SUCCESSFUL ERADICATION OF INTRODUCED ARCTIC FOXES FROM LARGE ALEUTIAN ISLANDS

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ABSTRACT: The Aleutians are a volcanic chain of 200 named treeless islands, islets, and rocks that extend west off the Alaska mainland for more than 1,100 miles. Almost all of the Aleutian Islands have had non-native mammals introduced, including foxes, since their discovery by Russia in 1741. Most islands are in the Alaska Maritime National Wildlife Refuge, and since 1949, the U.S. Fish and Wildlife Service has eradicated foxes from 36 islands (951,174 acres) using various methods. Most recently, foxes have been eliminated from some of the largest islands (more than 50,000 acres) in the refuge by simultaneously trapping from three two-person camps using primarily leg hold traps. Recently, M44 devices were used during eradication efforts, although most foxes were taken by traps and shooting. Foxes are being removed to restore the native biological diversity.

KEY WORDS: Aleutian Islands, Aleutian Canada goose, Alaska Maritime National Wildlife Refuge, alien species, arctic fox, biodiversity restoration, introduced species, red fox, seabirds

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INTRODUCTION

Arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*) were introduced to hundreds of islands in Alaska for fur production beginning soon after Russian discovery in 1741 and continuing through the 1930s (Bailey 1993). Native wildlife populations, primarily birds, provided food for the free-ranging foxes. In areas like the Aleutian Islands, ground-nesting bird populations were seriously depleted by fox predation. The Aleutian Canada goose (*Branta canadensis leucopareia*) barely escaped extinction (Jones 1963). Although most commercial trapping operations stopped about the time of World War II, foxes persisted on many islands.

Recognizing the serious problems that introduced foxes were causing to native birds, the U.S. Fish and Wildlife Service (who administered the Aleutian Islands National Wildlife Refuge where most of these activities occurred) began a program to remove introduced foxes from selected islands about 1949 (Bailey 1993). This was no small task. The Aleutian Islands group is composed of approximately 200 named islands, islets, and rocks which form an 1,100 mile arc extending between Alaska and Siberia and framing the southern edge of the Bering Sea. This region is famous for stormy weather. The peaks of submarine volcanoes (some a mile high), the rugged, treeless islands where foxes were targeted for removal, varied in size from less than 1,000 acres, to more than 100,000 acres. Over the half-century that the fox removal program has been underway, available methods for removing foxes have become more restricted by regulation changes, and removing foxes from larger islands has become much more difficult. This report reviews the fox removal program in the Aleutians designed to restore the native biodiversity of birds.

BACKGROUND

Although red foxes are native to the extreme eastern Aleutian Islands most of the islands never had terrestrial mammals (Bailey 1993). The idea that foxes in the Aleutians are introduced is well documented. There is no evidence that islands west of Umnak Island (Figure 1) ever had any native terrestrial mammals. Aleut midden sites do not contain terrestrial mammal bones (Buskirk and Gipson 1980) or fox traps (Hrdlicka 1946). Islands west of Umnak Island were never connected with the mainland even at the lowest extent of sea levels during the Pleistocene (Hopkins 1967; Buskirk and Gipson 1980). Shore-fast ice did not connect the Aleutians to the mainland either. The Aleutians are beyond the furthest extent of the polar ice pack and floes from the ice pack that could have transported arctic foxes. Records from the earliest Russian contact confirm the absence of terrestrial mammals in the central and western Aleutians (USDA Bureau of Biological Survey 1938; Murie 1959; Tikhmenev 1978; Bailey 1993).

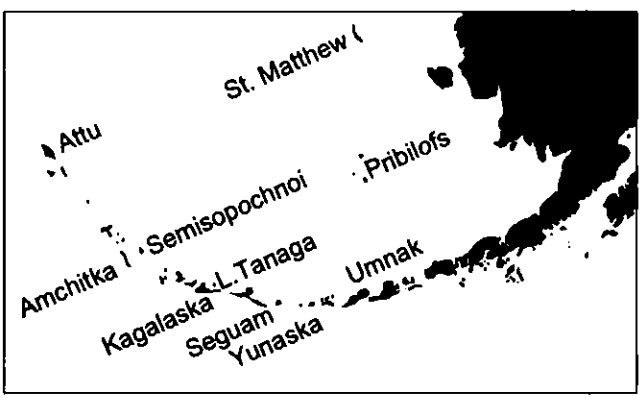

Figure 1. Aleutian Islands of Alaska.

As early as 1750, only eight years after the Aleutians were discovered by the West, arctic foxes from Russia were introduced to Attu Island (Black 1984), westernmost in the Aleutian chain. Sea otter and fox fur were very valuable, and the driving force to Aleutian colonization and economy. Foxes became increasingly important to fur traders as otters and seals became scarce because of commercial harvest. Buyers especially sought furs from blue foxes (a color phase of arctic fox), and ranchers commonly purchased blue foxes from fur farms to stock islands. Based upon archived permit records from the early fox farming days, most islands were stocked with arctic foxes, although red (especially the silver type) foxes were also widely distributed (Bailey 1993).

Over the next 100 years, essentially every habitable Aleutian island (about 86) was stocked with foxes except for a few islands either too small or too rugged for regular access by wooden boat. Stocking continued even after the Aleutians became a refuge (Bailey 1993). In spite of early warnings on the impact on native wildlife, the government permitted fox introductions until the 1940s. By that time, arctic and red foxes had been released on at least 450 Alaskan islands (Bailey 1993).

Arctic foxes survived on more than half of the Aleutian Islands and in the Kuril Islands in Russia where they were also introduced. Arctic foxes occur naturally on some islands off the coast of Alaska such as St. Paul and St. George in the Pribilofs, and St. Matthew and St. Lawrence Island in the Bering Sea (Fay and Cade 1959; Chapman and Feldhammer 1982,). These Bering Sea islands were part of the now submerged Bering Land Bridge and are far enough north to be surrounded by sea ice in winter. On these islands, foxes feed on and cache native birds and eggs during the summer which they use in addition to tidal life and debris during winter (Stephenson 1970). In the Aleutians, however, some islands had inadequate resources to carry over a fox population without the supplemental feeding by fur ranchers. Generally, released foxes were left to forage on their own, but on some islands, foxes were kept in pens and fed locally obtained meat from waterfowl, whales, seals, or sea lions. Rodents were sometimes released on fox islands as an additional food source. When fur ranchers stopped the supplemental feeding, the foxes died out on the smaller islands. Depleted bird populations probably caused fox populations to decline after initial peaks when prey was still abundant (Murie 1936, 1937; Black 1984; Bailey 1993).

IMPACT OF FOXES

About 30% of the 64 species of birds known to breed in the central and western Aleutians are endemic to the region. Many species of endemic birds in the Aleutians evolved in the absence of mammal predators. Introduced foxes killed adult birds and reduced production by preying on eggs and nestlings. Seabirds, waterfowl, shorebirds, ptarmigan, and possibly passerines were extirpated from islands or reduced to low population levels by foxes (Bailey 1993).

Aleutian Canada geese were particularly hard hit because they not only nest on the ground but are flightless for several weeks in late summer. Geese were eliminated on every island where foxes were introduced and were unable to colonize otherwise suitable islands where foxes were present. All of the Aleutian Canada geese that exist today came from remnant populations that survived on only three islands where foxes were never established (Jones 1963; Hatch and Hatch 1983; Bailey and Trapp 1984).

O. J. Murie of the U.S. Biological Survey, visited the Aleutians in the 1930s and reported the decline of seabirds on refuge islands with foxes (Murie 1936; Murie 1937). The refuge permitted fox introductions until the 1940s before being curtailed.

ERADICATION HISTORY

Prior to 1930, some fox ranchers accidentally or purposely trapped out some islands. One reason for trapping all foxes off an island was to eliminate red foxes so the more valuable blue foxes could survive. There are many examples where arctic foxes could not survive on an Aleutian island where red foxes are established (USFWS 1929-1939; Bailey 1993).

Aleutian fur ranching declined because of falling prices for pelts during the Great Depression, consolidation of villages in the Aleutians, and the evacuation of islands in World War II. Today, no private trappers choose to trap foxes in the Aleutian Islands. Introduced foxes died off on a number of smaller Aleutian islands, and evidently on nearly all southeastern Alaskan islands.

The refuge staff began eliminating foxes from islands in 1949. To date, foxes have been eradicated from 36 islands, 30 of which are in the Aleutians. Most islands where foxes were eradicated during this time period were less than 25,000 acres (Table 1). The refuge plans to eradicate foxes from at least five more Aleutian islands. A considerable amount of information about fox eradication on the Alaska Maritime National Wildlife Refuge is available in the form of project reports (e.g., Ebbert 1997, 1998; Thomson 1998).

From 1949 to the early 1970s, U.S. Fish and Wildlife Service personnel used toxicants (Compound 1080, strychnine, and diphacinone) to eradicate foxes from seven islands (Bailey 1993). Amchitka and Agattu were the first two islands from which foxes were eradicated, both over 50,000 acres (Table 2). In 1972, Executive Order 11643 prohibited the use of toxicants on federal lands. At first, it appeared the ban would preclude removing foxes from additional relatively large islands, because manually trapping foxes off was thought to be practical on only small islands.

In spite of the ban, Emergency Use permits were obtained to use toxins to restore habitat for the endangered Aleutian Canada goose on five islands. Of these five, only one was over 50,000 acres (Kiska 69,600 acres) (Table 2). M44 devices were initially banned, then allowed under new restrictions. M44s were used on two other islands after the 1972 ban; the largest was 12,425 acres. With the loss of toxicants and limited resources, the refuge attempted to clear only two islands over 15,000 acres (Yunaska and Little Tanaga) using only trapping and shooting. Other smaller islands were trapped free of foxes.

Alternate methods besides toxicants were considered such as fertility control or reproductive inhibitors, viruses or other contagious agents that could be delivered by bait.

Table 1. Size classes of fox project islands during two time periods.

Time Period	<25K	25K to 50K	>50K	Proportion >50K
1948-1995	25	1	3	0.10
1996-2000	2	2	5	0.56

Table 2. List of large islands where foxes were eradicated in the Aleutian Islands.

Island	Acres	Shoreline Miles	Main Camps	Spike	Foxes
Seguam	52,293	41	3	0	163
Agattu*	55,535	71			?
Semisopochnoi	56,013	40	3		170
Kiska*	69,600	90			481
Amchitka*	73,024	107			?
Kanaga	91,716	115	3	2	546
Tanaga	128,000	131	3	1	
Attu	223,812	153	6	1	360

*Islands where toxic baits were used, so number of foxes taken is unknown.

None of these seemed practical. However in 1984, an experiment to use sterilized red foxes to eliminate arctic foxes was successful on two small (<2,500 acres) Aleutian islands (Bailey 1992), but this technique was never tried on larger islands.

In the late 1980s, a new effort was made to get authorization to use M44s, but it was clear that authorization for additional use of Compound 1080 would be unlikely. In 1996, the sodium cyanide label was revised to permit M44 devices to be used to kill arctic foxes for the protection of endangered species, the Aleutian Canada goose. Funding increased after studies documented major increases in native bird populations on restored islands, and we began to pursue removal of foxes from larger islands. In 1996, Seguam (52,293 acres) was cleared of foxes using traps and M44s, and we realized that it was possible to be effective without toxic baits. Plans were made to work on even larger islands.

FOX REMOVAL METHODS ON LARGE ISLANDS

On large islands, it is important to start trapping in late winter when breeding birds are unavailable and foxes have depleted cached prey. Also, this early start provides a longer period to capture reproductively active foxes before whelping, and before new pups are independent in late summer.

We conduct a survey at least one year before trapping on an island begins. The entire island coastline is searched for naturally protected campsites with drinking water nearby, safe areas to keep and launch small boats, and hiking potential from the camp to trapping areas (Williams, et al. 1996; Williams 1999). Transportation to target island is provided by the 120-foot refuge vessel, M/V Tiglax. Two or more people conduct a survey by circumnavigating the island using an inflatable skiff when possible. Sites are mapped and classified as suitable for main or spike camps.

The density of foxes varies greatly between islands and between seasons. For example, 546 adult foxes were captured on Kanaga (91,716 acres) in 1998, but only 360 foxes were captured on Attu (223,812 acres). No attempt to inventory foxes is made at anytime during the eradication effort, except to count foxes as they are captured, and to constantly search for the presence of one or more surviving fox. Because all accessible coastline is trapped during the eradication, and because we know only a few foxes can repopulate an entire island, a preseason population estimate is not especially relevant to the eradication process.

Small (12 x 12 ft.) wooden cabins are built for late winter trapping (February to March), and weatherports (a type of metal-frame heavy tent built over a wooden plywood floor) are used for spike camps and for summer operations. Cabins are easier to heat than weatherports, and are reliable to withstand winds in excess of 100 kts. On Attu in 1999, for instance, winds were recorded in excess of 110 kts at the U.S. Coast Guard LORAN station before the annometer broke. However, the three fox trapper cabins built the year before did not incur any damage.

Since 1996, the refuge has hired most trappers through USDA Wildlife Services located in Palmer, Alaska. This partnership has worked well for both agencies. The Tiglax transports all traps, food, and camp gear needed for three to four months and the fox trappers. After gear is unloaded by skiffs from the larger vessel, if weather and time permits, traps are set from the relative safety of the Tiglax at locations difficult to reach from main camps. Sometimes the ship returns while the eradication is in progress to provide support for trapping, make repairs on outboard motors and other equipment, and to pass mail to the trappers.

The goal in trapping is to place the maximum number of foxes at risk of being captured as soon as possible. Typically, traps are spread over new areas fairly sparsely at first and then trap densities are increased by filling in gaps between sets. This allows trappers to get first hand knowledge of their entire trapline quickly, and they are better able to assess how to take advantage of sea and wind conditions effectively. However, weather and topography may initially limit trappers in the wintertime to only a few nearby beaches.

The length of shoreline trapped from each camp varies, but 20 to 26 miles of coastline is typical. Traplines are contiguous and rarely extend inland more than a quarter mile or so. Occasionally traplines will extend up valleys along fox trails, in passes or through valleys if evidence of fox sign warrants it. These inland sets tend to stay in working condition longer and capture foxes as they travel from one coastal area to another. The density of traps set on an island varies depending upon the topography special features of the island. On Attu for example, over 2,400 trap devices were set for 152 miles of shoreline. More traps are set on beaches that are difficult to check frequently. This strategy assures there is an adequate number of working traps to capture at least a pair and helper before the trapper is able to return and reset.

Trappers move sets and make additional sets after the island shoreline is ringed with traps. All traps are rebaited nearly every week throughout the entire time trappers are on the island. Fox pelts are not salvaged. The project is planned so that all foxes can be captured within three or four months, and before juvenile pups venture far from the den in late August. In the case of Attu, trapping on the south side of the island took place between late February and May, and trapping on the north side started in May and continued to September.

The year following the eradication effort, each island is visited one or more times to look for signs of surviving foxes. Areas are searched for fox sign (e.g., tracks, hair, scat, food caches, and fresh dens). If fox sign is present, traps are set in as many areas as time and weather allows. The island is visited again until the project leader is satisfied all foxes have been captured.

DISCUSSION AND SUMMARY

We have recently learned that islands larger than 50,000 acres can be trapped free of introduced arctic foxes within a single field season by using the methods described above. Trapping should begin in late winter so the effort can continue for five full months if necessary. The longer season is important on large islands to allow time to successfully capture the last fox. Time required to cover the coastline of an island with traps depends on weather conditions and depth of snow. Light snow does not inhibit travel by trappers, but it does reveal where foxes are travelling through areas where tracks are undetectable during summer.

Late winter trapping can expose more foxes to fewer sets. This is because traps can be initially set at predictable locations where foxes cluster because of reduced territoriality and clumped food resources. Foxes may be especially vulnerable to food attractants in late winter. By March, sex attractants compete better with increasing food resources during the breeding season. As foxes become territorial and restrict their range exclusively to coastal areas during whelping season, the island is typically already surrounded with traps.

When trappers work in pairs from main camps, they have the relative safety of a partner and the minimum manpower for working with the inflatable skiff. Typically topography, boating conditions, and distance limit the extent of shoreline that can be safely trapped from a camp, so more than two trappers in one camp does not increase the length of a camp's trapline.

Aleutian arctic foxes are highly vulnerable to all of our capture techniques. Even first-time fox trappers are able to quickly learn the skills necessary to make a successful set. Often foxes boldly approach trappers, and most foxes are shot at ranges less than 30 yards. Shooting is done opportunistically, although some trappers are adept at calling by imitating pups.

RECOVERY OF NATIVE BIRDS

Although recovery of birds has not yet been evaluated on the recently-cleared large islands, studies on islands cleared earlier demonstrate the response of birds to removal of foxes (Williamson and Emison 1969; Day et al. 1979; Nysewander et al. 1982; Zeillemaker and Trapp 1986; Byrd et al. 1994; Byrd et al 1997). Most populations of nesting seabirds increased five to ten times within ten years of fox removal (Byrd et al. 1994).

Most bird species have recolonized fox-free islands without translocations. Nevertheless, for some species, such as the Aleutian Canada goose, transplanting birds has been required to accelerate restoration (Byrd 1998). The restoration of 36 islands so far has benefited all of the endemic birds including waterfowl, shorebirds, ptarmigan, seabirds, and passerines. This is an example of a management program that directly "makes more birds."

With the apparent success on Attu Island (the largest island targeted for restoration), it seems there is no barrier to eradicating introduced foxes on the remaining islands within the refuge. This year, we plan to eradicate foxes from one additional large island and another smaller island. Trapping has already begun at the time this paper was presented. If successful, the this season the total acreage of restored islands on the Alaska Maritime National Wildlife Refuge exceeds one million.

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