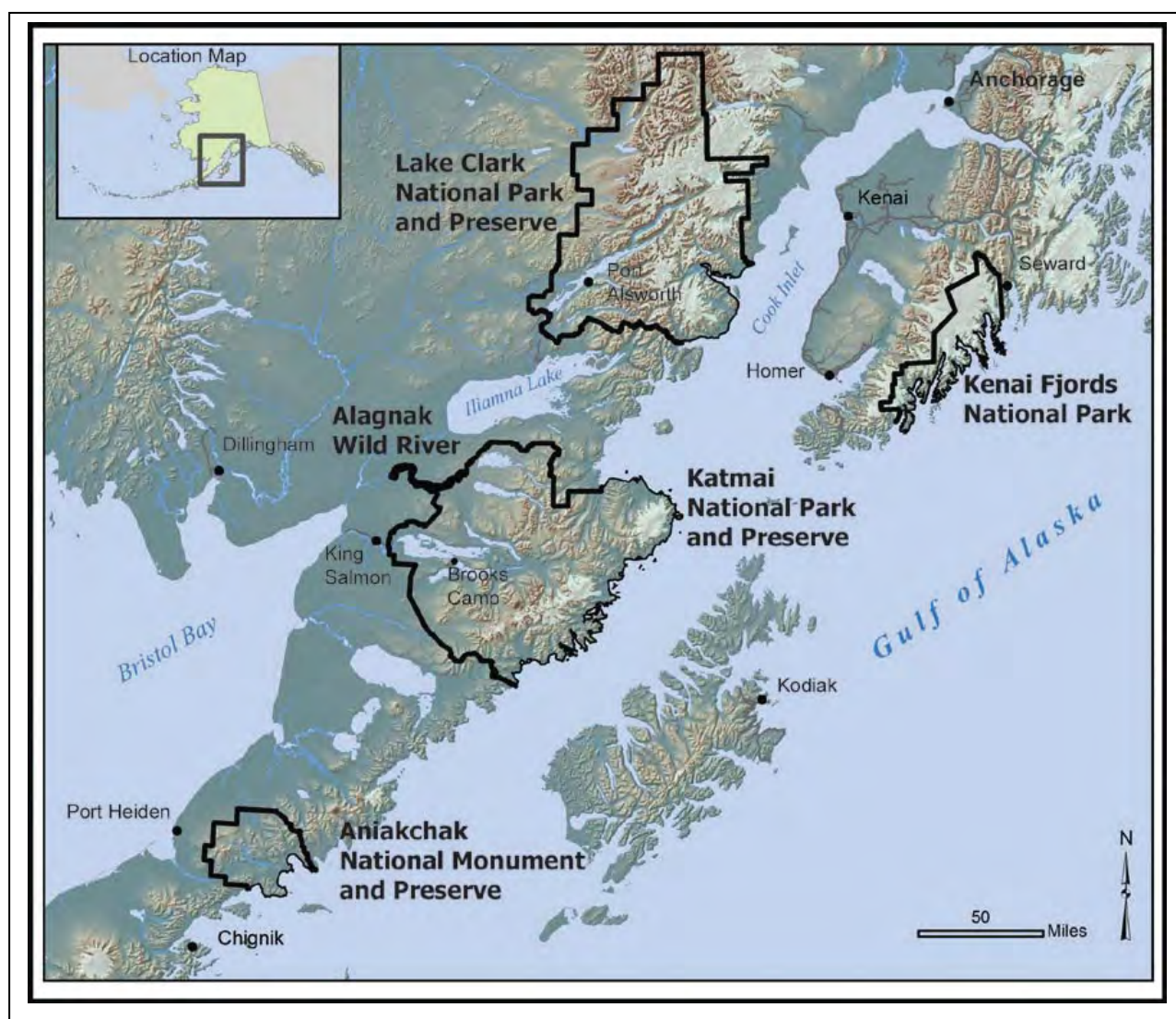




Vital Signs Monitoring Resource Briefs

Southwest Alaska Network Inventory & Monitoring Program

Natural Resource Report NPS/SWAN/NRR—2009/155



ON THE COVER

Southwest Alaska Network Map

Vital Signs Monitoring Resource Briefs

Southwest Alaska Network Inventory & Monitoring Program

Natural Resource Report NPS/SWAN/NRR—2009/155

Claudette Moore (Editor), Michael Shephard, Jeff Shearer, William L. Thompson, Chuck Lindsay, Heather Coletti, Amy E. Miller, Bruce Giffen

National Park Service
Southwest Alaska Network
240 W. 5th Ave.
Anchorage, AK 99501

October 2009

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the Southwest Alaska Network website (http://science.nature.nps.gov/im/units/swan/index.cfm?theme=reports_pub) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/NRPM>).

Please cite this publication as:

Moore, C., M. Shephard, J. Shearer, W. L. Thompson, C. Lindsay, H. Coletti, A. E. Miller, and B. Giffen. 2009. Vital signs monitoring resource briefs: Southwest Alaska Network Inventory and Monitoring Program. Natural Resource Report NPS/SWAN/NRR—2009/155. National Park Service, Fort Collins, Colorado.



Vital Signs Monitoring Resource Briefs Southwest Alaska Network

Inventory & Monitoring Program
March 2009

Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark



Cover photos credited to NPS

<http://science.nature.nps.gov/im/units/swan/>



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Vital Sign Resource Briefs

Vital Signs Inventory and Monitoring

Weather and Climate

- Weather and Climate
- Air Quality and Contaminants

Landscape Dynamics and Terrestrial Vegetation

- Glacier Extent
- Sensitive Vegetation Communities (Salt Marshes, Nunataks)
- Insect Outbreaks
- Vegetation Composition and Structure (Ground based and Remote sensing)
- Landscape Processes

Marine Nearshore

- Coastal Shoreline Change
- Marine Water Chemistry
- Kelp and Eelgrass
- Marine Intertidal Invertebrates
- Black Oystercatcher
- Marine Birds
- Sea Otter

Lakes, Rivers, Fish

- Surface Hydrology
- Freshwater Chemistry
- Lake Sediments
- Resident Lake Fish — Contaminants
- Salmon

Terrestrial Animals

- Bald Eagle
- Brown Bear
- Moose



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Vital Signs Inventory and Monitoring *Resource Brief*

Importance

Vital signs monitoring is the collection and analysis of repeated observations or measurements to evaluate the ecological condition of park resources. The broad-based, scientifically sound information obtained through vital signs monitoring generates relevant data and timely reports at various scales of spatial and temporal resolution. Park superintendents and natural resource staff are the primary audience for vital signs monitoring results. Other key audiences include park planners, interpreters, researchers, the general public, and Congress.



NPS

Buck Mangipane, LACL, records sensitive plant data reported by ecologists Amy Miller, SWAN, and JJ Frost, ABR, Inc. at Hallo Bay, KATM.



NPS

Jim Bodkin, USGS, and Chris Ehrler, Tena Environmental, collect marine invertebrate data as part of marine nearshore monitoring.

Resource Briefs

To be most effective, monitoring data must be analyzed, interpreted, and provided at regular intervals to key audiences in a useful format. Resource briefs are part of the SWAN information reporting system to provide highlights and key findings in a concise format. Although each resource brief generally addresses a single vital sign or one aspect of park ecosystem health, all of these resources are interconnected. Information contained in the resource briefs will be used by park interpreters and may be incorporated into newsletters, posters, and presentations. Twenty-one core Vital Signs are currently being monitored or undergoing development by the SWAN, park staff and/or cooperators. Data for seven additional Vital Signs are harvested from other agencies, and one (wolves) is still being tested for feasibility.

Status and Trends

Biological inventories have been completed in SWAN park units for amphibians, invertebrates, freshwater fish, birds, mammals and vascular plants. The only amphibian known to occur in SWAN parks is the wood frog. Biologists confirmed the presence of several previously undocumented bird species that were thought to reside in SWAN parks. Vascular plant inventories led to the documentation range extensions for several plant species.

Pilot monitoring for SWAN vital signs was initiated in 2006; additional monitoring projects are being phased in each year until 2011 when full implementation is anticipated. As data accumulate, resource briefs will report status and trend information, interpretation of results, and implications of any observed changes as they relate to managing and protecting park resources. Further information, annual reports, protocols, and project reports can all be found at the SWAN webpage:

<http://science.nature.nps.gov/im/units/swan/>



NPS

Coastal sedge, one of the sensitive plant communities monitored by SWAN, is an important food source for brown bears in the spring and early summer.



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Weather and Climate

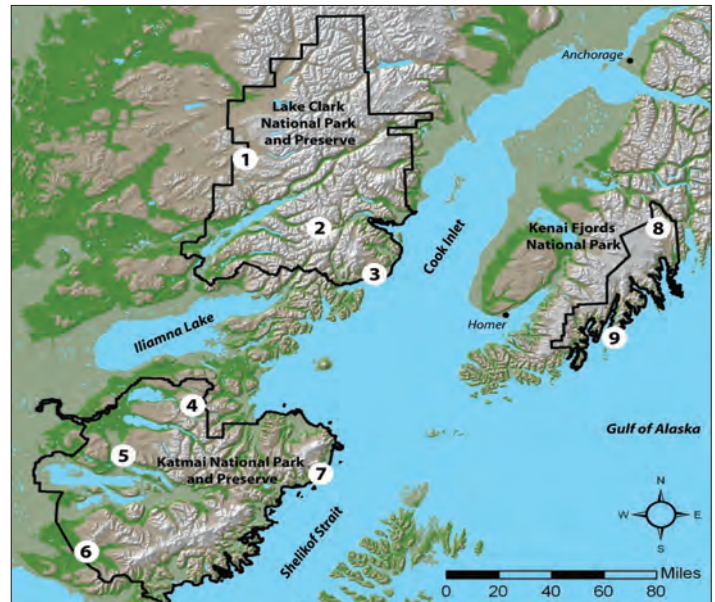
Resource Brief

Importance

Climate is considered the most important broad-scale factor influencing ecosystems. Because global climate models indicate that climate change and variability will be greatest at high latitudes, climate monitoring will be critical to understanding the changing conditions of park ecosystems. Potential effects in SWAN park units include a reduced snowpack, earlier ice break-up on lakes, warmer winters and wetter summers. These changes may affect the distribution, abundance, growth, and productivity of plants and animals.

Long-term Monitoring

In order to address the scarcity of climate information from national parks in southwestern Alaska, the SWAN recently installed seven weather stations. The objective is to record and archive weather observations in locations that are characteristic of the diverse landscape and topography within these parks. This effort will support real-time needs, identify natural variability in weather patterns and long-term climate trends, provide reliable climate data to researchers, and help interpret ecosystem changes.



SWAN weather stations: 1) Snipe Lake, 2) Chigmit Mountains*, 3) Hickerson Lake, 4) Pfaff Mine, 5) Coville, 6) Contact Creek, 7) Fourpeaked*, 8) Harding Icefield, and 9) McArthur Pass.

*Deployment scheduled for summer of 2009.

Status

Multiple government agencies and the public were involved in the site selection process; site accessibility was a key factor. The strategically placed stations form a network documenting a wide range of climate conditions—from the maritime climate of Kenai Fjords NP (KEFJ) to the continental climate of interior Lake Clark NPP (LACL). The Harding Icefield station, deployed in 2004, continues to operate under very harsh conditions. Six weather stations were deployed in 2008. Deployment of two additional stations, noted above, is scheduled for 2009. The stations are fully automated and solar powered. They record temperature, wind speed and direction, precipitation, snow depth, relative humidity, and solar radiation on an hourly basis. Data are transmitted by satellite, archived by the Western Regional Climate Center, and are available on the SWAN website at:

http://science.nature.nps.gov/im/units/swan/index.cfm?theme=weather_stations

Contacts

Bruce Giffen, NPS-AKRO, bruce_giffen@nps.gov

Chuck Lindsay, NPS-SWAN, chuck_lindsay@nps.gov



Bruce Giffen assembling the Pfaff Mine weather station, KATM (June, 2008).



Air Quality and Contaminants

Resource Brief

Importance

Air quality in SWAN park units is considered pristine by national standards, but airborne pollutants associated with increasing global and regional industrialization, and increased particulate loads associated with wildfire and volcanic activity have the potential to affect ecological processes in the Network. Increased nitrogen deposition associated with human activity may result in soil acidification, changes in plant communities, and increased emissions of greenhouse gases. Particulate sampling conducted in King Salmon (1987-1992) found that elements associated with anthropogenic sources were proportionately greater than in other parks surveyed in Alaska. In addition, current-use and historic-use pesticides as well as some heavy metals (e.g., mercury) were found in low concentrations in most Alaskan parks in the Western Airborne Contaminants Assessment Project. These contaminants are stored in lake sediments, vegetation, fish tissue and snowpack.

Status

The US Fish and Wildlife Service (USFWS) currently administers two IMPROVE (dry deposition) sites in the Tuxedni and Simeonof Wilderness Areas, which measure a range of particulates, including nitrate, sulfate, and carbon. These sites are located at the northern and southern boundaries of the SWAN and will be an important source for understanding deposition trends in SWAN park units.

Stair step moss (*Hylocomium splendens*) was collected in several SWAN park units in 2008 to estimate baseline concentrations of metals, sulfur and nitrogen. This moss is used to assess airborne contaminants because annual growth increments are easily observed, it is widely distributed, and, like all mosses, it lacks a vascular system; thus, deriving most of its nutrients from wet and dry deposition sources. The results will be used to design a more complete study to assess how contaminants move through and accumulate in the terrestrial environment.

SWAN will establish a wet deposition collection site in King Salmon as part of the National Atmospheric Deposition Program (NADP) in spring 2009. A seven-day composite sample will be collected and analyzed for a suite of chemical parameters including sulfate, nitrate, ammonium, phosphate, and pH. NADP is a long-term program that has been monitoring wet deposition for over 20 years. Collection sites are located throughout the U.S.; many are located in national parks.

Other projects include contaminants analysis in fish and mussel tissue and lake sediment analysis.

Hylocomium splendens is a common moss found throughout the Network.



http://www.flickr.com/photos/maximilian_millipede/230124870



NADP site in Denali NPP includes a wet deposition collector and electronic rain gage. A similar system will be installed in King Salmon in spring 2009.

Long-term Monitoring

Pollutants associated with regional and global industrialization are known to travel great distances and are deposited through wet and dry deposition to terrestrial and aquatic environments. SWAN scientists are in the early stages of incorporating air quality and contaminants monitoring into existing Vital Signs monitoring. Due to the complexity associated with air quality monitoring, SWAN will also partner with state and federal agencies currently monitoring air quality and contaminant concentrations within the vicinity of SWAN park units.

Contacts

Michael Shephard, NPS-SWAN, michael_shephard@nps.gov
Claudette Moore, NPS-SWAN, claudette_moore@nps.gov
Jeff Shearer, NPS-SWAN, jeff_shearer@nps.gov



Alagnak

Aniakchak

Katmai

Kenai Fjords

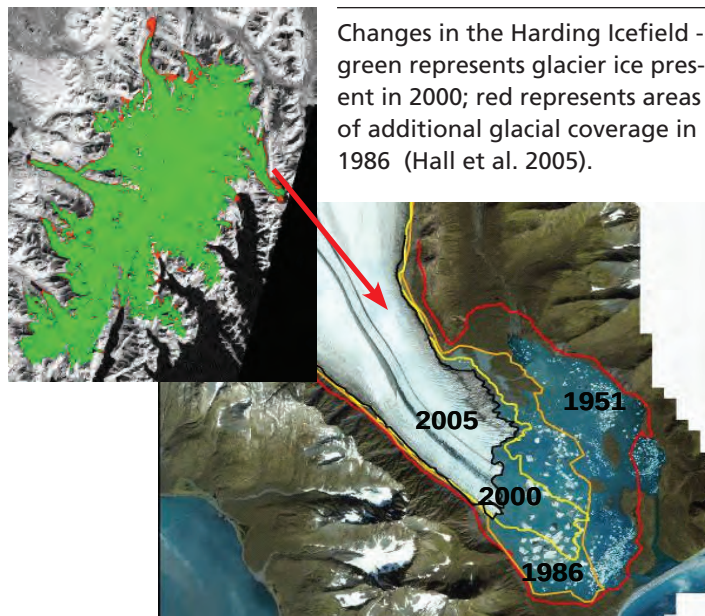
Lake Clark

Glacial Extent

Resource Brief

Importance

Glaciers are a significant feature in the SWAN park units, especially in Katmai NPP (KATM), Kenai Fjords NP (KEFJ) and Lake Clark NPP (LACL), where glaciers/permanent snowfields comprise approximately 5%, 50% and 22% of the landscape, respectively. Alaska's glaciers have been retreating since the waning of the Little Ice Age (~100 years ago). Although historically ice loss occurred at varying rates, current evidence suggests that the rate has increased in recent decades. This widespread glacial recession is largely responsible for substantial landscape changes in SWAN park units that are visible today. Glaciers act as huge ice reservoirs for many of the large freshwater systems in the Network and as such, glacial extent directly affects the character of the Network's watersheds and is indicative of potential shifts in aquatic communities.

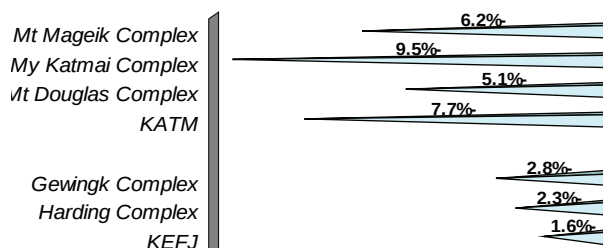


A 2005 Ikonos image of the Bear Glacier (KEFJ). Glacier terminus positions shown in red (1951), orange (1986), yellow (2000) and black (2005).

Long-term Monitoring

Landsat satellite imagery is being used to map glacier extent on a decadal scale in SWAN park units. Icefields and outlying glaciers are delineated using a combination of automated and manual methods. Geographic Information System (GIS) analysis is used to quantify change in glacier extent and identify those areas that are changing anomalously.

Glacier Retreat (percent loss) by Park



Overall glacier extent declined by 1.6% and 7.7%, respectively, in KEFJ and KATM between 1986/87 and 2000. However, the decline varies across the region. For example, the Mt. Katmai complex covered 563 km² in 1986 and 509 km² in 2000, a loss of 9.5%. The Harding Icefield complex, which extends beyond the park boundary, covered 1,828 km² in 1986 and 1,786 km² in 2000, a loss of 2.3%.

Status and Trends

In KATM from the early 1950s through 2000, interior-flowing glaciers exhibited rates of recession averaging 18 m/yr; coastal-flowing glaciers averaged a retreat of 17 m/yr. During the 1986/87 to 2000 time period, coastal-flowing glaciers exhibited rates of recession averaging 9 m/yr, whereas interior-flowing glaciers receded at more than twice that rate (19 m/yr). Glacier termini completely mantled by thick volcanic ash exhibited very little change in area.

All glacier termini measured in KEFJ have receded between the early 1950s and 2005; some have moved back dramatically. From the early 1950s through 2000, interior-flowing glaciers exhibited rates of recession averaging 29 m/yr, whereas coastal-flowing glaciers averaged 32 m/yr. However, between 2000 and 2005, the coastal glaciers in KEFJ show a dramatic increase in recession rates (78 m/yr), largely due to the dramatic recession of the Bear Glacier during this time.

Glacier mapping continues in LACL; no analysis is available at this time.

Contacts

Bruce Giffen, NPS-AKRO, bruce_giffen@nps.gov
Dr. Dorothy Hall, NASA, dorothy.k.hall@nasa.gov

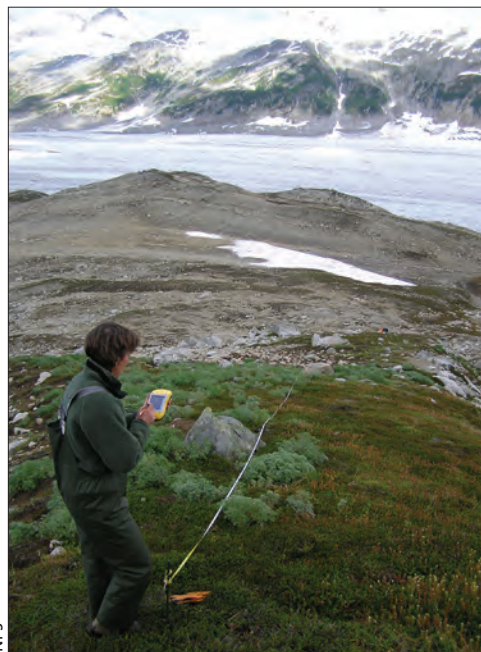


Sensitive Plant Communities

Resource Brief

Importance

Shifts in the composition and structure of sensitive plant communities are expected to serve as early indicators of change. Subtle changes in the environment may have significant long-term effects on communities that are strongly controlled by physical factors (e.g., hydrology, snow cover) or occur at the edge of their range. Among the sensitive communities targeted for monitoring are salt marshes and nunataks (alpine ridges surrounded by ice). Salt marshes provide critical foraging habitat for brown bears, nursery areas for fish and shellfish, and staging grounds for migrating waterfowl. Nunataks are thought to have remained ice free during the Last Glacial Maximum, approximately 20,000 years before present, and as a result may have provided habitat for species that are now regionally or globally rare.



NPS

Amy Miller,
SWAN
ecologist,
samples
nunatak plant
communities
above Tuxedni
Glacier, LACL.

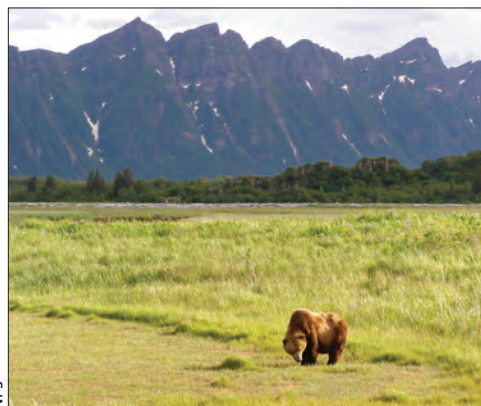
Status

Monitoring sites have been established at salt marsh sites in Lake Clark NPP (LACL) and Katmai NPP (KATM), and at nunatak sites in LACL and Kenai Fjords NP (KEFJ). In 2007-2008, three salt marsh monitoring sites were established in LACL and KATM. Methods for monitoring vegetation, sedimentation, and surface hydrology were field-tested through a contract with ABR, Inc. Species composition and soil characteristics were described along surveyed transects from the lower marsh to the forest edge, and dataloggers were installed to monitor water level and temperature in the tidal guts. Collectively, these data should provide an integrative measure of total environmental change.

In 2005, 11 nunatak sites were inventoried in LACL and KEFJ through a CESU Task Agreement with the Alaska Natural Heritage Program. Baseline monitoring was initiated at eight of the sites. Species of conservation concern included Lemmon's rockcress (*Arabis lemmonii*), rayless arnica (*Arnica diversifolia*), dunhead sedge (*Carex phaeocephala*), Alaska rock jasmine (*Douglasia alaskana*), pale poppy (*Papaver alboroseum*), and Drummond's cinquefoil (*Potentilla drummondii*).

Discussion

Established monitoring sites will be revisited every ten years, and where possible, aerial photos and ancillary climate data will be used to interpret environmental variation that could lead to changes in species composition. In both nunatak and salt marsh communities, changes in snow depth and duration, and/or changes in glacial melt, could have measurable effects on species establishment and turnover.



NPS

Salt marshes
provide
important
foraging
habitat for
brown bears
(Hallo Bay,
KATM).

Contacts

Amy Miller, NPS-SWAN, amy_e_miller@nps.gov
Torre Jorgenson, ABR, Inc., tjorgenson@abrinc.com
Matt Carlson, Alaska Natural Heritage Program, afmlc2@uaa.alaska.edu



Insect Outbreaks

Resource Brief

Importance

In the past, high latitude forests have experienced widespread mortality and/or loss of canopy cover due to insect and disease outbreaks. Variation in climate and/or changing land use patterns may affect the population dynamics of insects and forest pathogens, potentially altering forest structure and composition in the future.

Status

Since 1989, the spruce bark beetle (*Dendroctonus rufipennis*) has killed roughly 3 million acres of spruce forest in south-central and southwest Alaska, including approximately 172,500 acres in Lake Clark NPP (LACL) and Katmai NPP (KATM). Beetle activity has recently increased on the Alaska Peninsula, particularly in the Iliamna and greater Naknek watersheds.

Tree-ring data have been widely used to address issues of past disturbance and long-term climate variability in forested ecosystems. In 2005 and 2007, tree cores were collected from 15 sites in LACL and KATM to determine whether bark beetle outbreaks occurred historically. As beetles kill older, larger trees in the stand, younger trees in the understory are released from competition and show an increase in growth, or 'growth release,' evident in the tree rings (Fig. 1). Preliminary results from the LACL collections have shown growth releases in the 1810s, 1870s, 1910s, and 1970s-1980s, synchronous with release events recorded from the Kenai Peninsula. In KATM, major growth releases were recorded in the 1910s, one to three years following the 1912 Mt. Katmai eruption, and in the late 1970s-early 1980s.



Figure 1. Examples of growth release observed on tree-ring cores collected from the Tlikakila River, LACL. The cores represent a release in the 1910s.



Recent spruce bark beetle-induced tree mortality, Crescent River-Polly Creek, LACL.

Discussion

Tree-ring reconstructions from the Kenai Peninsula and LACL indicate that widespread forest thinning has occurred at a mean return interval of roughly 50 years over the last 250 years. In LACL, tree-ring evidence suggests that stand conditions were historically sufficient to support regional-scale outbreaks. In KATM, the tree-ring records are shorter, but stand-level releases during the last century coincide with the regional release events recorded for the Kenai Peninsula. The degree to which new outbreaks in southwest Alaska could disrupt ecological processes is unknown and will likely be the subject of future monitoring efforts. In addition, ongoing analyses are examining the relationship, if any, between release events and climate.



Dr. Ed Berg (left) and field assistant Matt Boswer examine spruce bark beetle damage at a site in LACL.

Contacts

Amy Miller, NPS-SWAN, amy_e_miller@nps.gov
Rosemary Sherriff, University of Kentucky, rsherriff@uky.edu
Dr. Ed Berg, USFWS, Edward_Berg@fws.gov



Vegetation Composition and Structure

Resource Brief

Importance

Vegetation is integral to ecosystem function and element cycling, and it is a sensitive indicator of environmental change. Enabling legislation for SWAN park units establishes the need . . . to *preserve in their natural state extensive unaltered arctic tundra, boreal forest, [alpine meadows], and coastal rain forest ecosystems*. In addition to their scenic qualities, these communities also provide habitat and forage for Dall sheep, caribou, brown bears, and a variety of other wildlife, and vital resources for subsistence users.

Status

Vegetation composition and structure will be monitored at two scales to capture landscape- and local-scale variation. At the landscape scale, remotely-sensed data are being used to detect broad-scale changes in vegetation and landscape features. An Interagency Agreement with the USFS-Pacific Northwest Research Station has been developed to use mid-resolution satellite images (Landsat TM/ETM+) to identify changes in major vegetation types through time. These changes include forest mortality due to insect outbreaks and fire, and establishment of vegetation on barren surfaces (e.g., following deglaciation and river channel abandonment). In addition, orthorectified aerial photos (1950s, 1980s, and 1990s-era) and high-resolution IKONOS imagery are being used to describe finer-scale changes on the landscape, including shrub and tree encroachment, pond drying, and tree-line migration (Fig. 1).

At the local scale, ground-based monitoring is intended to target changes in vegetation structure, species composition, and selected environmental variables that are too subtle spectrally, or occur at too fine a scale, to monitor through remote sensing techniques alone. For example, decreases in lichen cover associated with shrub encroachment are important ecologically, but are difficult to detect in aerial photos or satellite images. Monitoring will occur across an elevation gradient, in environments ranging from coastal forest to alpine tundra. Pilot sampling began in Lake Clark NPP (LACL) in 2007. In addition, a revisit of 15-year old inventory plots was completed in Kenai Fjords NP (KEFJ) in 2008.

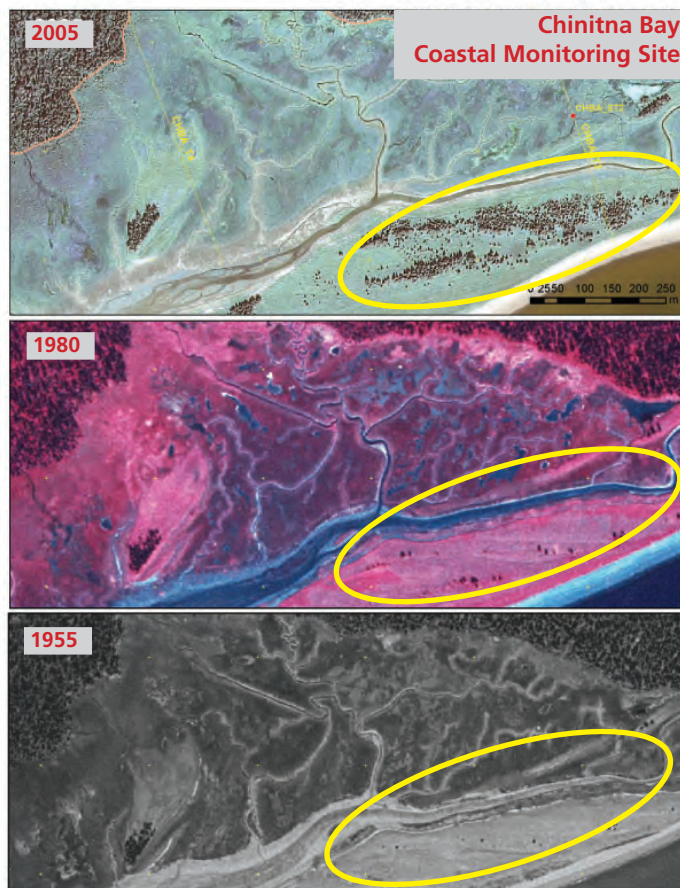


Figure 1. Increase in tree cover on a beach ridge, LACL, as interpreted from a time-series of air photos (1955, 1980) and high-resolution IKONOS imagery (2005). Tree establishment accounted for a 7% change on the landscape at this site.

Discussion

Methods for the use of satellite imagery and ground-based sampling continue to be refined. Pilot data and model simulations from LACL have been used to estimate sample size and frequency for ground-based monitoring. Qualitative estimates of vegetation change, derived from the revisit of KEFJ inventory plots, have shown that measureable changes in species composition can be recorded within 10-15 years.

Contacts

Amy Miller, NPS-SWAN, amy_e_miller@nps.gov
Robert Kennedy, USFS-PNW, robert.kennedy@oregonstate.edu
Warren Cohen, USFS-PNW, warren.cohen@oregonstate.edu

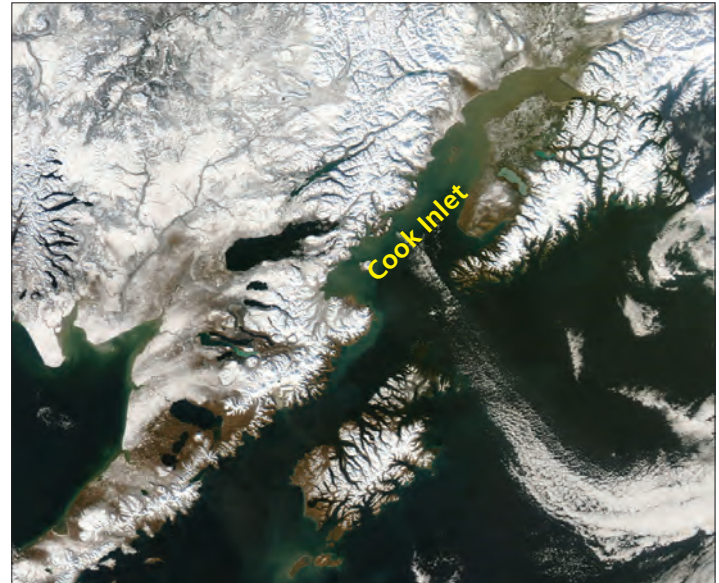


Landscape Processes

Resource Brief

Importance

Impacts of global climate change are expected to result in greater variation in the seasonality of snowpack, lake ice, and vegetation dynamics in southwest Alaska. All have wide-reaching physical and biological ecosystem effects in the region. SWAN has used MODIS satellite data to monitor these landscape metrics since 2001. The depth, timing, and spatial extent of snowpack can influence soil thermal regimes, lake ice thickness, surface and groundwater hydrology, nutrient turnover, vegetation dynamics and wildlife foraging, movement and predation. Longer growing seasons can result in increases in plant biomass, changes in community composition, and wildlife populations, including caribou, moose, wolves, bears, lemmings, and other prey species. Lake ice is an excellent integrator of regional weather patterns.



Early snow spreads across southwest Alaska and SWAN park units on Oct. 26, 2008.

Status and Trends

From 2001–present, snow cover duration was stable within ecoregions, with variable start and end dates. Lake ice freeze-up lagged the snow season by 2 to 3 months. For a given lake, freeze-up dates varied in timing and duration, whereas break-up dates were more consistent. Higher than average temperatures during the El Niño winter of 2002–2003 were expressed in anomalous ice and snow season patterns (figure 1). Lake ice seasons showed high interannual variability, whereas snow and growing season metrics were more stable across years.

Lake ice is highly responsive to short-term weather events. Snow cover was moderately variable at the beginning of the winter season, whereas duration of snow cover and the snow off dates were consistent. Timing of these cold weather systems is likely to remain erratic given the speculation for increasing temperature variability that could potentially impact the duration of snow season and timing of snow cover depletion. Results of this study will be out late in 2009:

Reed, B., M. Budde, P. Spencer and A. Miller. In press. Integration of MODIS-derived metrics to assess interannual variability in snowpack, lake ice and NDVI in southwest Alaska. Remote Sensing of the Environment.

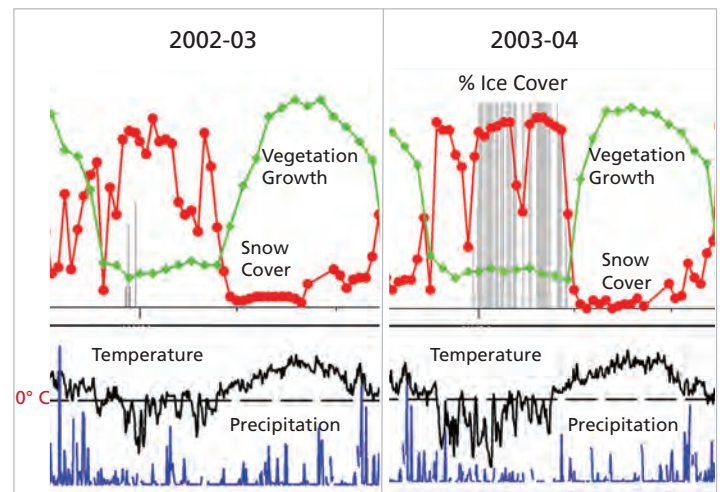


Figure 1. Timing for landscape and climate metrics near Skilak Lake for an “average” winter in 2003-04 (right), and strong El Niño in 2002-03 (left). Snow cover (red), vegetation productivity (green) and ice cover (gray) are shown on the upper image. Temperature (black) and precipitation (blue) are shown on the lower image; the dashed horizontal line is 0 deg. C. Note that very little ice formed during the El Niño winter when winter temperatures hovered at or above freezing.

Contacts

Page Spencer, LACL, page_spencer@nps.gov
Amy Miller, NPS-SWAN, amy.e.miller@nps.gov



Coastal Shoreline Change

Resource Brief

Importance

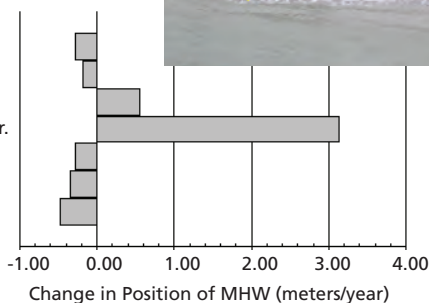
Land loss or gain at the marine edge has important ecological and jurisdictional implications. The SWAN coastal shoreline is dynamic and constantly changing due to coastal erosion and accretion from natural events, such as storm-driven waves, high tides, nearshore currents, rainfall and runoff, landslides, and earthquakes. Changes in the position of the shoreline affect the composition, relative abundance, and distribution of coastal habitats.

Status and Trends

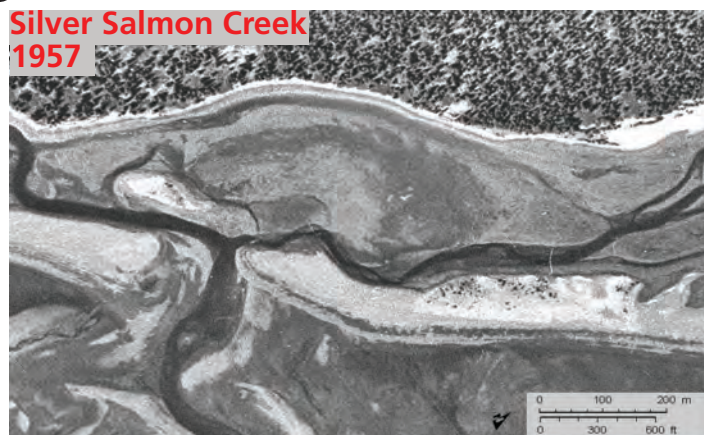
Seven of 10 cross-shore beach profiles established in 1992 were re-surveyed in 2004 using rod and transit leveling to evaluate shoreline changes along the 82 km coastline of Lake Clark NPP (LACL). The beach profiles revealed variation in rates of erosion and accretion along the parks coastline. Erosion, landward migration of mean high water (MHW), was observed at 5 profiles and accretion, seaward migration of MHW, was observed at 2 profiles. Annual average rates of erosion and accretion ranged from -0.18 to -0.50 m/yr and 0.55 to 3.13 m/yr, respectively.

Annual rates of erosion and accretion at cross-shore beach profiles, LACL-Cook Inlet Coastline, 1992-2004.

Polly Cr.
Crescent Cr.
Slope Mtn.
Silver Salmon Cr.
Spring Pt.
Clam Pt.
Glacier Spit



SWAN



Images display tidal channel dynamics, coastal erosion, forest expansion, and wetland change that occurred between 1957 and 2004 at Silver Salmon Creek (LACL).

Future Monitoring

William Manley (INSTAAR) developed a time series of rectified aerial photographs and satellite images for selected locations along the shoreline of LACL, which will be monitored through time.

Contacts

Bruce Giffen, NPS-ARO, bruce_giffen@nps.gov
Joel Cusick, NPS-ARO, joel_cusick@nps.gov
William Manley, INSTAAR, UC Boulder, William.Manley@colorado.edu



Marine Water Chemistry

Resource Brief

Importance

Water quality measurements, including temperature and salinity, are critical to intertidal fauna and flora and are likely to be important determinants of both long-term and short-term fluctuations in the intertidal biotic community. Basic water chemistry parameters provide a record of environmental conditions at the time of sampling and are used in assessing the condition of biological assemblages. Water quality (especially levels of contaminants such as heavy metals and organic pollutants) is also critical in structuring nearshore marine ecosystems and can cause both acute and chronic changes in nearshore populations and communities.

Discussion

Results from contaminant analysis suggests that total polycyclic aromatic hydrocarbon and metal concentrations in mussel tissues collected in 2007 from KATM and KEFJ were generally at the lower end of the ranges reported for other sites in the Gulf of Alaska, and are at or below “background” levels representative of contaminant free sites. Organochlorine concentrations, including DDTs, PCBs, and a variety of organic pesticides were also low at sites in both parks. Generally, levels were similar to those observed elsewhere in Alaska and well below the national median for tissue of mussels or oysters. The lone exception was at Amalik Bay where the household pesticide Chlordane, which has not been manufactured since the mid 1980s, was above the national median and higher than previously measured in Alaska. This site will be resampled in 2009. Intertidal temperature data from KATM show a wide range of temperatures between June ‘06 and June ‘07 (figure 1); the maximum yearly range was over 40° C (< -10° C to > 30° C). Colder temperatures are recorded during spring tides when the 0.5m tidal elevation is exposed to air. Temperature data collected from both parks are still being evaluated.

www.planet-ocean.co.uk/Star-Oddi/accessories/index.htm



Upper Left: Star-Oddi DST CD (conductivity, temperature and depth) data logger with housing.

Right: Hobo temperature logger in housing. One temperature logger is deployed at each rocky intertidal sampling site.

Long-term Monitoring

Water quality measurements are collected at each rocky intertidal site in Katmai NPP (KATM) and Kenai Fjords NP (KEFJ). HOBO temperature loggers are deployed at each site and record hourly water temperature data throughout the year. Two salinity loggers were deployed in 2008, one each in KATM and KEFJ. Additional salinity monitors will be co-located at all rocky intertidal sites in both parks in 2009. The loggers are downloaded annually during the site visits. Mussels were collected in 2007 for contaminant analysis at each rocky site.

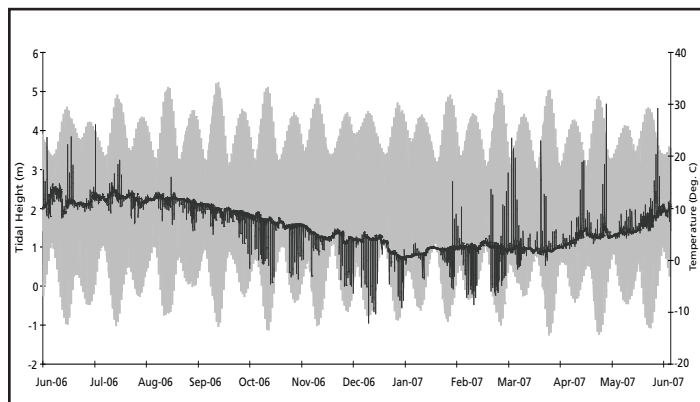


Figure 1. Tidal height and temperature data collected at 0.5 m MLLW (Kinak Bay, KATM).

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
Thomas Dean, Coastal Resources, Inc.,
tomdean@coastalresources.us



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Kelp and Eelgrass

Resource Brief

Importance

Kelp and eelgrass are “living habitats” that serve as nutrient filters and provide understory and ground cover for planktivorous fish, clams, urchins, and a physical substrate for other invertebrates and algae. Kelps and eelgrasses also provide spawning and nursery habitats for forage fish and juvenile crustaceans. Kelps are the major primary producers in the marine nearshore and because they are located in shallow water, they could be adversely impacted by oil spills and other human-related activities. Other potential stresses include activities that disturb the beds directly such as dredging and anchor scars, and events that reduce the ability for light to penetrate into the water column, such as runoff (increased turbidity) or nutrient addition.



NPS

Dr. Allan Fukuyama, FHT Environmental, conducting intertidal sampling at rocky sediment sites.



NPS

Eelgrass bed exposed at low tide in Kukak Bay, KATM.

Long-term Monitoring

Intertidal kelps are monitored annually at six sites in Katmai NPP (KATM) and five sites in Kenai Fjords NP (KEFJ). Percent cover is estimated from random point counts collected at -1.5 m and 0.5 m tidal elevations. Several methods to monitor eelgrass beds have been field tested to determine the most appropriate and cost effective method. Within a designated section of an eelgrass bed, a series of transects were delineated perpendicular to shore by deploying buoys to mark the beginning and end points. GPS-linked mapping software was used to record transect lines and eelgrass bed density. An underwater video camera was used to estimate eelgrass density categories along each transect.

Discussion

Alaria marginata is the dominant kelp species in the intertidal zone at both parks. At KATM, it occupies about 20% cover in the lower intertidal zone. Preliminary data from KATM indicate a probable increase in percent cover of *Alaria* over the 3 years. Data from KEFJ have not yet been evaluated. Subtidal canopy-forming kelps in both KATM and KEFJ include *Neroecystis leuetkeana* and *Alaria fistulosa*. Sonar and visual estimates of canopy cover were used to estimate relative abundance of subtidal kelps; however, these methods have not resulted in reasonable estimates due to high variability caused by tides and currents. We are examining the use of aerial photography to evaluate relative abundance of canopy-forming subtidal kelps. Eelgrass cover was estimated in selected eelgrass beds in KATM and KEFJ in 2007. These data provide a baseline estimate of eelgrass cover that will be used to evaluate trends over time.

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
Thomas Dean, Coastal Resources, Inc.,
tomdean@coastalresources.us



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Marine Intertidal Invertebrates

Resource Brief

Importance

Marine invertebrates provide a critical prey resource for shorebirds, ducks, fish, bears, sea otters, and other marine invertebrate predators. Benthic invertebrates are ecologically diverse in terms of habitat and trophic requirements; have a wide range of physiological tolerances and feeding modes; are relatively sedentary, and have short generation times. Changes in species composition, abundance, contaminant levels, and biomass of intertidal invertebrates can indicate important changes in the coastal ecosystems of which they are a part, and can have effects that cascade to other trophic levels.

Discussion

Intertidal clam densities at KATM and KEFJ were similar; *Macoma* spp. were most abundant at each park in 2007. However, the number of clams per quadrat varied extensively within and among sites. Other studies indicate clam populations associated with areas of prolonged sea otter foraging are characterized by lower densities and smaller size distributions. However, this study has not yet determined the impact of sea otter predation on prey communities in KATM or KEFJ. The rocky intertidal zone at both parks is dominated by several species of algae, barnacles, and mussels. Preliminary data from KATM indicate a probable increase in percent cover of mussels over the 3 years. However, it is uncertain whether this represents a long-term trend. Cover by other invertebrate species appeared relatively unchanged. Analysis of KEFJ data collected in 2008 is on-going.



James Bodkin, USGS, samples mussels to estimate size distribution and density of this important intertidal prey species.



Jen Coffey, biologist, samples a soft sediment site in KEFJ.

Long-term Monitoring

Five rocky and soft sediment sites were established in Katmai NPP (KATM) and Kenai NP (KEFJ) in 2006 and 2007, respectively. Annual sampling to estimate sessile invertebrate percent cover, limpet (*Lottia* spp.) size distributions, and the density of larger invertebrates is conducted annually in KATM and KEFJ. Initial sampling for mussel density and size distribution at these rocky sediment sites did not capture larger size classes, which are rare and widely dispersed. Mussels appear to be an important food source for black oystercatchers and sea otters; therefore, a separate sampling protocol was added during the 2008 field season in an attempt to sample these larger size classes. Soft sediment sampling occurs biannually to estimate bivalve species composition, size distribution and density. Soft sediment sampling will be conducted in 2009 at KATM and KEFJ, and will be initiated in LACL.

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
Thomas Dean, Coastal Resources, Inc., tomdean@coastalresources.us
James Bodkin, USGS-ASC, James_Bodkin@usgs.gov



Black Oystercatcher

Resource Brief

Importance

The black oystercatcher is a common and conspicuous member of the rocky and gravel intertidal marine communities of park shorelines. This species is completely dependent on nearshore marine habitats for all critical life history components, including foraging, breeding, chick-rearing, and resting, but is highly susceptible to human disturbance. The black oystercatcher serves as “keystone” species, which is important in structuring nearshore ecosystems.



Two adults with two chicks on rocky outcrop. Adults are vigilant protectors of their young.

Discussion

Results indicate that limpets and mussels account for the majority of the black oystercatcher diet in KATM and KEFJ. In 2008, mussels comprised the largest portion of the black oystercatcher diet in KEFJ (Table 1). This is consistent with a greater proportion of mussels observed in the sea otter diet in KEFJ, and suggests both sea otters and black oystercatchers have a greater reliance on these key resources in KEFJ. Results also revealed that black oystercatchers selected mussels and limpets near the largest sizes measured at the rocky intertidal sites, suggesting size-selective predation by the adult oystercatchers. Densities of active nesting pairs of black oystercatchers and nest productivity were slightly higher at KATM than KEFJ during 2008 (table 1). This may be due to the greater availability of appropriate black oystercatcher habitat in KATM.

Table 1. Nest success and diet data from KATM and KEFJ collected in 2008.

	KATM	KEFJ
Nest Success		
Nest density (#/km ²)	0.11	0.09
Nest Productivity (eggs + chicks/nest)	1.83	1.4
Diet		
Mussel proportion	0.25	0.53
Limpet proportion	0.73	0.41

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
James Bodkin, USGS-ASC, James_Bodkin@usgs.gov



Black oystercatcher nest with chick and egg. Nests are poorly defined; however, the eggs and chicks are well camouflaged and guarded by the adults.

Long-term Monitoring

Black oystercatcher breeding density, nest occupancy, and prey data were collected along five 20-km transects centered on each rocky intertidal invertebrate in Katmai NPP (KATM) and Kenai Fjords NP (KEFJ). In 2008, transect widths were extended offshore ~1 km to encompass islands, which will be used in the analysis of diet and nest occupancy. In addition, oystercatcher abundance, productivity, and diet data were collected from a selected site at Ninagiak Island and surrounding islets (Hallo Bay, KATM).

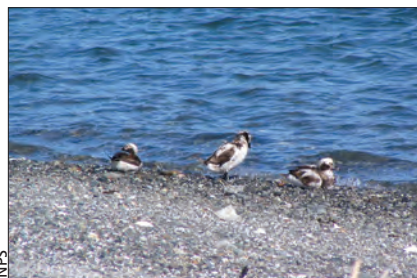


Marine Birds

Resource Brief

Importance

Marine birds rely heavily on habitats and prey associated with the marine nearshore ecosystem of park coastlines. These species are top-level consumers of marine invertebrates such as mussels, clams, snails, limpets, and forage fish. Because of these characteristics, marine birds are good indicators of change in the marine ecosystem. Monitoring will focus on birds that are trophically linked to the nearshore food web such as sea ducks (harlequin duck, Barrow's goldeneye, bufflehead, long-tail ducks, and scoters), mergansers, and shorebirds, specifically the black oystercatcher. Many of these species were impacted by the Exxon Valdez oil spill, and exhibited protracted recovery periods as a consequence of lingering oil in nearshore habitats. Public concern exists for the welfare of marine birds because they are affected by human activities like oil pollution and commercial fishing.



Over-wintering long-tail ducks observed during winter surveys (KEFJ, 3/2008).



Mew gulls are commonly sighted during summer surveys.

Discussion

2008 was the first winter survey in KEFJ since the 1989 Exxon Valdez Oil Spill. Based on this initial winter survey, the design of future surveys is being modified to better target habitats possibly used by over-wintering ducks such as protected bays and lagoons. Although there was no directed effort to survey areas with habitat attributes suitable for over-wintering sea ducks during the 2008 winter survey in KEFJ, we did observe a difference in the densities of Barrow's goldeneye, harlequin duck and common goldeneye between the winter and summer surveys (Table 1). Higher densities of these species are to be expected along the coasts in the winter, prior to their migration inland to breeding areas.

Table 1. Sea duck density results from KEFJ summer (2007) and winter (2008) surveys.

	Winter Density	Summer Density
Harlequin duck	14.10/km ²	12.45/km ²
Barrow's goldeneye	9.58/km ²	0.19/km ²
Common goldeneye	1.05/km ²	0.00/km ²

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
James Bodkin, USGS-ASC, James_Bodkin@usgs.gov



NPS biologists Heather Coletti, Shelley Hall and Meg Hahr conduct marine bird surveys (KEFJ, 3/2008).

Long-term Monitoring

Three years of summer surveys have been completed in Katmai NPP (KATM). Analysis to estimate annual variation is currently underway and will be available in spring of 2009. A winter survey of KATM is planned for March 2009. Two summer surveys and one winter survey have been completed in Kenai Fjords NP (KEFJ). Objectives for the winter surveys include characterization of species composition, density and distribution for over-wintering sea ducks prior to their migration to breeding grounds; other marine birds and mammals are also documented during the surveys.



Sea Otter

Resource Brief

Importance

Sea otters are a “keystone” species that can dramatically affect the structure and complexity of their nearshore environment. Sea otters prey on sea urchins (‘grazers’) that feed on kelp resulting in top-down cascading effects on the nearshore community structure. Heavy predation on sea urchins greatly alters the abundance and composition of lower trophic levels (e.g., kelps). Also, sea otters tend to have smaller home ranges in comparison to other marine mammal; require high caloric intake, have an incidence of disease that is correlated with contaminants; and have broad appeal to the public, which make them a prime species for monitoring. In September 2005, the Southwestern Alaska stock of sea otters, which includes the Katmai NPP (KATM) population, was federally listed as threatened.



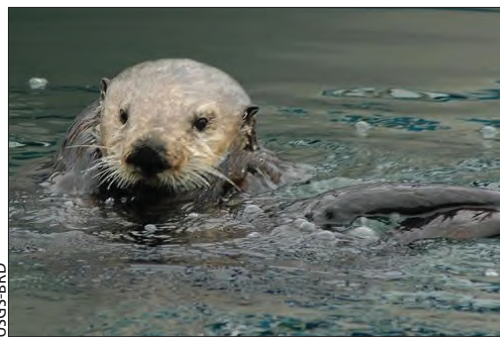
James Bodkin, USGS, observes foraging sea otters (KEFJ, 2007)

Long-term Monitoring

Sea otter monitoring was initiated in 2006 and 2007, respectively, in KATM and Kenai Fjords NP (KEFJ). Aerial surveys (conducted every 3 years) are used to estimate abundance. Data are collected on foraging sea otters to estimate prey size distribution, species composition and energy recovery. To supplement these direct observations, prey remains are collected from sea otter spraint found at haul out sites. In addition, sea otter carcass surveys are completed annually. A tooth is extracted from collected skulls to determine the age of the sea otter. This information is used to develop age-specific survival estimates based on population models. KATM has several sea otter haul out areas where large numbers of carcasses can be collected to obtain an adequate sample size. However, KEFJ has more limited sea otter haul out areas, making it difficult to implement the full protocol.

Discussion

There were an estimated 1,511 sea otters (Table 1) in KEFJ (2007) and 7,095 sea otters in KATM (2008). Preliminary results of foraging observations illustrate differences in sea otter selection of prey species between the two parks. Mussels are the predominate prey item in KEFJ, whereas clams are the predominate prey in KATM. In 2009, we will continue collecting sea otter foraging and carcass data in both KATM and KEFJ.



Sea otters shape the community structure of the nearshore ecosystem through predation.

Table 1. Results of sea otter population estimates.

	KATM	KEFJ
Population Estimate	7,095 (2008)	1,511 (2007)

Contacts

Heather Coletti, NPS-SWAN, Heather_Coletti@nps.gov
James Bodkin, USGS-ASC, James_Bodkin@usgs.gov



Surface Hydrology

Resource Brief

Importance

All biophysical interactions within SWAN aquatic systems are heavily influenced by hydrology. Maintaining the natural variation of hydrologic processes is critical to protecting the cultural, ecological, recreational, and economic value of aquatic resources Congress identified in establishing SWAN parks. Large-scale disturbances, such as climate change, can have a profound effects on hydrologic processes, such as increased stream flows from glacial melting or decreased ice cover on lakes. The end result is the potential for impacts to fish and wildlife populations, and associated human activities, in SWAN parks.



USGS-WRD

USGS-WRD hydrologist measures discharge at the outlet of Lake Brooks, KATM, with an acoustic Doppler current profiler.

Discussion

In 2006 and 2007, the U.S. Geological Survey Water Resources Division developed stage / discharge rating curves for several SWAN lake systems, including Naknek Lake and Lake Brooks in Katmai NPP (KATM), and Lower Twin and Telaquana Lakes in Lake Clark NPP (LACL). A rating curve for Lake Clark was developed through previous research. Based on these studies, SWAN is able to monitor daily lake levels and estimate a corresponding daily lake discharge value (fig. 1). SWAN will develop rating curves for major inflowing tributaries, such as the Tlikakila (LACL) and Savonoski (KATM) Rivers, to quantify the differences between lake inflows and outflows.



NPS

View of the crest staff gage at the outlet of Naknek Lake (KATM). A level logger is mounted at the base of the gage and measures lake level.

Long-term Monitoring

How are the timing and magnitude of peak river discharge and lake level changing in key SWAN glacial and non-glacial systems? To address this question, SWAN will monitor daily discharge into and out of large lake systems as well as lake level fluctuations during the ice-free period. Not only will these measurements allow us to quantify the amount of water flowing into and out of lake systems, and subsequent water storage, but also provide an estimate on concentrations of nutrients, trace metals, and other water quality constituents entering a lake. By comparing glacial to non-glacial systems, we will be able to monitor climate change on hydrologic processes, especially when comparisons are made in conjunction with glacial extent monitoring.

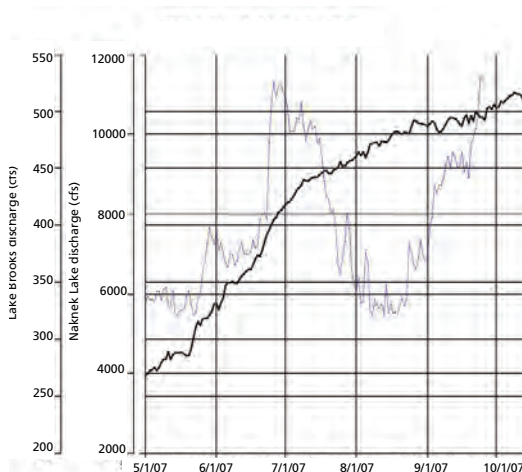


Figure 1. Average daily discharge for Lake Brooks (dashed) and Naknek Lake (black) during the open water season for water year 2007.

Contacts

Jeff Shearer, NPS-SWAN, Jeff_Shearer@nps.gov
Claudette Moore, NPS-SWAN, Claudette_Moore@nps.gov



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Freshwater Chemistry

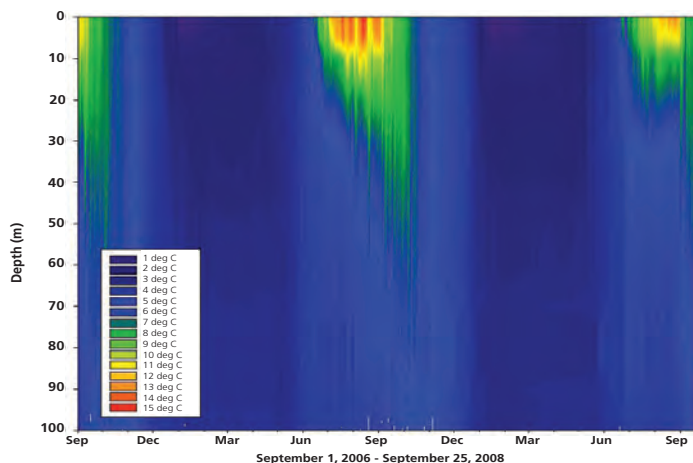
Resource Brief

Importance

As integrators of water, energy, nutrients, solutes, and pollutants from the landscape and atmosphere, lakes and rivers are interactive components of their environment. As such, monitoring water quality parameters, including temperature, dissolved oxygen, pH, and conductivity, provides an indication of watershed-level changes that may affect lake and riverine processes. Currently, SWAN parks contain some of the larger and more pristine freshwater resources in the national park system, represented by Lake Clark, Naknek Lake, and five designated “Wild Rivers.” Despite the remote, wilderness nature of lakes and rivers within SWAN parks, these systems are subject to large-scale anthropogenic influences, such as climate change and atmospheric pollutants. These man-made influences have the potential to impact many aquatic processes that are driven by water quality, such as lake productivity and fish reproductive success.

Long-term Monitoring

The remote, pristine nature of SWAN aquatic systems provides an ideal setting to examine natural variation of intact systems and the influences of man-made disturbances upon those systems. To examine human-induced alterations from natural conditions, SWAN is designing a water quality monitoring plan to assess a core (e.g., temperature, pH, dissolved oxygen, conductivity, and turbidity) and advanced (e.g., nutrients, ions, trace metals) suite of water quality parameters at lake outlets, inflowing tributaries, and throughout the lake basin. High priority lakes, such as Naknek Lake and Lake Clark, will be sampled annually during the ice-free season, whereas other lakes will be sampled less frequently.



Average daily water temperature, based on data collected from a moored temperature array, for Lake Clark, Lake Clark NPP (LACL) between September 2006 and September 2008.

Discussion

SWAN has monitored water temperature year-round in Lake Clark since September 2006. This sort of continuous monitoring allows us to assess freeze-up and break-up dates along with thermocline formation - all factors that greatly influence lake productivity. Continuous temperature monitoring was initiated in Naknek Lake in August 2008. Additionally, protocol testing for vertical profiles and continuous monitoring using automated data loggers was initiated in the summer 2008.

Contacts

Jeff Shearer, NPS-SWAN, Jeff_Shearer@nps.gov

Claudette Moore, NPS-SWAN, Claudette_Moore@nps.gov



NPS

SWAN aquatic ecologist, Jeff Shearer and physical science technician, Chuck Lindsay prepare to deploy a water quality sonde to monitor water quality parameters in Exit Creek, Kenai Fjords NP.



Lake Sediments

Resource Brief

Importance

As sediment and other material settle on the bottom of lakes, an excellent historic record of natural events is deposited. Scientists are able to collect lake sediment cores and precisely date the various layers, providing a timeline of past events, such as volcanic eruptions marked by the presence of ash. Much as water samples are analyzed to provide an assessment of current nutrient and contaminant levels, lake sediments can be analyzed to provide an historic perspective. There is a growing concern over contaminants, such as mercury, in the environment and SWAN is monitoring for the presence of contaminants through the Air Quality vital sign and by analyzing accumulations in resident lake fish and plant tissue. However, to achieve a long-term historical perspective on contaminant concentrations, SWAN has turned to lake sediment analysis.

Long-term Monitoring

In order to assess the impacts of the modern day industrial era, scientists must first have a good estimate on the historic levels of contaminants that occurred naturally. Mercury, for example, can occur naturally through the weathering of rocks. By using sediment cores, researchers can provide an estimate of contaminant levels dating back on the order of hundreds of years prior to the modern day industrial era - a period often linked to significant increases in atmospheric contaminant levels. Pacific salmon are known vectors of contaminants, transporting material accumulated during residence time in the ocean to freshwater spawning grounds. A comparison of sediment cores between anadromous and non-anadromous lakes allows researchers to evaluate the role Pacific salmon play in transporting contaminants into SWAN park units.

Sediment cores collected from ponds in LACL. Light gray color bands are volcanic ash deposited from past eruptions.



University of Alaska researchers, Dr. Bruce Finney and Andrea Krumhardt, collect a sediment core from Meshik Lake (ANIA).

Discussion

Between 2003 and 2005, researchers at the University of Alaska collected lake sediment cores from a range of lakes in Aniakchak NMP (ANIA), Katmai NPP (KATM), and Lake Clark NPP (LACL) as part of a research project to document the magnitude of Pacific salmon runs over time. Those archived sediment cores are now being used by University of Alaska researchers to measure historic levels of mercury, copper, lead, and several other elements in SWAN lakes. Sediment cores from lakes listed in Table 1 were selected for analysis to provide a comparison between lakes with and without a historic record of Pacific salmon runs and glacial inputs. The results should provide a good background record against which future contaminants studies can be compared.

Table 1. Lakes in KATM and LACL in which sediment cores were selected for contaminant analysis.

Lake	Geology	Fishery
Idavain (LACL)	non-glacial	non-anadromous
Kontrashibuna (LACL)	glacial	non-anadromous
Clark (LACL)	glacial	anadromous
Brooks (KATM)	non-glacial	anadromous
Naknek (KATM)	glacial	anadromous

Contacts

Jeff Shearer, NPS-SWAN, Jeff_Shearer@nps.gov
 Dr. LeeAnn Munk, University of Alaska Anchorage Professor of Geology, aflm@uaa.alaska.edu
 Dr. Bruce Finney, Idaho State university, finney@isu.edu



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Resident Lake Fish — Contaminants

Resource Brief

Importance

Resident lake fish serve important ecological, recreational, and subsistence roles in SWAN parks. They represent a variety of trophic levels (omnivores, insectivores, planktivores, and piscivores) and hence reflect changes that occur in the food chain. There is growing concern that fish species in some of SWAN's lakes have acquired elevated levels of mercury and other contaminants. Contaminants can enter a system through a variety of pathways, including naturally through weathering of inorganic material, atmospheric deposition, and migrating Pacific salmon. Mercury is considered especially toxic and can be converted in the environment to a highly toxic form called methylmercury. Contaminants can bioaccumulate and biomagnify in fish tissue, especially in long-lived, predatory species like northern pike (*Esox lucius*) and lake trout (*Salvelinus namaycush*). When contaminants reach high enough levels of concern, fish consumption advisories are often placed on a particular water body or fish species. Given the importance of resident lake fish as a food source for subsistence users, elevated contaminant levels in fish populations have ecological and human-health ramifications.



Northern pike, a common fish in many SWAN lakes, are among the species tested for contaminants due to their subsistence and recreational importance.

Discussion

In 2005, northern pike, lake trout, burbot (*Lota lota*) and Arctic grayling (*Thymallus arcticus*) were collected from Lake Clark, Lake Clark NPP (LACL), and tested for mercury and a suite of other contaminants (for a complete list, see: <http://www.dec.state.ak.us/eh/vet/fish.htm>). Total mercury concentrations ranged from 0.548 ppm (burbot) to 0.089 ppm (grayling). Mean concentrations in pike and lake trout were slightly lower than the national average of 0.35 and 0.30 ppm, respectively (Fig. 1)(US EPA National Listing of Fish and Wildlife Advisory fish tissue database, 2003 www.epa.gov/waterscience/fish). Mercury concentrations in fish may vary considerably from lake to lake. These data will be used with atmospheric deposition and lake sediment contaminants data to provide a regional synopsis of toxin concentrations in SWAN parks.

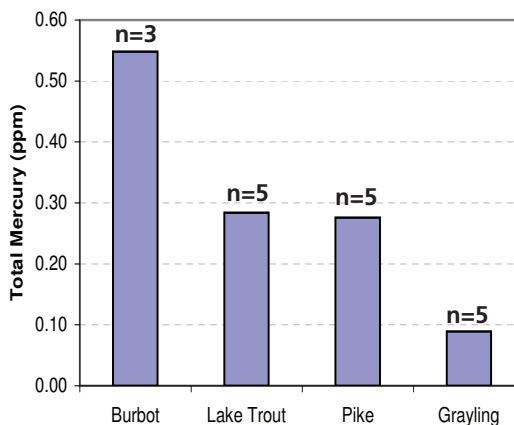


Figure 1. Results of total mercury analysis of fish species collected from Lake Clark in 2005 (LACL).

Long-term Monitoring

Are bioaccumulated contaminants increasing in fish communities in SWAN lakes? To answer this question, biologists are collecting and analyzing tissue samples of resident lake fish every 5 years from Lake Clark and Naknek Lake and less frequently within lower priority lakes. Alaska Department of Environmental Conservation (ADEC) currently collects biocontaminant data for several marine fish species, anadromous salmon, and two freshwater fish species. In conjunction with resident lake fish monitoring in the SWAN parks, samples for biocontaminant analysis will be collected to supplement the ADEC database. Samples will either be of whole fish or fillets with skin, preserving the option of analyzing contaminants that accumulate in fatty (e.g., PCBs, dioxins and organochlorine compounds) and muscle (e.g., mercury, arsenic, selenium, and copper) tissue.

Contacts

Jeff Shearer, NPS-SWAN, Jeff_Shearer@nps.gov
Dan Young, LACL, Dan_Young@nps.gov
Howard Teas, ADEC, Howard.Teas@alaska.gov



Salmon

Resource Brief

Importance

Sockeye salmon (*Onchorhynchus nerka*) are the life blood of the Bristol Bay region in southwestern Alaska. This species' importance in structuring the ecological framework of aquatic ecosystems is rivaled only by its storied history in Native Alaskan culture and today's commercial and subsistence fisheries. The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 specifically established Lake Clark NPP (LACL) for the following purpose, among others: "To protect the watershed necessary for perpetuation of the red salmon fishery in Bristol Bay..."

Additionally, ANILCA expanded Katmai National Monument (redesignated as Katmai National Park (KATM)) and created Katmai National Preserve "...to maintain unimpaired the water habitat for significant salmon populations..." Maintaining healthy runs of sockeye salmon is critical to the ecological, economic, and social integrity of the Bristol Bay region.

Long-term Monitoring

In Alaska, salmon are managed by the Alaska Department of Fish and Game (ADF&G) with assistance from the U.S. Fish and Wildlife Service (USFWS). Additionally, National Park Service resource staff supplement ADF&G and USFWS management efforts through salmon research and monitoring in parks. Counting towers, weirs, sonar, and aerial surveys are common methods used to estimate run strength and timing (collectively referred to as escapement) of migrating adult salmon. Escapement information is critical for the management of commercial, subsistence, and recreational fisheries. Currently, ADF&G operates salmon counting towers on the Naknek and Alagnak Rivers downstream of the KATM park boundary whereas LACL resource staff operate a counting tower on the Newhalen River downstream of the LACL park boundary. These three watersheds comprise the majority of the land area of SWAN parks draining into Bristol Bay. Thus, monitoring escapement on these three systems provides a good estimate of salmon numbers entering a large portion of KATM and LACL. Sockeye salmon escapement totals for 2008 are presented in Figure 1.

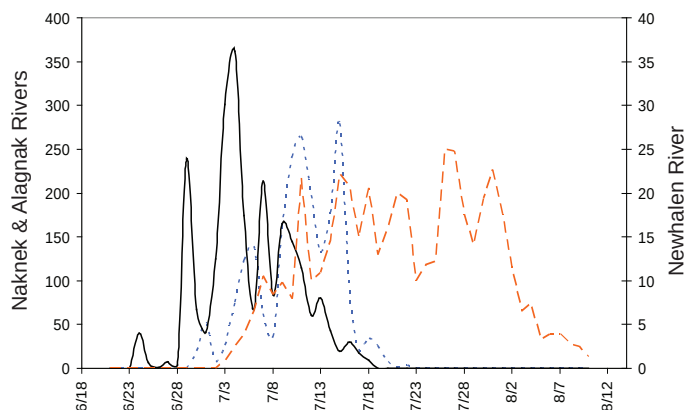


Figure 1. Estimated 2008 sockeye salmon escapement data for the Naknek (black), Alagnak (blue/short-dashed), and Newhalen (orange/long-dashed) Rivers. The data represent the number of fish x 1000.

Discussion

SWAN recognizes the valuable role state and federal agencies play in monitoring the sockeye salmon resources of southwestern Alaska. SWAN monitoring for the salmon vital sign will focus primarily on "harvesting" data collected by ADF&G. We will be developing a database for the storage and retrieval of salmon escapement data and will use this information along with other monitoring efforts to provide a broad perspective of ecological interactions within SWAN park units.



Sockeye salmon return to natal waters to spawn providing important resources for brown bears, and recreational, commercial and subsistence fisheries.

Contacts

Jeff Shearer, NPS-SWAN, Jeff_Shearer@nps.gov
Dan Young, LACL, Dan_Young@nps.gov



Bald Eagle

Resource Brief

Importance

Bald eagles are important predators on bird and fish populations and hence serve a vital ecological role in freshwater and marine coastal systems in SWAN parks. Their occurrence and reproductive performance may be influenced by weather conditions, toxic contaminants, food availability, human-related impacts, and climate. Thus, nest occupancy and reproductive rates of bald eagles may be useful indicators of both current condition and long-term change of freshwater and marine coastal systems. Katmai NPP (KATM), Kenai Fjords NP (KEFJ), and Lake Clark NPP (LACL) contain large breeding populations of bald eagles.



Bald Eagle nesting pair, LACL, May 2009.

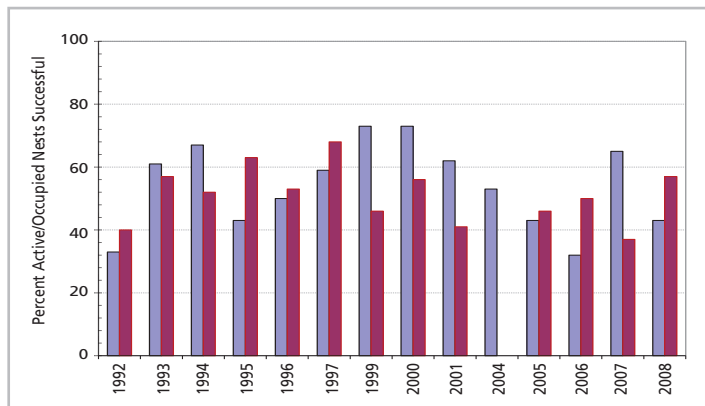


Figure 1. Percent nest success (producing at least one young) for bald eagles in LACL. Light blue indicates interior sites and dark red indicates coastal sites. Surveys were not conducted in 1998, 2002 or 2003.

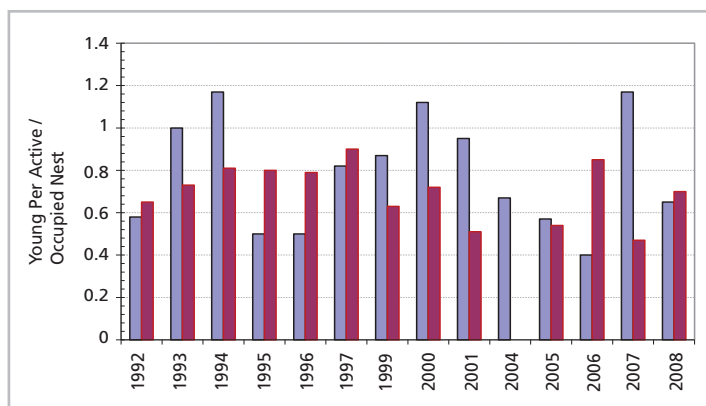


Figure 2. Bald eagle nest productivity (number of fledglings) in LACL. Light blue indicates interior sites and dark red indicates coastal sites. Surveys were not conducted in 1998, 2002 or 2003.

Status and Trends

Biologists from LACL have successfully adapted US Fish and Wildlife Service protocols to conduct annual surveys of bald eagle nests in the park's interior and coast. Average nest success and number of young produced per active/occupied nest was 54% and 0.78 in the park's interior, and 51% and 0.70 along the coast for most years during 1992-2008 (Fig. 1 and 2). Current data are not available on nest occupancy or productivity of bald eagles in KEFJ (last survey in 1998) or in KATM (last survey in 1994).

Discussion

Bald eagle populations are under continuing threat from the human-related impacts of ecotourism, sport and commercial fishing, timber harvest, potential mining activities, and potential oil spills or other accidents along marine coastlines. Protocol development in SWAN park units will be focused on evaluating the latest US Fish and Wildlife Service survey technique for monitoring bald eagles. This technique will be field tested in KEFJ, spring 2009 and in KATM, spring 2010.

Contacts

Buck Mangipane, LACL/SWAN, buck_mangipane@nps.gov
Shelley Hall, KEFJ, shelley_hall@nps.gov
Bill Thompson, NPS-SWAN, bill_thompson@nps.gov



Alagnak

Aniakchak

Katmai

Kenai Fjords

Lake Clark

Brown Bear

Resource Brief

Importance

Brown bears serve important ecological roles as top predators influencing population dynamics of other species and as a means of transferring nutrients from spawning salmon to the terrestrial system. Alagnak Wild River (ALAG), Aniakchak NMP (ANIA), Katmai NPP (KATM), and Lake Clark NPP (LACL) support high numbers of brown bears; densities along the coast of KATM are the highest reported in North America. Brown bears are also an economically important resource for wildlife viewing, sport hunting, and subsistence hunting.



NPS

LACL biotech, Jared Irvine, prepares for data entry prior to brown bear aerial survey.

Status and Trends

An aerial survey technique developed by statisticians at the Alaska Department of Fish and Game (ADFG) was used to obtain estimates of 2183 ± 379 (SE) brown bears in KATM during 2004-2005 and of 466 ± 232 (SE) brown bears in LACL during 2003-2004. These are the only parkwide abundance estimates of brown bears currently available for SWAN parks.

Discussion

The impact of large numbers of hunters, anglers and wildlife viewers on coastal brown bear foraging behavior, habitat use, and survival are largely unknown. Coastal sites containing salt marsh vegetation and rivers with salmon are heavily used by bears and humans, creating areas in need of increased management. Future monitoring efforts will focus on evaluating whether ADF&G's aerial survey method can be effectively applied to smaller areas of management concern within SWAN park units. This will allow for sustainable long-term monitoring and informed management of brown bears within these parks.



NPS

Brown bear feeding near the KATM coast.



NPS

Anglers watch a brown bear female with cub walk along Silver Salmon Creek on the LACL coast.

Contacts

Buck Mangipane, LACL/SWAN, buck_mangipane@nps.gov
Tammy Olson, KATM, tammy_olson@nps.gov
Bill Thompson, NPS-SWAN, bill_thompson@nps.gov



Moose

Resource Brief

Importance

Moose are an integral component of terrestrial systems in Alagnak Wild River (ALAG), Aniakchak NMP (ANIA), Katmai NPP (KATM), and Lake Clark NPP (LACL). During cycles of high abundance, moose have the potential to influence structure and function of terrestrial systems both through their browsing effects on vegetation communities and through their role as a prey species. Monitoring moose abundance and bull:cow ratios provides important information on dynamics of terrestrial systems. Moose also are an important natural and cultural resource to Alaskan sport and subsistence hunters.

Status and Trends

LACL biologists have used an aerial survey technique developed by the Alaska Department of Fish and Game (ADF&G) to estimate moose abundance and bull:cow ratios in portions of the park since 1992, and have used a modified version that accounts for sightability of animals in 3 survey units (Fig. 1) since 2003. Estimated numbers of moose decreased during the 2 years of surveys in Unit 1 (199 ± 37 [SE] in 2004 to 134 ± 27 [SE] in 2008) and in Unit 3-south (220 ± 29 [SE] in 2003 and 165 ± 24 [SE] in 2007). Bull:cow ratios increased by 12 bulls to 26 bulls:100 cows in Unit 1 and remained stable at 53-54 bulls:100 cows in Unit 3-south. There were an estimated 384 ± 72 (SE) moose and 41 bulls:100 cows in Units 2 and 3 north during 2005. KATM does not currently have a park-specific monitoring program for moose, although its staff have cooperated with other agencies to monitor moose population trends on the Alaska Peninsula.

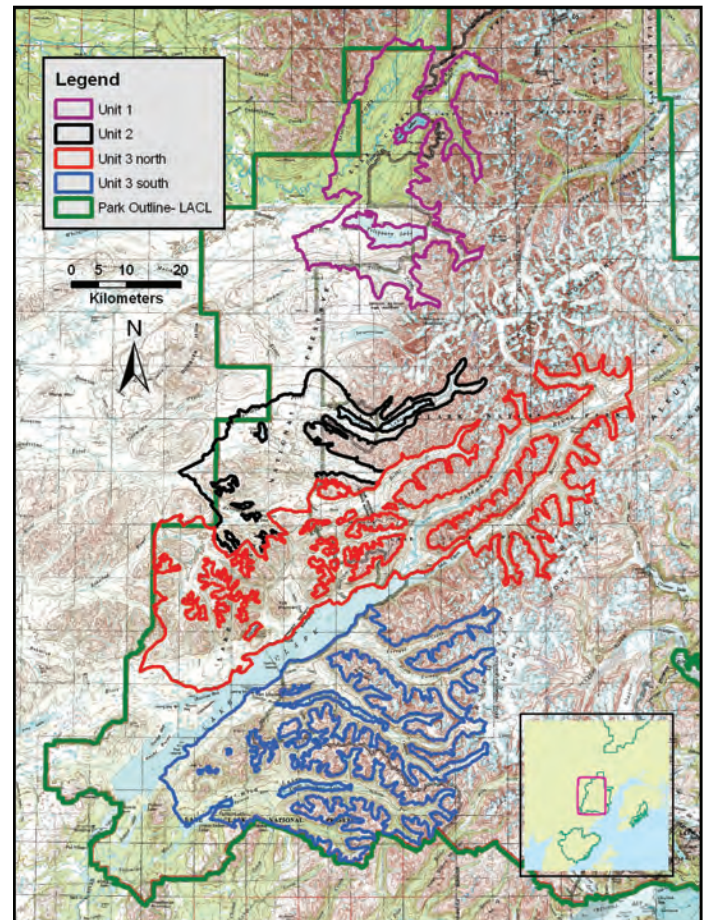


Figure 1. LACL moose survey units.

Discussion

The aerial survey method used by LACL for estimating moose abundance and bull:cow ratio does not translate well for use in KATM, because snow cover is more variable and patchy in KATM. A newer and more flexible survey method developed by statisticians from ADF&G will be field tested in KATM to assess its usefulness for monitoring KATM moose populations.

Contacts

Buck Mangipane, LACL/SWAN, buck_mangipane@nps.gov
Tammy Olson, KATM, tammy_olson@nps.gov,
Bill Thompson, NPS-SWAN, bill_thompson@nps.gov



Bull moose observed during LACL aerial survey.

National Park Service
U.S. Department of the Interior



Southwest Alaska Network

Inventory & Monitoring Program

240 West 5th Avenue

Anchorage, AK 99501

<http://science.nature.nps.gov/im/units/swan/>

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 953/100532, October 2009

National Park Service
U.S. Department of the Interior



Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov