much greater numbers, burrows being seen in many areas which two years before were completely barren. [...] The number of Buller's shearwater nesting on Aorangi increased in a spectacular manner after the eradication of pigs in 1936. Bartle (1968) estimated that by the end of 1964 there were about 100,000 burrows of that species on the island. Harper (1983) estimated that, seventeen years later in 1981, about 200,000 pairs nested on Aorangi. The number of Fairy prions nesting on the island also increase significantly to an estimated 40,000 birds by 1975 (Harper 1976). There is no evidence that the Pacific rat (*Rattus exulans*) or any other rodent has ever reached the Poor Knights group. The only known mammalian predators of petrels on those islands have been people and pigs." Predation Direct *Puffinus bulleri*; *Pachyptila turtur* Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (some of the primary observations could not be accessed, and we therefore do not have much information on how the observations were performed (the majority of them seem to consist in qualitative descriptions)); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) (the negative impact of pigs on native populations is established in this report based on a comparisons of the situations before/after the alien introduction and before/after the alien eradication)" Aorangi Island Poor Knights islands New Zealand Oceania Oceania The study is not describing any direct observation but is describing the impact of the alien on the native population based on direct observations described in other sources. LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Parkes, J., Easdale, T., Williamson, W. & Forsyth, D. (2015). Causes and consequences of ground disturbance by feral pigs (*Sus scrofa*) in a lowland New Zealand conifer-angiosperm forest. New Zealand Journal of Ecology, 39 (1): 34-42." 2015 Stomach contents were collected from 14 feral pigs shot within the study area by recreational and contract hunters during 2000-2006 [...] Below-ground dietary items were dominated by the adults and larvae of the stag beetle *Dorcus* (*Geodorcus*) *helmsii*; this species was 27% of the pigs' diet by dried weight and occurred in all but two of the pigs (Table 1). Predation Direct *Geodorcus helmsii*; earthworms; mammals; birds Animalia MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." It is unlikely that the impact is lower (predation events have been observed) Waitutu Forest South Island New Zealand Oceania Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Parkes, J., Easdale, T., Williamson, W. & Forsyth, D. (2015). Causes and consequences of ground disturbance by feral pigs (*Sus scrofa*) in a lowland New Zealand conifer-angiosperm forest. New Zealand Journal of Ecology, 39 (1): 34-42." 2015 "The density and height of seedlings was lower in areas disturbed by pigs than in areas not recently disturbed. However, when we considered plots disturbed during the study (n = 14) there was only marginally more reductions than there were increases in seedling density and heights, suggesting that differences between areas with and without signs of disturbance was not an immediate consequence of pigs' activities. Rather, it suggests that pigs more often disturb sites that already have fewer seedlings. Indeed, plots with shorter seedlings tended to be disturbed more often than expected by chance. Although the composition of seedling species was similar on disturbed and undisturbed plots, four species were more common on sites disturbed by pigs. [...] Surprisingly, once a site had been disturbed there was, on average, little long-term consequences for seedling size and abundance. Net temporal changes in density and height of seedlings were minor and resembled the slow net basal changes in undisturbed sites." Direct physical disturbance Direct *Coprosma rotundifolia*; *Coprosma serrulata*; *Griselinia littoralis*; *Coprosma serrata*; ;

Cyathea smithii; Nothofagus menziesii; Carpodetus serrata; Pseudowintera colorata; Coprosma ciliata; Coprosma foetidissima; Ripogonum scandens; Blechnum discolor Plantae MC Medium "The impact might be higher, if the study did not allow to detect an impact on the performance of native individuals (little long-term consequences for seedling size and abundance, but minor changes were still detected)." Waitutu Forest South Island New Zealand Oceania LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Gabor, T. M., & Hellgren, E. C. (2000). Variation in peccary populations: landscape composition or competition by an invader?. Ecology, 81(9), 2509-2524." 2000 "We studied two adjacent peccary populations, one sympatric with feral pigs and one allopatric to pigs, to determine the influence feral pigs have on native collared peccaries. [...] The peccary population on the pig-absent site had 5–8-fold higher densities, larger herd and group sizes, and smaller range and core area sizes than the population on the pig-present site. [...] Predictions of demographic consequences of competition, however, were not upheld. Reproductive characteristics, adult survival, and age structure of the populations did not differ between treatments. Litter size, pregnancy rate, and population size of peccaries also did not vary among years within treatments. These data suggested that both populations were stable during the years of the study." Competition Indirect Pecari tajacu (syn. Tayassu tajacu) Animalia MC High "It is unlikely that the impact is higher (the study has been led at a relevant spatial scale and all the population characteristics were studied (no decline was detected); only an effect on the local density was found (different fine-scale distribution), but this has been shown to have no effect on the performance of native individuals)." Chaparral Wildlife Management Area (Dimmit and LaSalle Counties) Texas United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Sweitzer, R. A., & Van Vuren, D. H. (2008). Effects of Wild Pigs on Seedling Survival in California Oak Woodlands. In Proceedings of the 6th symposium on oak woodlands: today's challenges, tomorrow's opportunities. General Technical Report PSW-GRT-217. Albany California: Pacific Southwest Research Station, Forest Service, US Department of Agriculture." 2008 "In a prior paper we reported fewer large oak tree seedlings (? 200 mm) along seedling belt transects in oak woodland habitats at research sites with high and very high density wild pigs (Austin Creek SRA and Henry Coe SP, respectively) compared to sites with moderate and very low density wild pigs (McCormick Sanctuary and Sugarloaf Ridge SP, respectively; Sweitzer and Van Vuren 2002). [...] To facilitate a more thorough examination of the effects of wild pigs on tree regeneration, we continued monitoring the number and sizes of tree seedlings in habitat and oak canopy control and exclosure plots at Austin Creek SRA and Henry Coe SP from spring 2000 to summer 2005. [...] We observed and documented a strong and consistent wild pig-related reduction in the number and size of oak tree seedlings in oak woodland habitats at two widely separated research sites in California. With the exception of oak woodland habitat plots at Henry Coe SP, the final differential for numbers of oak seedlings in fenced plots was at least double the number of seedlings in the control plots. The reduction in seedling number in the control plots could be directly attributed to wild pigs, because the plot areas experienced variable but significant levels of rooting over the six-year monitoring period (fig. 3)." Direct physical disturbance Direct Quercus kelloggii; Lithocarpus densiflorus; Quercus lobata; Quercus garryana; Quercus agrifolia Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "Austin Creek State Recreation Area (Sonoma County), Henry Coe State Park (Santa Clara County)" California United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Sweitzer, R. A. & Van Vuren, D. H. (2002). Rooting and foraging effects of wild pigs on tree regeneration and acorn survival in California's oak woodland ecosystem. USDA Forest Service General Technical Reports PSW-GTR, 184: 219-231." 2002 "After two years of research, our results indicate that rooting disturbance by wild pigs may exceed 35-65 percent annually in areas with high-density pig populations. Rooting disturbance by wild pigs contributed to significant declines in aboveground biomass productivity (fig. 2), which may reduce resource availability for a wide variety of terrestrial vertebrates and invertebrates. [...] Our data suggest that high levels of rooting by wild pigs in areas where densities exceed 2.0 pigs/km2 is contributing significantly to reduced tree seedling regeneration in oak woodland ecosystems in California. [...] Data on numbers of acorns associated with oak canopy experiments indicate that acorn consumption by wild pigs contributes to both reduced acorn survival to potential germination and reduced forage availability for wildlife" Direct physical disturbance Direct Quercus kelloggii; Lithocarpus densiflorus; Quercus lobata; Quercus garryana; Quercus agrifolia Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "Austin Creek State Recreation Area, Sugarloaf Ridge State Park, and the McCormick Sanctuary (Sonoma County), Henry Coe State Park (Santa Clara County)" California United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Wilcox, J. T. & Van Vuren, D. H. (2009). Wild pigs as predators in oak woodlands of California. Journal of Mammalogy 90(1): 114-118." 2009 "Of 104 wild pigs collected, stomachs of 42 (40.4%) contained; vertebrate remains totaling 167 individual prey animals; (Table 1). We identified prey representing 20

species that included; 11 mammals, 5 birds, 3 snakes, and 1 frog. California; voles (*Microtus californicus*) were the dominant prey species,; totaling 109 individuals and occurring in more than one-third of; all stomachs. Botta's pocket gophers (*Thomomys bottae*) also; were common prey, with 26 individuals in 13% of stomachs.; The remaining 18 prey species were recorded as single; occurrences in 1–6% of stomachs.[...] Our results confirm that wild pigs in oak woodlands of the; Diablo Range are consuming substantial numbers of vertebrates,; and that this phenomenon is common among pigs and; persistent over time. The prevalence of multiple vertebrates; per stomach indicates that this is not an occasional event,; especially considering the rapid rate of gastric emptying in pigs; (4–5 h—Ramonet et al. 2001). Our definition of carrion likely; was conservative because some animals considered prey may; have been consumed as recently dead carrion, particularly birds; that do not forage or nest on the ground. Nonetheless, the large; number and remarkable diversity of vertebrates contained in; pig stomachs suggest that most of these animals were taken as; live prey. [...] Wild pigs are a conservation concern because of the physical; impact of rooting, the effect of mast consumption on tree; regeneration, and competition with native species (Sweitzer; 1998). Results of our study extend the potential impact of wild; pigs to include predation on a wide variety of vertebrates,; especially small mammals. The potential for predation may be; especially pronounced in those environments, such as the; Mediterranean climate of California, in which wild pigs face; prolonged periods of protein deficiency. " Predation Direct *Microtus californicus*; *Thomomys bottae*; *Peromyscus maniculatus*; *Scapanus latimanus*; *Spermophilus beecheyi*; *Neotoma fuscipes*; *Peromyscus truei*; *Odocoileus hemionus*; *Sorex trowbridgii*; *Sylvilagus bachmani*; *Reithrodontomys megalotis*; *Callipepla californica*; *Phalaenoptilus nuttallii*; *Melanerpes formicivorus*; *Thryomanes bewickii*; *Pipilo crissalis*; ; *Contia tenuis*; *Coluber constrictor*; *Crotalus viridis*; *Pseudacris regilla* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (description of the diet composition of the alien, but the study did not test how the alien affected the native population(s))." "It is unlikely that the impact is lower (according to the authors, it is unlikely that the alien is feeding on carrions instead of predating on living individuals)." Blue Oak Ranch Reserve California United States North America North and Central America LS March 2017 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Kotanen, P.M. (1995) Responses of vegetation to changing regime of disturbance: effects of feral pigs in a Californian coastal prairie. *Ecography* 18(2): 190-199" 1995 "Pigs were the predominant agent of soil disturbance during this study. Between 1990 and 1993, transects indicated that pigs annually grubbed an average of 7.4% of the area of the five study meadows (mean calculated by pooling all data; see Fig. 1). [...] In some cases, grubbing was associated with some physical feature (usually damp ground or seeping water), or with the presence of a plant (e.g. bulb-bearing species such as *Brodiaea*, *Dichelostemma*, *Triteliaea*, and *Zigadenus*) [...] Grubbing removed or buried most surface vegetation, and disturbed soil to a depth of several cm (mean = 7.0, SE = 0.2 cm, based on 86 comparisons with nearby undisturbed surfaces). Nonetheless, most 25 x 25 cm plots contained survivors. In particular, *Danthonia californica* occurred as either survivors or seedlings in 82% of all disturbed plots within their first year, as opposed to 87% of control plots (percentages calculated with all meadows weighted equally). Bulbs of *Dichelostemma capitatum* and similar species also were common survivors in recently-grubbed areas, occurring in 53% of disturbed plots and 51% of control plots (all meadows weighted equally). [...] The species most conspicuously associated with grubbed areas were mostly natives (e.g. *Eremocarpus setigerus* (Hook.) Benth., *Navarretia* spp., and *Juncus bufonius*). [...] Nonetheless, native annuals and perennials both were abundant, and persisted or even increased in pig-disturbed areas. Alien annuals also colonized disturbed sites, but not in sufficient numbers to exclude opportunistic natives." Direct physical disturbance Direct "Brodiaea; *Dichelostemma*; *Triteliaea*; *Zigadenus*; *Danthonia californica*; *Dichelostemma capitatum*; *Eremocarpus setigerus*; *Navarretia* spp; *Juncus bufonius* " Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Coast Range Preserve California United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Roemer, G. W., Coonan, T. J., Garcelon, D. K., Bascompte, J. & Laughrin L. (2001). Feral pigs facilitate hyper predation by golden eagles and indirectly cause the decline of the island fox. *Animal Conservation*, 4: 307-318." 2001 "The hyperpredation model predicts that in the presence of a large pig population, an asymptotic population of seven eagles could cause the extinction of the Santa Cruz fox population in 6.7 to 11.5 years depending on prey preference (Fig. 5). If foxes were the only prey item available, the model predicts that five eagles could have extirpated the fox population in only 4 years. Thus island foxes alone could not have sustained an eagle population as large as that observed on Santa Cruz Island. Pigs, or some other abundant food, would have been necessary to explain both the number of eagles observed and their duration on the island." Indirect impact through interaction with other species Indirect *Urocyon littoralis* Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (agricultural activity)." San Miguel Island; Santa Cruz Island Channel Islands (California) United States North America North and Central America "Pigs increase the eagle population, which also feeds on the foxes" LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Jones, K. C., Gorman, T. A., Rincon, B. K., Allen, J., Haas, C. A., &

Engeman, R. M. (2017). Feral swine *Sus scrofa*: a new threat to the remaining breeding wetlands of the Vulnerable reticulated flatwoods salamander *Ambystoma bishopi*. *Oryx*, 1-8." 2017 "Following our initial observations of hog damage in several wetlands during the salamander breeding season in winter 2013–2014, we surveyed 28 wetlands for hog sign and damage during 2 April–20 August. [...] Critically, six of the 15 damaged sites had 20% of the wetland ecotone damaged by feral hog activity, and two of those six were occupied by flatwoods salamanders at that time (Plate 1). In all 15 sites where hog damage was recorded, the damage was focused exclusively on herbaceous vegetation. [...] Our assessments indicate that feral swine are damaging habitat that is critical to egg laying (Gorman et al., 2014), larval development (Gorman et al., 2009), and above-ground activity of metamorph and adult flatwoods salamanders (Jones et al., 2012). Our findings show that whether a site is currently used for breeding, known to have been used for breeding previously, or could potentially be used for breeding, if hogs are present there is a high likelihood they will damage the site. [...] These habitats are characterized by dense coverage of herbaceous vegetation, including *Aristida* spp., *Eriocaulon* spp. and *Xyris* spp. among others (Gorman et al., 2013), and we found that it was exactly these complex herbaceous plant communities that were the focus of hog rooting in these valuable wetlands." Direct physical disturbance Direct *Aristida* spp.; *Eriocaulon* spp.; *Xyris* spp. Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "The impact might be lower, because the performance of native individuals might not be affected (the impact on the reproduction has not been directly observed, but inferred from observation of physical damages)." Eglin Air Force Base (Okaloosa County) Florida United States North America North and Central America The potential impact on the flatwoods salamander has not been recorded because there is no observation allowing us to estimate that the salamander performance or population really suffers from the damages caused by the alien. LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Engeman, R. M., Addison, D., & Griffin, J. C. (2016). Defending against disparate marine turtle nest predators: nesting success benefits from eradicating invasive feral swine and caging nests from raccoons. *Oryx*, 50(02), 289-295." 2016 "As of 9 August 2007 there were 50 unhatched marine turtle nests on the Keewaydin Island beach, mostly of loggerhead turtles. The first of these to be depredated by swine was completely destroyed on 10 August. Within the next 35 days 48 of the 50 nests were depredated by swine. The final two were destroyed within 50 days of the initial depredation. Thus, once swine began to use turtle nests as a food source during the second half of the nesting season, they ended hatching on Keewaydin Island for 2007. As 100% of the existing nests were predated by swine, with 36 of those being caged, nest caging clearly did not prevent depredation by swine. [...] In the 2007 nesting season the hatchling emergence rate [...] was 78%. Using this factor for nests that were completely predated by swine, and using the 30-year mean clutch size of 102 eggs, an estimated 3,791 hatchlings were lost as a result of this nest destruction." Predation Direct *Caretta caretta* Animalia MN Medium "It is likely that the impact is higher, but the study did not allow to detect changes at the population level (the study show a significant reduction in the survival of young individuals, but did not test the effect on the dynamic of the whole population)." It is unlikely that the impact is lower (direct observations of predation on nests). Keewaydin Island Florida United States North America North and Central America Depredation of turtle nest by feral swine has been measured. LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Arrington, D.A. & Koebel, J.W. (1999) Effects of rooting by feral hogs, *Sus scrofa* L. on the structure of a flood plain vegetation assemblage. *Wetlands* 19(3):535-544." 1999 "Although our data indicate that hog rooting did not have a significant long term effect on total plant cover within wet prairie habitats, cover within rooted broadleaf marsh plots remained lower than in control plots for one year after rooting. [...] Broadleaf marsh was composed primarily of cut-grass (*Leersia hexandra*), maidencane (*Panicum hemitomon*), pickerelweed (*Pontedaria cordata*), and arrowhead (*Sagittaria lancifolia*), [...]" Direct physical disturbance Direct *Leersia hexandra*; *Panicum hemitomon*; *Pontedaria cordata*; *Sagittaria lancifolia* Plantae MN Medium "The impact might be higher, if a decline in the native population size has not been detected (the spatial scale of the study might be too small for estimating the impact on the population size)." "It is unlikely that the impact is lower (the performance of the individuals has been shown to be affected (smaller cover), but only on the short term)." Kissimmee River in central Florida Florida United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Boughton, E. H., & Boughton, R. K. (2014). Modification by an invasive ecosystem engineer shifts a wet prairie to a monotypic stand. *Biological invasions*, 16(10), 2105-2114." 2014 "In February 2012, feral swine breached the fence and rooted in over half of the fenced experimental subplots (26 out of 48 10 m 9 10 m plots; Fig. 1). [...] A few months later, we observed within the rooted area a large increase in the plant *Lachnanthes caroliana*, following which we mapped the boundary of all patches of *L. caroliana* with a Trimble GPS in July 2012 (Fig. 1.). Where *L. caroliana* occurred, the density of cover was so high that discerning edges of patches was easily achieved. [...] In rooted plots, there was on average an additional 41 % cover of *L. caroliana* and a reduction of 20 % cover in *Panicum longifolium* (the dominant bunch grass prior to rooting) and other dominant species (*Axonopus* sp.) whereas there were only slight changes in non-rooted plots [...] Species composition plots that had been monitored for a decade prior to feral swine disturbance allowed us to examine vegetation shifts as a response to intense rooting. We found that feral

swine disturbance shifted a bunchgrass dominated wet prairie to a near monoculture of *L. caroliniana*. In rooted plots, *L. caroliniana* increased on average 40 % while the dominant bunch grass, *P. longifolium* was reduced in cover on average by 20 %." Direct physical disturbance Direct *Panicum longifolium* Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (too small spatial and temporal scales to conclude anything at the population level (i.e. only rooted sites were investigated, at the time of the rooting))."

"MacArthur Agro-Ecology Research Center, Buck Island Ranch" Florida United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Jolley, D., Ditchkoff, S., Sparklin, B., Hanson, L., Mitchell, M. & Grand, J. (2010). Estimate of herpetofauna depredation by a population of wild pigs. *Journal of Mammalogy* 91: 519–524." 2010 "From April 2005 to March 2006, 68 stomach samples were collected from wild pigs. Sample sizes ranged from 0 to 10 per month. February 2006 was the only month during which no wild pigs were collected. Herpetofauna were present in 20.6% (n 14) of the samples. A total of 64 individual reptiles and amphibians was identified comprising 5 different species (Table 1). The eastern spadefoot toad was consumed in the greatest quantity and had the 2nd greatest percentage occurrence of consumption by pigs. One individual wild pig consumed 49 eastern spadefoot toads. Additional species found included the green anole, the species consumed most frequently by wild pigs. [...] Distinct seasonal peaks in herpetofauna consumption by wild pigs occurred in July–August and December–January (Fig. 1) and varied by species. The daily and annual rates of consumption of herpetofauna on Fort Benning were estimated to be 19/km² and 3,864/km², respectively (Table 2). Extrapolating these estimates to the entire population of wild pigs at Fort Benning yielded an estimate of 3.16 million herpetofaunal individuals consumed annually. [...] The data suggest that a substantial number of herpetofauna are consumed by wild pigs on Fort Benning each year. " Predation Direct *Scaphiopus holbrookii*; *Storeria occipitomaculata*; *Anolis carolinensis*; *Sceloporus undulatus*; *Hyla chrysoscelis* Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." "It is unlikely that the impact is lower (it seems unlikely that the pigs only consumed carrions, because of the large quantities of consumed native individuals)." Fort Benning Military Installation Georgia/Alabama United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Jacobi, James D. ""Vegetation changes in a subalpine grassland in Hawai'i following disturbance by feral pigs."" (1981). Cooperative National Park Resources studies unit. University of Hawaii at Manoa- Department of botany. Technical Report 41" 1981 "The change in plant cover for the portion of the exclosure that had initially been heavily uprooted (Transects 1 - 51, was considerably different from what was seen in the less disturbed portion (Transects 6 - 10). For Transects 1 to 5, *Deschampsia* showed a strong increase each year from 1974 to 1978. Cover for velvetgrass also increased; however, the change became - markedly less after 1975. *Gosmore* showed an increase to 9.2% in 1975, then decreased steadily to 2.8% cover in 1978. [...] In contrast, Transects 6 to 10 showed little change in individual plant species cover over the years sampled. *Deschampsia* 1975. Velvetgrass showed a slight increase in cover in both 1975 and 1976 but decreased again to its original level by 1978. Very little change was seen in the cover values for the remaining species. " Direct physical disturbance Direct "Deschampsia australis; *Holcus lanatus*; *Hypochaeris radicata*

" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Haleakala National Park (Island of Maui) Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Higashino PK, Stone CP (1982) The Fern Jungle exclosure in Hawaii Volcanoes National Park: 13 years without feral pigs in a rain forest. In: Smith CW (ed) Proceedings of the fourth conference in Natural Sciences. University of Hawaii Press, Honolulu, p 86" 1982 "We recorded all species present in 0-0.5 m and 0.5-2 m strata and estimated cover via the Braun Blanquet cover abundance scale. Percent of litter, exposed soil, the potential area diggable by feral pigs, the percent of the area actually dug, and the degree of root exposure (as an index to erosion) were also estimated. [...] Differences inside and outside the exclosure in 1981 were observed in: 1) more abundant cover of exotic grasses and herbs outside, 2) more exposed soil and roots outside, 3) greater average number of exotic species per plot outside, 4) greater frequencies of the exotics *Hypericum mutilum* and *Microlaena stipoides* outside and native *Uncinia uncinata*, *Ilex anomala*, *Lycopodium cernuum* and *Dicranopteris* litter inside, and 5) greater densities of natives *Sadleria pallida*, *Isachne distichophylla*, *Ilex anomala*, *Lycopodium cernuum* and bryophytes inside and exotic *Microlaena stipoides* outside. *Coprosma rhynchocarpa* was found in equivalent density and frequency inside and outside the exclosure.

" Direct physical disturbance Direct "Isachne distichophylla; *Dicranopteris linearis*; *Sadleria pallida*; *Ilex anomala*; *Lycopodium cernuum*

" Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the experimental set up of the study might have led to wrong conclusions (e.g. different sampling outside and inside exclosure))." Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Katahira, L. 1980. The effects of feral pigs on a montane rain forest in Hawaii Volcanoes National Park. Proceedings of the Third Hawaii Volcanoes National Park Natural Science" 1980 "Only species from 0 to 2 m tall were sampled since this is the size class most affected by pigs. I also recorded the total number of individual plants for selected species and noted the occurrence and percent ground cover uprooted by pigs. Using this modified method I sampled the enclosure twice: January 1979 and January 1980. [...] In the absence of pigs remarkable recovery of native vegetation occurred inside the enclosure. [...] A steady increase in cover was evident in all native species. Inside the enclosure with 'ama'u fern (*Sadleria pallida* Hk. & Arn.) showing the greatest response from 4.9% in July 1975 to 47.8% in January 1980. [...] Hapu'u fern also showed a significant increase from 1.0% in July 1975 to 6.0% in January 1980. [...] The preliminary results of this study show that pigs greatly reduce the herbaceous layer and the chance for seedlings to get established. However, when pigs are removed, the vegetation responds almost immediately, increasing both quantitatively and qualitatively." Direct physical disturbance Direct *Cibotium menziesii*; *Sadleria pallida* Plantae MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." "The impact might be lower, because the native population(s) might not be declining (native plants recover immediately in enclosures)" Volcanoes National Park (Island of Hawai'i) Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Cole, R. J. & Litton, C. M. (2014). Vegetation response to removal of non-native feral pigs from Hawaiian tropical montane wet forest. *Biological Invasions*, 16 (1): 125-140." 2014 "Total understory cover was 45 % greater in feral pig removal compared to feral pig present sites ($t = 6.07$, $P = 0.004$), and this pattern was also true for component categories of understory plants including native ferns ($t = 4.75$, $P = 0.009$), species of conservation interest ($t = 3.81$, $P = 0.019$), and native herbs plus native small woody plants < 1.3 m height ($t = 3.79$, $P = 0.023$). Stem density of ground-rooted small woody plants and seedlings was more than four-fold greater in feral pig removal sites than feral pig present sites ($t = 5.45$, $P = 0.005$). This pattern was most notable for two species, *Coprosma ochracea* and *Broussaisia arguta*, which tend to grow predominantly in mineral soil (ground-rooted) (Table 2). Species richness indices were significantly higher for ground-rooted small woody plants and seedlings in feral pig removal compared to feral pig present sites (Wilcoxon sign-ranked test, $P = 0.043$ in each case; Table 3). However, the stem densities of species of conservation interest, including all small woody plants, seedlings and saplings (< 10 cm height to < 5 cm dbh), were significantly higher in feral pig removal sites (Wilcoxon sign-ranked test, $P = 0.043$). [...] Both the percent cover and the abundance of small woody plants and seedlings rooted in mineral soil were markedly higher in feral pig removal versus feral pig present sites. [...] Overall native herbaceous cover decreased over time from 1994 to 2011 and this difference was primarily due to a decrease in the pig-present plots between sampling periods ($P < 0.048$)" Direct physical disturbance Direct *Coprosma ochracea*; *Broussaisia arguta*; *Cyrtandra* spp; *Psidium cattleianum*; *Psychotria hawaiiensis*; *Clermontia hawaiiensis*; *Clermontia parviflora*; *Cyanea floribunda*; *Cyanea pilosa*; *Cyanea tritomantha*; *Stenogyne calaminthoides*; *Touchardia latifolia*; *Trematolobelia grandifolia* Plantae MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." "Hawaii Volcanoes national park, Puu Makaala Natural Area Reserve (Island of Hawai'i)" Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Robichaux, R., Bergfeld, S., Bruegmann, M., Canfield, J., Moriyasu, P., Rubenstein, T., ... & Warshauer, F. (2001). Reintroducing Hawaii's silverswords. *Endangered Species Update*, 18(3), S22-S22." 2001 "The Mauna Loa silversword (*Argyroxiphium kauense*) suffered a similar fate. Historically, this species was common in moist to wet ecosystems between 5,000 and 8,900 feet (1,500 and 2,700 m) on Mauna Loa and Hualalai volcanoes. Following the introduction and spread of pigs, mouflon sheep, and other alien ungulates, however, the Mauna Loa silversword suffered a severe decline. The surviving individuals, numbering fewer than 1,000 plants, are confined to three small natural populations widely scattered across Mauna Loa. In addition to direct threats from alien ungulates, Mauna Kea and Mauna Loa silverswords may face serious indirect threats from alien insects, especially ants and wasps. These alien predators have the potential to decimate populations of native bees and moths that serve as pollinators, thereby greatly limiting seed set in silverswords. [...] The major threat to the recovery of silverswords (and many other endangered plant species in Hawaii) continues to be alien ungulates. Even at low numbers, these animals can have severe impacts. On the upper slopes of Mauna Kea, for example, where alien ungulate populations have been greatly reduced by a court-ordered removal program, browsing still caused significant seedling mortality, and serious damage to adult silverswords, at some of the outplanting sites in 1999." Grazing/herbivory/browsing Direct *Argyroxiphium kauense*; *Argyroxiphium sandwicense* ssp. *Sandwicense* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (the information source is unclear and the experimental design is not described); or, if the native population(s) is/are declining, because the alien might not have caused the observed decline(s) in the native population(s) but other stressor(s) might be alone the cause(s) of the decline(s) (the alien is mentioned as one of the current threats to the species survival among several threats, such as another alien ungulate and alien insects)." Island of Hawai'i Hawaii Islands United States North America North and Central America "This study does not seem to contain any direct

observation, but no reference is cited." LV October 2019 LS February 2020

Sus scrofa Suidae Cetartiodactyla "Murphy, M. J., Inman-Narahari, F., Ostertag, R., & Litton, C. M. (2014).

Invasive feral pigs impact native tree ferns and woody seedlings in Hawaiian forest. Biological invasions 16(1): 63-71."

2014 "Feral pig damage to tree ferns was widespread throughout the 4 ha study site, variable across the three Cibotium species, and associated with overall decreased growth and survival. Of 435 tree ferns relocated in 2010, 87 % were undamaged, 4.8 % were lightly-damaged, 6.4 % were moderately-damaged, and 1.6 % were heavily-damaged [...] These data support the hypothesis that feral pig damage decreases tree fern growth and survival. In particular, the majority of tree fern mortality was strongly associated with feral pigs. In contrast to undamaged tree ferns, moderately- and heavily-damaged tree ferns lost substantial trunk length. Even light damage, likely caused by feral pigs rubbing against trunks (e.g., to remove skin parasites...was associated with 50 % lower trunk length increment than that of undamaged individuals."

Direct physical disturbance Direct Cibotium chamissoi; Cibotium glaucum; Cibotium menziesii Plantae MN

Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only the growth and survival of native individuals were investigated)." Laup'hoehoe (Island of Hawai'i) Hawaii

Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Busby, P. E., Vitousek, P., & Dirzo, R. (2010). Prevalence of tree

regeneration by sprouting and seeding along a rainfall gradient in Hawai'i. Biotropica, 42(1), 80-86." 2010 "[...] feral pigs can significantly modify tree regeneration mode in wet forests. We found reduced relative density and basal area of seedlings outside the exclosure, which we interpret as resulting from pig disturbance given that the basal area and density of tree ferns do not differ inside and outside of the exclosure. [...] Our results also indicate that feral pig disturbance is positively correlated with the richness and diversity of sprouting species. Greater sprouting may result from basal or root damage caused by pigs. Together, the positive relationship between feral pig disturbance and relative importance of sprouts, and the richness and diversity of sprouts, suggests that pig disturbance may favor species capable of propagating by sprouts. Obligate seeders, like Clermontia parviflora, Cyrtandra lysiosepala, and Psychotria hawaiiensis, may decline with feral pig disturbance." Direct physical disturbance Direct Clermontia parviflora; Cyrtandra lysiosepala; Psychotria

hawaiiensis; (other plants not specified) Plantae MN Medium "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only seedling density was investigated)." "Ola'a-Koa Rain

Forest Unit (Hawaii Volcanoes national park, Island of Hawai'i)" Hawaii Islands United States North America

North and Central America "Exclosures have also been built in the Kaupulehu preserve and in Kipuka Ki (Mauna Loa), but pigs were not excluded in these locations." LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Cole, R.J., Litton, C.M., Koontz, M.J. & Loh, R.K. (2012) Vegetation

recovery 16 years after feral pig removal from a wet Hawaiian forest. Biotropica 44(4): 463-471." 2012 "Native and

nonnative understory vegetation responded strongly to feral pig removal. Density of native woody plants rooted in mineral soil increased sixfold in pig-free sites over 16 yr, whereas establishment was almost exclusively restricted to epiphytes in pig-present site. [...] The total density (ind./ha) of native understory woody plants was similar between treatments in both

1994 (1880.0 ± 621 pig-present; 2170.0 ± 306 pig-free) and 2010 (2380.0 ± 667 pig-present; 4250.0 ± 840 pig-free) although there was a marginally significant increase over time in the pig-free treatment (Table 1). [...] This pattern was particularly evident in the density of the most commonly occurring native species, Coprosma ochracea, which was virtually absent from the pig-present treatment (40.0 ± 2.4 in 1994; 0.0 ± 0.0 in 2010) but increased substantially in density in the pig-free treatment [...] We also found that density of small tree ferns (Cibotium sp. <50 cm length) increased significantly between sampling periods in the pig-free treatment, with no other differences in tree fern length between treatments or over time (Table 1; Fig. 2)." Direct physical disturbance Direct Diplazium sandwichianum; Nothoperanema

rubiginosa; Peperomia spp; Coprosma ochracea; Cibotium chamissoi; Cibotium glaucum; Cibotium menziesii Plantae

MO Medium "The impact might be lower, because the native population(s) might not be declining (small spatial

scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))."

"Ola'a-Koa Rain Forest Unit (Hawaii Volcanoes national park, Island of Hawai'i)" Hawaii Islands United States North

America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Loh, R. K., & Tunison, J. T. (1999). Vegetation recovery following pig removal in'Ola'a-Koa Rainforest Unit, Hawaii Volcanoes National Park. Technical Report 123, University of Hawaii at

Manoa" 1995 "The population distribution of hiipu'u changed substantially between 1991 and 1998 (Figure 4). Large

increases in the number of Cibotium glaucum individuals in the two smaller basal diameter size classes caused the population to shift from one containing relatively few small individuals to one dominated by individuals from the smaller size classes. [...] similar pattern of increased recruitment among the smaller size classes was found for Cibotium hawaiiensis

[...] Cover of hlpu'u 1 < 2 m in height increased significantly the first two years following pig removal, but did not change much thereafter (Table 4). [...] The largest increases were by ho'i'o, ho'i'o kula, and 'akblea (Athyrium microphyllum) [...]

The population distribution of native trees, and of the more abundant native tree species, 'bhi'a, olomea, pilo, and, 'blapa,

by basal diameter size classes are presented in Figure 5. Similar to hlpu'u, the seven years following pig removal saw

increased recruitment of individuals into the smaller size classes [...] Other native genera, and species that had big cover

increases included *Clermontia* spp., *Uncinia uncinata*, and 'ala'ala'wainui (*Peperomia* ~PP.). [...] Total vegetation cover increased following pig removal, with the cover of native and alien understory vegetation following two distinct trends. Native vegetation increased between 1991 to 1993 from 21.3% to 36.7% for cover elm, and from 18.7% to 28.1 % for cover 1<2 m, but did not change significantly between 1993 to 1998." Direct physical disturbance Direct "Cibotium glaucum; *Cibotium chamissoi*; *Perrottetia sandwichensis*; *Coprosma* spp; *Diplazium sandwichianum*; *Pneumatopteris sandwichensis*; *Cibotium menziesii*; *Clermontia* spp; *Uncinia uncinata*; *Peperomia* sp" Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size (only regeneration was investigated)." "Ola'a-Koa Rain Forest Unit (Hawaii Volcanoes national park, Island of Hawai'i)" Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Vtorov, I. P. (1993). Feral pig removal: effects on soil microarthropods in a Hawaiian rain forest. The Journal of wildlife management, 875-880." 1993 "Seven years after removal of pigs, total density of microarthropods in the forest nearly doubled, and biomass increased 2.5 times. Species numbers after removal of pigs recovered faster than abundance. [...] Microarthropods are non-burrowing animals, unable to create tunnels in soil; their population numbers depend on the presence of organic matter and abundant air spaces, which are strictly limited in compacted soil. In sites with pigs, disturbance to litter and compaction of the upper soil horizons create a substrate relatively unsuitable for microarthropod population. Springtails were the most sensitive to impact of feral pigs in terms of native species and population density." "Chemical, physical or structural impact on ecosystems" Indirect *Salina maculata*; *Isotomiella* sp.; *Lepidocyrtus innornatus*; *Harlomilsia oculata*; *Xenylla* sp.; *Tullbergia silvicola*; *Protaphorura cryptopya*; *Mesaphorura* sp.; *Neanura* sp.; *Folsomina onychiurina*; *Cryptopigus caecus*; *Parisotoma dichchaeta*; *Isotomiella* sp.; *Sinella caeca*; *Homidia sauteri*; *Lepidocyrtus inornatus*; *Salina maculata*; *Harlomilsia oculata*; *Neelides minutus*; *Sminthurides* sp. Animalia MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial scale, so the observed decline(s) might only be localised effects and not a general decline in the native population(s))." "Ola'a-Koa Rain Forest Unit (Hawaii Volcanoes national park, Island of Hawai'i)" Hawaii Islands United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Kaller, M. D. & Kelso, W. E. (2006). Swine activity alters invertebrate and microbial communities in a Coastal Plain watershed. American Midland Naturalist 156(1): 163-177." 2006 "We investigated the effect of an unmanaged population of feral and free ranging swine upon aquatic habitat, invertebrates and microbes in a coastal plain stream in Louisiana. [...] The ordination joint plot suggested a close relationship between FC and riparian disturbance, indicated negative associations between *Agnetina* spp., *Attaneuria* spp., *Baetidae*, *Caenis hilaris* (Say), *Calopterygidae*, *Chironominae*, *Gonielmis* spp., *Hydrobiidae*, *Laevepex* spp., *Lumbricidae*, *Microcylleopus* spp., *Planorbidae*, *Pomacea* spp., *Pythobanchus* spp., *Anodontoides* spp., *Stenacron floridense* (Lewis) and *Stenonema* spp. with the swine associated variables. [...] Therefore, the data suggest increasing riparian disturbance, FC and BOD shifted the invertebrate community from a diverse group of collecting and scraping insect taxa to a group dominated by gastropods. Although the mechanism behind the community shift is as yet undetermined, it could have significant effects on nutrient spiraling (Newbold et al., 1982) and other organisms dependent on the presence or activities of insects (predominantly) and mussels that were less abundant at sites adjacent to swine activity. Because swine activity was not associated woody debris habitat measurements, we do not believe community compositional changes were related to swine disturbance of the stream bottom. Instead, we believe microbial changes, as evidenced by the differences in bacteria we identified in sites with and without swine activity, to be the most plausible explanation. [...] Swine activity did not appear to alter stream habitats. However, swine changed the microbial taxonomic composition in the stream increasing pathogens." Indirect impact through interaction with other species Indirect *Agnetina* spp.; *Attaneuria* spp.; *Baetidae*; *Caenis hilaris* (Say); *Calopterygidae*; *Chironominae*; *Gonielmis* spp.; *Hydrobiidae*; *Laevepex* spp.; *Lumbricidae*; *Microcylleopus* spp.; *Planorbidae*; *Pomacea* spp.; *Pythobanchus* spp.; *Anodontoides* spp.; *Stenacron floridense*; *Stenonema* spp. Animalia MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." West Bay Wildlife Management Area (Allen Parish) Louisiana United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Worthington, David J., et al. "Abundance and management of Mariana fruit bats and feral ungulates on Anatahan, Mariana Islands." Pacific Conservation Biology 7.2 (2001): 134-142." 2001 "A survey of Mariana Fruit Bats *Pteropus mariannus* and feral ungulates was conducted on Anatahan, Mariana Islands, in July 1995. We estimated that a population of 1 902-2 136 bats persists on the island, based on a combination of direct colony counts, departure counts, and station counts of non-colonial animals. Our data suggest that bat numbers have declined since the last surveys were made in 1983 and 1984. [...] Goats were first introduced to Anatahan in the late 1950s or 1960, when an island resident released as many as 40 animals from Sarigan (Reichel et al. 1988; Rice 1992). Our estimated herd size of 5 000-6 000 animals is considerably larger than an estimate of 3 000-4 000 goats made in 1988 (Reichel et al. 1988), but neither estimate is based on rigorous surveys, nor should a population trend necessarily be inferred. However, Lemke (in

litt.) did not note significant erosion or large numbers of goats on Anatahan in the early 1980s, suggesting that the present severe damage on Anatahan has been rapid, possibly due to a sharp increase in the feral ungulate population. [...] The most likely causes for a decrease in fruit bat abundance on Anatahan during the past decade involve mortality from chronic illegal hunting and declining food resources induced by goat and pig damage to the island's forests. Although the extent of hunting losses are unknown, human visitation to the island has expanded significantly since 1984 and has probably been accompanied by a commensurate increase in the take of bats. However, without simultaneous counts on the islands north of Anatahan, emigration cannot be excluded as an additional contributing factor in the population's apparent decline."

Competition Indirect Pteropus mariannus Animalia MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (chronic illegal hunting, and Sus scrofa is not very abundant compared to Capra hircus, which might have caused the observed decline alone)." Anatahan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania DJ July 2017 LV June 2019

Sus scrofa Suidae Cetartiodactyla "Kessler, C. C. ""Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands."" Turning the tide: the eradication of invasive species (2002): 132-141." 2002 "The native forest on Sarigan was in an advanced state of decline due to the presence of feral goats (Capra hircus) and pigs (Sus scrofa). [...] Vegetation monitoring before and after eradication shows an increase in plant species richness, an increase in tree seedlings, and the rapid expansion of the introduced vine Operculina ventricosa. [...] The vegetation responded immediately to the removal of ungulates. The total number of plant species found in all 13 plots has increased from seven in 1997 to 17 in 1998, 22 in 1999, and 25 in 2000. [...] Tree species have increased from a total of four in 1997 to nine in 2000 (Fig. 4) and have shown a steady increase in the number of seedlings on the plots. These tree species are Aglaia mariannensis, Artocarpus mariannensis, Cocos nucifera, Erythrina variegata, Hibiscus tiliaceus, Neisosperma oppositifolia, Trema orientalis, Premna obtusifolia, and Carica papaya. [...] All are native species to the Marianas, except for C. papaya, which is from the Americas but considered naturalised (Raulerson and Rinehart 1991). [...] The subsequent loss of soil through erosion kills the trees. The eating of new growth by ungulates suppresses any regeneration capabilities of the forest. The result is a steady decline of forest habitat whether it is native or coconut forest." "Grazing/herbivory/browsing; Chemical, physical or structural impact on ecosystems" Direct;

Indirect Aglaia mariannensis; Artocarpus mariannensis; Cocos nucifera; Erythrina variegata; Hibiscus tiliaceus; Neisosperma oppositifolia; Trema orientalis; Premna obtusifolia Plantae MO Low "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Sarigan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania DJ March 2019 LV June 2019

Sus scrofa Suidae Cetartiodactyla "Kessler, C. C. ""Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands."" Turning the tide: the eradication of invasive species (2002): 132-141." 2002 "The native forest on Sarigan was in an advanced state of decline due to the presence of feral goats (Capra hircus) and pigs (Sus scrofa). [...] During January and February 1998, 68 pigs and 904 goats were removed by helicopter shooting, ground shooting, trapping, and tracking with dogs. [...] Glueboard traps were used for catching lizards. A line of 12 traps, with 5 m spacings was set in the morning and picked up in the afternoon. [...] Catch rates for blue-tailed skinks (Eumeces caeruleocauda) and the endemic Slevin's skink (Eumeces slevini) have greatly increased (Fig. 5) [...] The most rapid change of any wildlife species is the increase of skinks, mostly due to their high reproductive rate. The combination of an enlargement in forage area (increased vegetation) and the removal of a direct predator (the pig) has seemingly benefited these lizards." Predation Direct Eumeces caeruleocauda; Eumeces slevini Animalia MO Medium "The impact might be lower, if the alien did not cause -or contributed to- the observed decline(s) in the native population(s) but that the other stressor(s) is/are alone the cause(s) of the decline(s) (other introduced herbivores present)." Sarigan Island Northern Mariana Islands Northern Mariana Islands Oceania Oceania "The absence of changes detected in bird populations (Megapodius laperouse; Pteropus mariannus; Rattus exulans; Halcyon chloris; Aplonis opaca; Myzomela rubratra; Megapodius laperouse) have not been recorded as an absence of impact, because the authors of the study do not consider that the temporal scale was relevant to detect changes in bird populations." DJ March 2019 LV June 2019

Sus scrofa Suidae Cetartiodactyla "Baron, J. (1982). Effects of feral hogs (Sus scrofa) on the vegetation of Horn Island, Mississippi. American Midland Naturalist, 202-205." 1982 "Horn Island supports a small population of live oaks (Quercus virginiana) but during the 2-year study they did not produce acorns. [...] Underground plant matter taken by rooting (fungi, rhizomes of grasses and sedges, pineroots) made up 31% of the winter samples, and only 13% of the summer samples [...] A characteristic of Horn Island was the rapid recovery of the vegetation following disturbance. Areas that were disturbed in winter regained their original cover within 6 months to a year after rooting. [...] The rapid recovery and similar species composition between islands and between sample plots indicate little overall vegetation disruption. Horn Island does not seem to be seriously affected by the presence of feral hogs." Direct physical disturbance Direct Vegetation; Quercus virginiana Plantae MN High "It is unlikely that the impact is higher, because no decline in the population size was detected (study led at a relevant spatial scale)" Horn Island Mississippi United States North

America North and Central America Plot rooted vs plot unrooted. No fences LS January 2018 DJ; LV March 2019
Sus scrofa Suidae Cetartiodactyla "Bratton, S. P., Harmon, M. E., & White, P. S. (1982). Patterns of European wild boar rooting in the western Great Smoky Mountains. *Castanea*, 230-242." 1982 "Of particular concern to Park management is the intense rooting in some of the wet sites such as Houston Chambers Pond (80% rooted in areas dominated by *Isoetes engelmannii*) and the lighter but frequent rooting in wet sites such as Gum Swamp. [...] The enclosure plots showed their most dramatic increase in cover in the first year after hog exclusion. The cover of the spring flora in the enclosures at the time of establishment was 1.10 that of the rooted controls, on the average, and was 2.0 times that of the controls at the beginning of the second year. [...] The data show that wild boar rooting is very widespread in GRSM and that a wide variety of communities are affected. [...] Species on the states' "rare and endangered" lists were found in hog-rooted plots at both high and low elevations. Examples are *Stachys clingmanii* (TN) and *Woodwardia virginiana* (TN). Recovery after hogs are excluded from a disturbed understory may occur within 3 years, even at sites with intensive rooting. It is probable, however, that once species number is reduced, the flora may be slow to return to its original composition. *Claytonia* has been shown to be reduced by rooting and is also known to be an important food item for hogs (Howe et al., 1979). *Claytonia*, however, appears to be regenerating well, even after almost all the plants have been removed by rooting the year before." Direct physical disturbance Direct *Isoetes engelmannii*; *Stachys clingmanii*; *Woodwardia virginiana*; *Claytonia* spp. Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (small spatial and temporal scales and small sampling size (particularly for *Claytonia*), so the observed decline(s) might only be localised and temporal effects and not a general decline in the native population(s))." Great Smoky Mountains National Park Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Bratton, S.P. (1974) The effect of the European wild boar (*Sus scrofa*) on the high-elevation vernal flora in Great Smoky Mountains National Park. *Bulletin of the Torrey Botanical Club*, 101(4): 198-206." 1974 "The damaged wild flowers include such species as *Claytonia virginica*, *Dicentra cucullaria*, *Lilium superbum*, *Phacelia fimbriata*, *Stellaria pubera* and *Trillium erectum*. Disturbed species exhibit changes in population structure including a reduction in the percentage of mature and flowering individuals and reduction in clump size. [...] The cover in the disturbed areas in early spring is about half that of the undisturbed sites. All the disturbed sites were rooted by hogs during late spring [...] Despite its high frequency, the *Claytonia* population in the disturbed sites contains a large proportion of small and non-flowering plants. The number of *Claytonia* flowers in the hog-rooted plots was even more reduced than the cover. [...] In disturbed upper cove forest, such as Plots 8 and 9, hog rooting has broken up the clumps of *Trillium* and individual shoots are frequent even though the late spring cover of *Trillium* is still relatively high. *Trillium erectum* is 11.9% of the total cover in Plot 8 and 17.4% in Plot 9. In heavily disturbed Gray Beech Forest the *Trillium* population consists almost entirely of individual shoots, very few of which flower. Two of these plots, Plots 10 and 11, had no *Trillium erectum* at all in the 36 square meters sampled. [...] Most of the other spring-flowering herbs in the disturbed sites are also reduced in both cover and frequency. These include *Stellaria pubera*, *Phacelia fimbriata*, and *Dicentra cucullaria*. [...] Although the number of species per square meter is reduced in the heavily disturbed plots, the total number of species encountered over the whole 32-meter square plot is still relatively high. Extinctions do not yet appear to be occurring." Direct physical disturbance Direct *Claytonia virginica*; *Dicentra cucullaria*; *Lilium superbum*; *Phacelia fimbriata*; *Stellaria pubera*; *Trillium erectum* Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (short temporal scale, so the observed decline(s) might only be a temporal effects and not a general decline in the native population(s))." Great Smoky Mountains National Park Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Bratton, S.P. (1975) The effect of the European wild boar, *Sus scrofa*, on Gray Beech Forest in the Great Smoky Mountains. *Ecology* 56(6): 1356-1366." 1975 "In the process of soil sampling, Wolfe (1967) noted that the first knoll west of Double Springs Gap had "almost 100% ground cover." Since then Double Springs Gap has been rooted heavily by wild boar, and samples taken in 1973 indicate that the cover of the understory has been reduced to 8%-10% of the original value in the upper part of the gap [...] Although the diversity of the canopy does not yet appear to be affected by wild hog rooting and grazing, the reduction in herbaceous cover caused by wild hog rooting is positively correlated to a reduction in the number of species per plot for all the plot sizes sampled [...] The herbaceous understory after hog rooting is composed of essentially the same species as the mature undisturbed community. The major change is a steady decrease in numbers and cover with repeated attacks by hogs [...]" Direct physical disturbance Direct Herbaceous vegetation Plantae MO Low "The impact might be lower, because the native population(s) might not be declining (too short temporal scale, comparison between disturbed and undisturbed plots, so the impact on the whole native population is difficult to evaluate)" Great Smoky Mountains National Park Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Howe, T. D., Singer, F.J. & Ackerman, B.B. (1981). Forage relationships of European wild boar invading northern hardwood forest. *Journal of Wildlife Management* 45 (3): 748-754." 1981 "Stomachs from 47 wild boar were collected in northern hardwood stands during spring (Apr-Jun) and summer (Jul-Sep)

1977 and 1978. [...] We also sampled inside and outside of a 10 x 10-m enclosure protected from wild boar for 3 growing seasons, 1977-79. Macroinvertebrates were counted and roots were dried to a constant weight. [...] Spring beauty corms were reduced from a mean of 607 ± 41 kg/ha (\bar{x} - 95% CI) in areas unoccupied by wild boar to 138 ± 9 kg/ha in the occupied areas [...] Inside the enclosure protected from wild boar rooting for 3 growing seasons, biomass of spring beauty corms was 100% greater ($P < 0.02$), numbers of invertebrates were 40% greater ($P < 0.001$), and biomass of fawn lily tubers was not different ($P > 0.50$; Fig. 1) in comparison to a paired sample outside the enclosure. [...] We conclude that wild boar significantly reduce herbaceous and subterranean forages in mesic herb communities within the northern hardwood forest type. The enclosure studies suggested that substantial recovery of macroinvertebrates and herbs without perennial root systems may occur in as few as 3 years, but that plants with fine woody root systems may not recover as quickly. Our data do not predict any plant extinctions." Direct physical disturbance Direct Claytonia virginica; macroinvertebrates Plantae; Animalia MO Low "The alien might have caused a local extinction, but the study design does not allow to detect it." Great Smoky Mountains National Park Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Huff, M. H. (1977). The effect of the European wild boar (Sus scrofa) on the woody vegetation of gray beech forest in the Great Smoky Mountains. Department of the Interior, National Park Service, Southeast Region, Uplands Field Research Laboratory, Great Smoky Mountains National Park." 1977 "The data have indicated that the continual disturbance by hogs is holding blackberry (Rubus canadensis) in the lower vertical stratum near the ground [...] Although there is evidence that yellow buckeye, sugar maple, and shrubs are being disturbed, an assessment of the eventual impact of the wild boar on their distributions and on their gene pools will require careful work with permanent plots." Direct physical disturbance Direct Rubus canadensis; Aesculus octandra; Acer saccharum; shrubs (not specified) Plantae MN Low "The impact might be higher, but the study did not allow to detect the effect of the alien on the native population size." Great Smoky Mountains National Park Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Henry, V. G. (1969). Predation on dummy nests of ground-nesting birds in the southern Appalachians. The Journal of Wildlife Management, 169-172." 1969 "This study was undertaken to assess the possible effect of European wild hog predation on nests of ground-nesting game birds such as ruffed grouse (Bonasa umbellus) and wild turkey (Meleagris gallopavo). [...] The percentage of nests destroyed by species were as follows: snakes spp. (15.4), raccoons (10.7), foxes (9.0), opossums (8.2), crows (5.6), dogs (3.4), hogs (2.6), and striped skunks (0.9). [...] It is concluded that a certain percentage of nests of ground-nesting birds are invariably destroyed by predators each year. This predation is apparently haphazard and the species responsible depends on the relative populations of the various predators and the availability of other foods. European wild hogs are not believed to add to the predation of nests but only to replace that which would have occurred from other predators." Predation Direct Bonasa umbellus; Meleagris gallopavo Animalia MN Medium "The alien might cause a decline in the native population size, but the study did not allow to detect the effect of the alien on the native population size (even it mentions that "European wild hogs are not believed to add to the predation of nests but only to replace that which would have occurred from other predators.")." It is unlikely that the impact is lower (direct observations of predation on nests). Tellico Wildlife Management Area Tennessee United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Siemann, E., Carrillo, J., Gabler, C., Zipp, R. & Rogers, W. (2009). Experimental test of the impacts of feral hogs on forest dynamics and processes in the southeastern US. Forest Ecology and Management 258: 546-553." 2009 "Excluding hogs led to plots with on average less graminoid cover and bare ground but more forb cover, woody cover, and litter. [...] Excluding feral hogs from this forest in east Texas increased the diversity of woody plants in the understory, especially by increasing the likelihood that those with large seeds would occur in a plot (Figs. 1C and 2B). Indeed, every species with an average seed mass >250 mg was more than twice as abundant in fenced plots as in unfenced plots (Fig. 2B). This strong signal for plants with this particular life history characteristic likely reflects the consumption of tupelo seeds (Nyssa), acorns (Quercus) and hickory nuts (Carya) by feral hogs in unfenced plots. [...] The positive impact of hog exclusion on diversity indicates that they are impacting the composition of the understory, and perhaps the future composition of the canopy, by their feeding on seeds [...] Hog exclusion increased the height growth rates of saplings [...] In terms of a large effect on sapling numbers, we found no effect of hog exclusion on sapling abundance" Grazing/herbivory/browsing Direct Pinus taeda; Quercus pagoda; Quercus phellos; Fraxinus americana; Carya texana; Nyssa aquatica; Prunus serotina; Sassafras albidum; Cornus florida; Magnolia virginiana Plantae MO High "It is unlikely that the alien caused a local extinction, because individuals of the native population have been detected." It is unlikely that the impact is lower, because the decline(s) in the native population(s) is/are well shown and the enclosure(s) allowed to quantify the impact of the alien only." Big Thicket National Preserve Texas United States North America North and Central America LS January 2018 DJ; LV March 2019

Sus scrofa Suidae Cetartiodactyla "Cushman, J.H., Tierney, T.A. & Hinds, J.M. (2004) Variable effects of feral pig disturbances on native and exotic plants in a Californian grassland. Ecological Applications 14(6): 1746-1756."

2004 "[...] the richness of both native and exotic plant taxa increased in pig-disturbed areas, and exotic richness increased with increasing amounts of disturbance. [...] A striking result of our four-year study is that biomass of native perennial grasses was unaffected by pig disturbances. This pattern was robust, as it persisted in the two patch types that were dominated by different native bunchgrass species, *Deschampsia* in tall patches and *Danthonia* in short patches." Direct physical disturbance Direct *Deschampsia* sp.; *Danthonia* sp. Plantae MC Medium "The alien might affect the performance of native individuals (no decline in the native population size was detected in the study, but the effect of the alien on the performance of native individuals was not investigated)." Salt Point State Park California United States North America North and Central America LS January 2018 DJ; LV March 2019