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American mink (*Neovison vison*) trapping in the Cape Horn Biosphere Reserve: enhancing current trap systems to control an invasive predator

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Improvement of invasive American mink (*Neovison vison*) trapping methods in the Cape Horn Archipelago is a priority for wildlife managers. We assessed the use of cubby sets (16 × 16 × 30 cm plywood boxes) containing body gripping lethal traps to control mink along the Beagle Channel. We compared effectiveness, selectivity and weather condition resistance between two cubby set designs: (i) open front, and (ii) restricted entrance (lidded with a 6 cm aperture). The effectiveness of bait was evaluated between fresh *versus* canned fish. Thirteen minks and no non-target species were captured with the restricted entrance systems, as compared with three minks and 25 non-target individuals (six species) in open front cubby sets. Fresh fish resulted in more captures than canned fish, and lids made traps less susceptible to false activation. Traps inside restricted entrance cubby sets, baited with fresh fish were found to be most suitable for mink control and/or eradication efforts.

Introduction

Invasive terrestrial carnivores constitute a major threat to endemic biodiversity of islands (Courchamp *et al*. 2003), since native species often evolved without suitable defensive behaviors (Banks *et al*. 2004). Naïve native fauna on such islands have suffered population declines and even extinctions (Courchamp *et al*. 2003). The UNESCO Cape Horn Biosphere Reserve (CHBR) in the Tierra del Fuego Archipelago of southern South America (55°S) is found within the sub-Antarctic forest ecoregion, which has been classified as one of the world's

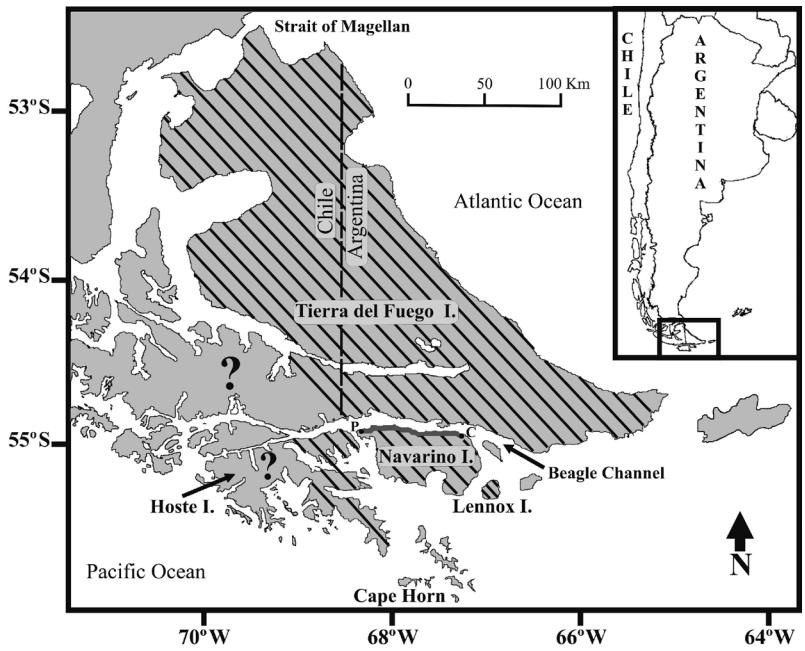

Fig. 1. Map of the Tierra del Fuego Archipelago, showing the islands where invasive American mink (*Neovison vison*) have been recorded (diagonal hatched lines). The trapping site (dark-grey line) was on the north coast of Navarino Island (Chile) between Caleta Eugenia (C) and Puerto Navarino (P). '?' indicates unconfirmed expansion fronts of the invasion on colonized islands.

most pristine remaining wilderness areas (Mittermeier *et al*. 2002). Nonetheless, more than 55% of the CHBR's terrestrial mammal species are exotic (Anderson *et al*. 2006). Among these, the American mink (*Neovison vison*) was released onto Tierra del Fuego Island around 1950 (Fabbro 1989). Within the CBHR, mink were first recorded on Navarino Island in 2001 (Rozzi & Sherriffs 2003), on Hoste Island in 2005 (Anderson *et al*. 2006) and recently (2009) on Lennox Island (Agricultural and Livestock Service SAG database). The mink's generalist feeding behavior, semi-aquatic habits and swimming ability have allowed it to colonize diverse areas (Dunstone 1993) and spread between the archipelago's islands. As an invader, the mink may be detrimental both to native species by direct predation or competition and to economic activities (e.g., predation on important tourism resources such as marine birds) of the invaded area (Macdonald & Harrington 2003, Bonesi & Palazón 2007). Considering the mink's known impacts in other areas, its widespread range in the CHBR (Fig. 1), and that the Beagle Channel has been prioritized as a significant biodiversity conservation zone for sub-Antarctic birds (Pizarro *et al*. 2012), natural resource managers and scientists are charged with generating a coordinated response to conserve native species and the ecosystem (Anderson *et al*. 2011).

Control strategies are the best way to mitigate the effects of invasive carnivores in isolated places with logistical complications (Zabala *et al*. 2010). Particularly, reductions in invasive mink populations were found to have a positive effect on the native fauna (Nordström *et al*. 2003). On the other hand, an efficient trapping mink system is critically important, yet a potentially expensive management priority to protect native species (Bonesi *et al*. 2007), and involves working at the interface between academia and application through government agencies (Anderson *et al*. 2011). This is because decision makers and the general public play a vital role in the development and success of these control efforts (Anderson & Valenzuela 2011). Also, trapping systems often require improvements over conventional methods to work in specific contexts (Zuberogoitia *et al*. 2006), particularly with minks as they are difficult animals to trap due to their elusive behavior (King *et al*. 2009). Therefore, a study on the best trapping system and appropriate bait is vital for the implementation of effective control programs (Moore *et al*. 2003). Currently, body gripping lethal traps are recommended and used to capture minks because they are easily

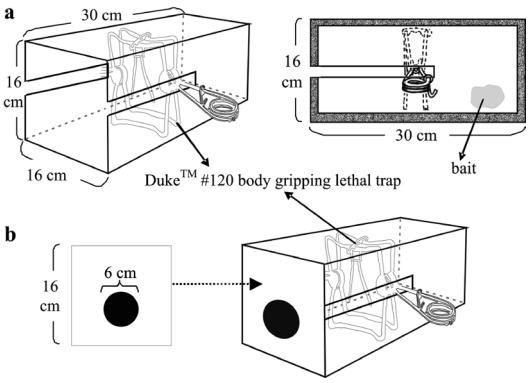

Fig. 2. Duke™ #120 body gripping lethal trap inside a wooden box (cubby set) used in this study. (**a**) Details of the trap with an open front (without lid), (**b**) more efficient design with a restricted entrance.

baited, set, checked and kill the target animal with the least amount of suffering (Hill 2006). However, this system may not be sufficiently selective towards the target species and may not work properly under extreme weather conditions (Harding 1906, Proulx *et al*. 1990). Also, to avoid the incidental killing of non-target species, the use body gripping lethal traps inside a wooden box, called 'cubby set' (Hill 2006), is recommended, yet at the same time the effectiveness of the traps may be compromised due to the cubby set system itself. In this context, the objective of the present study was to evaluate the effectiveness and selectivity of body gripping lethal traps used inside cubby sets to control American mink in the CHBR.

Material and methods

We placed body gripping lethal traps (model #120, Duke Traps Company, USA) inside a cubby set with two different designs. The cubby set system included a rectangular 16 cm × 16 cm × 30 cm box made from 1-cm-thick laminate plywood. Each box had a closed end to simulate a tunnel, which the animals feel safe to enter. Selectivity for capturing mink and non-target species of this system was evaluated by comparing cubby sets with restricted and open entrances. To restrict the entrance to the cubby set system, the open end of the box was covered by a lid with a hole 6 cm in diameter (Fig. 2). We also tested the effectiveness of fresh against canned fish as a bait to assess the best trap–bait combination. Trap sets weighed 2 kg and had a volume of 7680 cm^3. The addition of the lid increased the weight by only 30 g.

Suitability of this technique to trap minks was tested along the coast of the Beagle Channel on Navarino Island because this is the only area of the CHBR logistically accessible via a dirt road to allow a systematic and large-scale deployment of traps. Trap stations were set every 400 m along 91.6 km of the coast line from Caleta Eugenia to Puerto Navarino (Fig. 1). Two traps were set at each station (one with and one without a lid) within 30 m from the high tide line. The study was carried out between 15 October–30 November 2007 and 20 January–15 February 2008. During each period, half of the traps were baited with fresh fish and the other half with canned fish, alternating the bait of each trap type (with and without lid) between consecutive trap stations. Traps were hidden among the bushes or camouflaged with natural objects. After activation, each trap was checked and re-baited, usually on alternating days, until capture or for a maximum of 15 days.

Results

A total of 229 trap stations with 458 traps were set during a total of 2966 trap days. Cubby sets with restricted entrance captured 13 minks and no non-target species (Fig. 3). The open front cubby set system captured three minks and 25 individuals of six non-target species (Table 1). Most of the minks were lured with fresh fish, both in the restricted entrance system (11/13 or 85%) and the open front cubby set (2/3 or 67%). Similarly, 23/25 (92%) of the non-target individuals showed a preference for fresh bait. Additionally, traps without lids were eight times more likely to be activated for no apparent reason, and only once was a cubby set with lid arbitrarily activated.

Discussion

The present study provides evidence regarding important differences in trapping systems

that should be used in existing and planned mink control efforts. The use of body-gripping lethal traps within a restricted entrance cubby set system, covered with a lid having a 6 cm diameter hole and baited with fresh fish were found to be a suitable and successful method and should be considered for deployment at larger-scale control efforts for American mink in the remote CHBR based on: (1) demonstrating greater effectiveness and selectivity for capturing and killing mink; (2) targeting the mink specifically, rather than non-target species; (3) having less arbitrary false activations due to weather conditions or better access by non-target species; and (4) being more easily baited and handled and of lower volume and weight than formerly proposed trap systems (e.g., heavier and more voluminous PVC tube traps, Rozzi & Sherriffs 2003 and Tomahawk live traps, Anderson *et al*. 2006). Anderson *et al*. (2006) calculated that mink density along the rocky shore lines on the north coast of Navarino Island was 0.79 mink km^{-1}. According to this value, the maximum number of mink in the study area was approximately 72 animals. Consequently, during this study we could have potentially captured and killed at least 22% of the minks in the study area, demonstrating the importance of this trapping system for planning American mink control strategies. Also, we argue that it is inefficient, ineffective and even unethical to continue the use of body-gripping lethal traps within open front cubby set in the CHBR, given the high mortality of various non-target species. This approach was found to be particularly harmful for the native avifauna, which is precisely the group of animals that is in need of protection in the face of mink invasion and which has high levels of diversity along the shores of the Beagle Channel (Pizarro *et al*. 2012).

Table 1. Non-target species captured with the open-front cubby set system. * indicates exotic species.

Species	*n*
Birds	
Chimango caracara (*Milvago chimango*)	9
Southern caracara (*Caracara plancus*)	5
Kelp gull (*Larus dominicanus*)	2
Flightless steamer duck (*Tachyeres pteneres*)	1
Mammals	
Domestic/feral cat (*Felis silvestris catus*)*	6
Feral pig (*Sus scrofa*)*	2

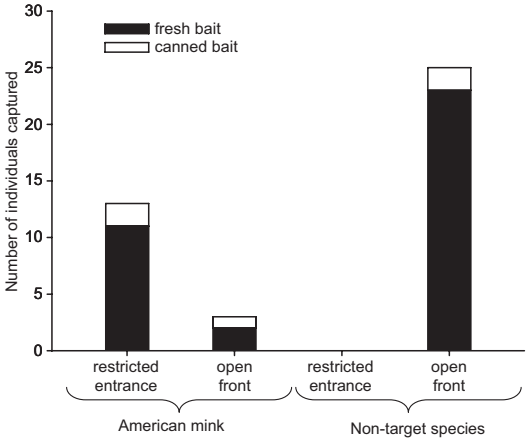

Fig. 3. Number of individuals captured (American mink or non-target species) by traps, their design (open front or restricted entrance), and fish bait (fresh or canned).

Future research should attempt a more holistic approach to invasive species management and focus on analyzing relationships among the invasive American mink and several ecological or social aspects of the CHBR, which can be directly applied to their control and/or eradication. These new applied studies should also further refine trapping systems, including such methods as floating rafts (Reynolds *et al*. 2004) and lures.

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