# Removing cats from islands in north-west Mexico

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**Abstract** Feral cats have been associated with extinctions of endemic island species throughout the world. Removing cats from islands is an effective way to protect biodiversity, but compared to other invasive alien mammals, cats are difficult to eradicate. Here we describe the techniques we used to eradicate cats from 15 islands in north-west Mexico between <1 and 43 km$^2$. These eradication techniques were developed and refined on small islands (<1 km$^2$) and then adopted successfully on larger islands (1– 43 km$^2$). Experienced hunters and trappers, and high quality hunting dogs were critical for successful cat eradication. The most effective technique was trapping and the most critical components of trapping were trap design and placement.

**Keywords** Gulf of California; Baja California; trapping; conservation; feral cats; eradication; introduced species.

## La remoción de gatos de las islas del noroeste de México

**Resumen** Los gatos ferales han estado asociados con la erradicación de especies endémicas en islas en todo el mundo. La remoción de estos gatos de islas es una manera efectiva de proteger a la biodiversidad. Sin embargo, en comparación con otras especies invasoras de mamíferos los gatos son difíciles de erradicar. Describimos aquí las técnicas que utilizamos para remover a gatos de 15 islas del noroeste de México entre <1 y 43 km$^2$ de tamaño. Estas técnicas de remoción fueron desarrolladas y refinadas en islas pequeñas (< 1 km$^2$) y posteriormente se adaptaron exitosamente a islas de mayor tamaño (1– 43 km$^2$). Cazadores y tramperos experimentados así como perros de caza de alta calidad fueron esenciales para la erradicación exitosa de gatos. La técnica más efectiva fue el trampeo y los componentes más críticos del mismo son el diseño y ubicación de las trampas.

## INTRODUCTION

Although less than 20% of the Earth's animal species are restricted to islands, 75% of all recorded animal extinctions since 1600 have been on islands (World Conservation Monitoring Centre 1992). Many of these extinctions were caused, at least in part, by predation, competition, and habitat alteration from invasive alien species (Atkinson 1989; Diamond 1989). Invasive alien species continue to cause extinctions on islands today (Mellink 1992; Smith *et al.* 1993; Alvarez-Castaneda and Cortes-Calva 1996; Moran 1996; Grant *et al*. 2000; Cowie 2001; Veitch 2001). Fortunately, introduced species can be eradicated, even from large islands. For example, nutria (*Myocastor coypus*) were eradicated from Great Britain (233,000 km$^2$; Gosling and Baker 1989), rats (*Rattus norvegicus*) were eradicated from Langara Island, Canada (31 km$^2$; Taylor *et al*. 2000), and exotic herbivores are being removed from increasingly-larger islands (Towns and Ballantine 1993; Keegan *et al*. 1994b; Simberloff 2001). Many of these projects benefited from the development of a host of new poisoning and hunting techniques that have dramatically improved eradication techniques for goats (*Capra hircus*) (Taylor and Katahira 1988; Keegan *et al*. 1994a; Parkes and Macdonald 2002), commensal rodents (*Rattus* spp. and *Mus musculus*) (Taylor and Thomas 1993; Taylor, *et al.* 2000; Thomas and Taylor 2002), rabbits (*Oryctolagus cuniculus*) (Chapuis *et al.* 2001), and pigs (*Sus scrofa*) (Schuyler et al. 2002).

In contrast to some of the above invasive alien species, cats remain very difficult to eradicate from islands (Veitch 1985, 2001). The largest island where cats have been successfully eradicated is Marion Island, South Africa (290 km$^2$), a project that took over 10 years (Bloomer and Bester 1992; Bester *et al*. 2000). The second largest island where cat eradication has been successful is Little Barrier Island, New Zealand (28.1 km$^2$); a project that took three years after previous failed attempts (Veitch 2001). Reasons for the inherent difficulty of successful feral cat eradications include the lack of effective baits that are attractive to cats (Morgan *et al.* 1990) or innovative hunting techniques comparable to the Judas goat technique (Taylor and Katahira 1988). Consequently, managers have had to resort to the persistent use of an array of methods (Veitch 1985). The difficulty of feral cat eradication poses a significant problem to the conservation of biodiversity, since cats are widely distributed on islands and are associated with many extinctions and extirpations (King 1985; Atkinson 1989; Diamond 1989). Thus, more information is needed on the distribution, ecology, and behaviour of feral cats on islands; successful cat eradications from is-

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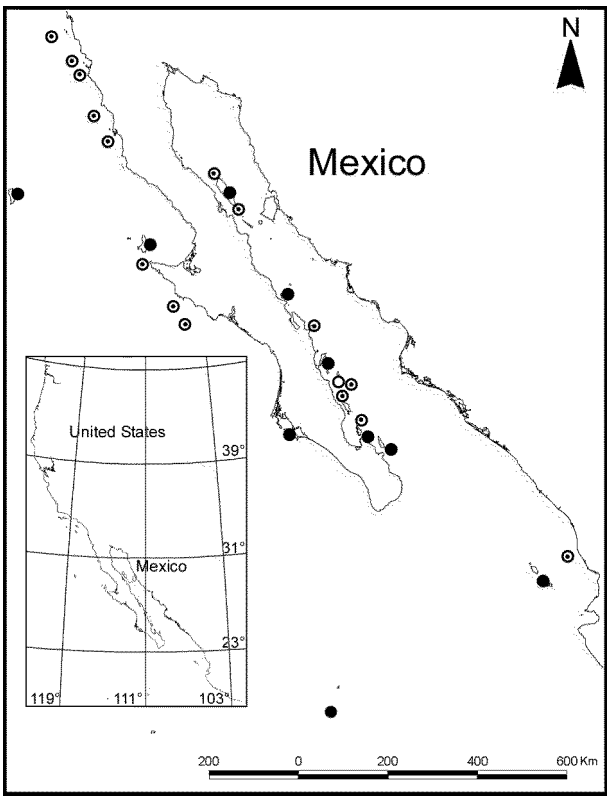


**Figure 1 The distribution of feral cats on islands in north-west Mexico (circles). Cats have been eradicated from 15 islands since 1994 (circles w/ black dots), an additional island (Santa Catalina) is near completion (white circle). Cats remain on 10 islands (black circles).**

lands; and the hunting, trapping, and poisoning techniques used.

Off the Pacific and Gulf of California coasts of north-west Mexico there are over 250 islands (Fig. 1). These islands are of both continental and oceanic origins and have numerous endemic reptiles, terrestrial birds, mammals, seabirds, and plants (Case and Cody 1983; Everett and Anderson 1991; Junak and Philbrick 1994a, 1994b; Alvarez-Castaneda and Patton 1999; Grismer 1999a; Donlan *et al*. 2000; Junak and Philbrick 2000). Cats have been implicated in several bird and small mammal extinctions and numerous seabird extirpations in the region (Jehl and Parkes 1982; Jehl and Everett 1985; Brattstrom 1990; Mellink 1992; Smith *et al.* 1993; Alvarez-Castaneda and Cortes-Calva 1996; Martinez-Gomez and Curry 1996; McChesney and Tershy 1998). Diet studies also indicate that cats may be impacting endemic reptile populations on some islands, although no reptile extinctions have been recorded.

In 1994, feral cats were present on 26 islands in north-west Mexico. In this paper, we describe the trapping and hunting techniques used to eradicate cats from 15 of those islands. These eradications were not conducted to test eradication methods and data were not collected on the efficacy of various techniques. Consequently, we are unable to present a quantitative evaluation of our techniques. Nevertheless, we feel that a detailed description of the methods used will be useful to those planning and conducting cat eradications.

The islands from which we eradicated cats are arid or semi-arid in climate, with precipitation ranging from <20-255 mm per year (with the exception of the subtropical island Isabela (600 mm rain/year); Hastings 1964; Hastings and Humphrey 1969). Vegetation communities on the islands of north-west Mexico include Mediterranean coastal chaparral, Sonoran desert, and dry subtropical forest (Shreve 1936; Levin and Moran 1989; Moran 1996; Esler *et al*. 1998).

## METHODS

To summarise the distribution of feral cats on the islands of north-west Mexico, we relied on published and unpublished literature as well as personal communications from researchers and island residents, and our own field notes. We recorded the presence or absence of cats on each island. These data were then compiled in a conservation database accessible to the public (http://www.islandconservation.org; Donlan *et al.* 2000; Tershy *et al.* 2002).

To remove cats from islands we adapted hunting and trapping techniques used by the most successful commercial bobcat (*Lynx rufus*) trappers in the south-western United States of America. These techniques have traditionally been closely-guarded secrets and have not been subjected to scientific testing. They involve hunting, the use of dogs, and trapping. The techniques described here compliment those of Veitch (1985, 2001).

We did not conduct specific research on cat behaviour or diet prior to eradication efforts. Nor did we attempt to estimate cat population sizes. Rather, after thoroughly surveying the island for cat sign and trails, we began eradication efforts. Eradication efforts then continued until there was no evidence of new cat sign for several weeks to months depending on the size and complexity of the island. After each island was thought to be free of cats due to the absence of sign, at least two subsequent visits were made at three to eight month intervals to check for new cat sign. We considered cats to have been successfully eradicated from an island after it had been re-visited at least twice with no cat sign detected.

### *Hunting*

We attempted to train biologists and inexperienced hunters to hunt cats, but had only limited success. Ultimately, the only effective hunters we employed had many years of experience hunting both at night and day. As night hunting is illegal in many areas of Mexico, former poachers are often the only individuals with these skills. We felt that in the process of learning to hunt effectively, inexperienced hunters ultimately trained cats to avoid hunters by

missing or only wounding the cats. If so, this could make it more difficult to eradicate the last cats.

Hunting at night with .22 and .222 calibre rifles was more effective than hunting during the day. Hunters walked quietly using an adjustable headlamp set on low power to locate cats by their eye shine. Once a cat was located, the hunter often increased the power on the light to aid in aiming. We felt that high candlepower spot lights frightened cats from farther away than we were able to effectively shoot them (within about 100 m). Occasionally, in order to attract the cats' eyes towards the light, hunters made calls that mimicked cat prey. Hunting during the day was most effective with the aid of trained dogs. Hunting with shotguns was not as effective as hunting with rifles because shotguns could only be used within about 40 m from a cat, a distance often difficult to achieve.

### *Dogs*

Acting on interviews with two successful mountain lion hunters, well-bred experienced dogs facilitated hunting and trapping. Out of the 12 dogs we field tested, we kept six; all of which were dogs bred for hunting and are valued at USD1000 – USD2000 each. Jack Russell Terriers were used exclusively because they were motivated to hunt cats and their small size facilitated both transportation between islands and maintenance of the dogs in the field. During the day, trained dogs tracked down and flushed out cats, or simply located areas where cats were present, which greatly aided in trap placement. On larger islands we believe that hounds trained for mountain lion (*Felis concolor*) hunting in the western United States could be especially useful. However, transport and field maintenance of these larger dogs will prove more difficult.

We attempted to train a number of dogs that were bred for show or as pets, but had limited success. We found that dogs from elite hunting lines were well worth the extra monetary investment because they were much easier to train, and performed more effectively than non-hunting dogs. Because there is no legal bobcat or mountain lion hunting culture in Mexico, we imported proven dogs from the United States.

Dogs are much easier to train when the density of cats is relatively high (i.e., at the beginning of an eradication campaign), rather than toward the end of a campaign when the density of cats is low. Also, one or two experienced dogs greatly facilitated the training of new dogs. Consequently, we prioritised buying and training top quality dogs early in our eradication programme.

### *Trapping*

Well-located traps were much more effective than hunting, especially for removing the last cats. Traps work 24 hours per day, seven days a week, and could be checked from a distance with binoculars. We used Victor #1½ padded leg-hold traps. Larger traps can injure cats and paradoxically, make them more likely to escape; cats could possibly pull free from smaller traps. We prepared new traps by first cleaning them of oil and grease with hot water or a steam cleaner. Next we dipped them first in a commercial trap dip solution to slow corrosion and take away the shine and second in wax to further protect the traps and lubricate the moving parts. Finally, we carefully adjusted the pan tension and height of the pan on each trap to ensure that it had the correct sensitivity for young and mature cats.

We used two types of sets. These were 'cubby sets', where the trap blocked the single entrance to a cave or hole, with the bait or scent placed behind the trap, and 'walk through sets', where the trap was along a trail and the bait or scent was placed above or slightly to the side of the trap. These sets are conceptually similar to Veitch's (2001) "baited set" and "walk through set".

All sets had the same basic structure. The trap was placed so that the jaws opened parallel to the cat's direction of travel. To ensure the cat stepped on the trap, the path was narrowed by placing rocks, or other obstructions, as close as possible on either side of the trap without touching the trap jaws. This insured that the cat could not step on either side of the trap. The rock on the dog, or trigger, side of the trap formed a perpendicular wall about 14 cm tall. A rock on the pan side of the trap was approximately the same height, but slanted slightly away from the trap. This arrangement encouraged the cat to step on the pan side of the trap with its front foot. To further encourage this behaviour, a small amount of bait or scent was placed on the rock on the trigger side of the trap. More importantly, an obstruction of twigs or small rocks about 5 cm high (slightly lower on the pan side) and 4-6 cm wide was placed on the path in front and behind the trap. Cats avoided stepping on this guide and stepped over it directly onto the trap. The exact width of the guides was scaled to the stride of the cats as determined by tracks.

Overall, the funnels, rocks on either side of the traps, and guides formed a series of subtle obstacles that made it easier and more likely for the cat to step on the trap pan than anywhere else. Cats could easily jump over any of these obstacles, but, when constructed correctly, cats tended to walk through them and step on the trap pan. Because cats that spring a trap without being captured may become trap shy, our goal was to capture more than 90% of the cats that travelled through these trap sets.

Rather than burying the trap, we often simply placed a pan cover over the pan and left the trap jaws exposed. The pan cover increased the sensitive area of the pan, protected the trap from being jammed by blown debris, and provided a more natural surface for the cats to step on, without the need to cover the trap. We made a pan cover for each trap out of plastic or nylon window screen mesh. The mesh was cut into a 12 cm square with a 4 cm slit cut from the middle of one edge toward the centre of the square. A contact adhesive was then sprayed on the mesh and gravel or coarse soil (ideally of the same type found on the island) was poured over the adhesive. When setting the trap,

this pan cover was placed over the pan, but under the open trap jaws.

Trap location was the most important element of success. We felt that one properly-placed trap was worth more than 10 poorly-located traps; subsequently, we spent much time scouting out keen trap locations on the island and designing trap sets. On some small islands, we caught the majority of cats in one location. Even on our largest project island (43 $km^2$), we had less than 50 traps deployed at any one time. We never attempted to trap on a grid system.

Traps were placed where cats were very likely to travel. To do this, we used the location of tracks and scats to guide trap placement. We especially trapped around "latrine areas" where one or more cats frequently defecated. We also tended to place traps along edges and natural restrictions where several trails came together (e.g., passes, trails through thick brush or high grass). Frequently, we narrowed natural restrictions with brush, rocks, and occasionally even 1m high plastic meshed fencing. Cats could easily jump over all these supplemental restrictions, but as long as they deflected the cats less than about 50 degrees from their direction of travel, cats tended to move along them and were funnelled into a trap. These funnels were designed to subtly guide cats into traps.

Scent, or occasionally bait, were used only to attract a cat from a few metres away, or to slow it down as it passed by the trap. Scent, made out of a mixture of cat faeces and urine with some glycerin added as a preservative, was used more often than bait because it remained attractive to cats longer and did not attract non-target species. Scent made from cats that do not live on the island (i.e., strangers) may be more attractive than scent made from cats living on the same island.

When fish or other bait was used, it was placed under a rock or bush to avoid attracting scavenging birds and direct sunlight. Bait had to be replaced every one to two days. Old bait was collected and disposed away from the set since cats can be repelled by spoiled bait (Veitch 2001). Small amounts of scent or bait were used because when large amounts were used, cats often rolled in the scent or bait. A cat rolling on a trap often results in the trap closing without catching the cat.

Our most experienced trapper (BW) usually selected ideal locations for traps and designed a series of trap sets in those locations. Once these tasks was completed, less experienced trappers were able to check and re-set traps while the more experienced trappers established new trap locations, or started work on another island. However, experienced trappers needed to periodically return to the island to scout new trap locations, design new sets in the same locations and check that traps were being properly re-set. This was especially true near the end of a project because it was often necessary to modify trap sets, baits, and scents in order to successfully trap the last remaining cats.

To increase the efficiency of checking the traps, a flag or stick was set loosely in the ground and the trap chain was wrapped around it. When a cat was captured and tugged on the chain, the flag or stick was knocked down. This system enabled us to check multiple traps from the boat or from distance with binoculars. In some hard-to-observe locations, we taped a wildlife radio transmitter with a magnetic on-off switch and a small magnet to the trap chain. We then doubled the chain, so that the magnet turned off the radio transmitter. When a cat tugged on the chain, the radio began transmitting, enabling us to check traps without directly observing them.

### *Toxins*

Poisoning with 1080 can be used effectively to eradicate cats (Veitch 2001). We did not use toxins because we felt it was more difficult to attract a cat to toxic bait, than to step into a well-set leg-hold trap. However, on future operations where we are limited by the number of skilled trappers, incorporating toxins into our techniques may prove effective.

## RESULTS

Feral cats were found on 26 islands in 1994 (Fig. 1). Island Conservation and Ecology Group, the Instituto de Ecología at the Universidad Nacional Autónoma de México, Centro de Investigaciones Biológicas del Noroeste, and the National and regional offices of Areas Naturales Protegidas collaborated with local people and community organisations to eradicate introduced cats from 16 islands (Fig. 1; Table 1). The operation on one of these islands, Santa Catalina, is still in progress.

## DISCUSSION

Feral cats cause extinctions on islands (King 1985; Mellink 1992; Smith *et al*. 1993; Towns *et al*. 1997; Dowding and Murphy 2001). The most effective way to permanently protect island species threatened by cat predation is eradication, and subsequently prevention of re-introduction. Yet removing cats from islands is difficult (Bester *et al*. 2000; Veitch 2001). The methods we have developed to successfully eradicate feral cats from 15 islands in north-west Mexico are not infallible, but when applied correctly, can greatly facilitate conservation.

The four essential lessons that we learned regarding cat capture techniques are:

- use the most experienced hunters, trappers, and hunting dogs available
- focus on trapping in order to get the last cats
- study cat movements and behaviour in order to select ideal trap locations, and
- a few well-constructed sets in key locations are worth hundreds of poorly-located traps

**Table 1 Islands from which feral cats have been removed and number of native taxa protected.**

| Islands (North to South) | Area ($km^2$)[1] | Breeding Seabirds | Endemic species and subspecies | | |
|---|---|---|---|---|---|
| | | | Reptiles | Landbirds | Mammals |
| Pacific | | | | | |
| Coronado Norte | < 1 | 11 ($3^5$) | 2 | 2 | 1 |
| Todos Santos Norte | < 1 | 5 ($1^5$) | | | 2 ($1^5$) |
| Todos Santos Sur | 1 | 6 ($1^5$) | 2 | $1^5$ | 2 ($1^5$) |
| San Martin | 3.2 | 6 ($3^5$) | 3 | | 2 ($1^5$) |
| San Geronimo | < 1 | 5 | | | 1 |
| Natividad | 7.2 | 6 ($1^5$) | | | 1 |
| San Roque | < 1 | 6 ($1^5$) | | | 1 ($1^5$) |
| Asuncion | < 1 | 7 ($4^5$) | | | |
| Gulf of California | | | | | |
| Mejia | 3.0 | 3 | 2 | | 2 ($2^5$) |
| Estanque | < 1 | 1 | 1 | | |
| Coronados | 8.5 | 1 | 1 | | 3 ($2^5$) |
| Monserrate | 19.4 | 2 | 2 | | 2 ($2^5$) |
| Catalina (incomplete) | 43.1 | 2 | 8 | | 1 |
| San Francisco | 2.6 | 1 | 2 | | 2 |
| Partida South | 20.0 | 0 | 3 | | 1 |
| Isabela[4] | 1.0 | 10 | | | |
| TOTAL | | 72 (20) 6[2] | 26 (20)[3] | 3 (3)[3] | 21 (18)[3] |

[1] Areas are estimates based on literature.
[2] 72 seabird populations (20 seabird species and subspecies), 6 endemic to north-west Mexico.
[3] Number of endemic populations (number of endemic species and subspecies), some taxa occur on more than one islands.
[4] Island Conservation and Ecology Group assisted Cristina Rodríguez of Instituto de Ecologia, Universidad Nacional Autónoma de México; Norway Rats still present.
[5] Possible extinctions (extirpations for seabirds); e.g., 3 ($2^5$) = 3 endemics, 2 of which may be extinct.

Using these techniques we have successfully removed cats from islands up to 20 $km^2$, and have removed most of the cats from a 43.1 $km^2$ island. We will soon be attempting to apply these same techniques to larger islands up to 250 $km^2$. On these islands research on cat home ranges, habitat use, and movement patterns will greatly facilitate trap spacing and placement. Furthermore, we may have to incorporate additional techniques such as disease and toxins to get an initial decrease in cat numbers as suggested by Veitch (1985) (Courchamp and Cornell 2000).

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