



Natural Resource Damage Assessment in Arctic Waters:

The Dialogue Begins

April 20 – 22, 2010

National Oceanic and Atmospheric Administration
Office of Response and Restoration

Coastal Response Research Center
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FOREWORD

The Coastal Response Research Center, a partnership between the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (ORR) and the University of New Hampshire (UNH), develops new approaches to spill response and restoration through research and synthesis of information. The Center's mission requires it to serve as a hub for research, development, and technology transfer to the oil spill community. In anticipation of potential oil spills in the Chukchi and Beaufort Seas, the Center, in cooperation with NOAA ORR and the Oil Spill Recovery Institute (OSRI) (Cordova, AK), hosted a workshop entitled "Natural Resource Damage Assessment (NRDA) in Arctic Waters: The Dialogue Begins". The April, 2010 workshop was held at the Millennium Hotel in Anchorage, Alaska. This report provides a summary of the workshop, and gives insight into the current state of knowledge regarding Natural Resource Damage Assessment (NRDA) in the Arctic, the gaps in current knowledge, and the steps to address them. Workshop participants represented a broad spectrum of constituencies and expertise including governmental agencies, industry, non-governmental organizations (NGOs) and indigenous people from the Arctic. Research priorities were identified by workshop participants to address gaps in preparedness and response for oil spills. The findings of this report will be used as a guide for directing activities to prepare for future NRDA's in the Arctic.

We hope you find the report interesting and exploring the discussion insightful. If you have any comments, please contact us. We look forward to hearing from you.

Sincerely,

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I. Executive Summary

As required by the Oil Pollution Act of 1990, Natural Resource Damage Assessment (NRDA) is a process available to determine what restoration actions are needed to compensate for injury to and loss of services from harm to natural resources and their human uses that occur as a result of an oil spill. The process requires natural resource trustee agencies (National Oceanic and Atmospheric Administration (NOAA), Department of the Interior (DOI), and state agencies) to link: the release of oil, its fate and transport in the environment, the exposure of natural resources to the oil, and the oil's effects on biota and human uses. Determining the amount of injury and appropriate restoration requires an understanding of the condition of the natural resources and human uses in the absence of the spill (i.e., baseline conditions). The liability for natural resource damages is in addition to the liability for spill cleanup (i.e., the response). In the case of large spills where response options are limited, the cost of restoring the environment through NRDA can far exceed the cost of the response.

Current scientific information suggests that environmental changes are occurring in the Arctic at rates much greater than those projected even five years ago. These changes are manifesting themselves in reduced sea ice extent and distribution, and ecosystem shifts. Recent models suggest that Arctic waters could be free of multi-year ice in the summer within the next 20 years. These changes suggest that over the next 10 – 20 years, ship activity will dramatically increase in Arctic waters, further increasing the risk of incidents. Predictions of large reserves of oil and gas are increasing pressure for exploration and production. One likely result of increased activity in the harsh Arctic conditions will be the accidental release of petroleum into the marine environment. When significant amounts of oil are released into Alaskan Arctic waters, it will be challenging to recover, especially if ice is present. Even under best-case scenarios, spilled oil could have serious consequences for natural resources and local communities, requiring a NRDA to be initiated. However, very little, if any, NRDA work has been done in the Arctic.

On April 20 - 22, 2010, the Coastal Response Research Center (CRRC) and NOAA's Office of Response and Restoration (NOAA OR&R) held a workshop on planning for NRDA in the Arctic. Attendees included: natural resource trustees, industry, and non-governmental organizations, academic scientists, and members of Arctic communities. By the end of the workshop, the following overarching conclusions were reached:

1) Arctic Baseline Shifts: physical conditions and biological use of Arctic habitats are changing. Indications include: Bering Sea fish moving north; polar bear moving into the tundra and walrus into shoreline areas; reductions in seasonal duration and areal extent of ice cover and thickness; and longer periods of tundra thaw.

2) Baseline Data: A large body of environmental data was identified that has been collected at various locations and over several decades for several purposes (e.g., fisheries monitoring, oil and gas lease development). In order to maximize their usefulness for NRDA, these data must be compiled, synthesized, continuously updated, managed and made publically available. Targeted collection of additional data would also be useful.

3) Restoration Planning: Because options for restoring coastal natural resources in the Arctic have not been developed, workshop participants felt it was vital to begin restoration planning immediately. Incorporating local and traditional knowledge of natural resources and subsistence, as well as cultural sensitivities is crucial to identifying and developing restoration options.

4) Coordination and Outreach: The participants felt that the workshop was a necessary first step in coordinating activity and interaction among NRDA stakeholders. However, there must be a concerted effort to build upon this initial coordination in two ways: linking emergency response and NRDA planning and preparation; and improving collaboration among government, industry, and community interests through drills, training, and joint planning efforts (e.g., development of protocols and agreements to support on-scene NRDA activities).

II. Introduction

Increasing average global temperatures have led to a dramatic decrease in overall sea ice extent in the Arctic, with measured reductions in area and thickness of sea ice, as well as the length of the ice-growth season. In general, sea ice coverage has been on a steady decline for the past 30 years, with an average decrease of 2.6% per decade (NSIDC, 2010). If these trends continue, the National Snow and Ice Data Center (NSIDC) predicts the Arctic will be ice-free in the Summer as early as 2030.

The decrease in Arctic sea ice has increased human activity in the region. Waters which were once inaccessible are becoming navigable during the summer months, and have become a viable option for: shipping, fishing, tourism, and oil, gas, and mineral exploration. In 2008, the U.S. Geological Survey (USGS) estimated that the Arctic contains a potential 80 billion barrels of oil and 17,000 trillion cubic feet of natural gas. As Arctic waters become more easily accessible, development and transport of these resources becomes more likely. Unpredictable and rapidly changing weather, ice coating of vessels, ice-breaking hazards, use of vessels that are not ice-strengthened, and limited navigational data are but a few of the challenges that increase the risk of accidents in the Arctic.

Although now eclipsed by the 2010 Deepwater Horizon blowout in the Gulf of Mexico, the 1989 T/V *Exxon Valdez* accident in Prince William Sound, Alaska held the title of the largest and most damaging U.S. oil spill for more than two decades, in part due to the sensitivity and slow recovery of sub-Arctic ecosystems. As described in the 2009 CRRC Report "Opening the Arctic Seas: Envisioning Disasters and Framing Solutions", an accidental oil spill in the Arctic and sub-Arctic regions could be environmentally devastating. With few resources currently available to respond, combined with the unique challenges the region poses due to sea ice and harsh weather, Arctic habitats could be contaminated for long periods of time without an adequate response or cleanup effort. A spill in such a unique environment could prove disastrous for habitats, local species, and the people who depend upon them for subsistence, commercial fisheries and culture.

As set forth in the Oil Pollution Act of 1990 and its accompanying regulations, Natural Resource Damage Assessment (NRDA) is a process to determine what restoration actions are needed to compensate the public for injury and loss of services to natural resources and services and their human uses resulting from a spill in the environment. The NRDA process requires natural resource trustee agencies (NOAA, Department of Interior, and state agencies) to link the release of oil to exposure and its impact to natural resources, and the associated effects on the biota and human uses. Once this link has been established, the amount of injury and appropriate restoration can be determined. As activity increases in the Arctic, the risk of a significant spill and need for a potential NRDA increases as well. Furthermore, in order to properly execute a NRDA, baseline data are required to demonstrate adverse impacts.

Local habitats are also changing in the Arctic. For example, climate change has been linked to changes to abundance and behavior of several species and ecosystems. These perturbations are reducing the value of previously gathered information as a baseline for NRDA. In order to develop an accurate and defensible NRDA baseline for the Arctic region, it is critical to incorporate input from all stakeholders. This not only includes the expertise from people in government, industry, and academia, but the knowledge of local authorities and indigenous peoples.

As a first step in developing a NRDA baseline for the Arctic region, CRRC, in cooperation with NOAA and the Oil Spill Recovery Institute (OSRI), hosted a workshop titled Natural Resource Damage Assessment in Arctic Waters: The Dialogue Begins. This workshop aimed to: assess the current baseline data available, identify gaps in current knowledge, and outline how to address these gaps to better prepare for NRDAs necessitated by Arctic oil spills.

III. Workshop Organization and Structure

The workshop, held at the Millennium Hotel in Anchorage, Alaska on April 20 – 22, 2010, consisted of plenary sessions where invited speakers gave presentations (Appendix F) on Arctic biology and habitats. Six breakout groups discussed topics that included: (1) Birds; (2) Mammals; (3) Fish and Invertebrates; (4) Ice and Under Ice habitats; (5) Lagoons and Near Shore Environments; and (6) Freshwater habitats. The workshop agenda (Appendix A), participants (Appendix B), and breakout session questions (Appendix C) were identified and developed by an Organizing Committee representing government, industry, and academia. The Organizing Committee identified participants from indigenous peoples; NGOs; industry, response organizations, natural resource trustees, and other governmental entities who have a vested interest and experience in the Arctic and/or oil spills, and NRDA (Appendix B).

The workshop was organized around three major topics: (1) Extent of baseline information available; (2) Gaps in the current knowledge; and (3) Efforts needed to close these gaps. These topics were investigated by answering questions in the breakout groups. The workshop participants addressed the questions in their respective breakout groups (Appendix D). After each breakout session, the groups came together in a plenary session and summarized their discussions for the larger group (Appendix E).

This report contains a summary of the discussions in each group, including: resources currently available for Arctic NRDAs, assumptions made about the region, current NRDA capabilities, gaps/problems identified in current NRDA protocols, and recommendations for enhancing the capacity of NRDAs. On the final day of the workshop, participants convened to summarize their findings and conclusions. Each group contained at least one representative from each of the earlier breakout groups. In these new groups, the participants developed a set of overarching recommendations. Once these recommendations were developed, the group reconvened and presented them to the plenary session. Under the direction of the Organizing Committee, these recommendations were developed into key overarching workshop findings and recommendations.

IV. Birds

A. Assessment of Current Baseline Information

To establish a point of reference, the bird group identified major species of concern which may be affected by an oil spill. These species include:

- Red-Throated Loon
- Yellow-Billed Loon
- Brant
- Common Eider
- King Eider
- Spectacled Eider
- Steller's Eider
- Long-Tailed Duck
- Gyrfalcon
- Red-Necked Phalarope
- Red Phalarope
- Kittiwake ssp.
- Ross's Gull
- Ivory Gull
- Common Murre
- Thick-Billed Murre
- Killitz's Murrelet
- Pigeon Guillemot
- Snowy Owl
- Barrow Geese
- Wainwright Geese

The group noted that Arctic habitats are unique and complex, and it is difficult to develop a uniform species list that applies to the entire region. Characteristics such as geographic location, oceanic current patterns, seasonal migrations, and life stage have a major influence on the species present in the region. Although species specific, Spring migration in the region ranges from March until May. Summer is a time of feeding, breeding, and nesting, and birds can be found near- and off-shore. The fall months see many of these birds feeding in the near-shore lagoons to build up energy reserves for the winter migration. A spatial division for these groups is the Chukchi and Beaufort Seas. Hence, these two areas are too distinctly different to be considered as a singular entity.

The group concluded that the most negative impact of a major spill would result in injury to the food supply and disruption of breeding grounds. Using the example of Murres in the Chukchi, a major spill during a critical point in their life cycle could kill a significant portion of breeding males, so that the population would take decades to return to current levels.

Several groups in the region have used birds for subsistence and cultural uses (e.g., headdresses), however, previous incidents have shown a willingness to sacrifice these uses. For example, after the *Selendang Ayu* spill in the Aleutian Islands, birds that were oiled, rehabilitated, and released were no longer hunted for cultural uses.

Several studies that monitor birds nesting and/or breeding on the tundra and barrier islands have been conducted. Some species, such as murres and kittiwakes are monitored annually, while many species are infrequently or never monitored.

B. Information Needs/Gaps

Very little is known about the off-shore feeding habits of birds in the Arctic. This is a critical knowledge gap because a large portion of birds in the region feed off-shore. In addition, the group identified a lack of data regarding the seasonal requirements of bird species, and how they may have been altered as a result of climate change. Data on subsistence use of birds are also needed. These data could be used to establish a more comprehensive baseline of the current conditions in the Arctic.

In order to assess the complete impacts of an oil spill in this area, it is essential to better understand the specific impacts it would have on bird species that inhabit the region. The group identified a need to understand the impacts of oil spills on food sources and trends in health, productivity, and reproduction over time. These are the major ecological drivers that will be most influenced by a spill.

The group was unable to comment on variation in trends due to climate change. This is, in part, due to discontinuation of long-term studies and/or a lack of baseline data. Changes and loss to habitat as the result of climate change will have a large impact on species in the region, and more research is needed to evaluate the effect habitat loss is having on the Arctic food web. A key issue the group identified was a lack of a comprehensive clearinghouse for data. Currently, data is held by those who conducted the studies, and may not be easily accessible. Better access to data would be a key element of improving baseline studies and making information available for a NRDA.

C. Steps to Address Needs/Gaps

The group concluded that the effort to conduct a NRDA in the Arctic will require an initial baseline data expansion to address the gaps in knowledge. This will be challenging, as the window for working in the Arctic is narrow and long-term studies are difficult. One solution to this issue would be to modify current studies to include data collection for NRDA purposes.

It is unclear if it will be possible to differentiate spill-related impacts from shifts in the baseline due to climate change or natural variation. This could be addressed by looking at previous impact studies of birds in other regions, which could identify possible trends in the Arctic.

With the Arctic being such a large area with very few resources available for a NRDA, the group recommended the use of designated plots as a method for observing proportions of oiled birds, unattended eggs, oiled habitats, and age-class studies. While there is high variation within the region, it is feasible to use designated plots for monitoring purposes.

V. Marine Mammals

A. Assessment of Current Baseline Information

To establish a point of reference, the group identified the major species of concern and their ecological value which may be affected by an oil spill. These species include:

- Bearded Seal
- Spotted Seal
- Ringed Seal
- Ribbon Seal
- Polar Bear
- Pacific Walrus
- Beluga Whale
- Bowhead Whale
- Gray Whale
- Killer Whale
- Harbor Porpoise
- Humpback Whale
- Narwhal
- Minke Whale
- Sei Whale
- Fin Whale
- North Pacific Right Whale

Many of these species have variable seasonal distribution and abundance, and the time of year a spill occurs will greatly affect which species are impacted. While many species leave the Arctic for part of the year, usually winter, others will remain year-round. For most whales and seals, spring is breeding, calving and pupping season, while summer and fall are an important time for feeding. Many mammals migrate to the Bering Sea for the winter months and return to the Arctic in the spring. Terrestrial animals that stay in the Arctic year-round will spend much of the winter in dens or maintaining lairs. The group noted that these are general trends for classes of species and do not necessarily apply to all species of concern.

Many of these species hold a high human value and are used for subsistence, tourism, and culture. This could pose an interesting challenge, as NRDA often does not include impacts related to subsistence in the continental U.S. Subsistence activities are defined as food, creation and sale of crafts, traditional medicines, and the passing of traditional knowledge. The group identified recreation and tourism as guided tours, and wildlife viewing and photography.

Marine mammals in the Arctic region are typically at the top of the food web. With the exception of seals, whose predators include polar bears and killer whales, Arctic mammals do not have any natural predators other than man. Marine mammals are known to feed on pelagic and benthic species, however, the exact diet varies with species.

Like birds, the effects of an oil spill on marine mammals will greatly depend upon the season in which it occurs. A spill in the spring or early summer months could disrupt the primary production that occurs as the ice starts to melt, and could have a potential cascading effect throughout the food web. A similar effect could occur if a spill were to happen in the late fall and the oil is entrained within the ice, resulting in its release in the spring. The group was also concerned about the long lifespan and slow reproduction rate of marine mammals. These characteristics could result in very long recovery times in the wake of a spill.

With their position and relationships in the food web, many of the marine mammal species can be intrinsically-linked. One such example is the connection between polar bears and ringed seals. Data have shown ringed seal abundance dictates polar bear abundance. This could be a major issue if ringed seals were adversely affected by an oil spill; Polar bear populations could see a concomitant downturn as well.

An assessment of the current literature shows much of the data regarding marine mammals is based on harvest assessments, household surveys, and incidental observations from vessel and aerial whale surveys. Many bowhead and beluga whales, as well as several different species of seals, have been tagged to better understand feeding and migratory patterns. Unfortunately, adverse weather and remoteness of the Arctic have made study of mammals particularly difficult, thus much data for the area are either opportunistic or inconsistent.

B. Information Needs/Gaps

Data for the Arctic region are scattered both spatially and chronologically. The scattering of this data makes it difficult to draw conclusions regarding marine mammal populations, their habits, and other pertinent information. More data exists for the Beaufort Sea than the Chukchi, largely due to studies associated with oil leases in that region. Scientific study is challenging due to the sparse human activity and the lack of resources.

The group highlighted the need for high-quality population estimates for species in the Arctic. Every year, some of the species of concern are surveyed; however, they are not population estimates, but rather observations of opportunity. These would be important data for not just NRDA, but also for wildlife management. The group also noted that data related to subsistence harvests may be confidential and proprietary, and not publically available.

The group identified several changes in traditional marine mammal behavior that could be caused by climate change. One such example is the increasing reports of human/bear interactions during the past few years. This may be a result of climate change, as the polar bear population does not appear to be increasing. In addition, walruses have begun using coastal areas much more often than previously observed. Locals in the area have also reported new species of fish not previously observed in the region. Seal hunting is commencing earlier in the season because of earlier ice-out, prompting seals to leave shore earlier. These changes may reduce the validity of previous studies.

C. Steps to Address Stated Needs/Gaps

Limited financial backing for studies was identified as a chief concern for the group. Significant funding would be required to conduct many of the studies necessary to prepare a comprehensive, defensible NRDA for the region.

Furthermore, logistics, methodology, and manpower were also of concern, as the Arctic is a harsh environment where few are trained to operate and the weather can severely limit research opportunities. Based on these challenges, the group suggested that an extensive synthesis of current data be done. This could identify the major gaps in the literature, allowing additional studies on marine mammals to be better refined to help address the data gaps.

Another concern related to whether population size would be the most effective method for assessing damage to Arctic marine mammals from an oil spill. The group suggested that other methods be investigated to monitor health of species, including measurements such as body condition, habitat use, reproduction trends, and survival of young. Another possibility was monitoring of reference groups (e.g., sub-groups within the population) to gain an understanding of what is occurring in the event of a spill.

VI. <u>Fish & Invertebrates</u>

A. Assessment of Current Baseline Information

The group identified a list of species of concern and species deemed key to human use:

-Arctic Cod
- Saffron Cod
-Sheef Fish
-Herring
-Rainbow Smelt
-Capelin
-Eulachon
-Halibut
-Flounder
-Salmon
-Snails
-Sea Urchins
-Tunicate
-Cisco
-Bering Salmon
- Arctic Salmon
- Freshwater Trout
- Freshwater Grayling
- Freshwater Pike
- Shrimp
- Clams
- Starfish
- Benthic Invertebrates
-Mysid Shrimp

Coastal areas, habitats underneath ice, and river deltas/lagoons are likely the most sensitive areas to oil spills. In comparison to other groups addressed at this workshop, populations of fish are less variable and prone to seasonal fluctuations. While some species remain under the ice throughout the winter, this is an important time for some species such as Arctic cod to spawn. However, this is not a universal trend; several species migrate between on-shore and off-shore habitats with the migration varying according to life stage.

Fish and invertebrates are of significant ecological and commercial value in the Arctic, and are an important component of the subsistence diet, as well as a large component of the Arctic food web. Human uses of fish and invertebrates include: subsistence consumption, use as bait, commercial fishing, and culture, including trade and sharing.

A major concern is the sensitivity of larval and juvenile life stages of species to oil in near-shore environments. These areas are used by several fish species as spawning grounds, and the presence of oil could have a significant impact on populations for several years. This is also a factor because of the long lifespan of several Arctic species, with some having lifespans up to 50 years. After death, their carcasses can become food and habitat for numerous species, potentially further contaminating the food chain and leading to bioaccumulation and biomagnification in the event of a spill.

Site-specific tide and ocean-current data, as well as bathymetric maps and sea floor characteristics are either unavailable or out of date for a large portion of the Arctic. Practitioner, consulting and industry data are available for developing a NRDA, however, the group acknowledged that there are several unknowns with respect to the current information, especially regarding geographic variation. There are Environmental Sensitivity Index (ESI) atlases for the region, but some must be updated to reflect current conditions, depending on their age and methodology. Several state and federal government agencies have data for these regions, but they are generally not found in a central location and can be difficult to retrieve.

B. Information Needs/Gaps

A significant gap in the knowledge is the spatial and temporal limitations of previous studies. Gaps in data from the winter months are common for many fish species, when studies become difficult to conduct. While some annual surveys exist in the region, they usually only include a few species, and often do not include invertebrates. Furthermore, the data which have been collected are not easily comparable, as different equipment and methods have been used. The tracking of seasonal trends in fish species will be a crucial step in completion of a NRDA.

There are information needs regarding: the role fish and invertebrates play in the Arctic food web; the natural variation in growth and reproduction rates; and the shifts in distribution of species. These are key questions that need to be answered in order to conduct a NRDA. Local knowledge could potentially be a valuable resource of information for NRDA and optimization of research in the region.

C. Steps to Address Needs/Gaps

The group acknowledged logistical and financial constraints are limiting factors in development of a comprehensive NRDA baseline for fish and invertebrates. In order to address this, reference areas could be used to establish baseline habitat health metrics. While this would not accurately reflect the individual variation of each habitat, it would give a solid basis for comparison.

The groups noted that a clearinghouse of all known data for the region should be established. This will help to more accurately identify important research needs and facilitate data sharing. The incorporation of local and indigenous knowledge will be a valuable resource for this process going forward.

VII. Ice and Under-Ice Habitats

A. Assessment of Current Baseline Information

The group divided ice and under-ice habitats into several, more specific habitats. These include:

- Multi-Year Ice
- First Year Ice
- Land Fast Ice
- Bottom Fast Ice
- Ridges
- Level Ice (Smooth Ice)
- Melt Ponds
- Below Ice
- Snow
- Fall Freeze Ice
- Columnar Ice
- Spring Break Ice
- Summer Melt
- Break Out Ice (Out To Sea)
- Brine Channels
- Pack Ice

A number of species that live in ice or under-ice habitats were identified as being susceptible to the effects of a large scale oil spill in Arctic waters. These species include: ice algae, amphipods, Arctic cod, and ice meiofauna (e.g., copepods, nematodes, tubelarians, and polychaetes). Effects such as acute toxicity, chronic toxicity, phototoxicity and mortality could affect each organism on an individual level. Larger problems, such as reduced reproductive rates and genotoxicity, could have a much more damaging effect on the ecosystem. Seals and birds are two examples of animals that may be adversely impacted while feeding on oiled prey. Possible effects include reduction in biomass, fecundity, or lifespan, as well as shifts in community structure, allowing some species to thrive at the expense of others.

Numerous ice-related human uses would also be affected by a spill, including hunting and fishing for subsistence. Hunting and fishing would likely be reduced or stopped altogether near the source of the spill. Travel could be restricted in areas surrounding the spill, again potentially impacting subsistence lifestyles. Travel restrictions would be instituted to prevent sea vessels from contributing to the spread of the emulsified oil, and to avoid obstruction of oil recovery efforts.

The key environmental factors that influence the food web in ice and under-ice habitats include: snow volume, ice concentration, ice thickness, temperature, salinity, light level, nutrient concentrations, water depth, wind direction, and currents. There are many ways the food web might be affected by an oil spill. Birds and mammals at the ice/air interface are susceptible to physical fouling and vapor inhalation, while phytoplankton and bacterial blooms may occur as a result of increased ice melt, or may be suppressed due to lower light availability. Human intervention (e.g., oil recovery efforts) may also cause unintended damage to the food web.

Factors that will determine how the ice and under-ice habitats are affected include: use of dispersant; solubility of the oil; and the amount of mixing between dispersants and the oil. Impacts caused by oil in the ice will be determined by the movement of oil within the brine channels, melting rates of the ice, and the amount of affected ice that does not melt each year. Impacts caused by oil on top of the ice will depend upon evaporation, biodegradation, and the melting rates of the ice.

B. Information Needs/Gaps

In order to better understand the impacts that an oil spill would have on ice and under-ice habitats, it is important to have a better understanding of the physical and chemical properties of the release, and how oil will behave in Arctic environments. In addition, properties such as biological response to oil, population recovery time, resiliency, inorganic nutrient loads, and the functional role of microbes are important information needs.

More information is required on the penetration of light within and below the surface of the ice, as this will significantly affect algal growth. To gather this information, an accurate measurement of the average snow depth and the standard deviation should be collected at several times throughout each season in the year. The volume of sediment contained on top of the ice, within the ice and within the water below the ice would also be beneficial. It would also be helpful to know the texture of the ice surface.

Regional information is helpful in determining the extent of the impacts to ice habitats caused by an oil spill. The effect of wind on the movement of sea ice, and the terrestrial effects of wind should be researched further. From this research, models that use satellite imagery should be developed so that movement of ice and oil within the ice can be predicted more accurately. Additionally, more research should be conducted to better understand the ultimate fate of contaminants released from the sea ice.

C. Steps to Address Needs/Gaps

Additional data should be collected on the background contaminant concentrations in species of concern prior to a spill. This could be done by analyzing tissue samples from certain species (e.g., PAHs in Arctic cod). These data could then be compared to samples collected in the months and years after an oil spill, so that there is a better understanding of the injury caused by the spill. Additionally, more information should be collected that tracks changes in the community size, biodiversity index and biomass of invertebrates, ice algae, and microbes. These data can also be compared to post-spill data to make a more accurate assessment of damage.

The group determined that it is possible to "work around" missing or insufficient baseline data by using reference areas in comparison to oiled areas. However, it should also be noted that this method can be expensive and technically challenging, but would be effective if reference areas were identified well in advance of a spill.

VIII. Lagoon and Near-Shore Shallow Water Habitats

A. Assessment of Current Baseline Information

To establish a common frame of reference, the lagoon and near-shore shallow water habitats group identified the major habitats and species of concern, their ecological services, and human uses which may be affected by an oil spill. The two major areas discussed were the Chukchi and Beaufort Seas.

Lagoons in the Chukchi Sea are seasonal, resulting in low productivity in the winter, and high productivity in the summer. Lagoons in this region provide many ecological services, including shelter, nursery habitat, and serve as an important source of food. Key wildlife associations with lagoons include marine mammals, birds, and fish. The beluga whale and Seaduck eiders use lagoons for molting. Lagoons are designated Critical Habitat for Steller's eider and spectacled eider for feeding, while fish in the lagoons include sheefish, juvenile fish, Bering cisco, and Arctic char.

The shallow near-shore of the Chukchi Sea was also discussed. The loss of sea ice in this area due to climate change has resulted in a shift in walrus behavior; they now routinely haul-out on land rather than ice. The shallow near-shore has a high benthic biomass with patchy distribution and locally low diversity. The shallow near shore region also serves as a migratory pathway and an important molting habitat. There are several human uses associated with the Chukchi Sea near-shore and lagoons, including Eider harvest and harvests of migratory mammals and other migratory birds.

Lagoons in the Beaufort Sea are similar to those in the Chukchi, in that they are seasonal, resulting in low productivity in the winter and high productivity in the summer. However, in contrast to the Chukchi, boulder patch kelp and delta habitats are present in the Beaufort. Lagoons in the Beaufort provide several ecological services, including shelter and nursery habitat, and as an important source of food. In some cases, lagoons are protected by barrier islands that act as important haul-out locations and additional near-shore habitat. Beluga whales use the lagoons for molting. Key birds include eiders and long-tailed ducks; they use the lagoons as a feeding area. The important fish in the Beaufort Sea lagoons are Whitefish, juvenile fish, Arctic cisco, and Arctic char.

The shallow near-shore of the Beaufort was also discussed as an area of concern because the loss of sea ice has resulted in polar bears spending more time on-shore. In contrast to the shallow near-shore of the Chukchi Sea, the Beaufort has relatively low benthic biomass. It also has locally low diversity and patchy distribution of benthic organisms. The Beaufort's shallow near-shore is an important migratory pathway and a seasonal source of food. The human uses associated with the Beaufort Sea include: the harvests of "migratory" marine mammals, birds (eiders), and fish.

In order to illustrate the potential effects of a spill on the near-shore and lagoon environments in the Chukchi and Beaufort seas, the group developed a scenario in which the oil release occurred in August and where heavy oil comes onshore and is blown into the lagoon. The impacted areas would be the near-shore (including the boulder patch), barrier islands, and lagoons. Oil would affect whales, seals, sea ducks, and the benthic food web in the near-shore area. Polar bear haul-out, bird nesting, and shorebird activities would be affected on the barrier islands. Shorebirds, sea ducks, fish, the benthic food web, and shoreline vegetation would be affected by an oil spill in the lagoons. Human uses affected by such an oil spill would include tourism, cultural aspects, and subsistence activities (e.g., whaling, fishing and hunting).

There are several environmental factors that influence how food webs would be impacted by an oil spill, including seasonal variations in ice cover, temperature, salinity, and photo-radiation. Climate change will also play an important role in the effects of an oil spill, as changes in patterns of erosion, fetch, and turbidity place additional stress on organisms. The food webs in the Chukchi and Beaufort Seas near-shore and lagoon habitats are distinct; the food web is benthic-dominated in the Chukchi, while it is pelagic-dominated in the Beaufort.

B. Information Needs/Gaps

In order to assess the impacts of an oil spill in Arctic habitats, some additional baseline data and information is required. Habitat injury assessments will include physical, biological, and human use aspects. The physical assessment of the habitat includes information about the substrate, water depth, wave exposure, currents, presence of contaminants, natural oil seeps near shore and off-shore, turbidity, and ice cover. The biological assessment would include evaluations of key species and habitat attributes. An assessment of the human uses would include information on fishing, whaling, seal, walrus, and bird hunting and egg collection.

To facilitate the sharing of information, an over-arching data management system is required. Archived data is often not transferred to electronic versions, and key data may be unavailable or lost without this transition. A comprehensive bibliography and synthesis of knowledge for various resources is also needed. It should be noted that baseline conditions are not a stable and have a high natural variability. Long-term monitoring may be required to develop an accurate baseline. However, long-term trends are difficult to normalize in part due to climate change; and determining a baseline may be difficult.

Current data and information that exist include the Alaska Resource Library Information System (ARLIS). This is a public system, but there may be fees involved with accessing it. Although ARLIS is available, there are many other useful information sources. Alaska ESI maps show shoreline sensitivity to oils, socioeconomic data, and biological resources. The Northwest Arctic and North Slope ESI Atlases were updated in 2002 and 2005, respectively. The maps have relatively low resolution (1:250,000) and seasonal information is included for each species. There is a significant amount of data not integrated into the ESI maps, and accordingly they will have limited usefulness during a NRDA process. Another source of information is the Alaska Shore Zone maps, which have a higher resolution and contain habitat information. The group discussed certain gaps in the data that have been collected. The one major piece of missing information is the lack of shore zone habitat maps for the central Arctic.

C. Steps to Address Needs/Gaps

Index sites (i.e., areas of intense study with strong statistical relevance) should be considered for NRDA baseline. These index sites are cost effective and can include multiple locations with temporal sampling and multiple habitats (e.g., near-shore, barrier islands, and deep and shallow lagoons). It is recommended that index sites first be developed for the Beaufort Sea. Specific site recommendations within the Beaufort Sea include: shallow and deep near-shore, barrier islands, Simpson Lagoon, and river deltas. The near-shore, barrier islands, and lagoons of the Chukchi Sea were also listed as potential index sites of priority. A third set of site indices were recommended for development within Kotzebue Sound. Current on-going studies that could possibly be expanded upon were discussed.

The group discussed whether it was possible to “work around” an insufficient or missing baseline using reference areas to compare to an affected area, and especially after an environmental event. Overall, the group felt it was possible to overcome potential obstacles and that reference sites were a possibility. Injury assessment would ideally incorporate a combination of index sites, reference sites, and monitoring. However, assuming no index sites or baseline data, some other steps could be taken. For example, one could identify affected areas, locate a reference site, and monitor recovery. In additional, ecological risk assessment principles could be used.

IX. Freshwater and Coastal Tundra

A. Assessment of Current Baseline Information

The group identified key species, ecological services, and human uses associated with freshwater and coastal tundra habitats that may be affected by a spill. The types of shorelines and their components were discussed.

The peat (organic) layer is the active (thaw and refreeze) layer overlaying the mineral (e.g., clay, sand, silt) layer on top of the permafrost. Microbial activity in this area is limited to a short period in the summer. The peat also serves as a rooting zone for tundra plants. Other types of tundra include tundra cliffs and wetlands interlaced with ponds. In river deltas, there are areas containing no peat (only sand and gravel) with forbs and shrubs growing on sandbars. The active layer in the river deltas is several meters thick. Barrier islands are also present along the coast. Gravel beaches with very fine sand or sediment are also present, but generally there are only wind-driven tides on these beaches.

Rivers are typically shallow, meandering, and include coastal mudflats. There is typically high flow during spring ice breakup over a very short period (i.e., days). Most of the coastal tundra is flat with sporadic rocky cliffs. The reaches of the storm surge will provide a practical boundary for the inland extent of the effects of an off-shore spill, however, the possibility of an inland pipeline leak affecting river habitats also exists.

The high sensitivity of tundra was discussed by the group. Tundra can take up to 30 years to recover from injury due to the short growing season. This process can be accelerated by seeding or transplanting, but even with these steps, recovery times still may exceed 20 years. Affected tundra may change during the recovery process and could host an entirely different community type (e.g., dry vs. wet), which may not support the same species. Thermokarst, an irregular surface of marshy hollows, occurs naturally, but can be increased by response efforts and associated disturbances. The weight of vehicles used during the cleanup effort can also significantly disturb the tundra and can lead to erosion and settling. The tundra is a high value bird habitat.

Many key species exist in the freshwater areas and coastal tundra including: polar bears, grizzly bears, caribou, fish, and birds. Caribou are a subsistence resource for human use. They seek out windblown areas near the coast to avoid insects in the summer and migrate inland to eat during the cooler days in the summer. Fish, including ciscoes, char, salmon, whitefish, grayling, blackfish, cod, and turbot, are an important food base within the freshwater and coastal tundra zone. Information on bird species and seasonal habitat usage patterns are available in the ACS tech manuals. These maps can be used to identify ecologically-sensitive areas and archaeological sites, unfortunately, they are not specific enough for a NRDA.

Industry has collected a large amount of data in this region, and synthesizing it is a crucial next step. A website (www.northslope.org) has been created that contains thirteen emerging issues papers on topics including: migratory birds, marine mammals, and their prey; increasing marine activity; permafrost; coastal and riverine erosion; contaminants; fire; vegetation change; caribou; tundra rehabilitation; and Arctic fish. The Audubon Society and Oceana's Arctic Marine Synthesis compiles public datasets. This data is spotty and not always comparable from site to site. A framework is needed to facilitate the sharing of data between industry and the stakeholders.

Human uses associated with the freshwater areas and coastal tundra were discussed. The rivers and Teshapak Lake are used for subsistence fishing and hunting. Boat access is needed during the open water season, while snowmobiles are used during the winter for ice fishing and caribou hunting. The Colville River does not completely freeze over, which allows for open-water fishing year-round. The freshwater and coastal tundra zones also provide for recreational use. There is bird watching near Barrow and Ellson Lagoon and near the mouth of Colville and the Arctic National Wildlife Refuge (ANWR). Sources for human use in these areas can be found on the National Research Council Report (2003) Cumulative Effects of Oil and Gas Activity on Alaska's North Slope, as well as the Arctic and Marine Oil Spill Program (AMOP) report and the Alaska Resources Library and Information Services (ARLIS) industry reports. The ecological services in these freshwater areas and coastal tundra include: nesting; molting; passive use; and fish foraging, overwintering and reproduction.

The effects of an oil spill in these habitats would be seasonally dependent. It may be easier to recover oil during frozen conditions, and there would likely be minimal penetration into the permafrost in the winter months (December-April). The summer months of (July to October) are open water season. The breakup season is relatively short (e.g., several weeks) in the near-shore environment. Fish migrate in late June to August. A release during spring and summer would likely result in less recovery of oil due to infiltration and absorption into the peat, as well as greater exposure to species of concern.

The effects of a spill are dependent on location. The Colville River delta is a highly sensitive area as it is a nesting place for eider ducks and other birds. Several areas are protected by barrier islands and fish migration occurs in specific rivers and lakes. In general, river deltas/mouths (including inundated tundra/wetlands) and areas protected by barrier islands are the most sensitive. Some areas are sensitive not because of the species present, but because of the behavior of oil. For example, oil penetration will be worse on a gravel beach than in a water-saturated mudflat.

The types of impacts associated with an oil spill in freshwater and coastal tundra are numerous. There are likely to be direct effects (e.g., birds displaced from traditional nesting areas) and indirect effects (e.g., stress during sensitive life stages causing deterioration of health). Caribou in coastal areas may lose their habitat and may need to move to a non-impacted area for insect relief.

Key environmental factors that influence the food webs were described by the group. The habitat may be altered by spill cleanup efforts. For example, tundra may compress and subside, creating a dry tundra (caribou habitat), which then becomes a wet tundra (potential bird habitat). As a result, increased thermokarsting reduces habitats for caribou, ptarmigan, and other species. The climate is another key factor. Increased winds may force saline water towards shore and alters the species of fish and birds living in the area. The breakup and freeze up times affects the length of the breeding season for birds and migration timing for fish.

The group also discussed how the food webs in these habitats might be affected by an oil spill. Oil in the river mouths may contaminate detritus, which is the base of the food web. There could also be restricted access to prevent animals from entering contaminated areas. Thus, there could be an increased pressure on adjacent habitats. A contaminated habitat may also serve as a reservoir for oil and be a pathway for exposure to animals using that habitat. An oil spill may also increase the human activity during response and cleanup, therefore limiting the use of the habitat by animals (e.g., migratory birds and caribou).

B. Information Needs/Gaps

While there appear to be existing data related to these habitats, a significant portion of it is inaccessible. Various groups (e.g., trustees, responsible parties, and various government agencies) have data for the region, but a central clearinghouse or repository for such data does not exist.

Some of the major gaps the group identified were a questionable scaling of past research, and a concern over the timing and seasonality of some of the experiments performed. Due to the highly seasonal nature of this region, timing of experiments is important. A concern was also raised that the current mapping efforts do not adequately reflect vegetation levels and types; this is mostly due to the resolution capabilities of the maps being used. A chemical baseline for the area also needs to be established. While some of this data is currently available, additional information is needed. Terrestrial and shorebird information is lacking in comparison to that for large waterfowl. There is little stream flow data for much of the region.

There are direct indications that the baseline is already changing in measureable ways as a result of changes in sea ice and snow cover, and other physical habitat changes likely caused by global climate change. Other indicators include: eroding coastline and saltwater intrusion, earlier snowmelts, desiccation of lakes, and the shortening of freeze season on the tundra by at least one month. Dates of nest initiations have moved up several weeks. These factors may affect the reproductive success of species in the region.

C. Steps to Address Needs/Gaps

Many of the data gaps can be addressed by supplementing data collection methods already being used rather than starting new monitoring programs. This makes it particularly easy to show change in data from before and after an oil spill. Being able to demonstrate a change in baseline conditions is critical when trying to assess injury to natural resources and determine the type and amount of restoration needed. Additionally, data collected should be available to the trustees and the public so they can decide if the amount of restoration is adequate when compared to the level of injury.

For animals present in freshwater lakes, ponds, streams, rivers, and coastal tundra, injury can be evaluated on different levels (e.g., molecular, population, ecosystem). Endpoints such as productivity, reproduction rates in key species, insect populations, and vegetation types should all be strongly considered for resource assessment.

Long-term trends can be identified through sampling in areas that have a high likelihood of an oil spill. Unfortunately, since it is not known where oil will wash on-shore in the event of an off-shore spill, a large number of sampling sites would be needed at river mouths and along the near-shore. The group suggested collection of baseline samples and freezing them for analysis in the event of a spill. This idea would be cost-effective because it would not be necessary to analyze the samples until a spill occurs and the baseline data is required, however, the issue of shelf life would need to be addressed.

There are a few tasks that should be completed to help organize existing information and data collected. A bibliography should be developed that compiles all of the sources related to oil spills in freshwater lakes, ponds, streams, rivers and coastal tundra. This will provide a quick reference guide that can be used in the event of an environmental event. A consistent habitat mapping program should be established to identify critical habitats. A data repository needs to be created that can be used to gather, organize, synthesize and share baseline data. It was suggested that the Alaska Resource Library and Information Service (ARLIS) should develop and maintain the data repository.

The group suggested that in the event of a spill, the federal on-scene coordinator (FOSC) and the state on scene coordinator (SOSC) be involved in the planning process for a NRDA response. Stakeholder relationships should be built around the NRDA and the NRDA teams should be identified in the next two years.

X. Workshop Conclusions and Next Steps

Overall, the groups highlighted common issues and themes:

- Differences exist between the Chukchi and Beaufort Sea systems. These differences make it difficult to generalize information needs and assessment approaches for the Arctic as a whole.

- A clearinghouse for baseline data is needed. Issues include difficulties with obtaining data, a lack of data synthesis, funding, and the need for a central system to house future data. There are several existing systems that could serve as a repository for NRDA baseline data.

- Numerous relevant historical studies in the Arctic exist, but in general, they cover local areas and short time scales, with very few long-term and continuing studies, even in local areas. The amount of information on seasonal variations in habitats and species is limited. Most data have been collected during the summer season.

- Some information on the effects of climate change are available, however, it is primarily related to: extent of ice and snow cover, shoreline erosion, melting permafrost, fish and bird distributions, and habitat use by polar bears and walruses.

- Information on potential food web effects is lacking. Information on birds, marine mammals, and ice-dependent food webs is of special concern.

- Additional basic environmental information is needed. Priorities include: information on tides, ocean currents, river flows, and winds; and habitat and seafloor mapping. Modeling of ice movement and additional satellite imagery would be valuable.

- Local and indigenous knowledge and resources to support spill responses and monitoring studies are valuable and need to be integrated into future projects and planning.

- There are significant constraints and barriers to entry to working in the Arctic. Sampling and assessment logistics are challenging and funding is minimal.

Common recommendations for assessments include:

- Compile bibliographies of baseline information.
- Use reference sites/areas after a spill to augment baseline data (may be challenging for birds and marine mammals).
- Create standardized plots, index sites, or reference sites for monitoring and baseline comparison, including collecting samples to evaluate background PAH concentrations in sediments and tissues.
- Gather additional local and traditional knowledge on natural resources that could be affected by oil.
- Modify on-going bird, fish, and marine mammal studies to include parameters appropriate for injury assessment.
- Make investigation of exposure pathways a priority.
- Gather/develop protocols and tools for Arctic injury assessment and for baseline data and information collection and management.
- Conduct drills that integrate NRDA and response.
- Gather additional socioeconomic data.
- Begin restoration planning now.

Finally, workshop participants developed a list of the recommended next steps in development of an Arctic NRDA baseline:

- Establish a data clearinghouse.
- Pre-plan for NRDA, including holding additional workshops.
- Develop NRDA protocols and methods.
- Identify Arctic restoration options.
- Synthesize available baseline data and prioritize data gaps.
- Begin/expand sampling for monitoring/reference areas

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APPENDIX

A: Workshop Agenda
B: Participant List
C: Breakout Questions
D: Breakout Groups
E: Breakout Group Notes and Report Outs
F: Powerpoint Presentations

APPENDIX A

WORKSHOP AGENDA

NRDA in Arctic Waters
The Dialogue Begins
April 20–22, 2010 • The Millenium Hotel • Anchorage, AK

Monday, April 19 — Arrival and Check-in

Tuesday, April 20

8:00 *Continental Breakfast*

8:30 Welcome & Introductions
Nancy E. Kinner, UNH Co-Director, CRRC
Amy A. Merten, NOAA Co-Director, CRRC
Robert Haddad, NOAA ARD
Nancy Bird, Oil Spill Recovery Institute

9:00 Background & Workshop Goals
Mary Baker, NOAA ARD

9:15 Participant Introductions
Jon Hockman, Workshop Facilitator

10:00 Workshop Structure, Logistics & Outcomes, Participant Operating Principles
Jon Hockman

10:15 *Break*

10:30 Plenary Session: Setting the Stage

Overview of NRDA Process
Gordon Robilliard, ENTRIX

NRDA: An Economist's Perspective
Norman Meade, NOAA ARD

Ice Primer/Overview
Christian Petrich, University of Alaska, Fairbanks

Oil Spill Scenario:

Open Water
Jacqui Michel, Research Planning, Inc.

Under Ice
Mike Bronson, BP

Broken Ice
Ken Lee, Fisheries & Oceans Canada

12:30 *Lunch*

1:15 Commissioning of Groups
Jon Hockman

1:25 Breakout Session: Key Resources & Services
Breakout Discussion Groups (Questions 1-3)

Group A: Birds
Group B: Marine Mammals
Group C: Fish & Invertebrates

Group D: Ice & Under-ice Habitats
Group E: Lagoon & Near-Shore Shallow Water Habitats
Group F: Freshwater/Coastal Tundra

3:15 *Break*

3:30 Plenary Session: Group Reports
(10 minutes each)

4:30 Wrap-Up
Jon Hockman

6:00 Shuttle to *Dinner at the Alaska Aviation Heritage Museum*

Wednesday, April 21

8:00 *Continental Breakfast*

8:20 Overview & Review/Recalibrate
Jon Hockman

8:30 Plenary Session: Restoration
A Panel Discussion (Erika Ammann, Steve McKendrick, Jenifer Kohout)

9:00 Breakout Session: Baseline Data
Breakout Discussion Groups (Questions 4-6)

11:00 *Break*

11:15 Plenary Talk: Breakout Group Reports
(10 minutes each)

12:15 *Lunch*

1:00 Breakout Session: Changes/Future
Breakout Discussion Groups (Questions 7-8)

3:30 *Break*

3:45 Plenary Session: Breakout Group Reports

4:45 Wrap-Up
Jon Hockman

5:00 *Dinner* (on your own)

Thursday, April 22

8:15 *Continental Breakfast*

8:30 Overview & Review/Recalibrate
Jon Hockman

8:45 Plenary Session: Synthesis & Prioritize

10:30 Break

10:45 Plenary Sesion: Next Steps

12:00 Adjourn

APPENDIX B

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APPENDIX C

BREAKOUT QUESTIONS

NRDA IN ARCTIC WATERS
THE DIALOGUE BEGINS
APRIL 20–22, 2010 • THE MILLENIUM HOTEL • ANCHORAGE, AK

Breakout Session I: Day 1, April 20

Questions:

Species Groups

1) What are the key species and their related human uses and ecological values that may be most affected by an oil spill?
2) How and when might these key species and their ecological services and human uses be affected by an oil spill, including response actions? How long might potential impacts last (i.e., magnitude, duration)?
3) What is the key role and characteristics of these key species in the food web? How might food webs that include these species be affected by an oil spill?

Habitat Groups

1) What are the key species, ecological services and human uses associated with or dependent upon this habitat group that may be most affected by an oil spill?
2) How might the key species, ecological services and human uses of this habitat be affected by an oil spill, including response actions? How long might potential impacts last (i.e., magnitude, duration)?
3) What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

Breakout Session II: Day 2, April 21 AM

Questions:

4) What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic habitats/species?

5) What is the current status of baseline data and information?
    - What data and information exist?
    - Are the data updated over time?
    - What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?
    - What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?
    - Are there gaps in the data that have been collected? What are they?
    - Is it necessary to fill gaps and if so, how will we fill these gaps?

6) Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

Breakout Session III: Day 2, April 21 PM

Questions:

7) Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?
   - How could injury be evaluated for this group?
   - What effects might you expect to see and what baseline information does that drive you to collect?

8) Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

APPENDIX D

BREAKOUT GROUPS

NRDA IN ARCTIC WATERS
THE DIALOGUE BEGINS
APRIL 20-22, 2010 • THE MILLENIUM HOTEL • ANCHORAGE, AK

Breakout Groups

Species Groups

Group A: Birds	Group B: Marine Mammals	Group C: Fish & Invertebrates
Room: Redington I-B	Room: Redington I-A	Room: Redington II
Group Lead: Catherine Berg *Recorder: Christine Boring* David Aplin Roger Helm Fredy Hernandez Steve Kendall Rick Lanctot Michael Macrander Dave Roseneau Todd Sformo	Group Lead: Mike Amman *Recorder: Nicolle Rutherford* Krieg Brown Peter Boveng Raychelle Daniel Susi Miller Fenton Rexford Cheryl Rosa Diane Sanzone Jen Schorr	Group Lead: Jacqui Michel *Recorder: Zachary Magdol* Erika Ammann Marty Cramer Matt Eagleton Scott Johnson Brenda Konar Libby Logerwell Norman Meade Larry Moulton Tom Okleasik

Habitat Groups

Group D: Ice / Under Ice	Group E: Lagoon / Nearshore Shallow	Group F: Freshwater / Coastal Tundra
Room: Redington III	Room: Turnagain	Room: Spenard I / Hospitality Suite
Group Lead: Scott Pegau *Recorder: Heather Ballestero* Holly Bik Mike Bronson Rolf Gradinger Jenifer Kohout Ken Lee Amy Merten Jeff Short Chris Petrich Jack Word	Group Lead: Dale Gardner *Recorder: Mandy Lindeberg* Jewel Bennett Tracy Collier Jack Colonell Bob Haddad Alan Maki Judy Miller Richard Prentki Jeep Rice Gordon Robilliard John Whitney	Group Lead: Gary Shigenaka *Recorder: Jessica Winter* Mary Baker Carol Fries Will Frost Lee Majors Steve McKendrick Caryn Rea Stanley Senner Faye Sullivan Ian Zelo

NRDA IN ARCTIC WATERS
THE DIALOGUE BEGINS
APRIL 20–22, 2010 • THE MILLENIUM HOTEL • ANCHORAGE, AK

REVISED GROUPS

THURSDAY APRIL 22, 2010

Group 1	**Group 2**	**Group 3**	**Group 4**
Catherine Berg	Jacqui Michel	David Aplin	Roger Helm
Nicolle Rutherford	Krieg Brown	Peter Boveng	Raychelle Daniel
Erika Ammann	Marty Cramer	Matt Eagleton	Scott Johnson
Mike Bronson	Rolf Gradinger	Jenifer Kohout	Ken Lee
Jewel Bennett	Tracy Collier	Jack Colonell	Bob Haddad
Lee Majors	Steve McKendrick	Caryn Rea	Stanley Senner
Jen Schorr	Tom Okleasik	Gordon Robilliard	John Whitney
Recorder: Jessica Winter	Recorder: Christine Boring	Mike Amman	Recorder: Heather Ballestero

Group 5	**Group 6**	**Group 7**	**Group 8**
Steve Kendall	Michael Macrander	Dave Roseneau	Todd Sformo
Susi Miller	Fenton Rexford	Cheryl Rosa	Claudia/Diane Sanzone
Brenda Konar	Libby Logerwell	Norman Meade	Larry Moulton
Amy Merten	Jeff Short	Chris Petrich	Jack Word
Alan Maki	Judy Miller	Richard Prentki	Jeep Rice
Faye Sullivan	Ian Zelo	Carol Fries	Mary Baker
Holly Bik	Scott Pegau	Dale Gardner	Gary Shigenaka
Recorder: Zach Magdol	Recorder: Mandy Lindeberg	Recorder: Jessica Winter	Recorder: Joe Cunningham

APPENDIX E

BREAKOUT GROUP NOTES AND REPORT OUTS

<u>Breakout Session I</u>

Key Resources and Services

Tuesday, April 20

Group A: Birds

1. What are the key species of birds and their related human uses and ecological values that may be most affected by an oil spill?

- Species identified are largely scenario specific
- Very different things happening in Chukchi vs. Beaufort
- Current patterns are very important (see map/handout from DR)
- 1,000,000 alcids and larids in Kotzebue Sound, Thompson, Lisburne, Cape Lewis
  - Kotzebue: Common murres/thick-billed murres. Murres come north early in April in leads with king eiders, loons, early migrants until early June when they come in and 'stick'/start to breed
- Winter (Nov.-Apr) pretty limited number of species using Arctic offshore
- Apr.-June: spring migration, leads opening (Chukchi), polynya zone, lagoons closed in Beaufort
- Mid-July-September: post breeding use of lagoons
- Chukchi: summer into August
- Black guillemots (key indicator species in winter) primary bird in the winter in leads using marine environment. Very little human use of blgu. BLGU eat sand lance, amphipods, brine shrimp, small arctic cod. Few ivory gulls and Ross's gulls
- Out on ice in winter: blgu, gyr falcons, snowy owls
- MMS: COMIDA: sediment chemistry, water chemistry, benthic ecology, plankton, fisheries. Adding birds and mammals this year. Shell/Conoco large baseline studies. Studies are 60 miles offshore (closest). Mechanistic understanding of Chukchi ecosystem during open water period. 3 cruises. System variable based on timing.
- Murre chicks swim west (Thompson/Lewis). Lisburne birds go west and north. Potential to wipe out most of productivity of 3 major colonies totaling 800,000 murres and breeding males. Mid-August-late October. A year's cohort and established breeding males could be wiped out by a major spill. Kivalina and Point Hope people take some birds, but primary thing is eggs (main in subsistence). 2500 eggs taken from Thompson, same from Lisburne, less from Cape Lewis.
- Nearshore lagoons: late summer/fall. Beaufort, some in Chukchi. Used by post-breeding shorebirds to build up energy reserves for migration. Major species: semi-palmated sandpiper most abundant on mudflats/lagoons. REPH, RNPH. Dunlin staging, sanderlings. Birds coming from other areas. 100,000s and is extremely variable. Winds, water levels, etc. cause variability on mud flats. Long-tailed ducks come to molt in lagoons in early Sept. in Kasegaluk Lagoon.

Baseline USFWS MBM surveys of all of the lagoons. Flocks of molting geese, scoters.

- OCSEPT: good staging north of Icy Cape, less in Kasegaluk. Lisburne: sanderlings (not huge numbers).
- A lot of birds congregate on Chukchi coast jump offshore; not big flocks of LTDU coming down Ledyard Bay/Cape. Going offshore. REPH head to sea. One of few that comes in big numbers on coast are eiders. Ledyard Bay is huge molting are. 20,000 flightless eiders. Numbers have really changed. Minimum of 50K eiders a day flying past Lisburne. Now you might see 5,000, mostly COEI, KIEI, a few SPEI. STEI early on when ice is on Cape. Only about 100 using area off Barrow. Staging for eiders is in Chukchi.
- Brant: fair numbers come down about 8 miles from Lisburne, but most cut in to Selawik, or out to sea. Big staging area is lagoon just north of Icy Cape. Sea lettuce beds are key. Don't see them again until Seward Peninsula.
- Barrow: subsistence take of eiders in spring and fall. Also at Point Hope. A little bit of eggs taken at Kaktovik. Brant taken in fall around Kaktovik.
- A lot of species taken in other places for subsistence. Important human-use for viewing.
- Could argue that nesting birds onshore are food source for onshore mammals and birds.
- SPEI, STEI are listed under ESA, yellow-billed loon are warranted (qualify) for listing. YBLO follow lead system and are all along the coast. Feed off of Lisburne, pretty much along that coast where there are wetlands inland a ways.
- Nesting: Brant mouth of Colville nesting right on islands. Big spill could wipe out brant. COEI nests are very sensitive on barrier islands. 2 key species: brant and common eider.
- Category for listed species: Kittlitz's murrelet in area; offshore in Chukchi Sea. Nest far inland, but forage out in water (30 miles, etc.). Go south in winter. Show up at Lisburne in Spring right in along shore in open patches of ice.
- Listed: STEI, SPEI, YBLO.
- Nesting: red-throated loons forage in marine areas (arctic cod). Nest inland. Lots of RTLO in wetlands east of Lisburne.
- Mackensie River delta: very similar to lagoon areas (ltdu, shorebirds). The timing is a little bit ahead in Canada. Island area hugely rich in birds and marine mammals: BLGU huge important species. Very productive. Important in US waters source areas for animals that migrate along Beaufort in fall.
- YBLO also used culturally (headdresses, etc.).

2. How and when might these species and their ecological services and human uses be affected by an oil spill? How long might potential impacts last (i.e., magnitude and duration)?

- Note: ‘how and when’ captured under question 1 bullets.
- Murre example (see above). Could lose a cohort and male experience if major spill in Chukchi. Could take 1-2 decades to build back males.
- If mollusk beds contaminated could affect LTDU, eiders.
- Guillemots feeding in nearshore in summer. As what happened with PIGU in PWS, could have similar long term impact on BLGU. Physical conditions lead to uncertainty. For instance, entrainment, long-shore transport, etc.
- Shoreline sensitivity would be a good indicator of longevity of spill impact of nearshore feeders.
- Potential subsistence and economic impact in Barrow and Wainwright (geese).Cultural use maybe more than subsistence as birds typically farther down the list from marine mammals, fish.
- Duration also linked to perception, but not as common with birds.
- Selendang example: birds that were oiled, rehabilitated and released were no longer hunted for cultural reasons.
- Potential to impact listed species and concentrations or local populations of some species depending on timing, etc.

3. What is the key role and characteristics of these species in the food web? How might food webs that include these species be affected by an oil spill?

- Ledyard Bay: staging eiders (molting/feeding). Eiders are foraging on benthic stuff. June-July: murres and kittiwakes going to LB. Late July shift N/NW out 70 miles. Murres and kittiwakes feed on pelagic drifting food web (copepods, larval fish, huge sand lance nearshore runs). Persistent winds/cold arctic waters can set up a gyre in LB and could conceivably get oil. Murres: arctic cod, sand lance, sculpin, demersal fish, shrimp.
- Important zones in Chukchi: LB, Peard Bay, Kasegaluk Lagooon system are top 3 nearshore areas. Offshore zonation: related to current patterns are reflected by the ice. Nutrients released into water column where ice melts early and you see pelagic feeding birds/mammals. Hannah shoal: productivity immediately to bottom, so benthic feeders, lower water column feeders.
- Ice edge in spring/summer/fall.
- 60-70 miles offshore highest densities are in Sept./Oct. including shearwaters, fulmars, etc. Open water season lots of STSH, crested auklets.
- Beaufort Sea lagoons: LTDU: benthic feeders (crustaceans), eiders, shorebirds (mudflats, sediments), phalaropes: plankton, copepods, mysids. Oil spill can really impact/coat mudflat. Dispersants may affect copepods/mysids. Wouldn’t use dispersants because you wouldn’t get dilution.
- Mostly nearshore: loons (fish eaters). Don’t know much about offshore Beaufort. MMS just beginning to focus on birds, not an abundance. Might argue change could occur if there is more open water.

- Most of productivity in Eastern Beaufort if driven by riverine influence. Chukchi water drops down and parallels coast or drops abyssal. Currents go shooting down Barrow Canyon.
- Most species are top of the food web. Are also in human and terrestrial food web.

Breakout Session II

Baseline

AM Wednesday, April 21

Group A: Birds

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic species?

- Murres: more adequate assessment of specific feeding areas, where chicks go, murre productivity
- Need relative abundance, identification of specific habitats (e.g., nesting, feeding, molting areas) by species and by season. This data is available for some, and not others.
- Understanding what their requirements are as they go through their season. What are the ecological drivers, and how is that changed by oil?
- Trends: relative population health and trajectory, productivity, monitoring through time.
- What impacts do oil spills have on food resources?
- What are the effects of oil and PAHs on energetics and reproduction in a chronic as well as a cumulative way.
- Subsistence use data.

5. What is the current status of baseline data and information?

- **What data and information exist?**
    - Murres: annual monitoring site. Data on kittiwakes every year.
    - Waterfowl: LTDU lagoon surveys were done for a period; annual survey of breeding birds on barrier islands (COEI and other species); annual survey of birds nesting on the tundra (loons, etc.). One time complete survey of barrier islands of refuge for COEI.
    - Proposals out for more comprehensive surveys of loons on the North Slope. There have been USFWS MBM surveys done in the past on the NS; some of it is pretty recent.
    - Shorebirds: 2005-2006 survey of entire North Slope staging, abundance, and habitat. Arctic Refuge surveys have been continued from 2005-2010. Looking at mechanisms, what food sources, why they are using these habitats.
    - Annual survey of STEI around Barrow.
    - Starting shorebird demographics study during breeding season (e.g., site fidelity, annual survival, chick survival) and other metrics on a network of sites.
    - Harvest surveys from 1998-2003 by village by month.
    - Relative to exploration and development sites, there are specific inventory and use studies both onshore and offshore. Offshore studies relative to

specific lease areas as well as broader areas in Chukchi and Beaufort Seas. Data is put in ARLIS.
  - NSB: eiders flying by Point Barrow.
  - Investigations of benthic environments in Demarcation Bay for LTDU, and in Chukchi.
  - ADF&G has subsistence harvest data for some locations.
  - ABR has done radar surveys over North Star (and other locations)
  - Cooper Island: 30 years of BLGU data George Divoky
  - Arctic NWR: 1002 studies from the 80s
  - Port side studies when looking at development
  - Arctic Gas studies from 1972-1977
  - OCSEPT: 2-3 years of Point Lay and Kasegaluk Lagoon; Icy Cape (LTDU, migratory study), LGL fisheries study at Point Lay
  - Project Chariot at Cape Thompson
  - Seabird database still being put together
- **Are the data updated over time?**
  - Murre and kittiwake data is updated every year.
  - Captured above
  - Existing data often a one time snapshot.
- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
  -
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
  - Data resides with whoever basically studied it, no real repository.
  - Some available online
  - ARLIS
  - Need some type of clearinghouse or repository
  - A lot of gray literature that goes way back
- **Are there gaps in the data that have been collected? What are they?**
  - Biggest data need is offshore, specifically in Beaufort
  - COASST beach bird surveys could be extended
  - Sublethal effects and chronic/cumulative effects from oil spills
  - Dispersed oil effects on biological community
  - Seabirds: no productivity data (e.g., murres), chick dispersement areas, more specific info on where breeding adults are feeding
  - Shorebirds along Icy Cape
  - Virtually no data on forage fish in nearshore waters in Chukchi Sea (e.g., Ledyard Bay) and in forage in general (e.g., food web, euphasids, etc.)
  - Need for more trends data. Natural variation makes trend data difficult to capture.
  - Diagnostic tools to determine the cause of mortality as it relates to the oil spill
  - Do we have adequate data on currents, wind, other oceanographic data?
  - Don’t have long term data to be able to answer question of direct indication of climate change in a robust way.

- **Is it necessary to fill gaps and if so, how will we fill these gaps?**
    - Community based monitoring programs that systematically collect data with a highly organized database
    - Need an education component: why do we collect/need this data?

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

Caveat: we see indications that suggest something of significant magnitude is going on, not 'direct indications'. We see consistent patterns.

- Kittiwake productivity has been declining as open water gets earlier. Tied to food, cod, etc. Decline started in early 90's; data started in 1976.
- Probably don't have baseline or long term data to be able to say.
- During open water period, or longer period with ice offshore, there have been significant storms, deltas underwater during nest initiation. Also, coastal lagoons flooding effects tern nesting. Scouring, erosion, storm surges, wave heights, sea level rise.
- Increased fetch creating storm waves that are 12-14 feet (previously 7 feet) causes loss of beaches, erosion.
- Potential indications with BLGU colony (30+ year study on Cooper Island).
- Phenology shifts? Don't have a long enough data set to say.
- Variability year to year, but data set is so short.
- Local knowledge suggests it, don't necessarily have the data.
- Insects come out early, can be a big impact.
- Lack of testable hypotheses.

Questions/comments:

- Any evidence taste of the food affecting harvest, and is there a measure of that?
    - Mostly perception (tainting) following EVOS studies.
    - Seafood quality inspectors
    - A lot of oiled animals by secondary exposure, but don't seem bothered by it

<u>Breakout Session III</u>

Changes/Future

PM Wednesday, April 21

Group A: Birds

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

- No money to acquire a baseline in a NRDA context.
- Industry: very targeted around specific locations
- Studies that are proposed framed with NRDA context
- Biggest data gap is around restoration.
- Is the question precision vs. accuracy?
- Do we have the ability to adequately predict impact? Aggressively trying to get a baseline, but in a piecemeal manner.
- Try to coordinate our studies to gather data in a comparable manner.
- Data management
- Modify existing studies: do some plot work in other habitats and along the shoreline for seabird colonies or shorebirds.
- In Alaska, seasonal window is so narrow that adding anything additional to your work is completely not feasible.
- In a spill context, you have money. Out of a spill context agencies have to come up with money.
- Baseline is about assessing magnitude of this injury.
- Challenges with assessing baseline in Arctic different than other places.
- Logistics

- **How could injury be evaluated for this group?**
  - Carcass collection
  - Persistence studies (how long is a carcass there before it’s rewashed, scavenged, or seen?)
  - Drift block studies (assimilate a floating carcass and see if you can find them)
  - Presumed density vs. area of impact
  - Monitoring ice in relation to bird activity
  - Modeling and trajectory analyses; BWASP in Beaufort Sea for 30 years (bowheads) offshore, never been a program like that for birds
  - Drone technology aerial systems with high-res digital photography
  - Nearshore long-term aerial surveys of birds
- **What effects might you expect to see and what baseline information does that drive you to collect?**
  - Dead birds
  - Chronic effects

- Productivity effects
- Oiled habitats
- Oiled eggs
- Oiled birds at colonies
- Baseline info to collect: watch birds on plots to see if they are oiled and what is the proportion; unattended eggs; oiled habitats; recruitment studies and age-class studies; survey of lagoon to see how birds where there, survey the deltas; evaluation of the forage

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- Maybe. Shouldn’t be ruled out.
- Depends on the events and logistics
- Finding a reference area for birds is really tough, would not recommend.
- Depends on the scale of the event. Larger events more difficult.
- Inter-annual variability; a reference area can help you calibrate and reduce uncertainty. May work in areas with same block of habitat. Can be patchy distribution.
-

Group comments:

- What do you mean by watching birds on plots?
  - Plots at Cape Lisburne that have been used for year. Can be used to monitor whether birds are oiled or not
- What do you do with birds that overwinter in ice covered waters?
  - Majority of species you have a narrow winter. Those that overwinter, distribution is different seasonally. Logistics of censusing birds in wintertime.
- What is philopatry?
  - Tendency for birds to come back to the same places over and over again.

<u>Breakout Session I</u>

Key Resources and Services

Tuesday, April 20

Group B: Marine Mammals

1. What are the key species of mammals and their related human uses and ecological values that may be most affected by an oil spill?

- Bearded, Spotted, Ringed, Ribbon seals all found in the arctic
- Polar Bears, Pacific Walruses
- Beluga, bowhead, gray, harbor porpoise, killer whales
    - vagrants
        - humpbacks, Narwhals, minkes (transient), sei (?), fin (transient), north pacific right whale (not data to support, consider potential b/c so little known and so few).
- Which are Year round residents? Is the population there year round? Or are there some individuals around throughout the year? Many of the species are strongly seasonal in their distribution. Some populations essentially leave the arctic for part of the year, but some individuals may stay year round.
    - Polar bears, seals
- Human Uses?
    - Subsistence consumption, sustenance, cultural uses, tourism,
        - Hard to separate out the sustenance/subsistence/cultural uses
            - Sustenance not a NRDA term that is heard
            - Subsistence: We will define as food, creation and sale of handicrafts, and transfer of traditional knowledge/medicines

Recreational use and tourism can also be hard to separate (ex. Guided Polar bear viewing trips) Wildlife viewing, photography

Species	Subsistence	Tourism/Recreational use	Cultural Uses	Passive/Existence Value
Bearded seal	X		X	X
Spotted seal	X		X	X
Ringed seal	X		X	X
Ribbon Seal	X (al little)		X (skins, hunting skills)	X
Pacific Walrus	X	X	X	X
Polar Bear	X	X	X	X
Beluga	X	X	X	X
Bowhead	X	X (increasing)	X	X
Gray	X (Makah has permit to harvest. There is also opportunistic	X (outside of the arctic)	X	X

	take in AK.			

- o **Ecological Values – lots of data gaps re: this question. Poorly known species from a scientific perspective. Lots of unknown aspects re: life histories. There is some knowledge that villagers hold that may be able to be accessed during an event, but it would need to be protected. Location and extent of subsistence use may be unknown or changing.**
  - Prey? Predators? Nutrient recycling? Bioturbation? Whale falls – after harvest, take body parts and push off the lead system into the water. Huge benthic communities that are supported by this.
  - Benthic feeders
  - Fish eaters
  - Key niches that are filled?
  - Polar bears – predators
  - Prey – ringed, bearded seals are polar bear prey. Walruses, killer whales take seals as well. How often are walruses preying on seals? Some people think it happens a lot, not much data on this.
  - Polar Bears (ringed, bearded seals) – not good population abundance estimates for many areas – Data gap
  - Ringed seals – eat arctic cod (some confusion re: terminology/naming conventions between CA & US references)
  - Bearded seals – benthic feeders – crustaceans, mollusks, fish
  - Ribbon seals – diet in arctic not well known (Data gap), fish?
  - Spotted seals – anadromous fish, etc.
  - Pacific Walrus – snails, crabs, benthic invertebrates, occasionally seals
  - Bowhead – zooplankton, euphasids, copepods, amphipods,
  - Beluga – fish?, data gap re: primary foods change seasonally and temporally
  - Gray – benthic invertebrates, small fish
  - Benthic feeders have bioturbation functions as well as nutrient recycling into the water column (data gap, unknown)

Crowd Questions & Comments:

2. How and when might these species and their ecological services and human uses be affected by an oil spill? How long might potential impacts last (i.e., magnitude and duration)?

- Include response actions
- What time of year are the key species vulnerable to a spill? How long will see effect?
- Each whale season of use is slightly different. Season will vary between the Chukchi & Beaufort.
- Bowhead – cow/calf pairs

- Calving, Reproduction
- Whale migration in Beaufort in fall
    - When are species present, and what important event is occurring at that time?

Reproductive activity for Bowheads seen at many different times of the year – not a huge data gap, but some question around time.

Beluga – not known where they go in the winter. Have been tracked in strange places

Chukchi – some areas where the Belugas hang out – shallow, nearshore areas for calving? In some Canadian areas, go to shallow creek mouths for molting

Molting?

Arctic Marine Synthesis: Atlas of Chukchi and Beaufort Seas – produced by Audubon Society came out in Jan 2010. Available online.
AK Fish and Game website good source of information on species too.

Belugas in the nearshore, so a summer spill would be especially bad

Species	Fall	Winter	Spring	Summer
Bowhead	Reproductive activity/Migration/feeding	Potential mating in late winter	Reproductive activity/Calving/Migration/feeding	Feeding
Beluga	Migration/feeding/	Migrate to Bering Sea?	Migration	Mating/Calving/Feeding/molting
Gray	Feeding/migrating		migrating	Feeding, mating
Polar Bear	Feeding/resting onshore (waiting for freeze up)	Feeding & denning	Breeding/denning (females)/feeding	Breeding/feeding/
Pacific Walrus	Feeding/resting (wait for freeze up)/nursing, haul out concentrations	feeding	Birthing on the ice/feeding/breeding	Haulouts, resting, feeding
Bearded seals	Feeding/migration	Mostly in Bering sea?	Pupping/Mating/Molting/feeding/migrating	Feeding
Ring seals	Feeding/migration	Maintenance of lairs/feeding	Pupping/Mating/Molting/feeding/migrating	Feeding

Some differentiation needs to be made – as spring vs summer – when split these months makes a difference when defining what activities are occurring.

In spring/early summer, have ice edge primary production that supports much of the life in the arctic. If spill occurs at this time, primary production could be highly impacted and have cascade population effects.

Time of year will be key. Spring lead system would be disastrous (less likely at this time), but fall would be terrible as well because of difficulty in responding and oil resurfacing in the spring. Subsistence could be highly impacted at this time too.

Ring seals in lairs, pupping in March. Snow melts out in early June. Are around on the ice.

Haul out concentrations – areas changing , very vulnerable during this time to trampling as result of disturbance. If ice is over Chukchi sea, they are there. If no ice, they take haul out to shore.

Length of potential impacts:
Duration of the effects will be dependent on oil type, season, length of exposure, etc. Could be long lasting population effects depending on number of animals affected. Important to realize that effects are likely to be longterm.

Bering Strait in the spring and fall is highly important. Acts as a choke point for the animals, vast numbers of the animals going through.

Impacts of the perception of oiled subsistence foods vs. actual contamination. In studies, organisms may clear oil from their bodies w/in a couple of weeks, but may not matter much to public who have seen the oil on the beach. Stigma associated with oiled food sources.

Slow reproducers, long lived species – looking at potentially long recovery times.

Avoidance? Behavioral response to floating oil is important data gap for most cetacean species. Polar bears are very curious, going to investigate noises, activity. Study done where polar bears showed no aversion to a pool of oil, were in an enclosed place. What killed the bears was renal failure as result of ingestion? Polar bears grooming often for thermoregulation purposes – will ingest oil if they are oiled.

Bowhead avoidance of noise and activities is a big deal because of hunting activity. Could be an issue during restoration activities.

Impacts on baleen? Ocular exposure? Renal failure, reproductive suppression
Data gap?

Young animals tend to spend more time on surface, so may have differiential impacts on different age groups.

3. What is the key role and characteristics of these species in the food web? How might food webs that include these species be affected by an oil spill?

- Benthic communities when impacted by an oil spill, then some of the mammals that feed on them could also be impacted. Also, may be direct impacts to the animals that feed on the benthos as result of encountering the oil (ingestion, smothering, etc).
- How well do we understand the food webs? Not sure of what some of the species eat. Know that some of these species are opportunistic feeders, others we have no idea.

- Polar bears and ring seal life histories closely tied. If one is impacted, the other will be affected. If oiling of ring seals, could result in population level declines. If large scale oil spill during ring seal pupping, population could be adversely impacted and polar bears could be impacted too.

- In spring/early summer, have ice edge primary production that supports much of the life in the arctic. If spill occurs at this time, primary production could be highly impacted and have cascade population effects.
- Dispersant effects on environment? In-situ burning as response effort – asphaltine residues? Lots of unknowns here and how would impact individuals and potentially communities, populations.
- Benthic/Pelagic coupling important in this system. Timing of sea ice melt in spring. How much stuff makes it to benthos? Could a spill disrupt the benthic/pelagic coupling with even larger community wide impacts? Unknown, data gaps here.

<u>Breakout Session II</u>

Baseline

AM Wednesday, April 21

Group B: Marine Mammals

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic species?

- Population size, Distribution, health or animal condition, demography (age, sex of animals present at time of spill), movement information, Environmental parameters (water quality, contaminant information, metals, etc.), Important biological and ecological areas that are important for reproductive activities, migration, feeding, etc. Also need more info re: subsistence uses and losses (some harvest data is available to help w/this, maybe household surveys).
- UA Fairbanks working on matrix of sharing among tribes of resources. Tribes give among one another – ex: Fenton's group gives Bowhead to other tribes while some send salmon north to their community.
- Chukchi has more data gaps than the Beaufort b/c of leasing activity in the Beaufort.
- Need to think about what is feasible too- pop size, distribution, etc. will be difficult to come up with and use as a metric. Parameters unavailable and imprecise, so hard to use. There are some quantifiable and relevant things though from working with subsistence hunters re: things they take and eat. Morphometric data like fatness, contaminant levels, life history stuff re: growth, pregnancy rates, health related parameters (disease screening). Bowhead pretty well studied, Beluga no. Seals – mostly contaminant information. Generally good access

Species	**Data needed**
Bearded seal	
Spotted seal	
Ringed seal	
Ribbon Seal	
Pacific Walrus	
Polar Bear	
Beluga	
Bowhead	
Gray	

5. What is the current status of baseline data and information?

- **What data and information exist?**
    - Harvest assessments, household surveys. Available through USFWS, North Slope Burough, ADFG, EIS's for some of the oil & gas sales,

Council on Arctic Flora & Fauna (have summarized data available for lots of Arctic species), Lot of gray literature that has been buried over time, could do some data mining. Dive data and location data for some seal species (NOAA NMML).
  - Biomonitoring (general health information, Medical baseline information
  - Communities have information on species that could be accessed.
  - Bowhead and Beluga tagging underway. Seal tagging
  - ESI atlas from NOAA. This has been updated by the Audubon atlas. See reference posted from yesterday's discussion.
  - Vessel and aerial whale surveys in fall in Beaufort. Starting in Chukchi too. Looking for whales, but other marine mammals noted at same time. These go back to the 70's. Some concern about the quality of the data b/c these are incidental observations of non-target species.

Cheryl Rosa will look to obtain and share Council on Arctic Flora & Fauna report.

- **Are the data updated over time?**
  - Most of the data collectton has been haphazard and not updated over time.
  - Marine mammal monitoring in arctic is tough.
  - EAs & EISs are recapping available data, not generally conducting new research. Quality of data re: subsistence uses is v. variable.
  - Annual surveys of some species, but not new estimates of populations necessarily. These are just rough surveys, not formal population estimates b/c it is v. hard to track the animals and know how many you are seeing at any one time..
  - Bowhead surveys happen every 4 years, but this is the exception.
  - Other groups that should have this effort? Maybe polar bears? Good population estimate for Beaufort, but took YEARS to get it. Chukchi effort just beginning – will be tough. Same with Walrus. Efforts coordinated with Russians a few years ago, but very difficult.
  - Would like to have population estimates for all species – not just for NRDA, but for management efforts. If money were no object, would look like: want to monitor seals where they are breeding – these numbers don't necessarily apply to a spill area. Can't do effective survey in summer when all spread out and most in the water. Breeding area for many species is down in Bering Sea. Survey effort might look like huge aerial survey in Bering Sea for three of seal species with separate survey for Ring Seals which are breeding in fast ice. Would need to be multi year effort with periodic analytical updates for population estimating purposes.
  - Particular surveys for Whale species? Feeding area information critical, but not good information.
  - Harvest sampling includes DNA work. AMTAP program provided well archived samples that could be accessed at a later date.
  - Communities harvest caribou that come to the coast to cool off. They do not harvest them while inland. Could be big impact to the species that

isn't well documented. V. important to well being of people. Need to keep in mind the caribou's presence on the shoreline.

- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
    - Spotty at best.
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
    - A lot of scattered data – some in gray literature, some not up to date. For most, not a good time series. Original data quite old, but only data available, so referenced heavily in EIS process.
    - Huge area, sparsely populated, so data is hard to get and v. expensive.
    - Subsistence harvest data has some confidentiality associated with it. E.G. Strike data for bowhead whales. Most info publicly available, just need to be aware that some is sensitive.
    - Industry data collection? Yes, for permit requirements, most environmental data being made available. Proprietary data not available. Is raw data available? Methods and circumstances under which data are collected need to be evaluated as well to ensure appropriate interpretation of info. Some distrust over industry data due to past practices. Good for industry to collaborate with the communities and seems to be happening to a larger degree.
    -
- **Are there gaps in the data that have been collected? What are they?**
    -
- **Is it necessary to fill gaps and if so, how will we fill these gaps?**

    Yes, but need some prioritization – some are more important than others.
    Population, Environmental, and Subsistence data should be high priorities.
    Bearded, Ringed seal and Walrus info should be priorities.
    Subsistence efforts should be documented – how much time does it really take to find and kill a whale? Could change drastically if there were to be an oiling event. Communities could be polled re: resources expended to conduct the activity.

Status assessments need to be done in response to ESA listing process, so some data is being synthesized that could be accessed. These are resources that available for data mining. Focused on risks to the species, probably some info, but not much re: subsistence use and values. Will have info re: harvest levels. Polar Bears ESA status review is complete. Walrus ESA status review is underway, Ice Seals – Ribbon and Spotted seals ESA status review is complete, Ringed and Bearded data review underway. No new petitions for whales. Data for original whale listings is quite old.

MMPA stock assessments

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

- Increase coastal use by Walruses. Haulouts in places now where in years past there never were.
- Polar bears - USGS published reports re: changes in population, size of animals, cub survival, body mass studies indicative of nutritional stress. Spending more time on land. Increased human/bear interactions because time of bears on land is longer, not because there are more animals.
- Seals – no direct indications of changes, but very low power re: ability to detect changes.
- Villages – speak to seeing new species of fish that they never saw before. Needing to go out earlier and earlier to capture seals while on the ice b/c ice is melting and leaving shore earlier. Season of use changing and getting earlier.
    - Bearded seals – people not catching them as easily as before – timing and distribution changing.

<u>Breakout Session III</u>

Changes/Future

PM Wednesday, April 21

Group B: Marine Mammals

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

Assuming no baseline, does it make sense to start collecting data now?

- How long would it take to do an appropriate assessment? One year or thirty? Trying to identify what data could be collected in the next year or two in preparation for a spill in the near term. USGS uses five years as time frame for mark and recapture surveys of walrus. All of these species, v. difficult to gather data with much precision.
- Yes, it makes sense to collect it, but it isn't economically feasible or practical. V. difficult to collect the data – expense and logistics. Even in the unlimited checkbook scenario, it is still challenging. Population abundance baseline for NRDA uses can be done,
-
- is just impractical – too much imprecision in baseline and subsequent NRDA actions. Walrus population estimate was hugely variable, so it would make it tough to use for NRDA purposes.
- V. difficult to collect the data – expense and logistics. Q is do we start collecting data now in preparation for a spill? Yes, but no funding. If we could get funding, what would we do? Even w/funding, methodology & manpower is difficult to find. If we assume blank check, then outline what could happen. Have a reality check at end of session to speak to what is feasible and fundable.
- Existing data is patchy and of variable quality, but if synthesize it, could do a gap analysis. Catalogue available data, requires shorter period of time, doesn't require field work, could use to build the start of a baseline.
- Need to recognize trade-offs and where line might be drawn.
- Other metric than population size to monitor health? Look at body condition, habitat use, reproduction, cub survival. What would restoration look like? Recovery= 6 cm of back fat on a polar bear? This is topic for future workshop.
- Pretty good info exists for Bowhead whales, not the ice seals, walruses, or polar bears.

- Discussion re: CA OSPR OWCN, equivalent in AK? OWCN has network of 25 or so facilities for housing and treating oiled animals. Do exist in AK, but much more limited in extent and currently having major budget problems.

Assuming no baseline, would there be utility or how would you modify existing, paid for surveys for other purposes or on-going studies so that they might help with NRDA in the future?

- Not clear how it would occur for ice seals – not many options for modifying or even how to do it in the first place.
- If there is body condition information being collected, could perhaps ask for targeted samples to be taken for analysis or storage.
- Instead of complete population estimate, could you do a density estimate for a specific area instead? Ex: Do some surveys for specific areas in preparation for drilling or development.
- Tack on requirements as part of permit issuance? E.g. Northstar – USFWS required polar bear surveys as part of permit issuance.
- Translate number of animals in the water to human use numbers? How long does it take a hunter to catch a seal and how has it changed over time? Catch/unit effort.
- Lots of reasons for wanting the baseline data, but may not be feasible to collect it. Perhaps would be useful to collect area specific data in preparation for NRDA if there was funding. Would not do as part of ESA data collection, but is being done in some areas as part of impact assessment. Should extend this strategy to some of these species and try to find funding for it, e.g. fly coastal aerial surveys for bearded seals in late spring before ice breakup along the coast of Chukchi & Beaufort Seas. Not how would be done for a population estimate, but it would give an idea of how many animals are around during the summer.
- Studies underway in the Chukchi by Conoco to examine marine mammal populations in the 193 lease areas – could this be expanded to include other areas? They are looking for marine mammals while conducting their seismic work so that they can shut down if necessary in response to their presence. Some discussion as to whether this is systematic or incidental observation and/or if there is a different study going on with it.
- Site specific studies should be conducted to assist the NRDA process.

- Marine mammal observations from air and boat could be used for multiple purposes

- Maybe some fines should be going to collection of baseline data.
- Walrus haulouts last year – two surveys w/in short period of time of each other with pretty different results re: populations.
-

- **How could injury be evaluated for this group?**
    - Beach surveys for dead animals. Not going to catch smaller animals that just go under out there though.

- Reference populations: If there is one that has had similar conditions, but wasn't oiled, could do comparison between the two.
- Subsistence impacts: Could look at how tribal harvest efforts change as a result of the spill and compare to pre-spill. Is the effort changing? Is the mix of species changing? Has the success of the effort changed? Workaround spill: Could consider taking captains to a different area for catching their quota. If there were an oil spill and animals were going through.
- Obvious effects: Dead animals, Ocular effects (corneal abrasions), baleen fouling
- Less obvious effects: body fat, stress hormones, cytochrome P450(?),
- PAHs clear from these large animals fairly quickly, so would be hard to track.
- Chronic vs. Acute impacts. V. hard to tease out chronic effects. Hard to say without a doubt that health impacts are a result of the spill.
  - Reproductive effects
- Escape/avoidance type behaviors
- Feeding impacts
- Long-term effects
- Challenge is teasing out the effects of an oil spill from other variables like Climate Change. Reference populations would be a key for this effort.
-
- **What effects might you expect to see and what baseline information does that drive you to collect?**
-

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- Yes, maybe, but couldn't compare Chukchi to Beaufort – pretty different environments. Also not very practical for population data b/c there is such geographic differences. Other data like harvest biosampling lends itself better to comparisons between reference sites. Could look at quality of blubber (lipid %), marrow fat, tooth condition, immune stress indicators,
- V. difficult to use reference concept with these species b/c they are highly migratory. Becomes less valuable of a tool. But finding that these animals are habitual in their site use, so may be able to use for limited areas.
- How successful is their reproduction this year vs previous years? If have dead animals can look at uterine scarring to get idea of pregnancy history – not necessarily indicative of successful birthing.
- Isotope analysis? Examining blubber to get information regarding animal's diet, but has a time component.

Species	Priority Species for addressing data gaps for resource management purposes (Subsistence, Ecological use, lack of data)	What data exist?	Data updated over time?	Data quality?	Availability to all parties?	Data gaps?	NRDA Data Priorities?
Bearded seal	X	Some LTK, biosampling of subsistence harvest*,	Annual collection of biosampling data, Harvest data for boroughs	Patchy	**	Yes, significant Population size Harvest numbers	Population size, ***habitat use, health baseline, subsistence use
Spotted seal		Some LTK, biosampling of subsistence harvest*	Annual collection of biosampling data, Harvest data for buroughs	Patchy	**	Yes, significant Population size Harvest numbers	Population size, ***habitat use, health baseline, subsistence use
Ringed seal	X	Some LTK, biosampling of subsistence harvest*	Annual collection of biosampling data,	Patchy	**	Yes, significant Population size Harvest numbers	Population size, ***habitat use, health baseline, subsistence use
Ribbon Seal		Some LTK, biosampling of subsistence harvest*	Annual collection of biosampling data,	Patchy	**	Yes, significant Population size Harvest numbers Lowest information here re: subsistence data b/c	Population size, ***habitat use, health baseline,

						not used as much.	subsistence use
Pacific Walrus	X	Population estimate (low confidence), Some LTK, biosampling of subsistence harvest*	Harvest data annually	Patchy Population estimate (low confidence),	**	Yes, significant Population size	Population size, ***habitat use, health baseline, subsistence use
Polar Bear		Population estimates in Beaufort, Some LTK, biosampling of subsistence harvest*	Harvest data annually	Good for Beaufort, Patchy elsewhere	**	Yes, significant Population size in Chukchi Sea	
Beluga	X	Population estimates, Some LTK, biosampling of subsistence harvest*	Annual effort	Patchy Population estimates have low confidence.	**	Yes, significant Population size	Population size, ***habitat use, health baseline, subsistence use
Bowhead		Some LTK, biosampling of subsistence harvest*, population estimates	Harvest & population estimates updated every 4 years. Health archive exists	Good to v. Good	**	Less than other species	***habitat use
Gray		Some LTK, Population		Good based on data collected	**	Habitat use?	***habitat use, health

		estimates		outside of AK			baseline, subsistence use

*Biosampling data: contaminants, life history, body condition, genetics, some disease screening, diet.
** Most data available w/exception of proprietary data related to industry (i.e. seismic exploration) and confidential data related to subsistence hunt. Some gray literature may be difficult to obtain/be aware of.
***Habitat use: foraging, migration, distribution, reproduction, refuge, response to changing ice conditions, etc.

Local & traditional knowledge (LTK) – data re: use & process information. Cultural uses. Some info available through Steven Braund and Henry Huntington – publication/reports

Breakout Session I

Key Resources and Services

Tuesday, April 20

Group C: Fish & Invertebrates

1. What are the key species of fish and invertebrates and their related human uses and ecological values that may be most affected by an oil spill?

- Unknowns associated with seasonality
- Species:
    - Arctic cod, saffron cod
    - Shee fish
    - Herring
    - rainbow smelt, capelin, eulachon
    - Halibut
    - Flounder
    - Salmon
    - Cisco, Bering, Arctic, least
    - Freshwater
        - Trout, grayling, pike
    - Shrimp
    - Clams
    - Starfish
    - Snails
    - Urchins
    - Tunacit
    - Benthic inverts
    - Mycid

Nearshore/coastal, under ice habitats, and river deltas/lagoons are most sensitive to oil spill

State commercial fisheries vs. federal commercial fisheries
State: salmon, herring, crab: king crab & blue crab
Federal: none

Note: baseline data missing, boulder fields' location, finer scale habitat delineation,
Key habitats, key species, seasonality, sensitivity
Key habitat important, finer scale

2. How and when might these species and their ecological services and human uses be affected by an oil spill? How long might potential impacts last (i.e., magnitude and duration)?

- Ecological services/uses
    - Human consumption: Meat, bait, eggs
    - Cultural uses: trade, potlatch, sharing
    - Association, predator/pray/food chain
    - Key species in food chain:
        - arctic cod – food for Baluga whales
        - capelin
    - ***Reference***: Arctic Marine Synthesis, 2010, Shape files available online, audoban society
    - Species can eat different things in different areas
    - Historical Chuckchi studies
    - Deep water fish:
    - Beaufort surveyed in 77 to 500 m then again in 08 (financed by MMS)
    - ***Reference:*** NOAAs Arctic Fishers Management Plan, August 2009
    - Canada – Arctic Cod modeling distribution, available online
    - MMS ITM
    - AK State Fish and Game office of subsistence
    - North Slope Borough Wild Life Dept

- **How long might potential impacts last**?:
    - Estimating recovery
        - Nearshore recovery incredibly slow
        - Boulder habitat (3-6 m) recovery slow, long term impacts
            - Sponges and corrals
        - ice pushes oil to sensitive area (directly under ice)
            - response issues with oil in/under ice
            - impacts from response
        - long term impact because oil can persist in environment (e.g., ice)
            - concentrated at ice/water interface which is an important habitat
            - seasonality plays a major role because of ice formation (spring/winter/fall)
    - ESI is dated –ESIs need update for arctic

3. What is the key role and characteristics of these species in the food web? How might food webs that include these species be affected by an oil spill?

- Food web models: chukchi, nearshore beaufort
    - Coastal food web models?
    - Feeding food webs relying on nearshore
    - Nearshore habitat more vulnerable than offshore
    - Future funding towards *nearshore* habitat -
    - *Ice/Underice* vulnerable
    - *Lagoon/barrier islands* habitat complex – anad fish
        - Important for subsistence, productive year round
        - Lot of camps at Lagoons
    - *Large shallow* bays – Harrison bay, Smith Bay – larger fish
    - Fish tagging studies
- Benthic key role in food web
- Onshore relationship to offshore-mixing on/offshore
- Key role: ice associated amphipods, feed arctic cod

    - Under ice food web
    - Ice associated fauna potentially affected by oil in/under ice
    - Cod feed and spawn under ice – during winter
    - Life cycle arctic fish: range 5-50 yrs
    - Seasonal transport via the central arctic ocean?
    - Bottom up vs. top down food web effects
- Recycling of environment/food web will be inhibited by large impact/mortality
    - Whale/seal carcass become important local habitat
- Migratory mammal populations depend on fish and inverts

Comments from Breakout Session I report out:

Add birds to food web effects
Sometimes oil can get encapsulated in ice within 24 hours
We need an exposure model
Look at studies done in Canada
Benthic species – juvenile more sensitive than adult
Young and early life stages are important

<u>Breakout Session II</u>

Baseline

AM Wednesday, April 21

Group C: Fish & Invertebrates

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic species?

- What info is available and where do we go to get it:
  - tide and current site specific data unavailable in most locations
  - bathymetric maps lacking, sea floor types (e.g., rock, sediment, sand)
  - salinity
  - ocean acidification
  - practitioner data
  - consulting data
  - No context for Arctic
  - Industry data
  - List of expertise needed for different locations
    - Fish studies
    - Contact experts
  - Data Gap: need to have a central location for all Arctic data
  -
  - Large pool of data
- What would be ideal baseline data to have?
  - Species abundance
  -
- Summer, Open Water Spill:

Baseline data by location:

Beaufort and Chukchi
Cape H is a natural split
Fish species and abundance

- SCAT data for fish species present
- Season
- Substrate data
- Field data collection – water, sediment, fish catching, how fast can we identify reference streams,

Species Distribution:
Presence/absence/abundance

Seasonality:
What are the key species doing at this season

Habitat:

Available data:
OCSEAP data for both Fish and Inverts, 75-90 (covers Chukchi and E. Beaufort)

Communication is critical

Scenario	Species distribution	Species abundance	Seasonality	Habitat	
Summer, open water	Presence/absence /abundance	Trends	Summer Life history	Trends due to climate change	

Quality/usefulness depends on site specific

General gaps: mostly summer (lack of life cycle data), lack of traditional knowledge, no coastal habitat mapping other than ESI, need to include groundtruthing, nothing subtidal

Note: finer scale, systematic sampling grid desired

Data	**Information (year, data)**	**Updated over time?**	**Quality/usefulness**	**Availability/ Accessibility (who: RPs, trustees, others)**	**Gaps**	**Location**	**How to fill Gaps**
MMS/OCSEAP	'75-ongoing	No, name change MMS, ITMs annually	Useful because it's the only data we have in some areas – broadest data spatially	Readily available – some not digital	Offshore, nearshore lacking	All	MMS has continued to fill gaps, chukchi and beaufort. Finer scale, details, site specific, region wide bathymetry (off and near shore)
NSB	88-present, index info, fish data (age structure, reproductive, fish	Yes, depends on location	Useful, management decisions,	working towards online	Limited because of small scale, limited temporally, spatially limited		Include more temporal data, higher frequency (5 yrs)
NMFS	2004-	6 years of	Useful, limited	Online	Limited	Barrow,	Establish

	09Summer only, passive samplers only in 2009, fish	data	spatially		spatially	nearshore	baselines, expand spatial coverage, sample over 5 year periods, seasonal sampling needed, passive samplers desired
Industry studies	81-ongoing, fish and inverts	Yes	Useful, consistent methodology, same sites, time series data, accessory data for water quality, habitat preference	Available through funding company	Limited to 3 m, very nearshore, seasonal	Prudhoe Bay and adjacent coastal areas	Spatial expansion, revisit old sites,
USFWS, ANWR	80-92, tag recapture	Unkown	Useful, only fish,	Fish and wild life library, ARLISS	Fish only	ANWR	Need to be updated, replication
Pt. Thomson,	99 and 00, fish, funded by BP	Yes, annually	Useful, site specific, nearshore	LGL website	Fish only	Pt. Thompson	Need to include inverts, update,
RUSALCA	08, fish and inverts	Ongoing	Useful, includes inverts, detailed taxonomically,	OBIS, presence/absence available online		Chukchi, offshore including shelf	Need to find out more about organization, source
Nearshore Boulder field	77-present	Intermittent	Useful, only info on known boulder	OBIS	Mostly summer, don’t	Prudoe bay, kaktovik,	Need winter, spring

surveys			fields, temporal data included, small amount of winter data,		know locations of all boulder fields	demarcation bay, Peard bay?	fall,studies, habitat mapping, surveys of areas never been surveyed
Alaska Coastal Management Plans (resource section)	80s-present	Every 10 years	Useful as a compilation of data, community consultation	Online, DNR	Large spatial areas	Statewide	Additional subsistence studies, include additional fish and inverts, important habitats
USCG, bathymetry	50s	Updated now UNCLOS	Useful as data for bathym	Online, CCOM	Just offshore, none nearshore	UNCLOS	So new, just out now
NPFMC Arctic FMP	09-current, fish and crabs	Every 5 years, includes EFH,	Useful, compilation of commercial fisheries, including socio-economic, includes latest research, arctic cod, saffron cod, snow crab (5 salmon species under separate survey)	Online, and paper, website	Nearshore, no commercial fisheries data, site specific, no systematic survey, no catch data,	FMP area, EEZ	Need test fisheries, need systematic abundance surveys, species data
ESI	Updated in 05	No plan yet	Useful, only shoreline habitat	Online, NOAA and paper	Large spatial areas, no	Chukchi and	Updated more than 10 years

			maps		groundtruthing, not considered scientific evidence by ACMP, can't infer subtidal habitat from intertidal maps	beaufort	(depends on changes). groundtruthing
AK Fish and Game Subsistence Management	70s – present	Depends on funding	Useful, based on subs. Data	Paper copies, older ones not digital	Dated	Spatially specific, based on village population	Need to be updated

Data Gaps:

- Spatially Limited
- Invertebrates often not surveyed
- Less winter, spring, fall data than summer
- Temporally limited – recommend revisiting every 5 years, or so

Questions/comments from Breakout Session II Reportout:
Studies differences. Difficult to compare studies because of different gear and dates and methodology
Some invertebrate data has been collected for the Chukchi- Caryn Rae
What about chemical baseline?
Difficult to look at contaminant level in fish across a large spatial area
Any info on biological condition of fish?
No

5. What is the current status of baseline data and information?

- **What data and information exist?**
    - o
- **Are the data updated over time?**
    - o
- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
    - o
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
    - o
- **Are there gaps in the data that have been collected? What are they?**
    - o
- **Is it necessary to fill gaps and if so, how will we fill these gaps?**
    - o

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

- Harvest patterns
- Coastal erosion, increase sediments

- Baseline data changes due to climate change
    - Range extensions north
    - More species, changing competition
    - Sockeye salmon in Colville R.
    - Some species improving like Cisco
    - Will species be able to adapt by less ice?
    - Shallower water of over wintering habitats
    -

Breakout Session III

Changes/Future

PM Wednesday, April 21

Group C: Fish & Invertebrates

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

- Spatial resolution is not fine enough, macro data sets and time lags between them won't know exactly what is on beach/impacted area
- Logistical questions come into play for sampling plan
- Satellite photography as one potential source of baseline, NGIA
- Chemical bio-marker data may help as evidence of exposure
- NSB has been using bio-markers recently
- Fish & Game monitors for mining impacts could be potential to expand for coastal
- Exposure is a good first step as a screening tool
- P450 for non-arctic species, will this work to establish a baseline in the arctic?
- Baseline can be a reference, can use outside spill zone
- How can we speed up the NRDA process?
- The species we are talking about are slow to recover

- Traditional knowledge will play a major role in establishing baseline data
- Note: Habitat recovery will take longer in arctic regions
- No empirical experience with habitat recovery in arctic
- Water column samples, biota samples,
-
- **How could injury be evaluated for this group?**
  - Presence/absence
  - Distribution and abundance
  - Condition of biota
  - Spawning area – estimate of # of fish affected
  - Community communication – users of resource will be critical to obtain injury data
  - State and federal agencies based in regional hubs could assist
  - Spawning biomass?
    - Carrying capacity
  - Change in index in biomass, catch rate
  - Almost no baseline data on biomass
  - Indices are more readily available (using catch)
    - Not an absolute density
    - Have done over summers, nearshore shallow
  - Change in indices
- **What effects might you expect to see and what baseline information does that drive you to collect? All below applies to fish and inverts**
  - Exposure levels and literature
  - Fish/invert kills
  - Compromised eggs and sperm for reproduction
  - Food web issues
  - Changes in population – need to have baseline population data
  - Absence of predator would be an easier indicator to visualize effects/injury
  - Stomach sampling of predator species
  - Char and larger fish species in the streams could be used as an indicator

  - Basic distribution and abundance – shift/decrease
  - Feeding rate – stomach fullness
  - Growth rates
  - Condition factor
  - Reproductive state – proportion that are reproducing
  - Environmental drivers (e.g., salinity, temperature, wind, etc.) – modeling analyses
    - Grain size key envi driver for benthic inverts
    - Pick reference site based on envi factors
    - Satellite imagery for temp. and other factors
  - Global biodiversity indices as a possible metric
  - Traditional knowledge useful sampling tool – observations of changes and impacts
    - Poorly documented and not often incorporated – need improved ways to incorporate
    - Quantify by using major activities (e.g., hunting)
    - Trace changes and patterns
  - Report coming out shortly: Interviewed native communities – Fishing Patterns in Barrow region – Karen Brewster, Craig George
  - Need for improved and increased bathymetry imagery (detailed imagery for 0-30 m)
  - Differences for inverts?
    - Different spawning areas
    - Spawning at sea
    - Larval drift?
    - Life stages

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- Arctic is changing so much now – variability will make it difficult to use “reference” area
- Lots of data but it isn’t always useful because of site specific issues
  - Reference sites may work because of existing data
- Reference site may not be perfect but it could work (would have no choice)

- Would not want to use Chukchi reference site for a Beaufort and visa versa
- Barrow is a split – east/west of barrow
- Cannot compare different boulder fields within beaufort
- Meta analysis of existing data

Are there any utilities to modify existing data/studies that would be helpful for an NRDA?

- Standardized gear for catching fish and inverts
- Revisit OCSEAP – higher frequency of surveys
- Bio-marker sampling and analysis standards
- Reference site grid for surveys and samples
    - Could be defined by depth
    - Who would maintain this reference grid data?
    - Sampling of opportunity (when surveyors have extra time/resources can collect needed data)
    - Need one central database and one single point of maintenance – possibly MMS? Or NMFS?
- What locations lack data

Day 3: Take home messages and 3-5 follow up actions

3 Take Home Messages:

- NRDA will need to rely on existing assessment
- Ships and equipment ooperated by response groups will be important to fill data gasp
- Sampling and observations can be made by insitu community – can groundtruth bio data – species abundance location
- Data synthesis process/organization needed with access for everyone, starting ASAP
- Challenging to develop effective fish restoration projects
- Data gaps – access database for everyone
- Reference sites – a way to determine appropriate reference sites
- Figure out recovery time
- Data may be available not always useful because of gaps

- Benthic invert data lacking
- Lack of data infrastructure
- More data available than anticipated
- Arctic is changing rapidly more difficult to establish baseline
- Need to utilize traditional knowledge
- More data available than thought
- Data exists over short times and space
- Environmental drivers for reference sitews
- Not being able to get baseline data
- Need centralized clearing house for data and meta data
- Need central planning platform of opportunity
- Need multiple years for survey for effective baseline
- Clearly identify baseline
- More info on habitat and nearshore
- Limit life stage lacking
- Recovery time needs to be determined
- Environmental drivers of fish and inverts can help to define change/reference sites
- Lots of data but needs synthesis
- Recovery time will be difficult to establish because we have no basis to compare

3-5 Follow up Actions:

- Creation of info clearing house (2)
- Nearshore mapping (3)
- Local monitoring program (3)
- Clearnighouse of data metadata (right away)
- Central planning site – platform of opportunity (now)
- Identify funding for baseline studies –(NOAA initiative) right now
- Cataloging – use grid system idea/reference site grid to collect data

- Expand offshore data – partic inverts
- Polling native elders – using native knowledge to notice trends – will help to fund what needs to be studied in more detail
- Size and compile data and identify gaps
- Need central body to control money, data, central clearinghouse
- Get scientists involved locally to establish reference sites – potentially not cost a lot
- NOAA needs to get off butt and start planning
- Conduct 3-D image of 0-30 countour start with Chukchi and then Beaufort
- Assess natural collection sites (marine debris)
- Assess known spawning sites/sensitive habitats
- Start identifying reference sites – use local knowledge
- Data repository – pull together agencies something NRDA affiliated
- Identify local contacts and resources that can be mobilized
    - Get them familiar with NRDA process
- Sampling grid useful – part of central clearinghouse part of a whole plan to develop partnership of all entities involved in NRDA – industry, local, NOAA, MMS, etc.
    - Archiving
    - Help determine future surveys
- Tribal users involvement
- Partnership between trustees and industry – support for assessment – planning for potential spills
- Fish and invert data synthesis need to identify native sources and gaps including trandition knowl
- Who what whwere GIS database
- Develop a plan to fill the gaps
    - Reference grid
    - Standardized gear
- habitat mapping nearshore
- fish and inver team that would review the data regularly – decide how to move forward
    - a continuation of meetings

<u>Breakout Session I</u>

Key Resources and Services

Tuesday, April 20

Group D: Ice and Under-ice Habitats

1. What are the key species (functional groups**), ecological services and human uses associated with or dependent upon ice and under-ice habitats that may be most affected by an oil spill?**

- Multi-year ice
  - Hunting
    - Stability/land fast
  - Drinking water
  - Travel (loss)
  - Ice endemic
  - Lower biomass
    - Functional group
    - Species change
    - Timing similar (low algal biomass then bloom)
- First year
  - Hunt
  - Travel
  - (more known about first year sea ice ecology)
  - Input to benthic habitat
  - Denning and resting
  - Pelagic
  - Feeding (e.g., seals and birds)
- Land fast
- Bottom fast
- Pack
- Transition
- Leads
  - Contact
- Ridges
- Level ice (smooth)
- Polynyas
  - Migration
- Melt Ponds
- Snow
- Fall freeze
- Winter growth
- Columnar ice
- Spring break/summer melt

- Break out- moving away from shore
- Break up-melt and wind blown

- Under
- Within (brine channels vs. bottom 10cm)
- Edge
- Below
- Functional groups
    - Ice algae
    - Ice meiofauna (e.g., copepods, nematodes, tubelarians, polychete juvenile)
    - Amphipods
    - Arctic cod

2. How might the key species, ecological services and human uses of this habitat be affected by an oil spill? How long might potential impacts last (i.e., magnitude, duration)?

- Acute toxicity
- Chronic toxicity
- Mortality
- Reduced production
    - Toxicity
    - Ice algae rely on nutrient flux through ice-oil blocks that
- Contact
- Human use
    - Restricted travel
    - Reduced hunting
    - Drinking water
- Genotoxicity
    - Cod eggs
- Phototoxicity
    - PAH
    - Ice communities
- Smothering
- Physical ice structure
    - Break up
    - Heat
-
- Tainting
- Under
    - Summer
        - Dispersion
        - Solubility

        - Mixing
        - Oil movement within ice
        - Multi year ice- may take longer for oil to move(?)
- Within (brine channels vs. bottom 10cm)
    - Flush-summer
    - Melt
    - Portion retained
- Edge
- Top
    - Oil stay until ice melts
    - Remove by runoff, melt ponds
    - Evaporation
    - Biodegradation
- Oil phase depends on what it affects

3. What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

- **Environmental *Factors*:**
    - Snow
    - Ice concentration
    - Thickness
    - Temperature
    - Salinity
    - Light level
    - Oil chemistry
    - Timing of spill
    - Nutrients
    - Water depth
    - Edges
        - Convergence zones
        - Ice water
        - Sediment
    - Winds, currents, upwelling/downwelling
    -
- **Key *Components* of food web:**
    - Arctic cod
    - Amphipods(e.g., copepods, nematodes, tubelarians, polychete juvenile)
    - Ice algae
    - Ice meiofauna
    - Top predators
    - Pelagic copepods
- **How habitat might be *affected* by oil spill:**
    - No biomagnifications

- Exposure pathways from lower level exposures (e.g., amphipods)

    - Birds, mammals, air/ice interface
    - Physical fouling
    - Vapor inhalation
- Ecosystem destabilization –food web
- Reduced light level
- Loss of diversity
- Toxicity
- Physical fouling
- Loss of breathing opportunities
- Human intervention-clean up methods
- Accelerated melting
- Phytoplankton plume stimulated by ice melt
- Seasonality

<u>Breakout Session II</u>

Baseline

AM Wednesday, April 21

Group D: Ice and Under-ice Habitats

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic habitats?

- Community composition unknown
    - microbial populations
    - Relating to benthic populations
- Baseline philosophy
- **Spatial and temporal dimensions**
- **Scales**
    - Pack ice vs. fast ice
    - Temporal
- **Chemical baseline**
    - Biological responses (Cytochrome P450)
    - SPMD PAH, PCB
    - Cyp1a, metabolism
    - SPME fibers for PAH background
    - Inorganic nutrient loads (biological function)
    - Nutrients/flux
- Pressure ridges (Arctic cod, amphipods)
- Natural seeps (background)
- **statistical strength**
    - Measurements of variance
    - Strength of sample size, n
    - Quantitative estimate of range
    - Solid sampling design
- Molecular analysis
    - Species determination
        - And functional role
    - Microbial classification in functional groups (algal, bacterial communities)
- Trained taxonomists (barcode of life-molecular markers for each species)
    - 18s (eukaryotes)
    - 16s (prokaryotes)
- **Light availability within/below ice**
    - Establish snow depth
        - Mean
        - SD
    - Sediment involvement
    - Smooth and rough
- **Sea ice properties**

    - Morphology
- Variability in species (relating to physical ice)
- Migratory patterns (birds, fish, whales)
- Fate of material released from sea ice (region specific)
- Benthic and sea ice coupling
- Protozoan, ciliate species
- Edges that create increased abundances of organisms
- **Species distribution**
    - Functional groups (mRNA, genomic studies)
    - Degradation potential
- **Biological variability**
    - Natural recovery time
    - Population structure
    - Resiliency
- **Primary productivity**
    - Abundances
    - 4 speicies,
    - Heterotrophic uptake
    - Nutrient recycling
- **Secondary productivity**
    - classify amphipods, copepods
- Migration/gene flow
- Wind relation to sea ice and predictive models (NSSI look at this); terrestrial effects on wind. MMS oil spill models inferences based on satellite imagery
- Monitor recovery
    - Impact and baseline but what technologies?
- Increased UV, microbial interactions

5. What is the current status of baseline data and information?

- **What data and information exist?**
    - Light availability (ref. from scott) for algal growth
    - Biological abundance and community relating to snow cover and ice thickness (Rolf-1970s fast ice, Barrow, Bering sea; biological in 2000's-deep sea; ice biology, fast ice)
    - Rolf work- Ice, pelagic, benthic-collect data spatially, online (OBIS) public data
        - Large scale distribution of ice (2010 goal; journal of marine biodiversity)
    - Population models (pinnepeds, whales)
    - North slope science initiative –coordinate agency work done on north slope (Alaska genome program), terrestrial, little bit of marine info. DOI funded-long term. Report catalogue of projects
    - Primary production (1970s data) in sea ice (break till 2002; fast ice and pack ice).
    - Better benthic community analyses.

        - Temporal component well known
        - Benthic, pelagic (terrestrial) coupling
    - Benthic and sea ice coupling (fast ice, Rolf ref.)
        - Amphipod grazing (Canada)
    - Timing of ice melt
        - Sooner-pelagic driven
        - Later- benthic driven
    - Jellyfish flux effects on zooplankton (holly reference-example outside arctic)
    - Chemical data
        - Sediment loads
        - Water (grab samples)
    - Fisheries data (LCLs?)
- **Are the data updated over time?**
    - Some data updated daily
        - Ice extent
        - Concentration
        - Fast ice in Barrow, Whales (once a year, April) Ice growth, properties, albedo, optical measurements, snow depth (Chris ref)
    - No plan to update anything regularly
- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
    - Biological (metazoans-small component undescribed-new species 2003 in ice) Under ice no substantial additions. Protozoans not well known (flagellates/ciliates)
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
    - Ice cover data
    - OBIS (online database-ends in 2010-stay tuned)
    - NSSI-north slope science initiative
    - OSCEAP reports
    - MMS reports-hard to get a hold of
    - No Gap-80s
    - Ice island-ice camps
- **Are there gaps in the data that have been collected? What are they?**
    - Pack ice
        - Spatial component
    - Limited understanding of scales involved
    - Relevance of earlier ice break up and later ice formation
    - Species classification/diversity
- **Is it necessary to fill gaps and if so, how will we fill these gaps?**
    - Yup

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and

other physical habitat changes that may be caused by Global Climate Change? What are these changes?

- Satellite data
- Summer time sea ice extent
- Freeze up-later
- thaw out - melt season increased in width
- climate change-alter baseline
- Jellyfish, salmonids
- Imported pollutants: More open water
- Increased summer melt, disappearance of amphipods, salinity issues
- Ice morphology, less multiyear ice, ridging
- UV; increased phototoxicity with decreased snow and ice coverage

<u>Breakout Session III</u>

Changes/Future

PM Wednesday, April 21

Group D: Ice and Under-ice Habitats

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how? ***Spill down the road-what can we do now to anticipate a spill; monitoring now***

- Refer to Question 4.
- **How could injury be evaluated for this habitat?**
  - Arctic Cod tissue samples
- **Existing programs to be modified for use of NRDA?**
  - Camida and chemical data-build upon (arctic cod)
  - Chemical baseline-vertebrates
    - Base cyp 1a response
    - Background contaminant levels
    - Tissue residue of PAHs (amphipods, copepods)
  - Invertebrates, ice algae, and microbes
    - Tracking changes in community
    - Biodiversity index, change
    - Biomass alterations
  - Spatial and temporal scale variability
  - Ice drift
  - Open access to information, public, internet
- **What effects might you expect to see and what baseline information does that drive you to collect?**
  - Biological response (mortality, production, functional changes)
  - Change in light regime
  - Different food supply to benthos
  - Interrupted life cycle of marine biota
  - Change in biodiversity
  - Occupancy of denning sites and pupping success of seals

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- Yes, but it is expensive and difficult to do—however it would be useful to identify some reference areas in advance right now
- The usefulness of the reference area depends on number of unknown gradients that become known later on, e.g. near river mouths with large gradients
-

All ya'lls notes.

How relevant is what we're doing here to NRDA?

-good potential, some direct and immediate (restoration planning and how to do assessment) Problem evaluation.

-Ultimately useful for components of NRDA.

Most NRDA processes very important to establish relationship and level of trust. Nice kick off for networking and beginning the discussion on this topic.

More coordination and clearinghouse –**alaska marine science** group. All areas of oceanography in arctic

North slope science initiative. –working on clearinghouse. Project catalogue at present. How do you translate information down to the bottom. Coordinated group vs. funding group. Clearinghouse dependent upon funding. -3yrs in the works, need to be connected.

Clearing house started-NRDA planning, field studies**, NRDA tool box** as a start. From FWS and NOAA, Spill event add to this, need components specific to Arctic and working in ice conditions. **Federal Tribal state working group**-add to tool box

Help us connect to tanker owners. West coast marine spills over last 15-18 spills mostly from non-tanker vessels. Cruise, cargo, other spills. Non-tank vessels have different damage assessment than larger companies. Industry helps set tone

What are we missing?

Long term perspective. IDP programs then Oxic programs? Funding peaks Aminida? Fragmented pieces of data sets-come and go with political times. Need 25-50 year monitoring base. Recognized by congressional funding for long-term. Major arctic changes in arctic that need to be understood.

Message from industry is equally as important coming from tribal, NGO, etc to federal agencies….more important than from within national. Mussel watch-25+ yr monitoring program which will terminate due to funding issues. Joint political pressure to move ahead.

What do economists need to valuate/figure out subsistence holders on north slope to see damages are irreversible

Write a letter or call gov't

Crill never mentioned-resource for everyone in food web. Archeological resources need consideration.

Spill response questions- practical aspects of when a spill happen.

-west coast example of academics wanting to be involved during spill-mms made program for individuals wanting to get involved. OSPR developed memorandum of understanding to have scientists coming out and collaborating with their studies prior/during a spill

NRDA is a legal process and as scientist can share, but when everything goes down (Spill) the scientitsts will be influenced by attorneys. Shell voice-level of knowledge and understanding of natural resources – legal, state and federal representatives.

Incorporate legal voice next time.

Experience on a spill-what if the resources are tied up for a spill on north slope-can't get there, have no tools to respond. Scientists- try to stop as much environmental damage as possible

3 vessels conducting science over the summer

Science during spill response can be chaotic

Conduct control field studies on spill response.

Representative clubs during spill. RP and cost sensitivity. Integrate nrda into response, make sure parties that need to understand that you aren't subjecting NRDA to authority of UC. Legal issues and liability – different cover for RP. Can confuse a situation

NRDA not under control of unified command.

Coordination-ICS process and NRDA process-information flows yet separate processes.

Information flow is key-what is it being generated for. Doesn't belong on situation report

Who's gonna be the commander in chief. What federal agency will be lead agency to coordinate oall response work?-coast guard. Who's under that? Involvement of specific parties? Logistics-if every plane is filled up, who will be first responders and how will they get up there? Cell phone availability, etc

Response side-coast guard is well established how response will go. DEC on stateside. RP have representative. Kaktovic will have someone representing them in UC. Establish command center at Prudhoe bay or kactovic. Regular drills to ensure things are going well. People who will be playing FOSC. SOSC. Coast guard commander . SCAT….process well known

What's missing-uscg –put issues in there

AccommodateNRDA.

Wrap-up

-protect and restore NR. Actual law. Response and NRDA. Clean up and response. Connection. Prevent long term ongoing and residual harm and effects.

-Integrate NRDA concerns into response more so than existing (w/ birds, mammals, etc).

Useful for USCG

Protect what, envi, species, habitats, people, long term protection

Get on same page

Legal framework and what NRDA has to prove.

Worried about release, how much, what kind of oil, hwere, what is it hitting, NRDA gets that from response side

Exposure set of information

Residual olil after clean up , residual effectgs on species, accumulation, responders collect some info for damage assessment on birds and stuff.

Geographic extent of damage, extent of NR damages

Grey area as to why collecting this information. Where the information is going and what we're going to do with it. Scale and assess what we need to do with the information

Work cooperatively with stakeholders and responders

Info for planning response and assessment in arctic

NRDA trustees in Alaska promise to continue this here. Work with stakeholders. Volunteers to help take leadership roles and plan ongoing activities

Federal/statetribal connections

Additional notes

4/20

Identify key species in maintaining a community

What organisms have an impact on the food web

Valued ecosystem component

Varied species composition among ice stages and seasons-temporal variation

Examples from lower 48 NRDA? –unique aspects to the Arctic

Surface vs underneath ice community differences. Organisms move through ice, ambient ocean species

Unique species to pack ice zone- food web interactions differ near shore vs. offshore. Certain species growth phases change spatially (ice to benthic).

US territorial miles (200 miles from shore); including multi year sea ice

Human interest portion (crustaceans, pinnipeds)

Air/ice interface – most vulnerable species are the ones that use this. Contact hazard. Seasonality

Pipeline burst-ice/water interface

WSF

Amphipods (4 species-highly abundant-near shore/offshore differences) and Arctic Cod that are critical species

-oil impacts on these species would drastically affect food web

Bottom 10cm has 90% biomass –seasonality component

Spawning activities of Arctic Cod, long period. Rely on algal bloom

-main nutrients from Fall

Copepods, ice algae (2000 species-5-7 dominant species, others rare), arctic cod

Ecology of first year ice more well known

Multi year offshore with whaling. Fall hunts (boat hunts in open water or ice edge=marginal ice edge bloom). Fall bloom-phytoplankton

More primary productivity near ice (march april-most productivity in ice). After ice melt, algae in ice get to ambient water or benthic communities. Zooplankton eat algae. Marginal ice zones, stimulation of growth. First year ice

Light availability, snow cover

Dirty ice (Russia) vs. other ice

-landfast ice bringing sediment offshore

-highly turbid water

Wind can bring multi year sea ice to shoreline. Not always deep water

Relation between whale hunts in summer with ice?

Key species/Functional groups: Ice algae, Ice meiofauna (e.g., copepods, nematodes, tubelarians, polychete juvenile), amphipods, cod

Movement of oil through ice

Melt season-weather dependent –once it comes to surface it keeps coming up

Spill duration- on surface of multi year ice-there for a long time

-situation dependent

Ice drift through melt pond-can get runoff

Biodegradation –surface to volume ratio. More dispersal, better

Oil will be encapsulated in ice if underneath. Can migrate up brine channels as ice warms. Some oil retention in ice mass

-still have dissolved component

Bulk oil-w/in year

Multi year sea ice oil migration – even when moves toward surface, ~20% can be retained in ice. Stay until ice melts or is flushed (years)

Dirll hole in ice, @ 0degC can flow up. Can collect from an accumulation spot – collection depends on dispersal of oil underneath

How long will oil soaked us last (black)?

Biota, ice algae, can recover within a season. Amphipods cannot recover quickly (3 years). Cod even slower (7 years). Multi year effects on larger organisms

-lifespan of cod not recovery time

May recolonize from pack ice quickly

Amphipods can withstand some oil (biomagnifications concerns)? Not really, fish are very good at detoxifying, same with mammals, and birds.

- still exposure pathways, energy inefficient to excrete and biotransform PAHs
- still can be toxic effects

Arctic has shorter food web and is more lipid rich (in comparison to other food webs-NRDA related)

Extreme seasonality in Arctic

- synchronized
- trophic levels,

Timing of spill influences on species/ice/habitat

- seasonality of likelyhood of spill
    - ice melt, open water, summer
- Response actions also adjust
- oil behavior at specific times
    - ice encapsulation and mechanical removal, have months before it’s immobilized.

-ice algae, dark adapted

Sea Ice

Multi Year

First Year

Landfast

Bottom fast

Pack ice

Transition

Leads

Ridges

Level ice (smooth)

Polynyas

Melt Ponds

Snow

Fall freeze

-rapidly incorporated into ice

-biologically –fall migration of seals; birds gone; citations gone/going; whales gone; migratory fish (e.g., pink salmon) gone.

-cod slow down

-lower trophic stored up for winter

-ice incorporate algae

-multi year ice still has community habitat association

Winter growth

-Similar to fall freeze

-slower oil encapsulation

-oil is more out of reach for responders

-keeping track of oil-always an issue

-late winter-reproduction, egg rearing

-Near surface-less retained in ice

-fresh, toxic, less weathering of oil

Spring break/summer melt

Break out- moving away from shore

Break up-melt and wind blown

-conditions getting better (response view)

-ice present to help with containment

-More daylight for response

-max benthic and pelagic interaction

-max in-ice production

-biodegradation picks up

Open (less than 10% ice-satellite)

-still important pieces of ice

-changing behavior

Columnar ice

Under

Within (brine channels vs. bottom 10cm)

Edge

Top

Nearshore D<200m

Offshore

Presentation Day 1,key points:

Many habitats of importance (Under, Within -brine channels vs. bottom 10cm, Edge, Below)

Impact of response operations

Functional groups rather than species

Questions: Retention of oil in ice

-importance of short, lipid rich food web

Ice communities are diverse and connected to pelagic and benthic

Duration of impacts on sea ice

Species at air/water interface and ice/water interface with aggregated oil

-transiting through interface is restricted.

Ice habitats important for food web and reproduction

Strong seasonal impact and response options

Responses to presentation:

Presentation re-summary: Sea ice has a variety of habitats with strong seasonality. Impacts of oil spill fate and behavior. Anthropogenic affects of response measures. Tied to benthic and pelagic food webs. Seasonality and duration of impact. Seasonality and oil fate influences response options.

Responses: zilch

<u>Breakout Session I</u>

Key Resources and Services

Tuesday, April 20

Group E: Lagoon and Near-Shore Shallow Water Habitats

1. What are the key habitats and species, ecological services and human uses associated with or dependent upon lagoon and near-shore shallow water habitats that may be most affected by an oil spill?

- Chukchi Sea:
  - <u>Lagoon</u> – seasonal impacts, low productivity in winter, high productivity in summer (export of calories into nearshore).
  - Ecology - Feeding, shelter, nursery
  - Species -
    Marine mammals - Beluga use lagoon for molting,
    Birds - Eiders (ESA critical habitat; molting area late summer), feeding area,
    Fish - Sheefish, juv. Fish, Bering Cisco, Arctic Char,

  - <u>Shallow Nearshore</u> (oil to bottom seds) – loss of sea ice has resulted in walrus hauling out onshore,
    High benthic biomass, locally low diversity, and patchy distribution.
    Migratory pathway, response impacts to migrations and molting habitats.

  - <u>Human use</u> – Eider harvest, harvests of "migratory" species (marine mammals and birds).

- **Beaufort Sea**:
  - <u>Lagoon</u> – seasonal impacts, low productivity in winter, moderate productivity in summer (export of calories into nearshore). Boulder patch kelp habitats. Delta habitats.
  - Ecology - Feeding, shelter, nursery; also on barrier islands, haul outs on barrier islands
  - Species -
    Marine mammals - Beluga use lagoon for molting,
    Birds - Eiders, feeding area, Long tailed duck
    Fish - whitefish, juv. Fish, Arctic Cisco, Arctic Char,

  - <u>Shallow Nearshore</u> (oil to bottom seds) – loss of sea ice has resulted in Polar bears onshore.
    Low benthic biomass, locally low diversity, and patchy distribution.
    Migratory pathway, response impacts to migrations and molting habitats.

  - Human use – Eider harvest, harvests of “migratory” species (marine mammals and birds). Fish and marine mammal harvest. Cultural.

2. How might the key species, ecological services and human uses of this habitat be affected by an oil spill? How long might potential impacts last (i.e., magnitude, duration)?

- Scenario: August, heavy oil, lands onshore and is blown into lagoon areas.
  - Areas impacted –
    - nearshore - whales, seals, sea ducks, benthic food web,
    - barrier islands - Polar bear haul out, bird nesting, shore birds
    - lagoons (boulder patch) - sea ducks, benthic food web, shore birds, fish, shoreline vegetation.
  - Human uses –
    - Subsistence – whaling, fishing, hunting
    - Cultural
    - Tourism
  - Long Term Effects

3. What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

- **Environmental *Factors*:**
  - Seasonal change – Ice cover, temperature, salinity, light
  - Climate change – erosion, fetch, turbidity,
- **Key *Components* of food web:**
  - Simple food web – benthic dominated in Chukchi and pelagic in the Beaufort
  -
- **How habitat might be *affected* by oil spill:**
  - Critical timing of calorie loading for annual survival and successful reproduction.

END OF DAY (4/20/2010) PRESENTATION AND QUESTIONS FOR LAGOON AND NEARSHORE GROUP

- none

<u>Breakout Session II</u>

Baseline
AM Wednesday, April 21
Group E: Lagoon and Near-Shore Shallow Water Habitats

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic habitats?

-

5. What is the current status of baseline data and information?

- **What data and information exist?**
  -
- **Are the data updated over time?**
  -
- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
  -
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
  -
- **Are there gaps in the data that have been collected? What are they?**
  -
- **Is it necessary to fill gaps and if so, how will we fill these gaps?**
  -

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

-

Breakout Session III

Changes/Future

PM Wednesday, April 21

Group E: Lagoon and Near-Shore Shallow Water Habitats

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

-
- **How could injury be evaluated for this group?**
    -
- **What effects might you expect to see and what baseline information does that drive you to collect?**
    -

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

-

Lagoon Nearshore Group 4/22/2010

- Important take home messages
  - We don’t know what biological info there is for lagoon
  - Chemical data is achievable
  - Difficult to do baseline when conditions are changing so fast (***)
  - Repeated surveys over time difficult
  - Response and cleanup include displacement of species using habitat
  - Subsistence use important for NRDA because of arctic
  - Obtain background chemistry catalogue
  - Less prepared for NRDA in arctic
  - Lagoon and nearshore often overlooked and under valued
  - Need to make data accessible?
  - Open minded about restoration options in arctic
  - Data clearing house past and future (******)
  - Integrated monitoring project (multi-agency) 50years! Not 2 years!
  - Restoration focus rather than injury assessment
  - What are the restoration options are?
  - Traditional knowledge in arctic is very valuable here.
  - Involve stakeholders and natives in NRDA
  - Need baseline (**)
  - Identify key species for arctic habitat to assess damages
  - All participants worked well together to find solutions.

- Follow-up Actions
  - Plan for chemical baseline for chemical for biota within 2 yrs. (*)
  - Establish a data clearinghouse in 2 yrs (*****) ARLIS?
  - Existing data should be reviewed 2-5 yrs including industry
  - Show there is money behind effort that is not going to disappear in the short term.
  - NRDA info needs should be leveraged with new initiatives DOI, NOAA.
  - Research on restoration techniques in arctic
  - Add NRDA table top exercises to industry drills (*).
  - Assemble playbooks for NRDA tailored to arctic (*)
  - Work towards integrated data and infrastructure 2-5 yrs
  - Risk assessment integrated with traditional knowledge. 2yrs
  - Restoration workshop 2 yrs (*)
  - Injury assessment workshop? (2yrs)
  - Better communication for ongoing research and monitoring
  - Super long monitoring (***)

<u>Breakout Session I</u>

Key Resources and Services

Tuesday, April 20

Group F: Freshwater Lakes, Ponds, Streams, Rivers and Coastal Tundra

1. What are the key species, ecological services and human uses associated with or dependent upon freshwater and coastal tundra habitats that may be most affected by an oil spill?

Building on Jacqui's list of types of shoreline- what types of shoreline are we looking at and what are components of these shorelines?

- Tundra: no peat on the slope (i.e. no thick seams of peat)
- peat (organic) layer is the active (thaw and refreeze) layer overlying mineral (clay, sand and silt) soil layer on top of permafrost
- Microbial activity is limited to a short time period in the summer- approx 90 days of activity.
- Peat is rooting zone for tundra plants
- Other types of tundra
    - Tundra cliffs
    - Tundra wetlands interlaced with ponds
    - In river deltas, there are areas of no peat (only sand and gravel) with forbs and shrubs growing on sandbars. Active layer is several feet or several meters thick
    - Barrier islands built up along the coast
    - Gravel beaches (very little fine sand or sediment). No tides on these beaches; only wind-driven.

- Describe characteristics of rivers
    - Meandering, low-gradient mudflats. Shallow
    - High water flow volume in spring ice breakup over a very short time period of several days
    - Other times, very low flow- even upstream flow at times due to wind
    - Rocky (bedrock) cliffs in isolated areas—elsewhere mainly flat
    - See report from Conoco/Shell
    - Storm surge extent can give us a practical boundary for inland extent of effects of offshore spill. But also concerned about pipeline burst on land.

- Why is inundated tundra so sensitive? (ESI 10)
    - Long time to recover naturally—20-30 years. Can accelerate by seeding or transplanting. Slow recovery due to short growing season.
    - Thermokarst → settling and leads to erosion. May recover to a different type of tundra community (wet vs dry) which may not support the same species. Thermokarst is occurring naturally but can be increased by response efforts

    - Cleanup effort can significantly disturb tundra (weight of vehicles leading to erosion & settling)
    - High value bird habitat
    - Includes salt marshes – low-lying islands. Classification as salt marsh vs inundated tundra is dynamic due to changing salinity → changing plants and fish using the area
- Aerial surveys by oil companies can be a tool to help us identify wetlands & other areas at risk. Surveys mostly done near oil infrastructure.

- Key species and data sources on these animals
    - Polar bear using the tundra area more due to ice receding.
    - Grizzly bear
    - muskox
    - Caribou as subsistence resource for human use. Caribou seek out windblown areas near the coast to avoid insects in the summer. Migrate inland to eat during the cooler temperatures in the summer
    - Fish Ciscoes, char, salmon (recent), whitefish, grayling, blackfish, cod, burbot.
        - Salmon had been observed in the western area previously but now also east of Point Barrow
        - State of AK collecting data on anadromous streams in AK with salmon spawning. Some streams have very limited data—some have multiple years. Anadromous Waters Catalog gives data on salmon presence, spawning, rearing. Updated annually. Conoco's data also entered into this state database. This is available to the public on the state's website.
    - Birds: We have tables inventorying bird species and seasonal habitat usage patterns. ACS tech manual. Use for spill response.
        - 1st volume: response techniques
        - 2nd: maps of north slope Canadian border to Point Hope + inland. Identifies priority sensitive areas (where to boom off; seasonality of usage) ecologically sensitive + archaeological sites www.alaskacleanseas.org
        - Part of this is in GIS- remainder is to be transferred into GIS later this year.
        - Data as presented in the manual is not specific enough for a NRDA. Underlying biological data could potentially be used. Not currently available to the public, but potentially in the future.
        - Also have tables on subsistence species
    - There is a large amount of data collected by the oil companies—next step is to synthesize it
        - www.Northslope.org science initiative. 13 emerging issues papers (issues selected by FWS, MMS, state reps, park service…) E.g. migratory birds, marine mammals + their prey, increasing marine activity, permafrost, coastal and riverine erosion, contaminants, fire, vegetation change, caribou, tundra rehab, arctic fish

        - Audobon & Oceana's Arctic Marine Synthesis compiles public datasets. Data is spotty & not always comparable from site to site (methodology, seasons, timing vary among different studies). Ex: Conoco Phillips data at their lease sites is good but does not give broad scale info. Suggest that agencies fill in the gaps between lease site permitting studies
        - Synthesis document for North pacific research board (Hopcroft) available at NPRB website (2008): survey of info gaps in outer continental shelf.
        - Cheryl Rosa compiling data on contaminants in subsistence foods. Work has been done on ciscoes and burbot (PCBs & PAHs) and data has also been collected on sediments. Exxon collecting sed data near Pt Thompson. Likely will not be publicly available. Conoco will make theirs publicly available when possible. Want to develop a framework for sharing this information. One outlet is BP's annual Long-Term Monitoring Report summarizing what datasets exist. The reports are provided to the agencies and are public information, but there's not an easy way to use the data (no single database).
        - Can these data be used as baseline in an NRDA if they've been collected prior to the spill but not released publicly?
            - Analogy to NOAA mussel watch
            - In an EA or EIS, need to agree on which data is being used as baseline. If this agreement was in place ahead of time, would be more comfortable using oil companies' collected data.
            - Would need time to look at the data and how it was collected to assess whether it's acceptable to use as baseline
            - Would want to collect other data within the critical first few weeks in case we don't have time to assess this data and it turns out to be insufficient

    - What other types of habitat would we want data on?
        - The lease site studies are only nearshore
        - We have data for GRS sites selected based on identification of priority wetlands from flyovers

- Human uses: depend on various bird species, caribou
    - Subsistence Fishing & hunting → access to rivers and Teshapak Lake. Boat from Barrow. During open water season, need boat access. During winter, access via snowmobiles, etc for ice fishing and caribou hunting. Colville not frozen all the way thru, so fishing year round.
    - Recreational use – birdwatching near Barrow and Ellson Lagoon & near mouth of Colville & ANWR. Kayaking
    - Data sources:

        - Natl Res Council (2003) Cumulative Effects of Oil and Gas Activity on AK's North Slope summarizes info on human uses.
        - AMAP report
        - Industry reports (Arlis)

- Ecological services: nesting, molting, passive use, fish forage /overwintering /reproduction

2. How might the key species, ecological services and human uses of this habitat be affected by an oil spill? How long might potential impacts last (i.e., magnitude, duration)?

- Impacts to vegetation may last on the order of decades
- Seasonally dependent-
    - easier to clean up in frozen conditions (esp Dec-Apr). At this time of year, there's minimal penetration (though still dependent on type of material spilled)
    - July-Oct is open water season
    - Breakup season is relatively short (several weeks in the nearshore envt)
    - Gauging stations operated by Univ and by oil companies on the rivers
    - Fish migration in late June-Aug
- Dependent on location
    - Colville R delta highly sensitive—nesting eider and other birds
    - ANWR
    - Areas protected by barrier islands (molting birds)
    - Fish migration in specific rivers and lakes
    - In general, in river deltas/river mouths (includes inundated tundra/wetlands) and areas protected by barrier islands are most sensitive
    - Are there areas that are sensitive not because of use by sensitive species, but because of behavior of oil in these areas (e.g. porous soils)?
        - Less penetration in mudflats because sediments are saturated
        - More penetration in gravel beaches
    - Still will give highest priority based on habitat (human use is also based on habitat).
    - ANWR as location with high passive use value
- Types of impacts:
    - Displacing birds from traditional nesting areas (e..g tundra swans)
    - Acute effects on molting birds + indirect effects (stress during sensitive lifecycle stage)
    - Caribou in coastal areas may lose habitat – need coastal area for insect relief
    - Tainting fish (or perception of contamination)
    - Reproductive or other sublethal effects of fish
    - Potential lethal effects to fish

3. What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

- **Environmental *Factors*:**
  - Habitat type may be altered by spill cleanup efforts. Ex: compress tundra → subsidence → dry tundra (caribou habitat) becomes wet tundra (potential bird habitat), so increased thermokarsting reduces habitat for caribou, ptarmigan, & others.
  - Climate. Increased winds bringing saline water in towards shore, alters the species of fish and birds living in the area.
  - Breakup and freezeup timing affect length of breeding season for birds and migration timing for fish → interaction between freshwater and marine envts
  - Seasonality
- **Key *Components* of food web:**
  - Freshwater invertebrates
  - Fish in wetland ponds
  - Grasses & other vegetation
  - Lichen (eaten by caribou)
  - Groundsquirrels & other small mammals foraging on forbs and seeds of flowering plants
  - Detritus from river mouths
  - *During presentation—question from the floor on insects. These could be added as a food web component.*
- **How habitat might be *affected* by oil spill:**
  - Oil in river mouths contaminating detritus (base of food web)
  - Restricting access to contaminated areas (hazing to keep animals out of this area)
  - Increase pressure on adjacent habitat areas
  - Habitat can serve as a reservoir for oil or can transport the oil
  - Increasing human activity limiting use of habitat by animals (e.g. migratory birds and migrating caribou)
  - To what extent is there acute toxicity impact on the habitat itself? Direct kill of *birds* (esp if a spill occurs in August during molting & migrating periods at river mouths). What about direct kill of plants or benthos?

For baseline discussion, would be useful to preidentify a series of potential reference sites. Suggest a workshop focused on selecting reference sites to represent different habitat types and identify the types of data we would want to collect at each. Considerations: where are leases? Where will wind/currents transport oil? What species are of interest/highly sensitive (e.g. molting birds)?
Also interested in collecting data between lease sites—characterizing disturbance as opposed to characterizing oil contamination effects.

+comment from the floor: Multiple state parks and archaeological sites in this region are additional sensitive/priority areas.
+disrupting thermal regime → subsidence & compaction (thermokarst)

Breakout Session II

Baseline

AM Wednesday, April 21

Group F: Freshwater Lakes, Ponds, Streams, Rivers and Coastal Tundra

Began with discussion of NRDA process in Arctic- how the process works and how it would differ from other areas.

Our group is inland- need to be aware of land-based spills as well as on-water spills.

River spills can apply knowledge from lower 48 – tundra experience will be very different. River mouths (low gradient deltas, braided streams) will also be different from lower 48. E.g. Cook Inlet significant amounts of mixing with sediment

Clarify scope of NRDA: is any oil spill subject to NRDA? Prudhoe Bay spills have not had damage assessments. Possibly because RP has stepped up and trustees' decision was not to pursue damages.

OPA is relevant statute: any spill/release that is not permitted is subject to NRDA. Trustees have discretion to determine whether to do an assessment based on magnitude, likelihood of recovery, whether RP is already responding adequately.

There are already good relationships between the trustees and RPs on the North Slope and have not needed to do an adversarial damage assessment.

But with added oil exploration in the Arctic, may be addl offshore spills and addl interest from lower 48 and from envtl groups → may lead to more formal damage assessments.

Large spill in Arctic may spur a different situation with different roles (FWS playing role of OSC)

Management of natural resources is done differently by BLM vs FWS vs other federal agencies- competing mandates. Similar contrast among oil companies.

Would Pam Bergman be responsible for coordinating DOI in an NRDA?

Select lead trustee based on which resources have been most affected. Usually either FWS or NOAA. Can change lead agency partway through an NRDA.

AK Clean Seas has general permits already in place with agencies for the life of the field or min 5 years. Response is well organized- NRDA needs to fit into this organization framework as well. Response plans are structured around ACS Tech Manual. Each company has its own contingency plan on a geographic basis.

- Unified Plan by Coast Guard & RRT. North Slope Regional Plan identifies seasonal sensitivities. May be lacking some oil companies' data. Very general—do not provide baseline data.
- Seasonal info on response plans. DEC website.

4. What baseline data and information are required (or desired) to assess oil spill impacts in these Arctic habitats?

- Chemical baseline data (soil, sediment, water, and tissue chemistry)

- Biological information (population size, growth and reproduction)
- Human uses
- Local data in the vicinity of oil infrastructure on
    - Habitat type
    - Species use
    - May not have larger synoptic data on a broader spatial scale.

5. What is the current status of baseline data and information?

- **What data and information exist?**

OASIS collecting a bibliography of data for BP for NRDA purposes. Other groups want to compile this data for other purposes but haven't identified who will take the lead.

Companies have reports for each rehabilitated site (multiple years of monitoring reports for ~50 sites) Bill Streever from BP, Sally Rothwell ConocoPhillips
DFG has reports on rivers on undercutting for road construction
For baseline data on ANWR ask Steve Kendall FWS
FWS aerial bird surveys of breeding pairs of waterfowl (Bill Larned) in coastal plain envt
BLM studies in NPRA
USGS AK science center (work on mammals incl Polar Bears in Chukchi and birds)
John Payne NSSI compiling list of studies & PIs.
ConocoPhillips has 20 years of data that will become available.
Companies have a large amount of data but methodologies are not all consistent
Reference doc from AK Clean Seas: AK DEC Tundra Treatment Guidelines Manual
Practical guide for restoration techniques. Printing & available soon.
Fish studies by Matt Whitman BLM, Craig George NSlope. State Habitat office in Fairbanks would have overview of state's fish data. Not all synthesized.
State Div of Subsistence would have data on subsistence fisheries.
Conoco Phillips 25 year study of arctic cisco in Niglet Channel
Sportfishing also monitored by the state
Larry Molton MGM collecting lots of fish data.
Fish data is mainly monitoring populations- less data on contaminants and lesions.
Underlying data behind these documents

Pathways:
USGS river flow data long term monitoring.
Snowpack on rivers (check with Larry Hinsman)
John Payne NSSI, Larry Hinsman both working on streamflow
Have not yet detected streamflow change related to climate change, but anticipating this will change. Banks slumping (warming permafrost).
Long term ecological research site at Toolik by NSF & UAF
DNR monitoring thaw depth Bobby Wellin

Habitat data (as opposed to resource data) is available but has not been synthesized and is typically focused on specific impacts (e.g. pipeline). Mainly on vegetation % cover on local scales. Univ (Jim McKendrick) studied revegetation potential.

- Ducks Unlimited veget map based on satellite/aerial photos (late 90s). Purpose: to assess & document habitat for waterfowl in this region. Could this be used to determine whether e.g. thermokarsting/ conversion from wet to dry tundra is occurring? Resolution of veg categories is not fine enough (need to subdivide these onto a scale meaningful for restoration)
- Shorezone aerial mapping of estuaries & nearshore- could this be tied in with industry's aerial photo characterization

Erosion data
- from USGS on NPRA coastline. Paper available from USGS with photo documentation.
- Isolated specific info on thermokarsting due to disturbances– could be done via remote sensing based on soil moisture & surface water, but may be difficult to detect because of seasonal and annual variation. Similar approach could be used for riverbanks.

Chemical baseline:
- Phosphorus is limiting nutrient
- Most existing data in soils is focused on plant nutrients and basic soil characteristics (e.g. pH). Univ research on soils.
- **Tundra Biome Project by NARL (now managed by NSLope Boro) program researching vegetation, soils, & insects near Barrow. Purpose: to describe function of tundra biome. Use this as long-term baseline (1960s). CREL.
- Philip Martin in Fairbanks FWS district office (Land Conserv C). baseline data on insect populations.
- Michael Baker —water quality and sediment quality in lakes (metals and hydrocarbons)
- Batelle/FIT OCS sediment-biota contaminants data
- MMS program in Beaufort on sed contam
- Could benthic mollusks be used to monitor status and trends? No mussels, no hard substrate

- **Are the data updated over time?**
  - variable
- **What is the quality and usefulness of the baseline vis-à-vis the required (or desired) data?**
  - There is high quality data for characterizing components of ecosystems on localized scales & some data on broader scales, but we don't have robust chemical baseline. Most localized data is sited near potential release sites (oil infrastructure).
- **What is the real availability and accessibility of the baseline information to all parties (e.g., RPs, Trustees, others) engaged in an NRDA?**
  - Variable based on who collected the data. Would like to have a central repository.
- **Are there gaps in the data that have been collected? What are they?**

    - Chemical baseline—some available from ANMADA, also from OCSAP (see OCSAP synthesis report, but most of this is marine, not freshwater)
    - May need more scaling data (population level information on fish & other resources of concern)
    - Some surveys were not done at the appropriate time and may not be representative.
    - Finer resolution for vegetation/habitat mapping is needed
    - Bird data exists for large waterbirds, but lack info on landbirds and shorebirds
    - Streamflow data?
- **Is it necessary to fill gaps and if so, how will we fill these gaps?**
    -

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

- Eroding coastline and saltwater intrusion
- Earlier snowmelt
- Drying up lakes
- Freeze season on the tundra has been shortened by 1 month.
    - → moved up dates of nest initiation by several weeks. See DNR data. Expect that this would affect species' reproductive success.
    - Also shrinks window of opportunity for ice roads for extraction—paper being developed.

Comments from the floor during presentation:
there is bad streamflow data. A few streams are gaged, but mostly do not capture high flow because this occurs during breakup. Need aerial recon.
Insects: NSF project will redo IVP work (terrestrial and aquatic)

Freshwater systems: does vegetation include microalgae? Are we including copepods and amphipods? These are important in other freshwater ecosystems, but what about on the north slope?

<u>Breakout Session III</u>

Changes/Future

PM Wednesday, April 21

Group F: Freshwater Lakes, Ponds, Streams, Rivers and Coastal Tundra

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services?

- Some of this data may be useful for other reasons (e.g. NEPA, state fisheries mgmt). Can we adapt some studies to make them multipurpose? It's essentially the same data with multiple applications. Different data quality objectives for the different purposes. What statistical power do we need for NRDA vs for permitting, NEPA?
- Identify questions ahead of time and use these to develop survey design. Need the input of a statistician
- Data needs to show change before vs after the spill to satisfactorily prove to industry that restoration is warranted; Trustees and the public need the data to show them the level of injury so they can judge whether restoration has been scaled correctly

If so, how?

- Look for existing data-gathering efforts that we could supplement rather than starting new monitoring programs

- **How could injury be evaluated for this group? What effects might you expect to see**
    - Different levels of effects: molecular level, population level, ecosystem level. Higher level effects may be more difficult to link to spill. Need to consider exposure pathways to identify these linkages. Consider both direct effects & indirect (e.g. food web) effects.
    - Indicators of habitat function include
        - Productivity
        - Reproduction in key species
        - Insect populations
        - Vegetation type—show causal role of oil spill by comparing baseline footprints (photos from pre-event) to post-spill overflight info. Need multiple years of data to see these effects at the ecosystem level. For populations, comparison between years may not be valid.
    - Habitat displacement- need to know what habitat the species of interest are currently using
        - Have people or species been displaced due to a spill
        - Is there acute mortality due to the spill
        - are there sublethal or lingering effects
        - What is recovery timeframe

and what baseline information does that drive you to collect?

- Want broad suite of reference sites ideally with historical multi year record. Still will collect baseline data immediately following event based on the trajectory, but this will allow longterm comparisons. Program like this in Calif. Partnership btwn various universities coordinated by MMS.
    - How would we select the locations? Colville R delta, which others?
    - Who will fund this data collection? Oil companies could only fund their own lease sites. Could AK Coastal Zone Mgmt Program possibly take this role? (problem with ACMP: local focus as opposed to centralized repository needed here.) BLM?
    - What protocol would be used for collection and data management? Different habitat types require different sampling methods.
    - What effects are we monitoring?
        - Chemistry in sediments, soil, water (especially in ponds rather than in rivers), & biota. Correlate this data to info on occurrence of birds and fish.
        - Birds (focus on ESA listed species & FWS and Audobon species of Concern).
            - Locations of nesting, molting areas.
            - # of birds and timing of use.
            - Fat content (use reference site rather than site-specific baseline).
            - Tissue chemistry – feathers, blood and/or bile.
            - Displacement (difficult to evaluate except with molting birds).
        - Fish
            - use—esp anadromous use of secondary streams (also look at resident fish). Data here is limited. Could start with a few sites and supplement as resources become available. Focus on sites with potential for transportation-related spills, road crossings, pipeline areas. Nearshore spills being driven into river mouths by onshore winds → consider locations near Bering Strait as high priority.
            - Bile as an indicator of exposure.
            - Biomarkers indicating environmental stressors—after the spill but do not collect as baseline.
        - physical characteristics;
        - productivity of grasslands (biomass measurements above and below ground—above ground may be easier to monitor but below ground more informative as far as long term effects, microbial activity, forage clipping analysis—caribou monitoring groups will have protocols for this)

        - Baseline data on chemistry in soil not needed for determining type of restoration, but needed for scaling restoration. Tundra can be assumed to be pristine with respect to hydrocarbon chemistry- no need for baseline. Tundra remediation is typically 100% excavation and backfill →little need for longterm monitoring of tundra chemistry.
        - Need baseline chemistry in water column and sediments in river deltas in order to determine where contamination came from and to determine cleanup levels (can we differentiate natural seeps from oil spill? What about atmospheric deposition?) Perhaps need only a single round of baseline sampling as opposed to longterm baseline trend for chemistry in a "pristine" area. If baseline chem. data is not available, how willing are we to use reference sites? This will depend on how credible the other potential sources are- location-specific.
    - Look at priority areas identified yesterday
        - In river delta/mouth habitat, look for displacement, acute mortality and lingering effects on birds,
        - Mortality and lingering effects on fish
        - Displacement of subsistence users or other human users
        - Chemistry- are there observable changes that will last for long term?
        - On tundra, also look at vegetation
    - Map and quantify habitat types
    - Identify chemical baseline for comparison

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- For fish and specific river drainages, might need baseline data—it would challenging to find comparable reference sites
- Spatial distribution of baseline monitoring.

1. Look for long term trends (baseline) in areas with high likelihood of spills. Don't need long term monitoring in other areas, but use unaffected parts of this area as reference site in a spill scenario.
2. Since we don't know where oil will be washed onshore from an offshore spill, we need a series of these sampling sites at river mouths. Some of these river mouths will be included in #1; need some additional.

- Cost-saving option to collect baseline samples and freeze and not analyze unless a spill occurs.

Session IV: Thursday AM
Take home messages

- Need central repository for data sharing +1 +1
- Develp bibliography of existing data

- Seek funding to manage this data
- Don’t reinvent the wheel—coordinate
- Emphasis on synthesis of data
- Inundated lowlying tundra and river mouths are most sensitive to oil spill injuries
- Lots of data exists esp in local areas and needs to be synthesized and shared +1 +1 +1—not necess freely available
- Annual frozen tundra period has shortened by 1 mo
- Need improved habitat mapping & consensus on habitat classification methods
- There is experience in tundra rehab
- Baseline data is location specific
- Tundra less critical than water delta areas in terms of data collection and response
- Challenging to get out and collect ephemeral data
- Inland habitat and river will be difficult to characterize in a robust way
- Extreme variability of envtl parameters→ difficult to characterize baseline
- Need reference sites because it will be difficult to get baseline
- Easier to characterize areas near existing facilities
- Baseline data changing due to increasing industry in the region

Follow Up Actions

- Need to develop habitat mapping program
- Establish consistent habitat classification system
- Use that to identify critical habitats (use ACS manual to inform this)
- Identify pre-spill baseline sites & synthesize info that exists for those sites
- Survey existing projects & supplement these for filling priority data gaps (e.g. Anad Stream Catalog)
- Create data repository and framework for key baseline data <2
- Establish sampling protocols for river injury assessment (water, sed & fish)
- Involve FOSC and SOSC in planning process for NRDA response
- Build stakeholder relationships around NRDA (<2 yrs)
- Identify who should be on our NRDA teams<2 yrs
- Gather and synthesize baseline data in key areas (2-5 yrs)
- Need central location for information <2 yrs
- Need info on areas not covered by past studies <5 yrs
- Organize bkgd data <2 yrs
- Implement baseline data analysis & identify gaps <2 yrs
- More basic training on the arctic envt<2 yrs
- Canvass industry & govt with presence on the north slope to ascertain data availability
- Establish baseline monitoring program
- Engage ARLIS (*some suggest a different entity)* to coordinate data repository
- Compile data dictionary (metadata)
- Cooperative relationship btwn different data collection processes (coordinate btwn NEPA, NRDA, etc)

1. repository
2. gap analysis
3. → monitoring program
4. habitat classification
5. identify expertise for NRDA teams (& train them in areas where expertise is lacking)

REPORT OUT – DAY 1 – GROUP A

Key Species: When, Where, and Food Web.

- Murres are key species in northern Chukchi Sea. Adult males with chicks. Mid-
- August through late October. TBMU: Diving and targeting arctic cod, small fish, crustaceans. COMU target sand lance, capelin.
- Eiders: common eiders, king eiders spring migration in leads feeding on mollusks.
- LTDU and shorebirds key species in Beaufort Lagoons. Mud flats on river deltas (sandpipers, SESA, DUNL) eating larvae. RNPH, REPH using lagoons and barrier islands, shift between ocean and lagoon side depending on winds, and are feeding on amphipods, small inverts. July-August.
- Ledyard Bay: Key feeding area for first half of summer for murres and kittiwakes. July and later big molting/staging area for eiders.
- Icy Cape: Brant feeding on sea lettuce in August in lagoon just north of Icy Cape. Peard Bay is another staging area.
- Nesting birds: COEI on barrier islands. Brant on islands in river deltas. Loons are foraging out in nearshore.
- Subsistence uses: egging for murre eggs along Chukchi coast. Waterfowl hunting for eiders in spring/fall. Hunting for geese in spring/fall.
- Winter: key indicator species is BLGU in the leads.
- Shearwaters, fulmars, and crested auklets 60-70 miles offshore in open water mid-summer on (mid-July through mid-October). Community affected by ice edge, current, drifting food web.
- Listed species: SPEI, STEI, YBLO (warranted), KIMU (candidate)

REPORT OUT – DAY 1 – GROUP C
Question 1&2:
Fish and invertebrate communities most sensitive to potential oil spills:

1) Nearshore/coastal, including benthic community
2) River delta/lagoon (anad fish)
3) Under ice (including offshore)
Related uses:

Human Use: subsistence use (e.g., food, bait, eggs)
Commercial fisheries limited to Kotzebue Sound (state waters)
Ecological values: Food web tightly coupled from primary to tertiary production
Algae, Zooplankton, Benthic/Under ice amphipods, Arctic Cod, Marine birds and mammals
Importance of Benthic, Planktonic, and Under ice coupling

Question 2:
Length of recovery

- Nearshore habitat recovery is unknown due to lack of information on oil degradation rates
- Boulder habitat of particular concern because recovery slow
  - Sponges and corrals
- Long term impact because oil can persist in environment (e.g., ice)
  - concentrated at ice/water interface which is an important habitat
  - seasonality plays a major role because of ice formation (spring/winter/fall)

Question 3

- Benthic key role in food web
  - Fish and inverts and mammals (e.g., gray whales, walrus)
- Ice habitat
  - Amphipods, feed arctic cod
  - Under ice food web
  - Ice associated fauna potentially affected by oil in/under ice
  - Cod feed and spawn under ice – during winter
  - Bottom up vs. top down food web effects

NRDA in Arctic Waters – Lagoon / Nearshore
REPORT OUT – DAY 1 - GROUP E

1. What are the ***key habitats*** and species, ecological services and human uses associated with or dependent upon this habitat group that may be most affected by an oil spill?

- Chukchi Sea vs Beaufort Sea
- Lagoons – deep or shallow
- Nearshore
- Shore Zone
- Barrier Islands, Boulder Patch

NRDA in Arctic Waters – Lagoon / Nearshore

1. What are the ***key habitats*** and species, ecological services and human uses associated with or dependent upon this habitat group that may be most affected by an oil spill?

CHUKCHI SEA

Marine mammals and migratory pathway- Beluga use lagoon for molting,

Birds - Eiders (ESA critical habitat; molting area late summer), feeding area,

Fish - Sheefish, juv. Fish, Bering Cisco, Arctic Char,

Loss of sea ice has resulted in walrus hauling out onshore,

High benthic biomass, locally low diversity, and patchy distribution.

Human use – Eider harvest, harvests of "migratory" species (marine mammals and birds).

NRDA in Arctic Waters – Lagoon / Nearshore

1. What are the ***key habitats*** and species, ecological services and human uses associated with or dependent upon this habitat group that may be most affected by an oil spill?

BEAUFORT SEA
Lagoon – seasonal impacts, low productivity in winter, moderate productivity in summer (export of calories into nearshore).

Species -
Marine mammals - Beluga use lagoon for molting,
Birds - Eiders, feeding area, Long tailed duck
Fish - whitefish, juv. Fish, Arctic Cisco, Arctic Char,

Ecological services. Low benthic biomass, locally low diversity, and patchy distribution.
Feeding, shelter, nursery; also on barrier islands, haul outs on barrier islands .
Loss of sea ice has resulted in Polar bears onshore.
Migratory pathway, response impacts to migrations and molting habitats.

Human use – Eider harvest, harvests of "migratory" species (marine mammals and birds). Fish and marine mammal harvest. Cultural.

NRDA in Arctic Waters – Lagoon / Nearshore

2. How might the key species, ecological services and human uses of this habitat be affected by an oil spill, including response actions? How long might potential impacts last (i.e., magnitude, duration)?

Areas and ecological services –
nearshore - whales, seals, sea ducks, benthic food web,
barrier islands - Polar bear haul out, bird nesting, shore birds
lagoons (boulder patch) - sea ducks, benthic food web, shore birds, fish, shoreline vegetation.

Human uses –
Subsistence – whaling, fishing, hunting
Cultural
Tourism

Long-term Effects

NRDA in Arctic Waters – Lagoon / Nearshore

3. What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

- Insert text here

NRDA in Arctic Waters – Lagoon / Nearshore

NRDA in Arctic Waters – Lagoon / Nearshore

Group Lead: Dale Gardner
Recorder: Mandy Lindeberg

1. What ?

2. How ?

3. What ?

NRDA in Arctic Waters – Lagoon / Nearshore

Group Lead: Dale Gardner
Recorder: Mandy Lindeberg

1. What are the key species, ecological services and human uses associated with or dependent upon this habitat group that may be most affected by an oil spill?

2. How might the key species, ecological services and human uses of this habitat be affected by an oil spill, including response actions? How long might potential impacts last (i.e., magnitude, duration)?

3. What are the environmental factors that influence the key food webs in this habitat? What are the key components of the food webs? How might food webs in this habitat be affected by an oil spill?

Group F
Freshwater/Coastal

REPORT OUT – DAY 1 – GROUP F

Key Components/Species

- Migratory Birds
- Fish
- Caribou
- Bear
- Subsistence use of these species
- Recreational use
- Nesting
- Molting
- Passive use
- Fish forage/overwintering/reproduction

Food Web

- Components:
  - Sedges and other vegetation
  - Lichen
  - Invertebrates
  - Forage fish
  - Detritus from rivers
  - Ground squirrels

Priority Areas

- River deltas
- River mouths
- Inundated tundra
- Areas inside barrier islands (lagoons)

- Lower priority
  - Open eroding coastline

Factors Affecting Habitat and Food Webs

- Timing of breakup and freeze
- Onshore winds/weather/storm surge directing salt water (and oil) up rivers

Oil Spill Impacts

- Seasonal variation (winter is less sensitive)
- Vegetation impacts (30 years post response)
- Habitat displacement/shift
- Acute and other effects on molting birds
- Effects on caribou in coastal areas (insect relief)
- Tainting and perception of contamination among subsistence users
- Lethal/sublethal effects on fish

REPORT OUT – DAY 2 Morning – GROUP A

Baseline data required

- Need relative abundance, identification of specific habitats (e.g., nesting, feeding, molting areas) by species and by season.
- Trends: relative population health and trajectory, productivity, monitoring through time.
- Understanding what their requirements are as they go through their season. What are the ecological drivers, and how is that changed by oil?

Current Status of Baseline

- Data exists amongst agencies, industry, and local knowledge regarding populations, harvest, food sources, etc.
- Much of this data is site and time specific, not comprehensive
- Status: scattered and not always readily available
- Data gaps regarding trends, productivity, and ecology (e.g., food webs)

Climate Change

- Caveat: we see indications that suggest something of significant magnitude is going on, not ‘direct indications’.
- Lack of baseline and long term data, as well as variability, makes definitive connections to climate change difficult
- Examples
  - Longer open water periods are changing food availability
  - Increased fetch leads to beach erosion and delta flooding
  - Potential shifts in phenology (i.e., hatch not coinciding with food availability)

REPORT OUT – DAY 2 AM - GROUP B

Species	Priority Species for addressing data gaps for resource management purposes (Subsistence, Ecological use, lack of data)	What data exist?	Data updated over time?	Data quality?	Availability to all parties?	Data gaps?	NRDA Data Priorities?
Bearded Spotted Ringed, Ribbon Seals	**Bearded Ringed**	Some LTK, biosampling of subsistence harvest*,	Annual collection of biosampling data, Harvest data for boroughs	Patchy	**	Yes, significant Population size Harvest numbers****	Population size, ***habitat use, health baseline, subsistence use
Pacific Walrus	X	Population estimate (low confidence), Some LTK, biosampling of subsistence harvest*	Harvest data annually	Patchy Population estimate (low confidence),	**	Yes, significant Population size	Population size, ***habitat use, health baseline, subsistence use
Polar Bear		Population estimates in Beaufort, Some LTK, biosampling of subsistence harvest*	Harvest data annually	Good for Beaufort, Patchy elsewhere	**	Yes, significant Population size in Chukchi Sea	

Species	Priority Species for addressing data gaps for resource management purposes (Subsistence, Ecological use, lack of data)	What data exist?	Data updated over time?	Data quality?	Availability to all parties?	Data gaps?	NRDA Data Priorities?
Beluga	X	Population estimates, Some LTK, biosampling of subsistence harvest*	Annual effort	Patchy Population estimates have low confidence.	**	Yes, significant Population size	Population size, ***habitat use, health baseline, subsistence use
Bowhead		Some LTK, biosampling of subsistence harvest*, population estimates	Harvest & population estimates updated every 4 years. Health archive exists	Good to v. Good	**	Less than other species	***habitat use
Gray		Some LTK, Population estimates		Good based on data collected outside of AK	**	Habitat use?	***habitat use, health baseline, subsistence use

- *Biosampling data: contaminants, life history, body condition, genetics, some disease screening, diet.
- ** Most data available w/exception of proprietary data related to industry (i.e. seismic exploration) and confidential data related to subsistence hunt. Some gray literature may be difficult to obtain/be aware of.
- ***Habitat use: foraging, migration, distribution, reproduction, refuge, response to changing ice conditions, etc.
- ****Lowest information for Ribbon seals re: subsistence data b/c not used as much.

Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change? What are these changes?

- **Yes**
- **Increase coastal use by Walruses. Haulouts in places now where in years past there never were.**
- **Polar bears - USGS published reports re: changes in population, size of animals, cub survival, body mass studies indicative of nutritional stress. Spending more time on land. Increased human/bear interactions because time of bears on land is longer, not because there are more animals.**
- **Seals – no direct indications of changes, but very low power re: ability to detect changes.**
- **Villages – speak to seeing new species of fish that they never saw before. Needing to go out earlier and earlier to capture seals while on the ice b/c ice is melting and leaving shore earlier. Season of use changing and getting earlier.**
- **Bearded seals – people not catching them as easily as before – timing and distribution changing.**

REPORT OUT – DAY 2 AM – GROUP D

Chemical baseline

- Biological responses (Cytochrome P450)
- SPMD PAH, PCB
- Cyp1a, metabolism
- SPME fibers for PAH background
- Inorganic nutrient loads (biological function)
- Nutrients/flux

- Some current data, but not very useful.

Physical Baseline

- Ice morphology
  - Variability in snow and sediment
- Change in baseline as result of ice reduction
- Optical measurements
  - Light penetration
- Best current data from physical monitoring

Biological baseline

- Genetic characterization of biota
- Biological variability
  - Natural recovery time
  - Population structure
- Resiliency of communities to respond to spill
- Significance of temporal, physical, and spatial scales
- Microbial degradation potential
- Methodology for environmental effects monitoring

- Large gap in biological knowledge and monitoring

Statistical strength

- Measurements of variance
- Strength of sample size, n
- Quantitative estimate of range
- Solid sampling design

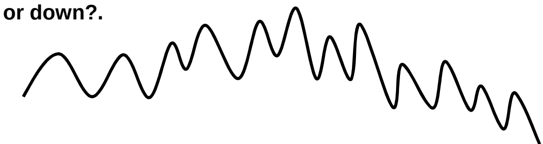
- Need for clearinghouse for literature
- Chemical baseline with molecular techniques (baseline and monitoring)

REPORT OUT – DAY 2 AM – GROUP E

NRDA - Lagoon / Nearshore

4. What baseline data information are required (or desired) to assess oil spill impacts in these Arctic habitats/species?

- **The baseline is not static, its dynamic.**
- **Identify long - term direction of baseline (trending up? or down?.**



- **Different types of baselines: chemical, ecological services, population status.**

NRDA - Lagoon / Nearshore

4. What baseline data information are required (or desired) to assess oil spill impacts in these Arctic habitats/species?

- **Different types of baselines: chemical, ecological services, population status.**
  - **Chemicals achievable**
  - **Population status most difficult to maintain over time.**
  - **Ecological services are limited in scope but may be most cost effective in damage assessment.**
- **Example – ice cover changes: polar cod**

NRDA - Lagoon / Nearshore

5. What is the current status of baseline data and information?

- **Habitat Baselines – what do we have:**
  - **Environmental Sensitivity Index Maps (ESI). Great response tool and starting point.
But it's not a baseline; shelf life issue**
  - **ARLIS – AK Resource Library Information System.**
- **Priority**

NRDA - Lagoon / Nearshore

5. What is the current status of baseline data and information?

<u>Habitat Baselines</u> – what do we need:

- **Archive of baseline data: updating ARLIS repository,**
- **But, need to add the different pockets of missing stuff**
- **GIS, searchable database; web based**
- **Add to over time, maps, chem data, population data**
- **Add past data as you can**

NRDA - Lagoon / Nearshore

6. Are there direct indications that the baseline is already changing in measurable ways as a result of changes in sea ice and snow cover, and other physical habitat changes that may be caused by Global Climate Change. What are these changes?

- **Yes, but…**
- **Example – ice cover changes: polar cod**

NRDA - Lagoon / Nearshore

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so how?

- **Insert text here**

NRDA - Lagoon / Nearshore

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- **Insert text here**

REPORT OUT – DAY 2 AM – GROUP F
Group F- Freshwater

Baseline Data

Data Required for NRDA

- All data needs to be collected on a seasonal basis
- Soil, sediment, tissue, and water chemistry
- Vegetation (classification of habitat type) & insects (as part of food web & as indicator)
- Populations of birds, mammals, and fish
  - Reproduction
  - Numbers

Current Status of Available Data

- Large amount of data, but has not been synthesized
- Strongest data is on a localized basis related to industry operations; weaker data on broad scale
- Availability is dependent on who collected the data and for what purposes. In a NRDA, access may be limited.

Data Gaps

- Geographic Gaps
- Vegetation mapping to characterize habitat on north slope
- Habitat surveys on rivers
- Fisheries
- Birds: have information on large waterbirds, but lacking information on landbirds and shorebirds
- Insects
- Adequacy of streamflow data?
- Chemical baseline (incl. in subsistence resources)
- Access and Availability

Changing Baseline

- Shorter tundra travel season (shorter frozen period)
- Earlier snowmelt
- Drying up lakes
- Eroding coastline and saltwater intrusion

REPORT OUT – DAY 2 PM – GROUP A

7a. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

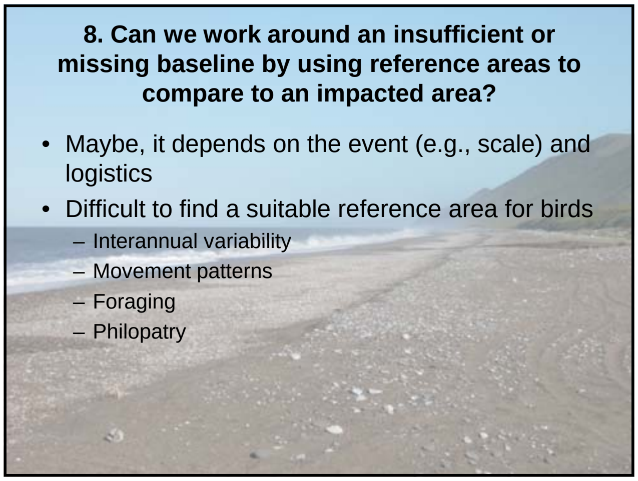
- Try to coordinate our studies to gather data in a comparable manner.
  - Sharing and data management of current and proposed studies
- It is a question of precision vs. accuracy.
- Challenges of the Arctic
  - Small seasonal window
  - Logistics
- Modify existing studies.
- Baseline is about assessing magnitude of the injury.

7b. How could injury be evaluated for this group?

- Established tools
  - Persistence studies/carcass collections
  - Surveys
- New tools
  - Modeling and trajectory analysis
  - Drone technology
  - Marking and tracking technologies
- Logistical challenges in the Arctic make development of assessment tools a priority

7c. What effects might you expect to see and what baseline information does that drive you to collect?

- Expected effects
  - Oiled birds/dead birds
  - Reduced nesting success
  - Reduced foraging
- Information to collect
  - watch birds on plots to see if they are oiled and assess the proportion;
  - unattended eggs;
  - oiled habitats;
  - recruitment studies and age-class studies;
  - survey of lagoon and deltas;
  - evaluation of the forage


8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area?
• Maybe, it depends on the event (e.g., scale) and logistics
• Difficult to find a suitable reference area for birds
– Interannual variability
– Movement patterns
– Foraging
– Philopatry

REPORT OUT – DAY 2 PM – GROUP B

- **Assuming no baseline, would there be utility or how would you modify existing, paid for surveys for other purposes or on-going studies so that they might help with NRDA in the future?**
- Yes
- Could perhaps tack on requirements as part of permit issuance or impact assessment.
  - E.g. Northstar – USFWS required polar bear surveys as part of permit issuance;
  - E.g. fly coastal aerial surveys for bearded seals in late spring before ice breakup along the coast of Chukchi & Beaufort Seas. Not how would be done for a population estimate, but it would give an idea of how many animals are around during the summer.

How could injury be evaluated for this group?

- Beach surveys for dead animals.
- Could look at how tribal harvest efforts change as a result of the spill and compare to pre-spill.
- Obvious effects: dead animals, ocular effects (corneal abrasions), baleen/pelt fouling
- Less obvious effects: body fat, stress hormones, biomarkers (cytochrome P450)

Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

Yes - but these species are highly migratory. May make the reference concept difficult to use. Can't compare Chukchi to Beaufort – different environments.

Data like harvest biosampling lends itself better to comparisons. Could look at quality of blubber (lipid %), marrow fat, body condition, immune stress indicators.

Isotope analysis could potentially provide information regarding animal's diet after a spill, but there are lots of caveats.

REPORT OUT – DAY 2 PM – GROUP C

Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so, how?

Information/data are available; site-specific studies are generally available to infer some knowledge.

How ?

- We believe there is enough information to design studies to quantify the injury using spatial and temporal data
  - fish and invert distributions, habitat associations, and life history information.
  - fish distribution can be predicted using wind speed (in the Beaufort)
  - Cisco and cod would be a good indicator species – could be used as a red flag
  - Traditional knowledge will play a major role in establishing baseline data
- We felt a focus should apply to juvenile distributions and populations.
  - Concentrations (spawning success)
  - Age frequencies and length
- Habitat and population recovery will take longer in arctic regions.
  - No empirical experience with habitat recovery in arctic
  - Exposure is a good first step as a screening tool (ieP450)

Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

- Arctic is changing so much now – variability will make it difficult to use “reference” area, but we understand environmental drivers to better select sties
- Seasonality supports sites are necessary
- Some evidence exists that Arctic faces several seasons vs the standard four
- Scale is an challenge and even within smaller sub-regions species diversity is high between comparable habitats (such as boulder fields taxa)

Recommendations

- A sampling grid needs to be established based on careful selection of drivers (physical and environmental)
  - Could be defined by depth
  - Who would maintain this reference grid data?
  - Sampling of opportunity (when surveyors have extra time/resources can collect needed data)
  - Need one central database and one single point of maintenance – possibly MMS? Or NMFS?
- Standardized sampling gear
- Bio-marker sampling
- 3-D imagery (side scan) is needed from 0 to 30 m. Information key to assess habitats that support fish and invertebrates

REPORT OUT – DAY 2 PM – GROUP E

NRDA - Lagoon / Nearshore

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so how?

- **Probably Not, but…**
- **Assuming some money…**
  - **Index habitat/sites – POTENTIAL INDEX SITES: (replicates for sense of variability within habitat type)**
  - **Beaufort Sea**
    - **Nearshore - gradients (shallow, deep)**
    - **Barrier Islands –**
    - **Lagoons – Simpson Lagoon**
    - **River Deltas –**
  - **Chukchi Sea**
    - **Nearshore –**
    - **Barrier Islands –**
    - **Lagoons –**
    - **Kotzebue Sound**

NRDA - Lagoon / Nearshore

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so how?

- **<u>Are there any ongoing studies that we could build on?</u>**
  - **YES – We think so…**
  - **New Initiatives - DOI landscape conservation cooperative, NOAA Arctic Initiative, etc.**
  - **Existing programs**
    - **Gov't: MMS, USFW (refuge inventory and monitoring), NPS, NMFS, PMEL, NPRB**
    - **Industry: SINTEF/oil- in- ice JIP, Arctic Specific Toxicity testing, Env. Studies Research Fund, etc.**
  - **Use Workshop information to inform the development of these new initiatives and existing studies, to the extent possible.**

NRDA - Lagoon / Nearshore

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so how?

- **How could injury be evaluated for this group?**
  - **Not sure what this question is really asking?? Seems like we answered this yesterday??**

NRDA - Lagoon / Nearshore

7. Assuming no baseline, is it practical and economically feasible to acquire a meaningful baseline in a time frame that makes the NRDA efficient at restoring services? If so how?

- **What effects might you expect to see and what baseline information does that drive you to collect?**
  - Assume shallow sediments will be oiled,
  - Gather suite of samples (sediments for chemistry, benthic community data, a transect sampling gradient)
    - Nearshore – Benthic data
    - Barrier Islands – Eiders nesting on drift line,
    - Lagoons – population counts for molting birds

NRDA - Lagoon / Nearshore

8. Can we work around an insufficient or missing baseline by using reference areas to compare to an impacted area? How practical is this after an environmental event?

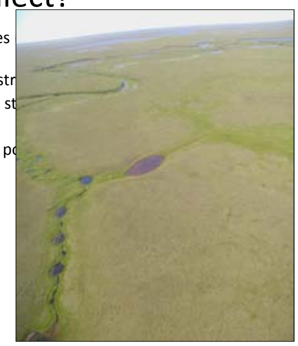
- **Ideally, a combination of reference sites and monitoring.**
- **Assuming no baseline data:**
  - **Identify impacted area, locate and sample ephemeral/reference habitats, and monitor recovery.**
  - **Compare with similar impacted habitats**
  - **Use ecological risk assessment principles**
- **Awareness of SUBSTANTIAL logistical challenges in the Arctic – limited resources for injury assessment.**
- **Do Industry contingency plans address NRDA logistical needs? (regulatory concerns with this?)**

REPORT OUT – DAY 2 PM - Group F

FRESHWATER

What type of baseline data should we collect?

- Data that serves multiple purposes monitoring)
- Focal bird species: habitat use, distr
- Fish: Habitat use & distribution in st
- Habitat mapping & classification
- Water and sediment chemistry in po



How could we evaluate injury?

- Vegetation productivity
- Acute mortality in birds, fish, and subsistence species
- Birds: Energy reserves and chemical exposure
- Fish: chemical exposure and histology
- Subsistence species: chemical exposure, perception of contamination

When to use Baseline vs Reference Sites

- Use reference sites where necessary since baseline data will not always be available
- Less problematic with respect to vegetation
- More challenging to find comparable reference sites for fish, mammals, and birds

REPORT OUT – DAY 3 – GROUP A

Group A-Birds: 3 Important Take Home Messages (List in order of priority)

- Data coordination, consolidation, and synthesis needs to occur for existing data and current/proposed projects and initiatives
- NRDA may be constrained by Arctic logistical challenges: temporal, spatial, weather, facilities
- Establishing reference sites will be difficult for birds

Group A-Birds: 3-5 Follow-up Actions

- Pull together data and develop centralized repository (<2 years)
- Drilling and testing current and new NRDA assessment technologies in the field (2-5 years)
- Getting together to discuss ongoing efforts and initiatives (e.g., NSSI) (1-2 years)
- Develop and define key bird species for NRDA (< 1 year)
- Investigate funding sources (1-2 years)

3 Important Take Home Messages

- Understanding that references areas are not likely to be used for birds
- Less reliance on baseline and going right to restoration
- Is there a better way to analyze variability in data
- Key spp. covered fairly well but need to be boiled down
- Data gaps should be identified better
- Synthesize old reports
- Seasonality #'s and distribution is very significant
- Nearshore and offshore comms need to be assessed separately
- Logistics are going to be very difficult and very little in-hand data
- A lot of data exists but needs to be brought data
- A lot of data collected but need to be coordinated
- Effort to determine restoration opps
- Baseline: existing pops, distribution, seas patterns, trends
- Need to bring existing data together
- Several programs have same data needs, so coordinate ongoing projects and initiatives
- NRDA efforts to assess and recover birds in Arctic will be significantly different
- Uncoordinated and inaccessible data
- Opps for marine spatial planning
- Need more sharing of info on projects and proposals past and present
- May need to add to NRDA toolbox for Arctic to address ice
- Can modify current efforts to incorporate NRDA baseline needs
- Reference sites are difficult for birds
- Came up with suite of sensitive spp
- Have baseline for some species, but data is patchy and snapshot surveys

REPORT OUT – DAY 3 – GROUP B

Group B- Mammals: 3 Important Take Home Messages (List in order of priority)

- Prevention and preparedness are key
  - Restoration options are limited
  - Reference areas problematic
- Severe lack of data or synthesis of existing data
  - Exception is Bowhead Whale
- Collecting additional data difficult & expensive, will need to focus on existing data like subsistence harvest, LTK

Group B-Mammals: 3-5 Follow-up Actions

- Establish data clearing house (w/in 2 yrs)
  - Synthesize existing data
- Conduct data gap analysis and develop strategy for filling data in relative to NRDA (w/in 2-5 yrs)
- Identify restoration opportunities (w/in 2 yrs)
- Increase inter-agency collaboration (e.g.NOAA OR&R and Science Center) (w/in 2 yrs)
-

Group C- Fish and Inverts: 3 Important Take Home Messages (List in order of priority)

- A lot of data available but has gaps (spatial, temporal, data type)
- Environmental drivers control fish and invert distributions and need to be understood in order to define patterns and reference areas
- Recovery of Arctic species and habitats likely to be long term and difficult to predict because of lack of knowledge

Group C-Fish and Inverts: 3-5 Follow-up Actions

- Fish and Invertebrate clearinghouse and synthesis that will identify data gaps (0-2 yrs)
- Develop plan to fill data gaps (2-5 yrs)
  - Grid, gear, species, data management
- Nearshore habitat mapping (0-5 yrs)
- Logistics for staging NRDA assessment teams (2-5 yrs)
  - Partnership with industry and local communities
  - Spill response infrastructure
- Incorporate traditional knowledge (2-5 yrs)
  - Using past knowledge and future involvement in monitoring and ephemeral data collection

Group D- Ice/Under Ice: 3 Important Take Home Messages (List in order of priority)

- Establish baseline spatially, seasonal, and inter-annual; integrated methods using biological, physical, and chemical methods
- Environmental persistence of oil in an ice environment
- Effectiveness and impacts of response operations

Group D-Ice/Under Ice: 3-5 Follow-up Actions

- Open access to data, clearinghouse 1-2yrs
- Trophic level dynamics 2-3 years
- International workshop to establish reference sites 1-2 years
- Physical, chemical and biological implications for exposure –next 5 years
-

(Include when action should be accomplished: within the next 2 yrs, within 2-5 yr, or more than 5yrs from now.)

Group E- Lagoon/Nearshore: 3 Important Take Home Messages (List in order of priority)

- different approach to baseline- index or reference sites sampled for the longer term

- a data clearing house (open access, georeferenced)

- need to involve traditional and cultural knowledge, stakeholders.

Group E-Lagoon/Nearshore Ice: 3-5 Follow-up Actions

- establish data clearinghouse (less than 2 yrs)
- contingency planning for NRDA, playbook, injury assessment, and restoration (less than 2 yrs)
- support for super long-term monitoring (50yrs) (2-5 yrs)
- chemical baseline for biota (less than 2 yrs)

Group F- Freshwater/Tundra: 3 Important Take Home Messages (List in order of priority)

- Large amount of data exists
  - Has not been synthesized
  - Not equal geographic coverage
  - Not equal seasonal coverage
- Rivers need more baseline analysis than tundra
- Lack of chemical baseline data
- Baseline is changing (e.g. shorter frozen period)

Group F-Freshwater/Tundra Ice: 3-5 Follow-up Actions

- develop data repository
  - Start in <2 years; develop further
- analyze existing data for gaps (<5 years)
- develop baseline data collection program & monitoring protocols (~5 years)
- develop consistent methodology for habitat classification and mapping (<5 years)
- develop NRDA team – includes training and relationship building (2 years)

GP 1 Follow up

- Data Clearinghouse (0-2)
  - Who would host, fund and maintain(ARLIS, UAF GINA)
- Identify/prioritize Data Gaps (post data clearinghouse conception)
- Develop Arctic NRDAR toolbox
- Identify Arctic restoration techniques, options and timeline (0-5)

GP 2 Follow up

- Data synthesis, gap analysis, repository (0-2)
- Develop a plan to address gaps (1-3)
- Regular info transfer and communication (annual)
- Draft NRDA logistics & protocols for initial data collection (0-2)

Gp 4 Follow-up Actions

-Workshop on international framework (<2yrs)
-Survey repository options (<1yr)
-Identify Arctic specific restoration and remediation options (2-5yrs)

GP 3 Follow-up Actions

- Interagency coordination & commitment
- Collaborative action and partnerships
- Open access to data
- Establish procedural playbook
- Establish future workshops

Gp 5 Follow-up Actions

- Establish a strategic planning arctic NRDA working group lead by NOAA
  - Seek Funding for Data Repository
  - Design/Implement 50 year monitoring
  - Meet Annually
- NRDA Training/Drills
- Data Clearinghouse w/ bibliography and contact info
- Establish Restoration working group

Gp 6 Follow-up Actions

- Clearinghouse
- Baseline/Synthesis
- Restoration
  - Focus for NRDA
  - Arctic specific
- NRDA Planning
  - Team, training, drills
  - Workshops
  - Econ. of subsistence use

Gp 7 Follow-up Actions

- Pre-plan/Contingency planning for NRDA (2 yrs)
- Establish Data Clearinghouse (2-5 yrs)
- Define indicators & methodologies at various levels of species & habitats (2-5 yrs)
- Additional workshops that are species/habitat specific as follow-on to this workshop (<2yrs)

Gp 8 Follow-up Actions

- Need for Clearinghouse/database action plan (<2yr)
- Reference site development (2-5 yr)
- Establish village-based process (<2 yr)

APPENDIX F

POWERPOINT PRESENTATIONS

Welcome

NRDA in Arctic Waters: The Dialogue Begins

NRDA in Arctic Waters: The Dialogue Begins

April 20 - 22, 2010

Nancy E. Kinner
Coastal Response Research Center (CRRC)
UNH Co-Director

LOGISTICS

- Fire Exits
- Restrooms
- Location of breakout rooms
- Dining - breakfasts, lunches & snacks (outside meeting rooms)
- Evening Dinner:
  - Shuttle - pick up every 10 minutes outside hotel beginning at 5:30 pm to 6:30 (or walk - get directions)
  - Location: Alaska Aviation Museum
  - Cash bar available (beer and wine) - 6:00 pm
  - Museum private tour - 6:15 pm
  - Buffet dinner provided by Sourdough Mining Co - 6:30 pm
- If you have any questions - check with staff at registration table

KEY CRRC STAFF

- Amy Merten - NOAA Co-Director
- Nancy Kinner - UNH Co-Director
- Joseph Cunningham - Research Engineer
- Kathy Mandsager - Program Coordinator
- Zachary Magdol - Program Support Assistant
- Heather Ballestero - Graduate Student

CRRC Overview

Coastal Response Research Center 5

CRRC CREATION

- NOAA's Office of Response and Restoration (ORR)/UNH spill partnership in 2004
- Co-Directors:
  - UNH - Nancy Kinner
  - NOAA - Amy Merten
- Funding for oil spill research decreasing
  - Government
  - Private sector
- Many research needs exist regarding spill response, recovery and restoration

Coastal Response Research Center 6

OVERALL MISSION

- Develop new approaches to response and restoration through research/synthesis of information
- Serve as a resource for ORR, NOAA and other agencies
- Serve as a hub for spill research, development and technical transfer for ALL stakeholders
  - Spill community (U.S. and internationally)

Coastal Response Research Center 7

SPECIFIC CENTER MISSIONS

- Conduct and oversee basic and applied Research and outreach on spill response and restoration
- Transform research results into practice
- Educate/train students who will pursue careers in spill response and restoration

Coastal Response Research Center 8

OUTREACH EFFORTS

- Workshops on hot topics to identify research priorities and partners
  - Dispersed Oil: Efficacy and Effects
  - Submerged Oil: State of the Practice
  - Human Dimensions of Spills
  - Dispersed Oil Research Forum
  - Integrated Modeling
  - PAH Toxicity
  - Environmental Response Management Application (ERMA®)
  - Environmental Response Data Standards
  - HEA Metrics Workshop
  - Opening the Arctic Seas: Envisioning Disasters & Framing Solutions
  - Oil Spill Research Needs

NRDA in Arctic Waters: The Dialogue Begins

- Workshop background
  - Oil-in-ice research
  - First CRRC Arctic workshop “Opening the Arctic Seas: Envisioning Disaster & Framing Solutions”
  - Second workshop
    - Biological focus
    - NRDA focus

Workshop Partnerships

- CRRC
- OSRI
- USARC

Organizing Committee

Mike Amman, Chevron
Mary Baker, NOAA
Catherine Berg, US FWS
Nancy Bird, OSRI
Dale Gardner, Alaska DEC
Nancy Kinner, CRRC
Ken Lee, Bedford Institute of Oceanography
Amy Merten, NOAA
Jacqui Michel, RPI
W. Scott Pegau, OSRI
Jeep Rice, NOAA
Gordon Robilliard, ENTRIX
Cheryl Rosa, North Slope/USARC
Jennifer Schorr, Alaska Attorney General Ofc

Coastal Response Research Center Website

www.crrc.unh.edu

Coastal Response Research Center

PARTICIPANT INTRODUCTIONS

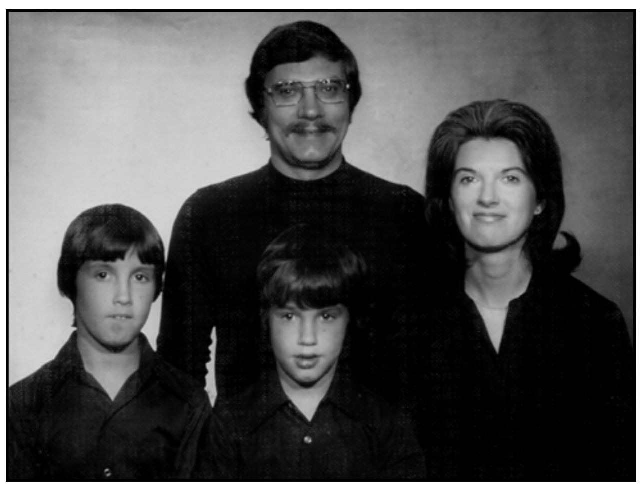
- **Name**
- **Affiliation**
- **Interest for attending workshop**

NRDA IN ARCTIC WATERS
THE DIALOGUE BEGINS
APRIL 20–22, 2010 • THE MILLENIUM HOTEL • ANCHORAGE, AK

JOHN HOCKMAN PRESENTATION

Introductions

- Name
- Affiliation
- Expertise

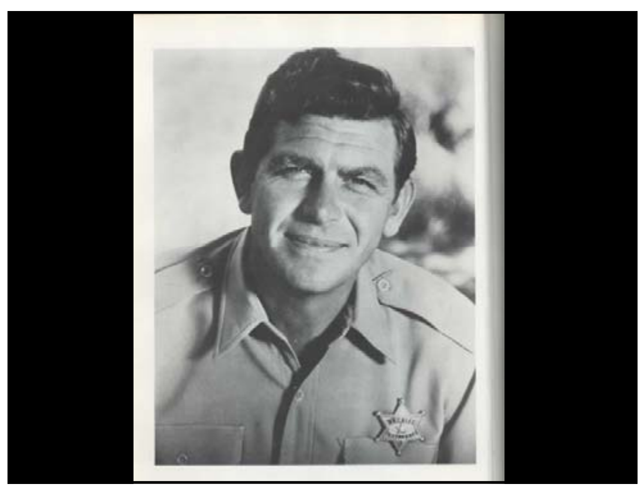



Sidney
Marysville
Piqua
Urbana
Columbus
Springfield
London
Bellefontaine


THE
OHIO STATE

AMERICAN UNIVERSITY
WASHINGTON, DC


Lafayette
West
Lafayette
Attica
Wabash River
Frankfort
Gas City
Fairmount
Tipton
Elwood
INDIANA
Covington
Lebanon
Noblesville
Anderson
Crawfordsville
Carmel
Clarksville
Fortville
Brownsburg
Lawrence
Danville
Greenfield
Rockville
Plainfield
Indianapolis
Greencastle
Greenwood
White River
Shelbyville
Franklin
Martinsville
Flatrock River
Cagles Mill
Lake
Edinburgh
Hope
Spencer



Facilitation

Executive Coaching

Strategy + Performance

NRDA in Arctic Waters
The Dialogue Begins
April 20–22, 2010 • The Millenium Hotel • Anchorage, AK

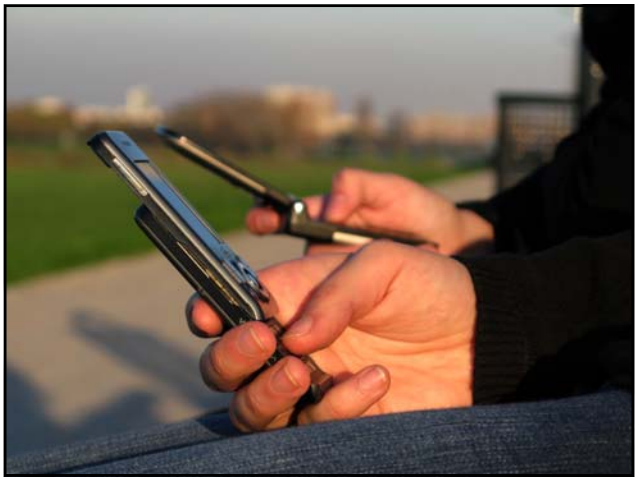
Expectations

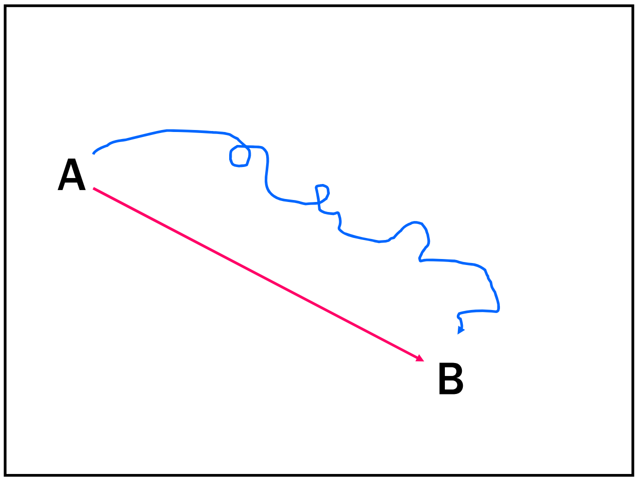
Intended Outcomes

- A preliminary understanding of which key resources/habitats might be at risk from spills and spill response
- An understanding of the likelihood of petroleum exposure to these key resources as a function of seasonality
- Identification of injury assessment models that are applicable to Arctic habitats/resources

Intended Outcomes

- Achieve consensus on most significant data gaps necessary to prepare for NRDA (i.e., what we need to study further?)
- Achieve consensus on the key injury questions to discuss in future workshops.
- What about restoration? Is it possible to restore any of the species likely to be injured?





no man becomes a fool until he stops asking questions.

--charles steinmetz

What?

So What?

Now What?

MARY BAKER PRESENTATION

Context

- Arctic environment is changing
- Increasing shipping
- Oil exploration/development
- Increased potential for spills
  - Response needs
  - NRDA and restoration needs

Goals

- Understanding how natural resources would be affected
- Understanding how natural resources are changing
- Identifying priority data gaps

Scope

- Definition of Arctic
- NRDA principles: must demonstrate release, pathway, exposure, AND effects
  - Baseline: condition "but-for" the release. Consider chemical background, physical degradation, natural variability. Baseline approach depends on the effect of concern.
- Background information available at CRRC web site and in packets

Extent of Bottomfast Ice and Landfast Ice at End of Typical Winter Season

(From "Oil Spills in Ice Discussion Paper" by Dickins et al (2000))

Mike Bronson

Oil in Ice

(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

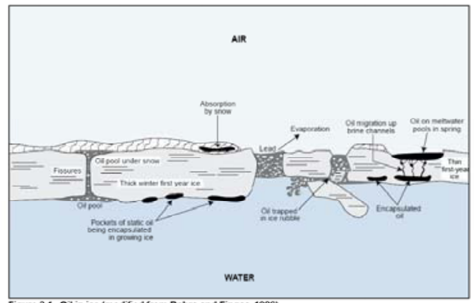


Figure 3.1. Oil in ice (modified from Bobra and Fingas, 1986).

Predicted Radius Spill Under Landfast Ice

(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

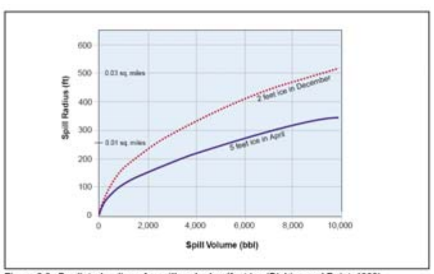


Figure 3.3. Predicted radius of a spill under landfast ice (Dickins and Buist, 1999).

Canadian Experiment: Oil Under Ice

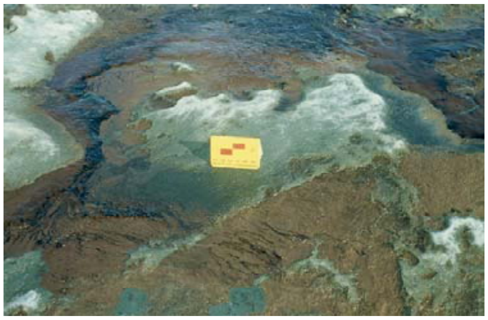
(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

Core Showing New Ice Growth Encapsulating Canadian Experiment Oil in Ice
(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

First Signs of Canadian Experiment Oil Migration to the Ice Surface
(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

Wind Herding of Canadian Experiment Oil in Meltpools in June
(From "Oil Spills in Ice Discussion Paper" by Dickins et al. (2000))

Canadian Experiment Oil on the Ice Following Drainage of Meltwater
(From "Oil Spills in Ice Discussion Paper" by Dickins et al (2000))



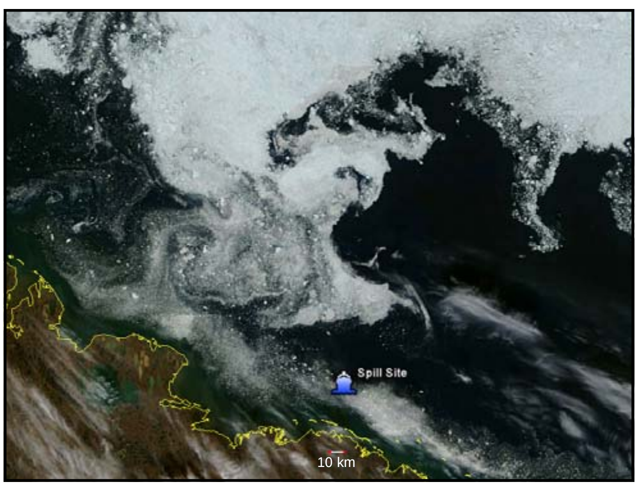
Oil Spill Scenario: Broken Ice

Kenneth Lee

Offshore Oil Centre for, Gas and Energy Research (COOGER)
Fisheries and Oceans Canada

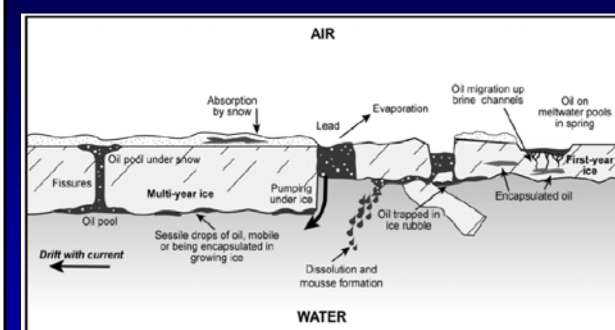
Broken Ice Spill Scenario

- Similar to the open water scenario but occurs on 05 September, 2006, *broken ice* is present at the study area
- An oil tanker on its way to Barrow (from a refinery in Canada), encounters rough weather and sank ashore on the barrier islands just west of Simpson Lagoon.
- Release of ~ 5000 m^3 oil (Density=900 kg/m^3 and viscosity=100 mPas s)
- Assume the current is U=3 to 7 cm/s and V=-7 to 5 cm/s
- Ice concentration 50-70%, thickness 0.7-1.5 m, and floe size ~12 m



Behaviour of Oil

Oil – Ice Interactions



Influence of Ice on Oil Spill Processes

- Oil Spreading: Dramatically curtailed by the presence of broken ice and brash ice. Spreading limited to the leads among the ice floes
- Evaporation: Not greatly affected, unless oil is trapped under or within ice
- Dispersion and Emulsification: Expected to be less than in open water as the ice tends to dampen the effects of wind.

Seasonable Variance

- During spring break-up, oil spilled in broken ice would be contained in the openings between floes and would coat the surrounding ice surfaces. The contaminated area increases as spring melt proceeds
- At high ice concentrations (>5/10), oil is effectively prevented from spreading and is contained by the ice
- As ice cover is reduced, oil will escape into larger leads as floe moves apart
- At less than 3/10 ice, oil behaviour is similar to that on open water
- During freeze-up, oil will be entrained in the solidifying grease and slush ice prior to forming sheet ice. Storm winds may break up and disperse the newly formed ice, leaving the oil to spread temporally in open water until incorporated in the next freezing cycle

Response Actions

- **Oil spills in ice are far more complicated to combat compared to oil spills in open waters**
- **Efficiency of booms and skimmers is reduced**
- **The weathering rate is normally much slower for an oil spill in ice**
  - **The rate of emulsification is reduced along with viscosity increases extending the "*window of opportunity*" for use of most response techniques.**
  - **The spreading of oil may be reduced resulting in an increased oil film thickness that may be favourable for oil spill response**
- **The formation, thickness, and percentage of ice coverage all affect the selection of response technologies**
- **One advantage of an oil spill in ice is that the ice can act as a natural containment in a variety of ice features such as floes, snow and ridges**

Response Actions

- **Predicting the fate of oil in the specific circumstances surrounding any incident, especially in an ice environment, is beyond the capacity of existing models.**
- ***New and improved algorithms are required* to take into account the seasonal variation, weathering, and other factors, that affect the behaviour of oil spilled on, in, or under ice.**
- **The spreading of oil under ice has been studied in laboratory and field experiments. Fewer efforts have been made to quantify the movement of oil in broken ice or amid smaller chunks of ice such as grease or brash ice.**
- **Simple models (such as Venkatesh et al., 1990; Yapa et al, 1997) are available but need to be validated against field experiments.**

Response Actions

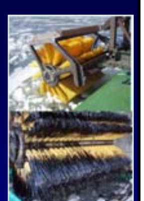
Estimated Impact Zone: 36 km²

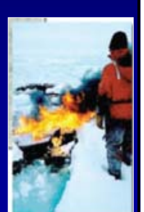
Response Actions

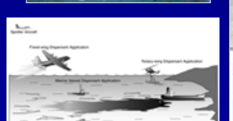
- Due to the limitation of models to predict oil-in-ice behaviour, real-time oil and ice surveillance and tracking are critical to response operations
- Available technologies: Tracking buoys, Satellite imagery, Airborne reconnaissance , Vessel surveillance etc.

Response Actions

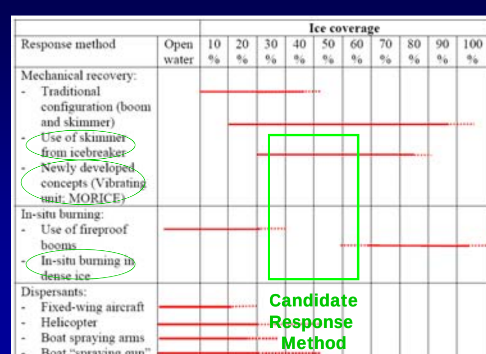
- Mechanical recovery: boom and skimmer
- In-situ burning
- Dispersant and Mineral treatment



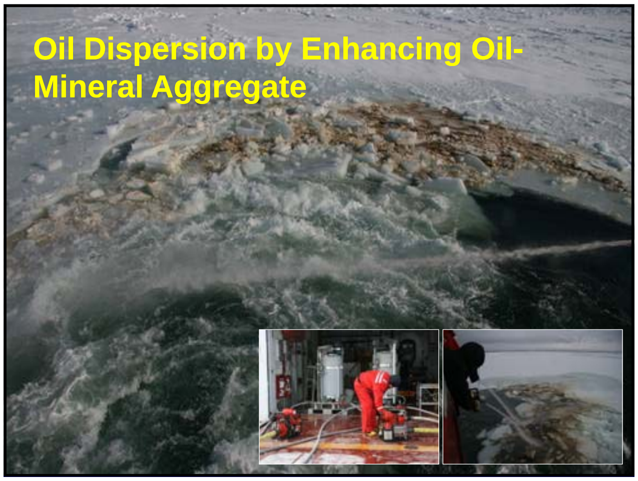




Effectiveness of Response Options as a Function of Ice Coverage (Evers et al, 2005)



Oil Dispersion by Enhancing Oil-Mineral Aggregate

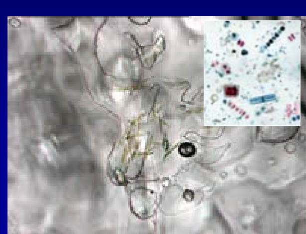


Organisms associated with sea ice in the Arctic

The ice algal community lives in and on the underside of sea ice and is comprised primarily of diatoms, as well as microflagellates and dinoflagellates

Algae mats form underside of the ice surfaces that may be very dense and attract other organisms which graze on them

About a quarter to one third of the overall primary production of the polar oceans is provided by algae associated with sea ice (Spindler, 1991).



Abundance of metazoans e.g. turbellarians, nematodes, rotifers and crustaceans (amphipods and copepods) which may feed on bacteria, algae and protozoa

A key species is the hyperiid amphipod *Themisto libellula* which connects the sea ice with deeper waters by means of feeding activities and migrations (Auel et al., 2002)

A swarm of amphipods under sea ice

The Arctic cod *Boreogadus saida* mainly prey on amphipods. In some regions of the Arctic, cod constitutes the only fish whose life-cycle is closely associated with the ice-edge ecosystem (Camus et al., 2006).

Cod under ice

Cod - *Boreogadus saida*

The induction of biomarkers in polar cod at very low bioavailable doses of B(a)P has been used to monitor contaminant oil in the Arctic (Nahrgang et al., 2009)

Higher trophic level predators at the ice edges that hunt and compete for zooplankton and fish include birds, seals and whales

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Valuation in Natural Resource Damage Assessment

Anchorage, AK
April 2010

Norman Meade
NOAA
Office of Response and Restoration
Assessment and Restoration Division

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Natural Resource Services

- ***Services are fundamental to the determination of interim losses and for scaling restoration***
- ***Services have value because humans care about them***
- ***Services are functions that one resource performs for another or for humans***
- ***A single resource may provide a variety of services***

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Categories of Natural Resource Services

- ***Ecological***
- ***Cultural/Historical***
- ***Sustenance***
- ***Commercial***
- ***Recreational***
- ***Passive/Existence***

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Scaling Approaches

- ***Service-to-service***
  - *Restoration action provides services of same type, quality and comparable value as were lost*
  - *A single metric is appropriate to capture quality differences between injured and replacement services*
- ***Value-to-value***
  - *Criteria are not met for service-to-service approach*
  - *Approach and method meet cost, timeframe and validity criteria*
- ***Value-to-cost***
  - *Service-to-service not appropriate; and*
  - *Valuation of lost services is possible, but valuation of replacement services cannot be done within reasonable timeframe and/or at reasonable cost*

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Choice of Assessment Methods

- ***Many factors influence the choice of methods***
- ***Type and magnitude of injuries and likely damages***
- ***Level of certainty required***
- ***Cooperative vs. non-cooperative assessment***
- ***Reasonableness of costs and timeframe***
- ***Private vs. public losses***
- ***Purpose of NRDA is to provide compensatory restoration***

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Service-to-Service Approach

Framework

- *Service losses due to injury = service gains from compensatory restoration*
- *Obtain equivalency between the services lost and those gained through restoration*

Conditions for use

- *Injured and restored resources and service are the dame type, quality and of comparable value or can be scaled to be equal*

Typically Encompasses

- *Habitat /Resource Equivalency Analysis (HEA or REA)*
- *Methods estimating direct human use resource services (e.g. recreation) subject to constraints/limitations*

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Value-to-Value Approach

Framework

- *Monetary value of losses due to injury = monetary value of gains from compensatory restoration project*

Conditions for use

- *Applied when service-to-service is not appropriate (with exceptions)*

Directly analogous to HEA scaling process

- *but uses monetary value, rather than measured service flows or proxy metrics as the basis of equivalency calculation*

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

Value-to-Cost Approach

- ***Monetary value of service losses due to injury = monetary cost of restoration projects***
- ***Used for limited types of injuries, e.g. recreation losses***
  - *Primarily when neither service-to-service nor value-to-value methods can be performed at a reasonable cost and/or within a reasonable time frame*
- ***Traditional approach pre-OPA and cooperative assessment process***

DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

<u>Contact</u>

Norman Meade
National Oceanic and Atmospheric Administration
Assessment and Restoration Division (N/ORR32)
1305 East West Highway
Silver Spring, Maryland 20910
U.S.A.
Telephone: 301 713 4248 ext.201
Fax: 301 713 4387
Email: norman.meade@noaa.gov

- **Webpage: WWW.DARRP.NOAA.Gov**

Open Water Oil Spill Scenario

Jacqueline Michel
Research Planning, Inc.

Objectives of the Scenario

- Provide a common framework for discussions by the breakout groups
- Provide common understanding of the oils fate and behavior in the water and on the shorelines
- Describe the shoreline types
- Describe oil response in terms of methods and effectiveness

Open Water Scenario

- Two barges under tow by tug from a refinery in Canada to Barrow
- Barge 1: 385,000 gallons of diesel;
  Barge 2: 350,000 gallons of heavy fuel oil
- During rough weather, the tow line parts and tug becomes entangled with the line

Open Water Scenario

- Barges drift, collide, then ground
- During grounding, 110,000 gallons of fuel from each barge is released
- Use the NOAA oil fate model ADIOS2 to show amount evaporated, dispersed, and remaining for each oil type spilled
- Use the NOAA oil trajectory model GNOME to show the extent of oiling

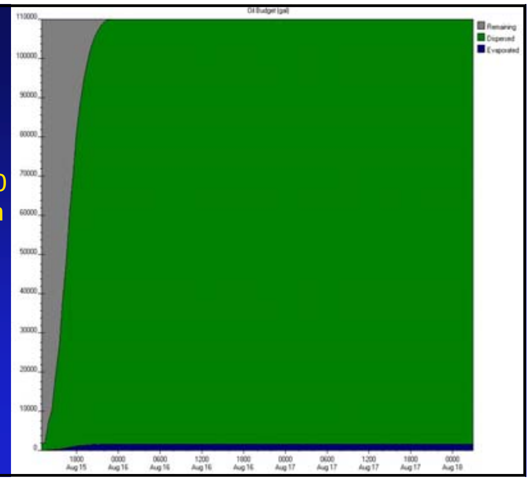
Winds During the Spill

Day	Month	Year	Hour	Speed (mph)	Direction (Degrees from North)
15	8	2010	13	25	90
15	8	2010	19	25	90
16	8	2010	1	27	67.5
16	8	2010	7	28	90
16	8	2010	13	25	67.5
16	8	2010	19	14	270
17	8	2010	1	12	292.5
17	8	2010	7	10	270
17	8	2010	13	10	292.5
17	8	2010	19	15	292.5
18	8	2010	1	12	292.5
18	8	2010	7	14	67.5

Diesel

110,000 gallons

Winds:10 - 25 mph

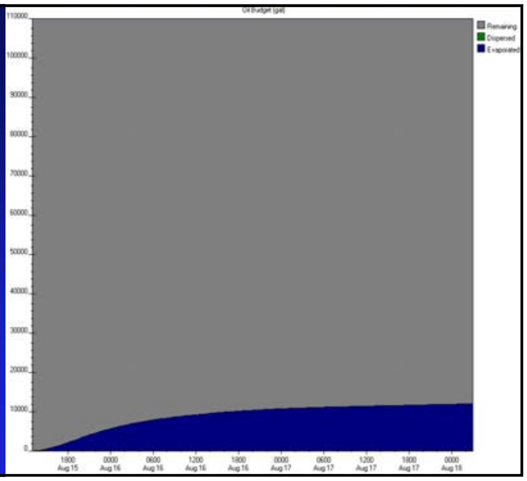


Diesel Spill from Sunken Vessel

Heavy Fuel Oil

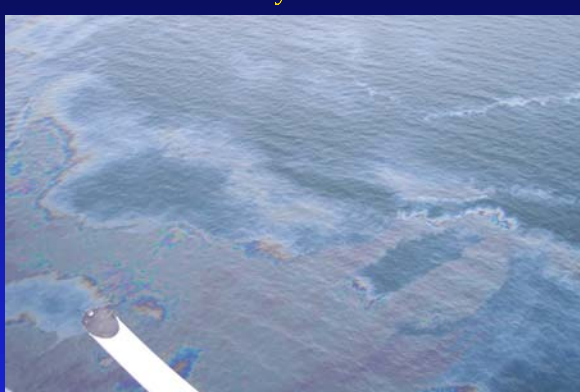
110,000 gallons

Winds: 10-25 mph

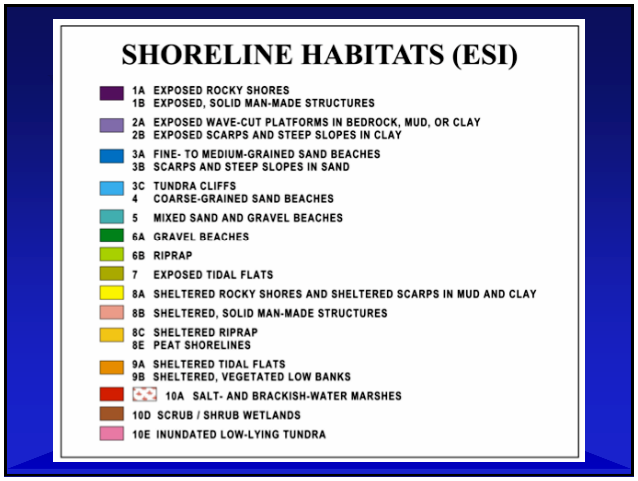


Heavy Fuel Oil

Heavy Fuel Oil



Heavy Fuel Oil


SHORELINE HABITATS (ESI)
1A EXPOSED ROCKY SHORES
1B EXPOSED, SOLID MAN-MADE STRUCTURES
2A EXPOSED WAVE-CUT PLATFORMS IN BEDROCK, MUD, OR CLAY
2B EXPOSED SCARPS AND STEEP SLOPES IN CLAY
3A FINE- TO MEDIUM-GRAINED SAND BEACHES
3B SCARPS AND STEEP SLOPES IN SAND
3C TUNDRA CLIFFS
4 COARSE-GRAINED SAND BEACHES
5 MIXED SAND AND GRAVEL BEACHES
6A GRAVEL BEACHES
6B RIPRAP
7 EXPOSED TIDAL FLATS
8A SHELTERED ROCKY SHORES AND SHELTERED SCARPS IN MUD AND CLAY
8B SHELTERED, SOLID MAN-MADE STRUCTURES
8C SHELTERED RIPRAP
8E PEAT SHORELINES
9A SHELTERED TIDAL FLATS
9B SHELTERED, VEGETATED LOW BANKS
10A SALT- AND BRACKISH-WATER MARSHES
10D SCRUB / SHRUB WETLANDS
10E INUNDATED LOW-LYING TUNDRA


2001
Videography
North Slope
Oblique Photographs
Arctic Ocean
Point Barrow
Beaufort Sea
Chukchi Sea
Point Hope
Alaska
Kotzebue
Sound
Legend
NS Photos
CS Photos


ESI online
Shoreline Video Capture for:
North Slope, Alaska (2005)
Image © 2010 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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USGS
2006
Photographs
Google


USGS Lat: 70.534930 Lon: -149.283471 UTC: 18:07:10 09 Aug 2006 IMG_9144.


USGS Lat: 70.472337 Lon: -148.824023 UTC: 18:01:31 09 Aug 2006 IMG_9113.JPG


USGS Lat: 70.513030 Lon: -149.494709 UTC: 23:26:10 07 Aug 2006 IMG_7827.JPG


USGS Lat: 70.481718 Lon: -149.147213

Alaskan Beaufort-Chukchi Coastline

Three shore types make up 54 % of the coast:

- Tundra Cliffs – 15.6%
- Peat Shorelines – 15.5%
- Inundated Lowland Tundra – 22.8%

Ice-Rich Tundra Cliffs (ESI = 3)

Peat Shorelines (ESI = 8)

Inundated Lowland Tundra (ESI = 10)

Heavy Oiling on Sand Beach

Tarballs on Sand Beach

Buried Oil on Sand Beach

Heavy Oil on Sand/Gravel Beach

Heavy Oil on Sand/Gravel Beach

Oil on Wetlands

Tundra Cliffs

	Oil Category			
Response Method	**I**	**II**	**III**	**IV**
Natural Recovery	A	B	B	B
Barriers/Berms	B	B	B	B
Manual Oil Removal/Cleaning	D	B	B	B
Mechanical Oil Removal	C	C	C	C
Sorbents	–	B	A	A
Vacuum	–	–	B	A
Debris Removal	–	B	B	B
Sediment Reworking/Tilling	D	B	B	B
Vegetation Cutting/Removal	D	D	D	D
Flooding (deluge)	A	A	A	B
Low-pressure, Ambient Water Flushing	C	B	B	B
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	–	B	–
Shoreline Cleaning Agents	–	–	–	–
Nutrient Enrichment	–	B	B	C
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	–	–	–

Inundated Lowland Tundra

Response Method	Oil Category I	II	III	IV
Natural Recovery	A	A	A	B
Barriers/Berms	–	–	–	–
Manual Oil Removal/Cleaning	D	C	C	C
Mechanical Oil Removal	D	D	C	C
Sorbents	–	C	C	C
Vacuum	–	B	B	B
Debris Removal	–	C	C	C
Sediment Reworking/Tilling	–	–	–	–
Vegetation Cutting/Removal	D	D	D	D
Flooding (deluge)	C	C	C	D
Low-pressure, Ambient Water Flushing	–	D	D	–
High-pressure, Ambient Water Flushing	–	–	–	–
Low-pressure, Hot Water Flushing	–	–	–	–
High-pressure, Hot Water Flushing	–	–	–	–
Steam Cleaning	–	–	–	–
Sand Blasting	–	–	–	–
Solidifiers	–	C	C	–
Shoreline Cleaning Agents	–	–	–	–
Nutrient Enrichment	–	I	I	I
Natural Microbe Seeding	–	I	I	I
In-situ Burning	–	C	C	C

Manual Removal

Manual Removal

Vacuum

Sorbents

Sorbents

Vegetation Cutting

Open Water Scenario Summary

- Diesel is mostly naturally dispersed in the shallow water column/sediments
- Heavy fuel oil contaminates intertidal and supratidal habitats
- Shoreline cleanup is effective on sandy substrates, moderately effective on sand/gravel
- Cleanup options for wetlands, tundra, sheltered tidal flats are limited, mostly natural recovery after gross oil removal

Sea Ice Overview

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Seasonal cycle:
- Winter and spring: landfast ice (immobile) and pack ice (moving)
- Summer and fall: pack ice (moving) or no ice

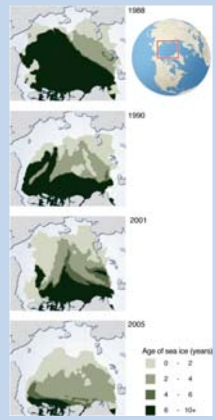
Pack ice movement : Beaufort Gyre vs. Chukchi Sea

Landfast ice in Beaufort Sea vs. Chukchi Sea:
- Differences in Extent and Timing

Contact points between oil and ice

NRDA in Arctic Waters, 20 Apr 2010

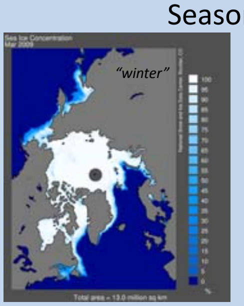
Age of Sea Ice in the Arctic

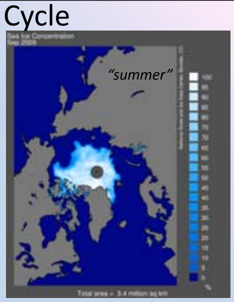


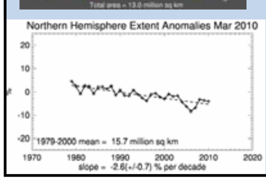
pack ice is getting younger (thinner)

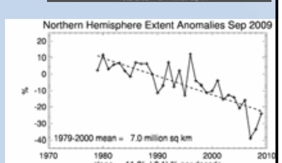
UNEP, Global Outlook for Ice and Snow (2007), based on State of the Arctic Report (2006)

Seasonal Sea Ice Cycle

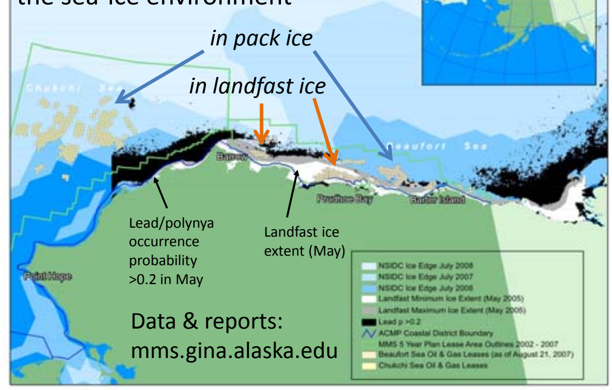






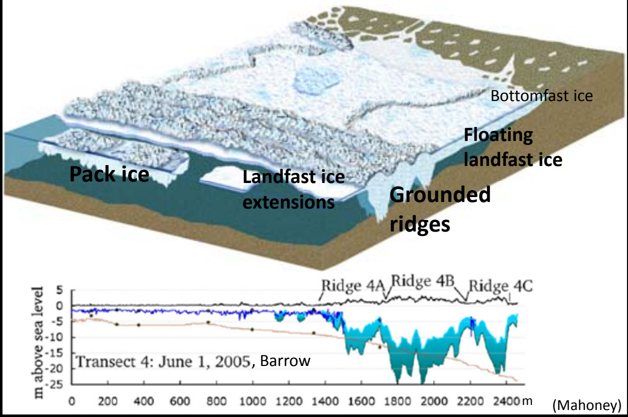


Offshore leases & the sea-ice environment



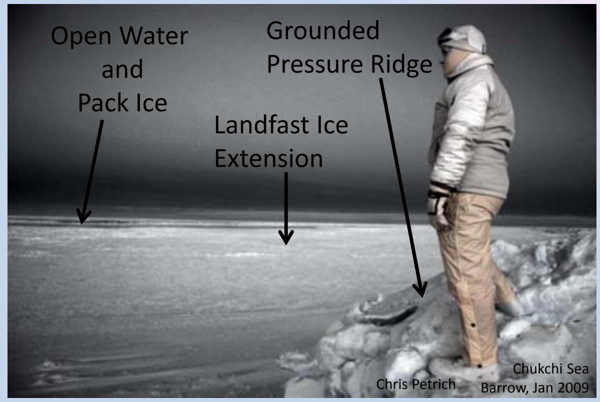
Data & reports:
mms.gina.alaska.edu

Landfast Ice

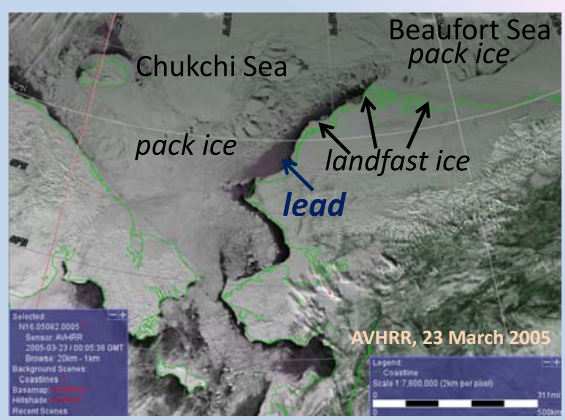


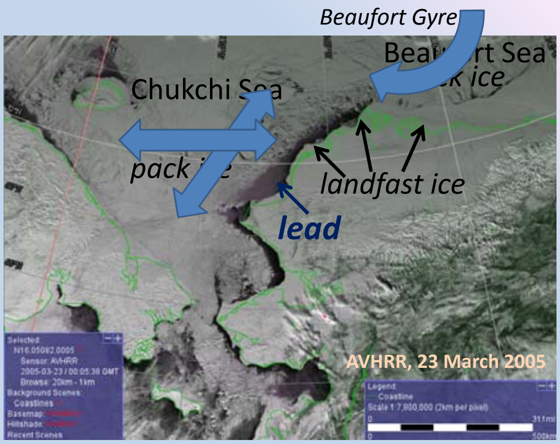
(Mahoney)

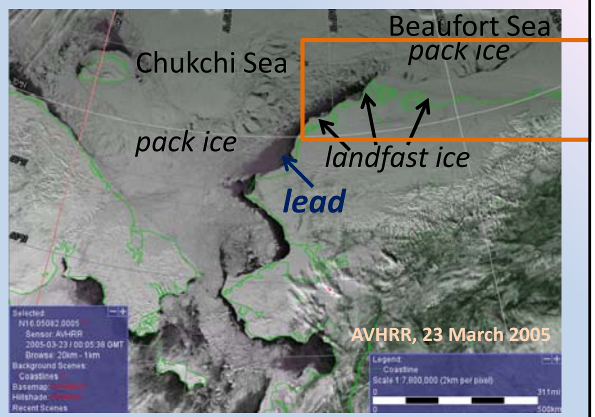
Landfast Ice Edge



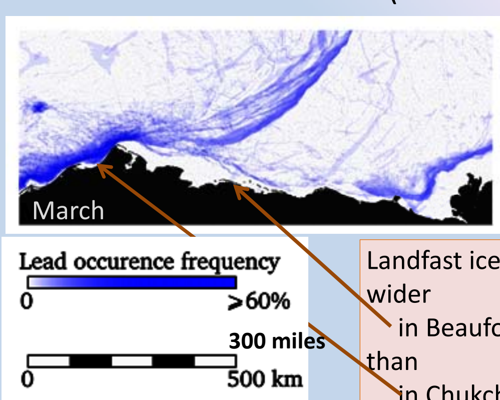
Landfast Ice Edge







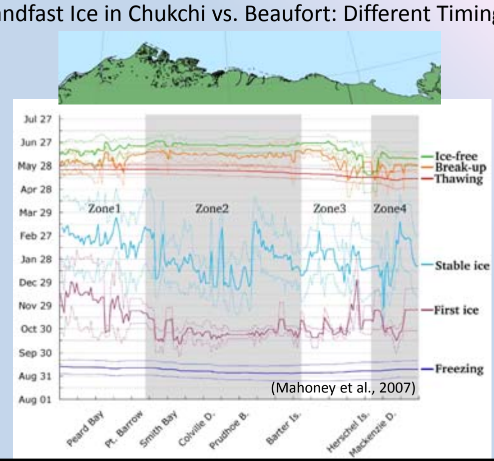
Lead Occurrence Patterns (1993-2004)



Landfast ice zone wider
in Beaufort Sea
than
in Chukchi Sea

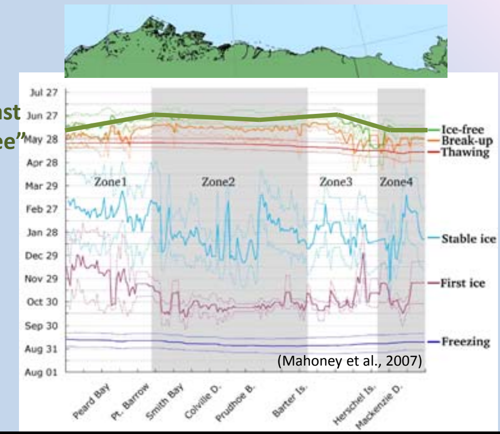
(Mahoney et al., 2007)

Landfast Ice in Chukchi vs. Beaufort: Different Timing



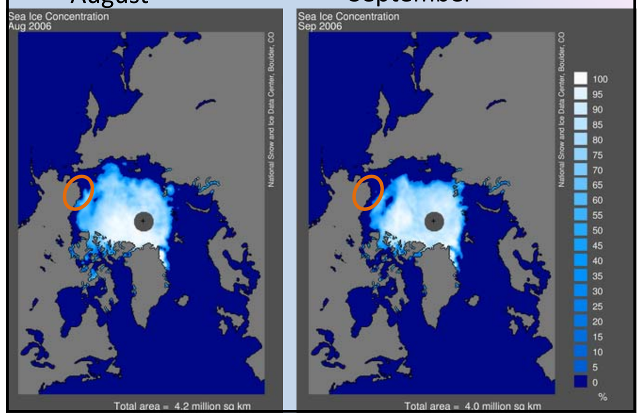
Landfast Ice in Chukchi vs. Beaufort: Different Timing

“Landfast Ice-Free”



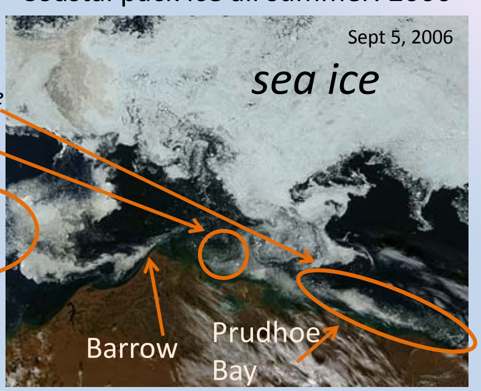
(Mahoney et al., 2007)

An Anecdote of 2006



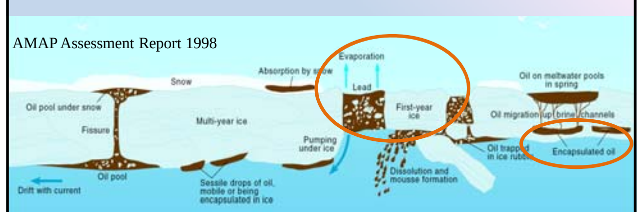
Coastal pack ice all summer: 2006

offshore leases



Courtesy: MODIS Rapid Response Team
AERONET_Barrow.2006248.terra.1km.jpg

Points of interaction between oil and ice

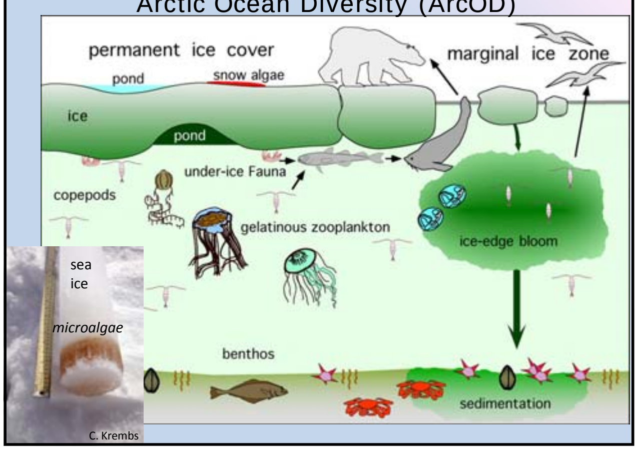


Oil in ice-covered waters

Oil in slush among pancake ice off the Canadian East Coast, 1986
(SL Ross and DF Dickins, 1987)

Example of oil encapsulation

Arctic Ocean Diversity (ArcOD)



NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) PRIMER

for

"NRDA in Arctic Waters: The Dialogue Begins"

Presented by
Gordon Robilliard, Ph.D.
ENTRIX, Inc.

Anchorage, Alaska
April 20-22, 2010

What is NRDA?

- **N**atural **R**esource **D**amage **A**ssessment
- A process to:
  - Determine & quantify the injury (~impact) to natural resources & resulting service losses
  - Scale injuries and interim "lost use"
  - Scale appropriate & cost-effective restorations
  - Determine damages ($$$) to implement
- Ultimate goal -- "restore, rehabilitate, replace or acquire equivalent resources and services"
- Key – restoration services must equal lost services

2

Legal Basis for NRD Claims

- Federal
  - Oil Pollution Act 1990 (OPA)
  - Clean Water Act
  - CERCLA (for contaminated sites)
- State
  - NRD-specific (e.g., WA, TX, CA, FL, NJ, LA)
  - Fish and Game Codes
  - Common Law Causes of Action

3

Key NRDA Concepts

- Natural resources provide services to people (e.g. recreational fishing) and other resources (e.g. prey)
- Trustee agencies hold natural resources in trust & manage them for the public (i.e., you and me)
- Spills and releases may injure (~impact) natural resources & reduce services
- "PRPs" obligated to pay **N**atural **R**esource **D**amages for:
  - Restoration of injured natural resources and lost services
  - Trustees' reasonable assessment costs
- NRD is not a fine or penalty, or part of response costs

4

Natural Resources Defined

Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state or local government or Indian [or Alaska Native] Tribe, or any foreign government,...

OPA 33 U.S.C. 2701, Sec. 990.30

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Typical Natural Resources – Arctic Alaska

- Subsistence areas (species and habitats)
- Whales and their migration and feeding areas
- Marine mammal rookeries and calving areas
- Rare, threatened, endangered or protected species
- Bird breeding, nesting, molting and concentration areas
- Archaeological and cultural sites
- National Parks and Historic sites
- Wildlife refuges or reserves and similar areas
- Species of recreational/commercial value (e.g., salmon, ciscoes, crabs)
- Recreational areas (e.g., fishing and hunting)

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Other Key Definitions

- **Services** - functions performed by a natural resource that benefit other resources and/or public
- **Injury** (**~impact**) - measurable adverse change or impairment of natural resource or service
- **Interim Losses -** reduction in services from beginning of injury until services recover to baseline
- **Damages** - cost of primary restoration + compensatory restoration + Trustees' reasonable assessment costs
- **Baseline** - condition of resources "*but for*" the release; includes natural and human impacts
- **Reference** – site or conditions not impacted by release but with similar biological, physical, chemical and/or human uses (& usually in the same area)
- **Trustees (in Arctic)** – NOAA, DOI (USFWS), ADFG, ADEC, ADFG, ADL, Alaska Natives

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Services – Some Arctic Examples

- Ecological
  - Prey and feeding areas
  - Breeding/nesting/spawning/denning areas
  - Resting/molting areas
  - Shelter
- Human (Active)
  - Subsistence hunting and fishing
  - Cultural areas and activities
  - Recreation

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Baseline Conditions

- Status of natural resources and services "but for" the spill or release impacts
- Injury ends when natural resources recover to baseline conditions
- Sufficient "on-site" baseline data may not be available prior to or during the spill or release
- Often based on data from reference areas
- May include: chemicals in sediments; "health" of individuals or populations; biological abundance, diversity, distribution, behavior; etc.
- **Fundamental to an NRDA & this Workshop**

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Reference Area

- Areas with associated habitats, species, and human uses that are not exposed to spill or release
- Ideally, reference areas will be
  - "Identical" or very similar to injured area in biological, physical, and chemical conditions and/or human uses
  - Located nearby
- Used to measure present baseline conditions and as a reference for natural or people-assisted recovery of resources and services
- A fall back if baseline data are insufficient
- aka *control area*

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NRDA Phases (OPA)

- Pre-spill Planning
  - NOAA included in preamble to regulations
  - This workshop is an example
- Pre-assessment and Injury Determination
- Restoration Planning
  - Injury Assessment and Quantification
  - Restoration Scaling and Selection
- Restoration Implementation

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Pre-assessment and Injury Determination Phase

- Trustees decide whether to pursue NRDA
- Injury Determination (*Is there a problem?)*
  - Which trust resources been exposed to oil?
  - Are they probably injured?
  - Can service losses be measured?
- Do feasible restoration options exist?
- May include limited data collection
- Initiate during or soon after initiation of response actions (cleanup is not restoration)

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Restoration Planning Phase

- Link between determination of injury & restoration
- Type and magnitude of injuries and service losses determines need for and scale of restoration
- 2 major components:
  - Injury Assessment (=quantification)
  - Restoration Selection and Implementation

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Injury Assessment Step

- *"How big is the problem?" "How bad is it?"*
- Quantify type, magnitude, extent & duration of injury
- Quantify impacts of response actions
- Conduct essential studies; collect samples
- Compare post-incident conditions to baseline (or reference) conditions; (note: Post-incident recovered conditions may not be the same as pre-incident conditions, especially over extended time period)
- Scale resource and service losses

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Restoration Selection & Implementation Step

- Plan for restoring natural resources & services
- Identify reasonable range of restoration options
- Scale service benefits of restoration option(s) against service losses due to injury
- Public review process
- Determine damages and settle with PRP(s)
- Implement restoration

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Restoration

- **Primary Restoration**
  - Restoration of directly-impacted resources to baseline
  - Usually occurs through natural recovery processes, esp. in oil spills
  - In-kind, in-place usually
- **Compensatory Restoration**
  - Compensates for the interim lost services from initial spill or release until recovery to baseline
  - Usually requires direct human intervention
  - May be in-kind, in-place; in-kind, out-of-place; or out-of-kind, out-of-place.
- **Topic of a future workshop**

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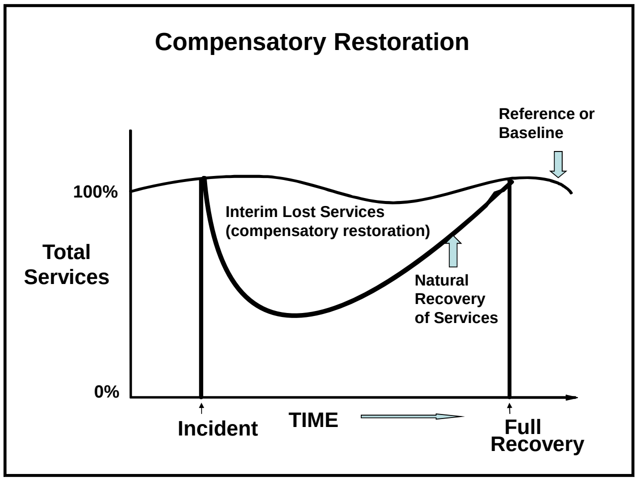

Restoration Nexus to Service Loss

- Trustees must develop a reasonable range of restoration options and identify preferred alternative based on:
  - Cost
  - Extent to which alternative returns injured resources to baseline or compensates for lost services
  - Likelihood of success
  - Prevention of future or collateral injury
  - Multiple resource benefits
  - Effect on public health and safety
- Additional criteria
  - Cost effectiveness
  - Geographic connection
  - Partnerships
  - Compliance with laws and policies

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