Alaska Park Science

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Science in Southwest Alaska

In this issue:

...and more.

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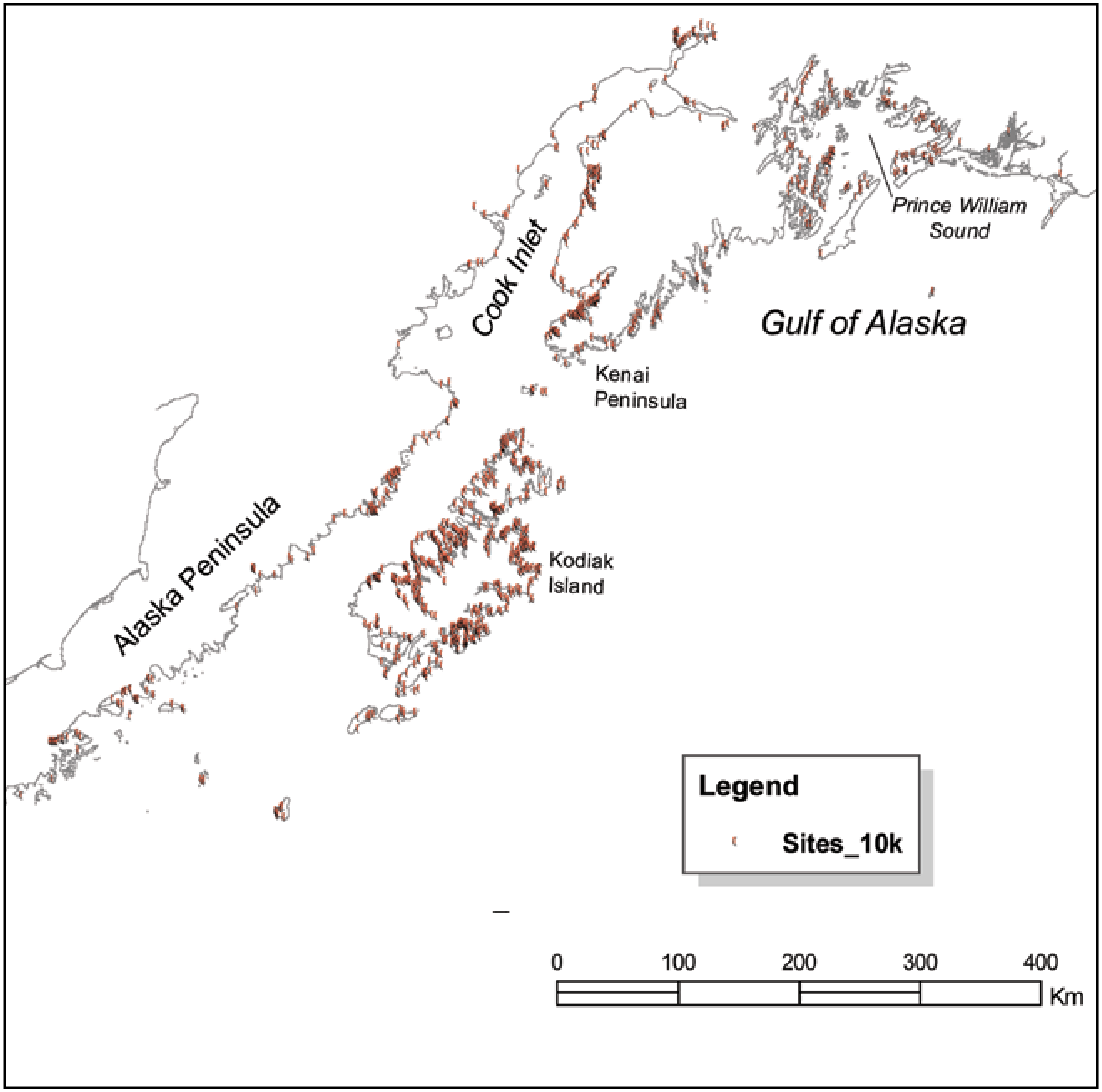
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Spatial Correlation of Archaeological Sites and Subsistence Resources in the Gulf of Alaska

By Aron L. Crowell, Joseph Liddle, and Mark Matson

Abstract

A GIS-based spatial analysis of 1,959 indigenous coastal archaeological sites in the central Gulf of Alaska coast demonstrated that settlements are clustered in areas where maritime hunters and fishers had access to numerous nearby locales for harvesting subsistence species. Zones of high resource richness – primarily associated with bay mouths and complex shorelines – provided stability of food access as the availability of individual species fluctuated both seasonally and as the result of decadal and centennial climate cycles. Factor analysis revealed distinct associations between site locations and groups of species that are more or less abundant during cold and warm climate phases.

Figure 1. Locations of all reported coastal archaeological sites in the central Gulf of Alaska.

Figure 2. A 3000 year-old fishing sinker at an eroded archaeological site in Nuka Bay, Kenai Fjords National Park.

Figure 3. Test excavations in midden at an 800 year-old Sugpiaq village site in coastal forest along Nuka Passage, Kachemak Bay State Park, 2007. Left to right: Forest Kvasnikoff (Port Graham), Mark Luttrell (Seward), Ann Ghicadus (Seward), and student intern Justin Malchoff (Port Graham).

Photographs courtesy of A. Crowell

Introduction

This paper summarizes preliminary results of a regional Geographic Information System (GIS) study of the spatial relationships between coastal archaeological sites and maritime subsistence resources in the central Gulf of Alaska. Two modes of variability are relevant to the model – the uneven geographic distributions of key subsistence resources and temporal cycles in the climate and marine ecosystem (*Crowell et al. 2003*). The latter include the annual seasonal cycle, the 20 to 50 year intervals of the Pacific Decadal Oscillation (PDO), and multi-century trends including the Medieval Warm Period (~A.D. 1000-1400) and Little Ice Age (~A.D. 1400-1900). Salmon increase during warmer PDO phases, while colder phases yield increases in forage fish and shrimp that in turn support larger numbers of the seals, sea lions, and seabirds who consume these prey (*Benson and Trites 2002, Finney et al. 2002, McGowan et al. 1998*). We propose that indigenous hunting and fishing peoples of the Gulf of Alaska settled primarily in areas with the highest numbers and diversity of marine fish, mammal, and bird harvesting locales in order to increase harvesting efficiency and to buffer the risk of individual species declines due to climate and marine ecosystem change.

Data and Methods of Analysis

The study area spans 10,560 mi (17,000 km) of mainland and island shoreline including the Alaska Peninsula, Cook Inlet, the Kodiak Island archipelago, Kenai Peninsula, and Prince William Sound, a region that encompasses the traditional territories of the Sugpiaq (Alutiiq) and coastal Dena'ina. The sample includes 1,959 known coastal archaeological sites: 41% are estimated from radiocarbon dates, artifacts, and features to have been occupied since A.D. 900; 10% are older than A.D. 900; and 49% are of indeterminate age (*Figure 1*). For each of the 6,800 shoreline segments (1.6 mi/2.5 km in length) we computed the number of archaeological sites present as well as the number of locally accessible harvest locales for each of 24 different fish, bird, and sea mammal species (*Figure 4*). Harvest locales for offshore subsistence species (e.g. seal concentrations, bird rookeries, and pelagic fishing areas) were counted as accessible if located within a 6.2 mi (10 km) kayak travel radius from any point on the shoreline segment. Access to anadromous fish streams was computed using a 0.6 mi (1 km) pedestrian radius, reflecting the ethnohistoric pattern of establishing fishing camps at these locations. Statistical analysis utilized simple "richness" scores – the total number of resource access locales (all species) for each segment – as well as multivariate correspondences between site occurrence and the availability of various species groups.

Results

Geographically, the highest richness scores occur in protected bays with complex shorelines (including

GIS Layer	Data Source
Archaeological Sites	AK Office of History and Archaeology
King Salmon	Alaska Dept. of Fish and Game 2006
Sockeye Salmon	Alaska Dept. of Fish and Game 2006
Coho Salmon	Alaska Dept. of Fish and Game 2006
Chum Salmon	Alaska Dept. of Fish and Game 2006
Pink Salmon	Alaska Dept. of Fish and Game 2006
Steelhead	Alaska Dept. of Fish and Game 2006
Sea Bird Colonies	U.S. Fish and Wildlife Service 2006
Harbor Seal Haulouts	National Marine Fisheries Service 2006
Sea Lion Haulouts	National Marine Fisheries Service 2006
Sea Lion Concentrations	National Ocean & Atmospheric Administration 2003
Harbor Porpoise	National Ocean & Atmospheric Administration 2003
White Whale	National Ocean & Atmospheric Administration 2003
Humpback Whale	National Ocean & Atmospheric Administration 2003
Minke Whale	National Ocean & Atmospheric Administration 2003
Fin Whale	National Ocean & Atmospheric Administration 2003
Dall's Porpoise	National Ocean & Atmospheric Administration 2003
Herring	National Ocean & Atmospheric Administration 2003
Pacific Cod	National Ocean & Atmospheric Administration 2003
Walleye Pollock	National Ocean & Atmospheric Administration 2003
Lingcod	National Ocean & Atmospheric Administration 2003
Halibut	National Ocean & Atmospheric Administration 2003
English Sole	National Ocean & Atmospheric Administration 2003
Dover Sole	National Ocean & Atmospheric Administration 2003
Arrowtooth Flounder	National Ocean & Atmospheric Administration 2003

Figure 4. GIS layers used in the study and sources of data.

bay mouth islands), while richness diminishes toward the inner reaches of bays and along straight, exposed coastlines (*Figure* 5). The pattern is multiscalar, applying to very large features (Cook Inlet and Prince William Sound) as well as more localized coastal involutions. The richest areas combine coastal complexity with proximity to the central Gulf of Alaska upwelling zone located at the mouth of Cook Inlet. These areas include the northern Kodiak archipelago, Cape Elizabeth and Kachemak Bay at the tip of the Kenai Peninsula, and the Kukak Bay-Amalik Bay section of the Alaska Peninsula,

A graph of site count per segment plotted against richness score (*Figure* 6) suggests a threshold at approximately 10 resources, below which relatively few sites are present at most locations. Out of 856 coastal segments where sites were present, 776 (90.6%) had richness scores of 10 or greater (*Figure* 7), a relationship that is highly significant ($p = <0.0001$). The presence of other sites within 7.5 mi (12 km) also has a strong predictive value ($p = <.001$), reflecting the clustering of sites within resource-rich zones (*Figure* 8). As a further indication of this pattern, all 1,959 regional archaeological sites were contained within only 13% of shoreline segments, while the other 87% contained no settlements. Some neighboring sites are probably villages and camps used by contemporary people during different parts of the year, while others reflect shared settlement preferences by unrelated groups at different times.

We also undertook a factor analysis of the resource matrix to determine which resources or resource groups have dominant effects on site location. The analysis showed that the 24 resource variables could be reduced to six factors. Three of these – Factor 1 (sea lions, cod, halibut, herring), Factor 4 (anadromous fish including 3 species of salmon and steelhead trout), and Factor 6 (seals and seabird colonies) were found to have highly significant influences ($p = <.0001$) on site count. Each one unit increase in Factor 1 increased predicted site count by 33.7%; in Factor 4 by 28.7%; and in Factor 6 by 8.6%.

This result indicates the relatively equal but segregated influences of pelagic fish (along with sea lions, one of the major predators of such fish) and of salmon, reflected in Factors 1 and 4 respectively. In part, this segregation is likely to reflect seasonal rotation between fall-winter-spring villages and mid to late summer salmon camps. Factor 6 represents the association of seal haul-outs and bird colonies on offshore islands and the influence that these have on attracting human settlement to proximate coastlines.

On a longer temporal scale, Factor 1 may represent subsistence emphasis and corresponding site location choices during colder phases when salmon are reduced but sea mammals and forage fish (e.g. herring) increase. Factor 4 would represent the alternative warm phase strategy, when coastal residents moved to major salmon rivers and relied on mass production and storage of this resource for winter consumption. Intraregional mobility of this type is documented by archaeological and ethnohistorical instances including Sugpiaq settlement along the salmon-rich Karluk River on Kodiak Island during the Medieval Warm period and later resettlement along the sea mammal-rich coast of eastern Kodiak at the peak of the Little Ice Age in the late 1700s (*Clark 1987*). Dena'ina groups expanded into Cook Inlet at the start of the Medieval Warm Period around A.D. 1000 and adopted an intensive salmon fishing orientation.

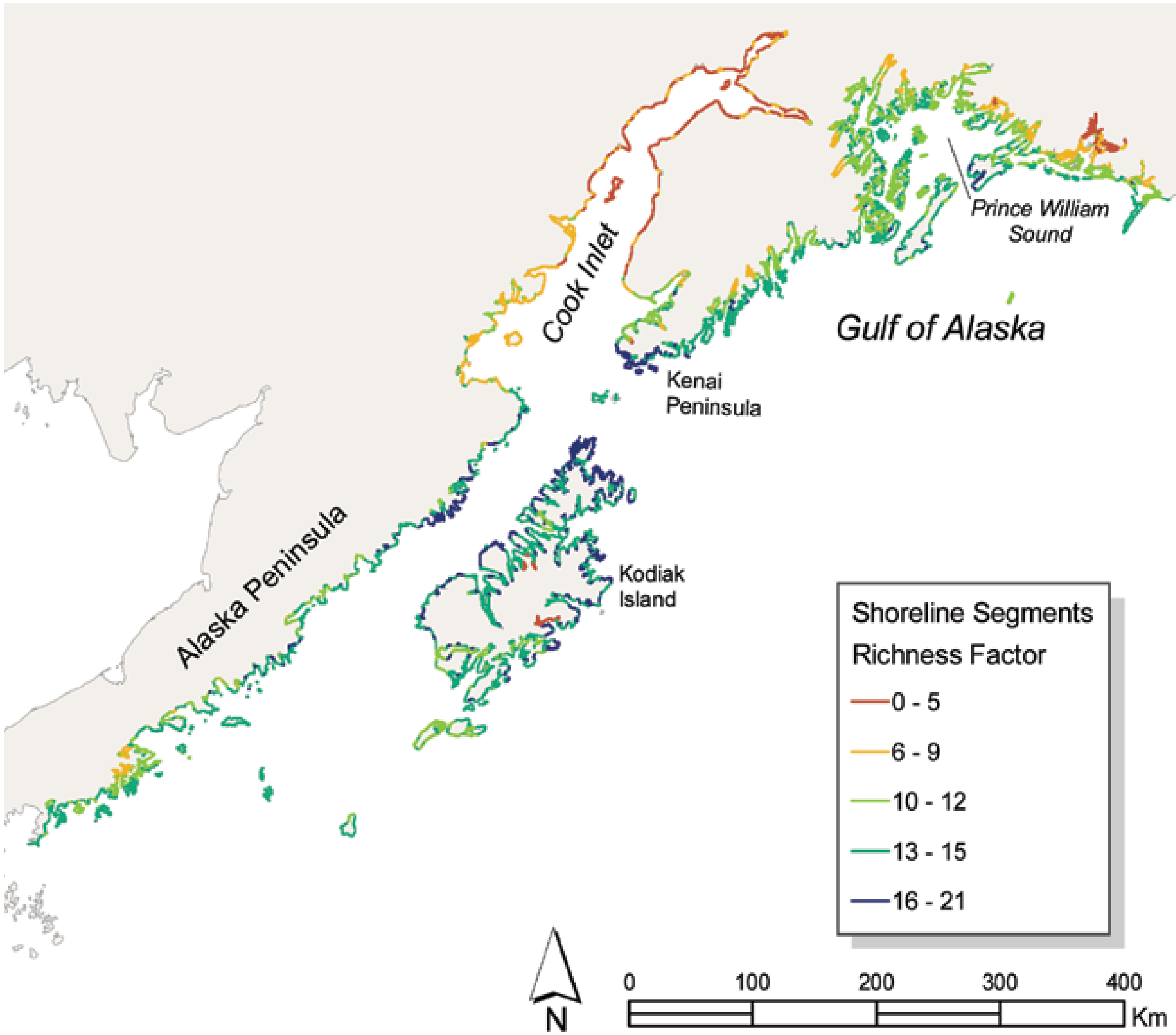

Figure 5. Computed resource richness scores for 6,800 shoreline segments (each 1.6 mi or 2.5 km long) in the central Gulf of Alaska.

Discussion

Indigenous settlement along the central Gulf of Alaska coast, as represented by a sample of almost 2,000 archaeological sites, was strongly influenced by proximity to marine subsistence resources. We have shown that distributions of fish, mammal, and bird species can be used to compute summed richness scores for individual shoreline segments, and that these scores correlate highly with the frequency of known coastal sites. In geographic terms, areas of resource richness and high site density are associated with complexly indented shorelines, in particular the protected outer portions of bays and fiords. We suggest that the concentration and diversity of resource harvest locales in such areas supported extended occupation across all time scales from seasonal to millennial by mitigating climatic and ecosystem fluctuations in the abundance of individual food species.

These regional findings extend and confirm our findings from a similar GIS study of resources and settlement patterns on the Gulf of Alaska coastline of Katmai National Park and Preserve (*Crowell et al. 2003*), as well as a previous regional study (*Erlandson et al. 1992*). This GIS predictive model has significant management implications for national parks bordering the Gulf of Alaska (Katmai, Lake Clark, Kenai Fjords, Wrangell-St. Elias, and Glacier Bay), where the most high priority regions for cultural resource documentation and protection are likely to be shorelines with associated high resource scores.

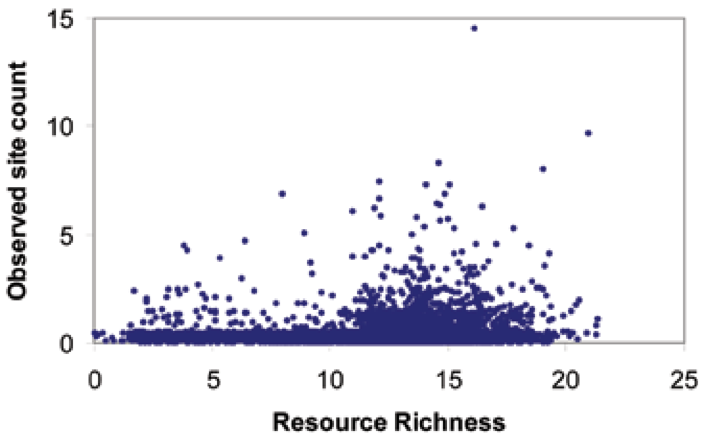

Figure 6. Scatter plot of resource richness compared to site count for 6,800 shoreline segments. The majority of sites (90.6%) occur on segments with access to 10 or more resources. Site count values are slightly "jiggled" to separate them and bring zero values up from the baseline.

	No Site	Site	Totals
Richness < 10	1072	80	1152
Richness > 10	4872	776	5648
Totals	5944	856	6800

Figure 7. Presence or absence of archaeological sites compared to richness scores of < 10 and ≥ 10. Site presence is not independent of the criteria that resource richness ≥ 10 ($x^2 = 40.15$, $p < 0.0001$).

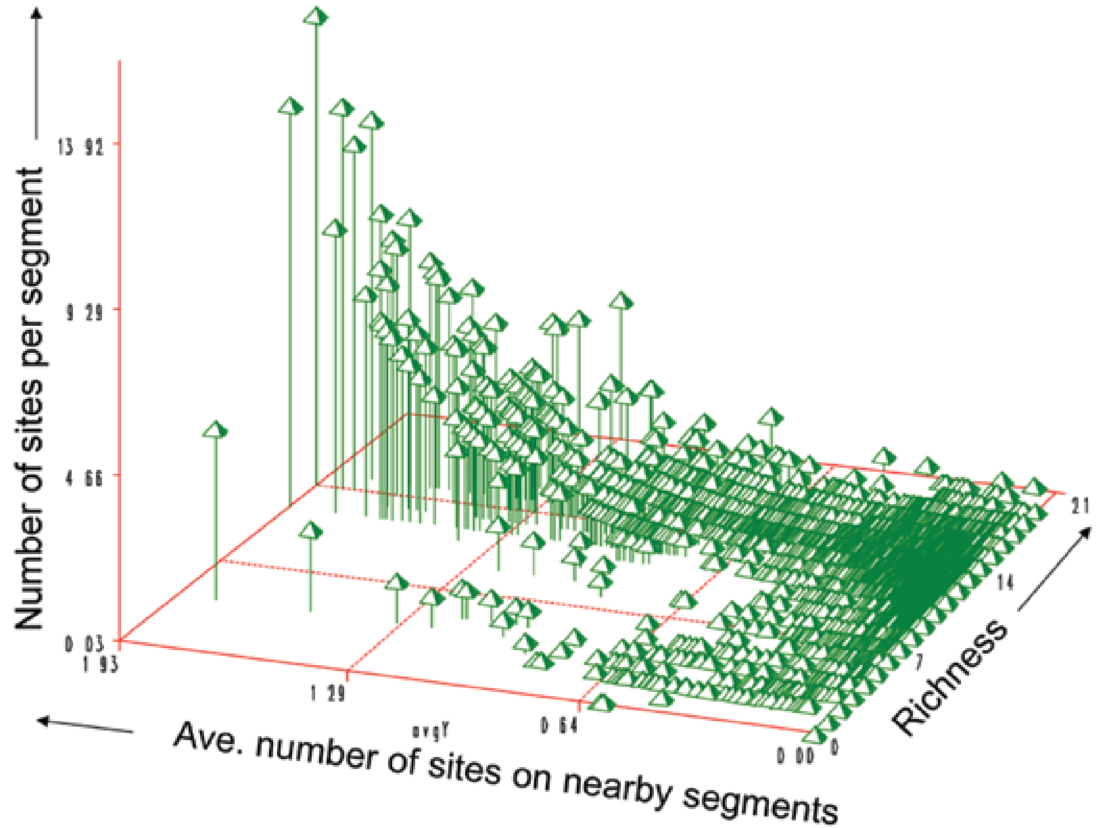

Figure 8. Predicted site counts increase as both richness and the average number of neighboring sites increase. The largest predicted site counts occur where richness is greater than 10 and the average number of neighboring sites exceeds 1.0.

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We acknowledge and appreciate a number of contributions to this collaborative project. The NPS Regional Office (Anchorage) and the Ocean Alaska Science and Learning Center (Seward) funded extensive archaeological site surveys by Aron L. Crowell and the Smithsonian Institution's Arctic Studies Center in Katmai, Kenai Fjords, Wrangell-St. Elias, and Glacier Bay national parks. A Wenner-Gren Foundation research grant to the Arctic Studies Center enabled the GIS analysis by Mark Matson and statistical analysis by Joseph Liddle. The Office of History and Archaeology (Alaska Department of Natural Resources) provided locational and descriptive data for the archaeological site sample. The Alaska Department of Fish and Game, the National Marine Fisheries Service, the National Oceanic and Atmospheric Administration, and the U.S. Fish and Wildlife Service provided digital data for the GIS model.

REFERENCES

Alaska Department of Fish and Game. 2006.
Alaska Waters Catalog of Anadromous Fish. (http://www.adfg.alaska.gov/index.cfm?adfg=maps.data)

Benson, Ashleen J., and Andrew W. Trites. 2002.
Ecological Effects of Regime Shifts in the Bering Sea and eastern North Pacific Ocean. Fish and Fisheries 3: 95-113.

Clark, Donald W. 1987.
On a Misty Day You Can See Back to 1805: Ethnohistory and Historical Archaeology on the Southeastern Side of Kodiak Island, Alaska. Anthropological Papers of the University of Alaska 21(1-2): 105-132.

Crowell, Aron L., Mark Matson, and Daniel H. Mann. 2003.
Implications of "Punctuated Productivity" for Coastal Settlement Patterns: A GIS Study of the Katmai Coast, Gulf of Alaska. Alaska Journal of Anthropology 1(2): 62-96.

Erlandson, Jon, Aron L. Crowell, Christopher Wooley, and James Haggarty. 1992.
Spatial and Temporal Patterns in Alutiiq Paleodemography. Arctic Anthropology 29(2): 42-62.

Finney, Bruce P., Irene Gregory-Eaves, Marianne S.V. Douglas, and John P. Smol. 2002.
Fisheries Productivity in the Northeastern Pacific Ocean Over the Past 2,200 Years. Nature 416:729-733.

McGowan, John A., Daniel R. Cayan, and Leroy M. Dorman. 1998.
Climate-Ocean Variability and Ecosystem Response in the Northeast Pacific. Science 281: 210-217.

National Marine Fisheries Service. 2006.
Harbor Seal Haul-out Locations and Stellar Sea Lion Sites. National Marine Mammal Laboratory, NOAA Alaska Fisheries Science Center, National Marine Fisheries Service.

National Oceanic and Atmospheric Administration. 2003.
West Coast of North America Living Marine Resources Data Atlas: Digital Version, 2003. (http://westcoastatlas.noaa.gov/download.html)

U.S. Fish and Wildlife Service. 2006.
The Beringian Seabird Colony Database. U.S. Fish and Wildlife Service, Migratory Bird Management.

Invasive Species Management in Southwest Alaska: Current Projects and Areas of Need

By Gino Graziano and Bonnie Million

Abstract

Throughout Southwest Alaska invasive plants have potential to impact natural resources and ecosystems. Weed management efforts exist on the Kenai Peninsula and Kodiak Archipelago. Areas around King Salmon and Dillingham are developing management programs. Other areas lack awareness of the issue, or struggle to implement effective management. To lessen the threat from invasion in underserved areas, collaborative approaches are needed to educate communities, implement prevention, conduct inventory, and manage invasive plants using integrated pest management practices. Existing cooperative efforts for invasive plant management provide guidance to develop new programs in these underserved communities.

Introduction

Invasive species are defined as introduced species that cause or are likely to cause harm to the environment, human health or the economy (Executive Order 13112). In this context, harm occurs when the benefits of the plant are fewer than the detriments of invasion (*NISC 2006*). Introductions are typically considered relatively recent events starting with Russian and American contact, and include anthropogenic influence establishment of species not native to the local area, even if it is native to other parts of North America or Alaska.

Highly invasive species are known to impact the resources and biodiversity of infested areas. In Alaska, some invasive plants have demonstrated potential to impact species and resources. White sweetclover, *Melilotus officinalis*, at high densities can suppress growth of *Salix alaskensis* on glacial floodplains (*Spellman and Wurtz 2010*). The European bird cherry, *Prunus padus*, in Anchorage riparian areas does not support comparable quantity or diversity of insects as native plant communities (*Roon 2011*), and contains toxins which caused the death of three calf moose during the winter of 2010-2011 (*Woodford and Harms 2011*). Other highly invasive species are present in Alaska, however research documenting impacts often does not occur until a species is too well established to eradicate.

Not all introduced and spreading species cause harm and are truly invasive. Some will simply integrate into the ecosystems with little consequence, while others are aggressive ecosystem engineers. The process of transitioning from invasion to harm can take many years, commonly referred to as the lag phase, with a plant seeming relatively innocuous before rapid expansion of the species. Once harm is realized from invasion it is often too late to eradicate the species. With 374 introduced plants recorded in Alaska, determining which are highly invasive and deserve management is complicated (*AKEPIC 2012*).

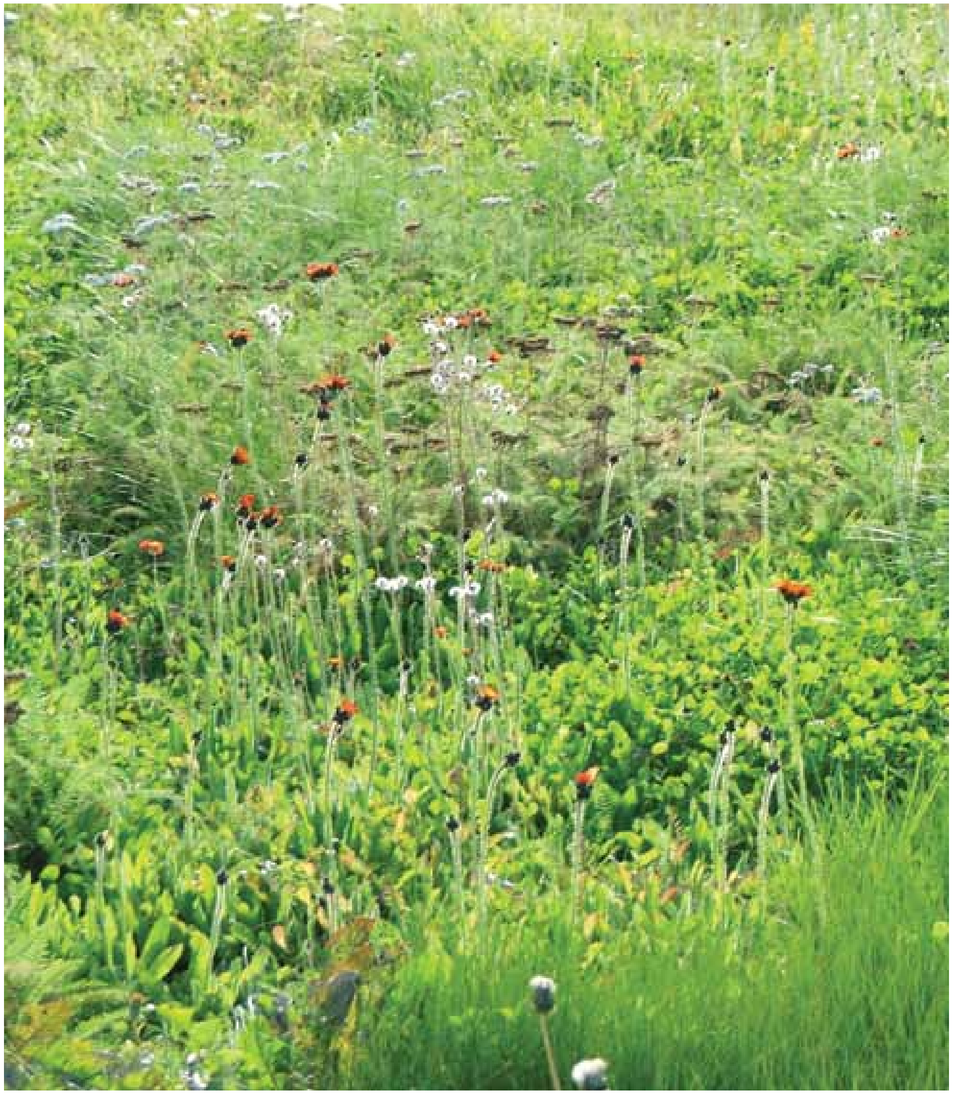
To help predict the potential harm from an invasive plant, biologists created a ranking system for invasive plants in Alaska (*Carlson et al. 2008*). The ranking assesses climate suitability to eliminate species unlikely to establish, and evaluates the introduced plants potential to impact an ecosystem. Ranks range from 0-100 where 0 is not invasive and 100 is the most invasive. Utilizing invasiveness ranks, land managers can prioritize multiple species for management in a given area.

Invasive plant introductions occur in a variety of ways. Invasive plants are sometimes deliberately introduced without knowledge of the species' invasive tendencies. However, with the realization of invasions from deliberate introductions, revegetation with indigenous plant material is increasing in practice. Humans often act as unknowing vectors of invasive species to new areas. Seed, hay/straw, fill material, horticultural products, heavy equipment, vehicles, and even camping equipment commonly used in research base camps all have potential to introduce invasive plant propagules.

The remainder of this article will cover prevention, decision tools to aid in management, areas in need of weed management activities in the Southwest Alaska Area Network (SWAN); and examples of successful weed management programs in the SWAN. There is need for prevention and management of all taxa of invasive species, however, this article will focus on invasive plants.

Figure 1. Canada thistle grows in a variety of habitats from roadsides and waste areas, to wet bluejoint meadows as shown in this picture of an Anchorage area infestation.

Photograph by Gino Graziano



Photograph by Gino Graziano

Figure 2. Orange hawkweed forms dense mats of vegetation, and shows up in gardens, cemeteries, and airports such as this picture taken in Skwentna.

Photograph by Gino Graziano

Figure 3. Spotted knapweed is an excellent candidate for statewide eradication with only five known infestations. Look for knapweed in waste areas frequented by vehicles or equipment. Shown above is an infested equipment staging area at Sutton, Alaska.

Prevention

Preventing introductions is the highest priority in effective invasive plant management. The suite of prevention measures commonly revolve around activities that disturb the land and include steps such as; cleaning equipment, using local materials (plant and fill), using certified weed free products (e.g. gravel, hay and straw), and staging camps and equipment in areas that are weed free. While typically used in major disturbance activities, land managers should utilize these same strategies whenever applicable to research camps and other human traffic in remote areas.

Certified weed free products are increasing in availability in Alaska. Focus for certification programs has remained on straw and hay products and also gravel recently. These products are inspected according to standards developed by the North American Weed Management Association (NAWMA). It includes a list of NAWMA prohibited weeds as well as additional weeds specific to Alaska (http://nawma.org/WeedFree.html). The certification program is designed to significantly decrease the chance of accidental introduction of the prohibited species, however, species not included on the prohibited list may still be introduced.

Management Decision Tools

When an invasive plant is established, coordinated action to manage the infestation is necessary. Approaching management involves using the principles of Integrated Pest Management (IPM), a common sense approach that aims to successfully manage pests with methods that minimize secondary impacts. Land managers can find assistance in developing sound IPM plans with the University of Alaska Fairbanks, Cooperative Extension Service, IPM Program (http://www.uaf.edu/ces/ipm/) and previously completed agency management plans.

Often multiple infestations of multiple invasive plants are known in an area, and limited funds force a triage approach. In these situations land managers should prioritize the following three themes: 1) Which species are likely to be the most invasive in the landscape? 2) Which infestations present the greatest threat of spread to sensitive habitats? and 3) Which infestations present the greatest probability of successful management with available funds?

The ranking system discussed earlier is a key component for prioritizing infestations as it describes the invasiveness of a species (*Carlson et al. 2008*). Spatial analysis of known infestations can determine which species are too abundant for eradication and which are in closest proximity to sensitive habitats. One approach to spatial prioritization developed by the Kenai National Wildlife Refuge for the Kenai Peninsula Cooperative Weed Management Area (CWMA) prioritizes watersheds and infestations for reed canary grass, *Phalaris arundinacea*, based on discreteness and isolation (*Maupin 2011*). The Kenai Peninsula approach considers watersheds that are more discrete and isolated a higher priority for prevention and management when an infestation is found.

Weed Management Needs

Finding and managing infestations with potential to affect resources in the SWAN is difficult. Agencies such as the National Park Service have conducted thorough inventories of park lands to identify priorities. More inventories are necessary in communities near park and refuge lands where inventories are complicated by private lands and expense to visit remote locations. One solution to help find and prevent establishment of infestations in these communities is education and outreach. Education and outreach efforts have uncovered new infestations in remote areas of Alaska and spurred the establishment and local ownership of weed management efforts. Tools for reporting and identification are already developed including a Yup'ik language invasive species guide (*Lisuzzo 2011*).

The discontinuity and varying organizational capacity of communities in the SWAN creates difficulties in organizing weed management efforts, particularly when management is outside of park boundaries. Still, these infestations are some of the most important to manage, as they are often recently established and isolated.

There are three known areas in the SWAN that are in need of increased management efforts to prevent established infestations from spreading to nearby park and refuge lands. Canada thistle, *Cirsium arvense* (*Figure 1*), is found in Tyonek and Cold Bay off federal lands. Survey crews visiting Tyonek and refuge staff in Cold Bay discovered the thistle infestations. Canada thistle grows in a variety of habitats including wetland and dry sites. It is capable of forming monocultures when left unmanaged. Orange hawkweed, *Hieracium aurantiacum* (*Figure 2*), found on Adak Island off refuge lands is highly aggressive in grass and forb dominated communities. Hawkweed is pollen-allelopathic, preventing seedling establishment of other species (*Murphy 2001*). Hawkweed can also reproduce asexually (apomixis), making it a highly successful colonizer of new areas, and aggressively spreads vegetatively. These adaptations allow hawkweed to form monocultures in areas that support diverse grasses and forbs.

Current Programs

Within the SWAN are a few interagency weed management programs. These include the Kenai Peninsula, Kodiak Archipelago, and Bristol Bay area. Each of these programs has a unique strategy to education, outreach and control work, utilizing multiple partners to facilitate implementation of action strategies.

The Kenai Peninsula CWMA consists of many partners including the Kenai Peninsula Borough, three soil and water conservation districts, the Kenai National Wildlife Refuge, Chugach National Forest, Cooperative Extension Service and others. Their programs focus on educating the public to manage weeds on their lands, through demonstration projects. They also support work done on refuge and national forest lands providing an avenue for the public to be informed about these weed management activities. Through their work they have successfully eradicated spotted knapweed, *Centaurea stoebe* (*Figure 3*), and are nearing successful eradication of Canada thistle.

The Kodiak Archipelago has an active CWMA that has a central partnership between the Kodiak Soil and Water Conservation District (SWCD) and the Kodiak National Wildlife Refuge (NWR). When the Kodiak NWR completed an Environmental Assessment to use herbicides on infestations they included a process to work off refuge lands with an entity that submits a pesticide use proposal to their program (*KNWR 2010*). In this way the refuge is able to fund the Kodiak SWCD to manage infestations off refuge lands. The two organizations also partner extensively to provide public outreach and agency education. The Kodiak NWR is managing remote infestations of orange hawkeed and other species on refuge lands (*Figure 4*).

The Bristol Bay Native Association (BBNA) has established efforts to inventory, manage and educate the public about invasive weeds. The program started with American Recovery and Reinvestment Act funds granted to the Alaska Association of Conservation Districts from The U.S. Forest Service. Presently the Ekuk Village Council is leading the efforts. The Bristol Bay weed management group has completed inventory and outreach in six of the area communities. Expansion of inventory, education and control work in the Bristol Bay area is supported through a grant from the Western Alaska LLC to hire technicians and inventory and educate the residents of 26 more villages.

Conclusion

Invasive species are best managed now before problems are realized. Implementing sound prevention, education, and inventory are necessary for early successful management.

USFWS photograph courtesy of Leslie Kerr

USFWS photograph courtesy of Bill Pyle

Figure 4. Orange hawkweed is actively managed by staff members of the Kodiak National Wildlife Refuge. Shown on the top is the picture of an infestation on Karluk Lake before treatment, and on the bottom is the result of several years of herbicide treatment.

REFERENCES

Alaska Exotic Plant Information Clearinghouse (AKEPIC). 2012.
Non-Native Plant Species List. Accessed January 27, 2012.
(http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plants-alaska)

Carlson, M.L., I.V. Lapina, M. Shephard, J.S. Conn, R. Densmore, P. Spencer, J. Heys, J. Riley, and J. Nielsen. 2008.
Invasiveness ranking system for non-native plants of Alaska. USDA Forest Service, R10-TP-143. Accessed January 26, 2012.
(http://aknhp.uaa.alaska.edu/botany/akepic/publications)

Executive Order 13112.
Invasive Species Info. Accessed January 26, 2012.
(http://www.invasivespeciesinfo.gov/laws/execorder.shtml)

Kodiak National Wildlife Refuge (KNWR). 2010.
Environmental Assessment- Integrated pest management of invasive plants on Kodiak National Wildlife Refuge and Vicinity. Accessed January 26, 2012.
(http://aknhp.uaa.alaska.edu/botany/akepic/publications)

Lisuzzo, Nicholas. 2011.
Protecting Southwestern Alaska From Invasive Species: A Guide in the English and Yup'ik Languages. Forest Service Alaska Region. R10-PR-024.

Maupin, Brian 2011.
Reed Canarygrass Management on The Kenai Peninsula: A Spatial View. Presented at the 12th Annual Alaska Invasive Species Conference, October 19-21, 2011. Accessed January 26, 2012.
(http://www.uaf.edu/ces/pests/cnipm/otherresources/12th-annual-proceedings)

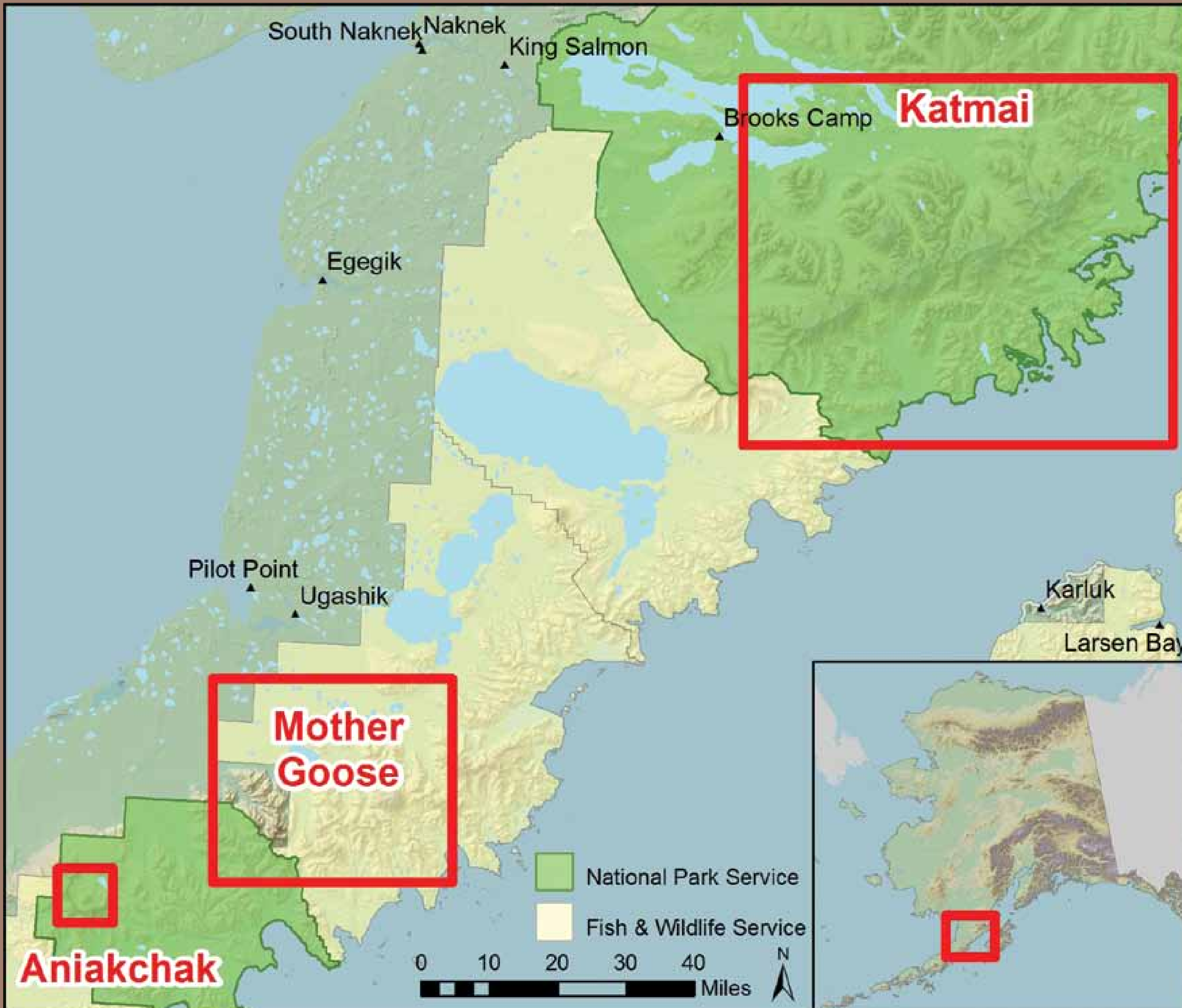
Murphy, Stephen D. 2001.
The Role of Pollen Allelopathy in Weed Ecology. Weed Technology 15(4): 867-872.

National Invasive Species Council (NISC). 2006.
Invasive Species Definition Clarification and Guidance White Paper. Definitions Subcommittee of the National Invasive Species Council. Accessed January 26, 2012.
(www.invasivespeciesinfo.gov/docs/council/isacdef.pdf)

Roon, David A. 2011.
Ecological effects of invasive European bird cherry (Prunus padus) on salmonid food webs in Anchorage, Alaska streams. M.Sc. Thesis. University of Alaska Fairbanks.

Spellman, Blaine T., and Trish L. Wurtz. 2010.
Invasive sweetclover (Melilotus alba) impacts native seedling recruitment along flood-plains of interior Alaska. Biological Invasions 13(8): 1779. Accessed January 26, 2012.
(doi: 10.1007/s10539-010-9931-4)

Woodford, Riley, and C. Harms. 2011.
Cyanide-poisoned Moose Ornamental Chokecherry Tree a Devil in Disguise. Alaska Fish and Wildlife News. March 2011. Accessed January 27, 2012.
(http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=501&issue_id=96)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Salmon in a Volcanic Landscape: How Salmon Survive and Thrive on the Alaska Peninsula

By Troy Hamon and Scott Pavey

Volcanic activity can alter freshwater habitats dramatically, including major changes to water chemistry, turbidity, temperature, and channel morphology (*Lucas 1986*). These effects can severely impact fish populations living in the waters during the eruption, and the longer-term effects are also generally negative. However, along the Alaska Peninsula, a zone of some significant historic and pre-historic eruptions, these effects coexist with some of the most productive salmon populations on earth (*Hilborn et al. 2003*). Studies conducted in the area of three of the Alaska Peninsula volcanoes shed some light both on the effects of volcanic activity on salmon populations in freshwater, as well as on the process of recolonization after an eruption (*Figure 1*).

The most recent evidence of major impacts from volcanic activity to freshwater habitats on the Alaska Peninsula comes from the acidification of Mother Goose Lake, within the Alaska Peninsula Wildlife Refuge (*Figure 2*). In 2005, the summit crater of Mount Chiginagak drained rapidly, resulting in a flood containing waters that were highly acidic. The arrival of this water into Mother Goose Lake resulted in the pH dropping to 3, a level of acidity that approaches the acidity of cola beverages. The acid killed all aquatic life and damaged riparian vegetation for miles downriver(*McGimsey et al. 2008, Schaefer et al. 2011*). The acidity of Mother Goose Lake has declined, resulting in pH climbing to around 7, which would be considered normal, by 2011 (*Schaefer et al. 2011*). While Mother Goose Lake and downstream waters were acidified, the Needle Lake drainage, a tributary to Indecision Creek which drains into Mother Goose Lake, was not. The value of small refugia such as the Needle Lake area in relation to the other large-scale freshwater drainages nearby (such as the Ugashik Lakes) is an active field of research, and systems like Mother Goose Lake are vital to the study of natural recolonization. It is very important to study natural recolonization, because human attempts in establishing reproducing populations of anadromous salmon rarely succeed (*Wood 1995*).

In 1912, the massive eruption of Novarupta Volcano filled an entire river valley with pyroclastic flow deposits, creating the Valley of Ten Thousand Smokes (*Figure 3*). Fish populations within the valley would have been wiped out, and ash falling in other nearby waters likely had an impact on those populations as well. Present day water conditions in the valley are still affected by this event. Water is highly turbid as it flows through the ash sheet in water courses cut deep into the welded tuff that constitutes the valley floor. The ash particles that are transported in the water are likely to disrupt fish respiration by damaging gill membranes. However, this same effect of turbid water can be seen from glacial silt, and we now know that there are spawning populations of salmon that make use of glacial systems (*e.g. Ramstad et al. 2010*). A waterfall on the Ukak River prevents fish from accessing the streams draining the valley, but information about fish in waters draining from the valley on all sides is sparse. It is possible that turbid habitats are widely used by salmon, but they are more difficult to study, because spawning fish cannot be seen by airplane, or even by walking alongside the river.

While the impacts of the pyroclastic flow that formed the Valley of Ten Thousand Smokes are clearly demonstrated by the altered landscape that persists to this day, the effects of the ash fall outside the valley are less certain. Though major ash deposition was reported as far away as Kodiak Island, recent work in Katmai has demonstrated that this ash fall was unlikely to have destroyed fish populations in lakes within the park. Though most of the waterbodies in Katmai ultimately connect to the ocean, one interesting avenue of study is to look at fish assemblages that are landlocked or not connected to the ocean. Kokanee, which are landlocked sockeye salmon (*Oncorhynchus nerka*), occur in three lakes within Katmai. Each lake is between 10 and 25 miles from Novarupta Volcano. Sediment core analysis has indicated that Jo-Jo Lake (about 25 miles northwest of Novarupta) was a basin of Naknek Lake that was eventually shut off as the Naknek Lake level dropped over the past thousands of years. The most recent contiguous water flow with Naknek Lake appears to have occurred more than 200 years ago, well before the Novarupta eruption, but the lake has populations of kokanee as well as other freshwater fish that must have persisted through the ash fall.

Figure 1. Map of the Alaska Peninsula region showing the extent of the more detailed maps illustrating each of the locations discussed.

Devil's Cove Lake (about 20 miles northeast of Novarupta) has a barrier waterfall that is well over 15 feet in height on the outlet river. The height of the waterfall precludes a recent origin for this barrier, and the lake lies in the main path of volcanic ash from the eruption, but this lake is also inhabited by kokanee, as well as other freshwater fish.

Finally, Dakavak Lake (12 miles southeast of Novarupta) has a barrier that is formed by a debris-choked ravine with subterranean flow. All water draining from the lake leaves through this massive debris field, emerging at the bottom of the slope. The origin of the debris field has not been ascertained. Attempts to core the lake were unsuccessful because the Novarupta ash layer was so dense it could not be penetrated. This lake might benefit from more intensive work to determine the origin of the outlet debris field. If the debris field was created by Novarupta ejecta, the timing of the actual barrier formation could have followed the eruption and the kokanee and other fish present might have established in the lake after the eruption and before the debris jam, but at this time it cannot be ruled out that these populations survived the massive ash fall mere miles from the eruption.

Aniakchak Caldera was formed around 3,500 years ago by an eruption that dwarfed even the Novarupta eruption (*Figure 4*)(*McGimsey et al. 1994*). Following that large eruption, which formed Aniakchak Caldera, a crater lake formed within the caldera, and somewhere around 2,000 years ago that lake drained in a catastrophic dam-failure flood (*Waythomas et al. 1996, VanderHoek and Myron 2004*). Following this flood, the smaller remnant water body in the caldera, Surprise Lake, was connected to the Pacific Ocean and therefore accessible to colonization by anadromous fish. Subsequent eruptive activity has included a moderate eruption 500 years ago and another smaller one in 1931. Genetic studies of the current sockeye populations in the caldera indicate they were wiped out and started anew following the 500 year old eruption, but likely persisted through the 1931 eruption (*Pavey et al. 2010*). The caldera is still dominated in appearance by the volcanic setting, as vegetation is sparse except along the lake shore, where years of dead, post spawning sockeye transported enough nutrients to the soil to support plants. Water quality in the lake is affected by water draining into the lake from the interior

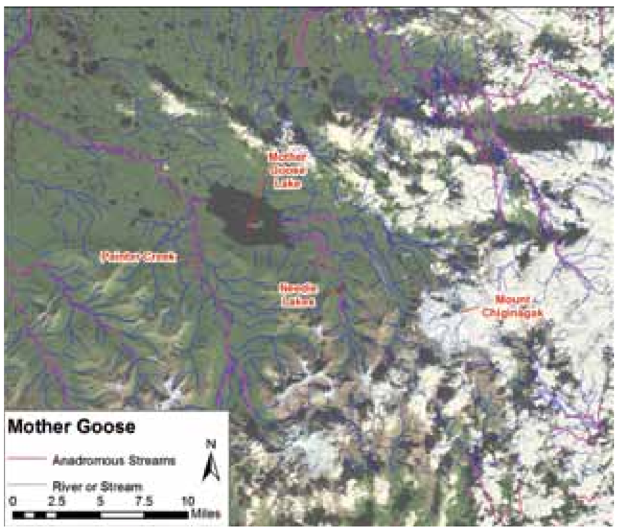

Figure 2. Map of Mother Goose Lake drainage, including Mount Chiginagak and the Needle Lakes drainages. Streams known to have salmon are shaded purple.

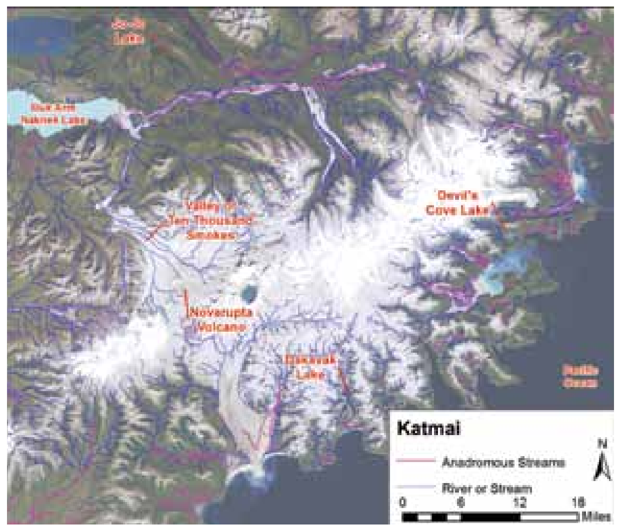

Figure 3. Map of Katmai area, including the Valley of Ten Thousand Smokes and Novarupta Volcano. The three landlocked salmon populations that appear to have persisted through the eruption are indicated: Jo-Jo Lake, Dakavak Lake, and Devil's Cove Lake. Streams known to have anadromous salmon are shaded purple.

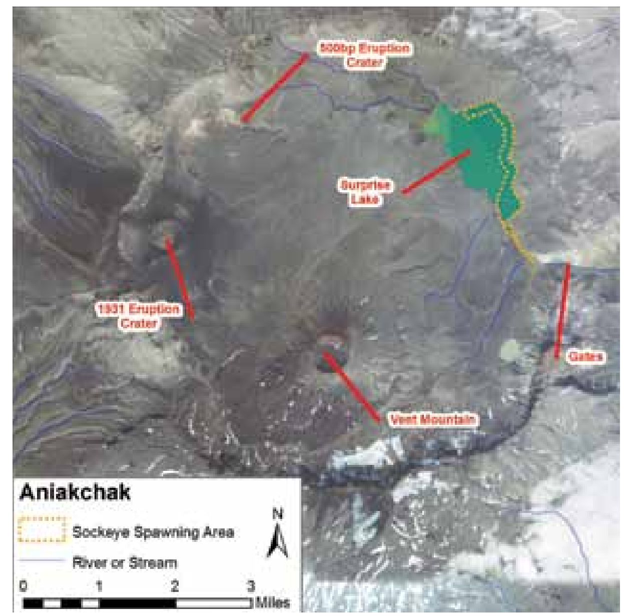

Figure 4. Map of Aniakchak Caldera, including the 500 BP eruption crater, the 1931 eruption crater, the Gates, and Surprise Lake. The sockeye salmon spawning activity is indicated by the area inside the dashed orange lines along the lake shore as well as the outlet of the lake.

of the caldera that is high in metals and low in dissolved oxygen, while the water from snowmelt coming in from the caldera wall is much more amenable to aquatic life.

Fisheries inventory work has confirmed that there are no fish populations in any flowing waters entering the upper end of Surprise Lake from the interior of the caldera. The streams draining the caldera wall are too small to allow upstream fish passage, but they bring water into the lake as groundwater that supports substantial sockeye spawning activity. As a result of this pattern, sockeye populations spawn all around the caldera wall side of the lake, and in the river below the lake outlet, while the side of the lake on the interior of the caldera has no spawning activity (*Pavey et al. 2007)*. Like Mother Goose Lake, this is a very rare example of relatively recent colonization. The park has spearheaded several research projects of this event. One of the findings is that the sockeye have locally adapted to different habitats in the caldera. The sockeye spawning in the outlet river are more streamlined than those spawning on the beaches, as they must swim against a swift current to maintain their spawning positions (Pavey et al. 2010).Within the lake itself, fish are subject to the waters that come in from the interior of the caldera. In comparison to sockeye from populations outside the caldera, Surprise Lake juvenile sockeye express more genes associated with metabolizing heavy metals, likely to assist with survival in these conditions (*Pavey et al. 2011*).

Summary

While volcanic eruptions have major effects on fish populations, those impacts decrease rapidly with distance from the eruptive center. The habitat diversity created by volcanic activity on the landscape may spur additional biodiversity within species, contributing to the overall fisheries productivity of these regions.

REFERENCES

Hilborn, R., T.P. Quinn, D.E. Schindler, and D.E. Rogers. 2003.
Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Sciences 100:6564-6568.

Lucas, R.E. 1986.
Recovery of game fish populations impacted by the May 18, 1980 eruption of Mount St. Helens: winter-run steelhead in the Toutle River watershed. In Mount St. Helens: Five Years Later, edited by S.E.C. Keller, pp 276-292.Eastern Washington University Press. Cheney, WA.

McGimsey, R.G., C.A. Neal, J.P. Dixon, and S. Ushakov. 2008.
2005 volcanic activity in Alaska, Kamchatka, and the Kurile Islands: summary of events and response of the Alaska Volcano Observatory. U.S. Geological Survey Scientific Investigations Report 2007-5269.

McGimsey, R.G., C.F. Waythomas, and C.A. Neal. 1994.
High stand and catastrophic draining of intracaldera Surprise Lake, Aniakchak Volcano, Alaska. In Geologic studies in Alaska by the U.S. Geological Survey, edited byA.B. Till and T.E. Moore, pp. 59-71.U.S. Geological Survey Bulletin.

Pavey, S.A., B. Sutherland, J. Leong, A. Robb, K. von Schalburg, T. Hamon, B. Koop, and J. Nielsen. 2011.
Ecological transcriptomics of lake-type and riverine sockeye salmon (Oncorhynchusnerka). BMC Ecology 11:31.

Pavey, S.A., T.R. Hamon, and J.L. Nielsen. 2007.
Revisiting evolutionary dead ends in sockeye salmon (Oncorhynchusnerka) life history. Canadian Journal of Fisheries and Aquatic Sciences 64:119-1208.

Pavey, S.A., J.L. Nielsen, and T.R. Hamon. 2010.
Recent ecological divergence despite migration in sockeye salmon (Oncorhynchusnerka). Evolution 64:1773-1783.

Ramstad, K.M., C.A. Woody, and F.W. Allendorf. 2010.
Recent local adaptation of sockeye salmon to glacial spawning habitats. Evolutionary Ecology 24:391-411.

Schaefer, J.R., W.E. Scott, W.C. Evans, B. Wang, and R.G. McGimsey. 2011.
Summit crater lake observations, and the location, chemistry, and pH of water samples near Mount Chiginagak Volcano, Alaska: 2004-2011. State of Alaska, Department of Natural Resources, Division of Geological and Geophysical Surveys, Report of Investigations 2011-6.

VanderHoek, R., and R. Myron. 2004.
Cultural Remains from a catastrophic landscape: an archeological overview and assessment of Aniakchak National Monument and Preserve. National Park Service AR/CRR-2004-47.Anchorage, Alaska.

Waythomas, C.F., J.S. Walder, R.G. McGimsey, and C.A. Neal. 1996.
A catastrophic flood caused by drainage of a caldera lake at Aniakchak volcano, Alaska, and implications for volcanic hazards assessment. Geological Society of America Bulletin 108:861-871.

Wood, C.C. 1995.
Life history variation and population structure in sockeye salmon.InEvolution and the aquatic ecosystem: Defining unique units in population conservation, edited by J.L. Nielsen. American Fisheries Society Symposium 17: 195-216.


Watmough Bay
45-SJ-280
Cat. # 45SJ280/LB 208

Using Archaeofaunas from Southwest Alaska to Understand Climate Change

By Dr. Michael A. Etnier and Dr. Jeanne Schaaf

Abstract

Archaeofaunal remains provide a unique record of how ecological systems have varied through time. Despite the fact that archaeologists in Alaska have been accumulating data for over 100 years, these data have never been compiled into a comprehensive database. While it is likely that human populations were not evenly distributed across the landscape, coverage of archaeological survey efforts are also not evenly distributed. Likewise, analysis effort has not been evenly distributed. Documenting the uneven distribution of sampling is an important first step to utilizing archaeofaunal data to their full potential.

Introduction

Archaeofaunal remains—preserved bones and shells from archaeological and paleontological sites (*Figure 1*)—provide important, but under-utilized, repositories of unique natural and cultural resource data spanning several millennia (*Figure 2*). These remains have the potential to add significantly to our understanding of the effects of past climate change at an ecosystem level. By extension, these data can provide a measure of the degree of ecological changes likely to be experienced in the future under various climate change scenarios.

Archaeologists have been excavating and reporting on their work in Alaska for over 100 years (*Dall 1877, Jochelson 1925, Veltre and Smith 2010*), amassing data from tens of thousands of sites statewide. However, the archaeofaunal data from these sites have never been compiled into a single, comprehensive database. Ultimately, we will be compiling these data into a web-accessible paleoecological database called Neotoma (www.Neotomadb.org). Neotoma already archives vertebrate paleontological and archaeological data from the contiguous United States. Until this has been accomplished for data from Alaska, this important source of information will continue to be under-utilized.

Here, we report on one aspect of our on-going efforts to compile archaeofaunal data from Southwest Alaska. Specifically, we present data on the number of archaeological sites for which archaeofaunal data are available relative to the total number of identified sites. Despite over 100 years of active research in the area, large data gaps still exist.

Figure 1. A typical sample of bones from a midden site. Bird bones are on the left, mammal bones are in the middle, and fish bones are on the right. Bones are from Watmough Bay, 45-SJ-280.

Photograph courtesy of Burke Museum of Natural History and Culture

Methods

We have been systematically accumulating taxonomic identification data from sites in Southwest Alaska from published and unpublished sources. This has been accomplished through literature reviews, personal knowledge of gray literature reports, and solicitations for information from members of the Alaska Consortium of Zooarchaeologists (www.akzooarch.org).

In addition, we queried the Alaska Office of History and Archaeology database of recorded archaeological sites, known as the Alaska Heritage Resources Survey (AHRS), for each of the 20 U.S. Geological Survey 1:250,000 quadrangle maps located within Southwest Alaska (*Figure 3*). First, we queried the AHRS database for a complete list of archaeological sites in each quadrangle. Because we are interested in compiling all known archaeofaunal data, no distinction was made between prehistoric and historic sites. Second, the AHRS database was queried for the list of sites in those quadrangles with any of the following terms in the catalog record: midden, bone, shell, or fauna. Site records were reviewed to eliminate instances where those search terms were negated (e.g., “no faunal remains found at this site”). Sites where human remains were the only bones observed were also eliminated from our list.

Finally, we checked our AHRS search results against the list of sites for which we have obtained taxonomic identification data, adding those cases for which identification data exist but did not appear in our AHRS queries.

Results

The AHRS site catalog includes 3,867 unique entries of archaeological sites in Southwest Alaska. The number of sites recorded in any given quadrangle ranges from two (Bristol Bay, XBB) to 1124 (Kodiak, KOD) (*Figure 6*). The number of sites reported to have preserved faunas ranges from zero (Stepovak Bay, XSB) to 330 (KOD). The number of archaeofaunal collections for which taxonomic identification data have been located is 57.

Figure 2.Photograph of an excavation unit at the Namumidden site in central British Columbia, showing how deep these deposits sometimes are.

As with the summary statistics for quadrangles, the spatial distribution of archaeological sites reported to have preserved faunal remains is also distinctly uneven (*Figure* 7), with the Kodiak Archipelago and portions of the Katmai Coast having disproportionately high numbers of sites with faunal remains.This is likely due to a combination of factors, which will be discussed below.

Likewise, the distribution of sites with available taxonomic information also appears to be unevenly distributed. Within the XMK quadrangle, the quadrangle for which we have the most complete data, 42 of the 229 recorded sites are reported to have faunal remains. Fifteen of those 42 have available taxonomic identification data—one of the highest percentages (36%) of any of the quadrangles in our study area. However, the bulk of the sites with available taxonomic information (10) lie within a single embayment (Kukak Bay), with decreasing percentages in each of several other areas within XMK (*Figure 8*).

Discussion and Conclusions

Our research into this topic is on-going, and these results should only be considered preliminary. However, while the overall numbers are expected to change somewhat, we expect the general patterns to remain the same. Specifically, it is clear from a number of different studies that the Kodiak Archipelago was one of the most densely populated areas in all of Alaska (*Crowell et al. 2001, 2003; cf. Steffian and Saltonstall 2008*). When coupled with the specific nature of the archaeological record—shell-bearing middens with excellent preservation—it should come as no surprise that this area also contains the highest number of archaeological sites reported to have preserved faunas.

What is perhaps surprising is the relatively low percentage of those preserved faunal samples that have been analyzed. When the data are combined for the quadrangles that comprise the Kodiak Archipelago—Afognak, Karluk, Kodiak, Trinity Island, and Kaguyak—only 21 sites have been analyzed out of a field of 560 sites with preserved faunas (3.8%, see *Figure 6*).

One potentially biasing factor in the analysis of the summary statistics for sites from the Kodiak Archipelago is that the term "midden" is used much more generally by researchers in that area to refer to any anthropogenic sediment deposit, regardless of whether or not faunal remains are preserved. Based on the site records on file with the AHRS, 160 sites have been tentatively included in our list despite the ambiguity of the use of the term "midden" in the catalog. In a worst-case scenario where all 160 of those sites were removed from our list, the percentage of analyzed sites would increase to 5.3% (21/400).

Finally, it should be pointed out that an accurate comparison of the gross number of sites in any given quadrangle should account for miles of coastline, survey effort, and geological/tectonic histories (*e.g., Crowell and Mann 1996, VanderHoek and Myron 2004*). Likewise, the current analysis accords equal weight to all analyzed archaeofaunal samples, regardless of sample size. Thus,

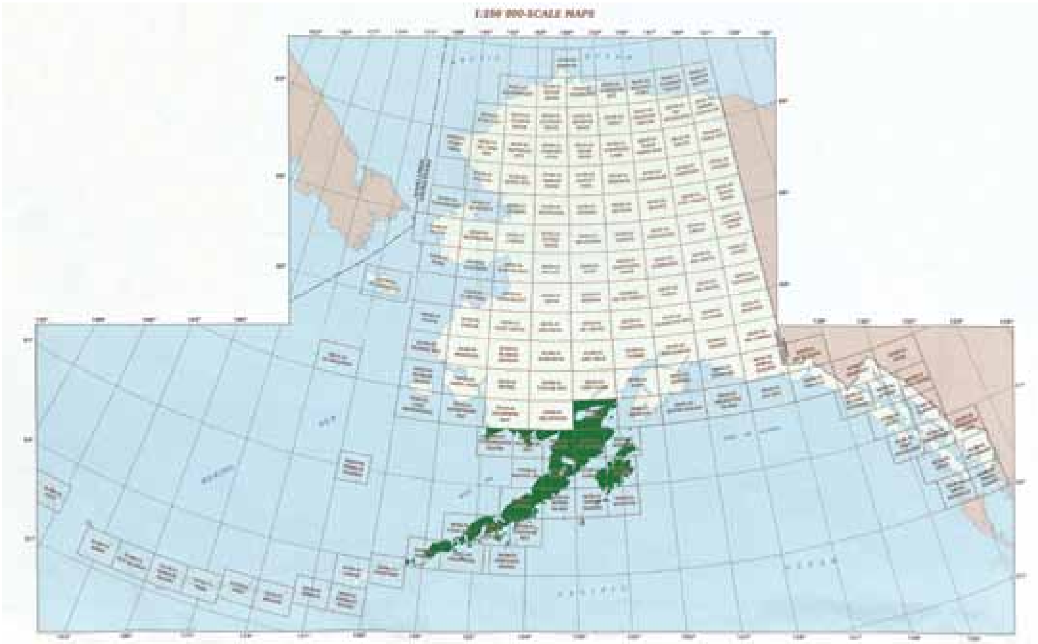

Figure 3. Portion of Southwest Alaska included in our study area shown in green. Based on USGS 1:250,000 index map.

Photograph courtesy of Mike Etnier

Figure 4. Author, Jeanne Schaaf, sits beside the exposed strata at a site in the Amalik Bay National Historic Landmark Archaeological District. The strata preserve the floors of camps and dwellings with associated archeofauna beginning 7,000 years ago and ending 4,000 years ago.

Photograph courtesy of Mike Etnier

Figure 5. A relatively thin midden layer, indicated by the pocket knife, overlays a series of volcanic ash layers. This midden represents a short period of time, and consists mostly of small periwinkle snail shells.

Quadrangle Name	Abbreviation	N of Sites	N with Faunas	N analyzed (if known)[1]
Afognak	AFG	268	98	4
Chignik	CHK	116	2	0
Iliamna	ILI	259	10	0
Kaguyak	KAG	20	4	0
Karluk	KAR	337	92	4
Kodiak	KOD	1124	330	12
Naknek	NAK	224	8	2
Sutwick Island	SUT	58	17	13
Ugashik	UGA	126	17	0
Unimak	UNI	130	22	3
Bristol Bay	XBB	2	1	0
Cold Bay	XCB	212	2	0
False Pass	XFP	187	1	0
Hagemeister Island	XHI	92	14	unknown[1]
Mount Katmai	XMK	229	42	15
Nushagak Bay	XNB	140	4	unknown[1]
Port Moller	XPM	119	4	1
Stepovak Bay	XSB	42	0	n.a.
Simeonof Island	XSI	57	5	2
Trinity Island	XTI	125	36	1

[1] We have not yet compiled faunal data for the Hagemeister Island and Nushagak Bay quadrangles.

Figure 6. Summary statistics showing the number of archaeological sites recorded in Southwest Alaska, by USGS quadrangle. Data include the number of those sites reported to have preserved faunal remains, and the number of sites with taxonomic identification data.

while it may at first glance appear that Kukak Bay, for instance, has been very well-studied, those analyses are, in fact, based on relatively small samples of archaeofaunas. These factors will be addressed in future analyses.

Management Implications

We acknowledge that this study does not yet address climate change, per se. Those analyses will come after uploading the compiled data to the Neotoma paleoecological database, which includes several analytical tools. However, any analysis of changing distributions of vertebrate and invertebrate taxa must be based on a solid sampling strategy. Therefore, analyses such as those presented here are an important first step to evaluating the sufficiency of the available data. Future steps include normalizing our counts of sites-per-quadrangle for field effort and extent of shoreline. Once this is accomplished, these data can be used to help identify areas that need more archaeological survey effort, recovery effort, and taxonomic identification effort.

Acknowledgements

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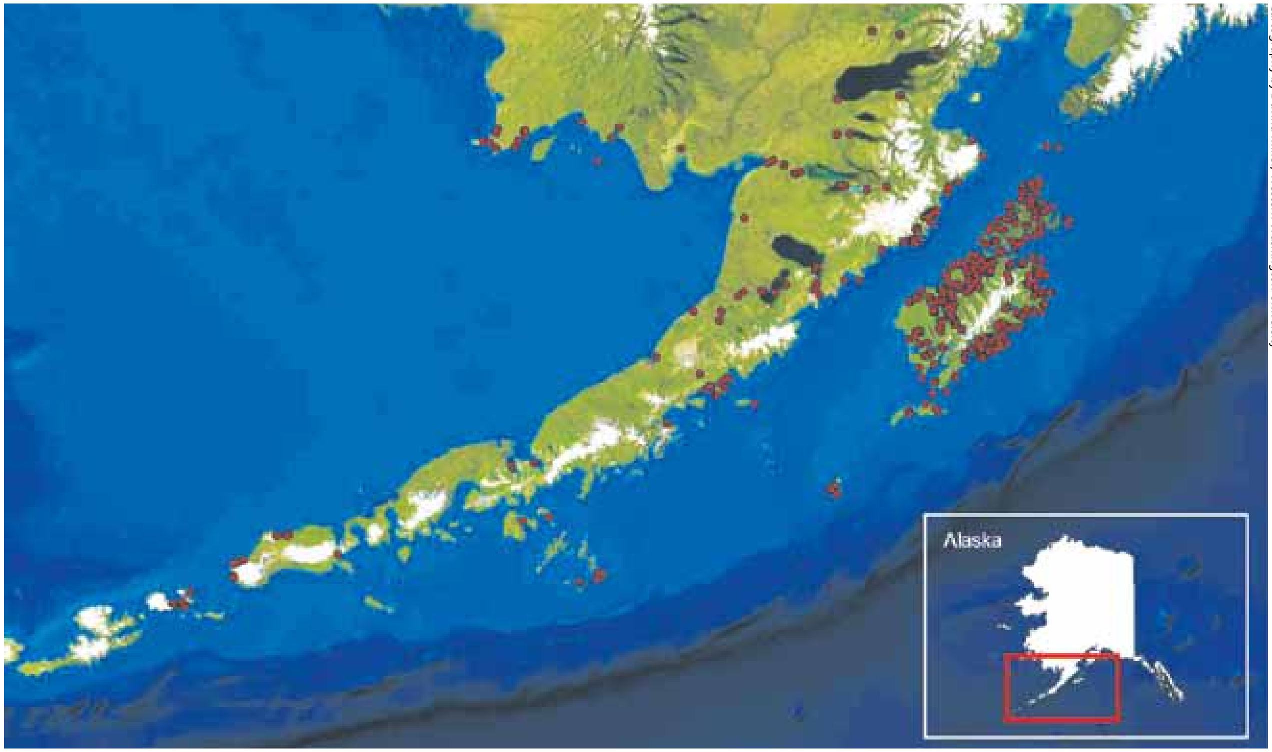

Figure 7. Distribution of archaeological sites in Southwest Alaska reported or known to have preserved faunal remains.

Area	Number of Sites with Fauna	N of Sites with Identification Data
Kukak Bay	13	10
Amalik Bay	18	4
Kinak Bay	3	0
Naknek Drainage	7	1
Dakavak Bay	1	0
Total	42	15

Figure 8. Variability of percentages of archaeological sites with preserved faunal remains that have been analyzed, from various locations within the Katmai quadrangle (XMK).

REFERENCES

Crowell, A.L., and D.H. Mann. 1996. *Sea level dynamics, glaciers, and archaeology along the central gulf coast of Alaska.* Arctic Anthropology 33: 16-37.

Crowell, A.L., M. Matson, and D.H. Mann. 2003. *Subsistence Resources and Archaeological Settlement Patterns on the Katmai Coast.* Alaska Journal of Anthropology 1(2): .

Crowell, A.L., A.F. Steffian, and G. Pullar (eds). 2001. *Looking Both Ways: Heritage and Identity of the Alutiiq People.* University of Alaska Press. Fairbanks, Alaska.

Dall, W.H. 1877. *On succession in the shell-heaps of the Aleutian Islands.* In Tribes of the Extreme Northwest. Contributions to North American Ethnology 1, edited by D.H. Dall, pp. 41-91. U.S. Government Printing Office. Washington, D.C.

Jochelson, W. 1925. *Archaeological Investigations in the Aleutian Islands. Washington.* Carnegie Institution.

Steffian, Amy F., and Patrick G. Saltonstall. 2008. *Kodiak Archipelago, Southcentral Alaska.* In Archaeology in America, An Encyclopedia, edited by Francis P. McManamon and Thalia Gray. Greenwood Publishing Group. Westport, CT.

VanderHoek, Richard, and Rachel Myron. 2004. *Cultural Remains from a Catastrophic Landscape: An Archaeological Overview and Assessment of Aniakchack National Monument and Preserve.* National Park Service, Alaska Office. Anchorage, Alaska.

Veltre, D.W., and M.A. Smith. 2010. *Historical Overview of Archaeological Research in the Aleut Region of Alaska.* Human Biology 82: 487-506.

Archiving Southwest Alaska's National Park bird data into eBird and Avian Knowledge Network Database

By Kelly Walton and Tracey Gotthardt

Abstract

In order to better understand the status of bird populations and permanently archive bird records, we initiated an effort to enter historical avian occurrence records from the Southwest Alaska Network of the National Park Service into the Avian Knowledge Network (AKN) and its sister database, eBird. In 2010, we archived 8,704 incidental observations for 183 bird species from 82 unique data sources, spanning the time period 1919 to 2004. In 2011, we expanded our effort to include data from 16 standardized surveys conducted between 2006 and 2010, which encompassed 29,575 unique observations for 173 species.

Introduction

Documenting the occurrence of bird species and generating species checklists has become a pastime enjoyed not only by professional ornithologists and naturalists, but also by the general public. The relative ease of identifying birds and their widespread distribution across a variety of habitats lends itself to citizen science data collection. Visitors to Alaska's national parks are encouraged to submit their wildlife observations for historic record, but to date, there has been no central repository to archive this type of information. Similarly, park researchers and rangers record the occurrence of avian species that are ancillary to their research or observed during river or backcountry patrol trips. These incidental records (not part of a formal bird survey) are often recorded in field notebooks or files, where the information remains unused and at risk of being discarded.

The value of entering historic data into archival databases cannot be overstated. These records help build historic perspective and allow users to look farther back in time when conducting analyses, planning future inventories, or looking at changes in species distribution due to changing conditions. The primary mission of the NPS is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of present and future generations (Marcy 2006). Many parks are currently unable to fully achieve this mission due to a lack of basic knowledge about park resources. A compilation of historic records by recreational and professional bird watchers in combination with standardized bird survey records will help parks realize this mission by providing baseline information for better understanding bird distributions across Alaska park lands.

There are currently two national avian archival database efforts in North America: eBird and the Avian Knowledge Network (AKN), both managed by Cornell Lab of Ornithology. These databases were designed to house observational data to assess patterns in distribution and dynamics of bird populations across the United States and Canada.

eBird (www.ebird.org) is a real-time, online checklist program that was launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society. Its goal is to maximize the utility and accessibility of the vast numbers of bird observations made each year by recreational and professional bird watchers by sharing these observations with a global community of educators, land managers, ornithologists, and conservation biologists. In 2007, Audubon Alaska launched the Alaska eBird website (www.ebird.org/ak), which is part of the greater eBird database, and is a tool for recording and analyzing bird populations in Alaska.

The Avian Knowledge Network (www.avianknowledge.net) is an international organization of government and non-government institutions focused on understanding the patterns and dynamics of bird populations across the western hemisphere. The goal of the AKN is to organize observational data and provide tools to discover, access, and analyze these data. Over time, AKN will educate the public on the dynamics of bird populations, provide interactive decision-making tools for land managers, and make data available for scientific research. The strength of the AKN lies in its varied and widely diverse bird datasets, ranging from citizen science to surveying and banding datasets.

The objectives of eBird and AKN are similar, but vary somewhat, resulting in slight differences in the data. eBird was designed to capture bird observations

Figure 1. Conducting a bird survey along the Alagnak Wild River.

Alaska Natural Heritage Program photograph

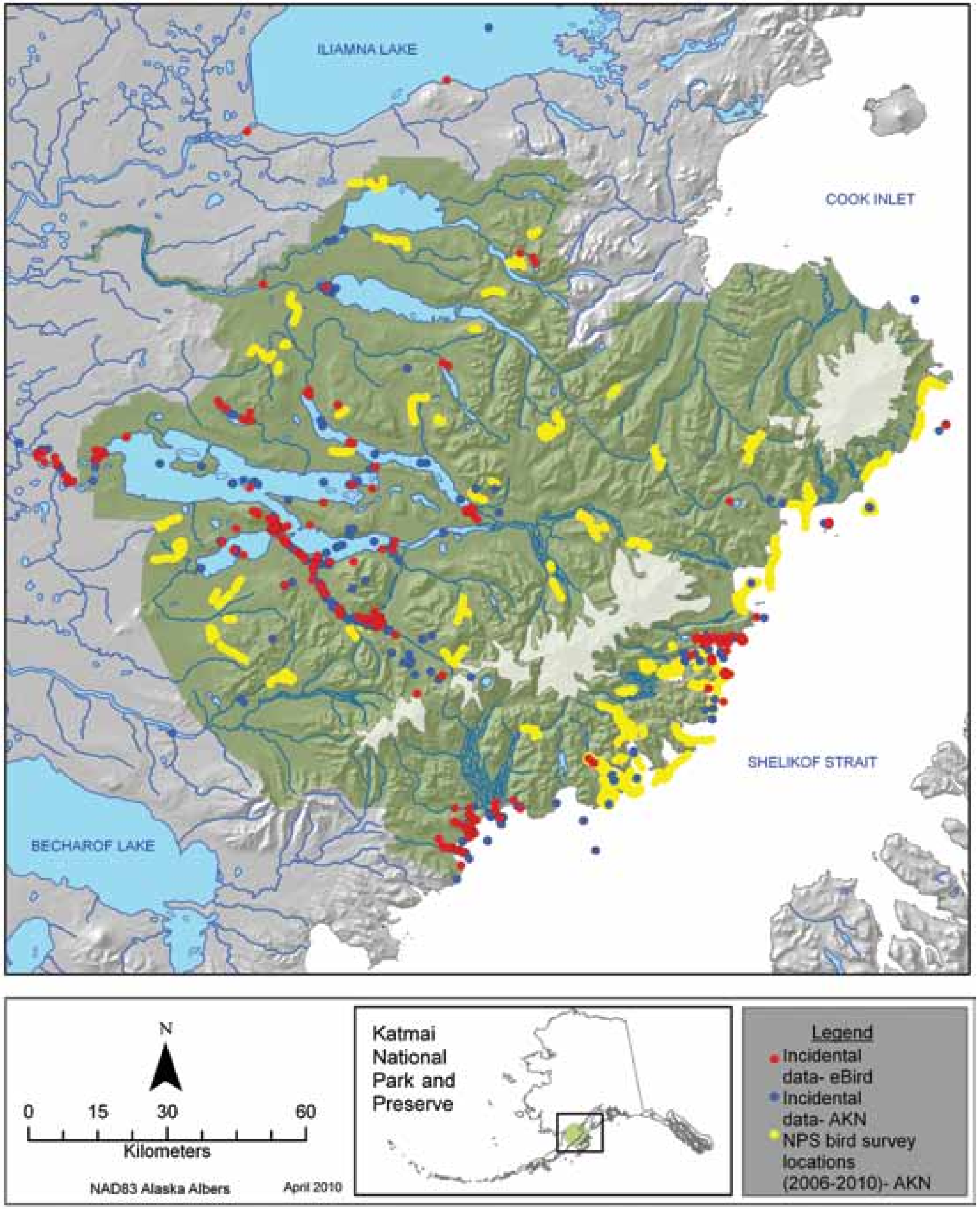

Figure 2. The distribution of incidental and NPS bird survey data in Katmai National Park and Preserve.

from amateur and professional birders and has specific fields for data entry that require an exact date and spatial location. In contrast, AKN is more flexible, and has a variety of fields designed to capture most information that may be recorded along with the bird observation. All eBird data is incorporated into the AKN, but eBird data can also be accessed independently at the eBird web-portal. AKN, in turn, shares data with other larger biodiversity initiatives, such as Ornithological Information System (ORNIS) and Global Biodiversity Information Facility (GBIF), allowing the data to be utilized by an even broader audience for the conservation of avian species at both state and global scales.

The goal of this project was to archive historic and contemporary bird data from Southwest Alaska Network (SWAN) parks into the eBird and AKN databases in order to improve the parks' and public's understanding of avian resources. Our specific objectives were to: 1) collect, assemble, and summarize existing incidental observations of the distribution and relative abundance of avian species from visitor observation cards, ranger trip logs, and camp checklists; 2) upload those incidental observations into eBird or AKN; 3) format and upload data from 16 standardized bird surveys conducted in SWAN parks into AKN; and 4) develop a user's guide for entering avian data into eBird.

Methods

Incidental bird observations

As part of a previous NPS project, Alaska Natural Heritage Program staff visited each of Alaska's 16 park offices to compile records of historical bird observations. These data were primarily comprised of bird checklists from established field camps, ranger trip logs, and visitor observation cards and contained a wealth of information on the presence of species and their relative abundances. For this project, incidental observations were extracted from these documents and entered into either eBird or AKN, depending on the type of data included. The initial goal of the project was to enter all observations into eBird;

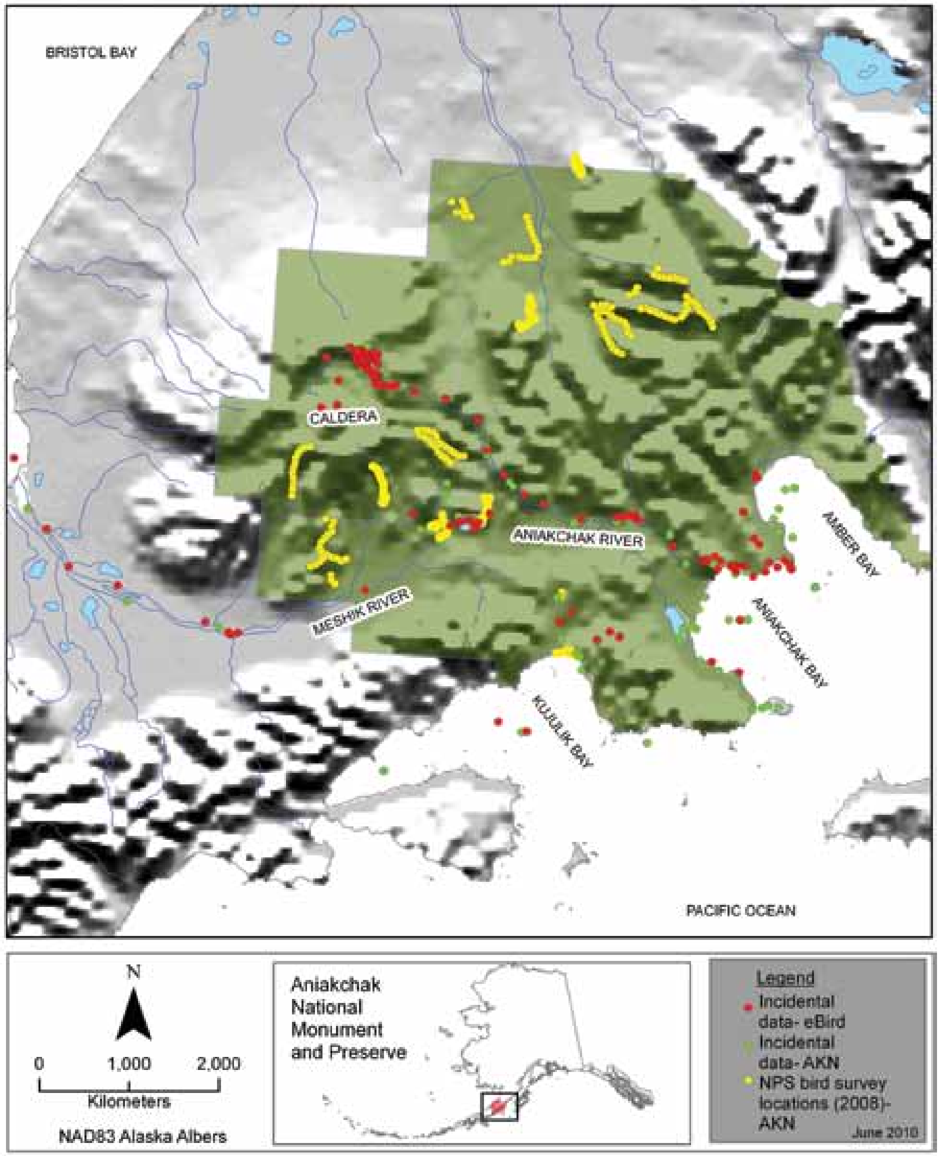

Figure 3. The distribution of incidental and NPS bird survey data in Aniakchak National Monument and Preserve.

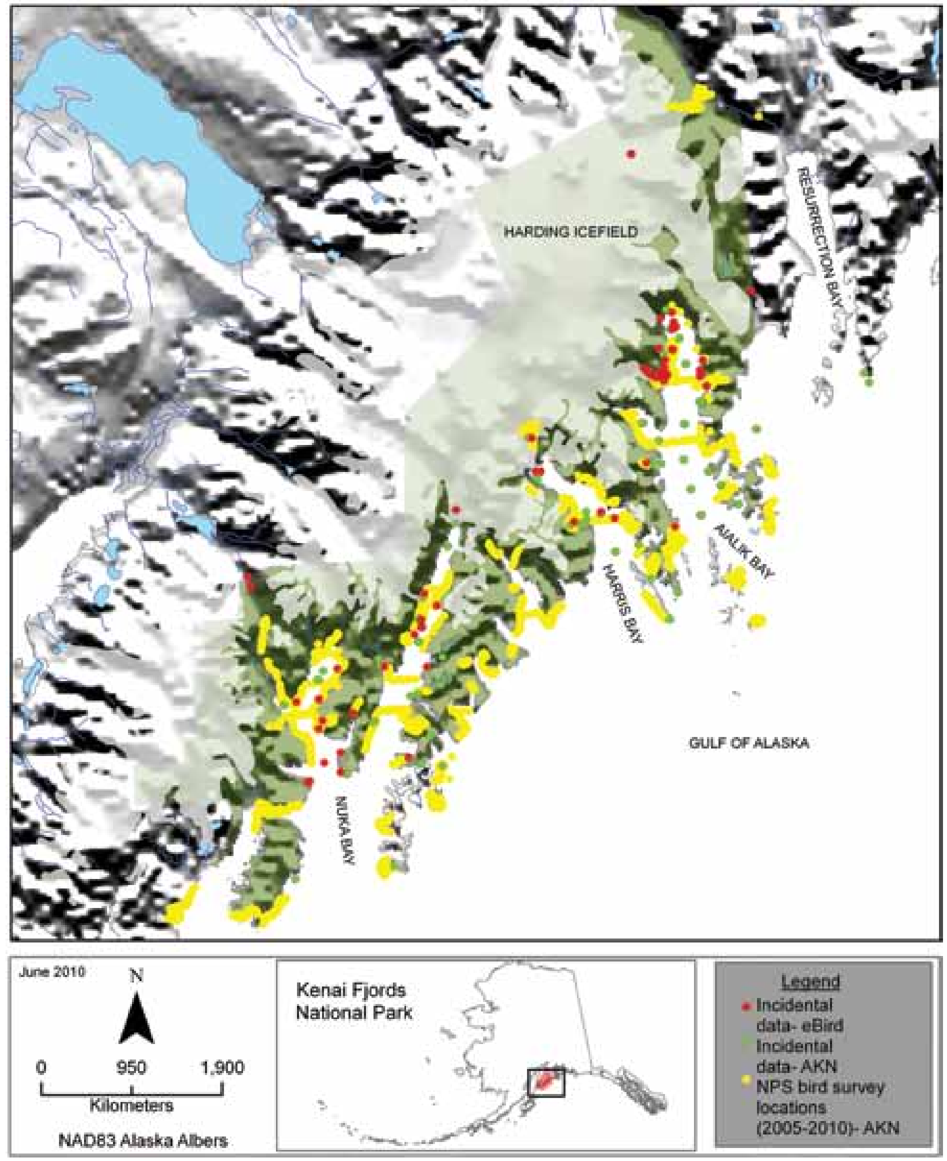

Figure 4. The distribution of incidental and NPS bird survey data in Kenai Fjords National Park.

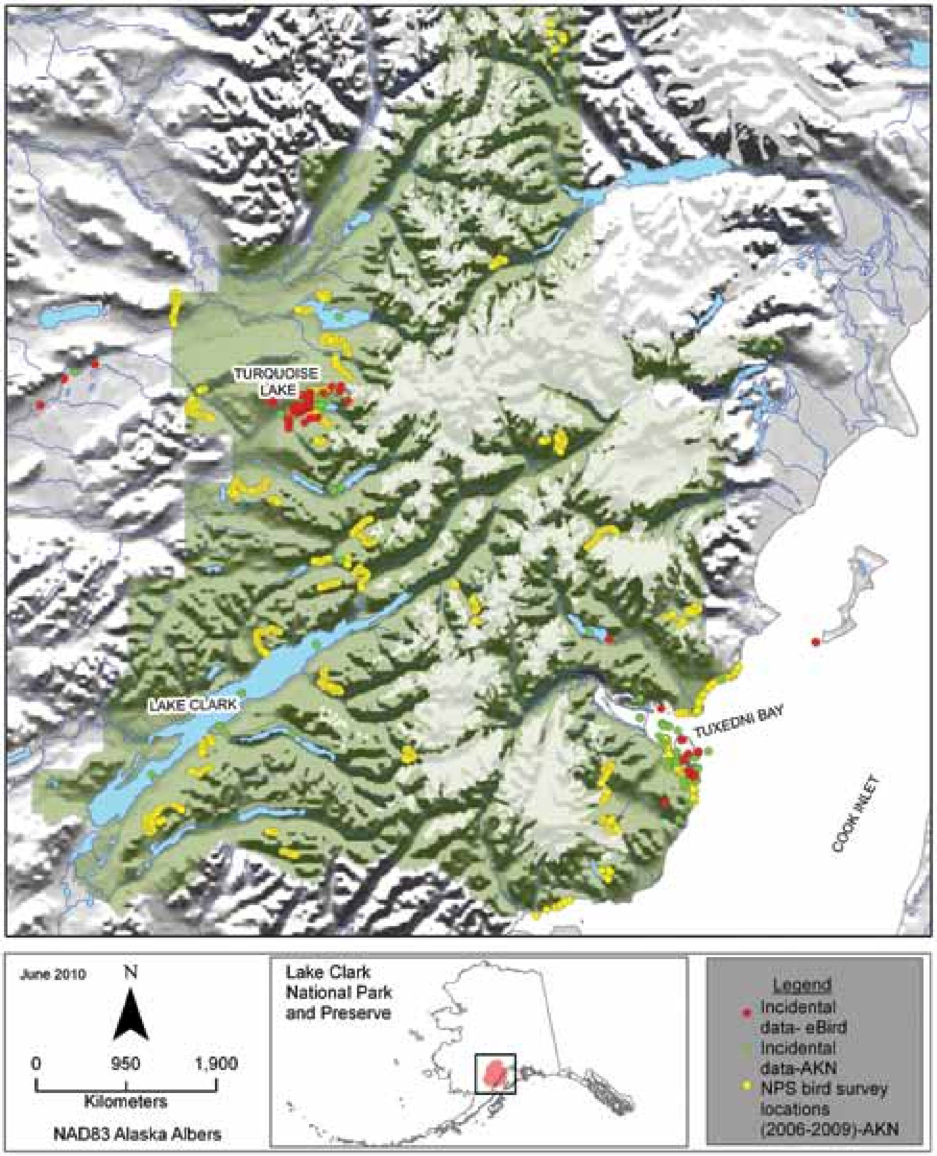

Figure 5. The distribution of incidental and NPS bird survey data in Lake Clark National Park and Preserve.

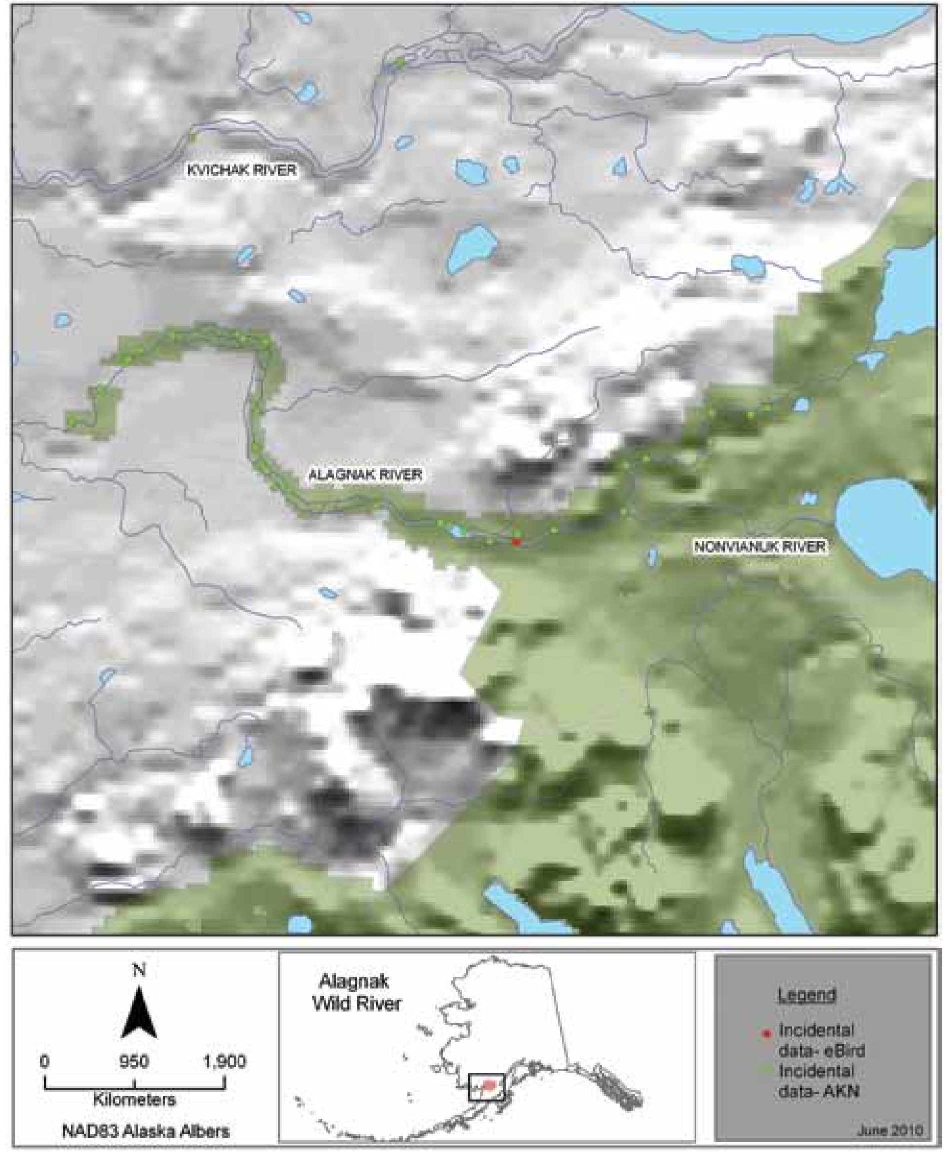

Figure 6. The distribution of incidental bird data along the Alagnak Wild River.

however, since eBird is not designed to handle spatial and temporal uncertainty (which many of the records had), some were entered into the more flexible AKN database. Due to a lack of information often associated with incidental observational data, we only used a subset of the fields available in each database for which we had information across most data sources. Additionally, we developed a user's guide with step by step instructions on how to enter bird observations into eBird.

Standardized bird survey records

We gathered 16 standardized terrestrial and marine bird datasets from the SWAN parks to archive into AKN. These dataset included landbird surveys in Aniakchak, Katmai, Lake Clark, and Kenai Fjords National Parks and nearshore marine bird surveys in Katmai, Lark Clark, and Kenai Fjords National Parks. An effort was made to crosswalk the fields from the NPS bird survey datasets with fields available in AKN to insure that no information was lost in the archival process.

Results

Incidental bird observations

We extracted bird observations from 82 unique sources ranging from ranger trip logs to visitor observation cards. We summarized a total of 8,704 observations for 183 species, of which 69% were archived in AKN and the remaining 31% into eBird. Records ranged from 1919 to 2004 and were clustered in areas that received greater visitation, such as lakes, rivers, bays, and wildlife viewing areas. We entered data on 65 species of conservation concern, as defined by Audubon Alaska, Partners in Flight, Boreal Partners in Flight, Alaska Shorebird Group, U.S. Fish and Wildlife Service, or the Alaska Department of Fish and Game. New park records (species not previously documented within a specific park) were recorded for four species: the red phalarope and semipalmated plover in Katmai and the willow flycatcher and red phalarope in Lake Clark. Additionally, we provided supplementary justification for the presence of 23 species that were previously recorded as probably present, encroaching, or unconfirmed in one of the parks. A user's guide, available from the Alaska Natural Heritage Program website, was developed to introduce the steps necessary to upload data via the eBird web portal.

Standardized bird survey records

We formatted and uploaded 29,575 records derived from 16 standardized terrestrial and nearshore marine bird survey datasets into AKN. The records were from surveys conducted between 2004 and 2010 and included a total of 173 unique species.

Discussion

Over the past two decades, new technologies have rapidly changed the way we collect, archive, and share scientific data. Twenty years ago, incidental species data collected by park personnel during the field season were recorded in field notebooks. At the end of the field season, these notebooks were filed in a drawer, where many remain today. Similarly, amateur and professional birders have been recording their observations for centuries in life-lists and personal journals. Recent initiatives have made use of the internet as a tool for efficiently gathering, archiving, and distributing bird information to a wide audience. These web portals allow for real-time information exchange, creating new opportunities for rapid integration of bird data into research, monitoring, management, and recreation activities.

We archived 38,279 bird records in and adjacent to SWAN national parks into both databases, providing valuable new information on the distribution and seasonal timing of over 170 avian species. Archival historic information provided justification for adding new species to existing park checklists, as well as validating the status of species which had previously been documented as probably present, encroaching, or unconfirmed. These additions demonstrate the utility and importance of archiving such information. Using incidental observations along with the standardized survey data helps to create a more complete map of distribution and seasonal usage of habitats than using one dataset by itself (Figures 2-6). Ultimately, these data contribute to a baseline of information that helps achieve the overall goal of this project, which is to improve the understanding of the status of bird populations in SWAN parks.

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REFERENCES

Marcy, S. 2006.
National Park Service Alaska Region science strategy 2006 and beyond: Integrating science to enhance natural resource management in a changing world. Prepared for the National Park Service.

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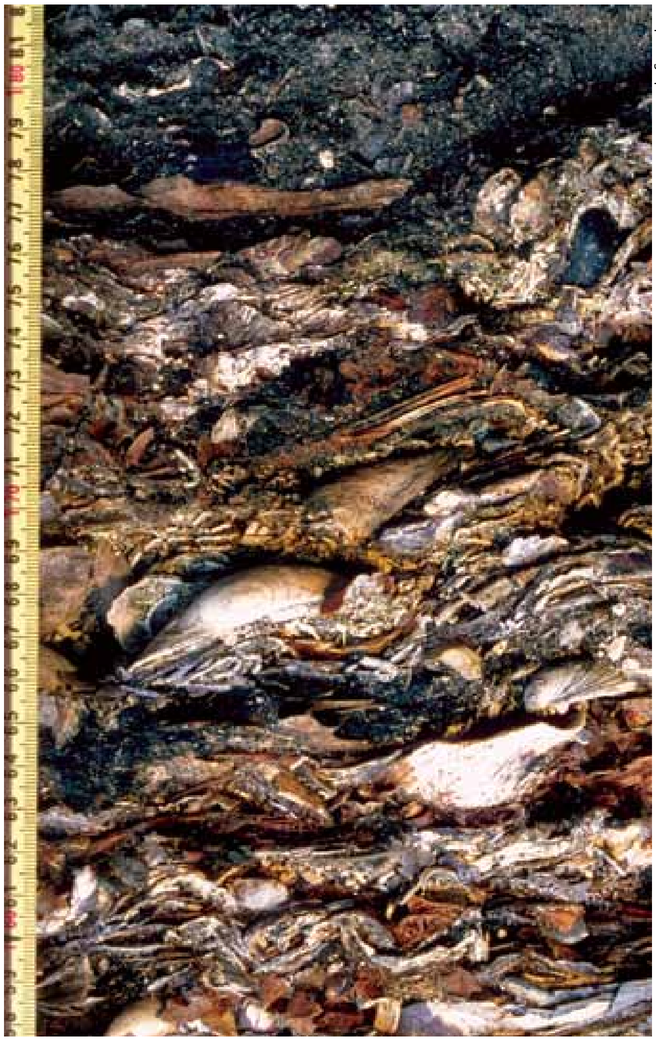

NPS photograph