

# WHISKERED AUKLETS *AETHIA PYGMAEA*, FOXES, HUMANS AND HOW TO RIGHT A WRONG

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## SUMMARY

WILLIAMS, J.C., BYRD G.V. & KONYUKHOV, N.B. Whiskered Auklets *Aethia pygmaea*, foxes, humans and how to right a wrong. *Marine Ornithology* 31: 175-180

Whiskered Auklets *Aethia pygmaea* forage exclusively on zooplankton concentrated in tiderips, swirls, tidal pumps and fronts of strong upwelling near islands or offshore reefs. This foraging habitat, which is common throughout the Aleutian and Kurile islands, is the primary factor determining the biogeography of Whiskered Auklets. Arctic Foxes *Alopex lagopus* were first introduced to nearly all of these islands devoid of terrestrial predators as early as the mid-1700's. Introductions reached their peak from 1913 to 1940 and were successful because foxes preyed on the native seabird populations. By 1940 at least 90 islands had non-native Arctic Foxes introduced, and there were thought to be only a few thousand Whiskered Auklets in the Aleutian Islands. The staff of the Aleutian Islands reservation (now part of the Alaska Maritime National Wildlife Refuge) started eradicating foxes from refuge islands in 1949. By 1974 the Whiskered Auklet Aleutian Island population was estimated to be approximately 25 000 individuals. By 2002, foxes had been removed from 40 islands (restoring 1800 miles of nesting coastline) and remained on only 6 islands. We estimate that by 2003 there were at least 116 000 Whiskered Auklets throughout the Aleutians Islands, widely distributed in formerly occupied nesting areas. Almost uniquely among alcids, many young and adult Whiskered Auklets return to the breeding colony after fledging to sleep on the surface of boulders at nesting colonies. This behavior disposed Whiskered Auklets to excessive predation relative to other crevice-nesting species that were thought to be safe nesting under boulders. We summarize evidence suggesting that Whiskered Auklets were abundant prior to fox introductions, experienced large declines at the peak of fur farming, and are now recovering to former levels after an active fox removal program. We argue that the introduction of non-native Arctic Foxes has regulated the distribution and abundance of Whiskered Auklets for the last 250 years.

Keywords: Whiskered Auklet, *Aethia pygmaea*, population regulation, Aleutian Islands, Arctic fox, predation, roosting

## INTRODUCTION

Whiskered Auklets *Aethia pygmaea* are relatively rare alcids, currently distributed on select islands within the Aleutian, Commander, and Kurile island chains of the North Pacific to which they are endemic (Fig. 1; Byrd & Williams 1993, Gaston & Jones 1998). Whiskered Auklets forage in tiderips, swirls, and tidal pumps or fronts on zooplankton that is concentrated near islands and offshore reefs by strong upwelling (Byrd & Gibson 1980, Byrd & Williams 1993, Gaston & Jones 1998). These foraging areas are persistent in space and time and largely do not depend on the season (Zubakin & Konyukhov 2001). Because of this, Whiskered Auklets are mostly non-migratory, unlike other *Aethia* species, and are found year-round within 16 km of shore (Byrd & Gibson 1980). This nearshore marine foraging habitat is common throughout the Aleutian and Kurile islands, and is the primary factor regulating the distribution and abundance of Whiskered Auklets (Zubakin & Konyukhov 2001).

During the 18th, 19th, and 20th centuries, fur trappers introduced Arctic Foxes *Alopex lagopus* into this region, for the purpose of fur farming, which caused substantial reductions in populations of native birds (Dall 1873, Snow 1897, Murie 1936, Bailey 1993). Whiskered Auklets and other seabird species that nest in rock crevices were expected to be less affected by fox predation than species that nest on the ground or in earthen burrows (Bailey 1993). However, historical accounts of Whiskered Auklet distribution and

abundance suggest this has not been the case (Dall 1873, Snow 1897, Murie 1936, 1937).

Until recently, little was known about the biology of the Whiskered Auklet. The earliest directed research documented distribution (Byrd & Gibson 1980), breeding biology (Knudtson & Byrd 1982), and food habits (Day & Byrd 1989), but all these studies were hampered by small sample sizes or were based on only a single year of data. Recent multi-year research has shed new light on courtship behavior (Hunter & Jones 1999), food habits (Hunter *et al.* 2002), molt (Konyukhov 2001, Pitoccelli *et al.* 2003), and breeding biology (Konyukhov & Zubakin 1994, Zubakin & Konyukhov 1999, 2001, Hunter *et al.* 2002). Based on some of these studies, we now know that in spite of nesting in rock crevices, Whiskered Auklets are particularly predisposed to predation by Arctic Foxes due to their unique biological characteristics within the *Aethia* family.

Originally the management of Arctic Foxes began with the objective of maximizing fur production, a practice that resulted in the exploitation of the insular avifauna, including Whiskered Auklets. Anecdotal accounts described decimated bird populations in the early 18th century (Dall 1873, Black 1984). Directed surveys by Olaus Murie in the 1930's (Murie 1936, 1937) helped changed the management policy from one of exploitation and decimation of the avifauna to one of conservation. In this paper, we summarize evidence suggesting that Whiskered Auklets were abundant prior to

fox introductions, experienced large declines at the peak of fur farming, and are now recovering to former levels after the onset of an active fox removal program. Furthermore, we argue that the introduction of these non-native Arctic Foxes has regulated the distribution and abundance of Whiskered Auklets for the last 250 years.

#### “Foxes come, birds go”

The Aleutian Islands have no native terrestrial mammals west of Umnak Island (Buskirk & Gipson 1980, Bailey 1993). Widespread introductions of Arctic Foxes began on Attu Island in 1750 by some of the first Russian traders in the region (Black 1984). Foxes were steadily introduced to new islands throughout the 1800s during the period of Russian occupation. Once introduced into this pristine environment, foxes prospered on the abundant birds that had evolved free of terrestrial predators. Fox farmers regarded seabirds simply as food for foxes (Bailey 1993). Islands that produced the most foxes were those which historically supported the largest number of birds – primarily seabirds (Alaska Maritime National Wildlife Refuge administrative files).

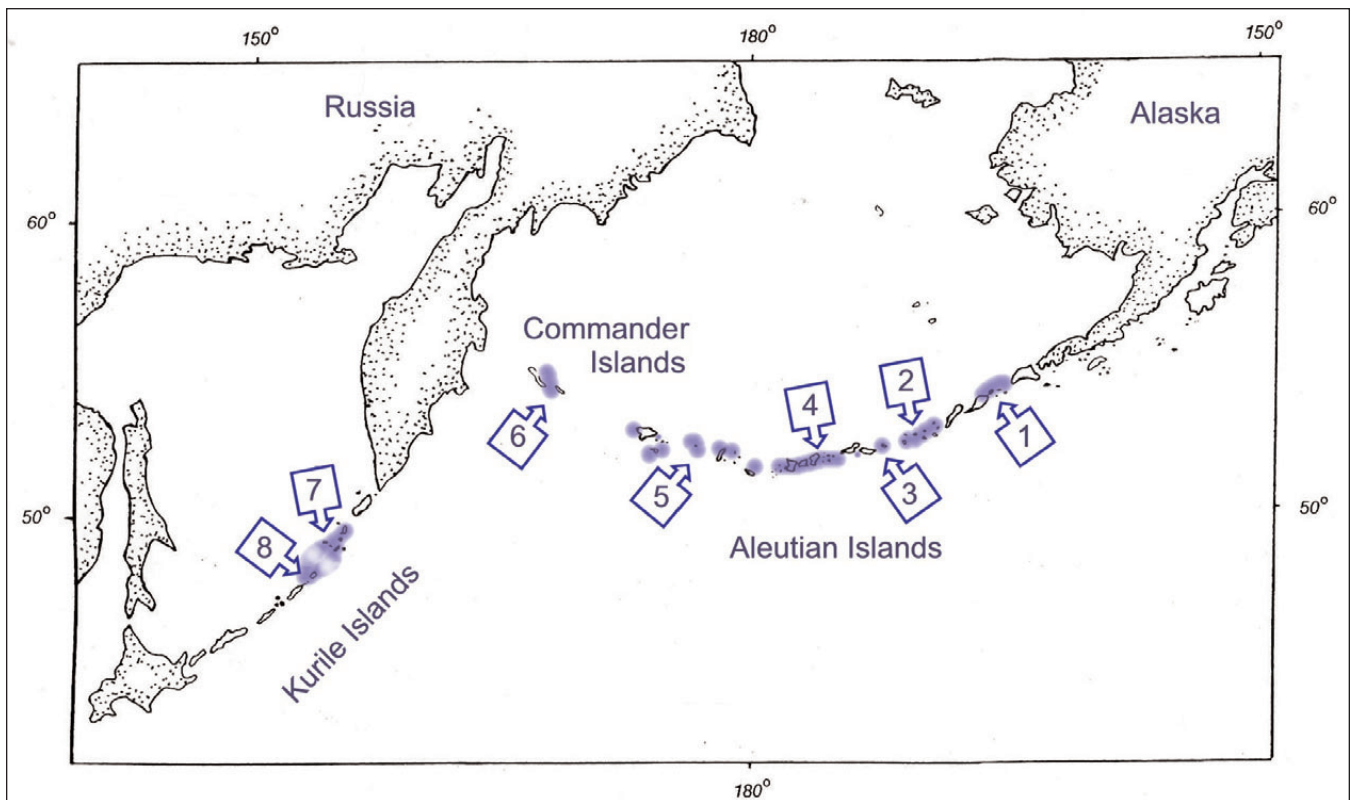
Not long after these initial fox introductions, early naturalists noted major changes in this remote environment. Naturalist William Dall (1873, p. 271) noted:

“...on those islands such as Attu and Atka, where the arctic fox and other land animals have been introduced by the Russians, the birds preferred to build on islets and

rocks offshore, or not accessible from the beaches. But on those islands where there are no such animals, the habits of the same species are quite different. They build without fear, on the banks and hillsides of the main island, and are not found on the rocky islets at all.”

By 1812, less than 60 years after foxes were introduced to Attu, birds were described as rare there and the native Aleuts were making clothing from fish instead of birds (Black 1984). On Amlia Island, the decline of avifauna after fox introduction was even more rapid. By 1811, only 20 years after fox introduction to this island, native Aleuts complained that foxes had driven away the birds which were formerly abundant and upon which they depended for food and clothing (Black 1984, Bailey 1993).

After Alaska was sold to the United States in 1867, the Secretary of the Treasury began formal leasing of Alaskan islands for fur farming in 1882; this practice continued for the next 60 years (Bailey 1993). Fox introductions to new islands reached a peak from 1913 (after the area was designated as the Aleutian Islands Reservation – precursor to the Alaska Maritime National Wildlife Refuge) to 1940 (when nearly every island had had non-native Arctic Foxes introduced). In 1921, at least 23 Aleutian Islands were under permit to fox farming operations, and by 1931 over 86 islands were permitted. Additional islands were illegally stocked with foxes or no records exist of their introduction to those islands (Bailey 1993).



**Fig. 1.** Map of the North Pacific showing major Whiskered Auklet concentration sites (arrows) and generalized areas of strong tidal currents (shaded). Numbered squares refer to (1) Eastern Aleutian Islands (including Baby Pass), (2) Islands of 4 Mountains, (3) Seguam Island, (4) Central Aleutian Islands (including Kanaga, Great Sitkin, Ulak, Kasatochi, Koniuji, and Amlia Islands), (5) Buldir (including Kiska to the east and Near Islands to the west), (6) Commander Islands, (7) Northern Kuril Islands, (8) Central Kuril Islands: based on information in Zubakin and Konyukhov (2001).

By the mid 1930s there were clear and serious conflicts between fox farming and the preservation of the Aleutian avifauna. In 1936, the Biological Survey (later to become the U.S. Fish and Wildlife Service) dispatched Olaus Murie and several biologists to investigate the situation “with a view to obtaining all possible information on which to form a basis for effective management of the Aleutian Islands Reservation” (Murie 1936, p.1). One of the people accompanying Murie was Douglas Gray, deputy Alaska game warden and future Refuge Manager, who summed up how dark the situation had become for the avifauna of the Aleutians:

“It was found that 99% of the total acreage [2 868 320 acres] was used for fox propagation purposes. ...*The entire refuge was operating for one purpose: fox farm production* [italics added]. No concern or protection was granted the various forms of wildlife inhabiting the refuge... In many cases, bird colonies were completely cleaned off as their numbers were too small to survive the depredations of the foxes. In the others, there is no way to determine how much wildlife has suffered. The natives sum up the situation with the terse remark ‘foxes come, birds go’”. (Gray 1939, p. 2)

The speed and extent to which foxes altered the abundance and distribution of avifauna appear to have depended on island size and the species composition of the breeding seabird populations (Murie 1936, 1937, 1959). The larger the island or colony size, the longer it took to reduce bird numbers. Only the largest colonies were thought to be able to withstand the intense predation pressure by foxes (Murie 1937). Smaller islands with fewer birds fared poorly. Burrowing species such as Tufted Puffin *Fratercula cirrhata*, Leach’s and Fork-tailed Storm-petrels *Oceanodroma leucorhoa* and *O. furcata*, Cassin’s Auklet *Ptychoramphus aleuticus*, and Ancient Murrelet *Synthliboramphus antiquus* rapidly disappeared because they could easily be excavated from their burrows by foxes (Bailey 1993).

Based on the reports of Murie (1936, 1937) and Gray (1939) the Biological Survey changed the manner in which many of the islands were managed and designated some as wildlife sanctuaries and others to remain as fox farms. In the late 1930’s the primary fox food source had become so depleted that most fox farmers were forced into supplemental feeding to make trapping economically feasible (Bailey 1993). During World War II, all civilians, including trappers, were evacuated and fox farming was abandoned as Japanese and American forces battled in the region. After the war, the fox farming business had become unprofitable because demand for pelts in the fashion industry significantly diminished. As a result most fox farm leases lapsed or were abandoned. However, the abandoned foxes remained on the islands eating birds and anything else they could find.

#### “Foxes go, birds come”

In 1949, Bob Jones, refuge manager of the Aleutian Islands Reservation, recognized the damage caused by introduced Arctic Foxes, and began eradicating foxes on Amchitka Island using traps and poison. This marked a significant change in management policy from one of exploitation to one of conservation (Bailey & Kaiser 1993). Later, environmental legislation and institutional changes formalized this approach (Sekora 1973). Removal of foxes from islands continued slowly but steadily until the 1970s, when the effort and funding

allocation increased and foxes were eradicated from approximately one island per year (Ebbert 2000, Ebbert & Byrd 2002). Foxes had naturally died off on a number of small islands where foxes had completely eradicated the native avifauna (Bailey 1993, Ebbert 2000). By 2002, the refuge had removed foxes from 40 islands, restoring approximately 2880 km of coastline and 4047 km<sup>2</sup>. Today, foxes remain on only 6 of the Aleutian Islands (Shemya, Tanaga, Kanaga, Adak, Atka, Chuginadak) to which they were introduced, and the region is returning to the conditions that existed prior to the human introduction of Arctic Foxes (Ebbert 2000). Tufted Puffins and other seabirds have dramatically increased in abundance and changed their nesting distribution from formerly fox-inaccessible offshore islets and rocks, to large islands (Byrd *et al.* 1994). Species such as Rock Ptarmigan *Lagopus mutus*, Aleutian Canada Geese *Branta canadensis leucopareia* and other waterfowl have also responded dramatically to the fox removal (Byrd *et al.* 1994).

#### Effects on Whiskered Auklet biogeography

There are only a few accounts from which to recreate the early historic abundance of Whiskered Auklets, but they provide a glimpse of the situation at a time when most fox introductions were just beginning. The naturalist Lucien Turner reported Whiskered Auklet as “quite abundant” in the Near Islands group of the Aleutians and “common” at locations in the central Aleutians in 1879 (Turner 1886). Snow (1897, p. 10 & 30) described Whiskered Auklet abundance in the Kurile Islands:

“...whilst millions of little auks, of several species (*Phaleris cristatella* [Crested auklet] and *P. mystacea* [Whiskered Auklet] being the most common)... large numbers of these auks [breed] on all the islands...”

Leonhard Stejneger (1885, p. 31) described Whiskered Auklets in the Commander Islands as “rather common”. However, Stejneger noted that an observer would need “good luck” to encounter the species even though they were common. Most likely this was because Whiskered Auklets are seldom found outside their preferred foraging places in rip tides and fronts off points close to land (Byrd & Gibson 1980, Byrd & Williams 1993) – treacherous places early sailing ships avoided for obvious reasons. After these observations, foxes were continually introduced to many of the Aleutian Islands.

In 1911, A.C. Bent (1919) spent several weeks in the Aleutians surveying for Whiskered Auklets throughout the island chain, but failed to observe a single specimen. No other descriptive accounts of Whiskered Auklet abundance exist until 1936, when fox introductions to islands were at their peak. Olaus Murie (1936) noted that Whiskered Auklets had disappeared from the Near Islands where they were once abundant and were becoming scarce elsewhere. He estimated that only a few thousand birds bred in the Aleutians at the time. In 1940 and 1946, Gabrielson (1959) considered himself “fortunate” to observe 2 birds throughout his travels in the Aleutians. Clearly, Whiskered Auklets had reached their population nadir just after the peak of fox farming activities. Over the next few decades, foxes died out on some small islands after the native avifauna was extirpated and no food source remained.

The first thorough surveys after Murie’s observations were those by Byrd and Gibson (1980), who spent hundreds of hours looking

for Whiskered Auklets in 1972-1974. They estimated that there were about 25 000 birds throughout the Aleutians, based on counts of birds at sea. Notably, they observed a single flock of about 10 000 individuals in the Islands of Four Mountains. Other areas of high abundance included Baby Pass in the eastern Aleutians, Seguam Island, and Great Sitkin Island. Additionally a few individuals were observed in the Near Islands.

By 2003, Whiskered Auklets were observed in growing numbers in places such as Agattu Island in the Near Islands where they were formerly “quite abundant” in 1879 (Turner 1886). New nesting records were noted on Kiska, Kanaga, Ulak, Kasatochi, Koniuji and Amlia – all now fox-free. Large numbers of birds were still noted in Baby Pass, Islands of Four Mountains/Yunaska, and Great Sitkin Island. Off Seguam Island, where foxes were removed in 1996, a single flock of whiskered auklets numbering 30 000 – 40 000 was observed – larger than Byrd and Gibson’s (1980) population estimate for the entire Aleutian Islands.

We conservatively estimate the current population of Whiskered Auklets throughout the Aleutians to be at least 116 000 individuals distributed as follows: Near Islands – 500; Buldir – 30 000; Kiska to Kanaga – 500; Adak to Atka – 30 000; Seguam – 35 000; Islands of 4-Mountains – 10 000; Umnak to Unimak – 10 000. These estimates, with the exception of Buldir for which we have detailed nesting information, are based on largest counts of birds observed at sea during the breeding season when many individuals were possibly attending nest sites, and should thus be considered minimum estimates.

#### Why are Whiskered Auklets so vulnerable to predation?

Nearly all seabirds were vulnerable to predation, particularly ground-nesting and burrow-nesting species, when non-native foxes were introduced to the Aleutians, but those nesting in crevices and on cliffs were generally thought to be less susceptible because foxes had greater difficulty gaining access to their nest sites (Murie 1937, Jones & Byrd 1979, Bailey 1993). Whiskered Auklets, however, exhibit several biological characteristics that make them especially vulnerable to foxes compared to other crevice-nesting auklets: low nesting densities, nearly year-round residency, and the return of adults and especially juveniles to sleep on shore after the breeding season. Many of these characteristics likely evolved as a result of competition with other auk species for nest sites (Hunter *et al.* 2002), and due to the proximity of the breeding sites to the nearshore foraging habitat (Zubakin & Konyukhov 2001).

Whiskered Auklets breed at low densities (Hunter *et al.* 2002). When foxes were introduced to islands, Whiskered Auklets lacked the protection afforded by large numbers of the more colonial Crested *Aethia cristatella*, Least *A. pusilla* and, to a lesser extent, Parakeet Auklets *A. psittacula*. Thus, Whiskered Auklets were more easily eradicated from many islands, particularly small ones, once foxes were introduced.

Research in the 1990s (Konyukhov & Zubakin 1994, Zubakin & Konyukhov 2001) indicated that, almost uniquely among alcids, many fledglings return to the breeding colony for at least a month or more after fledging. Nocturnal at the colony, the unwary fledglings can be found sleeping in the open after the breeding season, where they would be easily preyed upon by foxes that patrol beaches at night. It was often easy for Zubakin and Konyukhov to approach these sleeping birds and capture them by

hand or small net. Over the years, researchers had often encountered fledgling birds on the ground, apparently disoriented, far inland on islands where they breed (JCW, GVB unpublished data). For instance, Stejneger (1885) found fledglings sleeping in the sail of his ship, Gabrielson (1959) reported fledglings far inland on trails, and Gaston & Jones (1998) documented fledglings 1 km inland. In addition to fledglings returning ashore after the breeding season, Zubakin and Konyukhov (2001) observed substantial numbers of adults sleeping on the surface of the colony after the breeding season. While exposed Whiskered Auklets would be especially vulnerable to fox predation, fledglings of other *Aethia* species are almost never found under these circumstances.

Although these recent observations were the first clear documentation of this behavior, there were earlier hints that Whiskered Auklets visited land after the breeding season. Stejneger (1885) collected birds from shore near a colony in January and thought that Whiskered Auklets spent the night in crevices throughout the year. Similarly, Murie (1936, p. 71) reported that:

“The natives assured us that this species spends the winter among the Aleutians and that during the season the birds return to their retreats among the rocks to roost, where the foxes get them. Thus due to their roosting habit, these birds fall prey to the foxes year round and suffer much more than the other species [of auklets]. This could well be one of the factors in their present scarcity”.

Zubakin and Konyukhov (2001) hypothesized that the return of adults and fledgling birds to land after the breeding season was possible because of the proximity of year round foraging areas. In contrast, other *Aethia* family members disperse to open sea for much of the year (Gaston & Jones 1998).

#### DISCUSSION

The introduction of Arctic Foxes to the Aleutian Islands had a controlling effect on the distribution and abundance of Whiskered Auklets as a result of their unique biological characteristics, which makes them more vulnerable to predation. Was it a minor effect on population dynamics or was it a driving force that led to near extinction?

Almost 70 years ago Olaus Murie (1936, p. 108) considered the control foxes exerted on seabirds at Kasatochi Island:

“...as many as 29 foxes have been trapped in a year, with an estimated 24 remaining. If we consider a year with 30 foxes on the island, to be very conservative, and allow these animals to live through a bird nesting season, probably well over 100 days, and allowing only 1 bird a day we would have a loss of over 3000 birds. As a matter of fact, we found in a single cache of one pair of foxes over 100 birds, and none of these were badly decomposed. This in itself would indicate several times the number derived above. The loss of birds by various methods of calculations, such as allowing a cache like the one we found once a week, per pair, and other qualifying estimates, the figures run all the way from



three to four thousands to as many as 40 000 or even more for the season. The seabirds are prolific and tenacious, but this would be a heavy drain on the population, far in excess of the normal losses.”

Some of the seabird colonies in the Aleutians contain more than a million birds of several species, so unless the populations are closely monitored the loss of even 40 000 individuals might go unnoticed. Whiskered Auklets use a wide variety of nesting habitats and historically nested at relatively low densities probably on nearly every island throughout the Aleutian Islands. Murie (1936) stated Aleutian foxes appeared to specialize on certain seabird species and specifically mentioned the Whiskered Auklet as susceptible to predation. The effect of fox predation on seabirds, including Whiskered Auklets, almost certainly depended on how many foxes were present on each island. Little is known about the earliest years of fox farming in the Aleutians because the harvest records were often combined with foxes taken out of the region. However, hundreds of thousands of foxes were harvested during the Russian era (1750-1867) and later (Carnarhan 1979). It wasn't until the early years of the Aleutian Islands Reservation that we get a well-recorded glimpse of the magnitude of the problem. Approximately 27 000 foxes were harvested in the Aleutians from 1913 to 1936 (Jones & Byrd 1979), a time period of diminished returns for foxes because of depleted seabird populations. The actual harvest number was probably higher because not all historical records are available. Because trappers realized the importance of leaving a sufficient breeding stock on each island to ensure future returns, harvested fox pelts represented only a small portion of the total number of foxes preying on seabirds. Nevertheless, even a few foxes could remove large numbers of auklets. Bailey (1993) cited examples where just a few invading foxes killed tens of thousands of nesting birds.

Could the eradication of Arctic Foxes from islands have led to the increases in Whiskered Auklet numbers we have recently observed? We have documented the response of insular Aleutian avifauna after fox eradication since 1975 (Byrd *et al.* 1994, 1997). Increases of up to several hundred percent in just a few years were common as long as there were “seed populations” nearby from which to repopulate the islands. *Aethia* auklets appear to have the ability to rapidly colonize areas of suitable habitat (Gaston & Jones 1998). It is likely that Whiskered Auklets, which remain near potential nesting islands year round and use a wide range of nesting habitats, are capable of responding even more rapidly once released from predation compared to their congeners which require specific breeding substrates (i.e. large talus fields) found in only a few locations. On most islands in the Aleutians we see few impediments to further population increases and range expansion of Whiskered Auklet populations. However, Norway Rats *Rattus norvegicus* have been accidentally introduced to at least 16 islands (Ebbert & Byrd 2002) and may preclude the recovery of Whiskered Auklets and a number of other seabird species.

Unlike many anthropogenic habitat changes, the restoration of native biodiversity has been possible in the Aleutian Islands through an effective eradication program of introduced fox. The management actions resulting from a change in policy from fur production to wildlife conservation has served to right the wrong done to Whiskered Auklets and other native birds in the region.

## ACKNOWLEDGEMENTS

We thank Heather Renner, Greg Thomson, and Leslie Slater who commented on early drafts of this manuscript. This manuscript benefited from the suggestions of David Hyrenbach, Tony Gaston and three anonymous reviewers.

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