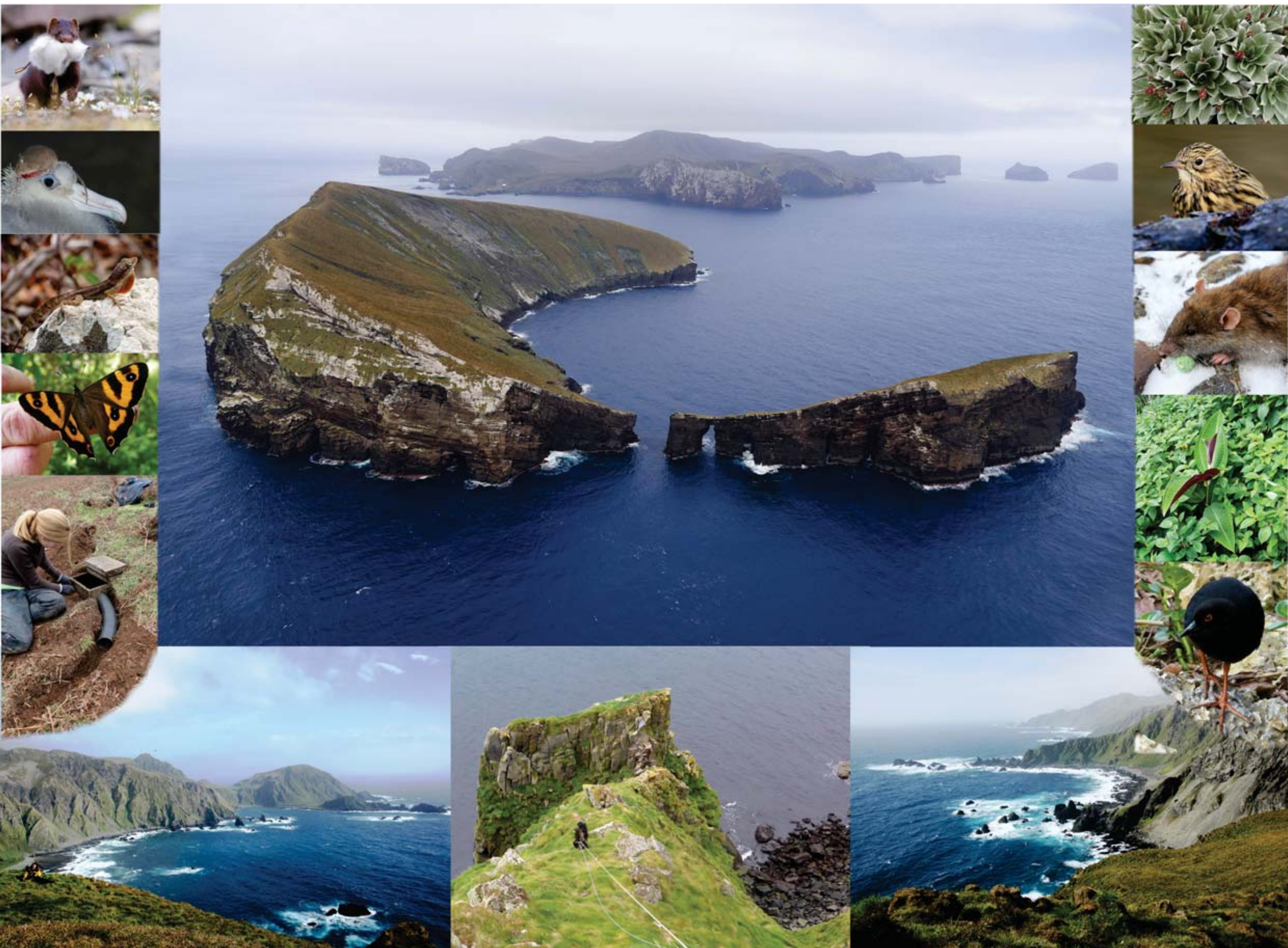
Island invasives: scaling up to meet the challenge

Proceedings of the international conference on island invasives 2017

Edited by C.R. Veitch, M.N. Clout, A.R. Martin, J.C. Russell and C.J. West



Occasional Paper of the IUCN Species Survival Commission Nº 62

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The papers and abstracts published in this book are the outcome of the Island Invasives 2017 Conference co-hosted by the University of Dundee and the South Georgia Heritage Trust, held at the University of Dundee, Scotland, from 10 to 14 July 2017.

The guidelines for this conference were: "any topic relating to invasive alien species on islands, where the term 'island' is broadly interpreted and (rather ironically from a classical perspective) may include a submarine island – e.g. a coral reef. The invasive species involved may be flora or fauna. Particularly encouraged were papers that relate to the theme of the conference – scaling up to meet the challenge – or to either biosecurity/quarantine or post eradication impacts on native biota."

The editors thank Carola Warner for her assistance with editing of many papers.

All papers have been peer reviewed and we thank all reviewers. The content of the papers is the choice of the authors. The style of presentation has been modified in consultation with the editors. Nomenclature follows international published standards.

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First results from a pilot programme for the eradication of beavers for environmental restoration in Tierra Del Fuego

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Abstract A pilot project for the eradication of beavers (*Castor canadensis*) in Tierra del Fuego started as part of a bi-national agreement, signed between Argentina and Chile, to restore the affected environments. The project covers nine pilot areas of different landscapes and land tenures in the Argentinian part of Isla Grande de Tierra del Fuego. We report on the results from operations in the first of the pilot areas. From October 2016 to January 2017, ten trappers (named restorers for advocacy purposes) used body-grip traps, snares and an air rifle, in a first phase, which included 2,237 trapping nights and 1,168 trap-sets. Shooting efforts were not monitored. Traps were set for 1,401 trapping-nights and caught 175 beavers at a success rate of 12.5% (captures per trap night). Snares were set for 936 snare-nights and caught 22 beavers at a success rate of 2.3%. Seven beavers were shot. Most beavers (65%) were removed during the first week of trapping in the different watercourse sections. Stopping trapping for a week or more did not increase efficiency. From March to May 2017 restorers removed 24 survivors and/or reinvaders, including 10 from two previously untrapped colonies. Capture efficiency for this removal period was low for body-gripping traps but not for snares. The sex ratio of catches was 47% females to 53% males. The age structure of catches was 15% kits, 29% yearlings, 51% adults, with 4% not aged. An estimated total of 41 colonies was trapped, giving an average of 5.6 animals per colony. After nominal eradication was declared by restorers, 154 camera trapping nights were deployed to assess eradication success. Nine cameras (of 26 cameras used) detected beavers. Therefore, eradication was not achieved using the methods and efforts in the first part of the pilot study. This highlights the need for more effort or the application of different techniques or trapping strategies. For example, daily checking of traps may cause the animals to be cautious so, the next step in the programme will involve exploring alternative trapping methods to reduce disturbance.

Keywords: Argentina, *Castor canadensis*, eradication programme, management, pilot study, trapping

INTRODUCTION

North American beavers (*Castor canadensis*) are semi-aquatic and territorial rodents. They live in family groups generally composed of two breeding adults, two yearlings and two kits; the yearlings are forced to leave the natal colony by the age of two (Lizarralde & Escobar, 1997; McTaggart & Nelson, 2003). The family group controls a group of adjacent dams, defending its territory from other beavers. Each family group can build one or more lodges (although they may also den in the river banks) and share a single food cache.

In 1946, 20 beavers were introduced from Canada to Tierra del Fuego, South America (Pietrek & Fasola, 2014), with the aim of developing a fur industry. Beavers found extensive suitable habitats, high availability of food, lack of predators and unoccupied territory (Lizarralde, 2004). These features allowed beavers to spread quickly throughout Tierra del Fuego (Skewes, et al., 2006; Anderson, et al., 2009). Several impacts on the environment of Tierra del Fuego were reported and it was suggested that beavers caused the largest landscape-level alteration to the region since the Holocene (Anderson, et al., 2009). The most obvious impacts are the reduction of the riparian vegetation due to their activities, which includes the building of at least 70,000 dams in Argentinian Tierra del Fuego (Eljall, et al., 2016), affecting at least 31,000 ha of forests, grasslands and peat bogs (Henn, et al., 2016), as well as the fen areas (Westbrook, et al., 2017). The beech forests of Tierra del Fuego are not adapted to the impact of beavers, so their impacts are long lasting (Anderson, et al., 2009). Their dams also limit the dispersal of native fish and the water in their dams changes the benthic communities, modifying the macroinvertebrate assemblages by engineering changes to the fluvial and riparian environment (Anderson, et al., 2006). Beavers also modify the dynamics of the streams by altering sedimentation (Vazquez, 2002; Martin, et al., 2015). Last, but no less important, beavers impact the economy by flooding roads and culverts, and affecting ranching activity, reducing pastures by flooding as well as affecting fences.

Attempts to control beavers by commercial hunting during the 1990s and 2000s failed. Beavers were detected in continental South America in the 1990s (Skewes, et al., 2006; Wallem, et al., 2007; Schiavini, et al., 2008; Anderson, et al., 2009), although recent dendrochronological evidence takes their arrival date to 1968 (Graells, et al., 2015). The presence of beavers in the continent raised alarm about the possibility of their dispersal through the greater American continent. In view of these issues, Argentina and Chile started, in 2005, to discuss a change in strategy.

Eradication was deemed as feasible (Parkes, et al., 2008), and adopted as a strategy by Argentina and Chile in 2008, after signing a bi-national agreement for the restoration of the southern ecosystems affected by the beaver (Malmierca, et al., 2011). At present, both countries are performing pilot projects, funded by the Global Environment Facility (GEF) and national counterparts. The pilot project in Argentina is under the umbrella of the major project “Strengthening the Governance for the Protection of Biodiversity through Formulation and Implementation of the National Strategy for Invasive Exotic Species” GEF Project ID 4768. The project runs from 2015 to 2019, covering nine pilot areas of Tierra del Fuego.

The objectives of the project (Schiavini, et al., 2016) are essentially to answer questions raised during the feasibility study: building capacity, learning about technical and organisational challenges of the process, showing the environmental benefits of beaver removal, and deciding the next steps between the two countries.

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Several research priorities and questions in relation to the eradication of beavers are expected to be answered by the pilot project:

- How much effort is needed to eradicate beavers and to declare eradication on a small scale?
- What factors affect effectivity of trapping? The tools used? The sequence of deployment? Learning by beavers to avoid traps?
- What is the effort demanded for active surveillance to avoid reinvasion?
- How to develop passive surveillance from society?
- Is the bureaucracy able to accommodate the dynamics of eradication projects?
- Are any beavers found, after nominal eradication is declared, likely to be survivors or reinvaders?
- Does the environment recover in a short time frame after beaver removal?

The nine Argentinian pilot areas cover an area of 1,017 km^2, with a range of 14–238 km^2 (Fig. 1). In this paper, we report the results of operations achieved in the first pilot area, Esmeralda-Lasifashaj, and discuss the challenges revealed for the larger major project.

MATERIALS AND METHODS

The Esmeralda-Lasifashaj area (54 km^2) belongs to the ecological region of the forest range (Collado, 2007). The landscape represents a U-shaped valley with the valley bottom covered with *Sphagnum* peat bogs and poorly drained mires (Figs 2 and 3). Slopes are covered with southern beech forests (*Nothofagus* spp.) with the vegetation line reaching about 700 m altitude. The main valley is surrounded by eight lateral valleys. The area is open to reinvasion as it has no geographical boundaries that limit beaver dispersal, mainly from the west and east. However, it was proposed as a pilot area for several reasons: it is located only 20 km from Ushuaia city, is used by the public for recreation and tourism, and the area holds a permanent cross-country ski trail, which is affected by beavers. For these reasons, the area was selected as a way of showing the environmental, social and economic benefits of removing beavers.

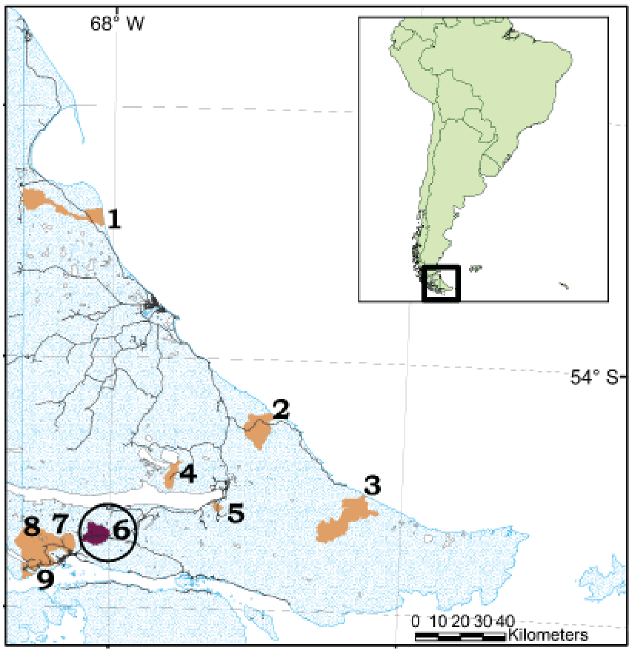

Fig. 1 The Argentinian sector of Isla Grande de Tierra del Fuego. Numbers refer to each pilot area. 1: Arroyo Gamma. 2: Arroyo Asturiana. 3: Rio Malengüena. 4: Río Mimica. 5: Arroyo Indio. 6: Esmeralda-Lasifashaj. 7: Arroyo Grande, 8: Rio Pipo, 9: south of Tierra del Fuego National Park. The black circle shows the location of the pilot area Esmeralda-Lasifashaj.

Fig. 2 An aerial view of a series of beaver dams in the bottom of the main valley of Esmeralda-Lasifashaj pilot area.

Fig. 3 An aerial view of a series of beaver dams in the Esmeralda-Lasifashaj pilot area, in an area of poor drainage at the contact between peat bogs and forest. Note the riparian forest impacted by cutting.

The dams and lodges built by beavers are so conspicuous that they can be identified in satellite images. During the planning process, beaver dams and lodges were mapped using Google Earth and integrated with the dams identified by Eljall, et al. (2016). Then, 363 locations of beaver activity were loaded into the GPS units used during the operation (Garmin eTrex 20x), to be used as a general guide for moving through the terrain to the areas impacted by beavers.

The skills of the personnel involved in hunting should include not only good trapping skills, but also the ability to spend several days in the field in the harsh weather of Tierra del Fuego and deliver good trapping data, essential for assessing trapping efforts and eradication success. Good, traditional trappers work with a focus on yield, while personnel needed for eradication need to "look for the last animal". With this change in focus, 10 people were selected and trained from a group of 39 people interviewed. The training was performed by our own personnel, staff from the National Parks Administration and from the volunteer fire brigade. Training included the use of trapping tools, data recording and first aid in the field. The final selection included a combination of people with previous trapping skills and people with good outdoor abilities and a willingness to learn. Hunters are publicly called "restorers" as a way of helping to advocate for the final objective of the project, i.e. building the correct conditions for environmental restoration by means of beaver eradication.

The trapping equipment and tools were purchased with advice from the Animal and Plant Health Inspection Service of the USA, who also provided a handbook for best-practice management. Two main tools are being tested, body-gripping traps and non-powered cable devices (snares), complemented with a PCP air rifle. The group was commanded by a chief of operations and assisted by a logistics officer.

The spatial and temporal progression of trapping differs from traditional trapping operations, where hunters deploy their tools progressively through the landscape, usually in a regular or grid mode. Given that the trapping target is located along watercourses or sectors of poor drainage such as edges of peatlands, trapping effort follows these landscape features. For planning purposes, the pilot area was divided into sectors that brought together groups of sections of channel or activity detected during planning. Watercourse sections were trapped inside sectors until "nominal" eradication was achieved, when trappers moved to another watercourse section. After nominal eradication of a sector, operations progressed to another sector.

At the watercourse section scale, trapping was made according to decisions made by each restorer. A "trap-set" is a trap (either a body-gripping trap or a snare) set at a particular location and for a number of consecutive trapping nights. Traps are usually set along watercourses and near dams with beaver activity denoted by the girdling of trees, fresh beaver trails, freshly gnawed branches in front of the dams, castor mounds, and /or accumulation of submerged tree branches with leaves. Traps are also set either in trails or slides made by beavers or in purpose-made openings at the front of the dam. The limits of beaver colonies are not always evident. However, during fall and winter, family groups gather at one lodge, so colonies are more easily distinguishable. During spring and summer, young animals disperse from their natal colonies, so the movement of animals leads to colony boundaries being confused. Also, traps can be set in the same place for more than one night. After a number of trapping nights, hunters noticed a reduction in their trapping efficiency, and at some point, they decided that a "nominal" eradication was achieved in this watercourse section and moved to another section. As a result, data recording is quite different from some other hunting and trapping operations, where hunters either traverse a landscape searching for their prey, or traps are set up more permanently at sites or along transects or grids.

The records of trapping and yields attempted to reflect the operation in great detail. An account of each trap set and its subsequent outcome (set, capture, activation without capture, not activated, removed) was recorded every day, taking into account the use of both the body-gripping traps and snares, with each one requiring daily checks for humanitarian reasons. Each trap had a unique number for identification. For data recording, an application was built into Cybertracker software (Steventon, 2017), allowing us to build a database with a record of each trap (set, revision and retirement, with or without capture), as well as ancillary data (e.g. location of placement, use of attractant). The application is available upon request, or at <http://cybertrackerwiki.org/index.php?title=Community_applications>. For data recording, we used an outdoor rugged tablet (Boolean A71, Boreal Technologies Inc). The database can be transferred to Spreadsheets or to any GIS system, as Cybertracker software can export shapefiles. Restorers also carried a GPS unit for tracking their activity.

Operations ran from October 24, 2016 to January 31, 2017 in the first phase. From March 2 to May 15, 2017 (Fig. 4), the area was checked again to remove survivors/invaders. Restorers worked mostly daily, during blocks of five days or four trapping nights, commuting each day from Ushuaia to the pilot area that is traversed by a National Route highway. When restorers worked on the lateral valleys, they camped for between three and five days. A Robinson R44 helicopter was used to search for dams in specific areas (Johnston & Windels, 2015) and to transport personnel and equipment to lateral valleys. Two colonies were left untrapped until the survivors-reinvaders removal phase, as they were used by tourist operators during the summer. Tour operators agreed as this would be the last time they would be using these colonies for their tours.

Trapped animals were aged in the field, based on external measurements, as kits, yearlings or adults, and were sexed by detection of the baculum. Samples were stored for accurate age determination, the breeding status of females and for future assessment of the accuracy of genetic tools to distinguish survivors from new invaders in areas free of beavers.

For verification of eradication, an independent team visited a sample of the watercourse sections, as restorers declared the "nominal" eradication, between December 12, 2016, and May 24, 2017. Twenty-six camera traps were set in front of artificial castor mounds with beaver lure at a 1–2m distance from the camera and no more than 1m from the water body. Each camera was placed at a height of between 20 and 40 cm from the ground to capture full images of beavers, and operated, on average, six days, with a range of 3–10 days. Cameras were located both in the main valley and in all the lateral valleys.

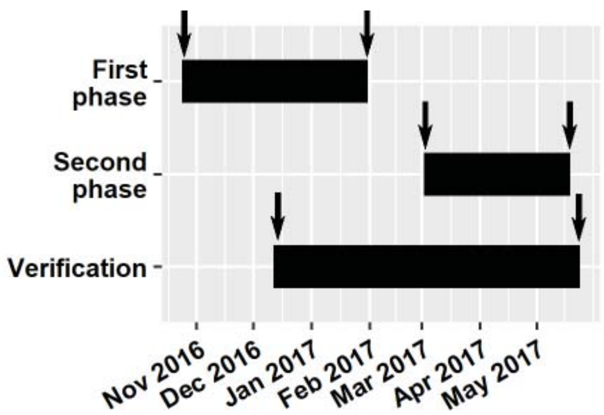

Fig. 4 Gantt chart including the first and second eradication step (the arrows mark the first and last capture) and the period of camera-trap vigilance (the arrows mark the first and the last detection).

As operations took place during spring and summer, territorial limits were difficult to assess. The total number of colonies was estimated based on the spatial distribution of catches following Johnston & Windels (2015). The Esmeralda-Lasifashaj area was divided into 18 sectors for data analysis. All statistical analysis was performed in Infostat (Rienzo, et al., 2016).

A monitoring plan measuring the environmental benefits of removal of the beavers is being developed by independent groups. The monitoring includes assessment of the of trees that will not be subject to beaver cutting after beaver removal, water quality, macroinvertebrate diversity, metabolism of the watercourse and fish diversity.

RESULTS

Mop-up phase

From October 2016 to January 2017, restorers walked 2,930 km over the area (Fig. 5). For logistic purposes, a helicopter was flown for nine hours. Trapping nights were derived from trapping records by summing up trap revisions and retirements. An additional 5% was added to the effort for the offset for traps that were not checked daily (based on an analysis of a subset of data).

Body-gripping traps were deployed in 715 trap sets, yielding 1,401 trapping nights. Snare traps were deployed in 453 trap sets, yielding 936 trapping nights. This represents a total of 2,337 trapping nights with 1,168 sets. Each trap operated on average 1.97 nights with a range of one to four nights. Rifle effort was not monitored, as it was employed in an opportunistic fashion. A total of 197 beavers were removed by trapping; 175 with body-gripping traps and 22 with snares, together with seven individuals that were shot (Fig. 6). The trapping efficiency was 12.5% for body-gripping traps and 2.3% for snares, giving an average efficiency of 9% for trapping.

The capture efficiency for each day of the working blocks was assessed. For example: during the first day of the working block the main activity was setting traps; during the second day of the working block there were 443 reviews or removals and 46 catches, which gives an efficiency of 10.4%; on the sixth or seventh day, very little field work was performed. This analysis was then limited to reviews and retirement of traps from Tuesday to Friday. Using a test of more than two proportions (Zar, 2010), the null hypothesis of the difference of proportions revealed no differences in catch efficiency over the different days of the week (χ^2 statistic, p=0.152, df=3). Therefore, restorers did not reduce trapping efficiency through cumulative disturbance by working consecutive days in a watercourse segment, since the efficiency was similar between the days of the working block. Another explanation might be that even though beavers are more "relaxed" or “naïve” to trapping early in the week (i.e. Tuesdays), restorers gradually perform better in a particular area during the week, compensating for the increasing caution of beavers with improved trapping sets.

The effect of disturbance from hunting over the weeks was also assessed, checking if leaving a section of the watercourse without trapping for a week after trapping for one or two weeks increases the trapping efficiency by reducing the awareness of traps by the beavers. The scarce data available for this analysis revealed no positive effect by leaving a watercourse section without traps. The first week of trapping in the watercourse´s section yielded 65% of the beavers, giving an average capture efficiency higher than the efficiency of the rest of the trapping days (10.3% and 9% respectively; p <0.0001, difference of proportions of Infostat). The capture efficiency did not differ between the main valleys and the lateral valleys, comparing the 10 channel sections of the main valley with the six channel sections of the lateral valleys (p=0.88).

A total of 151 traps (289 trapping nights) were set with attractant (beaver hormone, food lure): 142 traps (263 trapping nights) set with attractant, six traps (13 trap nights) with attractant added after the first review and three traps (13 trap nights) with attractant added after the second review. These 151 traps produced 13 catches (289 trap nights), giving an efficiency of 4.5%. If only beaver lure was considered, there were 10 catches in 89 traps (163 trapping nights), giving an efficiency of 6.1%.

The sex ratio of catches did not differ from 1:1 (p=0.26, 45% females vs 52% males, 3% unsexed). Also, the

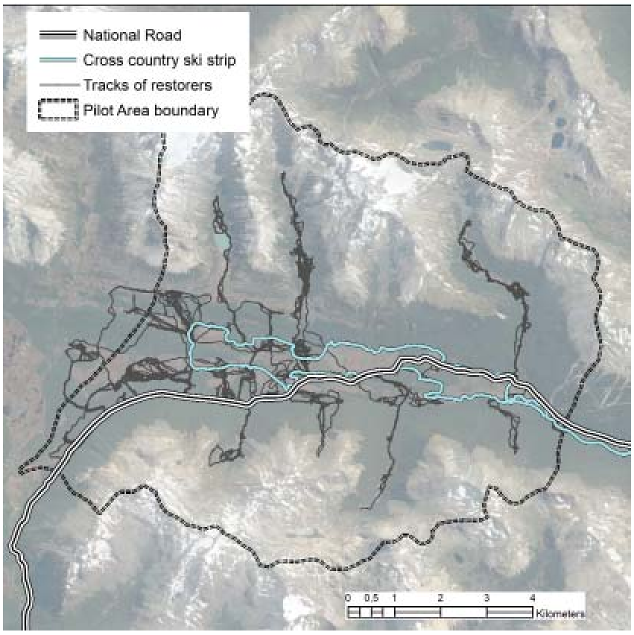

Fig. 5 Tracks recorded by restorers in the pilot area Esmeralda-Lasifashaj. Some tracks were not recorded due to failure of the GPS units.

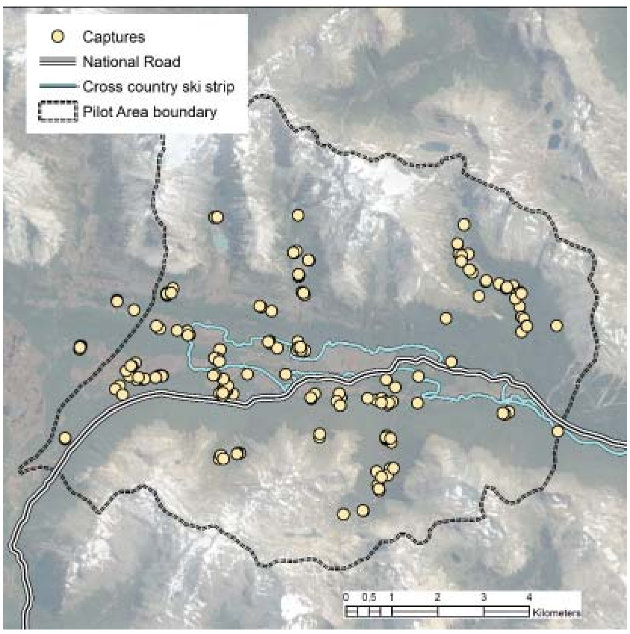

Fig. 6 Catches recorded for the pilot area Esmeralda-Lasifashaj

proportion of females did not differ between body-gripping and snares (difference of proportions = 0.003; p≈1). The age assessment made by restorers revealed an age structure of 15% kits, 29% yearlings and 51% adults (4% not aged), with similar proportions of age classes between body-gripping and snare traps (p=0.21). During the first days of trapping along each watercourse section, 83% of the sections yielded females while 50% of them yielded males (marginally significant difference, p=0.043).

Survivors/reinvaders removal phase

During this phase, restorers walked 380 km deploying 735 trap nights (529 body-gripping and 206 snares). This represented 23% and 31% of the previous walking and trapping effort respectively. Twenty-four animals were removed (22 with body-gripping traps and two with snares, Fig. 6). From them, 10 animals came from the two colonies left untrapped during the mop-up phase, and therefore 14 animals should be considered survivors-reinvaders. The main valley provided most of the captures (83%), although most of the trapping effort was focused there (83%).

Capture efficiency was 3.97% for body-gripping traps and 0.97% for snares. Trapping efficiency, compared with the first phase, was lower for body-gripping traps (p<0.0001), but not for snares (p=0.20).

One of the two colonies originally left untrapped yielded six males (one adult, four juveniles and one kit), one female and one animal of unidentified sex. The second colony yielded two males (one juvenile and one kit) and two females (one adult and one kit).

The survivors/reinvaders captured consisted of 10 males (six adults, three juveniles and one kit), six females (four adults and two juveniles) and two animals of unidentified sex. Five sites provided only males in this phase (including a site with only three males). Attractant was used in only seven of the sets, therefore the outcome was not analysed due to the low sample size.

Population assessment

Analysis of the spatial distribution of catches concluded that 41 colonies were trapped (plus a few recolonised sites). The average number of beavers per colony was 5.6, although this may exclude offspring, presumably dead inside dens (see Discussion). The survivors/reinvaders came from what we identified as 11 different colonies. As beavers were dispersing during the time of operations, it is difficult to compare the age/sex of the beavers caught during the mop up with those captured during the survivor/reinvader phase.

Non-target catches

Trap specificity was 90%. Non-target catches were recorded only during the first phase. One culpeo fox (*Lycalopex culpaeus*), and one upland goose (*Chloephaga picta*) were released alive. Native species killed included two spectacled ducks (*Speculanas specularis*), three unidentified ducks and two upland geese (*Chloephaga picta*). Exotic species captured included 10 muskrats (*Ondathra zibethicus*) and one mink (*Neovison vison*) which were killed and one grey fox (*Lycalopex griseus*) which was released alive.

Eradication verification phase

The 26 cameras yielded a total of 154 camera trapping nights. Nine cameras detected beavers after a period between zero to five days (average two days), and 17 cameras did not detect animals after a period of between three and 10 days (average six days). In addition, two persons walked 155 km to check for signs of presence/absence at the same time that the cameras were set. The last beaver detection was confirmed on 24 May, 2017, nine days after the last capture. Later in the year, from August to October, surveys for survivors/reinvaders were planned to continue.

DISCUSSION

This is the first eradication attempt for beavers from one area in a short time frame. The finding of survivors/reinvaders has two explanations, not mutually exclusive. First, operations may not have reached the last individuals. Second, the lack of physical barriers may ease the movements of dispersing beavers from neighbouring colonies. There had been two previous attempts at beaver removal (Schiavini, et al., 2016). The first attempt took place in the Tierra del Fuego National Park, where a sustained control plan aimed to reduce the size of the beaver colonies was followed by their complete removal from 2,000 ha in 2011. The second attempt took place in the provincial protected area of Reserva Provincial Corazón de la Isla in 2014, where beavers were removed from 4,900 ha in two months, although the project was discontinued for financial reasons and this area has been included as one of the pilot areas to be treated in the near future.

The estimated efficiency of body-gripping traps (12%) was lower than the 22% reported by Lizarralde, et al. (1996) for Tierra del Fuego. However, it must be noted that the first estimate derives from tests for trapping aimed at performance-oriented catches per number of captures. In contrast, the complete removal of animals from one area explains the lower trapping efficiency reported here. Results from the next pilot areas will allow us to have a broader view of the calculation.

The original trapping set and reviewing approach required daily checking of traps. The presence of people walking every day over the dams and dens, and in the vicinity of colonies, can make beavers more "cautious", affecting the likelihood of removing the last animals. The potential of beavers "learning" from disturbance and becoming wary (*sensu* Morrison, et al., 2007) is a problem for efficient eradication operations. Initial data analysis did not reveal the cumulative effect of the presence of the restorers in the capture efficiency. Neither did it find beneficial effects of not setting traps for a number of days. Because part of this pilot area was subject to different intensities of trapping over the years, animals from there may already have been cautious to human disturbance. However, capture efficiency did not differ between areas with more historical trapping effort (the main valleys) and areas less accessible to trapping (the lateral valleys), suggesting a lack of "memory" from previous trapping disturbance in the area.

The next trials will give us a chance to answer the questions raised above, and explore alternative trapping effort schemes – for example, the exclusive use of body-gripping traps. This lethal tool would allow us to leave traps unattended for several days, reducing the likelihood of disturbance. However, the size and weight of body-gripping traps limit the number of traps a person can transport and manage during a day, and the trade-off is that trapping effort would be overestimated by this approach. Nevertheless, the benefits of eradication would overcome the uncertainty associated with estimating the eradication effort.

The unexpectedly small number of kits present in the catch may be because they were too young to leave the dens. The trapping effort coincided with much of the breeding season. Also, the lodges were not destroyed as part of the management process because we wanted to avoid the escape of animals from their colonies. Consequently, the most likely scenario is that kits remained in the den and starved after the mother was captured. This poses a potential constraint on the timing of future eradication attempts if animal welfare issues are considered. Although the sex ratio of the capture was even overall, females outnumbered males by 1.66:1 (p = 0.043) early in the trapping of each watercourse section, when 83% of females were caught. These numbers support the idea of greater mobility of females outside the lodges due to their maternal duties.

Trapping efficiency was lower during the survivor/reinvader removal phase than during the first phase. This is to be expected due to fewer remaining animals, and/or because they may have "learnt" to be more cautious. However, it is expected that reinvaders would not be as cautious as survivors. More data are needed to explore this issue. During the mop-up phase we could not identify family colonies accurately from the spatial distribution of catches, and consequently we could not discriminate survivors from reinvaders based on their sex and/or age. It is expected that genetic analyses would assist in identifying survivors from reinvaders.

Of the 28 individuals captured during the survivor/reinvader phase, 18 came from colonies previously trapped; 10 males, six females and two of undetermined sex. In five sites only males were captured, and three males were captured at one site. Most of the females were captured at the same site next to males. The sex ratio of captures for this phase did not differ significantly from 1:1 (p=0.3), although male catch seemed to be larger. This could be a reflection of greater male dispersion from neighbouring areas, following source–sink dynamics.

Analysis of the spatial distribution of catches indicated that 41 colonies were trapped, plus a few recolonised sites. These values are in agreement with previously known colony densities for the area. Lizarralde (1993) reported 4.72 colony sites/km, defining a colony site as "a pond, or series of ponds used by a colony of beavers throughout the year or years", different than the usual definition of a colony, that refers to a family group living in a series of ponds and sharing a common food cache. Lizarralde & Escobar (pers. comm. 2000) reported, for 1998 and 1999, densities of 0.91 and 0.45 active colonies/km for the Olivia River and of 0.67 and 0.52 colonies/km for the Lasifashaj River, respectively. Schiavini, et al. (2016), reported densities of 0.42 and 0.37 colonies/km for the Olivia and Lasifashaj rivers in March 2010.

The estimated number of beavers per colony (5.6 individuals/colony) may underrepresent kits for the reasons explained above. On the other hand, since trapping occurred during a period of high juvenile mobility, the total catch is likely to overestimate the number of individuals per colony, since it would include animals from colonies neighbouring the pilot area.

Eradication was not achieved during operations in this first pilot area since beavers were detected by trap-cameras during the verification phase and the removal and revision work continued after the month of May. The main reasons are likely to be that the area is open to reinvasion and that trapping took place during a time of high juvenile dispersal. In view of these preliminary results, a large-scale eradication programme in the Isla Grande de Tierra del Fuego (48,000 km^2), must consider the spatial progression of the operations, adjusted to the possibility of reinvasion of the area under management and to the biological cycle of beaver dispersal. Large-scale operations should be carried out either in larger areas, covering areas with physical barriers for reinvasion, and/or restorers should cover the landscape in a more structured way. It is expected that the experience gained in the rest of the trial will allow us to adjust the strategy.

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