Aleutian shield fern
(Polystichum aleuticum)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Anchorage Fish and Wildlife Field Office
Anchorage, Alaska

5-YEAR REVIEW
Aleutian shield fern (*Polystichum aleuticum)*

1. GENERAL INFORMATION

1.1. Reviewers

Lead Regional or Headquarters Office --Contact name(s) and phone numbers:
Alaska Region, Sonja Jahrsdoerfer, (907) 786-3323

Lead Field Office -- Contact name(s) and phone numbers:
Anchorage Fish and Wildlife Field Office, Greg Balogh, (907) 271-2778

Cooperating Field Office(s) -- Contact name(s) and phone numbers:
None

Cooperating Regional Office(s) -- Contact name(s) and phone numbers:
None

1.2. Methodology used to complete the review: In 2005, the U.S. Fish and Wildlife Service (Service) initiated steps to complete its regulatory requirements for a 5-year review under section 4(c) of the Endangered Species Act (Act) for *Polystichum aleuticum* (Aleutian shield fern). The Service solicited information on this species through a Federal Register notice (August 31, 2005, 70 FR 51840); we received no comments in response to this notice. We reviewed current information on the status of, and threats to, this narrowly endemic species and consulted with species experts. The attached *Polystichum aleuticum* 5-year review summarizes the key information considered and the results of the Service's deliberative process

1.3. Background

1.3.1. FR Notice citation announcing initiation of this review:
70 FR 51840, August 31, 2005

1.3.2. Listing history:

Original Listing
FR notice: 53 FR 4626
Date listed: February 17, 1988
Entity listed (*species, subspecies, DPS*): Species
Classification (*threatened or endangered*): Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed:
Entity listed *(species, subspecies, DPS)*:
Classification *(threatened or endangered)*:

1.3.3. Associated rulemakings: None

1.3.4. Review History: None

1.3.5. Species' Recovery Priority Number at start of review: 8

1.3.6. Recovery Plan or Outline:

Name of plan: The Aleutian Shield Fern (*Polystichum aleuticum* C. Chr. In Hulten) Recovery Plan
Date issued: September 30, 1992
Dates of previous revisions: None

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

Using section 1.3 of the 5-year Review Guidance, Consideration of the DPS Policy during the 5-year review, and the DPS Policy (61 FR 4722) to guide you, respond to the questions below. Note that only a vertebrate can be listed as a DPS under the ESA (see guidance for more information).

2.1.1 Is the species under review a vertebrate?

_____Yes, go to section 2.1.2.
__X___No, go to section 2.2.

2.1.2 Is the species under review listed as a DPS?

____ ***Yes****, go to section 2.1.3.*
____ ***No****, go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

____ ***Yes***, *give date and go to section 2.1.3.1.*
____ ***No***, *go to section 2.1.4.*

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ ***Yes,*** *provide citation and go to section 2.1.4.*
____ ***No***, *go to section 2.1.3.2.*

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ ***Yes***, *discuss how it meets the DPS policy, and go to section 2.1.4.*
____ ***No***, *discuss how it is not consistent with the DPS policy and consider the 5-year review completed. Go to section 2.4., Synthesis.*

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ ***Yes***, *provide citation(s) and a brief summary of the new information; explain how this new information affects our understanding of the species and/or the need to list as DPSs. This may be reflected in section 4.0, Recommendations for Future Actions. If the DPS listing remains valid, go to section 2.2, Recovery Criteria. If the new information indicates the DPS listing is no longer valid, consider the 5-year review completed, and go to section 2.4, Synthesis.*

____ ***No***, *go to section 2.2., Recovery Criteria.*

2.2 Recovery Criteria

Recovery plans contain downlisting and delisting criteria which, if up-to-date with regard to both the species' status and threats, should simplify the 5-year review process. If current, a recommendation on whether or not to change the species status may be made based on evaluating whether recovery criteria have been achieved, and completing section 2.3, Updated Information and Current Species Status, should not be necessary.

2.2.1 Does the species have a final, approved recovery plan[1] containing objective, measurable criteria? *(Note: Some plans may not contain recovery criteria, either because they are older plans, or because criteria could not be determined due to lack of information. These plans may still contain goals or other objectives that provide a benchmark for measuring progress toward recovery and may warrant discussion in this section. If you discuss them here, be sure to distinguish them from formal recovery criteria.)*

____ ***Yes****, continue to section 2.2.2.*

_X___ ***No****, consider recommending development of a recovery plan or recovery criteria in section IV, Recommendations for Future Actions, and go to section 2.3., Updated Information and Current Species Status.*

The Aleutian Shield Fern Recovery Plan (Anderson 1992) (Plan) is an action-oriented document lacking measurable criteria by which to gauge progress toward recovery. The stated objective of the Plan is to protect and maintain the existing population of *P. aleuticum* and its habitat on Mt. Reed, Adak Island (part of the Aleutian Islands), Alaska. The Plan further identifies three non-specific, and one specific, down-listing criteria: the discovery of significant new populations; the maintenance of a greenhouse population of at least 1,000 mature sporophytes; the installation of genetic material in a germplasm repository; and the protection of the extant population from disturbance. The Plan indicates that due to the rarity and restricted occurrence of *P. aleuticum* delisting in the foreseeable future is considered to be unlikely; therefore, no delisting criteria are identified.

Although the Plan includes management actions necessary to achieve the stated objective, it does not provide an explicit assessment of threats to the species and how they will be eliminated or moderated by the recovery criteria or their associated actions, nor does it provide quantifiable criteria by which to objectively measure the species' progress towards recovery.

2.2.2 Adequacy of recovery criteria.

Recovery criteria should reflect the best available and most up-to-date information on the species and its habitat and address threats to the species relative to the five factor analysis. If criteria are current, the status of the species and its threats should be discussed briefly under each criterion in section 2.2.3., which will serve as the updated information on which the 5-year review results are based.

[1] Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

____ ***Yes,*** *go to section 2.2.2.2*
_X__ ***No****, go to section 2.2.3, and note why these criteria do not reflect the best available information. Consider developing recommendations for revising recovery criteria in section 4.0.*

In the 15 years since the Plan was completed, additional subpopulations have been located and habitat described, investigations into the reproductive biology and artificial propagation of *P. aleuticum* have been undertaken, and genetic and morphological analyses have been initiated. The actions have all expanded, but not completed, our understanding of the ecological niche occupied by this species.

At the time of listing, *P. aleuticum* was known only from the original collection made by Eyerdam in 1932 on Atka Island, Alaska, described by Christensen (1938), and one population on Adak Island originally discovered in 1975 (Smith 1985), then rediscovered in 1987 (Smith 1987). The estimated population at the time of listing was 7 plants, and upon completion of the Plan in 1992, the population was estimated to be 112 plants. Discoveries in 1988 (Talbot et al. 1995), 1993 (Talbot et al. 1995), and 1999 (Talbot and Talbot 2002) have increased the known number of individuals to 131 (Talbot and Talbot 2002). Access to these sites is limited due to steep, unstable, slippery slopes; therefore, this number likely underestimates the size of the population. Most plants occur in a narrow microhabitat consisting of rock grottos and moist crevices at the base of steep rock outcrops on east to northeast-facing slopes on the northeast arm of Mt. Reed, Adak Island. Each discovery since 1987 has expanded the elevational range of *P. aleuticum*, now thought to be between 338 m and 525 m (Talbot and Talbot 2002) *P. aleuticum* is associated with dwarf willow-moss, dwarf willow-sedge-moss, and sedge-anemone-arnica-moss communities (Talbot et al. 1995). Searches for shield ferns in similar habitats on 11 other Aleutian islands including Adugak, Aiktak, Amlia, Buldir, Chagulak, Davidof, Kasatochi, Khvostof, Kiska, Nizki, and Aliaga islands have been unsuccessful (Talbot and Talbot 2002).

At the time of listing in 1988 and completion of the Plan in 1992, little was known of the reproductive biology of *P. aleuticum*. Field observations revealed that the species regularly produces abundant mature indusia (a membrane enclosing and protecting developing spores) and sporangia (a structure producing and containing spores) (Tande 1989; Holloway 1995). While cross-fertilization, self-fertilization, and apogamy (development of an embryo without fertilization) are all possible mechanisms of Pteridophyte propagation, the extreme rarity of this species

suggests that reproduction is either unsuccessful or insufficient to offset mortality (Lipkin 1985). Research was initiated in 1989 to verify spore viability and identify optimum methods of *in vitro* spore germination and propagation. As of February 1992, the number of *P. aleuticum* plants in the greenhouse numbered 1,476 sporophytes. However, by the conclusion of this effort in 1994, fewer than 50 sporophytes remained and no mature, spore-bearing fronds had developed. Holloway (1995) found that *P. aleuticum* produces viable spores that germinate in approximately 6-8 weeks, and that, once begun, germination and development of prothallia (scale-like growth from a fern spore), antheridia (male sex organ) and archegonia (female sex organ) proceeds rapidly. Most spores are released in clusters, and multiple germinations per cluster are common; spores exhibited a thermo-dormancy at temperatures below 8°C and above 20°C. Finally, sporophytes developed from single prothallia as well as from populations of mixed prothallia confirming that apogamy and/or self-fertilization are possible modes of propagation. Problems associated with cultivation included abundant growth of algae and mosses, fungal infection, infestation by fungus gnats and aphids, and moisture control (Holloway 1995).

Spores were examined by scanning electron microscopy to characterize spore structure and to compare with that of *P. lachenense*. While spores of *P. lachenense* showed the ellipsoidal or globose shape commonly associated with *Polystichum* spp. (Tryon and Lugardon 1990), spores of *P. aleuticum* were of both globose and bowl shapes (Holloway 1995). While the sunken (bowl) shape observed in *P. aleuticum* might be a result of prolonged storage, handling, preparation, immaturity, or inviability, the bowl-shaped spores could also be a normal occurrence in this species. D. Britton of the University of Guelph suggests the differences in spore morphology between *P. lachenense* and *P. aleuticum* are consistent with differences observed among other taxa (Talbot et al. 2003)

Listing of *P. aleuticum* was based only on morphological examination of the very few herbarium specimens available. Subsequent isozyme electrophoresis failed to show any differences among individuals in the Adak Island population or between *P. aleuticum* and two samples of *P. lachenense* of Taiwan (Holloway 1995). Additionally, analysis of DNA sequence data suggests an extremely close evolutionary relationship (conspecific or sister-species) between *P. aleuticum* and *P. lachenense* (Talbot et al. 2003). However, in the absence of corroborating morphologic and physiologic evidence, both Holloway (1995) and Talbot et al. (2003) caution against placing *P. aleuticum* in synonymy with *P. lachenense*, as hybridization, allopolyploidy (two or more complete sets of chromosomes derived from different species), and apogamy all confound efforts to accurately elucidate phylogenetic relationships within the genus

Polystichum (Little and Barrington 2003). Results of morphological examination of spores collected in 2005 are pending.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? *(Note: If it can be clearly articulated how recovery criteria address all current threats to the species, evaluating whether recovery and/or downlisting criteria have been met in section 2.2.3 may be sufficient to evaluate the species listing classification and no further analysis may be necessary.)*

___ ***Yes****, go to section 2.23.*

_X__ ***No****, Go to section 2.2.3 and note which factors do not have corresponding criteria. Consider developing recommendations for revising recovery criteria in section 4.0.*

Although the stated recovery criteria are relevant to potential threats to *P. aleuticum*, they are based on our understanding of these threats in 1992. Our understanding of potential threats to this species has evolved in the intervening 15 years. Potential threats to the population on Adak Island at the time the Plan was completed included: human foot traffic; collecting for scientific purposes; grazing and trampling by introduced ungulates (caribou); destabilization of habitat; and the stochastic processes that act on small, isolated populations. Land ownership has changed and caribou populations have more than tripled since 1997, and steps have been taken to enhance the protective measures already afforded the shield fern through Alaska Maritime National Wildlife Refuge regulations. Pages 12 through 15 of the Plan outline management actions that are integral to the mediation or elimination of the above threats. Although none of the recovery criteria have been achieved, progress towards some of the management actions has been made.

2.2.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. (*For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here):*

Criterion 1: "Pending additional information, down-listing could be considered only if significant new populations are discovered" (Service 1992, Executive Summary).

"Until additional information is obtained on the causes of rarity and the potential for recovery, no precise recovery goal can be set for re-classification to threatened status. However, consideration for re-classification to threatened status could result from the discovery of additional populations" (Service 1992, page 11).

Associated management actions include the development of a survey plan with prioritized list of potential survey areas and protocol, and implementation of the plan.

> By 1992, the known number of individuals in the Adak Island population had increased 15-fold to 112 from the 7 documented at listing in 1988. This increase most likely resulted from the discovery of a second Adak locality (14 individuals) for the species, combined with a recount of the original Adak Island subpopulation discovered by Smith in 1975, and then rediscovered in 1987 (Sandy Talbot, USGS, pers. comm., February 21, 2006). In 1993, field surveys were initiated to search for additional shield fern locations on Adak Island. These efforts resulted in the discovery of the third Mt. Reed subpopulation numbering 5 individuals (Talbot et al. 1995). A fourth subpopulation was discovered in 1999 by researchers collecting samples for genetic studies (Talbot and Talbot 2002), bringing the total Adak Island population of *P. aleuticum* to an estimated 131 individuals. In addition to these directed searches, similar habitats on 13 other islands have been opportunistically searched, without success (Talbot and Talbot 2002).
>
> The discovery of 19 additional individuals since 1992 represents a population increase of almost 17%. However, this recovery criterion neither quantifies the population size nor characterizes the spatial distribution of subpopulations that would afford the greatest protection to the species from either unpredictable, destabilizing environmental events, or other disturbance sources. This criterion addresses, albeit incompletely, threats associated with the compounding effects of small population size, restricted gene pool, and restricted distribution (Factor E), and their interaction with the naturally occurring and human-caused threats identified in all 5 Listing Factors.

Criterion 2: "A greenhouse population of a minimum of 1,000 mature sporophytes should be maintained……" (Anderson 1992, Executive Summary).

Associated management actions include research into artificial propagation, and the establishment and maintenance of a greenhouse population.

> Research initiated in 1989 to verify spore viability and identify optimum methods of in vitro spore germination and propagation met mixed results. By February 1992, efforts had resulted in a greenhouse population of 1,476 *P. aleuticum* sporophytes, and our understanding of the reproductive biology of this species had been enhanced. However, by the conclusion of this project in 1994, fewer than 50 sporophytes remained and no mature, spore-bearing fronds had developed. Additional attempts to cultivate a greenhouse population at Kew Gardens, England and New York Botanical

Garden were also unsuccessful (Weinstein 1995; Margaret Ramsay, Royal Botanic Gardens, Kew, United Kingdom, pers. comm., October 19, 2005).

The mixed results of first attempts to establish and maintain a greenhouse population of *P. aleuticum* underscore the need to continue investigations into the development of a protocol for spore germination and sporophyte cultivation. A reserve population is important in the mitigation against several threats: 1) it provides living plant material for research that requires destructive sampling (Factor B), 2) it provides living specimens for reintroduction to offset catastrophic natural and anthropogenic losses to the wild population (Factors A, C, and E), and 3) it maintains germplasm (Weinstein 1995).

Criterion 3: "…genetic material should be stored in a germplasm repository" (Service 1992, Executive Summary).

Associated management actions include the determination of the viability of spores during long term storage and the accession of genetic material into an appropriate facility.

No progress towards this nonspecific Criterion has been made. Long-term storage of spores is of interest not only for ex situ conservation of *P. aleuticum* but also for taxonomic studies. The length of time over which Pteridophyte spores remain viable varies from species to species and is influenced by other factors, such as spore age, ploidy level, and storage conditions (Aragon and Pangua 2004). Collections of properly stored spores may constitute an important part of the conservation strategy for *P. aleuticum*. Additional investigations into the storage conditions that optimize maintenance of spore viability, genetic integrity and developmental capacity over the longest possible time are required. A spore conservation program may facilitate remediation of losses to the source population resulting from threats identified under all 5 Listing Factors.

Criterion 4: "The extant population should be protected from disturbance by humans and introduced ungulates" (Service 1992, Executive Summary).

Associated management actions include the mapping of the known population, the development and implementation of a management plan, investigations into the impacts on the habitat of introduced ungulates, and investigation into re-introduction.

The most current delineation of the Adak Island population can be found in Talbot and Talbot (2002). The Plan calls for the development of a management plan to guide protection and monitoring of the extant Mt. Reed population along with others yet to be discovered; specifically, the

management plan should expand upon protective measures already in place through refuge regulations, address restrictions on access, frequency and timing of population monitoring, and identify contingency actions to be taken in the event of catastrophic losses to the source population. The Alaska Maritime National Wildlife Refuge initiated development of the management plan in 2005 and finalized the plan March 2007 (Byrd and Williams 2007). The management plan summarizes the current status of *P. aleuticum* and identifies measures and management actions to be undertaken to protect the species from threats within refuge boundaries, and provides cost estimates for plan implementation. Area closures, fencing, photographic survey protocols, outreach, surveys for new populations, and the development of a caribou management plan are all proposed management measures.

In 1958 and 1959, 23 barren-ground caribou calves were introduced to Adak Island to provide sport hunting for residents of Naval Air Station, Adak, and as an alternate food source for the military base (Williams and Tutiakoff 2005). The stated caribou management objective was to maintain a pre-calving herd of 200-250 animals with an annual hunter harvest of 50. However, this long-term population goal was exceeded quickly by high reproductive and survival rates thanks to the lack of predators and biting insects along with good habitat quality and mild winters. By the 1980's the estimated population had increased to 300-400, and the threat to *P. aleuticum* posed by caribou was thought to be negligible at the time of listing in 1988. By 1993, the population had grown to an estimated 750 animals, and to nearly 900 by 1998. In 2005, Williams and Tutiakoff (2005) estimated the herd to number at least 2,751 animals. Although no obvious sign of grazing or trampling was noted in the immediate vicinity of known *P. aleuticum* locations, caribou are regularly seen on the lower slopes of Mt. Reed, and were observed in habitat very similar to that described for the shield fern. Williams and Tutiakoff (2005) described habitat destruction and trailing by caribou as now widespread and common on Adak Island. In addition, more visible evidence of caribou in the vicinity of fern locations was observed by researchers collecting spores in 2005, including animals bedded down 100-200 feet below known fern locations (Sandy Talbot, pers. comm., 2006). As rangeland quality diminishes, caribou could be expected to seek out locations not previously grazed; thereby increasing the threat these ungulates are thought to pose to the shield fern, although no formal investigations into the habitat impacts of introduced caribou have been undertaken.

When *P. aleuticum* was listed, threats to the fern from hunters and hikers were considered to be remote. However, while collecting spores during the summer of 2005, researches observed increased levels of use by all-terrain-vehicles on the lower slopes of Mt. Reed where they were not

observed in previous visits (Sandy Talbot, pers. comm., 2006). Access to the area appears to be either facilitated by or stimulated by the presence of caribou trails. An agreement signed by the Navy, U.S. Fish and Wildlife Service, and The Aleut Corporation in March 14, 2004 allowed for the transfer of 47,271 acres of the northern portion of Adak, including the downtown area, housing units, and industrial facilities, to The Aleut Corporation. Although Mt. Reed remains under the management authority of the Refuge, The Aleut Corporation has expressed interest in developing Adak into a community that includes a fish processing industry, fueling facility and a hub for air cargo traffic; the population on the island ranges seasonally from 50 to 300 people.

Careful management as laid out in the management plan will be the most effective tool to mediate the effects of predictable threats associated with the activities of island residents, be they human or caribou (Factors A, B, C, and D).

If you answered *yes* to both 2.2.2.1. and 2.2.2.2., evaluating whether recovery and/or downlisting criteria have been met in section 2.2.3 may be sufficient to evaluate the species listing classification and no further analysis may be necessary; *go to section 2.4., Synthesis.*

If you answered *no* to either 2.2.2.1 or 2.2.2.2, *continue to section 2.3. , Updated Information and Current Species Status, and consider adding updating of recovery criteria in section 4.0, Recommendations for Future Actions.*

2.3. Updated Information and Current Species Status

Briefly summarize new information, citing detailed information and analyses. Each summary of information below should indicate whether there is a change in species status or change in magnitude or imminence of threats since the last status review.

2.3.1 Biology and Habitat – *Provide an updated status of the species, citing new information about the species and its habitat; then go to 2.3.2. For species that are presumed extinct, note whether surveys have been completed or any other information that could be relevant to the species. The following provides a checklist of possible information to consider*:

The Aleutian shield fern is known from only two locations, Atka and Adak Islands in the Aleutian Islands, making it one of the most restricted ferns in North America (Talbot and Talbot 2002). In spite of repeated attempts, the Atka Island population has not been relocated since its original discovery in 1932 (Smith and Davidson 1988). In 1975, 15 *P. aleuticum* plants were discovered on Adak Island (Smith 1985); 3 additional sub-populations have been found there, bringing the total population to an estimated 131 plants distributed over 4 locations on the northeast arm of Mt. Reed. Access to these sites is limited due to steep, unstable,

slippery slopes; therefore, this number likely underestimates the size of the population.

Most plants occur in a narrow microhabitat consisting of rock grottos and moist crevices at the base of steep rock outcrops on east to northeast-facing slopes. The occurrence of all known sub-populations of *P. aleuticum* on northeast-facing slopes suggests that these habitats offer protection from the west-southwest winds that predominate on Adak Island from June to November, the period of time during which habitat would likely be snow-free (Talbot and Talbot 2002). All sub-populations are found between 360 m and 526 m elevation within about 400 m of each other (Talbot and Talbot 2002).

Tande (1989) and Holloway (1995) both observed that the species regularly produces abundant mature indusia and sporangia. However, efforts to cultivate the species in a greenhouse in the 1990s did not result in any mature, spore-bearing fronds being developed. Efforts at artificial propagation revealed that *P. aleuticum* produces viable spores that germinate in approximately 6-8 weeks and develop rapidly into a bisexual gametophyte generation. Sporophytes developed both from single prothallia as well as from populations of mixed prothallia, confirming that apogamy and/or self-fertilization are possible modes of propagation (Holloway 1995).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) - *For each of the five listing factors outlined below, provide a brief summary and citation(s) of any relevant new information, including conservation measures, regarding the magnitude (scope and severity) and imminence of previously identified threats to the species or new threats to the species. Note if any of the factors are not relevant to the species. Upon completion, go to 2.4, Synthesis*

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

An agreement signed by the Navy, U.S. Fish and Wildlife Service, and The Aleut Corporation in March 14, 2004 allowed for the transfer of 47,271 acres of the northern portion of Adak, including the downtown area, housing units, and industrial facilities, to The Aleut Corporation. Mt. Reed remained under the management authority of the Refuge under this agreement. The Aleut Corporation has expressed interest in developing Adak into a community that includes a fish processing industry, fueling facility and a hub for air cargo traffic. No present or anticipated development is likely to directly alter the alpine habitat where *P. aleuticum* occurs, and it is unclear if the number of residents on Adak would increase in response to these proposed developments. However, impacts resulting from all-terrain vehicle traffic are apparent even at current population levels. Anecdotal observations suggest that land use

patterns by residents and visitors have changed since the land exchange took effect in 2004 as they access traditionally used areas via new easements (Kent Sundseth, Refuge Operations Specialist, USFWS, pers. comm., April 13, 2006).

The caribou population on Adak Island increased 3-fold to 2,751 between 1998 and 2005, and caribou are regularly seen on the lower slopes of Mt. Reed where trailing has become common (Williams and Tutiakoff 2005). Researchers collecting spores during the summer of 2005 observed increased evidence of all-terrain vehicle use on the lower slopes of Mt. Reed, where it was absent in previous visits, and the propagation of these trails appeared to be associated with the presence of caribou trails (Sandy Talbot, pers. comm., 2006). Increases in the human population present on Adak Island, in combination with increases in the caribou population, may expand the area impacted by both of these change agents and further amplify the risk of harm due to habitat destabilization and destruction.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Collecting for scientific purposes has been a documented cause for loss of individuals from all known populations. The monitoring protocol developed by Tande (1989) was abandoned due to the potential for habitat destabilization resulting from on-site monitoring activities. Alternatively, the Management Plan for the Aleutian Shield-Fern (Byrd and Williams 2007) establishes a protocol for annual photographic surveys in which surveyors will remain outside the fern locations. In the event that habitat changes are apparent, the best approach to document population levels will be determined in consultation with the Regional Botanist.

2.3.2.3 Disease or predation:

In 1958 and 1959, 23 barren-ground caribou calves were introduced to Adak Island to provide sport hunting for residents of Naval Air Station, Adak, and as an alternate food source for the military base (Williams and Tutiakoff 2005). The population increased steadily, until in 2005, Williams and Tutiakoff (2005) estimated the herd to number at least 2,751 animals. Although no obvious sign of grazing or trampling was noted in the immediate vicinity of known *P. aleuticum* locations, caribou are regularly seen on the lower slopes of Mt. Reed, and were observed in habitat very similar to that described for the shield fern. Williams and Tutiakoff (2005) described habitat destruction and trailing by caribou as now widespread and common on Adak Island. In addition, more visible evidence of caribou in the vicinity of fern locations was observed in 2005, (Sandy Talbot, pers. comm., 2006). Additionally, caribou were observed to be foraging on Arnica spp., a vascular plant documented in association

with *P. aleuticum* (Sandy Talbot, pers. comm., 2006). As rangeland quality diminishes, caribou could be expected to seek out locations not previously grazed; thereby increasing the threat these ungulates are thought to pose to *P. aleuticum*.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

All plants occurring on National Wildlife Refuges are protected from collecting (50 CFR 27.51); therefore, the extant population of *P. aleuticum* is protected by this prohibition. Additional protection is afforded the species under section 7 (interagency cooperation) and section 9, which prohibits removal from Federal lands and reduction to possession of listed plants, and restricts interstate commercial activity. Currently, use of all-terrain vehicles anywhere on wilderness and non-wilderness refuge lands is prohibited. However, increasing use of all-terrain vehicles on Aleut Corporation lands may necessitate the need to both monitor potential impacts to refuge lands (Kent Sundseth, pers. comm., 2006) and devise effective means to control access to areas where *P. aleuticum* occurs.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Habitat characteristics of *P. aleuticum* consist of exposed, weathered rock outcrops in which rooting substrate is confined to fissures, crevices, and thinly mantled horizontal ledges (Lipkin 1985). Known locations are fully exposed to conditions of climatic weathering, and vulnerable to wasting, down slope creep, and the destabilizing effects of the freeze-thaw cycle. Human and animal foot traffic that creates breaks in the vegetation mat or dislodges rock, combined with reduced resilience associated with population isolation, low gene pool, and virtual lack of inter-populational crossing may magnify these threats.

2.4 Synthesis - *Provide a synthesis of the information discussed in sections 2.1, 2.2, and 2.3 to provide an updated assessment of the status of the species and its threats. Please note any significant changes in the species' status or its associated threats since the last review, and explain why the species meets the definition of threatened or endangered, as appropriate. This section should conclude with a recommended classification (downlist, uplist, delist, remain the same). See guidance and 50 CFR 424.11 (the factors considered for delisting are the same factors considered for listing; species may be delisted due to extinction, recovery, and/or data error). This synthesis will provide a basis for the results provided in section 3.0, Results, and the baseline by which to measure changes in status for the next review.*

The Mt. Reed population of P. aleuticum remains critically small in size (approximately 131 individuals) and vulnerable to the effects of increasing access to the slopes of Mt. Reed by hunters and hikers, over-collecting for scientific purposes, habitat destruction

and destabilization by a rapidly growing caribou population, and habitat instability inherent to steep eroding slopes. Consequently, endangered status remains the appropriate classification for this species.

3.0 RESULTS

3.1 Recommended Classification: *Given your responses to previous sections, particularly Section 2.4, Synthesis, make a recommendation with regard to the listing classification of the species.*

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X_ No change is needed

3.2 New Recovery Priority Number __8 (no change)__ *(indicate if no change; see Appendix E)*:

Brief Rationale: Although the Aleutian shield fern is vulnerable to the potentially destabilizing and destructive effects of increasing access to the lower slopes of Mt. Reed, these threats are not immediate and are considered to be moderate in degree. A high recovery potential for this species is derived from the protections afforded it both by its occurrence on National Wildlife Refuge lands and its current listing under the Endangered Species Act (sections 7 and 9). Additional protection may be realized through careful management as laid out in the management plan. Considering these factors and until our understanding of the species taxonomic classification changes, we believe no change to the recovery priority number for the Aleutian shield fern is warranted.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended *(see Appendix E)*

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (Removal from list regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS - *Provide recommendations for future actions that stem from this review and that focus on the highest priority actions needed prior to the next 5-year review. Recommendations may address, but are not limited to, data needs for future 5-year reviews, implementation of high priority recovery actions, actions on DPS-related issues identified in section 2.1, revisions or updates of recovery plans, or development or modification of special rules. For species where little to no new relevant information was available, make specific recommendations to address data and information needs. Completion of these recommended actions is not required, and subsequent reviews will not be precluded should recommended actions remain incomplete. If any of the recommended actions are identified in the species recovery plan, indicate the recovery action number.*

The Recovery Plan should be revised and brought into compliance with current guidelines for recovery planning: criteria should be specifically stated, measurable, and clearly linked to the threats they address; a clear prioritization of management actions deemed integral to achieving recovery of *P. aleuticum* should be provided; and, estimates of the time and cost required to achieve the goal and all intermediate steps should be included. Additional actions to consider (not in priority order) include:

- Establish downlisting and delisting criteria that specify population size, number of sub-populations, and spatial distribution of sub-populations.
- Continue searches for additional populations.
- Continue population monitoring with accepted protocol.
- Reinvigorate efforts to artificially cultivate and maintain a greenhouse population of mature sporophytes.
- Initiate molecular investigations to determine ploidy level.
- Reevaluate the desired size of the greenhouse population.
- Reevaluate the need for long-term storage of germplasm.
- Initiate investigations into optimal long-term germplasm storage conditions and feasibility.
- Initiate studies of effects of grazing on shield fern habitat.
- Initiate investigations into reintroduction and transplanting.
- Develop a caribou management plan.
- Conduct feasibility analysis proposed in the Refuge management plan.
- Investigate current all-terrain vehicle use patterns.
- Establish an outreach plan.

5.0 REFERENCES - *List all information and data sources used in this review. Include on this list any experts used and their affiliations and note whether they provided information or if they acted as peer-reviewers, or both.*

Aragon, C. F. and E. Pangua. 2004. Spore viability under different storage conditions in four rupicolous *Asplenium* L. taxa. American Fern Journal 94(1):28-38.

Anderson, B. L. 1992. Aleutian shield fern (*Polystichum aleuticum* C. Chr. In Hulten) recovery plan. U. S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Byrd, V. and J. Williams. 2007. Management plan for the Aleutian shield-fern (*Polystichum aleuticum*): an endangered species. U.S. Fish and Wildlife Service Report. AMNWR 07/07. Homer, Alaska.

Christensen, C. 1938. On *Polystichum aleuticum* C. Chr., a new North American species. American Fern Journal 28(3):111-113.

Holloway, P. 1995. Reproductive biology of the Aleutian shield-fern, *Polystichum aleuticum*. University of Alaska Fairbanks Agricultural and Forestry Experiment Station, Publication No. 95-1.

Lipkin, R. 1985. Status report on *Polystichum aleuticum* C. Chr. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Little, D. P. and D. S. Barrington. 2003. Major evolutionary events in the origin and diversification of the fern genus *Polystichum* (Dryopteridaceae). American Journal of Botany 90:508-514.

Ramsay, Margaret, Royal Botanic Gardens, Kew, United Kingdom, October 19, 2005, pers. comm. (Provided information).

Smith, D. K. 1985. *Polystichum aleuticum* from Adak Island, Alaska, a second locality for the species. American Fern Journal 75(2):72.

Smith, D. K. 1987. *Polystichum aleuticum* Chr. On Adak Island, Alaska: status report for 1987. Office of Endangered Species, Anchorage, Alaska, USA.

Smith, D. K. and P. G. Davidson. 1988. *Polystichum aleuticum* C. Chr. In Hulten. Site Survey of Atka Island, Alaska 1988. Anchorage Fish and Wildlife Enhancement, Anchorage, Alaska, USA.

Sundseth, Kent, April 13, 2006, Refuge Operations Specialist, USFWS, pers. comm. (Provided information).

Talbot, Sandra, February 21, 2006, Research Wildlife Geneticist, Alaska Science Center, USGS, pers. comm. (Provided information).

Talbot, S. S., S. L. Talbot, and W. B. Schofield. 1995. Contribution toward an understanding of *Polystichum aleuticum* C. Chr. On Adak Island, Alaska. American Fern Journal 85(3):83-88.

Talbot, S. L., J. R. Rearick, and S. S. Talbot. 2003. Preliminary results of molecular investigations of *Polystichum aleuticum* C. Christen, and *Polystichum lachenense* (Hook.) Bedd. Unpubl. Rep. Alaska Science Center, U.S. Geol. Surv., Anchorage, Alaska, USA.

Talbot, S. L. and S. S. Talbot. 2002. A new population of Aleutian shield fern (*Polystichum aleuticum* C. Christens.) on Adak Island, Alaska. American Fern Journal 92(4):288-293.

Tande, G. F. 1989. Aleutian shield-fern (Polystichum aleuticum C. Chr.) field studies for 1989: Establishment of permanent population monitoring plots and habitat characterization. Unpubl. Rep. Ecological Services Anchorage, U.S. Fish and Wildl. Serv., Anchorage, Alaska, USA.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Aleutian shield fern *(Polystichum aleuticum)*

Current Classification __endangered_____
Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable __NA___

Review Conducted By __Charla Sterne_____

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____Date_____

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve_____Date_____

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

Cooperating Regional Director, Fish and Wildlife Service (N/A)

_____Concur _____ Do Not Concur

Signature_____Date_____

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Aleutian shield fern *(Polystichum aleuticum)*

Current Classification __endangered_____
Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable __NA___

Review Conducted By __Charla Sterne_____

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 9/12/07

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 9/26/07

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

Cooperating Regional Director, Fish and Wildlife Service (N/A)

_____Concur _____ Do Not Concur

Signature_____Date_____

TEMPLATE **APPENDIX A: Summary of peer review for the 5-year review of *Aleutian shield fern (Polystichum aleuticum)***

If peer review was conducted, record information regarding how peer review was conducted and the results of peer review. If peer review was conducted in order to fulfill requirements of the OMB Peer Review Bulletin (PRB), reporting and posting information regarding peer review may be required. Information also may be provided as attachments.

A. Peer Review Method: *Provide information on any peer review methods or processes used, including type of peer review.*
No peer review is necessary because there is no new information, other than some updated survey results that found the species in several new areas. The surveys were conducted by recognized species experts. The level of public interest is low, as shown by the lack of public comment on our Federal Register notice announcing initiation of the 5-year review. Likewise, scientific uncertainty or controversy is low. The conclusion of the 5-year review was to leave the status unchanged.

B. Peer Review Charge: *Include any instructions provided to peer reviewers, including scope and objectives of peer review and any specific advice sought.*

C. Summary of Peer Review Comments/Report – *Provide a summary of peer review comments. The OMB PRB may require posting of peer review reports. A peer review report is prepared by the peer reviewers and describes the nature of the review and the findings and conclusions. The report also includes a copy of each reviewer's comments or represents the views of the group of peer reviewers as a whole. If posting of the 5-year review also will serve as posting of peer review information to fulfill requirements of the OMB PRB, include peer review reports as attachments.*

D. Response to Peer Review – *Describe how peer review comments were addressed. Include the following: whether we agreed or disagreed with any concerns; any actions undertaken as a result of peer review; and whether and how results of peer review were incorporated into the 5-year review.*