Integrated Services Plan

ARCTic

NOAA'S
ALASKA
REGIONAL
COLLABORATION
TEAM

Extending to the Arctic, Alaska's culturally diverse people, infrastructure, economy, and ecosystems are already experiencing the effects of climate change. Obtaining a better understanding of these early impacts will provide an integration of science and decision-making for adaptation on a global scale.

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NOAA

Executive Summary

NOAA's Alaska Regional Collaboration Team (ARCTic) initiated an effort in 2007 to develop an approach for strategic product and service enhancements. In concert with agency partners, the team assessed current NOAA services within the Alaska Region and built mechanisms to strengthen and promote stakeholders relations. The Integrated Services Plan (ISP) documents this effort and identifies future scenarios and trends NOAA should plan for in the Alaska Region. The plan covers background on the regional team, team accomplishments, trends occurring in the state of Alaska, twenty two scenarios for NOAA planning, and a summary of three overarching topics NOAA should address.

The ARCTic was established in the fall of 2006. It consists of employees of the National Weather Service, National Marine Fisheries Service, National Ocean Service, National Environmental Satellite Data and Information Service, and Office of Oceanic & Atmospheric Research. As a part of the team's work plan for fiscal year 2007, the ARCTic developed a prospectus for bringing together the agency and customers to build cross-awareness, assess the agency's activities, and identify the joint goals NOAA and its customers share. This project, involving both an Integrated Services Assessment (ISA) and the Integrated Services Plan (ISP), is expected to be just the beginning of a living and evolving process.

Eight ARCTic regional working groups were established as the structure for conducting the assessment. These working groups met during the fall of 2007 and developed a set of vision papers that described what the members either expected to happen in Alaska (e.g., movement of fish stocks north of the Bering Strait) or wanted to make happen (e.g., reduction in aviation fatalities). This plan includes 22 planning scenarios that are based on the vision papers. They form the bulk of the document and serve as nuclei for short term collaborations and long term plans.

The 22 planning scenarios described in this plan and organized by NOAA Goal are:

Climate
- Alaska Climate Services Partnership
- Climate Change Impacts – Observing and Monitoring
- Coastal Erosion Collaboration

Weather & Water
- Aviation Weather
- Aviation Services – Unmanned Aircraft Systems

Integrated Water Resources – Precipitation Frequency Estimates
- Integrated Water Resources – Climate Change Impacts
- Sea Ice Decision Aids, Ecosystem Impacts, Analysis, and Observation Program

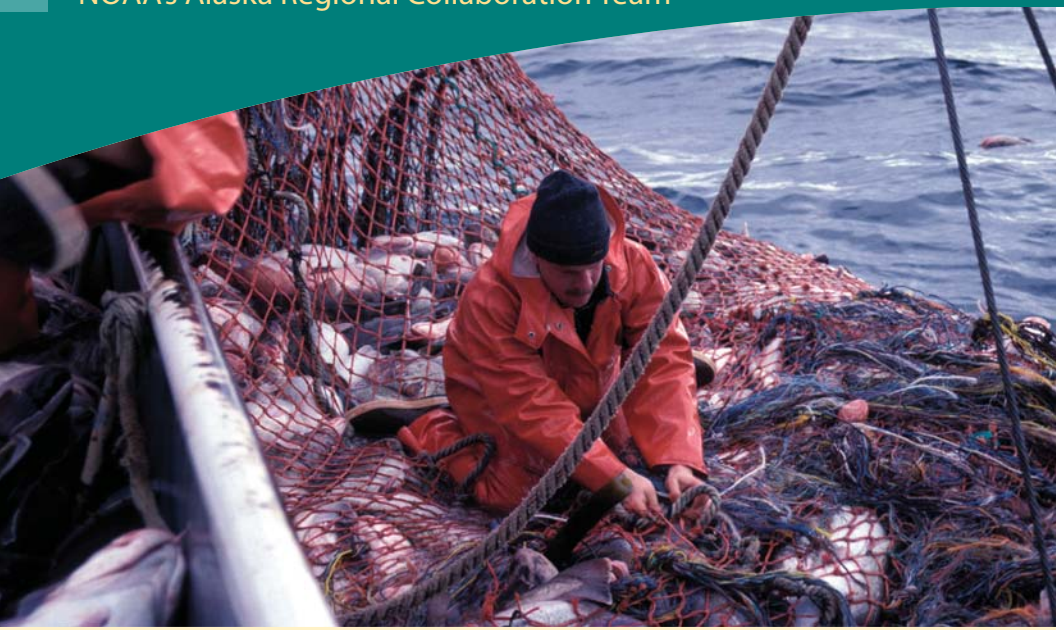
Commerce & Transportation
- Marine Navigation & Safety
- Mapping and Reference Framework for Alaska
- Bering and Chukchi Sea Oil and Gas Development
- Alternative Energy Support

Ecosystems
- Arctic Fisheries
- Ocean Acidification
- Integrated Ecosystem Assessments for Coastal Alaska
- Improving Coastal Observations in Alaska
- Ecological Forecasting for Coastal Change

Mission Support
- International Law of the Sea Treaty
- NOAA Ocean Environmental Literacy/Planet Earth Curriculum

All of these scenarios call on NOAA to do three things: (1) provide leadership in climate services; (2) invest in foundational infrastructure such as geodetic control that underpins other work; and (3) further expand regional collaboration with a particular emphasis on enhancing NOAA-state and cross federal agency engagement.

NOAA's Alaska Regional Collaboration Team



Alaska's rich marine ecosystem has some of the most productive and sustainable fisheries in the world

Within the agency, the ISP will provide input to NOAA Strategic Planning; the agency's annual Planning, Programming, Budgeting, and Execution System (PPBES) process; and as the driver for the ARCTic's annual work plans. Externally, we plan to use it as a basis for dialog on how to address regional issues in collaboration with partners. We hope this document will foster a rich discussion that will ultimately lead to greater internal and external collaboration, better NOAA services in the Alaska Region, and ultimately the achievement of common goals.

Introduction & Background

The Arctic is a vast, largely unknown region on the planet. As America's Arctic state, Alaska has a valuable contribution to better understanding climate change in the Arctic and across the globe. Global climate models have projected that the Arctic is an area where changes to the climate may be the largest in the world. The models predict a greater warming for the Arctic than the rest of the world and Alaska arctic and subarctic regions are already experiencing environmentally and economically-significant climate change. Observed data indicate that over the last 50 years, mean annual surface temperatures have increased 3-5 °F with some of the largest increases occurring along Alaska's North Slope. The extent of the sea ice reached an all time low in September 2007, shattering the previous record in 2005 by 23 percent. It was also 39 percent below the long-term average from 1979 to 2000. Additionally, winter freeze up and spring melt is now arriving more than three weeks later and earlier, respectively. Some waters around Alaska are showing an increase in sea level. On land, an increased seasonal thaw depth of the active layer is causing accelerated permafrost thaw. There is increasing evidence of changes in storm frequency and intensity, as well as shifts in storm tracks.

These observations are consistent with what is expected from warming arctic conditions and indicate how climate change may affect weather patterns and human activities. For example, there is a greater incidence of aviation icing conditions especially along the coasts of the Bering and Chukchi Seas. There are more frequent high amplitude weather episodes such as coastal sea ice breakouts and interior thaws; heavy precipitation causing local flooding; low water events affecting river transportation and subsistence; episodic high wind events; and more variable weather affecting forests and resulting in a record 2004 wildfire season where 6.5 million acres burned. In addition, lakes are shrinking and in cases catastrophically draining and winter/spring temperatures are increasing.

In the face of such a broad range and magnitude of changes, an assessment of the National Oceanic and Atmospheric Administration's (NOAA) current products and services is critical to understanding and anticipating evolving stakeholder requirements and ensuring NOAA is prepared to meet current and future needs. This document incorporates NOAA's ARCTic initial Integrated Services Assessment (ISA) into an Integrated Services Plan (ISP) which presents a vision for future agency services.

NOAA's Alaska Region

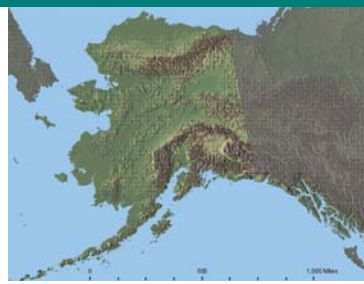
Extending into the Arctic, Alaska's culturally diverse people, infrastructure, economy, and ecosystems are already experiencing the effects of climate change. Obtaining a better understanding of these early impacts will provide an integration of science and decision-making for use not only in Alaska but also in adaptation strategies employed in the U.S. and around the world. The geography and environment in Alaska, also known as "The Great Land" or "The Last Frontier," is surrounded by the Pacific Ocean, Bering Sea, Chukchi Sea, Beaufort Sea, and the Arctic Ocean. While Alaska is geographically isolated from the contiguous 48-states, it is internationally connected and the only U.S. state to border two nations. The geographic scale of the state becomes evident when one considers Alaska is over twice the size of Texas and represents 54 percent U.S. coast and 66 percent U.S. continental shelf. Ninety-nine percent of the land area is federal, state, local or native corporation land. Sixty-five percent of all U.S. parklands and 80 percent of all wildlife refuges are in Alaska.

Alaska holds many records and unique landmarks such as North America's biggest earthquake and tsunami (the 9.2 magnitude Good Friday Earthquake of 1964 and resulting 115 foot tsunami and the 1,733 foot tsunami in Lituya Bay in 1958), the Nation's greatest concentration of glaciers, North America's tallest mountain (Mount McKinley at 20,320 feet), the Nation's farthest-north city (Barrow), and more than 40 active volcanoes.

Social and Economic Context

Alaska's strategic air and waterways present challenges and opportunities in terms of homeland security and economic development. The Ted Stevens Anchorage International Airport is ranked first in the U.S. for landed weight of cargo aircraft, and third in the world for cargo throughput. While over half of Alaska's population lives in the three largest cities, many people live in communities not connected by roads. These communities rely on aviation for year-around access. Alaska's rich marine ecosystem has some of the most productive and sustainable fisheries in the world (~$4 billion in 2006, about half of the U.S. catches). The Bering Strait is a 53-mile wide chokepoint that links both the Northwest and Northeast arctic passages for northern Asian, Russian, and European commerce. The Aleutian Islands serve as a major corridor for the Great Circle Route linking commerce from the U.S. west coast to southern Asia. No other marine system in the U.S. has such extreme weather and climate (environmental hazards), vast geographic distances (larger than the combined U.S. marine system), and an extensive coastline (~44,000 miles).

Alaska has extensive oil and gas reserves essential to the Nation's economy and national security. The Alaska Oil Pipeline loses approximately $1 million per hour during a shutdown. Prudhoe Bay, located on Alaska's Beaufort Sea coast, is one of the largest oil fields in the world. New development opportunities exist along the coast and in the Chukchi Sea, as evidenced by the 2008 Oil and Gas Lease Sale that generated more than $2.6 billion in revenue to the U.S.



Capabilities and Challenges

NOAA is leveraging and enhancing its diverse set of partnerships to proactively prepare for and respond to the potential immediate and future impacts of climate change on people, societal infrastructures, local/regional economies, and ecosystems. Climate change is already impacting our environment, seasons, and communities. Observable changes, many of which have regional and global implications, are underway across the Arctic. These changes are affecting the health, lives, and livelihoods of Alaskans, including the Alaska Native culture that is fundamentally threatened by climate change. NOAA is prioritizing and developing a baseline of observations and services to effectively monitor, evaluate, and assess climate change and variation in the Arctic Region. These include increases in weather monitoring, improved air quality sampling, improved ocean monitoring, an improved geo-spatial reference system (both horizontal and vertical), updated hydrographic surveys in high priority and emerging critical areas, and improved tide and current predictions to name a few. On the biological side, there are expanded opportunities and challenges in NOAA's marine ecosystems monitoring and man-

agement (fish and mammal). Assessing, monitoring, and predicting the responses of coastal and marine ecosystems in Alaska to the loss of sea ice and ocean acidification are primary initiatives related to this effort. In addition, further tsunami monitoring, research, and inundation modeling continues to be a priority.

NOAA's Regional Collaboration Initiative: http://www.ppi.noaa.gov/regional_collaboration.htm)

Components of NOAA have been serving Americans for over 200 years. Nautical charts have been produced since 1807, weather forecasts since 1870, and fisheries stewardship began in 1871. In 1970, these organizations were brought together under one agency to observe, predict and protect our environment.

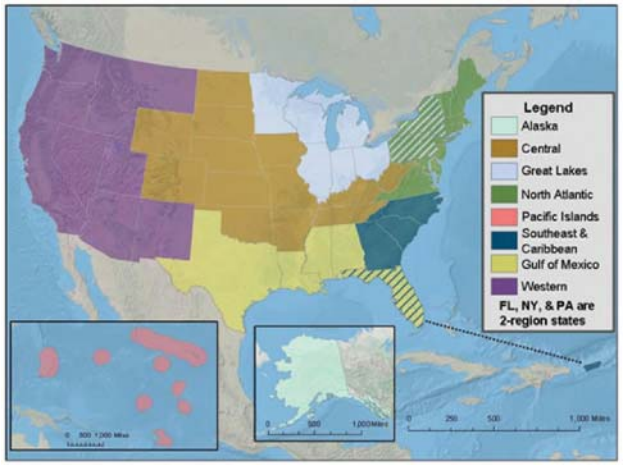
In the Executive Order establishing NOAA, President Nixon, declared:

> "The oceans and the atmosphere are interacting parts of the total environmental system upon which we depend not only for the quality of our lives, but for life itself. We face immediate and compelling needs for better protection of life and property from natural hazards, and for a better understanding of the total environment – an understanding which will enable us more effectively to monitor and predict its actions, and ultimately, perhaps to exercise some degree of control over them."

These words ring as true today as they did almost 40 years ago and underscore the interrelationship between the issues NOAA addresses and thus the need for the components of the agency to combine forces to achieve together what none of them could accomplish alone. Understanding and dealing with climate change is a case in point. To protect the fisheries that provide our nourishment, livelihoods, and recreation, it will take an understanding of the connections between weather, oceanography, biology, and other disciplines. Will the habitat our marine resources need to survive and prosper change due to increasing melt water from glaciers, sea level changes, water temperatures, ocean and bay chemistry and current patterns, etc.? It will take the combined strength of all NOAA entities and external partners to address these and other questions to develop more accurate predictions and forecasts, mitigate climate impacts and assist society in planning for the future.

For all the contributions NOAA has made to the Nation and the world, much more can and will be done to enhance the knowledge and understanding of the earth's climate system through improved integration of its assets and expertise toward current and future environmental and economic challenges. NOAA's Regional Collaboration Initiative is designed to identify shared internal and external regional interests and goals as the focal point to address regionally-distinct priorities bringing to bear the full breadth of NOAA's capabilities.

The roots of this initiative date back to 2002 and 2003, when the NOAA Administrator established five regional pilot programs to improve coordination within the agency and raise NOAA's visibility to its constituents. Four years later in 2006, NOAA Leadership assessed the pilot programs and provided guidance to establish the Regional Collaboration Initiative. Believing that it is at the regional scale that NOAA can blend the place-based needs of customers and partners with its priorities and responsibilities as a federal agency, eight geographic areas were identified for this effort and teams of key individuals from each of NOAA's line offices were established.



The guiding principles set forth for the regional and priority area task teams are the following: (1) NOAA will advance its goals for regional collaboration through existing authority and accountability structures. This effort does not entail changes to NOAA's organizational structure. (2) The overarching purpose of regional collaboration is to improve NOAA's productivity and value to customers. (3) All those participating in this effort will strive to identify, acknowledge, and apply NOAA's full range of capabilities, within and across regions, as needed to improve NOAA's productivity and value to customers.

Priority Area Task Teams (PATT)

As part of this effort, NOAA also identified four national strategic priorities to advance through regional collaboration: Hazard Resilient Communities, Integrated Ecosystem Assessments, Integrated Water Resources Services, and Outreach and Communications. For the Alaska Regional Team, that means putting NOAA expertise and resources toward erosion and flooding; conducting a wide-scale assessment of Alaska marine ecosystems; investigating the impacts of glacier, permafrost melt, and droughts on our air and river transportation systems and fire seasons, and improving outreach and education efforts across Alaska, such as greater use of the university's Sea Grant Program and curriculum development with the university and school districts.

NOAA is already actively engaged in many high priority partnership activities in the regions and Alaska is no exception. This regional collaboration effort, though, will strengthen NOAA's ability to support those existing activities and, in addition, develop new ways to add value in the regions. Nationally, all teams were given the overarching task to establish closer relationships with external stakeholders and partners and improve the effectiveness, value, and utility of NOAA's information, products and services. In Alaska, the team took this and the agency's history of collaboration within the state to heart and developed a strategy leading to expanded internal and external interactions and the development of this document. This ISP is a first look at the future of NOAA in Alaska and the new areas where the agency should invest in response to emerging changes to regional, national, and economic interests and opportunities.

Alaska holds many records and unique landmarks such as the North America's largest earthquake and tsunami, the greatest concentration of glaciers, North America's highest mountain, the Nation's northern most city, and more than 40 active volcanoes

NOAA's Alaska Regional Collaboration Team (ARCTic)

NOAA's Alaska Regional Collaboration Team was formed in late 2006 and consists of employees of the National Weather Service, National Marine Fisheries Service, National Ocean Service, National Environmental Satellite Data and Information Service, and Office of Oceanic & Atmospheric Research. Our purpose is to develop and implement strategies for addressing priority areas as appropriate for Alaska. We do this by:

1. Establishing supporting teams and ad hoc working groups as necessary to identify priority areas and achieve the goals of this effort.

2. Acting as the primary channel of communication of the effort to NOAA programs, offices, and employees within their region.

3. Identifying needs of regional customers, stakeholders, and partners.

4. Working with the Priority Area Task Teams, external partners, and each other to develop and implement strategies for addressing the national programmatic priority areas and other priority areas as appropriate for the region.

5. Developing and implementing an Alaska-specific outreach and communication strategy.

6. Participating in the NOAA National Outreach and Communications Task Team.

7. Participating in the four programmatic areas (Hazard Resilient Communities, Integrated Ecosystem Assessments, Integrated Water Resource Services, and Outreach and Communications) as appropriate for the region.

ARCTic focuses on Aviation Weather; Climate Change; Ecosystem Assessment; Communications, Education, & Outreach; Integrated Water Resources; Marine Navigation and Safety; Remote Sensing and Technological Innovation; and Sea Ice with internal and external partners and customers through the working groups based on the issues above established through the Integrated Services Assessment and Plan (ISA/P) process, as well as existing networks and mechanisms.

Participants in the ISA represented a cross-section of these disciplines:

- Climate
- Ocean and Atmospheric Observations
- Research (Basic and Applied)
- Search and Rescue (SAR)
- Oceanography (Open Ocean & Coastal) – Physical (includes Chemical) and Biological (Open, Coastal, Estuaries)
- Tsunamis, Coastal Currents, and Fresh Water Discharge
- Native and Cultural
- Transportation – Aviation, Marine, and Land
- Homeland Security, Emergency Management
- Mapping, Charting, and Geodesy (MC&G)
- Marine (Biological) Sciences
- Hydrology
- NOAA Informational Services (Weather & Climate)
- Social-Economic Sciences
- Communications

Overview of the ARCTic ISA/ISP Process

Adoption of ISP as an ARCTic Activity

The initial guidance to the NOAA regional teams was simple: respond to new external stakeholder and partner demands and improve the effectiveness, value, and utility of NOAA's products and services. As a part of the work plan for fiscal year 2007, the ARCTic developed a prospectus for bringing together the agency and customers to build cross-awareness, assess the agency's activities, and identify the joint goals we and our customers share. This project, known as the ISA/P is expected to be just the beginning of an evolving process.

Methodology

The ARCTic identified three objectives for the project:

1. Assess current NOAA services within Alaska Region with a focus on consistent services and service requirements. The partners we engage for input should include experts encompassing all aspects of NOAA's Alaska Region service areas with an emphasis on weather, climate, marine, and aviation elements.

2. Strengthen and promote open relations with key stakeholders.

3. Develop an approach for strategic product and service enhancements in concert with key partners and stakeholders.

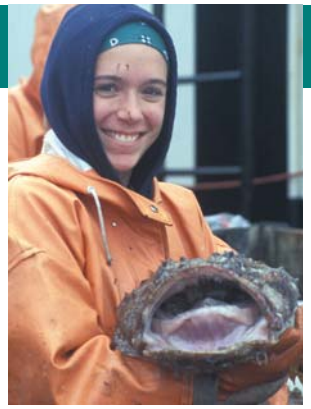
To meet these objectives, the project was divided into two phases: the ISA and the ISP.

Integrated Services Assessment (ISA)

The ISA consisted of workshop style meetings with external customers and compiling information from many Alaska focused sources including the Arctic Climate Impact Assessment, the Arctic Observing Network, the NOAA Alaska Regional Integrated Science and Assessment (RISA) Program, the Arctic Marine Shipping Assessment, the Alaska Ocean Observing System, our Hydrographic Working Group, our Satellite Sensor User Group, and the multi-agency Statewide Digital Mapping Initiative.

The first meeting was held August 15-17, 2007 at the NOAA/NOS Kasitsna Bay Laboratory (KBL) near Seldovia, Alaska. The purpose of the meeting was for the participants to get to know each other's missions and services and develop a structure for assessing where NOAA should collaborate and invest in the region's future. This accomplished the first 2 of 3 components of the ISA and set the course for the third.

Eight ARCTic regional working groups were established as the structure for conduct-



Alaska provides half of all U.S. seafood

Assessing, monitoring, and predicting the responses of coastal and marine ecosystems in Alaska to the loss of sea ice and ocean acidification are primary initiatives for NOAA

ing the assessment, which resulted in a set of vision papers that describe different aspects of Alaska's future (10-20 years) and what NOAA's role can be in these areas.

The eight working groups are: Aviation Weather; Climate Change & Impacts; Communications, Education & Outreach; Ecosystem Assessment; Integrated Water Resources; Marine Navigation & Safety; Remote Sensing; and Sea Ice. Participation in the working groups varies and includes ARCTic team members, participants from the KBL meeting, and additional internal and external specialists who bring topical knowledge and capabilities to the discussion.

Each Vision Paper consists of the following components:

- Vision

The world as it would be/as we would like to see it.

- Background

Sets the background and/or context of the vision.

- Objective

Objectives that if accomplished would help achieve the vision.

- Mission (NOAA's Role)

NOAA's role in achieving the vision; addresses what the Agency can control.

- Gap Analysis

Where we are vs. where we need to be.

- Immediate Actions

What we can do/are doing now and in the near future.

- Benefits & Risks

Benefits of filling the gap and risks associated with both taking actions to fill the gap as well as the consequences of not taking action.

Draft Vision Papers developed by the working groups were reviewed at the second ISA meeting held at the Federal Building Annex in Anchorage, Alaska, October 30-31, 2007. This meeting provided the input for the development of the ISP.

Integrated Services Plan (ISP)

The ISP was developed from November 2007-January 2008 by NOAA ARCTic members. It describes the ISA/P process and recommends areas for investment for NOAA between now and 2020. This document is strategic in nature and, as such, does not constitute commitments to specific activities or budgets. It is, however, intended to inform and guide NOAA planning, programming, and budgeting as well as give a focus for existing resources and activities.

Intended Uses of the Plan

The ARCTic expects this plan will be used both internally and externally to NOAA. We see it as a starting point to foster further discussions on these and other subjects with customers and NOAA Staff. As it evolves, we will use it internally as input to NOAA Strategic Planning; the agency's annual Planning, Programming, Budgeting, and Execution (PPBES) process; and the ARCTic's Annual Work Plan. Externally, the members of the team intend to use the ISP as a focus for cross-NOAA relationships with customers. The intent is to capture the shared visions well enough that they will be used in customer plans and meetings, and foster and solicit collaboration from additional persons and entities that can help Alaskans to reach shared goals and objectives.

This document is the culmination of the initial ISA/P effort and provides the ARCTic's view on areas for future NOAA investment in Alaska. It serves as a beginning of the dialog on the regional issues and provides a means of developing a joint pathway to address Alaskan regional concerns.

Current NOAA Services in Alaska

National Weather Service (NWS)

NOAA NWS Alaska Region's mission is to provide weather, hydrology and climate forecasts, and volcanic ash and tsunami warnings for the state of Alaska and its surrounding waters for the protection of life and property and the enhancement of the national economy.

The NWS Alaska Region is comprised of three Weather Forecast Offices (WFOs), 12 Weather Service Offices (WSOs), the Alaska-Pacific River Forecast Center (APRFC), the Alaska Aviation Weather Unit (AAWU), the Anchorage Center Weather Service Unit (CWSU), the West Coast and Alaska Tsunami Warning Center (WC/ATWC), the Anchorage Electronics Unit (AEU) and the Alaska Region Headquarters (ARH).

The Alaska Region Headquarters staff manages all operational and scientific meteorological, hydrologic, and oceanographic programs of the region including observing networks, weather services, forecasting, climatology, and hydrology. Some of the unique services provided by our Alaska Region offices include:

- Operation of the U.S. Tsunami Warning System via the West Coast and Alaska Warning Center (WC/ATWC) in Palmer. The WC/ATWC provides tsunami warnings for coastal communities and leads tsunami hazard mitigation efforts in the form of preparedness, education, and training for the Canadian coastal regions and ocean coasts of all of U.S. States except Hawaii.
- Operation of the Alaska Aviation Weather Unit (AAWU), which provides detailed aviation forecast products for all of Alaska. The AAWU also manages the Anchorage Volcanic Ash Advisory Center (VAAC) - one of only nine such centers worldwide. The Anchorage VAAC's forecast and warning responsibilities include the Anchorage Flight Information Region and far eastern Russia.
- Production of the television show "Alaska Weather", a cooperative effort with public television station KAKM in Anchorage. This daily 30-minute show (the only one it its kind in the country) provides a detailed depiction of weather across Alaska and is hosted by one of our meteorologists from the Anchorage WFO.
- An extensive marine forecast and warning area, which spans from the Canadian Border to the Russian Border and from Dixon Entrance (55 degrees North latitude) north. This includes the Gulf of Alaska, the Bering Sea/Aleutian Islands, and the Arctic Coast.
- Operation of an Ice Forecast Desk within the Anchorage WFO. This Ice Desk produces graphical analyses of sea surface temperatures and sea ice as well as five-day sea ice forecasts throughout the year.

To find additional information on NOAA's NWS offices in Alaska please reference the following link: http://www.arh.noaa.gov/wxoffices.php.

NOAA Fisheries Service

NOAA Fisheries' mission in Alaska supports the NOAA strategic goal of ecosystem management. The Alaska Ecosystem Complex is composed of 4 recognized Large Marine Ecosystems (LMEs) (Beaufort, Chukchi, Bering, and Gulf of Alaska). The agency's current priorities and services in Alaska

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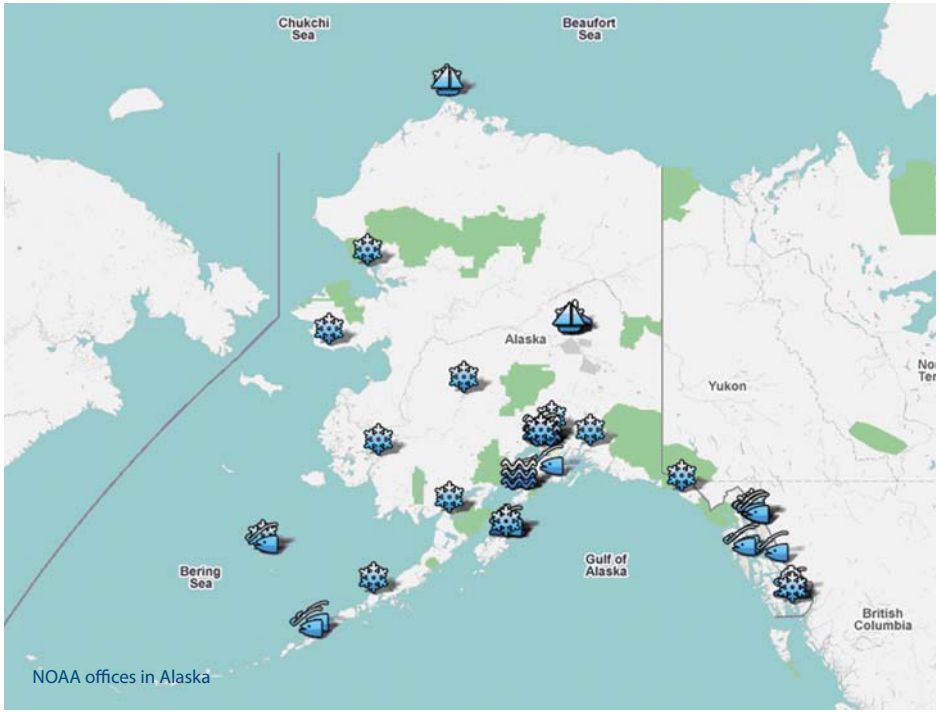
include:

- Fishery research, management and enforcement in the Federal waters of the U.S. Exclusive Economic Zone (3-200-mile zone off Alaska).
- Carrying out NOAA's marine resource stewardship mission through robust fishery and marine mammal research programs.
- Contributing to NOAA's understanding of Climate Change, particularly related to loss of sea ice off Alaska and its impacts to marine resources.
- Guiding regional fishery management in close collaboration with the North Pacific Fishery Management Council, a federal advisory body established by Congress.
- Implementing five Secretary of Commerce approved Fishery Management Plans.
- Incorporating ecosystem approaches to management, relating multispecies and habitat interconnectivity.
- Fulfilling in-season management responsibilities for halibut and sablefish Individual Fishing Quota (IFQ) programs.
- Expanding Market-Based Management Systems (LAPPs, IFQ, CDQ, Cooperatives) to generate economic stability to fisheries and fishery dependent communities.
- Conducting fish and marine mammal stock assessment surveys and fishery observer programs.
- Carrying out NOAA's co-management responsibility under MMPA and ESA for the sustainable harvest of marine mammals by Alaska Natives.
- Protecting and restoring essential fish habitat.
- Consulting with other agencies on living marine resources issues. Expanding permit application and review cabability.
- Coordinating, reviewing and providing comment on Corps of Engineers, Department of Transportation, Minerals Management Service, and other agencies resource development projects.

The organization's regional headquarters is in Juneau with field offices located in Anchorage, Kodiak, Dutch Harbor, and St Paul. Research components are located at NOAA Fisheries laboratories in Juneau, Sitka, Kodiak, and Seattle, Washington. Enforcement offices are located in Homer, Ketchikan, Petersburg, Seward, and Sitka.



NOAA offices in Alaska

Office of Marine and Aviation Operations

NOAA Office of Marine and Aviation Operations operate a wide variety of specialized aircraft and ships to complete NOAA's environmental and scientific missions. Aircraft are managed by the Aircraft Operations Center (AOC), located at MacDill Air Force Base in Tampa, Florida. Ships are managed by the Marine Operations Center (MOC) and located in various locations around the United States including two vessels located in Alaska, one home ported in Kodiak, AK, and another in Ketchikan, AK.

NOAA Ship MILLER FREEMAN and NOAA Ship OSCAR DYSON primarily support fisheries and ecosystem monitoring including Pollock, Cod, and Hake stock assessments, marine mammals surveys, as well as essential fish habitat monitoring. NOAA Ship RAINIER and NOAA Ship FAIRWEATHER primarily support nautical charting efforts along Alaska's 44,000 mile of coastline, some of which has never been surveyed. In addition to their primary focus, many of these vessels conduct projects in support of weather and Tsunami warning buoy deployments.

Five NOAA aircraft support projects across the main NOAA line offices. Projects complete in 2007 include:

- Winter Storms Project for NWS and NESDIS
- Snow Survey mission for NWS
- Alaska Airport Surveys for NOS
- Steller Sea Lion survey for NMFS
- Alaska Harbor Seals survey for NMFS
- Beluga Whale survey for NMFS
- Bowhead Whale Feeding Study(BOWFEST) for NMFS
- Bowhead Whale Aerial Survey Program (BWASP) for Department of Interior-Minerals Management Service with observers from NMFS onboard.

In other years, NOAA Aircraft have worked on Lidar Hydrographic surveys for NOS and air quality monitoring for OAR.

National Ocean Service

The National Ocean Service (NOS) products and services in Alaska include: real-time water level observations and tide predictions; coastal meteorological, water temperature and current data; navigation services (hydrographic surveys, nautical charts, navigation response teams); oil and chemical spill response; geodetic services, and coastal ocean science. NOS physical assets in the state include: the Kasitsna Bay Laboratory; Port of Anchorage Physical Oceanographic Real-Time System (PORTS®); and National Water Level Observation Network (NWLON) stations. NOS also provides operational support for the Kachemak Bay National Estuarine Research Reserve (KBNERR), which is operated by the Alaska Department of Fish and Game, Sportfish Division. NOS has relatively few employees based in Alaska, but provides many services to Alaska from out-of-state offices. NOS also provides extensive imagery and other data sets for Alaska, such as coastal photography, nautical charts, coastal survey maps, environmental sensitivity index maps, hy-

Climate change is already impacting our environment, seasons, and communities. Observable changes, many of which have regional and global implications, are underway across the Arctic

drographic surveys, estuarine bathymetry, and geodetic control points. Metadata for this information and access to many of the data sets are available via the Internet.

The Kasitsna Bay Laboratory (KBL) is the only NOS-owned and operated facility in Alaska. KBL is the Alaska field laboratory of the Center for Coastal Fisheries and Habitat Research, under the National Centers for Coastal Ocean Science (NCCOS). NCCOS partners with the University of Alaska Fairbanks (UAF) to conduct collaborative research and education activities at the laboratory. KBL research focuses on understanding the response of subarctic coastal and estuarine ecosystems to change – particularly climate variability, land and resource use, and extreme events. The mission is to provide federal, state, local and tribal agencies with the information, tools, and training needed for scientifically-based resource management, using an integrated approach to understanding the ecosystem. Research areas include: trophic dynamics, marine biodiversity, fish habitat, coastal monitoring, mariculture, cold water diving and application of emerging underwater technology to ecosystem assessment. KBL supports field and laboratory studies with flowing seawater and dry laboratories, a scuba facility for year-round cold water diving, dock, small boats, and housing for up to 48 people. The laboratory also supports formal and informal marine science education and outreach activities, to include graduate and undergraduate classes and research, as well as K-12 programs.

At 365,000 acres of lands and waters, the KBNERR is the largest of 27 reserves in the National Estuarine Research Reserve System and encompasses vast subtidal zones, intertidal expanses, extensive marsh systems and terrestrial forests. The KBNERR mission is to enhance understanding and appreciation of the Kachemak Bay estuary and adjacent waters to ensure that these ecosystems remain healthy and productive. Research priorities include: larval and juvenile fisheries recruitment and life history dynamics, coastal dynamics (natural and anthropogenic), land use change, natural hazards, ocean productivity, and long-term water quality monitoring. The reserve offers a variety of educational programs and activities targeted at coastal decision makers, K-12 students and teachers, as well as residents and visitors to the local area. For additional information on Kachemak Bay Reserve, please visit: www.kbayrr.org.

The NOS Center for Operational Oceanographic Products and Services (CO-OPS) operates 24 long-term continuously operating tide stations in the state of Alaska which provide data and information on real-time water level, tidal datums and relative sea level trends, and which are capable of producing real-time data for tsunami and storm surge warning. These stations are located at Ketchikan, Port Alexander, Sitka, Juneau, Skagway, Elfin Cove, Yakutat, Cordova, Valdez, Seward, Seldovia, Nikiski, Anchorage, Kodiak, Alitak, Sand Point, King Cove, Adak, Nikolski, Atka, Unalaska, Nome, Red Dog Dock (north of Kotzebue) and Prudhoe Bay. NOS also provides tidal water level and current predictions for coastal stations. Historical water level and current information is available for stations occupied for shorter durations. Several short-term tide stations are also occupied in Alaska each year by CO-OPS in partnership with Office of Coast Survey and National Geodetic Survey. These gauges provide vertical control for hydrographic surveying and shoreline mapping surveys, and also establish or validate datum reference bench marks and provide data and information for tidal predictions and other coastal applications.

CO-OPS' National Current Observation Program has been in Alaskan waters since 2001 collecting currents data and updating historic tidal current predictions for publication in the US Tidal Current Tables. Over 150 predictions in areas such as Cook Inlet, Prince William Sound and Southeast Alaska have been updated or added to the tables, including the addition of new reference stations. In FY08, CO-OPS is deploying 50 current meters in northern Southeast Alaska and will update the 100-year old reference station at North Indian Pass. In FY09 and FY10, CO-OPS will measure currents and predict tidal currents at over 40 locations in Kodiak, Afognak and Dutch Harbor, including Unimak Pass. In future years, CO-OPS will measure currents in the outer Aleutian Island chain. In 2003 and 2004, CO-OPS deployed HF-Surface Current Mappers (HF-SCM) to better understand the surface current movement in Cook Inlet. In FY09, CO-OPS intends to deploy HF-SCM in Prince William Sound to assist with AOOS efforts and hopes to use that data to update predictions in the Tables as well.

The Anchorage PORTS®, operated cooperatively between CO-OPS and the local maritime community in the Port of Anchorage, provides quality-controlled data which is disseminated in real-time to local users for safe and efficient navigation. The Anchorage system currently includes water level and meteorological measurements at two stations, in Anchorage and Nikiski.

The NOS Office of Coast Survey maintains a regional presence in the field to serve its customers and act as ambassadors to the maritime community. The Navigation Manager for Alaska is based in Anchorage and focuses primarily on resolving charting and navigation questions, educating constituents on emerging charting technologies and their uses, and soliciting feedback on NOAA's navigation products and services from the commercial maritime industry. The navigation manager also helps to identify the challenges facing marine transpor-

Understanding climate change impacts will provide an integration of science and decision-making for adaptation on a global scale

There are expanded opportunities and challenges in NOAA's marine ecosystems monitoring and management

tation. These agents assist the Coast Survey in overseeing NOAA's nautical chart data collection and information programs to meet constituent needs for information to navigate safely and efficiently.

The Geodetic Advisor is a jointly funded NOS employee that resides in the state to provide liaison between NOS and the host state. The Geodetic Advisor guides and assists the state's charting, geodetic and surveying programs through technical expertise. This program also provides technical assistance in planning and implementing Geographic/Land Information System: (GIS/LIS) projects. Currently the NOS Navigation Manager for Alaska is also serving as the Geodetic Advisor.

NOAA's Scientific Support Coordinators (SSC) provide guidance to reduce risks to coastal habitats and resources from oil and hazardous chemical spills. The Alaska SSC is based in Anchorage and works directly with U.S. Coast Guard spill response teams by providing critical scientific support to the federal On-Scene Coordinator (OSC) during spills of oil or hazardous materials. SSCs use oil spill trajectory estimates, chemical hazards analyses, and assessments of the sensitivity of biological and human-use resources to help the OSC make timely operational decisions. SSCs provide guidance, experience, and resources to develop spill preparedness plans that help identify the spill response action with the greatest environmental benefit.

The National Status and Trends (NS&T) program, run by the NCCOS Center for Coastal Monitoring and Assessment, includes Mussel Watch and Benthic Surveillance projects in Alaska. Mussel Watch is the longest continuous contaminant monitoring program in U.S. coastal waters, analyzing chemical and biological contaminant trends in sediment and bivalve tissue collected at over 280 coastal sites from 1986 to present. There are eleven sites that have been monitored in Alaska, with five sites in southeast Alaska, Prince William Sound and Homer that are currently monitored on an ongoing basis. Additional Mussel Watch sites are being collected to improve spatial coverage for the resource management and public health needs of state agencies (ADF&G, DEC) and Alaska Native organizations. The Benthic Surveillance Project analyzed chemical and biological contaminant trends in sediment and fish tissue collected at 183 coastal sites from 1984 to 1993. The database includes: sediment, fish liver and fish bile chemistry for over 100 organic and inorganic contaminants, and associated diseases in the fish livers. There are twelve previously sampled Benthic Surveillance sites in Alaska, with 2007 sampling in Kachemak Bay. NS&T data and related assessment reports are available via the Internet (http://ccma.nos.noaa.gov/about/coast/nsandt/welcome.html).

The NCCOS Center for Sponsored Coastal Ocean Research sponsors the Northeast Pacific Global Ocean Ecosystems Dynamic (GLOBEC) research program, which seeks to understand the effects of climate change on the distribution, abundance, and production of marine animal populations in areas important to the regional and national economies.

The NOS Data Explorer provides direct Internet access to primary NOS imagery and data holdings for coastal photography, nautical charts, coastal survey maps, environmental sensitivity index maps, hydrographic surveys, water level stations, estuarine bathymetry, geodetic control points and the Historical Map and Chart Collection. Extensive datasets for Alaska coastal areas can be accessed through this geographic driven search engine at NOS Data Explorer. In addition, NOS is the home of the IOOS Program Office and the Pribilof Islands Environmental Restoration Project.

NOAA's Office of Oceanic and Atmospheric Research

NOAA's Office of Oceanic and Atmospheric Research (OAR) supports NOAA's Ecosystem, Climate, and Weather and Water Goals in Alaska.

Ecosystem-related activities within OAR are conducted by two laboratories: Alaska Sea Grant, the Office of Ocean Exploration and Research, and the National Undersea Research Program. Both the Pacific Marine Environmental Laboratory (PMEL) in Seattle, Washington and the Earth System Research

Laboratory (ESRL) in Boulder, CO, provide fisheries research. PMEL conducts EcoFOCI in the Bering Sea and Gulf of Alaska, in conjunction with the Alaska Fisheries Science Center of the National Marine Fisheries Service (NMFS) and partners at the University of Alaska – Fairbanks, the Cooperative Institute for Arctic Research (CIFAR), and others. The goal of EcoFOCI is to determine the influence of the physical and biological environment on marine populations and the subsequent impact on fisheries. EcoFOCI scientists integrate field, laboratory, and modeling studies to determine how varying biological and physical factors influence large marine ecosystems in Alaska. Providing efficiency to fishery assessments, the Earth System Research Laboratory (ESRL) conducts surveys in the Alaskan coastal waters using NOAA Fish Lidar. The per kilometer cost of a survey using Lidar from a small aircraft is less than 10 percent of a ship survey, and the depth penetration is more than 3 times that of a visual survey.

NOAA's National Sea Grant College Program is a federal-university partnership that integrates research, education, and outreach. Alaska Sea Grant addresses priority coastal and marine issues affecting 54 percent of the U.S. Current research and outreach projects address impacts on the salmon industry, wiser utilization of fisheries, marine environmental issues, economic leadership, and diversification of Alaska's marine economy.

OAR also has a significant undersea research capability. The vision of NOAA's Office of Ocean Exploration and Research (OER) is "to make the unknown ocean known." OER research and discovery missions fit into four areas: (1) mapping the physical, biological, chemical, and archeological aspects of the ocean; (2) understanding ocean dynamics at new levels to describe the complex interactions of the living ocean; (3) developing new sensors and systems for ocean exploration; and (4) reaching out to the public to communicate the benefits to current and future generations of unlocking the secrets of the ocean. OER has sponsored diverse missions to

The Aleutian Islands are a major transit for the Great Circle Route linking commerce from the U.S. west coast to southern Asia

Alaskan and Arctic waters since 2001 to conduct seafloor mapping of geological features and biodiversity in the Arctic and Bering Sea, seamount exploration in the Gulf of Alaska, benthic communities in Bristol Bay, and exploration of shipwrecks in Southeast Alaska, among others.

Complimenting OER, NOAA's Undersea Research Program (NURP) provides undersea scientists with tools and expertise that they need to work in the undersea environment, from the shoreline to the deep sea. NURP is comprised of a network of six regional centers. Based at the University of Alaska Fairbanks, NOAA's Undersea Research Center for the West Coast and Polar Regions (WCPR) supports undersea research and scientific investigation in those areas. Developing a greater understanding of the habitats and life cycles of fisheries, which are a tremendously important resource in these regions, is a priority at WCPR.

OAR's climate-related activities include climate monitoring observatories and networks, short term forecast decision aids and long term climate research.

The Barrow Observatory is one of six baseline observatories supported by the NOAA's Climate Observations and Monitoring Program and operated by the NOAA OAR/ESRL Global Monitoring Division, located in Boulder, CO. The observatories are part of a global network monitoring atmospheric constituents that cause climate change and depletion of the ozone layer. The Barrow Observatory measures ozone, greenhouse gases, stratospheric ozone depleting gases, air quality gases, aerosols, and radiation above the observatory and monitors air pollution (arctic haze) flowing across the Arctic from Eurasia to Alaska. The Barrow Observatory is host to 25 cooperative research projects from various universities and government agencies from around the nation. In addition, ESRL is participating in several long-term climate research programs near Barrow. Radiometers and cloud radars routinely measure important properties of clouds that affect climate such as cloud height, thickness, particle type (ice or water), water content, and ice content. Ultimately, the knowledge of how arctic clouds affect the global climate system will be improved so that better predictions can be made regarding how man and nature might change climate.

Barrow, along with Nome and St. Paul Island, are sites where ESRL operates an ultraviolet radiation (UV) monitoring network. These measurements are taken as part of the ESRL GMD Radiation group's research on the Earth's surface radiation budget. Research efforts are devoted to the extent and cause of observed variations in long-term radiation and meteorological measurements, using satellite observations and climate model calculations.

NOAA is leveraging and enhancing its diverse set of partnerships to proactively prepare for and respond to the potential immediate and future impacts of climate change on people, societal infrastructures, local/regional economies, and ecosystem changes

To measure the distribution and trends of carbon dioxide (CO2) and methane (CH4), the two gases most responsible for human-caused climate change, ESRL operates a Cooperative Global Air Sampling Network, including a station at Shemya, AK. Other greenhouse gases and carbon monoxide are also measured. Shemya is a very remote location that samples air coming from the Asian continent. These measurements help determine the magnitude of carbon sources and sinks at northern latitudes in Asia.

Fairbanks is one of the locations in the United States where ESRL takes column measurements of the amount of ozone between the earth's surface and the top of the atmosphere. These measurements are used to determine the amount of ultraviolet radiation reaching the earth's surface. Excess ultraviolet radiation is responsible for human skin cancer and is also harmful to other biogenic organisms. These are important, as column ozone measurements monitor changes in the stratospheric ozone layer resulting from human-produced chlorine and bromine compounds that destroy ozone.

ERSL also operates from Fairbanks a new and growing small aircraft-based North American network of sampling sites (Carbon America) to measure vertical profiles of important greenhouse gas concentrations. Air is sampled above the surface up to approximately 25,000 feet above sea level using a reasonably small, light, and economical automated system to measure CO2, CH4, and other greenhouse gases. This data will improve global carbon cycle models.

In addition, ESRL contributes to a consensus seasonal forecast and other products for the fire season for Alaska and other states. This new climate decision-support tool provides information for a seasonal fire danger outlook used by the National Interagency Coordination Center for fires to make proactive short- and long-range decisions for strategy development and resource allocation, and to improve efficiency and firefighter safety.

Supporting weather and water hazards, OAR is active in Tsunami and Volcanic Ash research. The Tsunami Research Program at the Pacific Marine Environmental Laboratory (PMEL), seeks to mitigate tsunami hazards to the U.S. coasts. Research and development activities at PMEL focus on: 1) improved tsunami measurement technology and the design of optimal tsunami monitoring networks, 2) improved models to increase the speed and accuracy of operational forecasts and warnings, and 3) improved methods to predict tsunami impacts on the population and infrastructure of coastal communities. PMEL conducts these activities in collaboration with the states and the National Weather Service, including the West Coast and Alaska Tsunami Warning Center in Palmer.

Volcanic ash is an extreme hazard to aircraft, having caused more than $250M in damage during the past 20 years. ESRL, in collaboration with other federal and state agencies, has developed and installed the Volcanic Ash Coordination Tool (VACT). The tool enables the Anchorage Volcanic Ash Advisory Center to generate ash forecasts, diagnose eruptions, and forecast the presence of ash.

Cutting across these categories are the NOAA Arctic Research Program, and the Cooperative Institute for Arctic Research (CIFAR).

The Arctic Research Office (ARO) serves as a focal point for NOAA's research activities in the Arctic, Bering Sea, North Pacific, and North Atlantic regions. The office manages the Arctic Research Initiative and other funds allocated to it, supporting both internal NOAA and extramural research. It represents NOAA on the Interagency Arctic Research Policy Committee, leads U.S. involvement in the Arctic Monitoring and Assessment Program, and provides a point of contact between NOAA and the Cooperative Institute for Arctic Research (CIFAR) and the International Arctic Research Center at the University of Alaska Fairbanks.

CIFAR is a cooperative institute between NOAA and the University of Alaska, sponsored by NOAA Research. CIFAR conducts research in collaboration with NOAA on a wide variety of issues critical to the Arctic, including fisheries oceanography, hydrographic studies, sea ice dynamics, atmospheric research, climate dynamics and variability, tsunami research and prediction, and environmental assessment and monitoring. CIFAR works closely with researchers from the eight countries of the Arctic Council on climate impact assessments and plans joint oceanographic cruises with Russia.

National Environmental Satellite, Data, and Information Service

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) is dedicated to providing timely access to global environmental data from satellites and other sources to promote, protect, and enhance the Nation's economy, security, environment, and quality of life. To fulfill its responsibilities, NESDIS acquires and manages the National operational environmental satellites, provides data and information services, and conducts related research.

Satellite Operations

Alaska plays a critical role in the acquisition and distribution of data from NOAA and other environmental satellites. The NOAA Fairbanks Command and Data Acquisition (FCDA) Station (http://www.fcdas.noaa.gov/) represents the most significant physical presence of a NESDIS LO activity in Alaska. This primary NOAA polar satellite ground station provides telemetry, command, real time and stored mission data recovery in support of NOAA's mission requirements. The Fairbanks CDA Station current mission set includes support to the following NOAA and non-NOAA satellites: NOAA POES and GOES, DOD DMSP, Naval Research Laboratory (NRL) CORIOLIS, NASA

AQUA, AURA, and European METOP. During the summers of 2005-2007, FCDAS also provided direct downlink data capture services from USGS LANDSAT-5 for extensive Alaska mapping and wildfire management in cooperation with the University of Alaska and the U.S. Geological Survey. The FCDAS has received and transferred 10,885 LANDSAT-5 scenes into the National Satellite Land Remote Sensing Data Archive. By mid-2008, FCDAS is scheduled to assume operations for the COSMIC constellation of U.S. and foreign satellites and French CNES JASON-2 mission. Launch supports are a regular part of activities at the site, the most recent of which include NOAA-18 POES, as well as a new DMSP spacecraft.

The Fairbanks facility also provides a downlink for the International COSPAS-SARSAT program. The FCDAS SARSAT system provides emergency beacon response for the North Pacific, Alaska, Bering Sea and Arctic Ocean. The Alaska Personal Locator Beacons (AK PLB) Program established in 1994 utilizes a transmitted coded signal that is received by a COSPAS, SARSAT, or GOES satellite and relays the signal to a ground station that calculates the PLB location and transmits the information to the U.S. Mission Control Center. The USMCC recognizes the specially coded beacons as an AK PLB and transmits a distress message directly to the Alaska Rescue Coordination Center (AKRCC) at Fort Richardson just north of Anchorage. The AKRCC then uses state, local or federal assets to conduct the search and rescue. Other instruments located at the station include the ARGOS Master and Orbitography beacons, U.S. Climate Reference Network Station, and a CORS GPS. NESDIS also maintains a satellite ground station in Pt. Barrow to provide telemetry and command support for the POES primary spacecraft while also supplying high latitude real-time HRPT observations of the Arctic for use by the NWS, AFWA, AOOS, AVO and UAF researchers.

One example of an innovative operational achievement to improve data and information services to Alaskan customers is a new way of processing polar winds using NASA's AQUA satellite, real time MODIS data. AVHRR satellite data (30-40 passes per day) received at the Pt. Barrow ground station is also being used to operationally produce polar winds products.

Another example of NOAA's collaboration in the arctic region was with the Canadian Space Agency. NOAA and NASA established an agreement with the Canadian agency to use RADARSAT-1 (R-1), Synthetic Aperture Radar (SAR) data for identifying arctic sea ice and coastal winds. This demonstration ran from 1997 until May 2008 and documented the critical utility of SAR data to meet NOAA Missions in the following areas:

· Coastal wind patterns, especially through bays and passes. This data aided forecasts of dangerous gap winds like the ones that capsized the /F/V Pacific Lady/ in November 2007.

· Sea ice location, concentration, and motion along the coast. This data fed NWS ice forecasts as R-1 is the only platform that can see through the clouds. This kind of ice information is especially important to villages and towns where subsistence is still actively practiced as subsistence hunters will travel out onto the ice to hunt and fish when food supplies get low.

· Sea ice edge, location, concentration and motion offshore. This proved critical to the safety of commercial fishing vessels that fish right up against the sea ice edge

· Storm surge, coastal flooding and erosion. This is especially important for the northwest coast of Alaska where villages such as Kivalina, Shishmaref, Point Hope, Barrow, and Newtok are in peril of destruction from flooding and erosion of their coastline. This region has a low coastline being affected by permafrost thawing and the lack of sea ice to dampen storm waves from crashing freely into the shore.

· River ice break-up monitoring. The spring break-up of river ice often leads to disastrous floods. The SAR data allowed state-wide monitoring and advance warning for emergency managers.

In sum, it became rapidly apparent that the SAR data impacted our information on coastal winds, river and sea ice, storm morphology, waves, oil spills, flooding, glacial change, and volcanic eruptions. NOAA is now exploring options to acquire SAR data on an operational basis.

Research, Data and Information Services

Although not physically located in Alaska, the NOAA National Data Centers (NNDC) consist of three discipline-oriented national data centers - Climate, Geophysics, and Oceans – that manage and provide long-term archive and access to NOAA data including Alaskan data.

The National Climatic Data Center (NCDC) located in Asheville, NC, has a statutory mission to provide long-term storage and public access to the climate observations of the U.S., Alaska, and to use these observations to describe the climate of the U.S. As apart of this role, NCDC operates and manages the U.S. Climate Reference Network (USCRN), http://www.ncdc.noaa.gov/oa/climate/uscrn/ which provides reference climate observations. Currently, 4 USCRN stations are operational in Alaska: Fairbanks CDA, Pt Barrow, Sitka, and St. Paul Is. Between 2009 and 2013, a total of at least 29 USCRN stations will be installed and operational. These sites will provide a convenient platform for additional permafrost monitoring sensors. NCDC manages the Climate Data Modernization Program (CDMP) migrating data and information from analog format (paper and microfilm) to digital format. Historical Alaskan records are part of this project.

The National Geophysical Data Center (NGDC) located in Boulder, CO, archives earth observations from space (satellites including DMSP and GOES), space weather and solar events, bathymetry and global relief, marine geology and geophysics, natural hazards (tsunami, volcanic ash and eruption, and significant earthquake), as well as geomagnetic and gravity data and models. NGDC stewards the NOAA observational data associated with the Nation's Tsunami Program, including the Deep-ocean Assessment and Reporting of Tsunami (DART™), coastal tide gauge, past tsunami event and impact data and imagery, coastal relief (bathymetry and LiDAR) data and related products. NGDC works with partners at state, local, and federal agencies to assess the tsunami hazard to communities based on these historic tsunami data. One of NGDC's strongest connections to Alaska is its coastal digital elevation modeling in support of tsunami forecast, warning, and inundation mapping. NGDC is the designated data center supporting the U.S. characterization of an Extended Continental Shelf (ECS) as set out under Article 76 of the 1982 UN Convention on the Law of the Sea (UNCLOS).

The National Oceanographic Data Center (NODC) located in Silver Spring, MD, is a national repository and dissemination facility for global oceanographic data which acquires and preserves a historical record of the Earth's changing environment to be used for operational applications and ocean climate research. NODC's mission is to ensure that global oceanographic data sets are maintained in a permanent archive and easily accessible to include Arctic region ocean observations collected by NOAA Arctic program buoys and ice stations, as well as the Alaska Ocean Observing System (AOOS) observing systems. Data types include ocean currents, salinity, sea level, temperature, waves, and a variety of ocean biological data. NODC manages the NOAA Central Library Network. The NOAA Central Library, located in Silver Spring, MD, provides information and research support to NOAA staff and the public. Two of the 30 NOAA libraries are located in Alaska: (1) the Auke Bay Laboratory Library, NMFS Alaska Fisheries Science Center, Auke Bay Laboratories; and (2) the Ted Stevens Marine Research Institute, Juneau, AK. Description of collection and services: the collection includes books and journals on fisheries science, marine biology, zoology, chemistry, biochemistry, oceanography, and environmental effects (effects of oil, logging, marine litter, etc.). W.F. Thompson Memorial Library, NMFS Alaska Fisheries Science Center, Kodiak, AK. Description of collection and services: the collection includes books, journals, reports, and reprints on marine biology and fisheries, as well as U.S. Fish Commission Reports from 1871 and Bulletins from 1881.

The Center for Satellite Applications and Research (STAR) is the science arm of NESDIS that transfers satellite observations of the land, atmosphere, ocean, and climate from scientific research and development into routine operational products and other meaningful information. STAR activities related to Alaska include the development of products to detect or forecast several hazards to aviation, (e.g., volcanic ash, fog, and low clouds, icing, turbulence, and convective wind gusts), operational sea ice products (accurate daily maps of sea ice, tactical ice monitoring; and accurate short-term forecasts of sea ice), and products for use in meteorological applications (tropospheric winds, cloud properties, and surface radiation).

The National Ice Center (NIC) located in Suitland, MD, fulfills a critical national mission to provide U.S. civilian and military vessels with global ice analysis and forecasts products. The NIC, through a partnership with the U.S. Navy and U.S. Coast Guard (USCG), routinely produces ice analysis products in the Northern and Southern Hemispheres. These critical sea ice information products and services contribute to safe, efficient, and environmentally sound maritime navigation and transits in Alaskan waters and throughout the Arctic region. The Alaska Ice Desk provides additional details and higher resolution products complementary to NIC. Sea ice monitoring on a regular basis provides a database for climatology studies by numerous universities, environmental research laboratories, and weather prediction centers. Economic benefits of NIC products include the prevention of marine vessel damage or loss, as well as significant fuel savings for the marine transportation industry when they are able to navigate through the ice by the most direct path.

Routine NIC ice guidance products include global and regional-scale ice analysis charts, annotated satellite imagery, short and long-term ice forecasts, and legacy ice climatology information. Specialized support services include specific regional support, ship route recommendations, and pre-sail ship briefings. Ice products are produced using a variety of remotely sensed data, however, Synthetic Aperture Radar (SAR) data are critical to producing ice products because of its all-weather, cloud-discerning capability (Arctic & cold regions are cloud covered 75-80 percent of a typical winter season), especially over icy waters.

ARCTic Achievements

NOAA is prioritizing and developing a baseline of observations to effectively monitor, evaluate, and assess climate change and variation in the Arctic region

While NOAA entities in Alaska have collaborated for years, the advent of the ARCTic has provided a formal and sustained mechanism that has produced a number of accomplishments for both the agency and our customers. Several of these are detailed below. In addition, the development of this document and the intangible benefits of expanded networking are producing results and fueling even higher expectations for the future.

Climate Change

Input to Alaska Climate Impact Assessment Commission

The Alaska Climate Impact Assessment Commission was established in 2006 by the State Legislature to prepare a comprehensive overview of the likely impacts of climate change affecting Alaska, and steps we can take to mitigate that impact. In developing the overview the commission is considering facilities and infrastructure, identifying financial implications of climate change, and helping local Alaskan communities with planning activities. The NWS Alaska Region and NOAA Fisheries Alaska Fisheries Science Center participated in a hearing organized by the Alaska Climate Impact Assessment Commission on April 12, 2007 and other ARCTic members have provided subsequent information related to this ISP at the request of commissioners and individual assisting them. The report of the Commission will likely contain many NOAA related themes and recommendations.

Marine Navigation & Safety

NOAA-USCG Partnership Increases Data, Safety

NWS staff in Kodiak, AK, working with the USCG District 17 have put together a plan to provide training in three critical areas for the USCG: surface observations reporting, heavy weather, and ice reconnaissance. The first briefing is essentially done and NWS AK Regional HQ is reviewing it. The second will focus on heavy weather recognition and avoidance with a "North Pacific/Bering Sea/Gulf of AK" slant. The third could be on ice reconnaissance with help from the Ice Recon crews at the NIC at Suitland. The initial focus will be on the Kodiak USCG "Fish" school as part of the briefing school for cutters that will be conducting patrols in the Bering Sea.

Digital Ice Analyses

Digitization of the Sea Ice Analysis

The database produced by the Anchorage Forecast Office Ice Forecaster remains a very high priority for the Alaska Region. The archive consists of over 24 years of high spatial resolution, hand analyzed ice analyses preserved almost exclusively on paper. The analyses is of much finer temporal (3 times per week as opposed to one) and spatial resolution than what is produced at the National Ice Center. The Alaska Region and the UAA Engineering Department have established a project to transfer archived analyses into a geospatial information systems (GIS) format such as the ESRI shapefile. The ice analyses will then be available to the NWS as well as all NOAA customers for use in decision support systems (DSS), ecosystem analysis, as well as ocean and ice forecast models. Currently a small number of ice analyses have been transferred by UAA graduate students. Dialogue is underway to determine the full scope of the project.

Resource Management

2008-2009 Integrated Ocean & Coastal Mapping Project (IOCM) in Kachemak Bay

Ocean and Coastal Mapping provides information that is critical to many management decisions. NOAA alone needs bathymetry, habitat, and topographic data and maps for its missions. Currently, the data for each is collected separately at a great collective expense. NOAA, as part of the Interagency Working Group on Ocean and Coastal Mapping, has initiated a select number of pilot projects to determine if/how efficiencies can be found.

The primary objectives of the multi-year project in Kachemak Bay are to demonstrate multiple uses of ocean and coastal mapping data and define the process for planning and conducting IOCM surveys on a regular basis. Specifically, the Kachemak Bay project will show how one hydrographic survey can support habitat information for ecosystem based management, emergency management, and economic development as well as NOAA nautical charts. Activities will include hydrographic surveys, shoreline imagery and topography, contaminant sampling, and potentially subtidal substrate and habitat map development. Additional activities such as Marine debris surveys and removal, circulation modeling, V-Datum development (http://vdatum.noaa.gov/), watershed/hydrology modeling, and inundation mapping may be incorporated if funding and assets are available.

At the time of publication, each NOAA line office, USGS, USACE, and USCG are participating from the federal level; Alaska Department of Fish & Game and Alaska State Parks are contributing from the state; the local/regional government of Kenai Peninsula Borough, City of Homer, City of Seldovia, Seldovia Village Tribe, Port Graham village, and Nanwalek village are involved; and we're expecting participation from Cook Inlet Regional Citizen's Advisory Council (CIRCAC), Alaska Ocean Observing System (AOOS), and Cook Inlet Keepers as well.

Through the collaborative efforts of these partners, we expect the following outcomes:

- Ecosystem Based Management
  - Assist ADF&G and NOAA Fisheries fishery and habitat resource managers, both offshore and nearshore.
  - Benthic habitat with or without relief features, such as reefs, mounds, deeper pinnacles, sand waves, etc.
  - Address unknowns for nearshore EFH descriptions, such as juvenile rearing (nursery) areas.
  - Aid to assess anthropogenic (human-induced) processes that may or may not affect benthic habitat. i.e. coastal development, marine dredge disposal areas, oil and gas pipeline route.
  - Application to other embayments; start putting several pieces together.
- Safe Navigation
  - Provides mariners with new nautical charts for safe navigation.
- Economic Development
  - Provides USACE and City of Homer with information for Homer Harbor Expansion.
  - Provides Alaska Industrial Development and Export Authority members with

bathymetry and circulation data for Kachemak Bay Tidal Power Proposal.

- Emergency Management
  - Supports USCG use of Kachemak Bay as a Place of Refuge for damaged vessels.
- Better Government Services
  - Improves survey collaboration with Alaska state/local agencies.
  - Provides cross-training opportunity for NOAA ship crews.
  - Provides high resolution bathymetric data for circulation and watershed-estuary models.

The success of this project will play a large role in NOAA's evaluation of requirements for survey operations in the future.

Water Resources

Advanced Hydrologic Prediction Services (AHPS) Multi-sensor Array

The Alaska Pacific River Forecast Center (APRFC) and the U. S. Geological Survey (USGS) are participating in a joint project to implement the first stages of a water quality/water resources program. They jointly decided that water temperature would be the best parameter to measure in the first stage of the program. The NOAA Water Resources Initiative in support of the Advanced Hydrologic Prediction Service (AHPS) program provided funding to purchase water temperature sensors. The Alaska Habitat Conservation Division of NOAA's National Marine Fisheries Service and the Alaska Division of Fish & Game are participating as primary users of the data to help in site selection and dissemination methods. The USGS will install the sensors when they make routine visits to the gages between this winter and next spring. Real-time information is expected July 2008.

The representation of NWS and NMFS will allow for a comprehensive site selection. The APRFC hydrologists do not specialize in habitat conservation particularly as it relates to anadromous fish.

Special roles of line offices or partners – NWS and NMFS are taking the lead but are also working with NOS and their partners such as the Kachemak Bay Research Reserve.

Precipitation Baseline for Engineering & Environmental Studies

Precipitation frequency estimates (PFE) are a climate-related precipitation tool. The PFE data are commonly used to reduce the risk of runoff-related loss of life and property, and to prevent pollution. They provide rainfall related criteria used extensively by the engineering and environmental communities for the design of structures such as sewers and drainage systems, for environmental studies and design, and for sediment control. The criteria are used by the Federal Emergency Management Agency to update National Flood Insurance rate maps and by the Environmental Protection Agency's National Pollution Discharge Elimination System Program to regulate pollution control in streams.

The statewide PFE data currently available for Alaska is contained in two reports by the Department of Commerce called Technical Papers 47 and 52, last revised in 1963 and 1965, respectively. NOAA's NWS recent updated analyses in the Lower 48 indicated differences up to 30% between the old and new estimates. The Federal Advisory Committee on Water Information's Subcommittee on Hydrology has endorsed the work being performed by NWS and recommended the updates be extended to the rest of the country.

The updates for Alaska will cost approximately $800,000 over a three-year period. The University of Alaska Fairbanks (UAF) and the State of Alaska currently have support for half of the project. UAF obtained $200K from the Alaska University Transportation Center (AUTC) grant proposal which then qualified them for matching funds from the Alaska Department of Transportation. The additional funds are being provided by the NOAA's Climate Program Office and other external entities.

The first stage of the AUTC proposal focused on the transportation corridors of Alaska. NWS Office of Hydrologic Development is working with UAF to determine the appropriate technical approach, work allocation and schedule and will now be incorporated with the NWS secured funding and subsequent participation. This would allow the entire state to be updated and added to the world-class, NOAA Atlas 14 publication. UAF has started their component in August 2008, and overall project completion is expected in 2011.

Remote Sensing

DMSP Real-Time Support

In early 2007, the US Air Force (USAF) decided to reduce the number of DMSP (Defense Meteorological Satellites Program) field ingest terminals (Mark IVB) across the country and announced that the Elmendorf Air Force Base (AFB) downlink would be decommissioned on October 31, 2007. NWS AR has been directly receiving real-time DMSP data from Elmendorf AFB since 1992 and the loss of this data would have resulted in degradation of services and major impacts on the operational forecasts provided by the NWS. The USAF and NWS Alaska Region worked together on a solution that would continue the real-time capture and transfer of DMSP data in Alaska by utilizing the capabilities of the NESDIS Fairbanks Command and Data Acquisition Station (FCDAS) at Gilmore Creek, AK. This partnership ensured that real-time DMSP data would be available for operational and research use. USAF, NWS AR and University of Alaska Fairbanks (UAF) personnel met at the FCDAS on June 27, 2007, to put together a proposed plan that would test the capture, ingest, processing, and distribution of DMSP data by September 1, 2007. The capture system was rapidly developed and integrated into DMSP operations at the FCDAS and by mid August real-time supports were being scheduled using FCDAS developed software with 18-25 real-time DMSP files captured and disseminated to users daily. The FCDAS data transfer and University of Alaska (UA) Geographic Information Network of Alaska (GINA) data distribution to NWS AR and AFW was operationally verified on schedule with autonomous operations commencing on August 30th. Subsequently, USAF leadership changed, and the decision to decommission the MARK IVB was reversed but the partnership continues to the benefit of all involved with the FCDAS continuing to capture 18-25 DMSP passes and UA GINA processing the data for use by NWS Alaska Region, the university community, and the public at large.

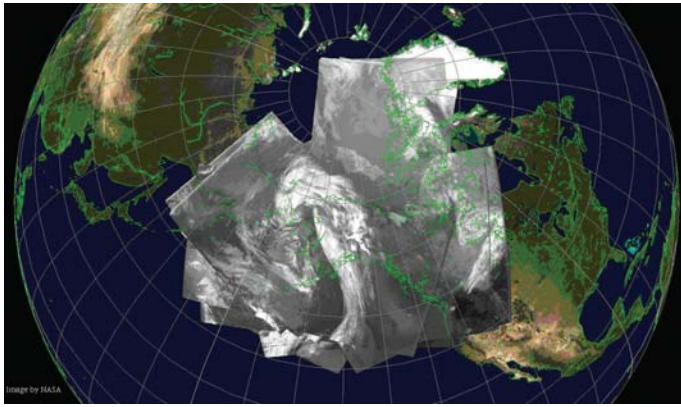
The DMSP real-time Operational Line Scanner (OLS) data is available via the UA GINA swath viewer program at http://sv.gina.alaska.edu.

High Latitude POES HRPT Observations Increased

In support of the NWS AR and UAF researchers, the FCDAS increased Barrow real-time supports at Barrow from 8 per day to over 40 supports per day during the 2nd Quarter of FY07. The data is transferred to UAF GINA for distribution to NWS, AVO, AOOS, and IARC researchers. FY07 4th Quarter total for additional Barrow supports scheduled locally by the FCDAS is 3,088 observations.

Our ability to leverage the NESDIS CDAS has allowed the team to ensure an uninterrupted flow of satellite data to the Alaska Region. In addition, participation on the team has enabled members to gain new access to satellite imagery and to initiate development of new satellite data applications. In FY07, the NOAA Scientific Support Coordinator (SSC) worked with the University of Alaska GINA to access high-resolution satellite imagery purchased by the U.S. Fish and Wildlife. The SSC used this imagery to help address coastal management issues along the Arctic National Wildlife Refuge coastline. Along with the Alaska Clean Seas, the North Slope industry oil spill cooperative, the entire ANWR coast was flown using the satellite imagery as a guide and a reference. Particular attention was directed to locations of the offshore barrier islands and whether or not it would be feasible to boom the openings between them or to use deflection booming to prevent oil from reaching the main ANWR shoreline.

Alaska has extensive oil and gas reserves essential to the nation's economy and national security. The Alaska oil pipeline loses approximately $1 million per hour during a shutdown.



Alaska Statewide Digital Mapping SPOT Satellite Receiving Ground Station

The State of Alaska is acquiring a new SPOT satellite capture, processing, and archive system based in Fairbanks. The system will create higher-resolution images covering the state's land and off-shore territories every 3-4 years at the lowest cost possible. Additionally, the SPOT satellites will be tasked to perform frequent repeat coverage to monitor areas of concern and rapid change and to provide emergency response. These multi-color images, at 2.5-meters spatial resolution, are sufficient to accurately evaluate coastal erosion, assess coastal storms, monitor sea ice, plan and monitor infrastructure development, respond to emergencies, and ensure effective resource management.

Images will be directly sent from the SPOT satellites to the NOAA Fairbanks CDA ground station in real-time, eliminating the cost and delay of satellite storage and transmission. Every pass over Alaska will be captured. Large data volumes will be processed rapidly into distributable products, assuring access to current information. The image data will be freely available to everyone via the web. Level 0 and higher data will be available to all government and university users for research, operations, and policy making at no additional cost.

The SPOT sensors will provide numerous benefits to NOAA scientists, operations staff, and end users of NOAA warnings, forecasts, and analyses. SPOT data will be a cornerstone element of the Alaska Regional Collaboration.

- Coastal processes: SPOT data supports work on coastal storms (surge, waves, and inundation) and erosion, which are of major concern to both Federal and State policy makers. Billions of dollars of impacts are anticipated in the coming decades.
- Sea ice: The high spectral and spatial resolution of SPOT data, with excellent temporal coverage, is ideal for studies of sea ice melt and especially the processes controlling the evolution of summer ice albedo, a factor of prime importance for the understanding of Arctic and global climate change.
- Flooding: NWS river forecasters will have rapid, enhanced access to high resolution imagery aiding creation of forecasts and warnings during breakup and flood events.
- Climate change: All of the above, plus additional effects such as accelerated permafrost degradation, increased wildfire, and associated carbon releases, will be exacerbated by climate change and can be tracked and understood using SPOT satellite data.

Communications, Education and Outreach

The Communications, Education and Outreach Work Group (CEO Work Group) has accomplished a number of projects and activities to date. These accomplishments are directly tied to the ARCTic Communications Plan outlined as specific objectives under three distinct goals. The goals include: (1) increase collaboration and communication efforts by building and maintaining effective partnerships; (2) inform the public about how to improve stewardship of coastal and marine ecosystems; and (3) develop coordinated campaigns within NOAA and with external partners to improve NOAA's local, national, and international recognition as a leader in environmental science, education, and stewardship.

Science on a Sphere and Datasets

The ARCTic CEO Work Group coordinated an effort with partners to seek funding for Science on a Sphere (SOS). As a result, NOAA Fisheries decided to fund the entire project in anticipation that the Team will work with a number of outside entities to develop datasets. The sphere will be permanently located in the Alaska State Museum in the spring of 2009.

The CEO Work Group in collaboration with a number of partners received funding under the Preserve America grant to develop a dataset for SOS that highlights the 1871 whaling fleet and links it to current and future communities, navigation, and safety issues in our rapidly changing Arctic. NOAA Fisheries has also initiated a Mentor/Intern Program for high school and university students to assist in the development of fisheries and marine mammal datasets. Based on this experience, the NWS partnership with the Anchorage School District Gifted Mentor Program could be utilized in the same manner. The student, mentor, and program coordinator work together in preparing a project that will expose the student to a real-life work environment, which is well suited for creating a multi-generational draw for SOS.

NOAA's ARCTic External Website

The CEO Work Group developed an external website that highlights the integration between NOAA agencies and external partners. This website is currently posted on the PPI website at: http://www.ppi.noaa.gov/NOAA_ARCTic/noaa_arctic.html. The website includes links to members, stakeholders, ARCTic activities, ARCTic plans, and more. This ISP will be posted on the website.

Virtual Alaska

The CEO Work Group secured funding through NOAA Fisheries for the start up costs for Virtual Alaska and a module specific to fisheries, marine mammals, and the ecosystem. The environment supplements NOAA's Virtual World, an ongoing project based in Second Life, which is a 3-D virtual world. The ARCTic is partnering with other line offices and stakeholders to expand Virtual Alaska over time. Recently, the ARCTic partnered with the University of Alaska, Juneau School District, and the U.S. Forest Service to establish a curriculum that includes content development for Virtual Alaska. The curriculum highlights climate change in Alaska. Other modules could eventually feature expansion on climate change, glacial ice melt, melting permafrost, Alaskan wildlife, tourism, Alaskan villages, and more.

"One NOAA" Events

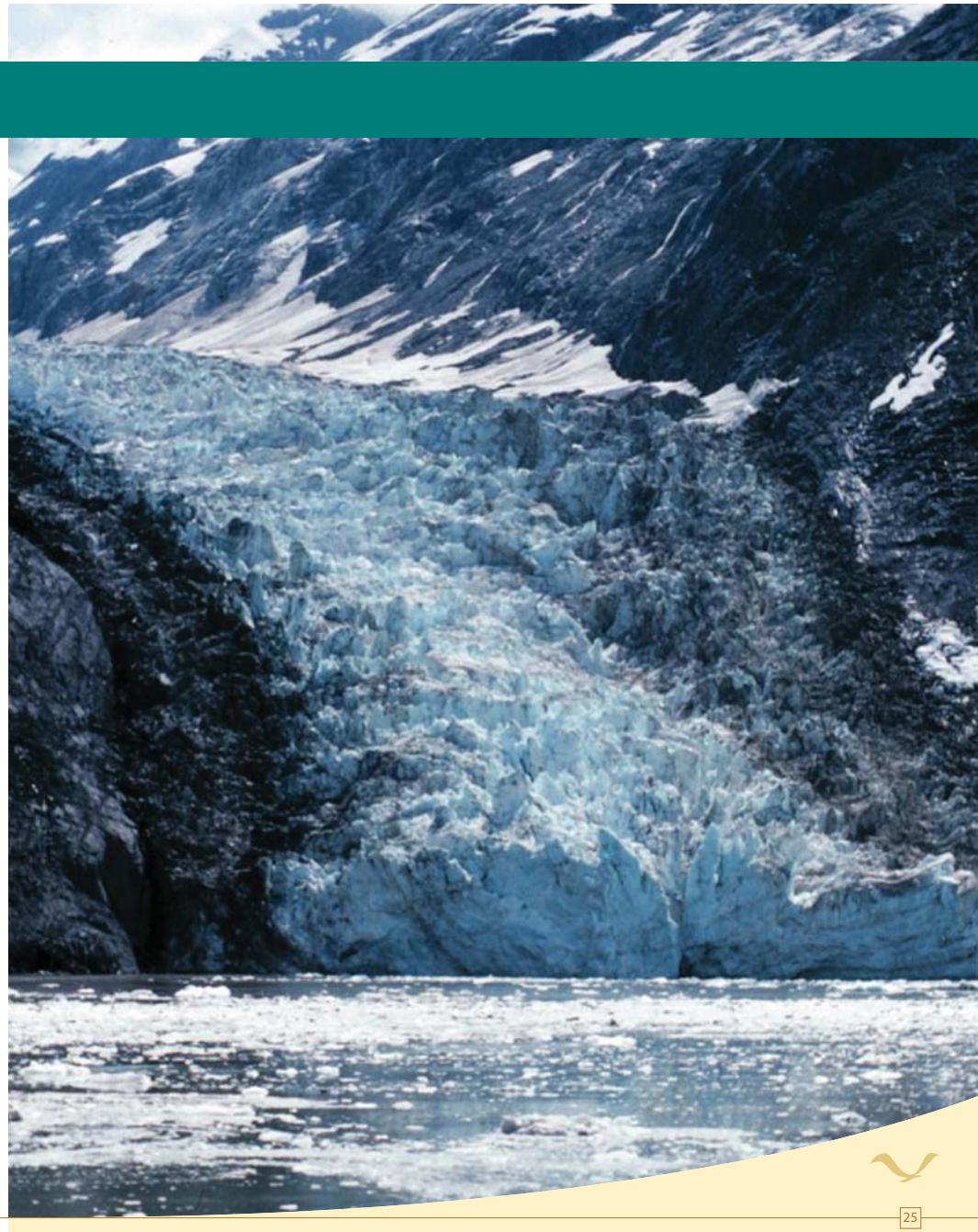
The CEO Work Group collaborated with other line offices to host a "one NOAA" booth at Pacific Marine Expo in Seattle, Washington in November. The large display showcased NOAA Weather Service, NOAA Fisheries Service, NOAA Law Enforcement and NOAA National Ocean Service.

During the Alaska Marine Science Symposium in Anchorage, AK, in January, the ARCTic hosted a workshop to highlight the ARCTic's purpose and gain feedback on the ARCTic Integrated Services Plan. A number of ARCTic team members representing various line offices participated in the workshop.

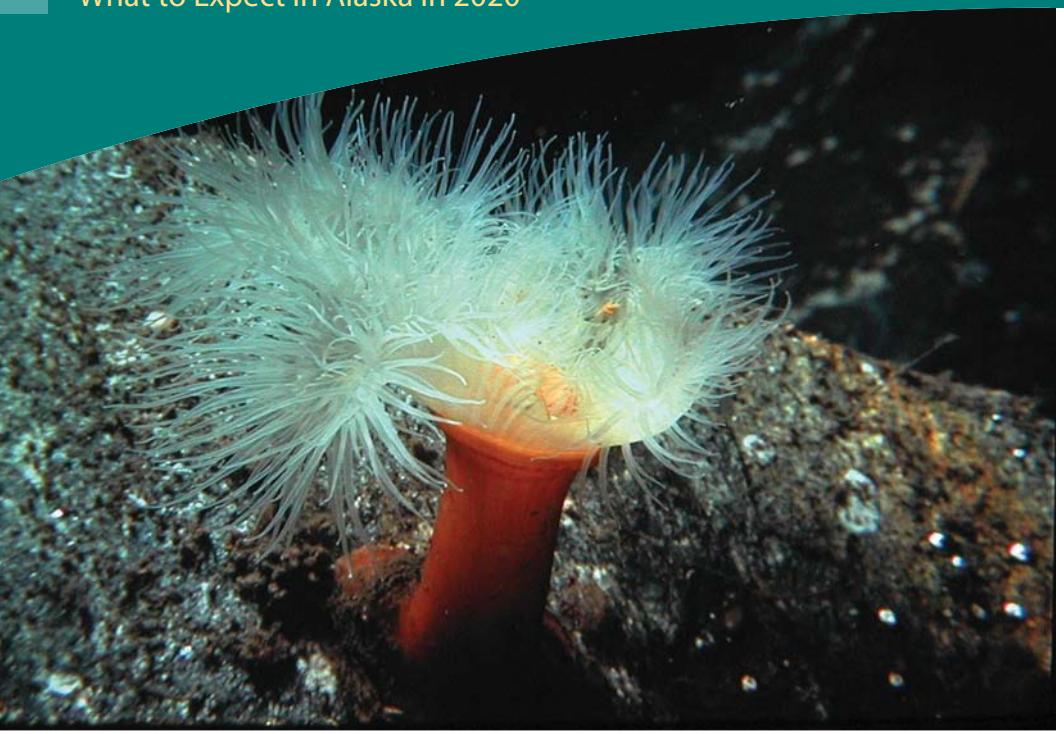
Information Campaigns

The ARCTic partnered with a TV Meteorologist/Producer for the NOAA National Weather Service Alaska Region to interview stakeholder Molly McCammon, Director of AOOS. The outreach segment was broadcasted by Anchorage KAKM-Channel 7, an affiliate of PBS Television Network.

Having an integrated NOAA team in Alaska has both enabled collaborations that would not have occurred otherwise and expanded existing partnerships and collaborations to provide more comprehensive services to our customers. Key to this is the ARCTic's ability to bring a bigger picture view of emerging opportunities and leverage the capabilities and assets of a broader range of users. Another factor in the ARCTic's ability to enhance collaboration and engagement with agencies, academics, and other entities is the team's focus on important, multi-dimensional issues that NOAA cannot address alone. Doing this has fostered a focus on common interests and laid the groundwork for achieving goals once thought out of reach.



What to Expect in Alaska in 2020



Alaska, also known as "The Great Land" or "The Last Frontier" is sorrounded by the Pacific Ocean, Bering Sea, Chukchi Sea, and the Arctic Ocean

One of benefits of integrating across the agency and establishing more regular contact with our customers is the increased understanding of emerging trends in the environment and industry. The following sections describe our understanding of expected and/or desired changes in Alaska between now and 2020. Given the complexity of many of these issues and the lead time necessary for agency action, we view the topics listed below as the core of what NOAA needs to plan for in order to be able to provide the services Alaskans and all Americans demand.

Climate Change Impacts on Alaska and the Adjacent Arctic Maritime Environment

This section of the ISP highlights key climate impact areas that the ARCTic and its non-NOAA partners have identified as priorities. One criterion for selecting these specific areas is that NOAA has a responsibility to provide useful and meaningful information, products, and services that are of direct value to Alaskans and other Arctic region decision makers and planners. The regional NOAA line offices in Alaska, in collaboration with regional partnerships, can reasonably expect to improve on existing and introduce new products and services in response to adaptation and coping with climate change. The vision papers associated with this ISA and ISP reflect specific actions being explored to address current gaps and potential future needs that NOAA must plan for in order to meet its mission in Alaska and the larger Arctic region.

Recent real world observed changes in the Arctic region demand that scientists re-evaluate current Arctic models and look more closely at the most recent rate and extent of observed changes to guide them in adjusting the performance of the models. Typically, historical observations and conditions are used to initialize forecast/prediction models. However, the time has come when the "traditional" approach to modeling requires a fresh perspective to capture current observed trends. Recent sea ice and permafrost conditions reveal that current models are not forecasting the actual rate and extent of change in these two critical observed physical conditions in Alaska and the Arctic region. Other observed conditions also appear to be more severe than predicted. Native Alaskan elders are coming to NOAA asking for assistance because the "old ways" no longer are useful in predicting sea ice and other conditions necessary to support subsistence hunting for the winter.

Temperature and precipitation trends are two essential climate variables that most directly influence the Arctic region and impact a wide range of societal and environmental factors. Significant physical characteristics readily measureable and monitored are sea ice, precipitation, sea surface temperature, sea level change, and the thawing of the permafrost and glaciers. Changes in these characteristics present opportunities and challenges to people and ecosystems. Less sea ice will cause shifts in the migration patterns of marine mammals, as well as the productivity of fish stocks and other levels in the marine food chain. Open coastal waters already have resulted in extensive and rapid coastal erosion in west coast communities such as Shishmaref. Similarly, on the North Slope, wind driven wave erosion from storms in September and October 2007 eroded 100 feet of shoreline in Cape Halkett.

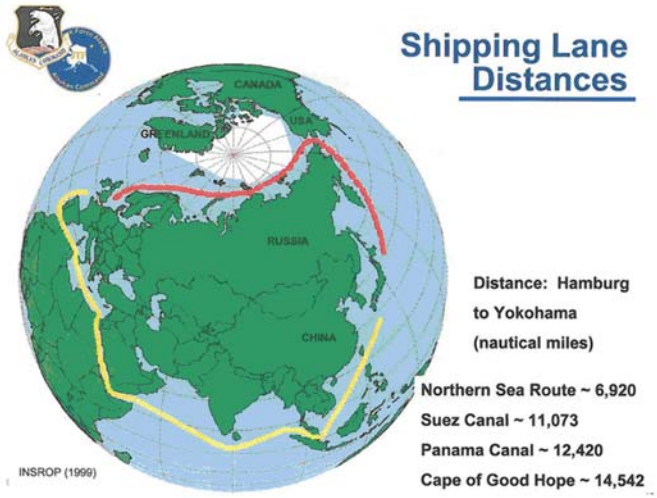
Through the Alaska Baseline Erosion Assessment, USACE compiled a list of communities that according to the community, an interested agency or stakeholder, is experiencing some type of erosion problem. To date, 181 communities have been identified. Of these, approximately 90 communities can be considered coastal communities with about 10 other communities being within area of tidal influence along rivers. Sea level rise increases the extent of coastal inundation and threatens coastal ecosystems and infrastructures. Permafrost thaw has affected terrestrial and coastal marine environments and threatens over land transportation routes through the collapse of the ground surface, draining of lakes and wetlands, toppling of trees, collapse of structures in susceptible areas, and accelerated coastal erosion in select locations.

The impact of climate change is directly tied to social and economic costs and risks. Key areas of concern are listed below and have driven the selection of vision papers in this ISP. It is important to recognize that all the vision papers are inter-related on the basis of adapting to and coping with the impacts of climate change on society and the environment. There are numerous climate change impacts listed in the Arctic Climate Impact Assessment Report, which indicates a need to focus on a few immediate, high risk ones, such as:

Coastal Erosion and Inundation – Related to sea ice (duration and extent) and possible increase in "storminess" (frequency and strength): Recent NASA time sequences and news reports highlight the model underestimation of the reduction in sea ice extent in 2007. This requires the development of Alaskan coastal and open ocean wind/wave hind-cast models and decision support tool for assessing coastal risks by location.

Overland Transportation – Related to permafrost and glacial melt: Supply routes to remote inland towns are threatened where there are no roads for use in the summer, such as places dependent on ice roads and/or river-based resupply routes (too little precipitation or too much glacial melt). Roads already built might begin to deteriorate beyond use and lakes that supply water to create the "ice roads" may no longer be available, not to mention structural failure of buildings, etc. There is a need to monitor and forecast permafrost thaw: where, how much, rate, etc. and rate of glacial melt. This requires improved NOAA, USGS, USACE, and DOT monitoring by expanding existing permafrost and river level/flow observing systems across Alaska and improved permafrost and hydraulic forecast models.

Arctic Ocean Natural Resources-the next Alaskan Gold Rush – Related to sea ice: Open water over greater areas, for longer periods of time will provide greater incentive to do offshore sea floor exploration for gas, oil, and other minerals. Exploration in the Chukchi Sea is about to begin and more licenses will be issued in the future in the Beaufort Sea and other areas. In addition, there are international issues of sovereignty and rights, particularly as related to the



Law of the Sea Treaty. This requires examination and evaluation of significant ecological issues.

Northwest and Northern (across Russia) Passages - Navigation and Maritime Hazards Accidents – Related to sea ice: Open water over greater areas, for longer periods of time will provide the incentive to increase ship traffic. This requires focus on relevant issues such as navigation accidents, oil spills, search and rescue, etc.

Native Way of Life Issues – Related to sea ice, as well as fresh water run off from glacial melt changing coastal ocean chemistry: Hunting whales, seals and walrus; changes in food chain tied to sea ice; sea surface temperature; ocean water chemistry (salinity, ocean acidification); and the food chain connected to walrus and seal feeding patterns, mating habits, denning, etc. There are indications that certain fish stocks are moving northward as the sea temperature increases. This requires expanding/completing/sustaining the arctic maritime observing systems and monitoring/assessing trends to determine the change in and on the marine ecosystems.

Drought-Increase wild fires and more – Related to changing weather patterns/precipitation trends and connected to permafrost thawing: immediate actions that will address observations, monitoring, and assessments include deploying the U.S. Climate reference Network to Alaska; updating Precipitation Frequency Estimates (PFE) for Alaska; and fully integrating with the NSF lead-U.S. multi-agency/international Arctic Observing Network (AON). NCDC already produces Drought Monitor Reports that include Alaska.

Assessing and coping with climate change will require a broad coalition of subject matter expert partners within Alaska. Key players in the state include NOAA (including operational units and the NOAA Arctic Research program); the NOAA Regional Integrated Sciences and Assessments (RISA) at the Alaska Climate Research Center (ACRC); UAF; NOAA Cooperative Institute for Arctic Research (CIFAR) at UAF; International Arctic Research Center (IARC) at UAF; the Alaska State Climatologists (SC); the Alaska Ocean Observing System (AOOS); the North Pacific Research Board (NPRB); coordinating bodies such as the Arctic Research Consortium, and North Slope Science Initiative; individual federal, state, and local agencies, such as the EPA, USCG, USGS, NPS, USDA, DOT, etc.; and industry. In addition, organizations from outside the state will also contribute. Some of these players are: the Western Regional Climate Center (RCC) in Reno, NV, the NOAA National Center for Environmental Prediction (NCEP), NOAA Pacific Marine Environmental Lab (PMEL) in Seattle, WA, and the NOAA Earth Systems Research Lab (ESRL) in Boulder, CO. Internationally, the Arctic Council and its six working groups provide a forum to coordinate the efforts across the Arctic nations.

Climate change is also being taken seriously in the State government. In 2006, the legislature established an 11 member Alaska Climate Impact Assessment Commission and the governor formed a Climate Change Sub-Cabinet. The Commission is tasked to develop a comprehensive overview of the likely impacts of climate change in Alaska and identify steps that can be taken to mitigate them. The Sub-Cabinet was formed to advise the governor and the legislature on the preparation and implementation of an Alaska climate change strategy. In the wake of the release of their final commission report on March 17, 2008, several advisory boards have been tasked to examine state adaptation and response options.

Commercial Development of the Arctic Ocean

As ice cover decreases around the Arctic Ocean, many industries have begun to evaluate potential opportunities presented by newly opened waterways, particularly the Northern Sea Route along the Russian coast and the Northwest Passage through the Canadian Arctic. While the potential for of these Trans-Arctic routes are clear, the economics and many other factors remain to be worked out, leaving the development of these sea lanes as a long term prospect. A review of recent and on going arctic shipping assessments suggest that increased regional shipping will likely increase in the short term, beginning in the Barents Sea via expanding the already existing resource exports from northern Russia. Regional shipping affecting Alaska in the foreseeable future is likely to come in the form of increased oil and gas development and fishing.

Increases in oil and gas activities are already underway. In January 2008, the Minerals Management Service (MMS) approved a Development/Production Plan for British Petroleum's Liberty Prospect in the nearshore waters of the Beaufort Sea. Liberty will be developed from shore using extended reach drilling and may see production within 5 years. On February 6, 2008, MMS held a Chukchi Sea Lease Sale that brought a record breaking $2.6 billion from 667 bids on 488 blocks. Additional Lease Sales are expected in the Beaufort Sea (late 2009 and 2011) and Chukchi Sea (2010 and 2012) over the coming years. These sales require the owners to explore the lease over a ten year period. If companies are successful in finding resources, the first production from the Chukchi Sea will be in the 10-15 year timeframe. Seasonal exploration campaigns into the Arctic currently consist of 15-20 vessels and are expected to become commonplace. In addition to these vessels, an increasing number of research vessels can be expected in the region to assess and monitor environmental baseline conditions, evaluate impacts of oil and gas exploration projects, and to detect changing trends in the ecosystem.

We held Chukchi Sea Lease Sale 193 on February 6, 2008. The Sale was record breaking with 667 bids on 488 blocks and brought in about $2.6 billion in high bids. From this, we expect to issue close to 488 leases. We're also expecting to hold Beaufort Sea lease sales in late 2009 and 2011, plus additional sales in the Chukchi Sea in 2010 and 2012. We expect an increase in the near future of industry-submitted exploration and development plans here on the Alaska OCS. However, this will be at a measured pace. If companies are successful in finding resources, we would not expect first production from the Chukchi Sea for 10 and more likely 15 years. In January, we approved a Development/Production Plan for BP's Liberty Prospect in the nearshore waters of the Beaufort. Liberty will be developed from shore using extended reach drilling and may see production within 5 years. Other production from the Beaufort Sea will depend on the results of any future exploration.

Increased fishing has the potential to add vessel traffic volume to the Arctic as we begin to evaluate commercial fish species ecosystems in the Arctic. Increasing water temperatures and a longer open water season is already promoting a migration of commercial fish species such as Walleye Pollock from the Bering Sea to Chukchi Sea. While the migration depends on many factors, NOAA Fisheries has found some Walleye Pollock species north of the Bering Straits on previous research surveys. Arctic Cod, a viable commercial species in Russian and Canadian waters could, with more research, be determined a viable species in Alaska. A commercial shellfish industry in the Chukchi is also a possibility. If these fisheries are realized, a seasonal presence of fishing vessels can be expected. The North Pacific Fishery Management Council is currently in the process of developing an Arctic Fishery Management Plan. This plan will go a long way to assessing the Arctic fisheries potential and will allow for estimates of number of vessels and potential for fleet services in the region.

The regional growth in Alaskan Arctic shipping will likely be from oil and gas development and commercial fishing activities. These activities will begin as self sufficient voyages by entrepreneurs. However, as the extent of the resources become known and Arctic operating procedures are developed, there will be an increasing need for support services from both private sector as well as government agencies. Demand for port services, hazmat response, and SAR capabilities will increase along with vessel traffic in the region. For NOAA, increased Arctic services cover a wide range, including offshore (high seas) marine and aviation weather forecasts, ecosystem assessments, updated nautical charts, space weather effect on radio and satellite navigation, and many others.

Expanding Homeland Security and Military Activities

The National Defense, Homeland Security, Fisheries Enforcement, Pollution Prevention and Response, and Search and Rescue aspects of the changing Arctic have prompted the USCG and the U.S. Military to significantly increase their operations in the region. In 2008, the USCG is planning to initiate both air and sea operations in the Arctic. At sea, the icebreaker Healy will continue its Law of the Sea mapping mission and the icebreaker Polar Sea will conduct Homeland Security related shipping and navigation assessments. Meanwhile, the cutter Spar will conduct a waterways analysis and management system mission along the North Slope. Bridging land and water, Barrow will likely be home for a tailored force package deployment that will focus on learning how to operate in the Arctic environment. Prudhoe Bay will see the arrival of a maritime security unit from Anchorage. Meanwhile, other Coast Guard members will engage with the coastal communities and help them adapt to dealing with large ships and other changes on the horizon.

Similarly, the U.S. Alaska Command is planning for an increased presence in the Arctic. Two initial actions are to develop a strategy for defending U.S. interests in the Arctic and initiating routine air and sea surveillance. Important to both entities is the choke point of the Bering Strait. In 2007, the USCG had to "fly the line" in a show of force between the U.S. and Russian fishing fleets that as a result of following their prey northward had reduced their normal separation from over 50 miles to less than a half mile. This underscores the need for the International Maritime Organization to set rules for the Arctic - a process that even if started in 2008 is likely to take 10 years to accomplish.

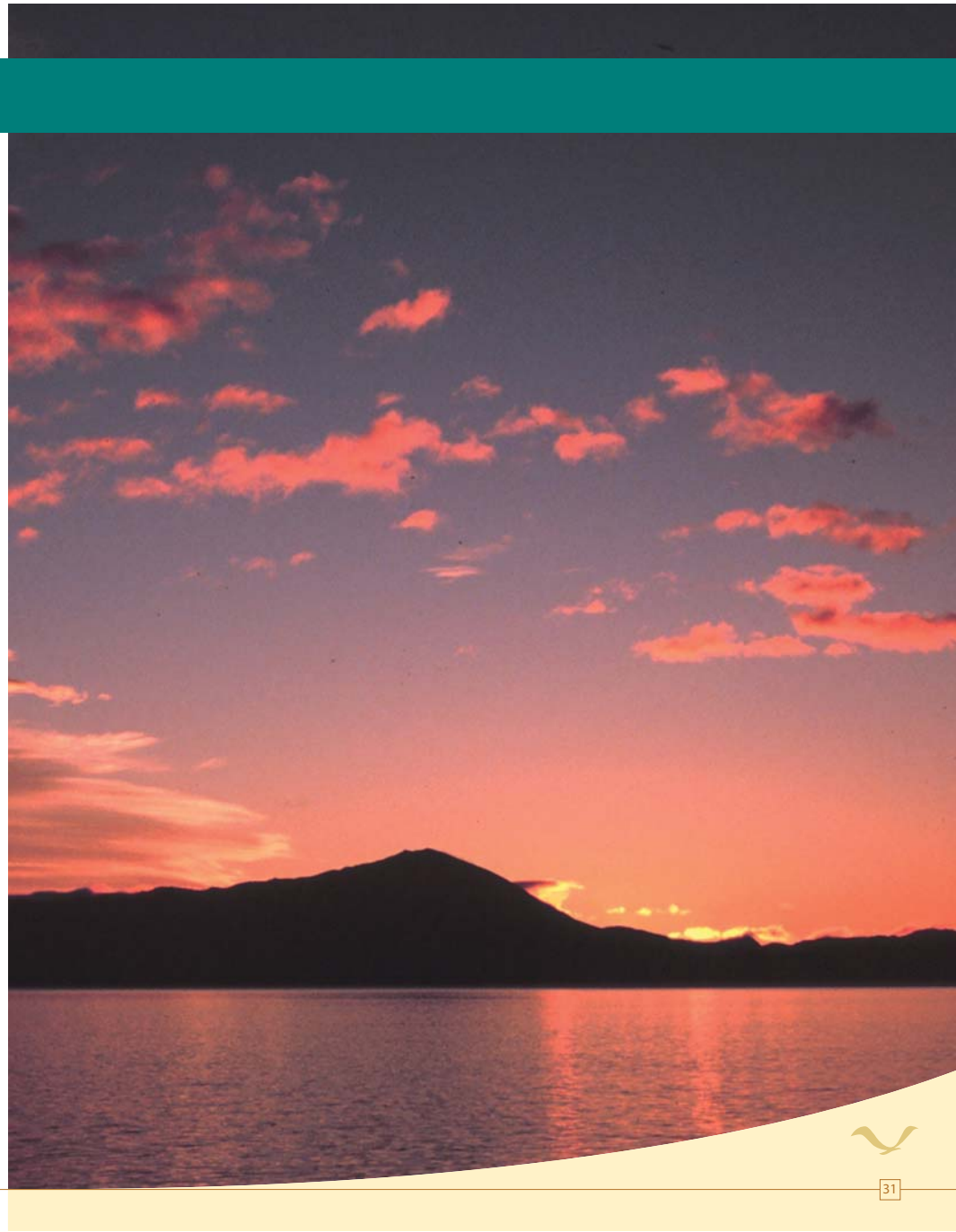
These trends and projections significantly increase the requirements for NOAA activities in Alaska. No corner of the agency is unaffected. Climate research and services; weather; nautical charts; tides and currents; positioning; remote sensing; and fisheries surveys are just a few of the agency functions that will be called for to address these changing conditions. With these prospects in mind, the ARCTic worked with representatives from key partner and customer organizations to identify scenarios for long term planning.

Satellite Data over Alaska and the Arctic Region

Alaska and the Arctic Region experience an incredible diversity of environmental phenomena, yet ironically the region is one of the most data-sparse areas in the world. Polar orbiting satellite-borne sensors offer one of the most cost effective means of gaining repetitive information on Alaska and Arctic weather and the environment on scales ranging from synoptic to mesoscale in a systematic manner over such a data-sparse region. Because of Alaska's high latitude location, polar satellites can provide coverage about every 2 hours at high resolution.

A new generation of satellite sensors to better monitor, detect and track weather and the environment are being designed (i.e., NOAA NPOESS) and some are actually in orbit. This replacement of older satellites will begin in earnest in 2009 and continue through 2020. These satellites involve not only our domestic and research satellites, but include foreign systems with unique sensors that will provide additional information on the environment and the weather. These new satellites offer increased capabilities and open new science opportunities for observing and learning about the atmosphere, ocean, cryosphere, lithosphere and biosphere systems. As an example, climate change is producing reduced ice cover in the Bering/Chukchi/Beaufort Seas, making coastlines vulnerable to coastal flooding and erosion. It is critical to capture rapidly moving storms with strong winds moving over large sea ice free areas that can produce large waves and storm surges that affect low lying coasts of northern Alaska. New and improved sensors will provide a greater knowledge and confidence of Arctic weather systems, thus resulting in improved lead times and quality of warnings and forecasts to the public, marine and aviation communities. In addition, the high resolution data will also provide critical information to our partners and collaborators on potential effects on the ecosystem, climate change, and social and economic ramifications.

To meet the expanding customer needs for timely, high resolution satellite data over Alaska and the Arctic, NOAA NWS, National Environmental Satellite and Data Service, along with the University of Alaska have formed a partnership to utilize the NOAA Fairbanks Command and Data Acquisition Facility (CDA) with its multiple satellite capture systems as the "NOAA Regional Downlink" for Alaska. The CDA will be responsible for capturing a diverse number of multi-satellite data and sharing that data with the National Weather Service, Alaska Region and its partners.



Scenarios for Long-Term NOAA Planning and Investment

Based on the trends we identified, our working groups identified a series of likely scenarios related to NOAA. This document is the first iteration of describing these possible futures and is intended to promote further discussion and collaboration.

These scenarios describe aspects of the future of Alaska as either how we expect it to be (e.g., environmental changes) or how we hope to influence it (e.g., increased safety). Each of these scenarios represents a conjunction of interests and goals between NOAA and its partners, constituents, and customers. Once the common ground was identified, we embarked on an effort to define NOAA's role in these scenarios and near and long term actions the agency should consider undertaking.

Alaska Climate Services Partnership

Vision

Long-term planning in Alaska will be guided in 2015 by an Alaska Climate Services Partnership.

Background

Climate change experts have long said that impacts will be greatest and observed first in the high latitude Arctic regions of the globe. Alaska is already experiencing climate change related impacts such as shortening of the ice season, loss of multi-year polar sea ice, retreat of glaciers, increased storm intensity, shifts in precipitation patterns, increase risk of wildfires, permafrost thaw, coastal erosion and inundation, and significant changes in ecosystems.

Congress is considering legislation regarding the establishment of a National Climate Service. In response, NOAA and other agencies are developing a draft National Climate Service strategy plan and concept of operations that would rely heavily on NOAA's extensive U.S. infrastructure, and leverage partnerships at the international, national, regional, state, and local levels, as well as academia.

In 2007-2008, Alaska State Legislature commissioned and completed an Alaska Climate Impact Assessment Study (Mar 17, '08). Also in 2007, the Governor of Alaska established a Climate Change Sub-Cabinet and charged it with the development and implementation of a state climate change strategy. Since formation, the Sub-Cabinet has established four working groups. The Immediate Actions Work Group delivered its first Recommendations Report on Climate Change in April 2008. State funding has already been applied to these actions. The Mitigation and Adaptation Advisory groups will deliver their recommendations in the spring of 2009. The fourth group, Research Needs, is also expected to be active in 2008-9. With Alaska at the forefront; it is time for NOAA and its partners to characterize the climate services partnership in the state.

Objective

- Develop an Alaskan Climate Services Partnership that provides decision-makers with information for climate change adaptation and mitigation actions.
- Bridge the Gap between NOAA and State Agencies. Improve communications between NOAA scientists and state government agencies (such as the Alaska Departments of Fish and Game, Environmental Conservation, and Natural Resources) on climate science, the potential impacts, and data needs for those agencies concerning climate change.

Mission (NOAA's Role)

- Continue to be a recognized leader in providing science-based research and operational products, and services relevant to Alaska and the Arctic region.
- Play a leadership role in the development and implementation of an Alaska Climate Services Partnership.
- Advocate for Alaska and the Arctic region in the larger National Climate Service Partnership.
- Provide a distribution mechanism for Alaskan and National Climate Products and Services
- Work with other federal agencies, academia and the research community to transition research to operations
- Identify and address unique Alaska-specific climate issues

Gap Analysis

The demand for relevant and reliable Alaska climate data, information, and services will continue to grow. However, there is no cohesive and coordinated clearing house or service available to provide the information government, industry, academia, and other sectors require to plan immediate response, adaptation, or mitigation actions across Alaska. The information that is available, such as that from the International Panel on Climate Change (IPCC) is too large a scale to be useful for local or regional decision-making.
Alaska needs:

- a forum for users to identify needs (products and services) appropriate for Alaskan and Arctic research and operational purposes
- a mechanism to leverage and coordinate all entities providing climate information
- a specific set of services (including the national services) appropriate for Alaskan and Arctic users
- a mechanism to distribute and provide access to the climate services in the state
- a comprehensive inventory of current research, monitoring and data collection efforts

Immediate Actions

NOAA can take immediate steps to improve/initiate:

- Identify existing NOAA organizations that support NOAA Alaskan customers.
- Inventory and catalog existing NOAA Alaska regional products and services.
- Provide common portal for access and contacting Alaskan NOAA-based activities, products, and services.
- Expand collaboration with academia and the research community as well as other governmental agencies regarding climate change.
- Increase dialogue with stakeholders and customers regarding climate impacts and climate service requirements.
- Maintain and continue to develop NOAA's relationship with the Alaska Climate Change Sub-Cabinet Advisory and Working Groups.
- Engage partners and stakeholders in the development of the concept and blueprint for an Alaskan Climate Service Partnership.
- Maintain an active NOAA Alaskan Regional Team to facilitate engagement of and collaboration with key partners and stakeholders.
- Identify existing NOAA activities that will support state immediate action, adaptation, and mitigation strategies.

Benefits & Risks

- Building the state's knowledge of the actual and foreseeable effects of climate change in Alaska
- Developing appropriate measures and policies to prepare communities in Alaska for anticipated impacts from climate change
- Improving understanding of the causes and impacts of climate change that will enable sound adaptation and mitigation strategies.
- Focused and coordinated Alaska/Arctic customer driven fora and approach to defining climate change impacts and the and the most pressing customer specific needs
- Improved capability to support the development and implementation of plausible and reasonable mitigation and adaptation plans and strategies that cope and respond to regional climate change impacts affecting people and the environment.
- Improved knowledge of ongoing Alaskan operational and research activities – opportunity to reduce individual government, university, and business costs while accelerating results driven outcomes beneficial to sustainable economic growth and security of Alaska and the Nation.
- Alaska specific customer information and access portal for data, information, and services relevant to Alaska and the Arctic region.
- Stimulate private sector entrepreneurial business development and opportunities, new technologies, and applications
- Enhancing local preparation for, and response to coastal inundation, sea ice loss, permafrost thaw, and other phenomena
- Sustaining efforts to integrate and keep engaged wide range of partners. Defining and prioritizing most needed NOAA products and services in view of wide range of users and partners.
- Risks of creating the partnership include the diversion of resources from existing programs and needs; loss of individual control for service providers; and the potential to create additional bureaucracy.

Dependencies: Cooperation and coordination with multiple federal, state, local agencies, Native communities/organizations, private/public business sectors (NSSI, Alaska Pilots Assoc., AK Mariners Assoc., etc.), research organizations (state climatologist, universities, WRCC, ACCAP, RISA, etc.), and international partners (Canada, IARC, AON, etc.).

Climate Change Impacts – Observing and Monitoring

Vision
For the Arctic region, define climate change impacts on socio-economic factors and ecosystems and contribute to executable plans for adaptation and coping with impacts.

Background
Recent real world observed changes in the Arctic region indicate the projections of current models are in some cases not adequately forecasting the recently documented rate and extent of change. One example is the annual arctic sea ice patterns with regard to extent and duration. Scientists need to reevaluate current arctic models and look more closely at the recent rate and extent of observed changes to guide them in evaluating and adjusting the performance of the models. Typical historical observations and conditions are no longer proving to be a solid basis for plausible future projections and predictions as evidence over the past few years. Researcher scientists require adequate quality and number of observations to monitor the present rate of change. Applied scientists need access to more observations and improved models to assist in the daily operational monitoring and generation of forecasts for use by the public.

This vision paper focuses on improving the access to and utility of newly taken observations to support monitoring the current "state of the climate" changes in the Arctic region. While the initial focus is on NOAA observing systems, the intent is to create an inventory and improved access to as many observing systems, NOAA and non-NOAA, operating in the Alaska/Arctic region. It contributes to NOAA plans for additional observations in the region and associated data management and access capabilities.

This vision paper is directly associated with other Alaskan Regional Team vision papers, which directly or indirectly are associated with climate change and impacts related issues.

Objectives
- Close critical observational gaps.
- Improve monitoring of change across Alaska through timely analysis of new observations linked to the historical observational records.
- Contribute to the development, testing, validation and improvements to operational models that provide predictive analysis and probabilities for design and delivery of decision support tools and information meaningful and useful to Alaskan planners.

Mission (NOAA's Role)
Provide climate change monitoring and analyses in support of national, regional, state, and local requirements for planning adaptation and coping strategies, and implementation of action plans that address socio-economic benefits and responsible environmental stewardship.

Gap Analysis
Observing and Monitoring:
- Lack comprehensive inventory of all observing systems that can contribute to measuring and monitoring climate change trends across Alaska and the adjacent marine environment. This includes NOAA, NPS, USDA, USGS, Federal/State DOT, and Others.
- Lack comprehensive inventory of data management archive and access locations for observations, data, and information.
- Lack central web-based "gateway" to easily access Alaska/Arctic data and information.
- Comprehensive solar radiation monitoring network in Alaskaa quality-controlled, comprehensive, and searchable climatological database for Alaska.

Applied Research to Operational Applications:
- Lack Priority List (and associated plan of action for development and transition to operations) for Alaskan decision support tools and other climate change impact related analysis and information from Alaskan user communities.
- Lack Alaskan User driven list of applied research topics and relevant priority.

Immediate Actions
Observing and Monitoring:
- Complete inventory of NOAA observing systems in Alaska. Leverage existing inventory development work done by entities such as AOOS
- Begin deploying USCRN stations in Alaska.
- Experiment with HF Radars for wave and current observations
- Begin inventory of non-NOAA agencies, i.e. AOOS, NPS, USDA, USGS, etc. Draw on existing coordinating entities such as AOOS, North Slope Science Initiative, and GINA
- Develop list for NOAA bottom mounted offshore wave sensors - priority placements.
- Submit list to NOAA NOS LO, IOOS, and Climate Goal GOOS for additional tide gauges (and possibly current meters) at AK coastal locations.

Applied Research to Operations Applications:
- Utilize the Alaskan Governor's Climate Change Sub-Cabinet Committee findings to define and prioritize research to applications requirements in Alaska.
- Conduct or collaborate on a comprehensive inventory of current research.
- Install (examine and tune for future operational runs) NWS NCEP and other potential wind/wave models and coastal surge on to the UAF supercomputer to better support arctic maritime communities and operations via development of return frequency climatologies for:
- extreme events and identifying the associated synoptic drivers.
- Include Alaska coastal zone projects under the NOAA Hazard (coastal) Resilience initiative (PATT).
- AK candidate HCN sites added to official USHCN list of sites.
- Review satellite data for the Arctic region received at Fairbanks for potential immediate use to support Alaskan communities.
- Communicate with the University of Alaska regarding potential joint activities.
- In collaboration with the Sea Grant College Program, the federal and state landowners, and the Alaska Native Regional Corporations, collect anecdotal and historical photo information on changes to local conditions.

Benefits & Risks
- Increase value and utility of satellite and other remote/in-situ measurements.
- Reduced (defer/minimize) cost of implementing adaptive-coping strategies.
- Increased support to Alaskan economic sectors, such as marine transportation.
- Improved model performance and better defined of uncertainty limits.
- NOAA not prepared to provide adequate climate information services across the spectrum of users and needs in response to the surge in natural resources exploration, maritime/aviation transportation, and changes related commerce and economic development in and around Alaska and the Arctic region.

Aviation Weather

Vision
Enhance NOAA's NWS aviation weather forecasts and warnings to contribute towards a continued reduction in the fatality rate for pilots in Alaska through 2015.

Background
While pilot fatality rates in Alaska have decreased 51% during the period 2000-06, they remain well above the national average. A 2006 study by the National Institute of Occupational Safety and Health reported that the commercial pilot's accident rate was five times higher than the national average. The disproportionate accident rate for Alaska is partly the result of the utter reliance of air travel between communities which have no road or other year-around access. Many of these flights are conducted in single engine aircraft, which are often most subject to the influences of weather. Given the size of the state (one fifth the size of the 48 contiguous states) exposure to weather is unavoidable. Improved weather forecasts, education and outreach efforts have played a role in the reduction of accidents during this decade, yet more remains to be done to bring this accident rate in line with the rest of the nation. The recently observed changes in coastal weather, and enlarged forest fire burns also impact aviation, making accurate and detailed aviation forecasts an absolute necessity.

Objective
Continue to contribute towards the reduction in the number of fatal aircraft accidents in Alaska through 2015 by providing more detailed and accurate forecasts and warnings delivered to aviators in a format which best meets their needs.

Mission (NOAA's Role)
- Provide aviation weather forecast products with increased accuracy and spatial detail.
- Provide products that are easy to access, clear in their content, and tailored to pilots' needs.
- Work closely with aviation community to develop and implement pilot education efforts regarding aviation weather.
- Conduct outreach efforts throughout the aviation community to ensure our customers have a clear understanding of the products and services available to them through NOAA's NWS.

Gap Analysis
Aviation Forecast Services:
- Allow NOAA's NWS to be able to translate advances in the science of meteorology towards improved operational aviation forecasts and warnings.
- Ensure these aviation forecast and service improvements are consistent with our customers' needs.

Education:
- Continue efforts to educate our customers in two areas:
- Alaska weather and climate, with a focus on the unique meteorological hazards inherent to aviation operations in Alaska.
- How to interpret and best utilize our aviation forecast products.

Outreach:
- Ensure our customers have a clear, concise knowledge of what aviation forecast products are available to them and how to access those products.

Immediate Actions
Aviation Forecast Services:
- Conduct a thorough review of the current 37 National Weather Service (NWS) Terminal Aerodrome Forecast (TAF) sites across the state to ensure they are representative of the needs of the aviation community.
- Continue development of an Aviation Weather 4-Dimensional Gridded data set (NextGen Weather Information Database). This will provide forecasters at the NWS' Alaska Aviation Weather Unit (AAWU), as well as forecasters at our NWS Weather Forecast Offices (WFOs) throughout the state, with a common meteorological data set. This will allow for a more accurate, consistent suite of aviation weather forecast and warning products.
- Actively pursue the acquisition of additional weather data, to include additional weather radars, meteorological satellite information, expansion of Tropospheric Airborne Meteorological Data Reporting (TAMDAR) systems, and support of the Arctic Observing Network projects.
- Leverage the centralized services of the NWS' National Centers for Environmental Prediction (NCEP) to provide AAWU and WFO aviation forecasters with additional forecasting support and information.
- Explore through research and development the ability to predict forest fire smoke distribution, which impacts aviation.
- Implement a graphical Volcanic Ash Advisory (VAA) at the U.S. Volcanic Ash Advisory Centers (Anchorage, Washington). This four panel graphic will depict 0, 6, 12, and 18 hour forecast positions and tops of ash clouds based upon real time observations, remote sensing, and dispersion model output. This graphic will satisfy International Civil Aviation Organization (ICAO) recommended practices.
- Partner with Flight Service on efforts to develop single internet site tying together all relevant weather product components.

Education:
- Develop a comprehensive "Alaska Weather Atlas for Pilots". This atlas would serve as a comprehensive pilot's guide to Alaska weather, which would be available in both hardcopy and interactive Internet version.
- Examine the feasibility of producing pilot training segments on aviation forecast products and making them available via our AAWU Internet home page.
- Investigate the possibility of developing an aviation segment to be included into NOAA's Virtual World, an ongoing project based on Second Life.

Outreach:
- Revise NWS' Alaska Aviation Weather Unit's current "Alaska Aviation Forecast Products" brochure to include information and services available from other aviation partners.
- Produce "Alaska Weather" educational segments on KAKM-TV which highlight these "Alaska unique" aviation products and services. "Alaska Weather", a cooperative effort between public television channel KAKM and the NWS, is a 30-minute show aired seven days a week across Alaska. Included in each show is an educational/public service segment which could be used to provide outreach to the aviation community.
- Develop a single Internet site which would tie together all relevant weather components (SIGMETs, FAA Weather Cameras, terrain, etc.) into a single geographically referenced, layered map using GIS/ArcView-type technology. Further development of the AAWU Internet home page could provide that resource. Also investigate the possibility of partnering on this effort with the FAA's Flight Service Stations.
- Explore the possibility of deploying weather kiosks to smaller airports across the state, similar to one which is already set up at Yakutat. These kiosks could tie in NWS aviation forecast products to Flight Services web portal briefing and flight planning services.

Benefits & Risks
- Significant growth in the science of meteorology has occurred over the past decade. Failure to apply these scientific and technical advances towards NWS aviation forecast services will result in little or no quantitative improvement to NWS aviation forecast products.
- Alaska is unique in both the number and different types of aviation weather hazards encountered by pilots. A robust education effort must be in place to provide pilots and Flight Service briefers with this critical information in order to continue the downward trend in aviation accident rates.
- New meteorological technologies will produce more accurate aviation forecasts in increasingly pilot-friendly graphical formats. Without increased outreach and education of these new aviation forecast products, pilots will not benefit from these technological gains.
- Unless these multiple resources are integrated into a single, easy-to-navigate site, these weather products will not contribute towards the reduction in pilot fatalities.
- NOAA is not prepared to provide adequate climate information services across the spectrum of users and needs in response to the surge in natural resources exploration, maritime/aviation transportation, and changes related commerce and economic development in and around Alaska and the Arctic region.

Aviation Services – Unmanned Aircraft Systems

Vision
By 2015, Alaska agencies will have the ability to operate Unmanned Aircraft Systems to enable long term monitoring and scientific studies of arctic climate change and weather including but not limited to: arctic pack ice (e.g., age, distribution, and thickness); river ice breakup jam threats (ice condition, location of jams, flooding extent); arctic boundary layer and clouds (e.g., energy balance, clouds, and aerosols); populations and habitat (e.g., ice seals, walrus, caribou, and birds); provision of observations for prediction of high impact weather (e.g., coastal erosion, wildfire suppression, volcanic ash, and oil spill response); homeland security surveillance activities (e.g., pipeline and border control); and ocean and terrestrial observation (e.g., ocean and coastal mapping and ocean color).

Background
Routine monitoring of key atmospheric, ice and ecosystems conditions is very difficult in the Arctic. Access to the arctic airspace is limited severely by current airspace restrictions, and the lack of certification of these aircraft. Most of these restrictions are directly related to the ability of an agency/operator of UAS to obtain certificate of authorizations (COA) from the Federal Aviation Administration. COAs to date have depended on visual flight rules (e.g., daylight, with limited cloudiness) and visual line of site with chase aircraft. Additionally, arctic conditions include frequent cloudiness and long intervals without daylight during periods when NOAA missions would be required. Use of chase aircraft offshore would poise a greater risk to flight crews in a region without search and rescue, and cannot stay on station with UAS for as long as the UAS flights.

Objective
Climate change is occurring throughout the arctic environmental system, and current observation systems are not adequate to detect the full suite of changes that are underway. There is an urgent need for enhanced, coordinated and sustained observing sites, systems and networks in the Arctic. Observations provide essential data on the magnitude, variation and rate of current and past environmental change, and are vital for the initialization, calibration and validation of computer models that allow simulation of the arctic environmental system and its global connections.

Mission (NOAA's Role)
The NOAA UAS project in the Arctic is poised to explore use of UAS to fill key observational gaps, jointly with the Climate Goal.

Gap Analysis
Climate changes are already occurring in the Arctic. The nation should apply 21st Century science and observations to address these changes. The need for measurements in the remote, and yet important, regions in and around Alaska, particularly for climate change, weather prediction and marine mammal monitoring are critical.

Immediate Actions
- Work with the UAS project manager to streamline the COAs process for NOAA missions in a "warning area".
- Urge FAA and UAS manufactures to certify their craft, including provision for "sense and avoid" so that they may fly unencumbered in the National Airspace System (NAS).

Benefits & Risks
An enhanced monitoring network will improve NOAA's ability to forecast hazards that threaten life and property in a timely fashion.

Marine Navigation & Safety

Vision
Provide an integrated and concise suite of NOAA products and services for the marine transportation community to aid safe, efficient and environmentally sound maritime operations.

Background
Alaska's marine environment is one of the most challenging in the nation. NOAA products and services are vital for understanding and forecasting everything from hurricane force storms in the Bering Sea, ice conditions in the Arctic and Cook Inlet, ecosystem health and abundance, and space weather effects on GPS systems and radio communications. Within this challenging environment the Alaska marine transportation system continues to grow and expand. Over 100 cruise ship and 1 million passengers visited southeast Alaska this year. Unimak Pass, a major commercial route through the Aleutian Islands, saw 4471 vessel transits in 2007. This was a growth of almost 25% over 2006 and an additional 5-10% annual growth rate is expected. Receding sea ice in the Arctic has begun to open up these waters to commercial and recreational interests. New sea routes, development of oil & gas resources and increased tourism will all require an increase in the types and quality of NOAA products for the Arctic.

Objective
- Develop an initial assessment of current NOAA marine products and services in each region of Alaska: Southeast, South Central, West, Aleutians and Arctic.
- Integrate across line offices existing and newly developed NOAA marine products.
- Combine NOAA and external partners' observations and infrastructure to provide a fuller awareness of the Alaska marine environment and to identify trends in all aspects of the system.
- Participate in International oil in ice studies and experiments in order to assist the Coast Guard to minimize the effects of a maritime mishap in the Arctic.

Mission (NOAA's Role)
Have a full understanding of marine users' information needs to be better positioned to provide integrated NOAA products and services to remote Alaskan waters as maritime activities and research increase.

Gap Analysis
An overall analysis of the adequacy of NOAA products and services for the maritime community across line offices will identify areas where integration or modification would better serve the community. Currently there is limited baseline data on marine traffic in Alaskan waters. Work with internal and external partners as well as maritime stakeholders to collect information on current and projected Alaska marine transportation system usage will go a long ways in filling this gap. Information on how population growth (Outside and well as in Alaska), increasing energy prices, and the impact these two issues will have on the transportation industry in Alaska is limited.

Immediate Actions
Create an index of NOAA products and services currently available to the marine user. Including but not limited to current and forecast tide, currents, ice and weather information, emergency response tools, environmentally sensitive areas, and Coastal Mapping products. Look for areas of integration.

Conduct Information exchange with the marine community regarding current and future marine products and services. As an initial project, integrate space weather forecast/indices into HF/Navtex marine forecasts to give marine users situational awareness of space weather impacts on satellite navigation and radio communications.

Conduct a study in cooperation with the Marine Exchange of Alaska to develop the process to collect weather data utilizing the AIS (Automatic Identification System) vessel tracking and communications infrastructure and satellite vessel tracking systems.

Benefits & Risks

The benefits of concise integrated NOAA products are the prevention or improved response to marine casualties that result in loss of life, environmental harm, loss of property and interruption of commercial activities such as transportation of goods, and the exploration and production of raw materials.

The risks of not providing the above information are the diminishment of the U.S. role in the utilization of new frontiers in the Arctic and an increase in marine casualties due to the non-availability of information to vessel operators, managers and planners.

Mapping and Reference Framework for Alaska

Vision
By 2020, Alaska will have a geospatial reference frame that will meet national standards of accuracy and resolution to support detailed digital mapping with in the state as well as fast accurate GPS positioning with sub-foot accuracy both horizontally and vertically.

Background
Alaska is the only state that does not have digital imagery and elevation maps at nationally accepted standards. The sheer size and remoteness of the state has precluded this in the past. The underlying horizontal and vertical reference datums, NAD 83 and NAVD 88 are the foundation of our nation's National Spatial Reference System (NSRS), which is the geodetic control system of the National Spatial Data Infrastructure (NSDI), as mandated by OMB circular A-16. However, in Alaska the NSRS does not have the density of control points to support sub-meter accuracies for mapping and positioning activities. In the case of the vertical datum, NAVD 88, it does not even provide coverage to the entire western half of the state. Today, almost all spatial mapping and data collection is GPS based. It is essential for the NSRS to have the accuracy needed to support positioning activities in Alaska.

A number of projects in Alaska will be significantly more accurate and useful if they are built on an updated and accurate NSRS. For example, accurate flood modeling and floodplain determination depend greatly on vertical accuracy of the vertical datum used in creating floodplain maps. To monitor sea level rise and coastal erosion, vertical datum accuracy is also critical. Tsunami inundation models and wild fire predication and control are other areas where accurate positioning and mapping is essential. Many of these are being addressed through the Alaska State Digital Mapping Initiative (SDMI). However, the high resolution and accuracy of the digital elevation model SDMI is planning will only be as good as the underlying reference frames, or datums, that it is built on.

Objective
- To improve the current NSRS in Alaska to meet national mapping standards.
- To increase the density of CORS stations within Alaska especially in coastal regions. To support NGS's GRAV-D plan through planning and budgeting process as a mean to improve NSRS in Alaska
- Assist in the Alaska SDMI to ensure the products are available to all NOAA line offices who's work involves Alaska issues.

Mission (NOAA's Role)
To fully develop the horizontal and vertical datums in Alaska upon which all geospatial data is based and support the Alaska SDMI to provide digital imagery and elevation models that will be beneficial to a wide range of NOAA products and services

Gap Analysis
Two main aspects of a National Spatial Reference System need to be addressed in Alaska. The first is the coverage and density of the continuously operating GPS reference stations or CORS. Currently Alaska has about 30 CORS. Increasing the number of CORS through cooperation and collaboration with internal and external partners will increase the accuracy of positions determined through GPS and will connect remote area of the state with the NSRS. Second, in order to determine orthometric heights ("elevations above mean sea level") a geoid model (part of Earth's gravity field) is needed to covert GPS measured (ellipsoid) heights to the more physically meaningful orthometric heights. (Orthometric heights determine the direction of water flow). Currently the geoid model for Alaska has as much as 2 meters of error. NOAA's National Geodetic Survey (NGS) has developed the GRAV-D plan to conduct a nationwide gravity survey with the aim of developing a high accuracy geoid model for the nation. Alaskan coastal areas are one of the first areas to be addressed in that plan. This survey would provide the vertical accuracies needed to for many geospatial data users, especially those interested in flooding, coastal erosion and other height related issues.

Immediate Actions
- The Arctic Regional Collaboration Team should show support for NGS's GRAV-D plan in annual budget and program input processes
- Collaboration across NOAA line offices and external partners should occur to co-locate a CORS station at existing or planned facilities
- Show support for and assist Alaska's SDMI and provide input to final data products

Benefits & Risks
A well defined NSRS covering all of Alaska that is able to support modern GPS surveying techniques and GIS is a fundamental step in providing accurate positioning for the future. With the importance of the Arctic and climate change in this region, the risk of not addressing this is significant. A well defined and robust reference system is central to all spatial data collected or produced in Alaska.

Arctic Fisheries

Vision
In 2015, commercial fishermen could be harvesting groundfish species north of the Bering Straits.

Background
As ocean temperatures rise, highly migratory fish such as walleye Pollock and Pacific cod are expected to expand their biological distribution and could migrate northward from the southeastern Bering Sea, through the Bering Straits and into the Chukchi Sea. Since these two species comprise the majority of commercial catch in the $2billion groundfish fishery, it is reasonable to expect that the commercial fishing fleet will likewise want to move northward during the summer months to explore and harvest marketable species. Such a shift in historical fishing patterns will require new infrastructure along the Chukchi Sea coast, produce new Russia-U.S. management issues and enforcement conflicts, elevate the risk of oil spills and lost fishing gear, and could result in overfishing of native stocks.

Objective
Continue marine resource stock assessment surveys in the US Exclusive Economic Zone of the Bering Sea and expand the surveys into the Chukchi and Beaufort Seas off Alaska. Calculate relative and absolute abundance estimates for potential target species. Determine if abundance levels will support a new fishery. Determine if changes in ocean temperatures and chemistry are adversely affecting known fish and marine mammal stocks.

Mission (NOAA's Role)
To understand and predict changes in the environment, and to conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs.

Gap Analysis
There presently exist very little information of fish species distribution, abundance, or habitat north of the Bering Straits. Biomass surveys must be undertaken to assess current fish and marine mammal species, their relative abundance, and their likelihood to change as a result in loss of sea ice, increased water temperature and changes to upwelling and currents and increased fishing activity. Ship surveys must continue in the Bering Sea and Aleutian Islands region to monitor shifts in migratory patterns of fish and marine mammal species. Produce products and services that can be used by managers and the industry to define the environmental baseline in this region

Immediate Actions
NOAA must start planning for scientific research in the Chukchi and Beaufort Seas NOAA Fisheries conducted a Beaufort Sea Marine Fish Survey in August 2008 through collaboration with the Alaska Fisheries Science Center, the Universities of Alaska and Washington, and the Minerals Management Service.. Data from the 2004 and 2008 Russian-American Long-term Census of the arctic cruises can also provide baseline information. In addition NOAA should:
- Establish network with coastal residents for purposes of collecting data,
- Sponsor- joint US-Russia scientific projects, and
- Support the establishment of a regulatory regime (a Fishery Management Plan) that will prevent unrestricted exploration and exploitation of marine species until sufficient research has been conducted.

Benefits & Risks
Determine the environmental baseline for fish and marine mammal resources in the Chukchi Sea and Beaufort Sea will reduce the risk of overfishing resident stocks as the commercial fleet expands into the area. Sensitive marine habitat can be identified and protected from fishing disturbance. Scientific information can be used as the basis for US-Russia treaty or co-management agreements. Stock assessment surveys will provide the information needed to determine whether a commercial fishery can be sustained in the Chukchi and Beaufort Seas. Continued stock assessment surveys are needed in the Bering Sea to prevent overfishing known populations.

Bering and Chukchi Sea Oil and Gas Development

Vision
By 2015, the North Aleutian Basin and the Chukchi Sea/Hope Basin will be known as one of the largest oil and gas discoveries of recent times. By 2025, this region will become a major producer of oil and gas for the North American market.

Background
The U.S. Department of Interior Minerals Management Service (MMS) recently proposed an oil and gas program for 2007-2012 that includes one lease sale in the southwest corner of the North Aleutian Basin Planning Area-an area of about 5.6 million acres that includes most of the southeastern Bering Sea continental shelf and all of Bristol Bay. Any sale would be subject to environmental reviews, including public comment, before any development could proceed. The proposed lease sale is currently scheduled for 2011, but environmental studies may begin as early as 2008. Currently, there are no existing leases in the North Aleutian Basin.

In 2008, the first Chukchi Sea/Hope Basin lease sale since 1991 was held and resulted in a record number of tracts receiving bids. The total value of the bids offered surpassed $3.4 billion and the total value for the bids accepted exceeded $2.6 billion. Such a successful sale reflects the heightened interest in this region by the oil and gas industry. Mitigating potential environmental impacts of industry activity on subsistence hunting requires increased knowledge on marine mammal abundance and behavior in the Chukchi Sea region.

Objectives
Develop an up-to-date database for marine resources in the region for use in evaluating potential oil and gas development projects and their environmental effects.

Mission (NOAA's Role)
To understand and predict changes in Earth's environment and to conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs.

Gap Analysis
Considerable biological information was obtained as part of the 1970's MMS OCSEAP. Since then most resource surveys on marine fisheries and marine mammals have been undertaken by NOAA Fisheries and USFWS. Independent research on marine species, marine habitats and oceanography has produced other data. An analysis is needed to determine where data gaps exist and where new data collection efforts should be focused. In addition, detailed wave/storm climatologies, expanded response capabilities, and expanded marine navigation services including marine weather and ice forecasts are needed for safe oil and gas operations

Immediate Actions
Through the NPRB and other overarching organizations, all physical, biological, and economic data need to be identified and cataloged for future use. Continue and expand resource surveys throughout the region. NOAA is reviewing the emerging requirements to define marine navigation requirements and identify priority actions. In addition the agency is establishing new marine offshore weather forecast zones in the Chukchi and Beaufort Seas as well as enhancing their ice forecasting capacity.

Benefits & Risks
The MMS estimates the North Aleutian Basin may contain as much as 750 million barrels of oil. But the basin's potential for nearly nine trillion cubic feet of natural gas makes it particularly attractive for exploration and development. If developed, the basin's energy resources may be worth $37 billion over the next 30 years.

The proposed North Aleutian Basin lease sale lies within some of the world's most lucrative commercial fisheries and pristine wildlife habitat. The exvessel value of Bering Sea king and tanner crab, much of which is caught within the proposed lease sale area, was approximately $55 million in 2007. The nearby Pribilof Islands snow crab fishery was worth about $56 million in 2007. The Bering Sea region also is home to herring, halibut, Pollock, cod, and other groundfish fisheries that together are valued at more than $2 billion each year.

Within the North Aleutian Basin, and east of the proposed lease sale, lies Bristol Bay, which is the center of one of the largest salmon fisheries in the world. Commercial, subsistence, personal use and sport fisheries define the region's people, communities and economy. In 2007, Bristol Bay fishermen harvested nearly 30 million salmon, mostly sockeye, worth almost $108 million. Trophy hunters, photographers, eco-tourists, and others are attracted to the region's several national and state parks, refuges, and monuments. The basin also is considered essential habitat for endangered species including the North Pacific right whale and Steller sea lion.

Ocean Acidification

Vision
In 2015, NOAA will have enough information about the potential effects of ocean acidification on the Alaska marine ecosystems, and will be in a position to explore adaptive management techniques to mitigate adverse effects.

Background
Approximately 30-50% of global anthropogenic CO2 emissions are absorbed by the world's oceans. Increased CO2 uptake by the oceans is expected to reduce surface ocean pH by 0.3-0.5 units over the next century, which would be the largest change in pH to occur in the last 20-200 million years. Ocean acidification reduces the calcium carbonate (CaCO3) saturation point. Dramatic reductions in calcium carbonate saturation have been observed in the North pacific since the industrial revolution.

Ocean acidification likely will impact the ability of marine calcifiers, such as corals and mollusks, to make shells and skeletons from calcium carbonate. This will occur principally because of a reduction in the availability of chemical constituents needed for calcified shells and plates. In addition, ocean acidification may elicit broad physiological responses from non-calcifying organisms through less obvious pathways. For example, changes in ocean pH may affect the availability of nutrients to phytoplankton, the bioavailability of marine toxins to bacteria and phytoplankton, and internal CO2 concentrations of marine animals. Ocean acidification may indirectly affect fish and marine mammal species through reduced abundance of marine calcifiers at the base of the food web. Changes in ocean pH also may affect reproductive success of commercially important species by reducing demersal egg adhesion or the fertilization success of eggs broadcast into the ocean. Coldwater corals provide shelter for structure-oriented species such as rockfish. The numerous pathways for effects imply that ocean acidification may have important impacts on many marine species. Congress is considering the establishment of an interagency committee to develop an ocean acidification research and monitoring plan, to be administered by NOAA.

Objectives
- Understand processes of how high carbon dioxide levels affect calcification, respiration, reproduction, settlement, and remineralization in order to develop models to forecast the impacts of ocean acidification in Alaskan waters.
- Understand whether/how well marine calcifying organisms can acclimatize to ocean acidification effects.
- Understand how species (important for economic, social, and biological reasons) are likely to adapt to life in water that is more acidic than recent historic states.
- Develop adaptive management techniques to mitigate impacts of Alaska ocean acidification scenarios.

Mission (NOAA's Role)
- The NOAA Alaska Fisheries Science Center is responsible for conducting scientific research to support conservation and management of fisheries and marine mammals in the US Exclusive Economic Zone (e.g. 200-mile limit) off Alaska.

Gap Analysis
The AFSC, as part of its integrated ecosystem strategy to studying living marine resources from the North Pacific Ocean and Bering Sea, plans research in four areas to address the threat of ocean acidification:
- Conduct research targeted at understanding species-specific physiological response to ocean acidification.
- Develop models to forecast the population, community and ecosystem impacts of the physiological responses.
- Develop scenarios to forecast social and economic consequences of these impacts.
- Collaborate with NOAA's Pacific Marine Environmental Laboratory to monitor ocean pH.

Immediate Actions
The AFSC has a well-developed single species and ecosystem modeling capability. This capability will be applied to forecast potential effects of ocean acidification (scenarios) and integrate studies of species-specific physiological response. Other immediate actions include:
- Collaborate with NOAA's Pacific Marine Environmental laboratory to monitor ocean pH using AFSC's NOAA and chartered ships. PMEL plans to conduct long-term monitoring of ocean acidification in the North Pacific Ocean and the Bering Sea. AFSC will supply sampling platforms to PMEL scientists as well as collect data during its fisheries and marine mammal surveys.
- Explore partnerships with Sea Grant and the University of Alaska's Institute for Social and Economic Research regarding predictions of social and economic consequences.

Benefits & Risks
The risk of not taking action is that we will be unable to understand the potential impacts of acidification to Alaska and Alaska food webs. Mitigative actions that may be possible through adaptive management require some understanding of impacts in order to be effective. The benefit is that we may be able to maintain stability both of the ecosystem state and of human activities that use the ecosystem.

International Law of the Sea Treaty

Vision
By 2020 the U.S. will have successfully defined the outer limits of an extended continental shelf (ECS) as set out under Article 76 of the 1982 UN Convention on the Law of the Sea (UNCLOS), enabling better management of the living and non-living resources of the ECS over which it has sovereign rights.

Background
Under Article 76 of UNCLOS, coastal states may extend their sovereign rights for exploring, exploiting, and managing natural resources on and below the seabed and subsoil beyond the 200 nautical mile exclusive economic zone (EEZ). This includes oil and gas resources and living resources such as clams, crabs, scallops, sponges, and mollusks that live on the seabed, but does not include rights to conventional (non-sedentary) fish stocks. The Gulf of Alaska, the Bearing Sea, and the Arctic Ocean all have potentially vast ECS regions. Under UNCLOS, nations submit scientific data and reasoning to extend their continental shelf to the Commission on the Limits of the Continental Shelf, which, if supported, strengthen the legal certainty underlying the country's assertion of entitlement. NOAA is leading the data management and integration effort supporting the multi-agency United States effort to characterize its ECS.

Objective
- Establish and maintain a long-term central database and metadata repository to support the analyses and compilation of the United States ECS submission to the CLCS.
- Develop an ecosystem management plan for the resources within the potential U.S. ECS.
- Provide products and services extending to the limits of US jurisdiction.

Mission (NOAA's Role)
- Acquire, ingest, steward and serve data for analysis to define the U.S. ECS.
- Manage living marine resources within the expanded area of the potential U.S. ECS.
- Provide navigation services to support shipping safety within the expanded area.
- Provide forecasts and warnings to protect lives and property.

Gap Analysis
- We know very little about the depth, shape, and geophysical characteristics of the seabed and sub-sea floor for our northern waters and virtually nothing about the resources they contain.
- There is currently no comprehensive Alaska spatial data compilation to support the data analysis and development of the U.S. ECS submission to the CLCS.
- Regular fisheries surveys are not conducted in the Chukchi and Beaufort Sea
- NOAA weather forecasts and warnings do not cover the expanded area of the potential U.S. ECS.
- Bathymetric information is extremely limited north of the Bering Strait.

Immediate Actions
- Coordinate and collaborate with the U.S. Task Force managing the ECS project.
- Design a data management system to support the integration and analysis of data.
- Continue arctic seafloor mapping.
- Extend arctic fishing survey beyond currently planned area.
- Collaborate across agencies to leverage available research funds to manage the ECS area.
- Extend marine forecasts to the extent of the potential U.S. ECS.

Benefits & Risks
- Better accounting and understanding of the living and non-living resources of the U.S. ECS within the Gulf of Alaska, the Bering Sea, and the Arctic Ocean.
- Sovereign rights over the resources on and under an extended area of the seabed.
- Increased weather and navigation information will support safe vessel operations.
- Fishery data will allow for effective management and law enforcement.
- Input into climate and circulation models helping scientists predict future conditions in the Arctic.
- Negative impact on international relations and domestic management capabilities in the region.
- Falling behind neighboring States undertaking work to support their claims to ECS in the Arctic.
- Potential loss of fishery resources.
- Potential conflicts between oil and gas, shipping industries, and marine mammals and other threatened species.

Integrated Ecosystem Assessments for Coastal Alaska

Vision
In 2015, NOAA will have substantially improved and integrated coastal ecosystem assessments to provide Alaska coastal managers with information and tools for scientifically-based decisions on resource management and coastal development planning.

Background
Alaskan coastal ecosystems, to include human communities, are experiencing changes associated with accelerating climate change and increasing coastal development, including offshore oil and gas activities, large-scale mines, and increased population. These ecosystems also continue to be threatened by natural and manmade coastal hazards, including tsunamis, earthquakes, volcanic eruptions, severe (including hurricane force) storms, coastal erosion, harmful algal blooms, and oil spills, among others. Alaska coastal managers need science-based information and decision support tools that are integrated across multiple disciplines to more effectively manage coastal resources and protect community and ecosystem health. NOAA is moving to more effectively meet existing coastal and fishery management responsibilities by adopting ecosystem approaches to management (EAM). An EAM is one that provides a comprehensive framework for marine and coastal resource decision making. More simply, it means looking at the whole picture, rather than just the parts. In contrast to individual species or single issue management, EAM considers a wider range of relevant ecological, environmental, and human factors bearing on societal choices regarding resource conservation and use. Integrated Ecosystem Assessments (IEAs) are tools to support EAM. NOAA senior management has articulated the need for ecosystem based approaches to management, but there are many unanswered questions as to how these approaches can actually be implemented and how IEAs can be used to support that process. Alaska coastal environments provide a key testing ground for these efforts, based both on the scope of NOAA management responsibilities in the state and degree of change it faces in the immediate future.

Objective
- Conduct Integrated Ecosystem Assessments (IEAs) at appropriate spatial scales, including basin (e.g. Gulf of Alaska, Bering Sea, North Slope), regional (e.g. Cook Inlet, Prince William Sound) and local (e.g. Kachemak Bay). Coordinate Alaska-focused projects with national-level efforts, particularly in the Pacific Ocean.
- Conduct pilot projects on improving new technology to ecosystem characterization in remote Alaskan coastal environments.

Mission (NOAA's Role)
NOAA has multiple, cross-line office management responsibilities in coastal Alaska, and will coordinate development of IEAs with state, federal, tribal, academic, non-profit and industry partners. NOAA envisions IEAs as tools to synthesize existing information in an integrated, multidisciplinary framework, to more effectively support coastal management needs and guide future NOAA and partner investments in observing systems and ecosystem forecast models. NOAA will also need to develop more effective ecosystem characterization capabilities to address Alaska's remote environments and challenging conditions. Developing these new capabilities would involve partnerships between NOS (NCCOS and OCS), NMFS (AFSC and Alaska Region) and OAR (Arctic Research Program, NURP, and Sea Grant).

Gap Analysis
NOAA is limited in our ability to meet mission goals in coastal Alaska due to limited or absent analyses of historical data and integrated frameworks for natural science and socioeconomic information that supports coastal management needs. The large extent and remoteness of most of the Alaska coast also requires both novel and integrated approaches to most effectively and efficiently address gaps.

Immediate Actions
- Conduct a pilot coastal IEA at a local (bay or estuary) spatial scale in collaboration with Alaska Ocean Observing System.
- Participate in an ecosystem assessment and research efforts of NOAA budget programming and the North Pacific Research Board.
- Entrain university participants in the Alaska IEA planning.
- Explore need for Alaska-specific, NOAA-sponsored IEA workshop.
- Explore linkages with terrestrial issues such as freshwater inflow

Benefits & Risks
Benefits include providing more scientifically-based and integrated information for coastal management decisions, thus improving the ability of Alaskan coastal communities to proactively adapt to short- and long-term ecosystem changes. Additional benefits include more effective targeting of future NOAA investments in research, observing systems and physical and ecological modeling for the vast Alaska coastline. The risk of not making these investments will be less proactive and potentially costlier coastal management actions, increased economic costs for communities to adapt to the changing ecosystems, and increased risks to public health.

Improving Coastal Observations in Alaska

Vision
In 2015, NOAA will have new operational coastal observing system capabilities to provide Alaska coastal managers with the real-time and climatological information necessary for scientifically-based decisions on resource management and coastal development planning.

Background
Alaskan coastal ecosystems, to include human communities, are experiencing changes associated with accelerating climate change and increasing coastal development, including offshore oil and gas activities, large-scale mines, and increased population. These ecosystems also continue to be threatened by natural and manmade coastal hazards, including tsunamis, earthquakes, volcanic eruptions, severe (including hurricane force) storms, harmful algal blooms, invasive species (including pathogens) and oil spills, among others. Half of the coastline of the U.S. is in Alaska, and existing coastal observations in Alaska are inadequate to support existing and future NOAA and other federal and state agency resource management, marine transportation, emergency response and public health responsibilities in the state. The Alaska Ocean Observing System (AOOS), with NOAA and other partner funding, has started to address these observing gaps, with initial efforts concentrating on physical parameters and within Prince William Sound. NOAA's Integrated Ocean Observing System (IOOS) program addresses these issues at a national level.

Objectives
- Sustain and expand existing NOAA, other federal agency, AOOS and state of Alaska operational coastal observing networks.
- Initiate new monitoring networks, particularly of biological parameters such as harmful algal blooms, to provide information that is currently missing, but critical to natural resource and public health management.
- Conduct pilot projects on improving the application of existing and new technology to making observations in challenging and remote Alaskan coastal environments.

Mission (NOAA's Role)
NOAA operational coastal observation networks include: CMAN stations; NDBC buoys; tide gauges; National Estuarine Research Reserve (NERR) System-wide Monitoring Program (SWMP) stations, and the National Status and Trends Program contaminant monitoring (Mussel Watch and Benthic Surveillance Projects). NOAA also provides funding for AOOS, which supports additional observing networks.

Gap Analysis
NOAA and other federal, state, tribal, academic and private partners cannot effectively meet multiple mission responsibilities in coastal Alaska due to regional gaps in or complete lack of coastal observations for physical, chemical, biological and socio-economic parameters. The large Alaska coastline cannot be instrumented in the same way as the other half of the U.S. coast, so novel approaches and applications of new technology will be required to effectively and efficiently address these gaps.

Immediate Actions
- Support sustained funding, through the NOAA budget planning process, for existing NOAA coastal observing networks.
- Develop coordinated, regional priorities for the new investments needed for targeted expansions of these networks, using Alaska stakeholder input collected by AOOS and others.
- Support sustained funding of operational observing networks operated by non-NOAA partners by providing partners with NOAA requirements for that information. For example, some of the USGS stream gauge data used by NMFS for essential fish habitat efforts may require interagency support to compete successfully within the USGS budget process.
- Collaborate with NURP, AOOS and other partners to support pilot projects for application of new technology, including remotely operated vehicles and innovative power and data telemetry, to make observations in remote environments.
- Partner with existing UAF programs such as those run by faculty of the UAF School of Fisheries and Oceans Marine Advisory Program, who operate community based observation programs in communities such as Unalaska
- Investigate collaborative efforts between NOAA and the State of California for application in Alaska.

Benefits & Risks
Benefits include providing the sustained, multidisciplinary observations in coastal environments needed for resource management, maritime safety and transportation, emergency response, coastal development, research and other NOAA coastal missions. Without this information NOAA is less able to meet its management responsibilities, and there are increased risks to maritime safety, decreased efficiency in maritime commerce, increased economic costs for communities to adapt to ecosystem change, and increased risks to public health.

Ecological Forecasting for Coastal Change

Vision
In 2015, NOAA will have developed an initial ecological forecast capability to provide Alaska coastal managers with information and tools for scientifically-based decisions on resource management and coastal development planning.

Background
Alaskan coastal ecosystems, to include human communities, are experiencing changes associated with accelerating climate change and increasing coastal development, including offshore oil and gas activities, large-scale mines, and increased population. These ecosystems also continue to be threatened by natural and manmade coastal hazards, including tsunamis, earthquakes, volcanic eruptions, severe (including hurricane force) storms, harmful algal blooms, invasive species (including pathogens) and oil spills, among others. Alaska coastal managers need science-based information and decision-support tools to more effectively manage coastal resources and protect community and ecosystem health. Ecological forecast models provide a tool to assess the risks posed to resource conservation and sustainable use by taking or not taking specific management actions. Developing and operating ecological forecast models requires an integrated understanding of the ecosystem (link to Integrated Ecosystem Assessment vision paper), as well as sustained observations for input to the models (link to Coastal Observations vision paper).

Objective
Initiate development of a coastal ecosystem modeling capability to support coastal management needs in Alaska.

Mission (NOAA's Role)
NOAA's primary use of ecological forecasts in Alaska is in fishery stock assessments and these tend to be empirical, statistical models focused on a single species. At a national level NMFS, NOS/NCCOS and OAR/Sea Grant are seeking to develop ecosystem forecasting capabilities. NOAA has needs for ecological forecasts that link coastal and offshore processes in support of federal and state fishery management, as well as for coastal management such as shellfishery management, development planning and public health.

Gap Analysis
NOAA has almost no coastal ecosystem forecast capability in Alaska. Models need to be developed that help coastal managers better assess the risk of action or inaction on their part. Operational ecosystem modeling will ultimately require investments in human and facility infrastructure to develop and run the models, as well as provide output products and services.

Immediate Actions
Participate in NOAA planning efforts of the Ecosystem Research Program and Ecosystem Goal Team related to ecological modeling, to provide Alaska Region input to that process. Initiate discussions with federal, state, tribal, academic, industry and non-profit partners about a workshop on ecological forecasting needs for coastal Alaska.

Benefits & Risks
Benefits include accelerating the process of identifying requirements for and developing ecological models for coastal management support in Alaska. An additional benefit will be to improve guidance for investments in coastal observing systems and ecosystem assessments. Ultimately these models will provide improved decision-support tools for coastal managers and help communities to more proactively respond to the accelerating coastal ecosystem changes in Alaska. The risk of not starting to develop ecological forecasting capabilities now will be less effective targeting of resources for observing systems, delayed implementation of decision support tools for coastal management, and increased economic and public health costs to adapt to ecosystem changes.

Integrated Water Resources – Precipitation Frequency Estimates, Predictions, and Streamflow

Vision

By 2015, Alaska will have information about the quantity, timing, and quality of water on key waterways to enable wise decision making about the impacts of low water, high water, flood waters, and interactions of freshwater with marine coastal waters. Alaskans will be able to expect infrastructure design and site selection based on updated precipitation frequency and flood frequency analyses using data that reflects the current climatic regime. Additionally, methodologies will be utilized or developed to assess streamflow in the many ungauged basins throughout the State where ground-based monitoring is not feasible. Improved methodologies for forecasting streamflow will be developed.

Background

Alaska has 3000+ river systems, with over 90% of those currently unmonitored. All Alaskans rely on inland and coastal waterways in one or more ways, including but not limited to industry, transportation, food, potable water, energy, and culture. River systems provide important habitat for species important to subsistence and commercial interests. Moreover, coastal freshwater discharge plays an extremely important role in the marine ecosystems surrounding Alaska. Precipitation frequency estimates are required for design and construction of infrastructure. Presently, engineers are using an outdated precipitation frequency estimate for design of new structures and the prediction of precipitation amounts is a nascent science in Alaska. Increasing understanding of current and expected conditions in all of these areas will allow sound decision making to improve protection of life, property and the management of Alaska's biological resources.

Objective

Increase the number of rivers that are monitored or modeled to forecast water quantity and quality. Utilize proven and robust techniques, such as forensic (or paleoflood) hydrology, to determine maximum flood exceedance values and flood frequencies for Alaska's numerous ungauged basins. Develop remote sensing capabilities and runoff models to provide tools to quantify aspects of hydrologic budgets at the watershed scale and at time steps ranging from daily to annually. Coordinate an update of the precipitation frequency estimates for design of Alaskan infrastructure. Improve the prediction and verification of precipitation amounts. Increase our knowledge of the impact of water quality and quantity on the freshwater-seawater interface and the ocean and how these characteristics and interactions may be expected to change with various potential climate scenarios.

Mission (NOAA's Role)

NOAA uses observations of water quantity and water quality, as well as precipitation predictions, to make forecasts of future conditions. NOAA studies and measures the impacts of these characteristics on the biomes and structure of rivers, lakes, estuaries, and oceans. Other mandates include

- Provide climate data and information that meets rigorous scientific standards for quality. (Data Quality Act).
- Provide access to Climate Data and Information (timely, easy, and convenient) related to the state and changing state of the climate system in a variety of formats to NOAA's customers, Federal Records Act, National Climate Program Act, NARA Records and Guidelines, ICSU World Data Center Guidelines & Policy).
- Provide monitoring, assessment, and analysis of the climate system through adequate quality observations and measurements of atmospheric, ocean, and select terrestrial "essential" variables. Global Change Research Act, National Climate Program Act, and National Weather Service Organic Act).
- Analysis and interpretation of hydrologic data for planning works of improvement (Hydrologic Support to Department of Agriculture: 16 USC 1005)

Gap Analysis

Updated precipitation frequency estimates must be prepared to support state planning. Currently, there are less than 200 real time river gages in Alaska, with less than 100 of these reporting on any components of water quality. Additional discharge and water quality measurements are needed on key representative rivers. The US Geological Survey's (USGS) National Streamflow Information Program (NSIP) was designed as a nationwide system of federally-funded stream gauges that would provide information for several purposes, including flood forecasting by NOAA. In Alaska, an analysis was conducted to determine the optimum network design. This analysis was used to create the NSIP list of stream-gauges. Geographic Information Systems, precipitation and flood frequency studies, new mesoscale meteorological, hydrologic and hydraulic models and techniques, greater forecaster involvement, and advanced remote sensing tools may allow development of novel forms of gridded forecasts as tools for non-gauged areas, as well as gauged areas. Inclusion of new research and models is needed to better understand the physical and chemical characteristics of freshwater-seawater interfaces.

Immediate Actions

NOAA is working with collaborators such as the USGS, Natural Resources Conservation Service, and the university systems to maximize use of new and existing observation sites for multiple purposes by adding additional sensors. New hydraulic, hydrologic, meteorological, and general water circulation models are being identified or developed. Coordinate updating of the presently outdated precipitation frequency estimate. NOAA's Alaska Region and one of NOAA's national centers have just initiated a partnership to enhance weather predictions through real-time collaboration.

Benefits & Risks

An updated precipitation frequency estimate,enhanced modeling capability, and greater forecaster focus, and monitoring network will improve NOAA's ability to forecast hazards that threaten life, property, and terrestrial and marine environments in a timely fashion. Benefits of a greater understanding of hydrologic processes derived from a program of long-term monitoring, innovative modeling, and specialized forecaster training, are no less than a revolution in the understanding of Alaskan hydroscience and its prediction. There are also more modest, but equally important benefits, such as the ability to provide the State and Native villages the information necessary for relocation due to hydrologic, glacial, or sea level threats. The Department of Transportation and Public Facilities, Boroughs, and municipalities benefit from long-term hydrologic monitoring by using these data to properly construct bridges, culverts, storm water collection and treatment systems, and other roadside drainage features. Undersized bridges and culverts are prone to damage or destruction in floods thus requiring costly repairs. Undersized storm sewer systems can lead to unsafe driving conditions and ineffective storm water management. Oversized bridges, culverts, and other drainage structures have unnecessarily high construction costs. Furthermore, this same information can benefit zoning decisions, thus saving life and property by insuring Alaskans are not building in a previously-unrecognized floodplain. Finally, a better understanding and prediction of Alaska's hydrologic processes will affect both freshwater and marine fisheries management.

Integrated Water Resources – Climate Change Impacts

Vision
Alaska's land resource managers, industry, and subsistence users will be provided with near to long-term drought and water availability information for planning and management.

Background
Climate changes are already occurring in the Arctic. Observed data over the last 30 years show that mean annual surface temperatures have increased by 3-5 ˚C with some of the largest increases occurring on the Alaskan North Slope. As temperatures continue to rise, changes in precipitation and an increase in evapo-transporation are also expected and permafrost will continue to thaw. This may result in an overall net decrease in stream discharge and a net dryer environment with long-term drought issues. To the contrary, headwater glacier areas are expected to see an increase in stream discharge particularly during the spring and fall months.

This increase in temperature may also bring about longer, more severe and more widespread fire seasons in Alaska. Based on annual precipitation, much of interior and northern Alaska can be classified as a desert; however, due to the approximately six months of freezing temperatures that precipitation is only used by vegetation for the other half of the year. With an extended warm season, the water needs of the vegetation will expand as well and the available moisture may be insufficient.

Objective
Provide a better understanding and forecasts of hydrologic changes in Alaska and how these changes (such as the thawing of permafrost and extended warm seasons) impact such diverse areas as wild fire activity, industrial transport on water and ice, subsistence travel and harvest, and habitat and migration of wildlife.

Mission (NOAA's Role)
Work with stakeholders to provide enhanced precipitation estimates and short term and long term drought forecasts including enhanced hydrologic information on water availability, quality, and quantity both for stream flow and vegetation.

Gap Analysis
Alaska stakeholders currently have limited access to precipitation data in a useful form that is available from the regional climate center (Western Region Climate Center). NOAA currently lacks the ability to produce gridded hydrologic modeling for Alaska, and limited ability to provide the tools needed for near and long term drought forecasting.

Immediate Actions
NOAA's Alaska Pacific River Forecast Center will continue to monitor the implementation the National Operational Hydrologic Remote Sensing Center's gridded physically-based snow modeling in Alaska. They will also develop techniques that will be needed to run a distributed hydrologic model in Alaska. Additionally, NOAA's NWS will work with the University of Alaska Fairbanks to integrate regional climate information and permafrost hydrology to produce hydrologic response scenarios.

Benefits & Risks
The Alaska Department of Natural Resources has shown that they can mount a successful initial attack on a small fire with an average cost of $5,000 dollars per incident, whereas the cost to suppress a well-developed fire in Alaska generally ranges between $3 M and $30 M dollars. Improved weather and soil moisture forecasts have obvious and great cost benefits for every U.S. taxpayer. There are also significant costs related to infrastructure modifications as they relate to thawing permafrost impacts and changes in regional hydrology. Traditional knowledge regarding subsistence travel and harvest are valuable and should be documented and supplemented with new data collection.

Alternative Energy Support

Vision
In 2020, the number of operating wind and ocean energy plants make Alaska the US leader in the use of alternative energy.

Background
Alaskan governments and industries are advocating the development and adoption of alternative energy use in the state. Organizations such as the Alaska Industrial Development and Export Authority and the Alaska Energy Authority are 'looking at tidal and ocean energy to displace diesel in areas of Alaska that make economic sense.'

Objective
Foster the development and the operations of alternative energy facilities while ensuring environmental protection.
Proactively work with developers in the design stage to address environmental concerns and reduce the problems identified at permit review stages.

Mission (NOAA's Role)
Provide weather, water, and climate products and services to ensure the most effective and efficient siting and operation of alternative energy facilities.

Gap Analysis
Right now, other than hydropower support, NOAA has virtually no relationship with the energy industry in Alaska. NOAA will need to make contacts within the energy industry to identify and understand the requirements of each type of alternative energy. Once the requirements and interests of the industry are known, decisions can be made on what products and services are appropriate for NOAA to provide. For example, NOAA has the capability to produce wind climatologies, long-range wind forecasts (like CPC's temperature and precipitation), and peak gust estimates. On the ocean side, tidal facilities may be better sited with the aid of NOAA fisheries consultations, bathymetric surveys, tidal measurements, circulation modeling, storm surge estimates, and ice analysis while operations could be enhanced by turbidity forecasts, ice and storm surge forecasts, and ocean temperature predictions (if used in cooling, etc.).

Immediate Actions
In the near tern, the ARCTic will establish ties with the Alaska Industrial Development and Export Authority and Alaska Energy Authority, attend relevant energy conferences and meet with the Chamber of Commerce and alternative energy industry representatives to establish initial relationships. Current circulation model activities with the USACE and academia in Cook Inlet will lay the groundwork for the information needed to support ocean energy development.

Benefits & Risks
Helping the alternative energy industry in Alaska succeed will pave the way for additional development across the US and a reduction in oil dependency. This effort will demonstrate products and services needed for this emerging customer sector.

NOAA Ocean Environmental Literacy/Planet Earth Curriculum

Vision
By 2020, establish an ocean literate Alaska through a new integrated Planet Earth environmental degree curriculum in the University of Alaska system and through an array of ocean outreach and education programs targeted to all sectors.

Background
Planet Earth Curriculum: There are currently many individual components of an environmental degree at different campuses with programs in marine sciences and engineering. However, there is no meteorology or climate degree program in the University of Alaska. If such an integrated program could be developed that would fill the meteorology/climate gaps and tie them all together, we could encourage more Alaskans to work in Alaska after graduation, and hence facilitate the education of Alaskan citizens, municipalities, and industries (and the world) about the interconnections of the planet's land/water/ice components and how their changes affect living things on the planet. Successful implementation of an integrated Planet Earth environmental degree program would not only meet all seven objectives in the Outreach and Communications Team plan, it would position Alaska to be a leading resource of experts in environmental evolution and how to best manage the evolution for the benefit of all. Ocean Outreach/Education Programs: NOAA would collaborate with a number of partners to develop outreach and education tools, products, and services targeted to all segments including schools (K-12), university students, general public, visitors, Alaskans, and the world.

Objective
Develop a NOAA cooperative model of fostering research in a multi-faceted discipline that would establish an ocean literate Alaska accomplished through a curriculum in the University of Alaska and through a myriad of ocean outreach and education programs.

Mission (NOAA's Role)
The ARCTic recognizes the importance of public outreach and environmental literacy in Alaska. The unique characteristics of the Alaska Region and the role NOAA plays in addressing economic, social and environmental needs in Alaska provide an opportunity to effectively showcase NOAA's contributions within the region, nationally, and internationally. The ARCTic would support NOAA's commitment to promote and enhance environmental literacy, both regionally and globally, through partnerships with stakeholders.

Gap Analysis
The Planet Earth curriculum is a non-traditional program that may take five years to complete and may require several "work study" projects in the field. Successful implementation of an integrated program would position Alaska to be a leading resource of experts in environmental evolution and how to best manage the evolution for the benefit of all.

Immediate Actions
Collaborate with the University of Alaska and others to:
- Build on existing NMFS and NOS Alaska Native education efforts to increase minority opportunities within NOAA.
- Expand opportunities for students in oceanic and atmospheric sciences.
- Implement NOAA science-based mentor programs that encourage students to seek future careers with NOAA.
- Coordinate with communities to establish "work study" projects in the field that model an integrated Planet Earth curriculum.
- Develop a collaborative network of ocean educators and scientists in Alaska.
- Create various ocean outreach and education products that encourage a deeper understanding of NOAA's role in the complexities of global and regional forces.
- Educate Alaskan citizens, municipalities, industries, and the world about the interconnections of the planet's land/water/ice components and how their changes affect living things on the planet.
- Develop various outreach and education services that reach out regionally and globally to provide information about the Alaska region.
- Provide all Alaskans the information and tools needed to make and/or understand the tough decision that lie ahead with respect to climate change, and better assist each other in dealing with resiliency.
- Explore opportunities to incorporate Weather Service Offices, Warning Coordination Meteorologists, Sea Grant Extension agents into the strategy.

Benefits & Risks
The benefits of a literacy program are immense and would have a direct impact on how NOAA provides products and services in the future. An established partnership with the University that includes a well-developed curriculum would provide the public with tools and resources to have a better understanding and knowledge of climate change in our environment. This curriculum could use some of the ARCTic educational tools that are in place including Science on a Sphere and Virtual Alaska.

Coastal Erosion Collaboration

Vision
In 2020, Alaska is provided with coastal hazard products that are responsive to the dynamically changing coastline which threatens a number of Alaska communities.

Background Arctic Ocean and the warm waters of the Pacific generate a steady stream of significant weather hazards that make NOAA's task especially challenging and which merit frontline support. These result in annually damaging events to coastal infrastructure and fisheries, commercial and subsistence alike. There is high interest in coastal erosion in Alaska and its threat to various villages and towns. There is increasing awareness not only nationally but globally.

Objective
Create a collaboration of federal agencies and researchers with affected villages to monitor the erosion of Alaska coastline near villages and their transportation infrastructure so that the impacts of coastal flooding, high surf and the resulting erosion can be anticipated.

Mission (NOAA's Role)
Provide weather, water, and climate products and services to ensure appropriate actions are taken by villages in advance of, and during a coastal hazard threat.

Gap Analysis
NOAA's NWS offices in Alaska issue Coastal Hazard products (Coastal Flood Warnings or High Surf Advisories) according to their mission to provide warnings for the protection of life and property. Unlike the occurrence of many other weather hazards, each coastal erosion event creates a more serious situation for the next event that may come along – be it a day later or a year later. Keeping track of the erosion and flood potential at each coastal village is an important way each NWS forecast office can tailor the coastal hazard statements to each community whenever a coastal hazard event is expected. Utilizing modern technology (Aerial Analysis, Lidar, Satellite remote sensing, GIS, modeling of storm surge and wave height, etc) melded with routine village contact and ground-truth measurements at designated sites at each affected community will create and maintain a threat database that would be dynamically updated through manual means and technology. This database would be shared with the public via NOAA website, and tailored to be understood by the general public.

In addition to extremely detailed surge and bathymetry needs, addressing coastal erosion would also require spatially and temporally detailed follow up to re-categorize bathymetry and shore profile at the very least once per season.

Immediate Actions
- Develop a ground truth hazard measurement procedure which can then be taken to each affected village in order to provide training to a qualified individual.
- Prepare outreach and/or education sessions that will also be delivered in each community, tailored to their particular environmental hazards, especially those associated with coastal erosion. (For instance, some content from the State Division of Homeland Security and Emergency Management's Fall Sea Storm Guide, annually distributed to each village can be incorporated into the outreach and education). As the database is built and provided in a way that the general public can understand, then provide training on those graphics to each village.
- Create a preliminary schedule of visiting the affected communities.
- Collaborate with USGS, USACE, and others to maximize shoreline mapping efforts and resources.

Benefits & Risks
As shore erosion continues at locations along Alaska's coast, and as this phenomenon continues to grow in national and global awareness, NOAA will be increasingly called on to provide greater expertise and service in the monitoring and forecasting of coastal hazards to these villages. This will help build NOAA's expertise and responsiveness to its Alaska customers. A risk associated is the buy-in by each village to assist in providing ground-truth data on a regular basis. A second risk is the potential lack of permanence of maintaining the ground truth data. A third risk is maintaining adequate funding to visit all affected villages on a yearly basis. A fourth risk is acquiring adequate funding to incorporate new technology in the years ahead.

Sea Ice Observation Program

Vision
Establish a sea ice observation program to ensure a consistent, coherent sea ice database going forward.

Background
Sea ice observations are not standardized. In addition there is no sea ice observation training program. These circumstances make correlation between sea ice observations and remote sensing tools problematic, and limit the usefulness of human observations.

Objective
- Identify and engage all stakeholders (e.g., USCG, whaling captains, etc.);
- Develop a sea ice observation plan, and training program for observers;
- Develop a means to format and disseminate observations to all stakeholders in a timely fashion;
- Ensure sea ice observations are archived in a database;
- Correlate sea ice observations with imagery from remote sensing tools;
- Collaborate with international organizations to work towards consistent products and services.

Mission (NOAA's Role)
Serve as a resource and center of gravity for the sea ice observation program at both the national and international levels.

Gap Analysis
Currently the US has no coherent sea ice observation program.

Immediate Actions
- The NWS Forecast Office in Anchorage has begun collaboration with the US Coast Guard to develop a framework for a sea ice observation program.
- This effort could be coordinated with similar programs in Canada.

Benefits & Risks
- Increased quantity and quality of arctic sea ice observations will enhance marine safety;
- Increased quantity and quality of arctic sea ice observations will improve sea ice models and sea ice forecasts;
- An improved arctic sea ice observation program will enhance Search and Rescue effectiveness as well as spill and HAZMAT response capabilities.

Ice Analysis

Vision
Provide a clear assessment of the arctic sea ice evolution to enable people to make informed choices and plans for the future.

Background
Satellite observations indicate arctic sea ice has decreased measurably during the preceding 30 years. However, no holistic examination of arctic sea ice data exists prior to the advent of satellite to help better characterize the longer term trends.

Objective
- Establish an arctic sea ice trend analyses for the Bering, Chukchi and Beaufort seas that will provide a baseline for understanding climate change and its potential impact on the arctic ecosystem and commerce to include data and information prior to the advent of satellite imagery;
- Enhance the Alaska Sea Ice Atlas to include a web interface, and real-time update capability;
- Utilize comprehensive arctic sea ice analyses to better understand polar ocean circulation systems, the polar atmosphere, and the Arctic climate;
- Utilize comprehensive arctic sea ice analyses to improve global climate models.

Mission (NOAA's Role)
Serve as a resource and a center of gravity for both national and international collaboration to ensure that the historical ice record is optimized. The NWS Anchorage WFO Ice Desk, National Ice Center, and National Snow and Ice Data Center are the NOAA entities involved.

Gap Analysis
Currently there is no complete geospatially enabled arctic sea ice analysis database integrating knowledge from the indigenous people, empirical observations, human analyses, as well as remote sensing tools.

Immediate Actions
- The NWS Forecast Office in Anchorage is finalizing a proposal to digitize the 28 year record of sea ice analyses in the vicinity of Alaskan waters.
- This effort could be collaborated with similar efforts in Canada, Russia, and Scandinavian countries to ensure the database covers the entire arctic in an internally consistent fashion.

Benefits & Risks
- A complete and accurate historical record is essential in order to make timely and accurate decisions, and forecasts of arctic sea ice.
- Without a comprehensive sea ice database atmospheric, oceanographic, ocean circulation, and ice model forecasts cannot be validated properly.
- Without a comprehensive sea ice database critical decisions at the national and international levels that impact commerce, the environment, and the peoples who inhabit the arctic regions are problematic.

Sea Ice Decision Aids

Vision
Develop arctic sea ice expert systems that incorporate indigenous knowledge as well as science to assist governmental and business decision makers, and end-users in making consistent, informed choices.

Background
There are a variety of independent information sources regarding arctic sea ice. These resources range from anecdotal observations and insight from indigenous people, satellite imagery, buoys, to sea ice forecast models.

Objective
- Implement a methodology to categorize ice regimes in a consistent manner such as the method the Canadian Coast Guard used for decisions on passage of ships of a certain ice class.
- Implement a data mining application to sift through large amounts of data to produce data content relationships, and extract hidden patterns in the arctic sea database;
- Improve arctic sea models to enhance simulation and hindcast capabilities as well as sea ice forecasts;
- Develop a scalable, interactive Decision Support System (DSS) that integrates all arctic sea ice related resources in a systematic fashion.

Mission (NOAA's Role)
Serve as a Center of Excellence for arctic environmental databases, sea ice analyses and forecast models, and DSS.

Gap Analysis
- No consistent method to categorize ice regimes is used in Alaskan waters;
- Very little work has been performed to assimilate science-based and traditional knowledge to provide a more complete understanding of arctic sea ice;
- No DSS exists to assist arctic communities, or groups with interests in the Arctic make consistent, informed decisions that affect safety of navigation, the economy, resource management, and ecosystem protection;
- No single source for education and training exists for arctic residents, users and advocates arctic resources, and arctic researchers.
- Research and development of sea ice models considerably lags the resources allocated to oceanographic and atmospheric models.

Immediate Actions
- Survey NOAA assets (e.g., NWS AR, National Ice Center, NWS NCEP/CPC and EMC, NOAA Fisheries Service, NCDC, etc.) to determine the Subject Matter Experts, and the current state of activity related to arctic sea ice within NOAA.
- Use NOAA SME's to identify potential external partners and SME's (e.g., university researchers, village elders, oil/gas/mineral producers, marine shipping companies, etc.)

Benefits & Risks
- A comprehensive characterization of arctic sea ice would provide the necessary baseline for sea ice forecast models and DSS's;
- An improved sea ice decision making process would enhance safety, and socio-economic and public-policy decisions;
- Tactical and strategic judgments are problematic without a coherent arctic sea ice decision making process.

Sea Ice Ecosystem Impacts

Vision
Advance our understanding of arctic sea ice dynamics, particularly in response to increased climate variability, in order to predict physical, biological, social and economic consequences.

Background
Long term historical sea ice dynamics are only partially understood, but observations over the past two decades suggest that reductions in ice coverage (such as more northerly seasonal extent in the Arctic Ocean) may be a result of increased global climate variability. Ecosystem level impacts may be dramatic, ranging from changes in the demography and distribution of marine species, community structure and habitat characteristics, to disruption of commercial and subsistence use opportunities, to rapidly altered patterns of human use in the Arctic (e.g., marine transportation, commercial fisheries and oil/gas development). While none of these changes may be directly influenced by increased understanding of sea ice dynamics in and of itself, an organized effort to collect available information, augment its scope and extent and enhance opportunities for its use are critical to incremental growth in science-based advice to managers and the public so that they may make informed decisions of benefit to both stewardship and anthropogenic goals.

Objectives
- Foster the development of systems to create and maintain readily accessible databases that include (and where possible to link) the widest practical range of biological, oceanographic, atmospheric, social and economic parameters;
- Facilitate access to these data and promote expansion of the databases themselves;
- Increase interest and opportunities for conducting collaborative research by facilitating both access to data and communication among interested parties;
- Develop strategies to assess ecosystem impacts.

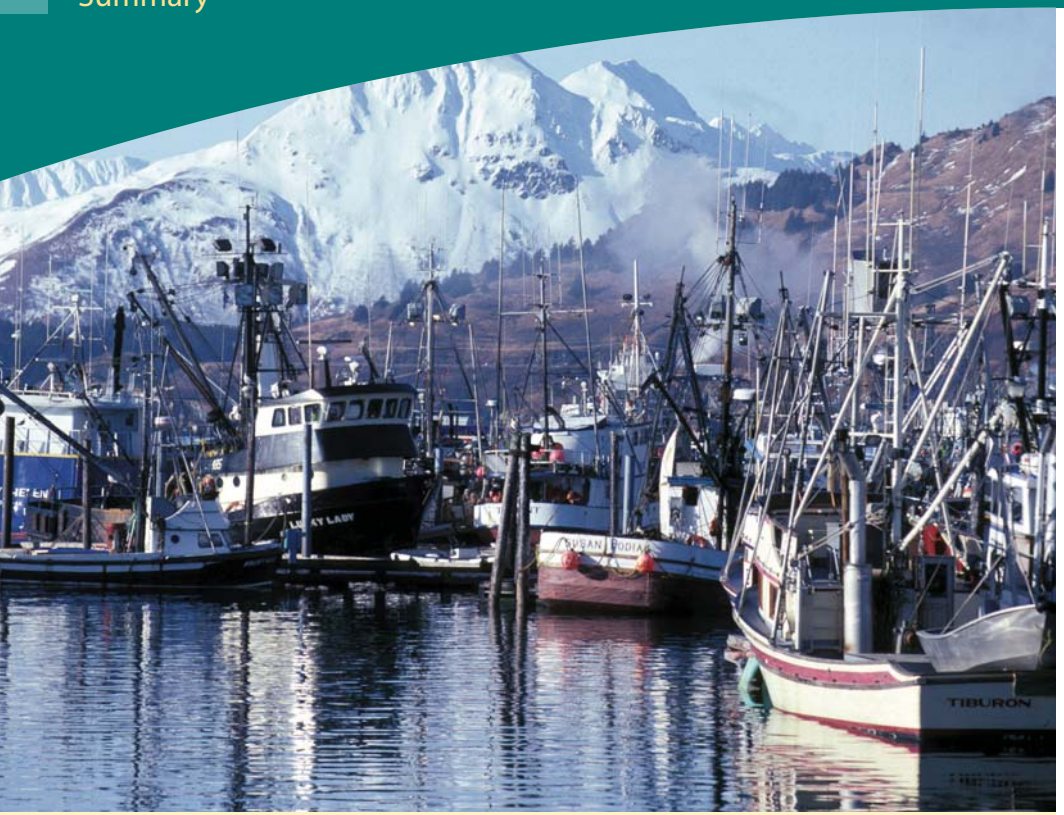
Mission (NOAA's Role)
Build on NOAA's Ecosystem Goal Team efforts to develop an Ecosystem Approach to Management (EAM), with emphasis on an Integrated Ecosystem Assessment (IEA)for Alaska. Using this work as a catalyst, engage foreign, state and local governments, as well as non-governmental organizations with interests in the Arctic to coordinate current monitoring efforts, devise new monitoring procedures and promote ongoing ecosystem scale research.

Gap Analysis
- Very little has done to coordinate current or future ecosystem observational activities in the Arctic;
- No mechanism exists to relate historical arctic sea ice data and associated changes in the physical oceanography to ecosystem impacts;
- An integrated weather, water, and climate database does not exist to support this

Immediate Actions
- Establish (fund) a pilot IEA in Alaska. This will leverage the information already collected on ecosystem indicators by the National Marine Fisheries Service (and others?) in Alaska to lead the development of an Integrated Ecosystem Assessment protocol that will become the foundation for practical and predictive information for managers and the public. Loss of sea ice in the Arctic Ocean should be included both a result of climate change and cause of downstream ecosystem changes.
- Survey NOAA activities (e.g., NWS AR, National Ice Center, NOAA Fisheries Service, NOS, etc.) and identify cross-cutting activities in the Arctic, particularly those activities linked to ecosystem health;
- Use NOAA SME's to identify and connect with potential external partners (e.g., university researchers, village elders, oil/gas/mineral producers, marine shipping companies, etc.) working on corresponding activities.
- Collaborate with the Alaska Center for Climate Assessment and Policy on integrating indigenous knowledge.
- Investigate historical information from older Alaskan ice charts dating back to the 1950s (including the impressive summer ice retreats north of Alaska (1954, 1958, 1968)) for placing recent sea ice extremes into context.

Benefits & Risks
- Coordinated and collaborated ecosystem monitoring/assessment activities would more effectively use limited money and resources;
- A multidisciplinary effort would have a greater chance of correctly characterizing the major issues related to changes in the arctic sea ice and thus be in a better position to provide solutions;
- Allowing both governmental and non-governmental organizations to proceed independently pursuing ecosystem impact studies will lead to a greater likelihood of incoherent or incompatible public policies.
- Delay in efforts to increase our understanding of ecosystem scale consequences of sea ice dynamics may have highly adverse impacts and efforts to accelerate the pace of those efforts is not only warranted, but likely to be cost effective.

Summary



The Alaska Regional Collaboration Team and this Project

The Alaska Regional Collaboration Team was formed in the fall of 2006 to enhance customer and stakeholder relationships and facilitate collaboration across NOAA and its partners. In 2007, the team embarked on a process to increase mutual awareness among Alaskan NOAA offices and key customer groups and develop an approach for strategic product and service enhancements. This document is the first product of that effort.

This Integrated Services Plan outlines the process the team used to engage key customers in assessing where we are now and what conditions and circumstances the agency must plan for in the future. The objective was to find common goals and identify the NOAA role in reaching those objectives.

Based on face to face meetings with customers and partners as well as compiled information from many sources such as the Arctic Climate Impact Assessment, the Arctic Observing Network, Arctic Marine Shipping Assessment and the NOAA Alaska RISA, the Arctic Marine Shipping Assessment, the Alaska Ocean Observing System, we identified the following drivers for future NOAA planning.

Drivers for Future NOAA Planning

Climate change was consistently identified as an overall driver that is impacting and will continue to impact NOAA services in Alaska. Researchers have predicted that Alaska be one of the areas where impacts be felt early and significantly, and current observations indicate that this is proving to be the case. Increased erosion on Alaska's west coast due to a later arrival and earlier departure of sea ice is threatening to destroy coastal communities such as Shishmaref and Kivalina. Other coastal areas are also feeling the pressure of erosion and inundation, with over 150 communities in danger.

The sea ice retreat has been far more rapid than predicted by the Intergovernmental Panel on Climate Change and has enhanced activity in several sectors. Maritime shipping is one of these areas. The Arctic Council's Arctic Maritime Shipping Assessment will be released later this year. What is clear already is that while companies might not fully exploit the 40 percent distance savings of using the northwest and northeast passages across the Arctic for decades, more and more vessels are in the Arctic each year. The largest growth is occurring in the cruise ship and regional, and oil and gas exploration sectors. More fishing vessels are also being seen, although no commercial fisheries have been established north of the Bering Strait.

Decreased sea ice has also enabled increased activity in seafloor mapping in the Arctic related to resource claims under the Law of the Sea Treaty. Nations are actively researching seafloor features that would allow them to claim sovereignty over areas with great energy and other resource potential. More traditionally, the February 2008 oil and gas lease sale for the Chukchi Sea yielded a record $2.6 billion in accepted bids. These regions have a lack of maritime transportation support and incident response infrastructure and this is causing concern as the number of vessels plying the Bering, Chukchi, and arctic seas increases. If an incident similar to the sinking of the M/V Explorer cruise ship in the Antarctic occurred off Alaska, the outcome might not be as fortunate.

Expansions in explorations for oil, gas, and mineral resources and increases in maritime shipping have prompted the U.S. Coast Guard and the Department of Defense to significantly increase their operations in the Arctic. For the USCG, increased shipping, oil and gas activities, and fishermen exploring the newly ice free seas have added requirements for their Homeland Security, Fisheries Enforcement, Pollution Prevention and Response, and Search and Rescue missions.

While the ultimate climate impacts on fisheries are unclear, ocean temperatures, salinity, acidification and shifts in commercial fish stocks, are topics of high interest. Reports indicate that species are moving: new species of salmon are being caught off the North Slope and pollock are being found further and further north of the Bering Sea. The impact of increasing freshwater inflow to key habitat areas is unknown. While we know that Alaskan fishery resources are among the most vulnerable to the effects of ocean acidification and experiments indicate the survival and growth of juvenile blue king crabs is adversely affected, we need to learn much more before management actions can be recommended.

Other already significant climate impacts in Alaska include: 1) lowering water levels on rivers are preventing supply barges from reaching rural communities, which means fuel must be flown in at a much higher cost; 2) warming temperatures are thawing permafrost and accelerating the growth of wildfire fuels; 3) increasing stream temperatures are exceeding state thresholds for salmon reproduction and growth; and 4) changing weather patterns are increasing aircraft icing dangers and the appropriateness of existing runway configurations.

Planning Scenarios and Recommendations

With these prospects in mind, the ARCTic identified 22 vision papers or planning scenarios where we have common interests with our key customers in improving NOAA services. Topics covered in the papers include aviation; climate change; communications, education, and outreach; ecosystem assessment; marine navigation and safety; freshwater resources; remote sensing; and sea ice. In each scenario, the ARCTic identified what the NOAA role would be and what efforts could be started immediately to address these impending issues.

In developing and examining these scenarios, it is clear that the agency is on the right path with the initiative to enhanced regional collaboration. Addressing these issues will require enhanced integration across NOAA offices, with other agencies, and with external stakeholders. Collectively, the information garnered from this assessment effort has signaled that the agency must focus on ensuring it can provide the leadership, foundational infrastructure, and expanded collaboration to meet the challenges of the coming decades.

Leadership

NOAA provides key products and services for understanding, predicting and adapting to climate change and the agency has a natural leadership role in this area. By stepping up and leading a cooperative effort with other agencies and organizations, NOAA will fill a clear void. There is a need to define regionally appropriate climate services, the absence of which will hinder not only the agency's, but the nation's ability to make reasoned decisions based on sound science. Both the Alaska Climate Change Impact Assessment Commission and the Immediate Actions Working Group of the Alaska Governor's Sub-Cabinet on Climate Change have released reports in early 2008. Each calls for additional NOAA products and services to support state and local actions. The extent to which the agency is responsive to these emerging requirements will determine the extent government, industry, and the public will view NOAA as a leader.

In Alaska, economically-significant climate change impacts are readily seen at the coasts. NOAA's range of expertise in climatology, hydrometeorology, oceanography, resource management, and decision support position the agency to take a greater role in addressing the state's needs. As an outcome of this effort, the ARCTic will develop a pilot project with the state to demonstrate the power and return on investment of integrating the agency's services. On a broader scale, the ARCTic will develop a concept and blueprint for NOAA Climate Services in Alaska and seek collaborators in defining an Alaskan Climate Services Partnership. This multi-agency, multi-sector structure will integrate the roles of government, academia, and other appropriate parties in harvesting the best knowledge and tools available for decision support and societal adaptation.

Foundational Infrastructure

The ability of the agency to meet its potential in serving Alaska is contingent on the agency devoting sustained committment, creativity, expertise, and resources to establishing and evolving foundational infrastructure. The two components most critically needed are observations and infrastructure for integrated environmental prediction.

To meet the vast observation needs of Alaska, new ways of thinking, resources, and partnerships will need to be employed. The solution must be adequate to meet multiple missions and be dynamic enough to evolve as new knowledge and demands arise. In the near term, focus must remain on implementing the Arctic Observing Network, expanding the Alaska Flood Forecasting Observation Network, and integrating priorities of these and other plans such as the Marine Weather Observation Network into regionwide networks such as the Alaska Ocean Observing System. NOAA cannot , for instance, support efforts to save rural communities and Alaska native communities from being lost if we do not apply our capabilities in an integrated fashion. The agency should link its capabilities on how the climate reduces the ice extent and changes the storm tracks driving the waves and water levels over the topography of the sea floor to erode and inundate coastlines forcing evacuations and the need for precise and accurate heights for egress and relocation planning.

The first step in meeting this challenge is to collaborate across the NOAA line offices and disciplines and the ARCTic is proud to be a part of moving the agency in this direction. However, collaboration alone will not meet future challenges. The second step is to boldly envision the infrastructure it will take to enable truly integrated environmental prediction. NOAA has made strides in coupling forecast models across physical disciplines and in preliminary efforts in ecological forecasting. NOAA must continue to develop the infrastructure to enable oceanographic, meteorological, hydrologic, biological, and other physical models to be interconnected and influence each other. Accelerating these efforts and supporting them with an operational infrastructure is critical to meet its mandates nationwide. These efforts are particularly important in Alaska.

Expanded Collaboration

Collaboration among NOAA's line offices and customers will not be enough to address the breadth of the issues facing Alaska's future. An integration across agencies with regard to products and services is necessary. Two coordinating activities that NOAA is already engaged with are the Statewide Digital Mapping Initiative and the Comprehensive Study of Alaska's Navigation Transportation System. Developing similar integrating frameworks for coastal erosion and inundation and climate change activities in general should be pursued.

Intended Uses of this Plan and Next Steps

This plan is intended for use both inside and outside of NOAA. Internally, it will be used to build awareness of key issues in Alaska. The ARCTic will use it to influence the next NOAA Strategic Plan; guide long-range budget planning; and provide a focus for annual plans at all levels. Externally, the ISP is intended to foster dialog on regional issues and the appropriate NOAA role in them. As a living document, the ISP does not commit the agency to any specific course of action. It does, however, serve as a vehicle for gaining customer, stakeholder, and public input on what investments NOAA should make in Alaska in the coming years. If successful, the resulting rich discussion will lead to greater internal and external collaboration, better NOAA services in Alaska, and ultimately the achievement of common goals.

ARCTic WEBSITE

http://www.ppi.noaa.gov/NOAA_ARCTic/noaa_arctic.html

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