

Short Communication

Invasive American mink *Mustela vison* in wetlands of the Cape Horn Biosphere Reserve, southern Chile: what are they eating?

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Abstract The impact of alien American mink on the native fauna of oceanic islands has been demonstrated in a number of locations. In the sub-Antarctic Cape Horn Biosphere Reserve of southern Chile the species is currently expanding in an area where the native fauna evolved in the absence of terrestrial predators. To evaluate any emerging problems we therefore investigated seasonal variation in prey use by mink on Navarino Island within the Reserve. We identified undigested remains in 414 scats collected from the shores of 27 ponds over January–November 2006. Diet consisted mainly of mammals and birds. Mammals, including both native and exotic rodents, were the predominant prey in all seasons but birds were of equal importance during the summer (when birds breed and their abundance and diversity increases on the island). Exotic rodents were the only identifiable mammalian prey item during winter. Native wetland birds constituted a substantial proportion of mink diet, and greater than that reported in other areas. Many birds breeding on Navarino Island are ground-nesting, a strategy that evolved in the absence of native mammalian predators. Considering the international importance of this region, our results emphasize the need for an assessment of the impact of mink predation on the populations of native prey.

Keywords American mink, Cape Horn, diet, invasive species, *Mustela vison*, seasonal variations, wetlands.

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The Cape Horn Archipelago has been identified as one of the 24 most pristine ecoregions of the world (Mittermeier et al., 2003), and was recently declared a Biosphere Reserve (Rozzi et al., 2006). Although the archipelago is isolated and located in the sub-Antarctic region it has not been spared the blight of biological invasions (Vitousek et al., 1996). One of these was by the American mink *Mustela vison*, imported to fur farms in southern Chile and Argentina during 1930–1950 (Jaksic et al., 2002). Accidental escapes and intentional releases led to the establishment of feral populations in many areas of both southern Argentina (Chehébar, 1985) and Chile (Medina, 1997; Jaksic et al., 2002). The c. 2,528 km² Navarino Island, part of the Cape Horn Biosphere Reserve, is located south of Tierra del Fuego. Although mink were found in the wild in Tierra del Fuego as early as the 1960s, the first mink on Navarino Island was only recorded in 2001 (Rozzi & Sherriffs, 2003). As birds constitute the most diverse vertebrate group in the Reserve, with several ground-nesting species (Rozzi & Sherriffs, 2003), there is concern over which species are part of the diet of the alien American mink. Here we quantify the diet of mink and its seasonal variation to examine the potential impact of this alien species on ground-nesting birds in the wetlands of Navarino Island.

Navarino Island, which contains one settlement, Puerto Williams, with 2,262 inhabitants (Fig. 1), consists of thousands of water bodies (lakes, ponds, streams and bogs) and forest areas. The ecoregion corresponds to the Sub-Antarctic Magellanic Forest, dominated by the genus *Nothofagus* within a mosaic of *Sphagnum* spp. bogs. Most of the aquatic bird species inhabiting the wetlands are non-residents and arrive in summer to breed (J.T. Ibarra, R. Rozzi, H. Gilabert, C.B. Anderson, S.M. McGehee & C. Bonacic, unpubl. data). There are 56 species of birds in 25 families in the wetlands and adjacent habitats of Navarino Island. Potential mammalian prey of mink on the island include both native (yellow nosed grass mouse *Abrothrix xanthorhinus* and long-tailed pygmy rice rat *Oligoryzomys longicaudatus*) and exotic rodents (beaver *Castor canadensis*, mouse *Mus musculus*, muskrat *Ondatra zibethica* and Norway rat *Rattus norvegicus*). Aquatic prey include native fish (*Aplochiton taeniatus*, *Aplochiton zebra*, *Galaxias maculatus* and *Galaxias platei*) and introduced trout species (*Onchorynchus mykiss* and *Salvelinus fontinalis*),

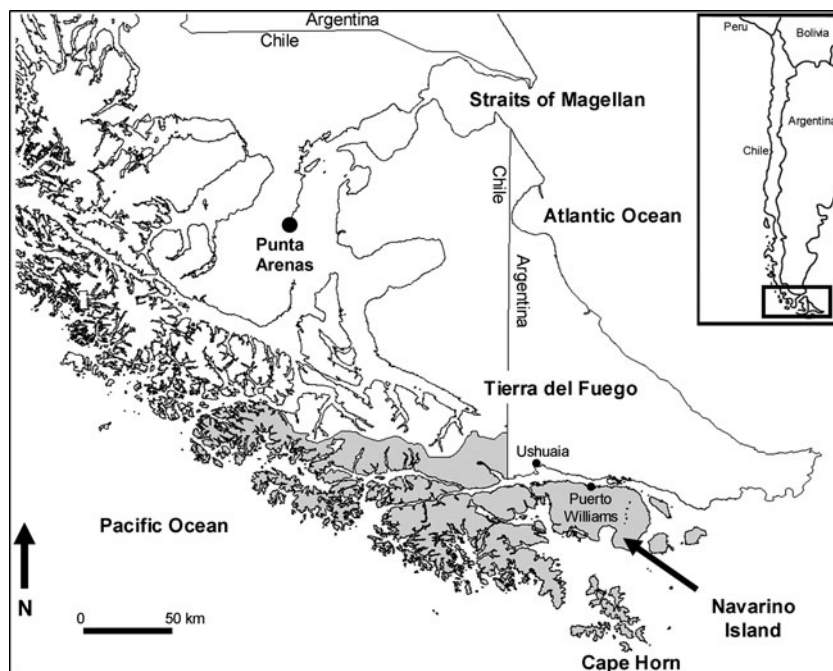


FIG. 1 Southern South America, showing the Cape Horn Biosphere Reserve (shaded in grey) and Navarino Island, Chile.

which are known to be eaten by mink in other regions of Chile and Argentina (Medina, 1997).

A total of 414 mink scats were collected over January–November 2006 along the shoreline of 27 ponds. Faeces were sorted into seven categories according to their contents: (1) bird, including feathers, bone fragments and egg shells; (2) mammal, including hair, teeth, and bone fragments; (3) fish, including vertebrae, scales and otoliths; (4) insects, including appendages and exoskeleton fragments; (5) crustaceans, including appendages and exoskeletal fragments; (6) molluscs, including valve parts; (7) plant matter, including seeds and leaves. Mammals and birds were identified to species, if possible, using taxonomic keys and references. In the case of mammals, teeth and the medullar and cuticle scale patterns of hairs were compared to patterns described in guides (Reise, 1973; Chehébar & Martín, 1989; Pearson, 1995). For the few bird species, feather colour patterns were used for identification. We computed frequency of occurrence expressed as a percentage (number of scats with a prey category divided by the total number of scats, by season), and percentage of bulk of a prey category (proportion of volume of a scat with a prey category multiplied by dry weight of the scat, divided by total dry weight of scats, by season).

The diet of mink in Navarino Island's wetlands consisted mainly of mammal, birds, insects and plant matter. Whereas the occurrence of mammals and birds in scats was similar during summer and winter, the representation of mammals in the scats in autumn and spring was almost double that of birds (Fig. 2). Of 272 scats with mammal remains, 235 comprised fragments amenable to further

identification, including native, exotic and unidentified mammals (Table 1). Exotic mammals (identified in 86 scats) were most abundant in the scats during autumn and winter, whereas native mammal species dominated during the summer (Table 1). Hair identification showed that muskrat ($n = 78$) was the most important exotic mammal prey followed by beaver ($n = 4$) and murid rodents ($n = 4$). Bird consumption was higher during the summer when 58.5% of scats contained bird remains (Fig. 2). Bird remains were identified in 202 scats, but only 11.4% contained remains that could be identified to species level. Remains of three species were identified: the ground-nesting upland goose *Chloephaga picta*, and tree-cavity nesting thorn tailed rayadito *Aphrastura spinicauda* and southern house wren *Troglodytes musculus*. Egg shells were found in only 0.03% of the scats collected during spring and summer ($n = 9$) but mink eat the contents of eggs without necessarily eating the shell (Ferrerás & Macdonald, 1999). Plant matter was more frequent in winter scats and seemed to compensate for the decrease in mammal consumption recorded for this season (Fig. 2). For details of the importance of other prey items see Fig. 2.

American mink have only recently invaded Navarino Island and this is the first report of their diet in the early years of their establishment, with a significant representation of native wetland and terrestrial birds. The consumption of birds was highest during the warmer months. Of mammalian prey, introduced species were mainly consumed during autumn and winter. This demonstrates that introduced prey species are available for mink when wild rodents and birds are probably less abundant. The

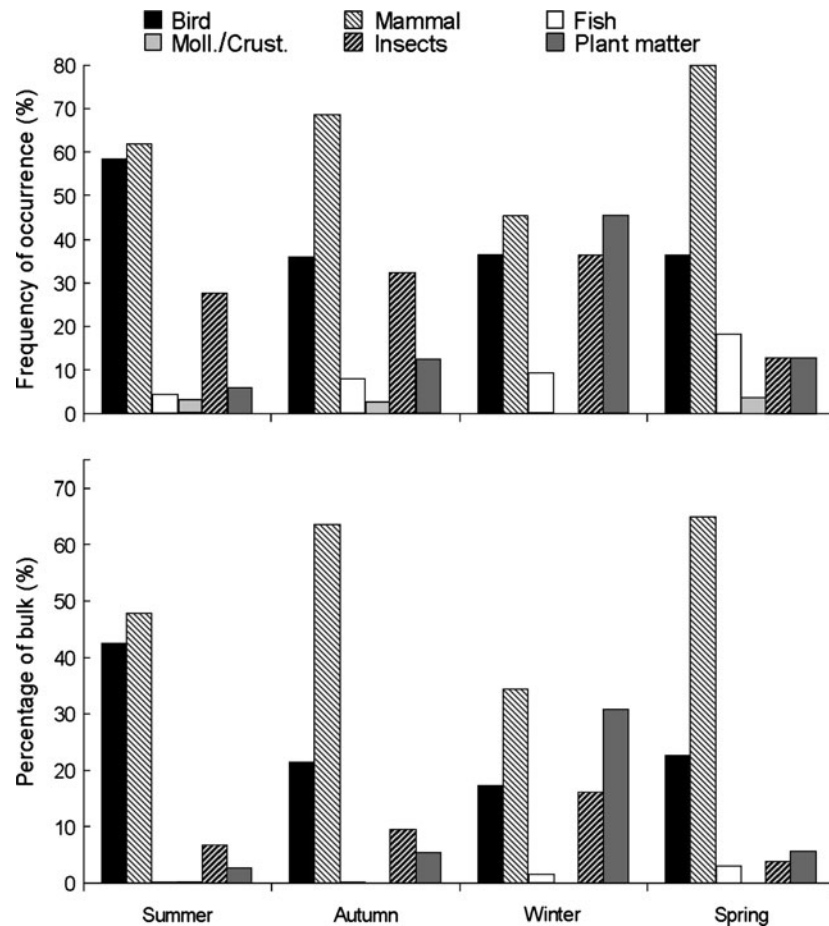


Fig. 2 (a) Percentage frequency of occurrence and (b) percentage of bulk of bird, mammal, fish, mollusc/crustacean and plant remains (see text for further details) in American mink scats collected on Navarino Island (Fig. 1), by season (see Table 1), in 2006.

three bird species identified in scats have their southernmost breeding distribution in the Cape Horn Biosphere Reserve.

TABLE 1 Mammalian remains found in mink scats, by season, with % of scats containing exotic, native and unidentified mammal species, on Navarino Island (Fig. 1).

Season	No. of scats	No. with mammalian remains	% with exotic mammals	% with native mammals*	% with unidentified mammals
Summer (Jan.–Feb.)	236	146	21.2	51.4	27.4
Autumn (Apr.–May)	112	77	46.8	26.0	27.3
Winter (July–Aug.)	11	5	60.0	0.0	40.0
Spring (Oct.–Nov)	55	44	36.4	38.6	25.0

*Representation of native mammals differed significantly from that of exotic mammals between seasons ($\chi^2 = 18.97$, $df = 2$, $P < 0.0001$; analysis excluding winter data). Differences were driven by summer peak in consumption of native mammals (significant differences disappeared when summer was excluded; $\chi^2 = 2.13$, $df = 1$, $P = 0.144$).

The consumption of birds by mink in the Reserve appeared to be higher than reported in other parts of Patagonia (Medina, 1997; Previtali et al., 1998) and elsewhere (Erlinge, 1969; Melquist et al., 1981; Ferreras & Macdonald, 1999) but comparable to that on Scottish islands in the UK (Clode & Macdonald, 1995). Unsurprisingly, birds mostly featured in the diet of mink during the nesting season.

Because there are no terrestrial mammalian predators native to Navarino Island (Anderson et al., 2006), many bird species have evolved ground-nesting strategies (Moore et al., 2003). Under these circumstances invasive mammalian predators are particularly damaging (Amarasekare, 1993; Macdonald et al., 2007). The high proportion of birds in the diet of mink on Navarino Island is only comparable to that recorded for islands sharing the same characteristics (Clode & Macdonald, 1995) and where negative effects of mink on native birds were corroborated. Our findings indicate unambiguously that mink on Navarino Island are feeding on native vertebrates. We emphasize the need for further research to reveal whether predation by invasive American mink is affecting the populations of native mammals and birds in the Cape Horn Biosphere Reserve.

We are designing studies that will allow us to answer this question.

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Biographical sketches

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