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ELEVENTH INFORMATION TRANSFER MEETING

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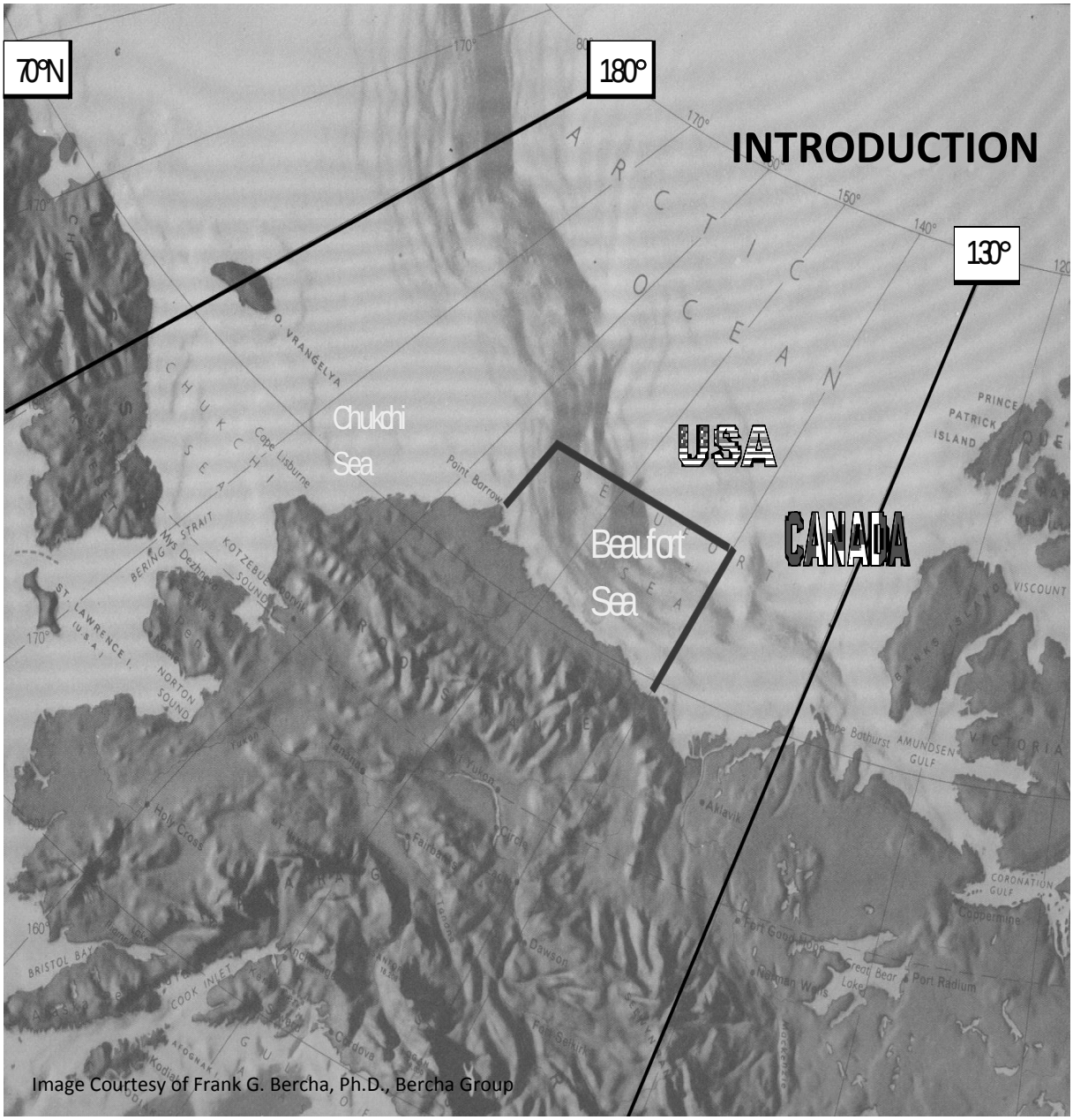

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INTRODUCTION TO THE ELEVENTH INFORMATION TRANSFER MEEETING

Minerals Management Service, Alaska OCS Region

The Alaska OCS Region hosted the **Eleventh Information Transfer Meeting** (ITM) on October 28-30, 2008 in Anchorage, Alaska at the Downtown Marriott Hotel. Information on the ongoing environmental research in OCS Alaska was shared at the MMS ITM with twenty five presentations being given. These included topics covering protected species, biological studies, social sciences and economics, fates and effects, physical oceanography and multi-disciplinary topics.

The MMS Alaska ITM was held concurrently with the first "United States and Canada Northern Oil and Gas Research Forum: Current Status and Future Directions in the Beaufort Sea, North Slope and Mackenzie Delta." Over 400 people gathered in Anchorage for three days of science talks highlighting research conducted for the planning and management of oil and gas activities in the U.S. and Canadian Beaufort Sea and onshore areas.

The U.S. and Canada share a history of oil and gas exploration and development in the Beaufort Sea and adjoining coastal areas. Currently, both countries are considering proposals for the transmission of natural gas resources to southern markets, and both continue to explore and develop oil and gas resources. At the same time, both countries have also undertaken significant research in support of the environmental assessment and regulatory processes associated with oil and gas development in these areas. This research is important as it enables governments and industry to fulfill their responsibilities to minimize environmental and social impacts while pursuing economic development and energy production.

The "Forum" was conceived by personnel from MMS Alaska and Department of Indian and Northern Affairs Canada as an international forum for U.S. and Canadian scientists, industry, and regulators to focus on sharing research programs and future directions for northern oil and gas development. The forum provided an opportunity to share research, identify synergies and build on existing partnerships, to move the research agenda forward.

To enhance scientific exchange, MMS shared nine of its ITM presenters to form a solid foundation for this first Forum. The abstracts for those nine presentations at the Oil and Gas Forum have also been included in this final proceedings report.

An Abstract Volume for the Forum was published and available on the North Slope Science Initiative webpage (NSSI.org) and a final report containing the abstracts and Power Point Presentations as well as a summary of the meeting and facilitated closing discussion will be available soon on the NSSI and MMS Alaska webpages.

This final proceedings report, MMS 2009-005 and Power Point presentations from the Eleventh Alaska ITM will be available on the MMS Alaska webpage at http://www.mms.gov/alaska/ref/AKPUBS.HTM.

WELCOME TO THE INFORMATION TRANSFER MEETING AND THE ALASKA ENVIRONMENTAL STUDIES PROGRAM

Dr. Dee Williams

Chief, Environmental Studies Section
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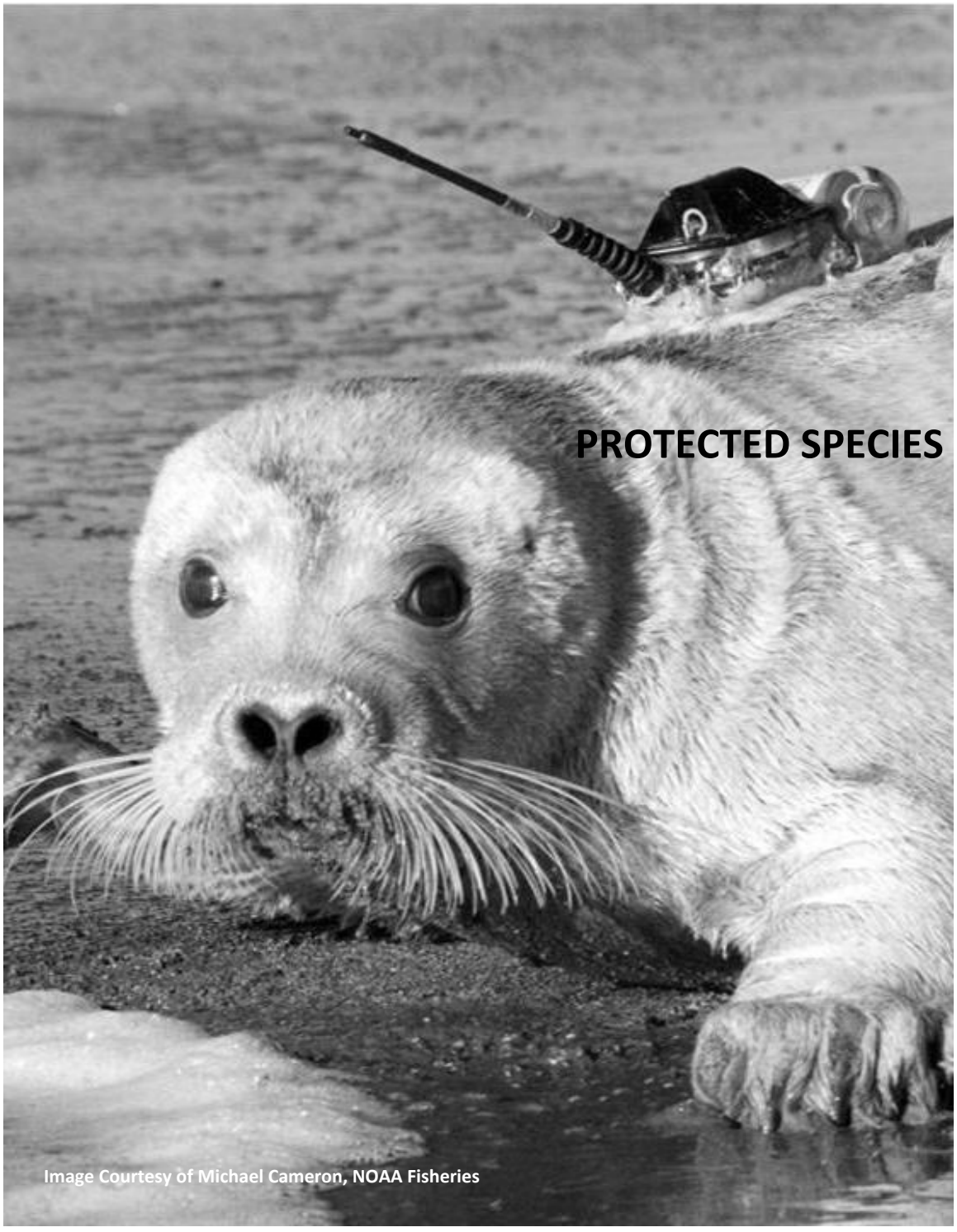
Thanks for coming everybody. Welcome to the 11th Information Transfer Meeting (ITM) of the Minerals Management Service (MMS). My name, for the record, is Dee Williams; I am the Chief of Environmental Studies for the Alaska Region. I wanted to say a few brief words of orientation before we have our first panel. Our studies program is mission-oriented, which means that we follow mission goals, and our key goal is to establish the information needed to predict, assess, and manage the potential effects on the human, marine, and coastal environment as they relate to oil and gas activities on the outer-continental shelf (OCS).

The purpose of this ITM is to have a periodic opportunity to share what are primarily interim results of current study projects. Another significant goal that we try to achieve in this event is to receive useful public input to our studies' planning process. And in that regard, I just want to call your attention to several items in our informational packet that you picked up at registration. Our Regional Director, John Goll has mentioned, but I just want to emphasize, that we are currently in a period of our calendar planning where we are especially receptive to input from other agencies and the public about new study proposals. In your registration packet, there's a profile template that we invite you to use when submitting ideas for our consideration as we plan our study "new starts" for our fiscal year 2010. There are some other handouts that I'll call to your attention; those are the sheets with multi-colored columns. This sheet provides a quick reference key to our ongoing program. This changes on a frequent basis, but it provides a useful over-view of the studies that we are currently managing, and planned "new starts" at this particular moment. On the back of the form, I would like to draw your attention to the long list of research partnerships that our program endeavors to maintain. We do our work in close collaboration with many other research partners.

Logistically, I want to call your attention to a few concerns. For this ITM to work smoothly, we need to try to synchronize our speakers as closely as possible with the scheduled agenda. That's why we are going to start on time even though the United States and Canada Northern Oil and Gas Research Forum (Forum) is a little behind. So I would ask speakers and guests alike to please help us make an effort to stay on track, and to minimize disruption as you move back and forth between auditoriums.

Each of our sessions will be chaired by a discipline specialist, and they are wearing green tags as an identifier. They will be timekeepers as well as moderate the question and answer period. Feel free to track them down for further questions or conversation after your session is over. That concludes my remarks, and at this time, I would like to introduce Dr. Charles Monnett, who will chair our first session.


PROTECTED SPECIES
Image Courtesy of Michael Cameron, NOAA Fisheries

INTRODUCTION TO PROTECTED SPECIES

Dr. Charles Monnett
MMS Session Chair

In this little mini-session, we have three talks. Two are by Janet Clarke and one is by Alex Zerbini, both of the National Marine Mammal Laboratory (NMML). I will introduce each of them in their time. I just want to say that I am really proud, in general, of the way that the laboratory has stepped up to implement these studies in just about every case recently. The studies have been implemented six months ahead of the funding, and without the extreme flexibility and innovative approach that we have seen by John Bengtson and his associates, we would have almost nothing to talk about right now. In a way this is the NMML ITM, and eventually, we will be talking about data that MMS has paid for, but right now we need to thank these folks.

I'm just really pleased with the way MMS has made a transition into the Bowhead Whale Aerial Survey program, and we've come full circle now. The first speaker, Janet Clarke, was one of the original people involved at an early point in the program's inception. Janet will give the first two talks. They will not be segregated; she will continue presenting until both are complete.

Figure 1: Bowhead Whales Sighted During Research.

MONITORING THE DISTRIBUTION OF ARCTIC WHALES and COMIDA: DISTRIBUTION AND RELATIVE ABUNDANCE OF MARINE MAMMALS: AERIAL SURVEY

Janet Clarke

Science Applications International Corporation

Large-scale aerial surveys of marine mammals were conducted in the northeast Chukchi Sea, as part of the Chukchi Offshore Monitoring in Drilling Areas (COMIDA) project. This work was the first comparably broad aerial survey conducted in this area since 1991. The objectives of the survey were to augment scientific knowledge about the distribution and abundance of marine mammals in the Chukchi Sea Planning Area from June to August; document areas of importance for specific behaviors, such as feeding, calving, and hauling out; and to provide data in a format consistent with previous work to allow for real-time management activities.

The survey was divided into two time periods and covered an approximate range from 68-72º North latitude and 157-169º West longitude. COMIDA1 was a series of seven survey transects (7,263 total transect kilometers completed in 35.3 hours) flown from June 16 to July 7, 2008. There were relatively few survey transects flown during this period due to flight-prohibitive weather conditions. Sea ice during this period was still quite prevalent in the survey region. Among the marine mammals sighted during COMIDA1 were polar bears, bearded seals, gray whales, beluga whales, and a single fin whale.

The data for total counts of mammals were presented in nine categories: bowheads, gray whales, unidentified cetaceans, beluga whales, fin whales, walrus, polar bears, bearded seals and other pinnipeds. Total mammal counts were presented in number of sightings/number of whales. For COMIDA1, the following populations of mammals were sighted: 0/0 bowhead whales, 9/30 gray whales, 2/3 unidentified cetaceans, 5/63 beluga whales, 1/1 fin whales, 48/288 walrus, 1/1 polar bears, 14/18 bearded seals and 45/68 other pinnipeds.

COMIDA2 consisted of 12 survey transects (11,990 transect kilometers completed in 57.6 hours) flown from August 3 to 26, 2008. During this survey period, most of the sea ice had melted, creating a greater area of open water for surveying. There were a lot more total sightings of marine mammals during this survey period. Among the species sighted most often were gray whales, concentrated along the Beaufort Shelf, and walruses, sighted in high concentrations outside the Beaufort Shelf. The presenter emphasized the possibility that walrus may have been severely underestimated, as concentrations on a single haulout were often very dense, and in a fast fly-over, accurate counts were not always possible. During this work, a single bowhead whale was sighted in the extreme northwest quadrant of the survey area.

For COMIDA2, the following marine mammals were sighted: 1/1 bowhead whales, 86/183 gray whales, 28/31 unidentified cetaceans, 1/4 beluga whales, 0/0 fin whales, 144/5707 walrus, 16/16 polar bears, 88/44 bearded seals and 286/498 other pinnipeds.

The results for gray whale sightings were presented overlaid with historical sightings of gray whales throughout the northeast Chukchi Sea. These data differed from the historic data since gray whales

were concentrated on and around the Bering Shelf, whereas historic sightings show gray whales distributed throughout the study area and beyond it to the north. The historic data shown in this presentation are for sightings from August through November 1982-2007, but the recent data span June through August 2008. Future research may show a wider distribution of gray whales consistent with that shown in historic data.

Discussion:

Tom Newberry: My impression is that there was some evidence of killer whales in the Chukchi Sea earlier in the year, and I think it's important in the report to mention that you could see them if they were there but you saw none. The reason I think it's important to add that, in future years they may become more abundant in the area and I think it's important to start recording when they're there so that things aren't blamed incorrectly on activities, and also because I think it may have a very significant affect on the bowhead whale; they are really sitting ducks, they've been separated from that predator by ice for centuries, and now that separation, it's disappearing.

Janet Clark: Thank you, Tom. We didn't see any killer whales, and so certainly when we do the report, we try to incorporate information as we get it, but for our purposes, we can put in what we saw, not what we hoped to see. No, if we put in what we hoped to see, then there would be right whales up there. But it's a very good point. I think that it needs to be, you know, and I think there's more and more a move towards this, incorporating, for example, traditional ecological knowledge into all of these different types of studies, and so I think when we start getting into, one of our purposes for this long range is to start publishing more on these data, both the BWASP and COMIDA data, and that's where you generally start to see that type of information worked in on possible other…I understand what you're saying, and that would certainly be something we would be looking at.

Janet Lage, ASRC Energy Services: In your last slide where you showed the 1990's combined whale survey; maybe I was sitting too far back, but I didn't see any bowhead whales, and you said that you surveyed through November. Was it just not posted? Did you not see any bowhead whales?

Janet Clarke: Those were only gray whales. We saw only one bowhead so far. As for the Chukchi Sea survey, we only saw one bowhead, and we found that a little bit odd to see that. So far, that's all we've seen. So one thing I really want to stress is that we are flying, right now with different time periods than where we were before.

Janet Lage: Did you survey in September at all this year, or were you just in the Beaufort Sea?

Janet Clarke: Just in the Beaufort Sea in September. Our last survey period ended on October 6th.

Janet Lage: Did you notice how far westward the bowheads had gone in that transition period? Do you know when they actually started migrating into the Chukchi Sea, or can you not tell that from the data that you have?

Janet Clarke: I don't think we really could tell, to tell you the truth, because currently, our survey was recorded in certain ways, so we only ….with one exception, came along survey lines into the Chukchi, so I think it's very hard for me to say…..right now.

Charles Monnett: Let me answer part of that. I think you'll want to make sure to come to Lori Quakenbush's talk, which is tomorrow I believe. That's the satellite tagging data, and then you'll find that indeed, the whales do pass through the Chukchi to get to Russia.

Janet Lage: In future years, do you think you'll be going into the Chukchi Sea around that September timeframe, or are you not sure?

Charles Monnett: We've been talking about that a lot. We've got a pretty conspicuous gap in our coverage area, and so this was the first year of the Chukchi Sea study, and we started up kind of fast and NMML wasn't even funded for the first two complete surveys. We tried to really spread it as widely in the timeframe as we could, so we got there very early, maybe too early, and we're still out there, which is looking stupider and stupider right now. So, we expected as time went along, since we were fairly naïve in how we needed to conduct this study, that we needed to make adjustments, and we probably will be moving everything more towards the center and busier period.

NORTH PACIFIC RIGHT WHALE (*EBALAENA JAPONICA*) RESEARCH IN THE BERING SEA

Alexandre N. Zerbini, Ph.D

National Marine Mammal Laboratory, Alaska Fisheries Science Center; Woods Hole Oceanographic Institution

Session Chair-Dr. Charles Monnett: *These surveys are part of a multi-disciplinary integrated program. We have three other major studies, particularly of bowheads and other whales taking place mostly in the Barrow area and the Chukchi Sea. You will hear the results of those talks. I would also like to direct you to the websites, so pay attention during the talks and note the websites, which are pretty spectacular, and tend to be mostly up to date. It's really an impressive transfer of information in nearly real time. This next talk will be by Alex Zerbini, and he's going to tell us about the study of Right Whales in the North Aleutian Basin, and I already mentioned the heroics of NMML in getting this study started. It began on sort of an emergency basis last year when MMS realized that we're probably going to go there, and we needed the data as soon as possible, and we put this study together very quickly. We had a little bit of a slow start last year, but this year we had really impressive results.*

The North Pacific Right Whale (*Eubalaena japonica)* is one of the most endangered species of whale in the North Pacific. This whale measures approximately 18 meters in maximum length and weighs from 60 to 100 tons. It is easily distinguished from humpback whales by its absence of a dorsal fin and callosities on the head. These marine mammals feed primarily on large zooplankton. Whaling in the 19th and 20th centuries resulted in over 15,000 takes. Illegal whaling by Soviets in the late 19th century may be contributing to a continued low population. The current distribution in this species is limited to the known feeding grounds, now established "critical habitat areas," in the southern Bering Sea and off of the east coast of Kodiak Island.

Nautical and aerial surveys were conducted in the southern Bering Sea; research that was motivated by a need for better data to assess potential impacts of oil and gas development in the Northern Aleutian Basin Lease Area. Methods employed during this work included sighting surveys (aerial and nautical), photo-identification, biopsy sampling, satellite telemetry, acoustics, radio tagging, and oceanographic prey sampling.

Aerial surveys were conducted from July 22 to August 30, 2008. The survey covered three distinct areas along the northeastern Aleutian rim. Aerial survey methods included visual surveying and photo-documentation, with the objective being to provide large-scale coverage of the survey area. Aerial surveys covered approximately 7,200 nautical miles with a total of 576 individual cetaceans sighted, only 13 of which were right whales. Eight of the individuals photographed during aerial surveys were identified as having been previously sighted (markings matched those of other photos).

Figure 2: Right Whales Sighted During Survey.

Ship surveys were conducted from August 2 to September 13, 2008. The methods employed from the ship included acoustic surveying (ongoing acoustic mooring research), visual survey, photo-documentation, satellite tagging, and foraging ecology studies using plankton nets. The ship surveys covered approximately 1,200 nautical miles, sighting 440 individual cetaceans, 37 of which were right whales. Though analysis was not complete as of this talk, approximately 7 to 10 individuals were photo-identified as having been previously sighted.

Three hundred and two sonobuoys and three acoustic moorings were deployed. Recordings of right whales have been made, and acoustic research using these recorders will continue for two years.

The data from these acoustic recorders may help determine the extent of the range of right whales beyond the established critical habitat areas. Acoustic data as of this presentation only show right whales within the established critical habitat area in the Bering Sea.

One right whale was instrumented with a satellite tag. The results of telemetry for this whale show that the animal was within the Bering Sea critical habitat area from August 25 to October 18, 2008.

Oceanographic prey sampling was conducted via boat using plankton nets. Right whale prey in this area likely includes a large zooplankton specie - *Calanus marshallae*. Interestingly, a large number of jelly fish were also collected during this work. Water column research shows a warm, salty subsurface front with a deep chlorophyll layer within the critical habitat area. Such ocean conditions contribute to the microfaunal community on which these whales feed.

As of this presentation, a full analysis of the data on right whales has yet to be prepared. A large body of data was also collected for other species of marine mammals, and though these data were only cursorily discussed during the presentation, there will be papers and presentations prepared in the future that cover this subject.

Discussion:

Norman Anderson: It would have helped if we had some sort of a printout to go along with your presentation. You went through that information very fast. I tried to make some notes on that. The area for the critical habitat for the Pacific right whale had been expanded. It used to just be a little sliver area, and because the identification of the whale into a larger area that had been encompassed and the borders now extend into the lease sale, which is 214 now, but I was kind of disturbed that of all the studies that had been done, there's no results on the current distribution, the migration paths, traditional knowledge from the local people could tell and contribute to that since we live in the area and make our living off of there, so we know as far as Nunavik Island, and different areas, the distribution of the whales there. I tried to make some notes on these buoys and the different things, and it would be nice to have access to that data online at some particular time, so it's kind of fun in some areas. You can listen to some of these and to follow along with these. Just on a side note, I live and work out of Dillingham now, and 5 miles up the Nushagak, we had killer whales this year, which is kind of an oddity, but I'd like to talk to you about some other information later on. Thank you.

Brad Smith: I was wondering whether you saw any behavioral characteristics, or anything, especially in comparing the north Pacific right whales to their Atlantic counter-part that would predispose them to ship strikes; either behaviorally as a ship approached, or whether you looked at the plankton. Do you have any indication that the whales are feeding on the surface more at night, or that they're just …. Any observations that would give you conclusions about how much exposure we have to the potential ship strikes.

Alex Zerbini: Well, in regards to the feeding, these are preliminary results, so we haven't gotten to the point that we can look at possible differences in feeding at night or during the day, and where they are feeding; this will be done in the future. As for ship strikes, one thing we noticed specifically with these whales is that they are very elusive and very unapproachable, so, if you compare those whales to the north Atlantic right whales, it's likely that the north Atlantic right whales are more prone to ship strikes than these whales. These whales were very aware of the presence of boats, and they were very evasive once we actually approached them. Obviously, it always depends on the boat you're talking about. If you are talking about a large boat, or a smaller boat, and the speed of the boat is moving, so there are a lot variables you have to consider when you talk about …*indiscernible…* to ship strikes. So in this specific case, they were relatively unapproachable, and that was one of the reasons we didn't get more solid

tags and more of the radio tags that we actually wanted to get, is because they were difficult to get close to.

Dr. Charles Monnett: I just want to point out there's another full field season with all of the tasks in play next year and I think the groups learned a lot. There was a small study last year, and more right whales were detected, in spite of a pretty good presence of ships, and acoustics, which strongly suggested that the whales weren't in the same area, so we're dealing with something that's highly variable, and it would probably require a number of years to really figure out where they are, because we'd be a lot more concerned if the whales were showing up down around Unimak Pass or some of the areas where the ship traffic is likely to concentrate. And we just haven't done enough to have those kinds of answers yet.

Max Kotokak: I'm from Canada. I'm with the Fisheries Joint Management Committee. Sorry I missed most of your presentation, but some of your recordings; I'm assuming it picks up beluga whale sounds as well?

Alex Zerbini: First thing, our recordings, the ones that I showed you, were done in areas where beluga whales were not common to occur. Second thing is that I need to go back and look at the acoustics, the set up, but most of the recordings were low frequency, and belugas call in much higher frequency, so we are sampling a frequency range that we can listen to right whales but we're not going to listen to beluga whales. Is that clear?

Max Kotokak: Yeah, I guess the other thing too is maybe when you take recordings, when you deploy, can you pick up from here in Anchorage? Can you pick up the sounds right now?

Alex Zerbini: No, no. We deploy the instruments, and…..there are two types of instruments that we are using. The sonobuoy…we have to be close to the buoy to record, and that's a real time recording and the acoustic moorings are deployed in the bottom of the ocean, the instruments stay there for the whole year, you go there next year, you retrieve that back, and you analyze the data. So there's no way you can have immediate access to that right now or from here. You actually have to go back and pick it up then analyze the data.

Max Kotokak: Okay, thank you.

Dr. Charles Monnett: You may want to come back in about two years, because we've got a number of very large studies that are either beginning now, or in the next year, and are deploying large numbers of acoustic moorings. The other thing you would look at is industry. The industry has been using moorings out there for maybe 5 years and has a huge amount of data. That's not to say that necessarily all the moorings are going to provide useful information, because it depends on what they're set to receive. If they're concentrating on lower frequency sound, it's very hard to interpret anything that would be useful for bowheads. It's hard to do both. It's a real challenge.

Robert Suydam: Actually it's not a question. Hi Alex, welcome to Anchorage. Actually I just wanted to follow up on Tom's question a second ago, his comments on killer whales in the Chukchi Sea; that change has already occurred. You know, I've been in Barrow for about 20 years now and Craig George has been there for about 30 years. And when people or hunters would see killer whales, we'd hear about it. But it's so common now that we don't hear about killer whale sightings anymore. So there has been a substantial change in killer whale presence in the Chukchi Sea, and it seems like more and more

killer whales are being seen in the Beaufort Sea as well. The other thing I wanted to comment on was kind of a single cause as to why marine mammals die in the Chukchi Sea. Over the years, we see lots of carcasses floating in and around out there, and without a doubt, many of them killed by killer whales, but many of them are never examined, and so we really can't assign a cause of death until we start examining the animals. I think there's a real need to develop a response program where we're going out and examining whales to see if they've been hit by ships; to see if there's hearing damage; to see if they've been attacked by killer whales. So there's a real need to do necropsies on marine mammals that show up dead. Thanks Chuck.

Dr. Charles Monnett: Well that's another interesting research question, isn't it? How do you record data on the things that people never say that are really important? Another thing that we never record is narwhal. We know they're up there, so we could have quite a table with a lot of blank spaces in it, I guess, saying we looked for things, and we probably need to recognize what we're potentially seeing up there. It would be pretty likely, I suppose. Well, that closes our session for now and we'll be back here later for more protective species talks.

SEASONAL MOVEMENTS, HABITAT SELECTION, FORAGING, AND HAUL-OUT BEHAVIOR OF ADULT BEARDED SEALS IN THE CHUKCHI SEA

Peter L. Boveng, Ph.D and Michael F. Cameron

National Marine Mammal Laboratory, NOAA Alaska Fisheries Science Center

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Bearded seals (*Erignatus barbatus*) are an important subsistence resource to native people in Northwest Alaska, yet this sea mammal is one of the most poorly understood by the scientific community. The pups are born on the ice in late April and are weaned in approximately 2-3 weeks. The bearded seal is a benthic feeder, feasting largely upon crustaceans, mollusks, flounder, sculpins and cod. From what little is known about their behaviors, bearded seals represent a key component in the Alaska Moon ecosystem, predominantly as a major prey for polar bears, and they are strongly associated with patterns of sea ice advance and retreat. With sea ice declining rapidly, there is a great potential for endangerment or extinction of bearded seals. Unfortunately the basic quantities for assessing their status are essentially unavailable. There are no current estimates of abundance, trends, or long range movements and their habitat requirements are not very well known. With so little information presently available about bearded seals, there is correspondingly little known about the impacts that major industries may be having on the seals. Bearded seals are currently under review for consideration for listing under the U.S. Endangered Species Act, out of concern about decline in their sea ice habitat. NOAA Fisheries has received a petition to list them as threatened or endangered. Quantitative data must be presented in order to bring this legislation to the aid of bearded seals. This study aims at addressing some of this fundamental lack of information.

Presently, the study is organized into two phases. Phase I consists of: 1) working with Alaska native communities to identify local interest and priorities for research, in the form of community meetings, 2) identifying the locations and seasonal timing and particular situations with the most promise for encountering and capturing bearded seals, 3) development and refinement of techniques for capturing

and safely handling these animals in the form of doing workshops to test various proposed methodologies. The latter two items will involve close collaboration with Alaska native hunters who can provide personal insight about the behaviors of these animals. Phase I of the study is meant to be adaptive. As more information and better techniques become available, the methodology in capturing and handling these seals safely, for both the researchers and the animals, will be refined.

Phase II of the study will consist of fieldwork, analysis and reporting. The goals of this phase include fully incorporating the interested community members into the fieldwork process, and applying analytical techniques that have been used in similar studies in the past (i.e.: research on young bearded seals in the Chukchi Sea and harbor seals in Cook Inlet) to generate a more comprehensive understanding of the routines and habitat concerns for the whole species. Pedestrian and marine, and underwater surveys are planned for future studies. Challenges faced by researchers include the wariness, size, and strength, of the adults. Satellite telemetry data will be used to understand "haul out" patterns. "Haul out" refers to the proportion of the group that is in the water and feeding during a given season. Understanding the "haul out" patterns in which bearded seals engage is of seminal importance to the proper interpretation of survey data. Satellite Telemetry will also be used to generate data on the general movements, daily and seasonally, of the adult members of the species. This includes marine spacial patterns and dive depth information. Quantitative studies and regression analysis will be applied in order to identify habitat variables that are most important in determining habitat selection or preference.

Research being performed by Russian and Norwegian teams may provide additional insight into Bearded Seal behavior. Future community meetings should be held whereby the following information could be gathered: 1) What are the local concerns about bearded seals, and how can future studies be designed to address these concerns; 2) Are there local places and times where adult bearded seals are frequently encountered?; 3) How can we develop an approach to live-captures, in particular without impacting subsistence use?; 4) What logistical resources (e.g., boats, camps) are available locally?

No Discussion.

A COOPERATIVE APPROACH TO WALRUS RESEARCH—HUNTERS AND SCIENTISTS WORKING TOGETHER

Lori Quakenbush, P.I.

Institute of Marine Science, University of Alaska, Fairbanks, and Alaska Dept. of Fish and Game

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Pacific walruses (*Odobenus rosmarus)* are a critical component in the ecosystem of the Bering and Chukchi Seas, as well as an important subsistence resource for native people in the area. Pacific walruses winter together in the Bering Sea. In summer, the population segregates. While males go to terrestrial haulouts along the Bering Sea coast for the summer, females migrate north to the Chukchi Sea, where they calve on sea ice and feed in benthic zones up to 100 meters deep. In recent years, the summer ice retreat has gone far beyond the 100 meter isobathic range, forcing female members of this species to haulout on land rather than sea ice. This environmental change may be having a significant impact on the viability of Pacific walruses. These impacts are likely exacerbated by increased activity by oil interests in the Chukchi Sea. In an effort to assess the impacts that these changes are having on

Pacific walruses, a cooperative research effort is being made between the Eskimo Walrus Commission, the University of Alaska – Fairbanks (UAF), the United States Geological Survey (USGS), the Fish and Wildlife Service, and native hunters, fishermen and interested persons. The objective of this research will be to work with local hunters and fishermen in villages throughout Alaska's northwest coast to safely capture and fit Pacific walruses with satellite transmitters: The data from these transmitters will be used to obtain current information on the migrations, feeding areas, haulouts and behaviors potentially resulting from environmental change. In the past, similar research has been conducted on Beluga whales. Locals will be stationed along the coast to observe seasonal changes in walrus behaviors, attach satellite transmitters, and protect walrus haulouts throughout the year. The cooperation and input from local villagers, fishermen and hunters greatly advanced the success of previous research efforts, particularly with regard to a study of Beluga whales in the Bristol Bay area. Similar success has also occurred in bowhead whales. Locals provided an intimate understanding of animal behavior, currents and bathometric information, and practical skills (such as net-setting and repair methods) that greatly advanced the success of research without interfering with subsistence activities.

Figure 3: Three Generations of Pacific Walrus Females.

Discussion:

John Bengtson: Do we have an estimate or an idea of what proportion of walrus are still out on ice, or are they all on shore now?

Lori Quakenbush: That has been very variable. This year, the ice retreated about the same, but there was a tongue of ice near Barrow. It was still there in July and as that broke up, it left small pieces of ice in the Chukchi Sea that was available to walruses this year. I have talked to several people this year who have seen walruses hauled out on small pieces of ice…some of the oil industry folks. And also Chad J with the USGS had some satellite transmitters out, and these transmitters were saying that there were walruses hauled out although you could not see the ice present with the satellite. They were using small pieces of ice in the Chukchi sea. So there were fewer hauled out onshore on the Alaska coast and the Russian coast this year than we would have expected, given how far the ice retreated. But it looks like that tongue of ice that came around Barrow was the reason why there weren't more on-shore.

John Bengtson: Part of what I'm thinking is trying to get an idea of how these terrestrial haulouts in the Chukchi Sea, especially in areas where there is possible coastal development…whether we can anticipate that they will get larger, and if so, by how much, or are there more still coming ashore as we have more record years of these ice minima.

Lori Quakenbush: I think the guess is that there will be more walruses hauling out on-shore as the ice leaves the Chukchi Sea sooner and more often. They basically won't be able to go with the ice as it goes off of the shelf. And we will have walruses needing to haul out somewhere. And the only place would

be either the Alaskan coast, the Russian coast, and Wrangell Island. And depending on potentially where they are when that happens will determine whether they go more to Alaska or Russia. And then there is the disturbance factor: polar bears figure it out, they push the walruses into the water over and over again. So that might be someplace walruses won't go back to and they might go someplace else…those are types of things that could happen as well. Some areas might be greater disturbance areas, and might push walruses other places.

RINGED SEALS AS INDICATORS OF CHANGE: HARVEST-BASED SAMPLING NEAR ULUKHAKTOK (HOLMAN) (1992-2007) AND SACHS HARBOR (2003-2007), NT, CANADA

Harwood, L.A., J. Alikamik, and H. Melling

Canada Department of Fisheries and Oceans Institute of Ocean Sciences and Arctic Science Division, Olokhatomiut HTC

Ringed seals (*Phoca hispida)* are a strong indicator of the health of the arctic marine ecosystem. They are the primary prey for polar bears (*Ursus maritimus*), yet they are the primary predator of many of the smaller marine animals in the ecosystem. They also respond strongly to seasonal ice pack variations, as demonstrated in this research.

Past and present research has shown that ringed seals display a response to climate change, in both body condition and reproductive success. Past research (1974/1975) showed reduced abundance and reduced ovulation rates as a result of a particularly heavy ice season. More recent data have been collected annually since 1992, during annual subsistence harvest practices in Sachs Harbor and Ulukhaktok. This research has been a cooperative effort between researchers and native people living in these two villages. The field data have been collected by John Alikamik since the project's inception in 1992. The results of this later work support the conclusions of the 1974/1975 study and indicate that, while shorter ice seasons are beneficial to the health and reproductivity of ringed seals, too little ice presents a threat to the survival of the young when the lactation period is interrupted because ice breaks up too soon.

Body condition was measured in terms of blubber thickness (BMI). These measurements were taken at the hip in each animal. The overall body condition of adult males, adult females and sub-adults has shown a steady decline since 1992. The blubber thickness of pups has remained stable, indicating that, although mothers aren't getting quite enough nutrition themselves, their ability to feed their young has not been compromised. The total average width of girth in this sample is approximately 1 centimeter. Ovulation rates and pup population decreased sharply during 2005, when the winter ice pack was unusually long.

1992 was an unusually warm year, with a shorter ice season and a very early breakup. While the compiled data indicate that these conditions are generally good for ringed seals, this extreme case led to negative impacts to nursing seals on the ice periphery. As the lactation period is spent on the ice surface, this unusually early breakup interrupted the lactation period, causing many nursing pups to

drown. While the effect of short winters is generally good for ringed seals, there is a point at which too little ice does negatively impact the population.

Short winters and long open water seasons are linked to increased seal condition, reproduction and pup production. Long winters and short open water seasons are linked to reduced seal condition, reduced ovulation and reduced pup production.

No Discussion.

MONITORING MARINE BIRDS OF CONCERN IN THE EASTERN CHUKCHI NEARSHORE AREA (LOONS)

Dan Rizzolo

United States Geological Survey - Alaska Science Center

Figure 4: Yellow-Billed Loon.

Yellow-billed loons (*Gavia adamsii*) and red-throated loons (*G. stellata*) are two species that are currently of conservation concern due to steadily declining populations. These birds have recently been studied using Satellite Telemetry technology. Loons are piscivores that rely primarily on marine resources for food. Although their feeding habitat is coastal, they nest on inland lakes, carrying marine fish to their nests to feed their young. Loons can live up to 20 years, including an extended juvenile period, ranging from 2-7 years depending on the species. During this work, the researchers tagged nesting adults of five red-throated loons, and 11 yellow-billed loons with satellite transmitters.

The data for red-throated loons were limited to the fall migration, as the bird's small size restricts the size of battery that can be used. The data showed that nesting individuals of this species were located in the Chukchi Sea from late August into September, and that their nesting grounds were up to 30 kilometers inland. By late September, these individuals migrated south, across the Chukchi Sea into Asia and the Seward Peninsula.

Yellow-billed loons were capable of carrying a larger battery, and were able to provide data for approximately one year. The results showed that loons are scattered along the north and northwest coasts of Alaska, St. Lawrence Island, and in coastal areas in northern Asia during May. By mid-Summer, these individuals have migrated to their nesting grounds inland of the north coast of Alaska. During mid-to late-Summer, individuals were found to spend a portion of their time in the marine habitat feeding on marine fish. Some of this population may include individuals who were unsuccessful in their

nesting attempt and remain entirely on the coast. By September, the population re-distributes across the Chukchi Sea, with some individuals already documented in Asia, where they will remain for the winter.

As an extension of this study, work is being conducted over the course of the next few years to increase the sample size and lengthen tag battery-life in order to better quantify the use of Chukchi Sea by adult and juvenile red-throated and yellow-billed loons. The planned research includes objectives to quantify reproductivity, model energetics in nesting and make interspecific comparisons with sympatric Pacific loons. As of 2008, 69 nests are being monitored, and migration patterns of adult and juvenile loons in both species have been mapped.

Discussion:

Tom Newberry: Why do the Loons all go to the Asian side of the Bering Sea?

Daniel Rizzolo: That's a good question. It's a pretty common migratory pathway for birds that nest on the North Slope of Alaska and it's a pretty short jump for birds to cross over that way. It's just as easy to go that way as it is to go down the west coast of North America.

Tom Newberry: But why not the Yukon Kuskoquim Delta?

Daniel Rizzolo: That's a good question. We don't know. There's a definite demarcation north of the Seward Peninsula. Most birds, until this one Red-throated loon that went down to Bristol Bay, all loons went to Asia, north of the Seward Peninsula and south stayed along the west coast of North America. Why that demarcation point is there, we don't know (*sic)*.

PREMIGRATORY MOVEMENTS AND PHYSIOLOGY OF SHOREBIRDS STAGING ON BEAUFORT LITTORAL ZONE

Abby N. Powell, Ph.D

Department of Biology and Wildlife - University of Alaska Fairbanks; U.S. Geological Survey; U.S. Fish and Wildlife Service

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Several species of Arctic shorebirds were observed along the Alaskan north coast. Particularly, this study sought to gather information on the use of and their use of pre-migratory staging areas along the Beaufort littoral zone. The species include Semi-palmated Sandpipers, Western Sandpipers, Dunlins, Red-necked Phalaropes and Red Phalaropes. Arctic shorebirds stay in selected coastal areas to gain the necessary fat reserves for their winter migration south. These animals are particularly vulnerable to changing environmental conditions, human disturbances and contamination. Understanding their migration patterns and basic coastal ecology is necessary in assessing the potential impacts of these conditions to the various species on the North Slope coast. This study sought to provide information on geographic distribution, species composition, phenology, timing and movement patterns to further develop effective monitoring programs.

This work included several periods of aerial and pedestrian surveys, as well as radio-tagging and tracking. The study area spanned the area from south of Kasegaluk Lagoon to the Canadian Border. The study area was divided into four regions. Region 1 included the Chukchi Sea from south of Kasegaluk Lagoon to Point Barrow. Region 2 spanned the area from Point Barrow to the Colville River Delta. Region 3 stretches from the Colville River Delta to the Arctic National Wildlife Refuge (ANWR). Region 4 spans ANWR to the Canadian Border. Aerial surveys were conducted in two minute survey intervals from helicopter (2005) and fixed-wing aircraft (2006, 2007). The 2005 survey was conducted from August 7 through August 16. In 2006, four surveys were repeated every 10 days from July 22 to August 27. Bad weather prevented flying in ANWR in 2006, so this segment of the study area was surveyed from August 7-8, 2007.

The results of aerial surveys showed high concentrations of shorebirds in Peard Bay (Region 1), Elson Lagoon, Cape Simpson, and Smith Bay to Cape Halkett (Region 2), and Beaufort Lagoon (Region 4). Some birds were documented at locations all along the North Slope coast, but the densities of populations were relatively small when compared to these more densely-concentrated areas. The vast majority of shorebirds were identified in Region 2, a part of the North Slope coast that is characterized by multiple river deltas.

Nine, 1-kilometer pedestrian transects were surveyed over a period of 3 days at each of a series of camps across the study area. During this work, age composition (juvenile vs. adult), species composition and phenology (peak abundance and length of time at each staging area) were recorded. In general, populations of adults peaked earlier than juvenile populations at each survey area. Semi-palmated Sand Pipers peaked earlier than other species and they peaked earlier in Beaufort Sea camps than in the Chukchi Sea camps. Dunlin and Western Sandpiper populations peaked later, but were more protracted than Semi-palmated Sandpipers. Phalarope populations were found to peak generally later. Population diversity at these camps varied greatly across the North Slope coast. While species diversity at Point Barrow (Chukchi Sea) is quite high, there is generally more species diversity in camps along the Beaufort Sea than those along the Chukchi Sea.

Radio transmitters were deployed on 336 individuals of Semi-palmated Sandpiper, Dunlin, Western Sandpiper, Red-necked Phalarope and Red Phalarope species. Telemetry was conducted by air, on the ground using handheld antennae and remote telemetry towers. The results of this radio tracking program showed that Semi-palmated Sandpipers fly from eastern and western staging areas to the Canning River, then south. These data strongly suggest that shorebirds are actually using river systems to migrate south. Dunlins were found to fly both north and south after leaving their staging areas, but collect in the Yukon-Kuskokwim Delta. While these are the strongest trends found during this research, the presenter notes that detection rates were fairly low. Approximately 58 percent of transmitters were detected during departure times and only 13 percent were detected during movements. The fact that collected data indicate that southward migrations center around rivers is very compelling.

Discussion:

Stephen Robey: Do you plan to have any listening stations set up in the mountains to see if you can get a little bit longer trajectory on that hypothesis of birds using the river system to go south?

Abbey Powell: That would be nice but the study is over. Maybe in the future it would be nice to have some listening stations down there.

RADIO FREQUENCY IDENTIFICATION (RFID) TAGS FOR GRIZZLY AND POLAR BEAR RESEARCH

Richard Shideler

Alaska Department of Fish and Game; United States Geological Survey

Richard Shideler presents the results of a pilot study that used Radio Frequency Identification (RFID) tags to identify and track grizzly bears and polar bears in Alaska. There is a need for innovation in the technology for tracking bears. Collars and highly visible ear tags, such as those that are currently being used in bear research, can be easily lost or removed by the animal. Current technologies such as very high frequency (VHF) and satellite (SAT) or global positioning system (GPS) trackers are quite cost prohibitive, with prices ranging from $400 to $3,000 per unit. RFID tags cost only $20 each.

RFID technology is already commonly used in domestic pets (subcutaneous microchip) and retail/warehouse inventory tracking. Several aspects of using the RFID were adapted during this study.

Figure 5: Young Grizzly Sighted During Research.

The RFID unit is small, fitting in the palm of one's hand, but the ear tag case was found to be inadequate for use on a bear's ear. During the study, the tag design was re-engineered, adding a thicker plastic case around the transmitter and a longer stem for ease of insertion into a bear's ear. During this pilot study, various types of antennae were also tried.

The Yagi Antenna was selected because it provided the widest reception range for tracking animals up to 2,600 meters from a fixed-wing aircraft. RFIDs send a signal to a handheld reader, and these data are translated and displayed on a Palm Pilot or laptop computer. This display system is cumbersome, necessitating multiple people on a survey crew during the tracking phase. The software is being engineered to consolidate the reader and the display into one unit so that radio tracking can be performed by a single individual and with one hand.

While RFIDs were found to be less visible, less expensive, and more adaptable for field tracking, only 30 percent of bears retained their tag. One adaptation that is being planned is to insert RFIDs subcutaneously, as they are commonly used in domestic pets. Researchers plan to implement remote monitoring stations and wireless alarm systems to enable radio tracking off the road system. Also, increased signal strength and antenna switch systems are planned to further enhance radio-tracking.

No Discussion.

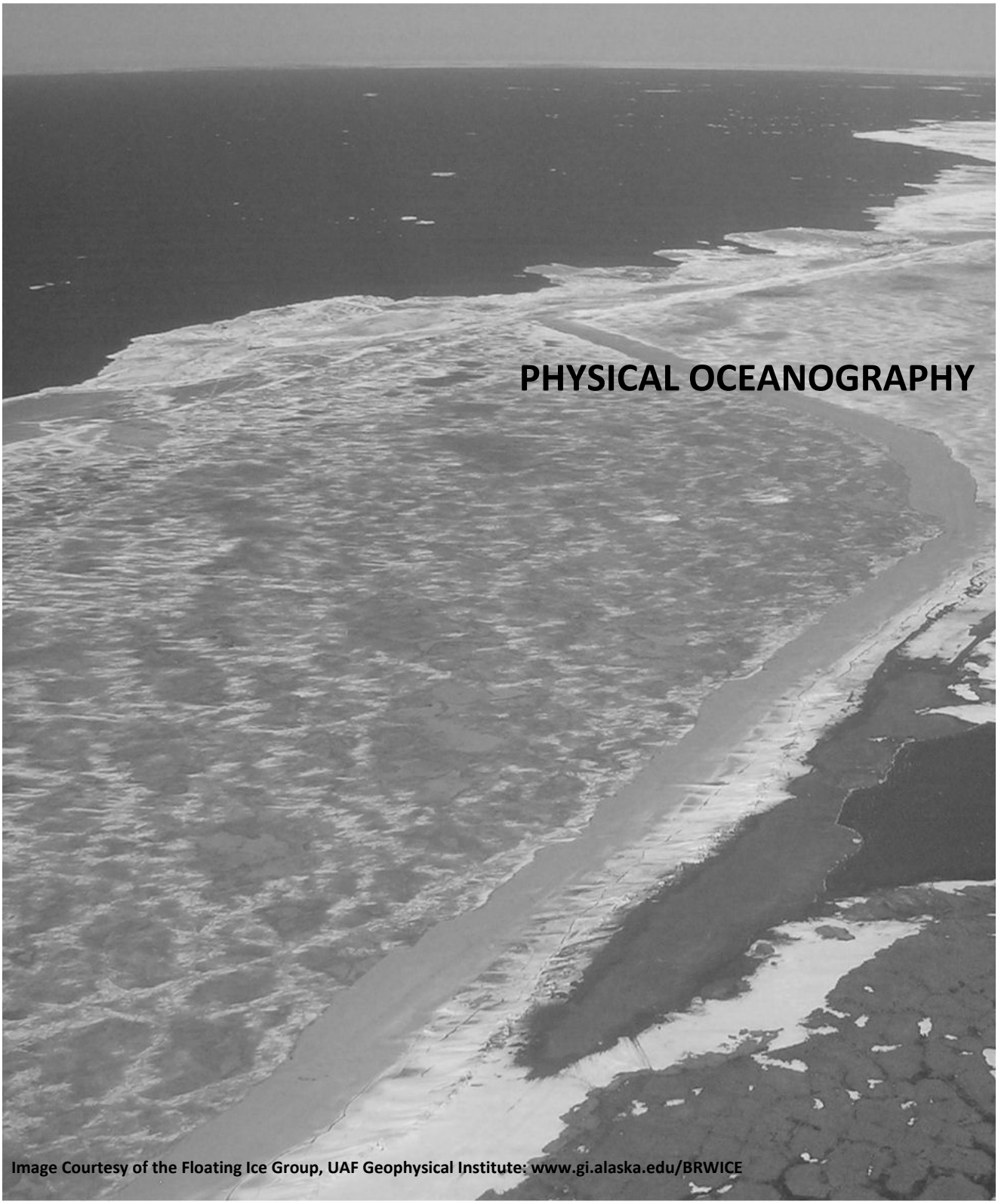

Image Courtesy of the Floating Ice Group, UAF Geophysical Institute: www.gi.alaska.edu/BRWICE

SEASONAL VARIATION IN CIRCULATION AND WATER PROPERTIES IN THE NEARSHORE BEAUFORT SEA

Tom Weingartner, Ph.D

Institute of Marine Sciences, University of Fairbanks

As an introduction to the topic of physical oceanography, seasonal changes in nearshore circulation patterns and water properties are explained with respect to the advance and retreat of landfast ice. Acoustic backscatter signature studies have been implemented to map under-ice plumes; the seasonal landfast ice season, and shearing patterns in both the cross-shelf and along-shore currents have been studied. The research indicates that seasonality in the meteorological and thermal patterns have a great influence on driving the ocean current. However, these patterns of influence are not always congruent with the patterns seen in nearshore environments at lower latitudes and where ice is less prevalent or non-existent.

There are four seasons that impact the patterns of currents in the nearshore environment. Landfast ice occupies the nearshore environment from October to May. During this season, bottom track speed essentially stops and along-shore velocity significantly decreases. Whereas winds generally have a significant impact on the current, there is no correlation between wind and current during the landfast ice season in the Beaufort Sea. Salinity and suspended sediment increase during this season, as well. Prior research of wind and current patterns has demonstrated no correlation between wind and current during the landfast ice season in Beaufort Sea.

In June, the temperature rises, allowing landfast ice to break up and river runoff to enter the ocean carrying sediments from land. Freshwater, being less dense than saltwater, remains at the surface of the water column. Whereas wind and tides would generally cause mixing in a brackish water environment, these are not present. Thus, stratification in the water column is pronounced during the breakup season. During this season, the along-shore current remains stable while the velocity of the cross-shelf current increases.

Runoff and ice retreat peak between July and September. During this season, current patterns are heavily impacted by changes in wind direction. During an eastward wind event, there is no shearing in the cross shelf, while the along shore current shears slightly. Westward wind causes dramatic shearing in the cross shelf current, but there is no shearing in the along shore current. The reason for this pattern is not known. During a predominantly westward wind event in 2007, fronts formed along the shelf causing mixing in the water column and carrying suspended sediments out to deeper waters.

Finally, from September to October, westward winds pick up, increasing alongshore velocity and turbidity levels. With well-mixed water (no stratification in the water column), the along shore current and velocity strongly correlate to wind direction.

No Discussion.

ONGOING AND SUGGESTED RESEARCH EFFORTS IN UNDERSTANDING THE OCENAOGRAPHY OF THE ALASKA BEAUFORT SEA

Tom Weingartner, Ph.D

Institute of Marine Sciences, University of Alaska, Fairbanks; Woods Hole Oceanographic Institute

The following presentation outlines the key research issues that are presently being addressed, the issues that need to be addressed, and the technologies and organizations that are contributing to the understanding of these issues. Among the research topics that are presently being studied, Weingartner specifically discusses Chukchi Sea inflow onto the Beaufort Shelf, seasonal stratification cycles, cross-shelf exchange, shelfbreak current from Barrow Canyon to the central Beaufort Sea, marine mammal response to oceanographic conditions, and ice kinematics.

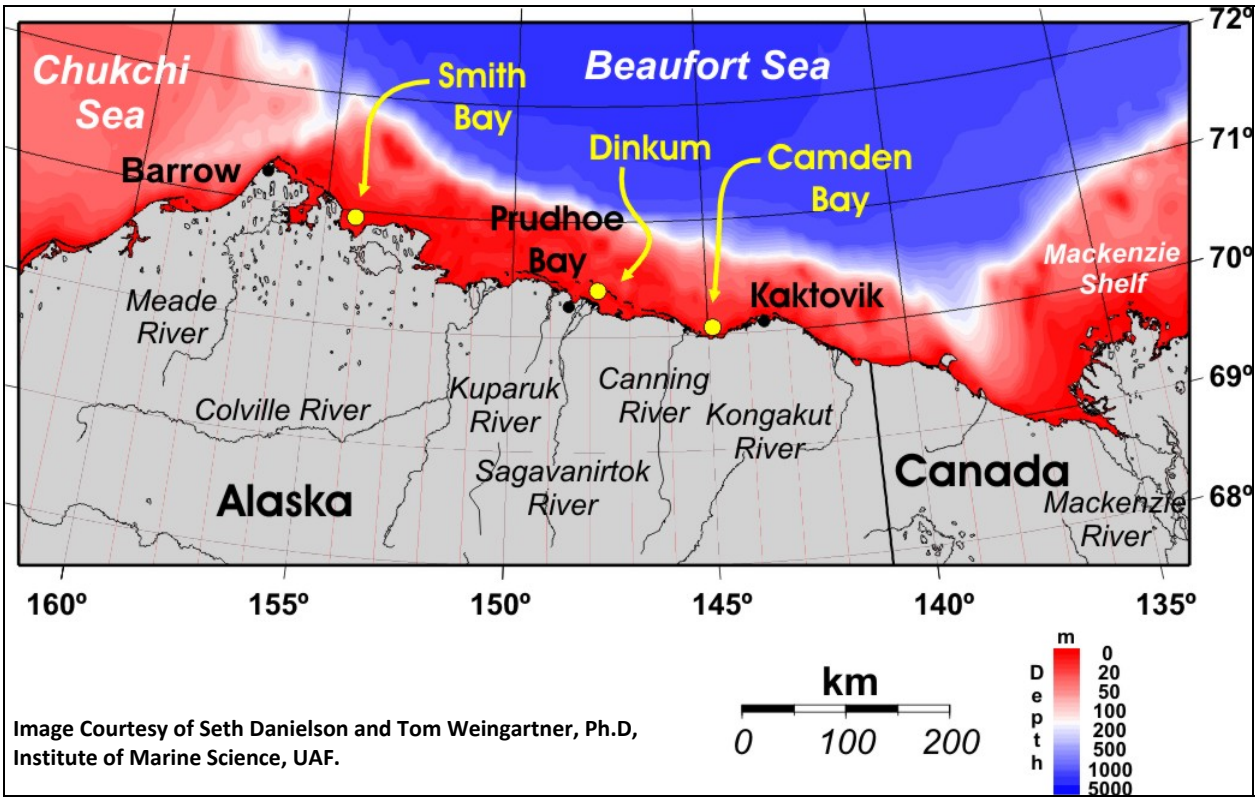

Figure 6: Bathymetric Map of the Beaufort Sea.

Several programs are currently working to address these topics, including the National Ocean Partnership Programs (the Office of Naval Research (ONR), MMS, the National Science Foundation, Shell Exploration and Development and the North Slope Borough), Ice-Covered Response to Atmospheric Storms (ICORTAS,), the Marine Fish Survey, and various Canadian Industry Efforts. These groups have employed various types of mooring arrays, autonomous underwater vehicles, and shipboard conductivity-temperature-depth recorders, and SONAR.

Several research topics need attention. Some topics are easier researched than others. These topics include 1) under-ice plumes (easy); 2) under-ice topography and its influence on flow (difficult); 3) the relationship between the Mackenzie Beaufort and Eastern Beaufort shelf (moderate); and 4) inter-annual variability in the Barrow Canyon , the Beaufort shelfbreak, the inner shelf, and the Mackenzie shelf (easy). With respect to item 1, bottom-mounted moored profiling arrays and through-ice moored profilers can be used to accomplish this research with year-round and winter recordation of currents, stratigraphy and temperature. The study of item 2, under-ice topography, is more difficult. While hand- or machine-pulled sonar devices have been demonstrated to be most effective, this method is heavily limited by the topographic conditions on the ice surface. A greater range of data can be collected more quickly with a helicopter-mounted sonar device. However, the resolution of the data that are collected by helicopter is greatly reduced. Cooperative research efforts between the U.S. and Canada may be the key to addressing topics relating to the Mackenzie Shelf and the eastern Beaufort Sea—a relationship in which Canadian organizations have already expressed an interest.

Discussion:

Tom Newberry: You had a slide up there about work that you thought needed to be done and I wanted to suggest something. During one of the previous talks there was a comment from an industry person about the desire to do work during what's called the "shoulder season." My impression is that the shoulder season during the spring doesn't change a lot. Breakup still doesn't occur until July. There's still thick ice, and coming out of the winter there's still thick ice. It just isn't changing much. But in the autumn there's a big change. Freeze up used to come, say, in early October. But now it's open into October, November, and even into December. It's a new season during which there can be operations. I think we need more data for assessment of those operations: the discharges during autumn, of the fate of spills during the autumn, the industry needs information for their operations like anchoring vessels. I suggest a study. Something like "Alaskan Arctic Shelves: a new season for operations" or " a new shoulder season." I think there's a definite need for data on that season, and not just a particular type of data, kind of anything.

Allan Reece: As I was trying to absorb the data you were showing-and there was a lot of it-and I was thinking about stratification and strudel issue, and the river overflood over the ice. Just because I have old information in my head, I couldn't get away from the notion that the water was coming out over the ice and then plunging to the sea. I don't know if you have a feel for what percentage of water comes out over the ice and lays on it, and what percentage maybe comes in under it. And then what the role might be of this phenomenon-the bathtub drain phenomenon-in terms of disrupting the stratification or forming the stratification. It's a discussion question.

Tom Weingartner: I don't know. That was a question I had myself. I know a portion of the overflow is…*indiscernible…*versus the underflow. I have no idea how that strudel would effect the stratification. I'm just curious about the velocities…*indiscernible*…does anyone have any idea?

CHUKCHI/BEAUFORT SEAS MESOSCALE METEOROLOGY STUDY

Jing Zhang

Arctic Region Supercomputing Center, University of Alaska Fairbanks, Alaska Climate Research Center, University of Alaska Fairbanks

Ongoing oil exploration and development in the Beaufort Sea presents a continued risk for oil spills. Accurate estimation of surface winds is critical to the assessment of the impacts that such spills can potentially pose for the environment. Jing Zhang presents the results of windfield research using the Weather Research and Forecast Model (WRF). The research includes data collection and analysis, testing the model sensitivity, and, following, necessary adjustments to the model domain, windfield simulation for the Beaufort Sea area.

With regard to understanding the windfield in the Beaufort Sea region, one must consider both the orographic effects of the Brooks Range and seasonal patterns in sea breeze and the effects on the overall windfield patterns. To address this issue, wind data were compiled for a span of 5 years, from stations throughout the Beaufort Sea coastal area and the Brooks Range. Winds were recorded as alternately bearing east and west through the winter months. However, in the summer, the wind direction was generally east due to the presence of a sea breeze, which counteracts western wind during the ice-free season.

Next, the compiled data on wind speed and direction were used to test the model sensitivity and adjust certain parameters within the domain for greater predictive accuracy. Ten kilometer (km) and 5 km resolutions were tested, finding no significant difference in the predictive accuracy between the two resolution settings. As such, 10 km resolution was selected. The Lin Microphysics scheme was found to predict wind speed and direction more accurately than other physics schemes when compared to the compiled data. Finally, to incorporate the effects of sea breeze and orographic impacts to the windfield, the data from the summer of 2004, and that from the winter of 2008 were incorporated into the model domain. These were record warm and cold seasons, respectively, and are optimal datasets for isolating terrain and sea breeze effects.

Following these adjustments, windfield simulations were generated for wind speed and direction at Barrow, Cottle Island and Barter Island. The results of these simulations were acceptably similar to the observed data, showing that the WRF performs reasonably well in estimating the surface winds. Next, the model simulated temperature, potential temperature, wind field circulation along the north-south cross section, and horizontal winds centered at Lonely. This test demonstrated that the WRF is capable of simulating the sea breeze influence on surface wind. Finally, to address the question of the extent of orographic effects into the offshore environment, wind speed and wind direction were simulated both with and without terrain at three locations along the Alaskan north coast. The effect of the Brooks Range on the offshore windfield appears to increase toward the east, and significant impacts appear to extend at least as far out as 150 km off the shore.

Continued improvements to the WRF are planned for Phase II of this study. Further data for offshore open water areas will be used to validate the WRFs performance for the offshore environment. The

model can be improved by incorporating a sea ice model. A thirty year production model can be used to produce a high spatial and temporal resolution Chukchi/Beaufort Sea mesoscale meteorology data set. Climatological features, inter-annual variability and long-term change can be evaluated against observed trends for the area.

Discussion:

Humphrey Melling: This is a question for Jing having to do with the forecast winds. I noticed in your validation you had a number of events where the observed winds were up to around 15 meters per second and your model was simulating perhaps 10 meters per second. Do you understand why that's happening? And what's your target for a degree of correspondence between observations and model? When do you think you will have an accurate enough model for the sorts of marine applications that we have in mind?

Jing Zhang: So did you mean that 4 month long simulation? Yeah that was a pretty long time simulation period. We do have some in a strong wind range during that period. But we did do some static analysis for the modeling results. Like for the (bares?) the model seemed to give a 1:2 meter per second in (bares?) compared to the observation. That is an order of the model areals. But this is some kind of strong forcing event. For some ordinary weak events (*indiscernible*) because a strong synoptical system can give you strong forcing for this mesoscale model from the larger scale data. So the model can be easily constrained to this synoptical system. But for some weak systems, the model tends to do a poor job for that (sic).

Warren Horowitz: I'm the Contracting Officer's Representative on this project. We have tasked the project team to create a very extensive surface observational database that's going to extend along the Chukchi Sea coast, the North Slope, all the way to the Mackenzie Delta, including much of the model domain. The surface observational database will include available offshore meteorological observations, including any buoys that we may deploy during Phase II of this study. The surface observational database will be utilized by the project team to validate the hindcast results.

MAPPING SEA ICE OVERFLOOD USING REMOTE SENSING FROM SMITH BAY TO CAMDEN BAY

Greg Hearon

Coastal Frontiers Corporation, Chatsworth, CA

Composite mapping of overflood on sea ice was conducted using helicopter global positioning system (GPS) and several satellite remote sensing platforms, spanning the Beaufort Sea coast from Smith Bay to Camden Bay. This research was aimed at identifying the maximum extent of overflood, potential impacts to human activities on the ice (including hazards to industrial site locations), and the potential to use composite remote sensing methods to assess the extent of overflooding in oil spill impact assessment.

During spring, stream breakup causes over flooding of freshwater onto the surface of landfast ice, flooding areas up to 1,000 km^2, and extending up to 10 km offshore. Overflood waters drain through cracks in the ice, most frequently through crack drains or circular drains. The force of overflood drainage (strudeling) scours the seafloor, creating craters up to 6 m deep. Overflood action can be high in energy, presenting hazards for human activity at some site locations, including industrial sites, and acting as a vehicle for potential oil spills both atop and below the ice.

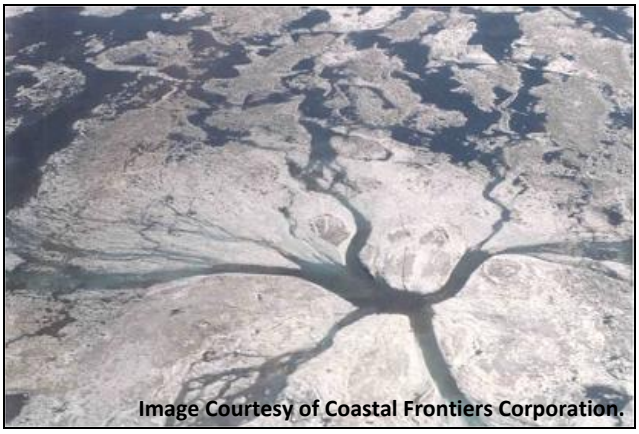

Figure 7: Circular Drain in the Beaufort Sea Ice Field.

This research compiled data from Helicopter GPS surveys, visual satellite imagery (Landsat, SPOT, and MODIS) and radar satellite imagery (Radarsat, Landsat). The use of compiled data allowed the researchers to compare the benefits and limitations of each, as well as to assess the accuracy of data from each method. While the Helicopter GPS survey is the most reliably accurate method for ascertaining the maximum extent of overflood, it is costly and requires an intimate understanding of the seasonal timing of the overflood event. Each satellite platform records data continuously as it circumnavigates the globe, allowing researchers access to satellite imagery from their own office. However, the timing of the overflood event must correspond with a favorable position of the satellite in the sky. As such, applicable images were collected for each of the five satellite platforms listed above. In the case of Radarsat, images are not impacted by cloud cover. However, these images are quite costly.

By employing all platforms of satellite imagery and compiling these data with helicopter GPS surveys, the researchers were able to develop a reasonably reliable estimation of the overflood maximum for the study area. Satellite images also presented data on physical and environmental variables such as strudel scours, circular and crack drainages, and ice roads. Despite limitations with timing and cost, Radarsat was determined to be the most promising satellite imaging platform, as it is not impacted by cloud cover.

Discussion:

Thomas Weingartner: Do the strudel scours tend to repeat their position, or are they scattered all over?

Greg Hearon: It's pretty random. And as you can see by the variability in the overflood areas, there's going to be times when the overflood is biased to one side or the other of a feature. And then the drainage features themselves are very irregular, with the exception, of course, of tidal cracks that tend to occur around the five or six-foot contour.

Tom Newberry: I remember seeing a slide of radiant heating from the pipeline coming from Northstar and then making the ice cover thinner near shore.

Greg Hearon: That's right Tom. We've done a lot of work for Northstar over the years. And with their permission, we published a paper and gave a presentation where we talked about radiant heating on

the pipeline and how bad it influences the locations of strudel drains. Tom's referring to a picture where you can actually see a signature in the ice of the pipeline in the ice in the shallower waters.

Tom Newberry: Was that one where you had the ice road? That wasn't the one where the pipeline is?

Greg Hearon: No that was a supply road that runs from Westsdock out to the island they build each year.

MODELING CIRCULATION IN THE LANDFAST ICE ZONE

Jeremy Kasper

University of Alaska Fairbanks

Ocean circulation beneath landfast ice in the Beaufort Sea was modeled using an experimental modeling system which simplifies ice morphology and across-shelf sea level slope and uses a uniform wind speed (14 knots) and wind direction (from east to west) within a rectangular domain of 66 km (across-shore) by 600 km (along-shore). While these variables change regularly in nature, both within the landfast ice season, and from year to year, they are made stable for the purpose of interpreting complex under-ice current observations. This simulation yielded three simplified results. First, cross- shelf sea level slopes, due to landfast ice, may drive currents near the fast ice edge opposite to local winds. Second, alongshore differences in fast ice distribution and topography drive currents under fast ice. Third, modeled particles under landfast ice are transported from under fast ice to the open ocean.

Observational data was collected with under-ice moorings from 1999 to 2008. This data included wind speed, direction, currents (both under ice, and at the ice edge), and bottom tracking. The landfast ice season is defined as spanning from approximately mid-October through June. Whereas currents generally move in the same direction as the winds, the currents reverse and move opposite to the wind direction during periods of landfast ice. The model demonstrates that thickened ice near the edge (the Stamukhi Zone) creates a cross-shore current dynamic in which boundary currents at the surface and the base of the water column are flowing away from shore, while the middle of the column flows

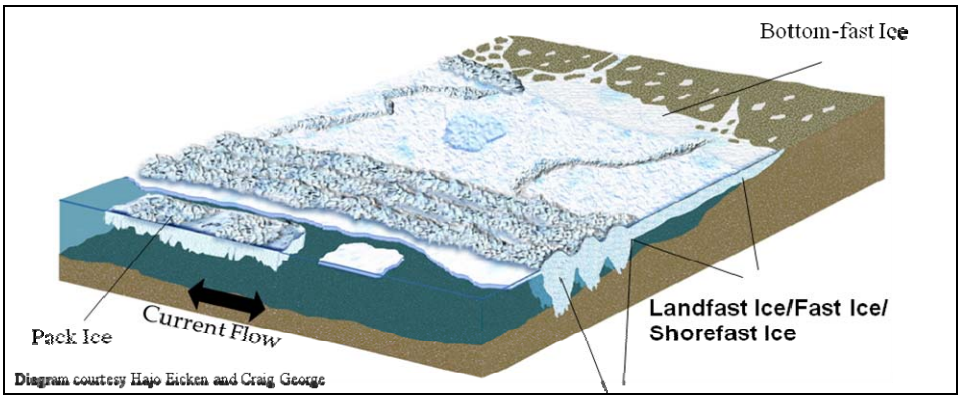

Figure 8: Diagram Showing Landfast Ice Formation in the Nearshore Zone.

toward the shore. The Coriolis force pushes water to the right, opposite the predominant winds on the ice edge. While different magnitudes and offshore profiles of fast ice can account for lack of correlation between local winds and currents under fast ice, there continues to be a correlation between sea level and winds. These unique current acts as a vehicle for particle movement from below sea ice out to the open ocean, and could allow particles, such as contaminants from an oil spill, to escape the fast ice zone.

Discussion:

Dick Prentki: Now that you've been working with your idealized system, I'd like you to picture the less idealized system where you occasionally have that landfast ice extend much further offshore to deeper water for a period of a couple of weeks or so, and what that does to the Beaufort Sea circulation.

Jeremy Kasper: I can't answer that, but we're currently working on it. I'm trying to get some models to run where I have 5 km of ice near Barrow and maybe 30, 40 or 50 km of ice offshore at the eastern edge of the boundary. Basically we think the difference in the offshore extent of the ice will cause a pressure gradient. That's about as far as I can go with that. It's a guess.

MULTI-DECADAL COUPLED SEA-ICE/OCEAN NUMERICAL SIMULATIONS OF THE BERING SEA

Katherine Hedstrom, Ph.D

Arctic Region Supercomputing Center, University of Alaska Fairbanks; Institute of Marine and Coastal Sciences/Rutgers; Institute of Marine Sciences, University of Alaska Fairbanks

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The Regional Ocean Modeling System (ROMS) has been changed to account for more specific ocean dynamics within the Bering Sea. The ROMS is a community coastal ocean model which is used by hundreds of people world-wide. It is currently in active development, with an on-line discussion forum. A vertical coordinate system that follows the local terrain is employed for best representation of near-shore processes. The model has a 10 kilometer horizontal resolution, 42 vertical layers, and data have been input for the years 1958 through 2004.

Several parameters of the system must be adjusted, including improvements to the input of freshwater at the coast, improvements to ocean stratification by adding tides and better boundary conditions, and decreasing the minimum depth to account the shallow water areas within the Bering Sea. The tides are expected to improve the vertical mixing. Currently, eight tidal components from the Oregon State tidal model are used as boundary conditions. The model is currently being compared to tide gages. Additional metrics that are being developed include float tracking, vertical stratification, flow through the passes, and comparison to moorings.

A recent simulation has yielded high-quality ice data in winter/fall when compared to satellite observations. However, the spring retreat is not timed right in the simulation. The modeling may improve if ice algae or ice sediment are added to the domain, however these improvements are more critical to the understanding of the ecosystem than to simulations of tides and ice formation. The

northeast Pacific domain is being used as the test bed as it changes the sea surface temperature that the atmosphere receives off of the coast of California.

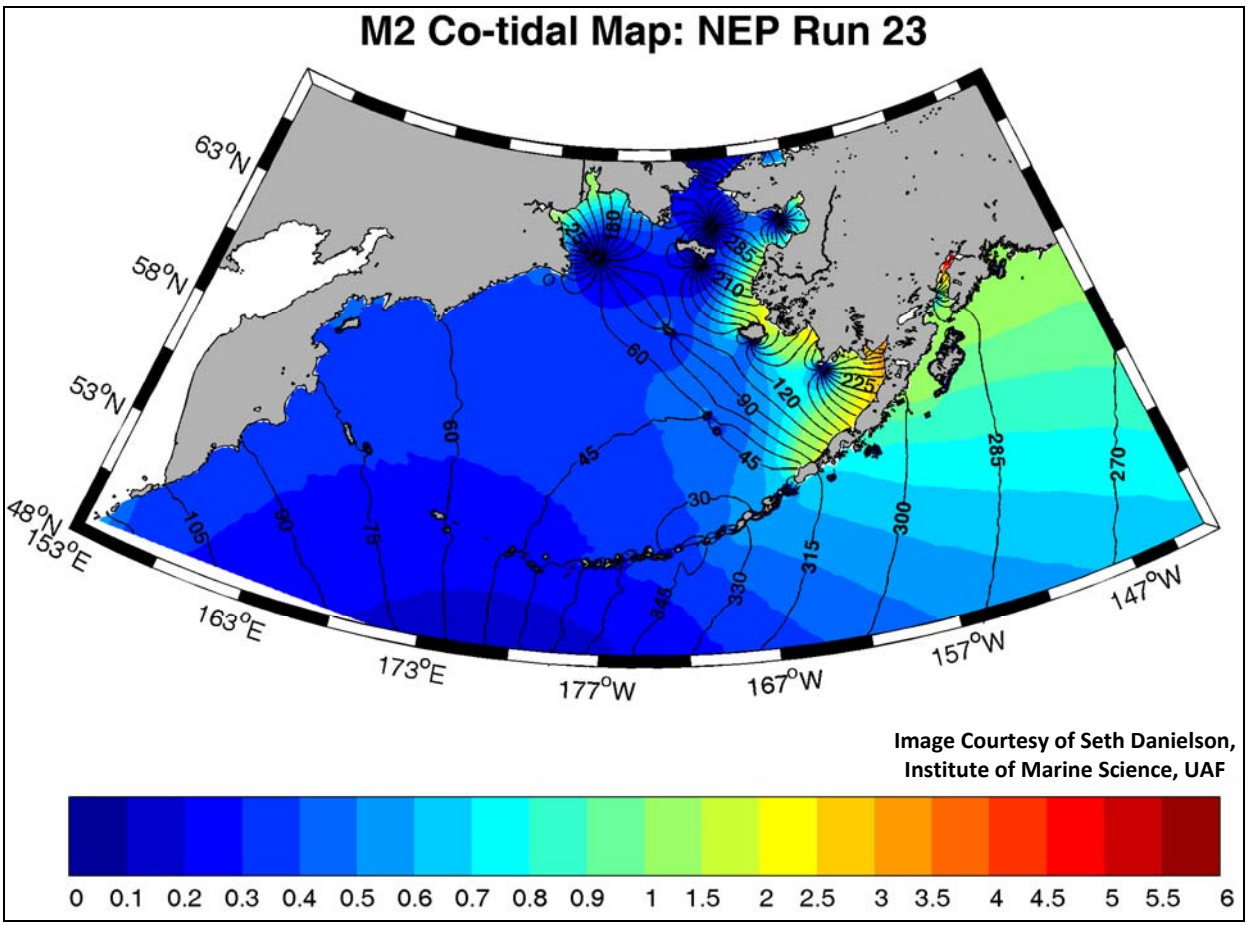

Figure 9: Simulated Co-Tidal Map of the Bering Sea.

The project may contribute to larger modeling projects by the Bering Ecosystem Study and Bering Sea Integrated Ecosystem Research Program. A proposal is under consideration for providing a multi-decadal hindcast of the ice and ocean in the Bering Sea. This project is closely coupled with an ecosystem model. There will also be a set of forecasts of the ice/ocean/ecosystem using different atmospheric estimates of the future. The ocean model is being considered for inclusion as a high resolution option within the National Center for Atmospheric Research global climate model.

No Discussion.

FATES AND EFFECTS

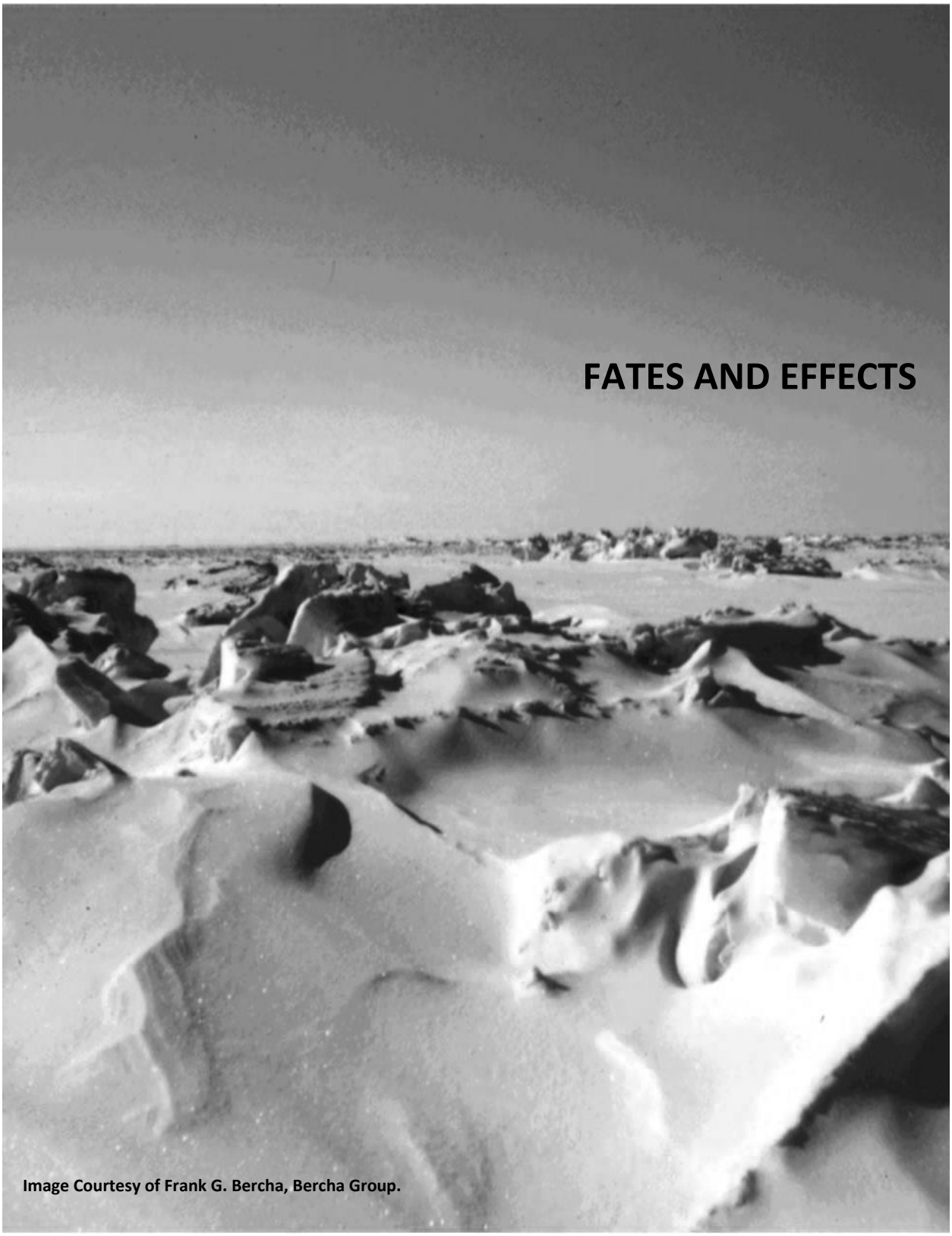

Image Courtesy of Frank G. Bercha, Bercha Group.

UPDATES TO THE FAULT TREE APPROACH TO OIL SPILL OCCURRENCE ESTIMATORS FOR THE BEAUFORT AND CHUKCHI SEA

Frank G. Bercha, Ph.D.

Bercha Group

In the absence of a large body of historical data, a method has been developed for estimating the occurrence of oil spills and their uncertainties in the Arctic using spill data from sites in other parts of the world. These data are adapted for application to the Arctic, and then placed into the Arctic-specific Fault Tree Model, a modeling method that allows one to calculate quantitative risk probabilities of events in the absence of historic data. Specific types of adaptations include specified spill causes, such as freeze-thaw effects on pipelines and strudel scour. Certain spill causes are removed from the model, such as hurricane risks, as these do not apply to the Arctic region. The Monte Carlo method is then applied to the data to generate probability distributions and to quantify uncertainties.

This model simulated oil spill risks 30-40 percent lower for the Beaufort and Chukchi Seas, when compared to non-Arctic environments. In general, pipelines have the most risks for spills, although these spills are generally small. Oil wells have the least risk, but individual spills are generally much larger. Platform spills are in-between. This trend proved true for the Beaufort and Chukchi Seas as well. Ice gouge effects dominated the oil spill causes for waters up to 20 meters deep, but these risks decrease in deeper isobaths. Pipeline spill rates were found to be up to 30 percent lower in Chukchi Sea locations, because waters in this sea are deeper than those of the Beaufort Sea. Platform spill rates were shown to be the same for both seas. Total spill rates for the Chukchi Sea and the Beaufort Sea were approximately 50 percent. Although the risks for spills in the Arctic were found to be generally lower, there is still a great potential for spills and a need for remediation planning.

Discussion:

Ben Greene: I would like to thank you both very much. Those were deeply illuminating talks and very fertile topics for consideration. I represent the North Slope Borough and the residents of coastal villages who would have the front row seats if there were to be offshore development in either the Beaufort or the Chukchi Sea. When you travel to the villages as I've done one of the first things that comes up and certainly never goes away is the potential for a catastrophic oil spill. I don't need to drive that point home because everyone has heard it over and over again. I thought it was interesting thinking about the process of trying to develop an oil spill likelihood statistic when all the data that exist come from the Gulf of Mexico. It seems like we're really considering two types of causes: causes that could occur anywhere, and causes that are unique to the Gulf of Mexico and can be dropped out of the Arctic analysis. But the third class of causes includes those that are unique to the arctic and are not considered in the Gulf of Mexico. I can think of lots of things. From my office window I look out at the Chukchi Sea and I can tell you right now it's already frozen up and that ice will continue to get thicker and thicker for the next 6 months. And it strikes me that we've been in the Gulf of Mexico for 35 years so we're talking about technologies that have become highly refined. But when we're talking about the Beaufort or Chukchi Sea, we're talking about a huge number of complete, absolute unknowns and engineering challenges that we can't even really estimate. So it seems terribly difficult to me—the

confidence interval thing seems just frightening. We're talking about environmental variables, ice, extreme temperatures, a lack of daylight, and so on. So any additional comments you have, I'd appreciate it and I'd definitely like to spend some time with the background literature that you've both provided. Thank you very much.

Ted Eschenbach: I think you've described the situation with the detail that someone who lives with it can. But I believe both the work of Frank and mine has very clearly identified those three separate things: what can happen anywhere, what can happen only in the Gulf, and what can happen only in the Arctic. I know that I certainly have said, in the report I think very clearly, that there are huge uncertainties that we are dealing with on the Arctic-specific causes. We don't yet know enough to put good confidence limits on some of that. But that's why you do more work. This work was originally funded a long time ago. It used the data that were available at the time. It developed some new methodologies that go beyond what MMS was currently doing. And now the question is; can we extend this work? I think the report that I talked about; and I'm sure Frank feels the same about his report; make an addition to what we know about modeling a very important phenomenon. Frank has done a lot more follow up work than I have, so he may have fewer unanswered questions. But I know I have a whole bunch of unanswered questions that I went very rapidly through.

Frank G. Bercha.: I think I agree with everything that you've said and everything Ted said. But I would like to amplify one area and that is of Arctic engineering experience. I've been working in the Arctic since the early 1970s, and we have done millions of dollars worth of work on these various reliability and engineering issues, like welding ice. The world has done many additional studies and designs, and one of the things you'll find in the Arctic is that designs, manufacturing, and operations are a much higher quality and reliability than there are in the gulf where there are a lot of older platforms. The database certainly reflects some of the failures of older technology. In the Arctic, this is a top notch technology and that is certainly reflected, not only in the effort that goes into it, but also into the costs. To drill a well in the Arctic costs at least 10 times as a comparable southern well. And a lot of additional precautions are taken. For example, in drilling, we have shear rams on the blow out preventers, and so on. So perhaps that puts you at a little bit of ease in regard to the findings that we had, and that is that for a comparable development in the temperate regions, the probability for spills is significantly higher. That said, the Arctic environment is much more fragile, and even an increase in reliability may not allay, and probably shouldn't allay your concerns about major spills in the Arctic. I certainly sympathize with what you are trying to say. We're both trying to report what we think is there. That's the facts of what we've come up with. We have a relatively high probability of a spill over the life of one of these developments. Industry and state workers should try to reduce that. That has not been reflected in our work.

Ted Eschenbach: Obviously when we do these models we have to base it on data. You don't want us making it up out of our heads. The data reflect a certain set of approaches, circumstances, stages of technology, maturity, et cetera. Some of the risks can be addressed during the design stage. If you are unsure about the impact of ice-keel gouging, one thing you can do is bury the pipe a little deeper. If you are unsure about the impact of strudel scour, you can monitor what's going on atop the ice and say, "gee, is there a hole that's formed at the root of the pipe? If so we can make sure there isn't much oil in the pipe right now." Some of these are operational issues, some are design issues, but there are ways of tackling the uncertainties. And in addition if you can gather more data; you can analyze it more completely.

Jim Clark: Similar to this idea, you've got to start with the historical data you've got. Congratulations on working through the assumptions. I was pleased to see that you were able to break out older historical data with more recent historical data and able to recognize that more recent operations have a different trend and the goal of industry is to continue to improve on that trend. Part of what you had said about improving technology is getting fed into the operating systems so historical data carry some bias, but getting into a whole new area; you can't address that. In the Gulf of Mexico, it's an older operating environment and there's a much broader diversity of operators there than what you see on the North Slope and what you see among the bidders for the arctic. Is the historical database large enough to separate the large bidders, who will be at the forefront of the very expensive ventures and compare that with broader industry?

Ted Eschenbach: For the statistical approach, I don't believe so. You can't take a database of 36 spills and slice it very many ways and have enough data left to be able to say a lot; which is why the starting point for the statistical approach was to use as much data as we could, generate a spill-size model and spill-cause model. We've used the 36 to generate a model; now what fraction of it applies to this particular circumstance? We wanted to look at water depth and length of the pipeline segment. It turns out that in the Gulf of Mexico, some of the data are just not readily available. Operator data wasn't something we looked at, but I don't think you can do it.

Frank G. Bercha: I don't fully agree with my colleague. I certainly can't tell you with certainty that you could do this. But I do think it would be worth a try if that was an important issue. If you had a very strong trend for onset of operators-because the information isn't in the data for which the operators were-if there was a very strong trend for one set of operators, then I guess you'd have a trend.

Ted Eschenbach: I agree with Frank, I'd love to get paid to look!

ALTERNATIVE OIL SPILL OCCURRENCE ESTIMATORS FOR THE BEAUFORT/CHUKCHI SEA OCS (STATISTICAL APPROACH)

Ted Eschenbach, Ph.D.; P.E.

TGE Consulting; Otterbein College

A statistical model has been developed for risk assessment of oil spills in the Arctic Region. The model uses data from the Gulf of Mexico and other parts of the world, and adapts the data for better statistical application in the Arctic. Spills in the Gulf of Mexico are dominated by 3,400 active platforms, representing approximately 25 percent of total United States production. The number of pipeline spills in the database was 1.33 per billion barrels of production and 0.32 platform spills per billion barrels of production. The data covered the timeframe from 1964 to 1999. Of the pipeline oil spills used in the study, 25 percent were caused by third party damage, 17 percent were caused by hurricanes, 39 percent were caused by operational or mechanical failure, 11 percent were caused by corrosion, 6 percent were caused by natural occurrences such as mud slides, and 3 percent had unknown causes.
In an effort to extract the most meaningful information for the Arctic Region, the Poisson method for goodness of fit, and the Exact Poisson method were selected to determine confidence intervals. The

data set included all spills greater than 50 barrels, allowing exploration of impacts from small spills and large ones. The causes of oil spills had to be evaluated for inclusion in this work. Some causes can happen anywhere, whereas others can happen only in the Gulf of Mexico (such as hurricanes), and finally there are causes that are unique to the Arctic that must be included in the statistical analysis. Whereas the rates of exposure in previous statistical risk assessments have been based on production (spills/number of barrels of oil pumped), the exposure rate is based on infrastructure, and a new model linking pipeline exposure to platforms was proposed, as many pipeline spills occur at the platform.

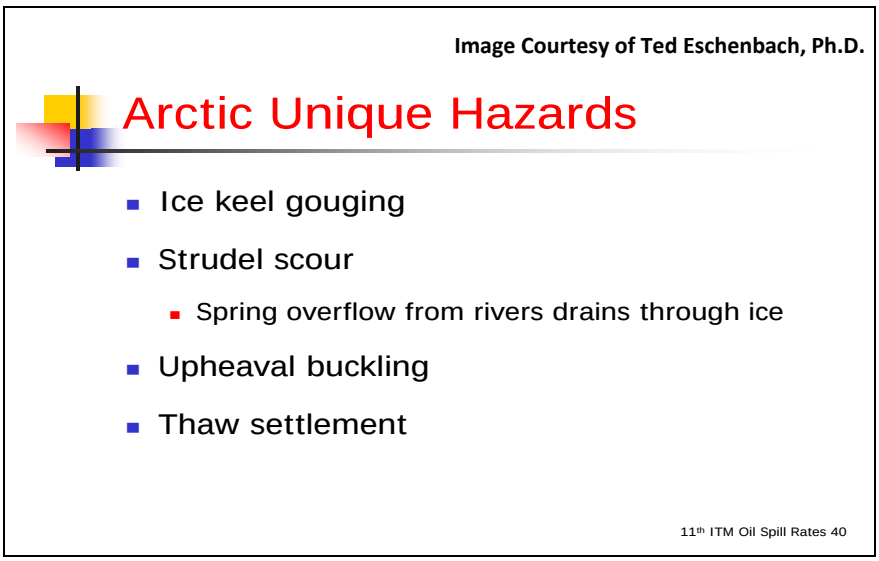

Figure 10: Arctic Unique Hazards That Have Been Proposed for Inclusion in Oil Spill Modeling.

While statistical analysis assessed the risks to be lower in the Arctic than lower latitudes, there is a glaring lack of information on factors that are unique to the Arctic Region. In particular, there is little information on the effects of ice-keel gouging, strudel scour, upheaval buckling and thaw settlement. Ice-keel gouging is believed to be a key hazard in the arctic environment, but is very difficult to evaluate because it occurs under water. Furthermore, this hazard is likely in flux due to the changing Arctic ice pack. Strudel scour is mainly a concern in 2 through 5 meters of water. Shallower than this interval and the flow is small, and deeper than this interval and the water column dissipates the force. This risk of strudel scour occurs near the mouths of rivers. Placing landfalls and pipeline corridors between river mouths can mitigate this hazard. Upheaval buckling occurs as a result of strudel scour, when the pipe is uncovered and therefore the restraining weight is reduced; thermal expansion of the pipe then occurs because of the hot oil.

No data are available concerning the thaw settlement hazard. This hazard is a gradual phenomenon so it is difficult to monitor. In the absence of a good understanding of these factors, engineering can address the hazards of thaw settlement. For instance, impacts from strudel scour can be avoided by situating the platform away from a river.

No Discussion.

Image Courtesy of the Alaska Fish and Wildlife Service: images.fws.gov

ARCTIC CISCO GENETICS AND OTOLITH MICROCHEMISTRY

Jennifer Nielsen, Ph.D.

United States Geological Survey, Arctic Science Center

Otolithic microchemistry studies were conducted on Arctic cisco (Coregonus autumnalis) in response to concerns raised by elders of the Inupiat village of Nuiqsut on the Colville River. Nuiqsut's are heavily reliant on Arctic cisco for subsistence. Nuiqsut elders are concerned that Arctic cisco abundance and size are declining, possibly in response to climate change. The decline in Arctic cisco fisheries has the potential to permanently destroy a sustainable subsistence harvest practice. It is unclear whether these changes are occurring due to changes in Arctic oscillation or changes in prey abundance. To address these concerns, researchers had to gain an understanding of this anadromous species' migration pattern, and evaluate the possibility of hybridization, environmental factors that influence fish growth, and evaluate the genetic relationship between populations in different spawning areas.

Seasonal migrations from freshwater to brackish/salt water were explored through study of the otolith, a bone in the fish ear that acts as a natural growth recorder. As the fish grows each year, the otolith gets another ring of bone containing strontium and calcium deposits from the surrounding water, the proportions of which fluctuate with different levels of salt in a water body. This bone not only provides a reliable record for fish age and size, as tested during this research program, but an accurate record of the strontium/calcium ratio that would have been present in the water during that fish's lifetime, making it possible to establish migration patterns for a single individual.

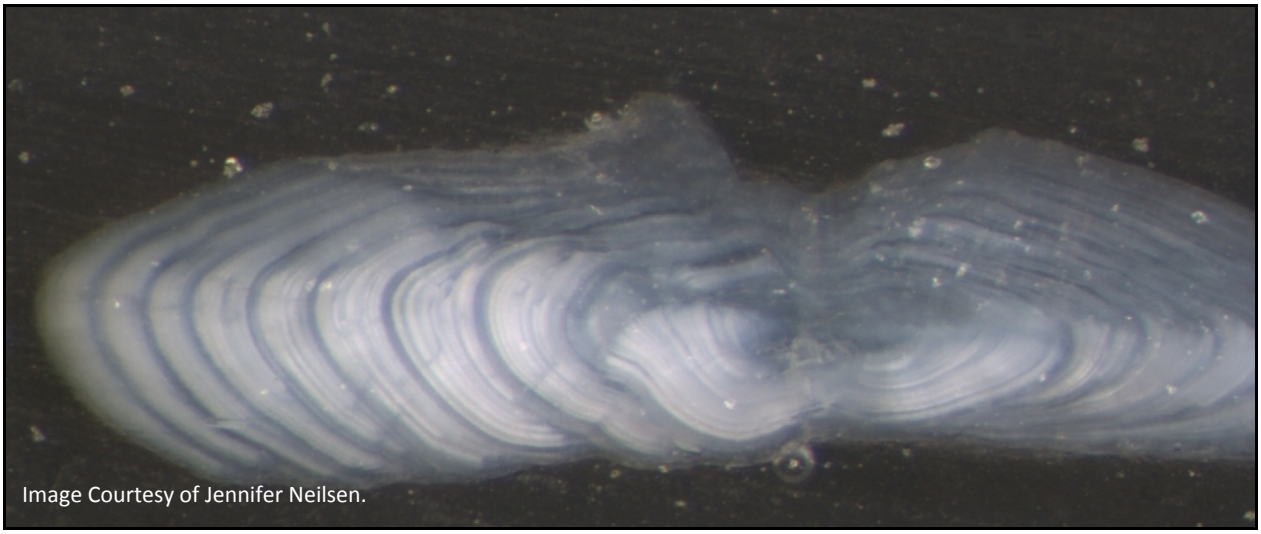

Figure 11: Otolith from an Arctic Cisco Showing Annual Growth Rings.

Residual young of the year increment size was plotted against winter Arctic oscillation, demonstrating a strong correlation between the oscillation factor and size. Positive correlations were found in similar comparisons between growth and air temperature, Easterly wind speed, and Mackenzie River Discharge. Interestingly, the influence of Mackenzie River discharge lagged fish growth by two years, indicating that

the benefits of increased discharge reach Arctic cisco when the input stimulates the lower trophic production cycle.

In terms of genetic structure, no significant genetic differences were found between Alaskan and Canadian Arctic cisco. Mitochondrial DNA (mDNA) analysis suggests that some hybridization may be occurring between cisco species in the arctic. However, this result may be the result of misidentification of a few individuals in the field. The results from the mDNA analysis will be retested with samples from 2007 field work.

In conclusion, young of the year growth in Arctic cisco populations was found to be highly dependent on the Mackenzie River discharge, easterly wind speed, temperature, and Arctic oscillation. The genetic portion of this research concludes that there are high levels of gene flow between putative spawning populations in the Arctic Red and Peel rivers, and there is similarity in the genetic structure of fish from the Colville and Mackenzie Rivers, supporting the "Mackenzie Hypothesis" that there is one population of origin for fish caught in the Colville River subsistence fishery.

No Discussion.

EPISODIC UPWELLING OF ZOOPLANKTON WITHIN A BOWHEAD WHALE FEEDING AREA NEAR BARROW, AK

Carin Ashjian, Ph.D

Woods Hole Oceanographic Institute

Dense accumulations of krill in Barrow Canyon provide excellent feeding habitat for bowhead whales. Recent research (2005-2008) indicates that there is an intimate link between wind direction and bowhead whale feeding habitat. The mechanism by which these zooplankton are brought to the Beaufort Shelf and accumulated in dense quantities remains to be understood. While the recently collected data were presented during this talk, a full analysis has yet to be conducted. The hypothesis of this research is that reversals in wind direction cause subsequent changes in ocean currents. With winds blowing predominantly from east to west, krill upwell from deeper waters onto the Beaufort Shelf east of Point Barrow. Deposits during this event are diffuse, but they are condensed when winds reverse (blowing west to east), creating a favorable feeding environment for bowhead whales.

The purpose of the recent study was to document the occurrence, frequency and persistence of wind-driven upwelling along Barrow Canyon, to document short-term and inter-annual variability in the ocean system, and to document how these are associated with the presence of bowhead whales. In order to gain a complete understanding of the oceanographic dynamics that contribute to the phenomenon of krill upwelling and accumulation, researchers had to collect pervasive data on the ocean system in the area. Oceanographic moorings were employed to record various types of data in the short-term and inter-annual intervals. The mooring equipment included hydrophones, temperature sensors and in one case, an acoustic Doppler current profiler (ADCP) for measuring velocity and acoustic backscatter. Additionally, specialized sensing equipment was also employed to measure temperature, salinity,

pressure, optical backscatter, chlorophyll and chromophoric dissolved organic matter fluorescence, nutrient and microzooplankton (conductivity, temperature, and density; and Nisken Bottles). A video plankton recorder and plankton nets were also used to collect additional data. Further analysis is also being conducted on Bowhead whale prey, by way of taking whale stomachs during subsistence whaling activities (2008-2010).

The results from the short-term moored ADCP show that the current direction corresponds directly to wind direction. Winds blew predominantly to the east until August 29, 2008, thereafter blowing toward the west. The current changed direction three days later. This trend shows that there is a direct correlation between wind and current direction, but it takes a protracted period of wind to generate a reversal in current. Current reversal corresponds with a re-distribution of backscatter on a daily basis. This trend is believed to relate to an increase of microzooplankton in the water column as a result of changes in the ocean currents.

The data show considerable changes in the physical properties of the ocean, including inter-annual variability of water masses (ice, melt water, winter water and Pacific water), with density and salinity changing rapidly from year to year. These changes reflect both a reduction in sea ice and possible influx of water from the Pacific Ocean. The years 2007 and 2008 had summers with the smallest extents of ice in the Beaufort Sea. Temperature and salinity were measured to identify different water masses. Three water body types were identified. Pacific water is warm and low in salinity. Melt water is relatively cold and fresh. Winter water is water that has remained liquid from the previous year's melt, and it is very cold and very salty.

A possible influx of Pacific water may be altering the biota in the study area. *Coccoid cyanobacteria* were found in abundance when Pacific water mass peaked in 2005. Whereas no such bacteria were found in 2006 or 2008, years in which no Pacific water was present in the study area. The presence of Coccoid cyanobacteria may be an indicator of Pacific water coming into the Arctic Ocean.

Water temperature and deep water chlorophyll levels showed a great deal of inter-annual variability, as well. Cooler water was recorded in 2006 and 2008, with correspondingly high levels of chlorophyll found in the deeper water. Warmer water and very low chlorophyll levels were recorded in 2005 and 2007. Warmer temperatures and increased chlorophyll levels at depth are thought to relate to *Chaetoceros debilis,* a phytoplankton species.

Final results from this research were not discussed during this presentation, as much of the data have not been fully analyzed. A more complete presentation and publications will be made available in the future.

No Discussion.


cANIMIDA
Image Courtesy of Gary Lawley, Kinnetic Laboratories

CONTINUATION OF ARCTIC NEARSHORE IMPACT MONITORING IN DEVELOPMENT AREA (cANIMIDA): INTRODUCTION AND OVERVIEW

Greg Durell

Battelle

cANIMIDA is a continuation of the 1999-2004 ANIMIDA Program, which provided baseline monitoring results for the vicinity of the Northstar and Liberty development sites. The monitoring period covered the pre-construction, construction, and the early production periods for Northstar. The project was designed to gather long-term monitoring data to provide a basis for evaluating potential effects from development and production in the Beaufort Sea. Studies included characterization of sediments, characterization of suspended sediments (including those from both natural sources and dispersion), partitioning of chemicals between dissolved and particulate phases, characterization of chemicals in biota (including bioaccumulation and its effects), monitoring the Boulder Patch ecosystem, and assessment of subsistence whaling. cANIMIDA was undertaken between 2004 and 2008 and included three field survey seasons and annual reporting and communication.

Specific cANIMIDA tasks included: 1) core contractor coordination and management; 2) characterization of sediments with respect to hydrocarbon and metal contamination; 3) evaluating sources, concentrations, and dispersion pathways for suspended sediments; 4) evaluating the portioning of potential contaminants between the dissolved and particulate phases; 5) conducting integrated biomonitoring of bioaccumulation of contaminants in biota; 6) monitoring the impact on the Boulder Patch ecosystem; 7) monitoring the impact on whaling and other subsistence activities on Cross Island.

Quality Assurance for cANIMIDA began with comprehensive planning documents. Rigorous quality assurance procedures were developed for both the field and the laboratory. A Senior Science Advisor and a Statistics Council were part of the quality assurance team. The work was reviewed by an independent, three-person review group.

Several organizations and contracting groups were involved in collection and dispersal of information for this project. Each group was responsible for publishing/dispersing collected information and was subject to review by an independent peer review group. cANIMIDA presented an opportunity to share and communicate on technical work that was being conducted on a range of environmental topics in the Beaufort Sea, providing venues for report publication, program meetings, conferences, and a database. With well circulated data, researchers were able to use one another's information to enhance the interpretation of their own data. Among the volumes of important, new data that were collected, Durell specifically mentions the value of information from water flow studies on the Kuparuk River to the interpretation of other subject data. These studies indicated that the majority of suspended sediments, along with most of the metals and organic constituents are carried to sea via the Kuparuk and Sagavanirktok Rivers during the 2 to 3 weeks of spring melt.

No Discussion.

cANIMIDA: HYDROCARBON CHARACTERIZATION OF SEDIMENTS IN THE cANIMIDA STUDY AREA

John Brown

Exponent; FIT; Battelle

A sediment hydrocarbon study was conducted from 1999 to 2006 as part of the cANIMIDA study. The work was initiated prior to the construction of the Northstar and Liberty Units. The objective of the study was to monitor the sediment chemistry in the area associated with the development activities of the Northstar and Liberty Units in the near-shore Beaufort Sea. Phase I (baseline sampling) of the sampling program occurred between August and September of 1999 and Phase II of the sampling program occurred in August of 2002-2004-2006. Sediment samples were collected from waters throughout the region, and in radials around each development. The sampling program was designed to provide both regional and site-specific coverage, with statistical replication. A combination of historic Beaufort Sea Monitoring Program stations was incorporated into the study.

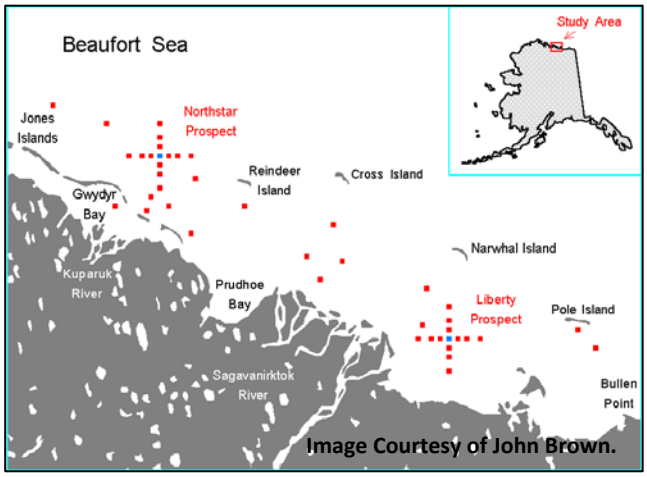

Figure 12: Plan View Map Showing the Northstar and Liberty Oil Platform Sites.

During the course of the study, more than 300 sediment samples were collected. Bottom sediments and biota were analyzed for organics including saturated hydrocarbons (SHCs), polynuclear aromatic hydrocarbons (PAHs), and chemical biomarkers (steranes and triterpanes). Bottom sediments were also analyzed for total organic carbon and sediment grain size.

The pre-construction data were used as a baseline for understanding the impacts of oil production in the Beaufort Sea in terms of the deposition of hydrocarbons into the surrounding water. The results of the baseline work yielded moderate hydrocarbon concentrations within the historical range for the region, and these hydrocarbons reflected natural background concentrations from regional sources with one noted exception. A significant increase in bulk hydrocarbon parameters (PAHs and SHCs) was observed post-construction at Northstar, with silt and clay as a covariate, but not with perylene as a covariate. Thus, a conclusion was drawn that the observed changes in the Northstar bulk hydrocarbon concentrations are likely due to natural fluctuations in hydrocarbon concentrations in the surface sediments. Sediment PAH concentrations were also found to be well below the range where adverse biological effects would be expected.

Discussion:

Paul Stang: When MMS started this program, it was to look at the Northstar and Liberty areas where MMS anticipated subsequent development. Obviously with Northstar that came to fruition. With Liberty that didn't happen. There's still no Liberty project and when it occurs, it's going to be happening

from shore with directional drilling. So in a sense, the Northstar and Liberty provide interesting contrast. In one area with data gathered before any disturbance, through construction of the island, and now after seven years of production. Is there any significant difference between data that's collected around Northstar and the data that's collected from non-production areas—anything that's significant scientifically? Secondly, if it is, is any of it potentially correlated to the development of oil and gas there or the construction of the island?

Richard Prentki: I think I can probably say that there's nothing which is environmentally significant. When it comes to statistical significance, there are a few things people have been able to see.

Jerry Neff: There are small differences in hydrocarbons and metals, sediments, biota, but the relative significance varies from year to year. Statistical differences were not environmentally important….

Paul Stang: Not environmentally significant and even though not significant environmentally, is there a correlation with the development in Northstar versus non development elsewhere.

Jerry Neff: Well as I say, some parameters are higher at Northstar than at Liberty.

Paul Stang: Correlated to the development or not, or can't you say?

John Brown: In the sediments, there's no correlation between Northstar development and increases in the concentrations in the sediments. In the statistical treatment of the sediment data, we included Liberty as a background station, but we found no differences in the multitude of statistical treatments looking for a Northstar construction effect.

John Trefry: Northstar is just a teeny blip that doesn't discharge anything. It is just a small, 7-acre footprint on the surface. In some ways it's a pleasant surprise, but not a big surprise.

Tom Newberry: Oil spills almost always stay on the surface, but diesel mixes down into the water column. How deep was that Liberty 8 station?

John Brown: If you remember John's (Trefry) presentation on anomalies, there was an anomaly that occurred year after year at Liberty 8, and that was forbearing. What we were looking at was not an oil spill, but a mud spill. We were looking at a historical diesel mud spill. To answer your question, we were going down about 4 to 5 centimeters into the sediments and finding that year after year the concentrations were getting less and less. So I think we were mixing it out.

John Goll: With regard to the two anomalies. Was that back in the days when diesel mud was used and maybe that could have been discharged. Maybe that's something we need to be looking at. What was the year you thought that signal was for?

John Brown: I wish I knew. We don't know the date for that. We didn't get a good geochronology core from that site, which is what we would need to have in order to date that. The historic record should show when the drilling activity was happening…
John Goll: and the relationship to Tern Island…

John Brown: No, it's on the other side of Liberty from Tern Island.

John Goll: But the second one, the Northstar pyrogenic signal that you said may have come from the flare. I'm trying to understand what the pathway was for that with regard to the winds, deposition of particulate matter, current. Was Northstar flaring quite a bit, or was it from one event, or was it from somewhere else?

John Brown: Let me clarify that. When we originally saw that pattern, we wondered what could be causing this because Northstar seemed to be higher than the region in the annual variability. If the pattern continued, it would look like a significant Northstar pattern. The pattern didn't continue. The other thing that's important to remember is that it's a very sensitive ratio of pyrogenic to petrogenic. And we weren't seeing the PAHs going up. In other words, we were glad to see the ratio go away because we were a little bit perplexed. We didn't have a good answer for it. If flaring from Northstar was the cause then you would expect the whole PAH concentration to go up. It didn't. The relative distribution went up and it seemed to track throughout the region and that's why, when ultimately we found year after year it settled back down, we were looking at regional variability in that ratio. I hope that made it clear. I didn't mean to suggest that we found a Northstar signature.

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cANIMIDA: TRACE METALS AS INDICATORS OF HUMAN ACTIVITIES IN THE COASTAL BEAUFORT SEA

John Trefry, Ph.D

Florida Institute of Technology; Louisiana Universities Marine Consortium; Oregon State University; International Arctic Research Center – University of Alaska, Fairbanks; Kinnetics Laboratory

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Trace metal monitoring was conducted in bottom sediments, water, suspended sediments and biota in the Beaufort Sea, as a baseline study for applications in future risk assessment research. Trace metals are present in varying concentrations throughout the ecosystem, and their concentration levels are influenced by the natural biological systems within the environment. For instance, deposits of aluminum and chromium are much higher in clay than in sand or shell deposits. When a seafloor sediment deposit contains sand, clay, and shell, trace metals will appear in a range of concentrations within the sample. As the natural influences of the ecosystem heavily influence trace metal deposits, it was critical to establish a baseline for comparison of metal deposits in order to correctly identify anthropomorphic contamination. The project was conducted continuously throughout the ANIMIDA and CANIMIDA study programs, spanning the Alaskan north coast from Harrison Bay to Camden Bay.

Metals are useful indicators of anthropogenic activity. For example, nickel-cadmium batteries are composed of 12 percent cadmium and pipe dope is composed of 30 percent lead. Metals that were studied during the CANIMIDA program include aluminum, iron, silver, arsenic, barium, beryllium, cadmium, chromium, copper, mercury, manganese, nickel, lead, antimony, tellurium, vanadium, and zinc. The presence of these metals was assessed in bottom sediments, suspended sediments, water, and biota (including clams, amphipods, fish, and caged mussels).

Prediction samples were developed from sample data from 1999-2002. These prediction intervals were used to measure changes in various metal concentrations in later sample years. Anomaly deposits, lying far outside the prediction interval, may be due to human activities. For the 2004-2006 samples, less

than 1 percent of the data points were anomalous for surface sediment samples. Equally low rates of change were found for dissolved metals and metals ingested in biota. Relatively few instances of trace metal contamination have been identified in the coastal Beaufort Sea to date. Because trace metals can be detected in extremely small concentrations, increases due to anthropomorphic activities can be identified and remediated before concentrations reach cleanup levels. However, modern analytical chemistry allows us to detect lower and lower concentrations of chemicals and we must be careful to utilize these data in the correct perspective.

Discussion:

Pamela Miller: I can just comment that at each of the oil fields on the North Slope during the initial operation of the facility, there is a very significant amount of flaring. For example at Alpine, when it started up, its amount of flaring was more than all the other North Slope fields combined in that year. So that start up event and all that discharge of waste products that would go up as a means of disposal would happen during that initial startup so you may have clusters of that information. I wonder if you looked back at the particular sites that the US Fish and Wildlife Service surveyed in a contaminant study in the lagoons back in the 1980s where they found persistent concentrations of contaminants, heavy metals, and I don't know if they did hydrocarbon analysis, after there had been intense offshore exploratory programs where there was dumping in the Arctic ocean of drilling lines.

Richard Prentki: What lagoons are you talking about?

Pamela Miller: There are a number of lagoons all along the coast in the central Beaufort Sea. It's a paper by West *et al*.

Richard Prentki: I think they found high barium at an old exploration site. John you found something at Harrison Bay…

John Trefry: Yes there are relics in Harrison Bay. I'm not sure how that ties into flaring.

Richard Prentki: She's talking about exploration sites and old drilling discharges.

John Trefry: There are certainly some scattered sites. There are a variety of papers that have shown that, if you go back and look at these old sites you'll find some higher barium and higher chromium. There are several published papers on that.

Pamela Miller: Have you done anything looking at the long term…to go back and measure those same sites.

John Trefry: Yes, last time I gave a presentation I showed a core we collected in Harrison Bay. There was a barium peak in 1989. We collected a sample in 1989 that was high in barium. When we went back in 2006 it was at 5 centimeters. When we measured the sedimentation rate, that was exactly the amount of sedimentation that should have covered it in 5 years. It's getting buried in Harrison Bay. Other places it's not getting buried. Where we can get a good geochronological record, and the sedimentation rate is at $1/10^{th}$ or $2/10^{th}$ of a centimeter per year, the old deposits are getting buried…of the couple we've seen in Harrison Bay.

cANIMIDA: INTEGRATED BIOMONITORING AND BIOACCUMULATION OF PETROLEUM HYDROCARBONS IN MARINE ANIMALS FROM THE cANIMIDA STUDY AREA

Jerry Neff, Ph.D

Neff and Associates; Battelle

Jerry Neff presents the results of a marine faunal study, addressing the question of whether chemicals associated with offshore drilling enter the Beaufort food web. To address this question, researchers sampled several species of fish, amphipods, isopods, mysids, mussels and clams from waters near Northstar and in the proposed location of the Liberty production facility. The tissues of these marine animals were tested for PAH, SHCs, sterane/triterpane (St/Tr) and 18 metals (the results for metals in biomarkers were presented separately by John Trefry, Ph.D).

The study occurred during 2004 through 2006. Only indigenous invertebrates and fish were included in the study. The study found that there are large inter-annual variations in total PAH concentrations in clams and amphipods. This variation was attributed to large natural inter-annual variability. In fact, total PAH concentrations in fish were greater in 2004 and 2006 than in 2005. Total PAH concentrations were also greater in the vicinity of Northstar in 2006. Total PAH concentrations were also found to be greater in demersal (sculpin and flounder) species than in anadromous species. The larger percentage of PAH constituents was found to be naphthalene, which provides evidence of petrogenic origin, and uptake from water. However, biomarkers in fish indicated a low overall exposure to PAHs.

Figure 13: Amphipod *Anonyx sp*.

PAHs, SHCs and St/Trs exist in nature in very low quantities, particularly from petrogenic, pyrogenic and biogenic sources, the greatest of which is likely peat from contributing river systems, such as the Coleville River. Marine animals are likely absorbing most of the PAH, SHC and St/Tr from water, as peat in freshwater streams contributes a great proportion of the naturally occurring deposits of these chemicals in water. PAH concentrations were higher in clams and amphipods than in fish. Amphipods had lower rates of PAH than clams, likely because amphipods can metabolize PAH, but clams cannot. In conclusion, there was no evidence of significantly higher concentrations of PAH, SHC, or St/Tr in marine animals in waters surrounding Northstar than in marine animals in undeveloped water.

Discussion:

Paul Stang: When MMS started this program, it was to look at the Northstar and Liberty areas where MMS anticipated subsequent development. Obviously with Northstar, that came to fruition. With Liberty that didn't happen. There's still no Liberty project and when it occurs it's going to be happening from shore with directional drilling. So in a sense, the Northstar and Liberty provide interesting contrast. In one area with data gathered before any disturbance, through construction of the island, and now after seven years of production. Is there any significant difference between data that's collected around Northstar and the data that's collected from non-production areas—anything that's significant scientifically? Secondly, if it is, is any of it potentially correlated to the development of oil and gas there or the construction of the island?

Richard Prentki: I think I can probably say that there's nothing which is environmentally significant. When it comes to statistical significance, there are a few things people have been able to see.

Jerry Neff: There are small differences in hydrocarbons and metals, sediments, biota, but the relative significance varies from year to year. Statistical differences were not environmentally important….

Paul Stang: Not environmentally significant and even though not significant environmentally, is there a correlation with the development in Northstar versus non development elsewhere.

Jerry Neff: Well as I say, some parameters are higher at Northstar than at Liberty.

Paul Stang: Correlated to the development or not, or can't you say?

Bob Perkins: With regard to petrogenic naphthalenes, I think of naphthalenes as evaporating or oxidizing quickly. Is that going a lot slower in these waters because it is cold or dark, or am I wrong that they don't go away very quickly?

Jerry Neff: Certainly the parent, naphthalene goes away very quickly. The concentrations are so low that we have a problem in the laboratory because we get naphthalene from floor polish…or who knows what! So we subtract that out when we have very low concentrations. So, some of that parent naphthalene is a laboratory artifact. But the fact is that the naphthalenes are the most abundant and that's why I interpret it as possibly from fuels, even though the Northstar crude oil has lots of naphthalene in it. The alkyl-naphthalenes go away much more slowly than the parent naphthalene. They don't evaporate as fast. Most naphthalenes go away by evaporation…just as mothballs. But I think, despite the low temperatures, you still get a significant….its probably slower than Southern Alaska or the lower 48 but it still happens.

Bob Perkins: So there's simply a lot more of them and that is why they are still there. And the alkylated will evaporate more slowly. But the fish had high concentrations of naphthalene. I would think that they would be metabolized more quickly. Perhaps the answer is the same: there are simply more of them and that's why they're there.

Jerry Neff: That's part of the answer and also that the SIP1A enzyme system appears to metabolize the higher rate molecule compounds more rapidly than the lower rate molecule compounds. And of course naphthalene doesn't so the SIP1A system in the animal can be exposed to a fair amount and not rapidly metabolize it. But if the system is induced, the naphthalenes would go slower than the higher rate compounds.

cANIMIDA: LONG-TERM MONITORING OF THE BOULDER PATCH KELP ECOSYSTEM IN THE cANIMIDA STUDY AREA

Ken Dunton, Ph.D

University of Texas at Austin; LGL Alaska Research Associates, Inc.; Institute of Marine Science – The University of Alaska - Fairbanks

Recent cANIMIDA research has been conducted on the relationship between light and the growth/development of the benthic community in the Boulder Patch in Stefansson Sound. This research was conducted over the course of ANIMIDA and cANIMIDA, using SCUBA and underwater recorders to collect information on sediment loading, light attenuation and kelp production to assess the impact of oil and gas development in the Arctic. During this work, *in situ* ambient light (PAR) and total suspended solids (TSS) were continuously monitored, kelp samples were collected annually, detailed mapping of kelp productivity variation was performed, and benthic faunal diversity was assessed. Combined with historical data, this corpus of data was used to develop the Temporal and Spacial Productivity Model, a model that predicts kelp production at seven sites based on calculated production versus irradiance curves (P:I curves). Continued research verified that kelp growth is directly related to TSS, which is a direct function of wind speed. When wind speed increases, kelp growth (incorporation of carbon) declines proportionally. During monitoring, kelp growth reached an all-time low that was directly related to a massive storm event in 2003, which generated peak TSS levels.

Specific project tasks included: 1) Define the spatial variability in annual kelp productivity and biomass; 2) Monitor incident and in situ ambient light; 3) Continue to collect baseline data on the quantitative relationship between TSS, light attenuation, and kelp productivity; 4) Measure benthic faunal community diversity; 5) Incorporate historical datasets into ANIMIDA datasets, providing a long-term record of kelp productivity, ambient light, and benthic diversity; 6) Develop a strategy for future Boulder Patch monitoring.

Biodiversity in the Boulder Patch was measured in 2005 and 2006, by identifying faunal species present within the community and estimating their total biomass. Interannual patterns in community structure were found to show no considerable variation or to possess specific site signatures. The biomass and biodiversity in the Boulder Patch, as assessed at seven dive locations, appears to remain stable from year to year.

In conclusion, increases in shoreline erosion, river discharge, cloud cover, storm activity, sustained winds, and anthropogenic disturbances associated with climate change and development could have significant impacts on kelp production and survival.

Discussion:

Tom Newberry: You've talked the last couple of years about the dense concentration of particulate matter in coastal water, and your theory was that there was a lot more production. But I think it could have been coastal erosion. Are you closer to an answer on that?

Ken Dunton: I need 10 years of data, Tom! The problem is that the variability is just so high and it is so difficult. And during that time there was the construction of Endicott. We have only 7 years of pre-Endicott data. I just don't know how to separate those out easily. With the kelp growth, there is a tremendous amount of variability that has taken place over time. It seems that there have been more intense storms—and this is something I'm working with Tom Weingartner on—have storm intensity and frequency increased over the last decade and a half? Particularly westerly events because they seem to be the ones that develop the most intense re-suspension because there is a lot more fetch associated with a westerly event. I cannot say with any certainty what the source of those materials is, or if it has changed over the last 3 decades.

ATTACHMENT I—ITM AGENDA

Minerals Management Service (MMS) Alaska OCS Region

Eleventh Information Transfer Meeting (ITM) October 28-30, 2008

Downtown Marriott Hotel, Anchorage, AK

The ITM will be held in conjunction with the United States and Canada Northern Oil and Gas

Research Forum '08. Go to link http://www.northslope.org/ for more information.

DAY 1 TUESDAY, OCTOBER 28, 2008		
7:30 am	Registration Table Open	*Forum* Main Ballroom
8:30 – 8:40 am	**Welcome**	*Forum* Main Ballroom
8:40 – 9:05 am	**Opening Remarks** (USA – Drue Pearce) (Canada – Patrick Borbey)	*Forum* Main Ballroom
9:05 – 9:15 am	**Purpose of the Forum**	*Forum* Main Ballroom
9:15 – 9:40 am	**Overview of the USA Northern Oil & Gas Activities and Research Programs**	*Forum* Main Ballroom
9:40 – 10:05 am	**Overview of Canadian Northern Oil & Gas Activities and Research Programs**	*Forum* Main Ballroom
10:05 – 10:20 am	BREAK	*Forum* Main Ballroom
10:20 – 11:20 am	**Panel: Management Research Needs and Priorities** **United States:** John Payne, Executive Director, North Slope Science Initiative John Goll, Regional Director, Minerals Management Service **Canada:** Robert Steedman, National Energy Board; Calgary, Alberta Norm Snow, Executive Director, Inuvialuit Joint secretariat	*Forum* Main Ballroom
	DAY 1 ITM SESSION BEGINS *Please move quietly to the Juneau / Haines Room*	
11:20	**Welcome to the ITM and the AK Environmental Studies Program** **Dee Williams, Ph.D., Chief, Environmental Studies Section**	**Juneau / Haines Room**
	PROTECTED SPECIES **MMS Session Chair: Charles Monnett, Ph.D.**	**Juneau / Haines Room**
11:25 – 11:40 am	**Monitoring the Distribution of Arctic Whales** Janet Clarke, Senior Biologist, SAIC Ocean Sciences Division, Buckley, Washington	**Juneau / Haines Room**

11:40 – 11:55 am	**COMIDA: Distribution and Relative Abundance of Marine Mammals: Aerial Survey** Janet Clarke, Senior Biologist, SAIC Ocean Sciences Division, Buckley, Washington	**Juneau / Haines Room**
11:55 – 12:15 pm	**North Pacific Right Whale (Eubalaena Japonica) Research in the Bering Sea** Alexandre N. Zerbini, Ph.D., National Marine Mammal Laboratory Alaska Fisheries Science Center, Seattle, Washington	**Juneau / Haines Room**
12:15 – 12:30 pm	QUESTIONS	**Juneau / Haines Room**
12:30 – 1:30 pm	**LUNCH** - Limited seating: Pre-registration and ticket are required. Host: Government of Canada Speaker **"Arctic Net"** Dr. Martin Fortier, Executive Director	*Forum* Main Ballroom
1:50 – 2:10 pm	**Creation of Leads and Ridges: What is the Ice Behavior?** Max Coon, North West Research Associates, Inc.	*Forum* Main Ballroom
2:10 – 3:10 pm	**Forum Talks** (See Forum Agenda for Details)	*Forum* Main Ballroom
3:10 – 3:30 pm	BREAK	
PROTECTED SPECIES CONTINUED		**Juneau / Haines Room**
3:30 – 3:50 pm	**Seasonal Movements, Habitat Selection, Foraging and Haul-out Behavior of Adult Bearded Seals in the Chukchi Sea** Peter Boveng, Ph.D., Program Leader, Polar Ecosystem Program, National Marine Mammal Laboratory, Seattle, Washington	**Juneau / Haines Room**
3:50 – 4:10 pm	**A Cooperative Approach to Walrus Research – Hunters and Scientists Working Together** Lori Quakenbush, Arctic Marine Mammal Program Leader, Alaska Department of Fish and Game, Fairbanks, Alaska	**Juneau / Haines Room**
4:10 – 4:30 pm	**Ringed Seals as Indicators of Change: Harvest-based Sampling near Ulukhaktok (Holman) (1992-2007) and Sachs Harbour (2003-2007), NT, Canada** Lois Harwood, Department of Fisheries and Oceans, Arctic Science Division, Yellowknife, NT, Canada	**Juneau / Haines Room**
4:30 – 4:50 pm	QUESTIONS	**Juneau / Haines Room**
4:50 – 5:10 pm	**Empirical Weathering Properties of Oil in Snow and Ice** Ian Buist, S.L. Ross Environmental Research Limited	*Forum* Main Ballroom
5:10 – 5:20 pm	QUESTIONS on Theme I	*Forum* Main Ballroom

DAY 2

WEDNESDAY, OCTOBER 29, 2008		
8:00 – 8:45 am	**USA Industry Research Priorities**	*Forum* Main Ballroom
8:45 – 9:30 am	**Canadian Industry Research Priorities**	*Forum* Main Ballroom
9:30 – 9:50 am	QUESTIONS	*Forum* Main Ballroom
9:50 – 10:10 am	**Variability in Cross Island (Arctic Alaska) Subsistence Whaling: An Examination of Natural and Anthropogenic Factors** Michael Galganitis, Applied Sociocultural Research	*Forum* Main Ballroom
10:10 – 10:30 am	**The Study of Ecosystem Services and Sharing Networks to Assess the Vulnerabilities of Communities to Oil and Gas Development and Climate Change in Arctic Alaska** Gary Kofinas, Ph.D., University of Alaska, Fairbanks	*Forum* Main Ballroom
10:30 – 10:50 am	BREAK	
	DAY 2 - ITM SESSION BEGINS *Please move quietly to the adjoining room*	
	PHYSICAL OCEANOGRAPHY **MMS Session Chair: Warren Horowitz**	**Juneau / Haines Room**
10:50 – 11:10 am	**Seasonal Variations in Circulation and Water Properties in the Nearshore Beaufort Sea** Thomas Weingartner, Ph.D., Professor, Institute of Marine Science, University of Alaska, Fairbanks	**Juneau / Haines Room**
11:10 – 11:30 am	**Ongoing and Suggested Research Efforts in Understanding the Oceanography of the Alaskan Beaufort Sea** Thomas Weingartner, Ph.D., Professor, Institute of Marine Science, University of Alaska, Fairbanks	**Juneau / Haines Room**
11:30 – 11:50 am	**Chukchi/Beaufort Seas Mesoscale Meteorology Study** Jing Zhang, Research Assistant Professor, Geophysical Institute, University of Alaska, Fairbanks	**Juneau / Haines Room**
11:50 – 12:10 pm	**Mapping Sea Ice Overflood Using Remote Sensing from Smith Bay to Camden Bay** Greg Hearon, Coastal Frontiers Corporation, Chatsworth, CA	**Juneau / Haines Room**
12:10 – 12:30 PM	QUESTIONS	**Juneau / Haines Room**
12:30 – 1:30 PM	**LUNCH** - *Limited seating: Pre-registration and ticket are required.* Host: University of Alaska Fairbanks Geographic Information Network of Alaska - Speaker: **"Arctic observation systems, current and planned"** Aimee Devaris, U.S. National Weather Service, Alaska Region, Deputy Dir., Anchorage, Alaska	*Forum* Main Ballroom
1:30 – 1:50 pm	**Forum Talks** (See Forum Agenda for Details)	*Forum* Main Ballroom

1:50 – 2:10 pm	**Populations and Sources of Recruitment in Polar Bears: Movement Ecology in the Beaufort Sea** Andrew Derocher, Ph.D., University of Alberta	*Forum* Main Ballroom
2:10 – 2:30 pm	**Satellite Tracking of the Western Arctic Stock of Bowhead Whales** Lori Quakenbush, Wildlife Biologist, Alaska Department of Fish & Game; Fairbanks, AK	*Forum* Main Ballroom
2:30 – 2:50 pm	**Bowhead Whale Feeding Variability in the Western Beaufort Sea - Feeding Observations and Oceanographic Measurements and Analyses** Carin Ashjian, Ph.D., Woods Hole Oceanographic Institution; Woods Hole, Massachusetts	*Forum* Main Ballroom
2:50 – 3:30 pm	**Forum Talks** (See Forum Agenda for Details)	*Forum* Main Ballroom
3:30 – 3:50 pm	BREAK	
	PHYSICAL OCEANOGRAPHY CONTINUED **MMS Session Chair: Heather Crowley, Ph.D.**	**Juneau / Haines Room**
3:50 – 4:10 pm	**Modeling Circulation in the Landfast Ice Zone** Jeremy Kasper, Graduate Program in Marine Science and Limnology, University of Alaska, Fairbanks	**Juneau / Haines Room**
4:10 – 4:30 pm	**Multi-decadal Coupled Sea-ice/Ocean Numerical Simulations of the Bering Sea** Katherine Hedstrom, Ph.D., Arctic Region Supercomputing Center, University of Alaska, Fairbanks	**Juneau / Haines Room**
4:30 – 4:50 pm	QUESTIONS	**Juneau / Haines Room**
	DAY 3 **THURSDAY, OCTOBER 30, 2008**	
8:00 – 8:20 am	**Timing and Location of King Eiders Staging in the Beaufort and Chukchi Seas** Abby N. Powell, Research Ecologist, U.S. Geological Survey; Fairbanks, Alaska	*Forum* Main Ballroom
8:20 – 8:40 am	**Subsistence Mapping of Nuiqsut, Kaktovik and Barrow** Stephen R. Braund, Stephen R. Braund & Associates; Anchorage, Alaska	*Forum* Main Ballroom
	DAY 3 ITM SESSION BEGINS *Please move quietly to the adjoining room*	
	FATES & EFFECTS **MMS Session Chair: Richard Prentki, Ph.D.**	**Juneau / Haines Room**
8:40 – 9:00 am	**Updates to the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Sea**	**Juneau / Haines Room**

	Frank G. Bercha, Ph.D., Ph.D., Bercha Group, Calgary, Alberta, Canada	
9:00 – 9:20 am	**Alternative Oil Spill Occurrence Estimators for the Beaufort/ Chukchi Sea OCS (Statistical Approach)** Ted Eschenbach, Ph.D., TGE Consulting; William V. Harper, Ph.D.	**Juneau / Haines Room**
9:20 – 9:40 am	QUESTIONS	**Juneau / Haines Room**
	PROTECTED SPECIES **MMS Session Chair: Terry De Bruyn, Ph.D.**	**Juneau / Haines Room**
9:40 – 10:00 am	**Monitoring Marine Birds of Concern in the Eastern Chukchi Nearshore Area (Loons)** Dan Rizzolo, Wildlife Biologist, Alaska Science Center, USGS, Anchorage, AK	**Juneau / Haines Room**
10:00 – 10:20 am	**Premigratory Movements and Physiology of Shorebirds Staging on Beaufort Littoral Zone** Abby N. Powell, Ph.D., USGS, Biological Resources Division, Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska Fairbanks	**Juneau / Haines Room**
10:20 – 10:40 am	**Radio Frequency Identification (RFID) Tags for Grizzly and Polar Bear Research** Richard Shideler, Wildlife Biologist, Alaska Department of Fish and Game	**Juneau / Haines Room**
10:40 – 11:00 am	QUESTIONS	**Juneau / Haines Room**
11:00 – 11:20 am	BREAK	
	BIOLOGY **MMS Session Chair: Catherine Coon**	
11:20 – 11:40 am	**Arctic Cisco Genetics and Otolith Microchemistry** Jennifer L. Nielsen, Ph.D., Supervisory Research Scientist, USGS Alaska Science Center, Anchorage, Alaska	**Juneau / Haines Room**
11:40 – 12:00 pm	**Episodic Upwelling of Zooplankton within a Bowhead Whale Feeding Area near Barrow, Alaska** Carin Ashjian, Ph.D., Associate Scientist, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts	**Juneau / Haines Room**
12:00 – 12:20 pm	QUESTIONS	**Juneau / Haines Room**
12:20 – 1:40 pm	**LUNCH** (On Your Own)	
	cANIMIDA **MMS Session Chair: Richard Prentki, Ph.D.**	
1:40 – 3:05 (cANIMIDA session)	**Continuation of Arctic Nearshore Impact Monitoring in Development Area (cANIMIDA): Introduction and Overview** Greg Durell, Battelle, Duxbury, Massachusetts	**Juneau / Haines Room**

cANIMIDA session continues	**cANIMIDA: Hydrocarbon Characterization of Sediments in the cANIMIDA Study Area** John Brown, Exponent, Maynard, Massachusetts	**Juneau / Haines Room**
cANIMIDA session continues	**cANIMIDA: Trace Metals as Indicators of Human Activities in the Coastal Beaufort Sea** John H. Trefry, Ph.D., Florida Institute of Technology, Melbourne, Florida	**Juneau / Haines Room**
cANIMIDA session continues	**cANIMIDA: Integrated Biomonitoring and Bioaccumulation of Petroleum Hydrocarbons in Marine Animals from the cANIMIDA Study Area** Jerry M. Neff, Ph.D., Neff and Associates, LLC, Duxbury, MA	**Juneau / Haines Room**
cANIMIDA session continues	**cANIMIDA: An Ecological Characterization of the Flora and Fauna of the Boulder Patch Kelp Community in Stefansson Sound, Alaska** Ken Dunton, Ph.D., University of Texas at Austin, Port Aransas,	**Juneau / Haines Room**
3:05 – 3:20 pm	QUESTIONS	**Juneau / Haines Room**
3:20 pm	**CONVENE BACK AT FORUM**	*Forum* Main Ballroom

ATTACHMENT II—FORUM AGENDA

United States and Canada Northern Oil and Gas research Forum: Current Status and Future Direction in the Beaufort Sea, North Slope and Mackenzie Delta

October 28-30, 2008
Marriott hotel
870 W. 7th Avenue
Anchorage, Alaska

Day 1: Tuesday, October 28, 2008

8:30 - 8:40 **Welcome**

8:40 - 9:05 **Opening Remarks**
USA:Due Pearce,Federal Coordinator, Office of the Federal Coordinator, Alaska Natural Gas Transportation Projects; Washington, D.C.
Canada: Patrick Borbey, Assistant Deputy Minister,
Northern Affairs Organization, Indian and Northern Affairs Canada; Ottawa, Ontario

9:05 - 9:15 **Purpose of the Forum (Facilitator)**
Setting the stage for the Forum
Objectives agenda and results
Key questions for consideration throughout the workshop
Expectations for wrap up session

9:15 - 9:40 **Overview of USA Northern Oil and Gas Activities and Research Programs**
Mead Treadwell, Chairman of the U.S. Arctic Research Commission; Anchorage, Alaska

9:40 - 10:05 **Overview of Canadian Northern Oil and Gas Activities and Research Programs**
Ruth McKechnie, Senior Advisor, Northern Oil and Gas Branch, Indian and Northern Affairs, Canada, Ottawa, Ontario
Natalie Shea, Science and Technology Advisor, Energy Science and Technology Programs, Natural Resources Canada; Ottawa, Ontario

10:05 – 10:20 **Health Break**

10:20 – 11:20 **Panel: Management Research Needs and Priorities**
United States: John Payne, Executive Direcotr of the North Slope Science Initiateive
John Goll, Regional Director of Minerals Management Service
Canada: Robert Steedman, National Energy Board; Calgary, Alberta
Norm Snow, Executive director, Inuvialuit Joint Secretariat

Technical Engineering

11:20 - 11:40 **Alaskan Beaufort and North Slope Solid Waste Disposal Under the UIC Program**
Thor Cutler, United States Environmental Protection Agency; Seattle, Washington

11:40 - 12:00 **Ice Engineering Issues for Beaufort Sea Development**
Garry Timco, National Research Council of Canada; Ottawa, Ontario

12:00 - 12:20 **Ice Road Construction and Recovery on Tundra Ecosystems, National Petroleum**

Reserve, Alaska (NPR-A)
Scott Guyer, Bureau of Land Management, Alaska State Office; Anchorage, Alaska

12:20-12:30 **Questions on theme 1**

12:30 - 13:30 **Lunch Hosted by the Government of Canada**
Speaker "**ArcticNet**" Dr. Martin Fortier, Executive Director

13:30 - 13:50 **Speculation on the Origin and Persistence of Thick Multi-Year Ice in the Arctic**
Humfrey Melling, Fisheries and Oceans Canada; Sidney, British Columbia

13:50- 14:10 **Creation of Leads and Ridges: What is the Ice Behavior?**
Max Coon, North West Research Associates, Inc.; Seattle, Washington

14:10- 14:30 **Materials R&D for Northern Pipelines – Integrity, Safety, and Environmental Protection in the North**
Winston Revie, CANMET Materials Technology Laboratory, Natural Resources Canada; Ottawa, Ontario

14:30 - 14:50 **Questions on theme 1**

14:50 - 15:10 **The Status of Current Technology for Oil Spill Cleanup in Ice**
Ian Buist, S.L. Ross Environmental Research Limited; Ottawa, Canada

15:10 - 15:30 Health Break

15:30 - 15:50 **Detection of Oil on and Under Ice: Phase III Evaluation of Airborne Radar System Capabilities in Selected Arctic Spill Scenarios**
John Bradford, Boise State University; Boise, Idaho

15:50 - 16:10 **The Oil Spill Recovery Institute: Present and Future Work in the Arctic**
W. Scott Pegau, Oil Spill Recovery Institute; Cordova, Alaska

16:10 – 16:30 **ERMA: A New High Resolution Environmental Data Display and Management System for Oil Spill Planning and Response**
Amy Merten, Co-Director, NOAA Coastal Response Research Center; Silver Spring, Maryland

16:30 - 16:50 **Oil Spill Preparedness, Response and Countermeasures Planning in the Arctic**
Steve Potter, S.L. Ross Environmental Research Limited; Ottawa, Ontario

16:50- 17:10 **Empirical Weathering Properties of Oil in Ice and Snow**
Ian Buist, S.L. Ross Environmental Research Limited; Ottawa, Ontario

17:10- 17:20 **Questions on theme 1**

17:20 – 18:20 **Poster Session – Meet the Authors of the Posters**
End of Day 1

Day 2: Wednesday, October 29, 2008

Industry Panel

8:00- 8:45 **USA Industry Research Priorities:Highlights of current and future development scenarios, research issues and priority areas for future research**
Pete Slaiby, General Manager, Alaska, Shell Exploration & Production Company
Geoffrey Haddad, Manager Alaska Exploration, ConocoPhillips Alaska, Inc.
Marilyn Crockett, Director Alaska Oil and Gas

8:45 – 9:30 **Canadian Industry Research Priorities: Highlights of current and future development scenarios, research issues and priority areas for future research**
Gary Bunio, VP Operations and COO, MGM Energy, Calgary
Bob Bleaney, Manager Commercial & Regulatory Affairs, ConocoPhillips Canada
Paul Barnes, Manager - Atlantic Canada, Canadian Association of Petroleum Producers

9:30-9:50 Questions

Socio-cultural/ Socio-economic

9:50 - 10:10 **Variability in Cross Island (Arctic Alaska) Subsistence Whaling: An Examination of Natural and Anthropogenic Factors**
Michael Galganitis, Applied Sociocultural Research; Anchorage, Alaska

10:10 -10:30 **The Study of Ecosystem Services and Sharing Networks to Assess the Vulnerabilities of Communities to Oil and Gas Development and Climate Change in Arctic Alaska**
Gary Kofinas, Director, Resilience and Adaptation Program, School of Natural Resources and Argicultural Sciences, University of Alaska, Fairbanks; Fairbanks, Alaska

10:30 - 10:50 Health Break

10:50 - 11:10 **Inuvialuit Community Perspective: Mackenzie Gas Project - Impacts, Planning and Mitigation**
Amanda Cliff, Inuvialuit Regional Corporation; Inuvik, Northwest Territories

11:10 - 11:30 **The Environmental Stewardship Framework in the NWT**
David Livingstone, Director, Renewable Resources and Environment, Indian and Northern Affairs Canada; Yellowknife, Northwest Territories

11:30 - 11:50 **Caribou Harvest Monitoring in the National Petroleum Reserve-Alaska: Developing Effective Future Mitigation**
Stacie McIntosh, Bureau of Land Management, Arctic Field Office; Fairbanks, Alaska

11:50- 12:10 **Social and Economic Effects in Canada's Mackenzie Delta Region from the Return of**

Oil and Gas Activity 2000-2004
Thom Stubbs, Integrated Environments Limited; Calgary, Alberta

12:10- 12:30 **Questions on theme 2**

12:30 - 13:30 **Lunch Hosted by the University of Alaska Fairbanks Geographic Information Network of Alaska**: "**Arctic observation systems, current and planned**"
Aimee Devaris, U.S. National Weather Service, Alaska Region, Deputy Director; Anchorage, Alaska

Biological Sciences

13:30 – 13:50 **Assessing the Potential Effects of Near Shore Hydrocarbon Exploration on Ringed Seals in the Beaufort Sea Region 2003-2006**
Lois Harwood, Fisheries and Oceans Canada; Yellowknife, Northwest Territories

13:50 - 14:10 **Populations and Sources of Recruitment in Polar Bears: Movement Ecology in the Beaufort Sea**
Andrew Derocher, Department of Biological Sciences, University of Alberta; Edmonton, Alberta

14:10 - 14:30 **Satellite Tracking of the Western Arctic Stock of Bowhead Whales**
Lori Quakenbush, Wildlife Biologist, Alaska Department of Fish and Game; Fairbanks, Alaska

14:30 – 14:50 **Bowhead Whale Feeding Variability in the Western Beaufort Sea – Feeding Observations and Oceanographic Measurements and Analyses.**
Carin Ashjian, Ph.D, Woods Hole Oceanographic Institution; Woods Hole, Massachusetts

14:50 - 15:10 **Seasonal Distribution of Canadian Beaufort Beluga Whales**
Pierre Richard, Research Scientist, Marine Mammal Stock Assessment, Arctic Research Division, Fisheries and Oceans Canada; Winnipeg, Manitoba

15:10 - 15:30 **Questions on theme 3**

15:30 - 15:50 Health Break

15:50 - 16:10 **Bowheads and belugas in the Alaska Beaufort and Chukchi Seas: implications of oil and gas development and climate change**
Robert Suydam, Wildlife Biologist, North Slope Borough; Barrow, Alaska

16:10 - 16:30 **Northern Marine Coastal and Ecosystem Studies, CCGS *Nahidik* Fishing Program**
Patricia Ramlal, Arctic Research Division, Fisheries and Oceans Canada; Winnipeg, Manitoba

16.30 - 16:50 **Fish Research in the Western Canadian Arctic in support of Hydrocarbon**

Development
Jim Reist, Arctic Fish Ecology/Assessment, Fisheries and Oceans Canada; Winnipeg, Manitoba

16:50 – 17:10 **Questions on theme 3**

End of Day 2

Day 3: Thursday, October 30, 2008

Biological Sciences

8:00-8:20 **Timing and location of king eiders staging in the Beaufort and Chukchi Seas**
Abby Powell, Research Ecologist, U.S. Geological Survey; Fairbanks, Alaska

8:20-8:40 **Subsistence Mapping of Nuiqsut, Kaktovik and Barrow**
Stephen R. Braund, Braund & Associates, Anchorage, Alaska

8:40-9:00 **Effects of Oil Field Infrastructure on Calf Growth and Survival in the Central Arctic Caribou Herd**
Steve Arthur, Wildlife Biologist, Alaska Department of Fish and Game; Fairbanks, Alaska

9:00 - 9:20 **Science-Based Decision Making: the Mackenzie Gas Project and Environmental Impacts on Birds**
Craig Machtans, Forest Bird Biologist, Western Arctic Unit, Environment Canada; Yellowknife, Northwest Territories

9:20-9:40 **Questions on theme 3**

Physical Sciences

9:40 - 10:00 **Seabed Geo-environmental Constraints to Offshore Hydrocarbon Development in Beaufort Sea**
Steve Blasco, Marine Environment Geoscience, Natural Resources Canada; Dartmouth, Nova Scotia

10:00 - 10:20 **Waves and Sediment Mobility in the Southeastern Beaufort Sea**
Steve Solomon, Marine Environment Geoscience, Natural Resources Canada; Dartmouth, Nova Scotia

10:20 - 10:40 **Automated Lagrangian Water Quality Assessment System (ALWAS)**
Robert Shuchman, Co-Director, Michigan Tech Research Institute, Michigan Technological University; Ann Arbor, Michigan

10:40 - 11:00 **Questions on theme 4**

11:00 - 11:20 Health Break

11:20 – 11:40 **Subsidence, Flooding, and Erosion Hazards in the Mackenzie-Beaufort Region**

Don Forbes, Marine Environmental Geoscience, Natural Resources Canada; Dartmouth; Nova Scotia

11:40 - 12:00 **Enhancement of Permafrost Monitoring in the Mackenzie Valley**
Sharon Smith, Permafrost Research Scientist, Natural Resources Canada; Ottawa, Ontario
Lois Harwood, Dept. of Fisheries and Oceans, Canadalois.harwood@dfo-mpo.gc.ca

12:00 - 12:20 **Questions on theme 4**

12:20 - 13:40 Lunch

13:40 - 14:00 **Characterization and Water Use of Alaskan North Slope Lakes**
Daniel White, Institute of Northern Engineering, University of Alaska Fairbanks and Michael Lilly, GW Scientific; Fairbanks, Alaska

14:00-14:20 **Hydrology of the Mackenzie Delta Region**
Philip Marsh, Land Use Impacts on Hydrology and Aquatic Ecosystems, Environment Canada; Saskatoon, Saskatchewan

14:20 - 14:40 **Wind and Wave Hindcasts for the Beaufort Sea**
Val Swail, Climate Data and Analysis, Environment Canada; Downsview, Ontario

14:40 - 15:00 **Regional Hydro-Climatology and Its Relationship to Northern Oil and Gas Development**
Barrie Bonsal, Climate Impacts on Hydrology and Aquatic Ecosystems, Environment Canada; Downsview, Ontario

15:00 - 15:20 **Questions on theme 4**

15:20- 17:00 Wrap Up Everyone (Facilitated)

17:00 – 17:15 Next Steps and Closing Remarks
End of Day 3

ATTACHMENT III—PRESENTER ABSTRACTS

MONITORING THE DISTRIBUTION OF ARCTIC WHALES

Janet Clarke

Science Applications International Corporation

The Bowhead Whale Aerial Survey Project (BWASP) has been ongoing in the Alaskan Beaufort Sea since 1982 and is funded by the Minerals Management Service. In 2007, management of BWASP transitioned to the National Marine Fisheries Service-National Marine Mammal Laboratory. The objectives of BWASP include 1) determining the timing and location of the annual fall migration; 2) monitoring temporal and spatial trends in the migration; and 3) abundance and behaviors of whales relative to environmental parameters. Other marine mammals, including belugas, polar bears, gray whales and pinnipeds, are also documented. The study area, ranging from 140ºW to 157ºW between shore and 72ºN, is subdivided into twelve survey blocks. These blocks are surveyed using randomly selected survey lines, one per each 30 minutes of longitude. A DeHaviland Twin Otter with increased flight range (up to 8.5 hours) is used for safe and effective survey coverage. Flight altitude was generally 1,000 to 1,500 feet, and air speed was near 110 knots. In 2008, the BWASP survey season was prepared to start on 31 August, with the first flight occurring on 5 September. Surveys will continue until 20 October, weather permitting. Preliminary information to date (14 October) includes 127 sightings of 272 bowhead whales during 76.9 total survey hours; 65 sightings of 120 bowheads have been seen during transect survey effort totaling 47 hours and 9,600 kilometers. Fifteen bowhead calves have been seen; all were sighted during subsequent circling after an initial sighting of an adult bowhead was made. There have also been two sightings of two gray whales, five sightings of 15 belugas, 21 sightings of 95 polar bears, and numerous pinnipeds sightings (most of which cannot be identified to species due to the altitude of the aircraft). Most of the polar bears (n=78) were sighted on Cross Island on five different occasions and it is likely at least some are repeat sightings. Environmental conditions in 2008 were similar to those observed in 2007, with completely ice-free waters throughout the survey area and the multi-year pack ice well north of the study area. Preliminary flight summaries are posted daily on a website maintained by the National Marine Mammal Laboratory (http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php) to allow for rapid dissemination of information to interested parties.

COMIDA: DISTRIBUTION AND RELATIVE ABUNDANCE OF MARINE MAMMALS: AERIAL SURVEY

Janet Clarke

Science Applications International Corporation

The Chukchi Offshore Monitoring in Drilling Areas (COMIDA) aerial surveys commenced in summer 2008, and are the first broad-scale aerial surveys to be conducted in the northeastern Chukchi Sea since autumn of 1991. The project is funded by Minerals Management Service and managed by the National Marine Fisheries Service-National Marine Mammal Laboratory. The objectives of COMIDA Aerial Surveys include providing data to be used in estimating distribution of cetaceans and pinnipeds within the Chukchi Sea Planning Area and documenting areas of importance for specific behaviors such as calving/pupping, feeding, migrating and hauling out. The study area, encompassing the region from 68°N to 72°N and from shore to 169°W, is currently subdivided into 10 survey blocks. These blocks are surveyed using randomly selected survey lines, one per each 30 minutes of longitude. A DeHavilland Twin Otter with increased flight range is used for safe and effective survey coverage, and a laptop computer is used to record data quickly and efficiently. Surveys were conducted from 16 June-7 July (COMIDA1) and 3-26 August, 2008 (COMIDA2); a third survey period (COMIDA3) is currently underway and will finish on 10 November. The following results are preliminary, as final results will not be available until the field season ends. During COMIDA1, a total of 35 hours of survey was conducted, of which 17.7 hrs were on transect. Marine mammals seen included gray whales (nine sightings of 30 whales), belugas (five sightings of 63 whales) and walrus (48 sightings of 288 animals). The most notable sighting was a fin whale at 69.23N, 165.68W, which is the farthest known documented fin whale sighting on record. The sea ice edge during most of COMIDA1 was ~70.5N, with 40-100 percent broken floe ice north of there. During COMIDA2, substantially better survey conditions prevailed allowing for greater survey coverage. A total of 57.6 hours of survey was conducted, of which 26.3 hours were on transect. Marine mammals seen included a single bowhead, gray whales (86 sightings of 183 whales), likely gray whales based on presence of well-defined mud plumes (27 sightings of 31 whales), belugas (one sighting of 4 whales), walrus (144 sightings of 5,705 animals) and polar bears (17 sightings of 17 animals). Sea ice conditions during COMIDA2 had changed remarkably since the previous surveys ended one month prior. Broken floe ice was still present in the northern areas of the study area, but percentages ranged more often from 10-50%. Preliminary flight summaries are posted daily on a website maintained by the National Marine Mammal Laboratory (http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php) to allow for rapid dissemination of information to interested parties.

NORTH PACIFIC RIGHT WHALE (EUBALAENA JAPONICA) RESEARCH IN THE BERING SEA

Alexandre N. Zerbini, Phillip J. Clapham, Catherine Berchok, Amy Kennedy, Brenda Rone and Mark Baumgartner

National Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA Fisheries, Biology Department, Woods Hole Oceanographic Institution

The North Pacific right whale (*Eubalaena japonica*) was once abundant and widely distributed throughout the North Pacific. The eastern population is arguably the most endangered stock of whales in the world. Although there are currently no estimates of abundance, the extreme rarity of sightings in recent decades suggests that the population numbers in the tens, the result of extensive historical whaling in the 19th century, followed by large illegal catches by the USSR in the 1960s. Little is known about the distribution, movements, migrations or habitat use of this population, but the scant existing data suggest that it now occupies a reduced range compared to historical times, when right whales were clearly widely distributed across the Gulf of Alaska and Bering Sea. Research on eastern North Pacific right whales has been sporadic and poorly funded. An inter-agency agreement between the National Marine Fisheries Service and the Minerals Management Service was developed to support a comprehensive program of surveys for a period of three years (2007-2009). This research includes ship-based and aerial surveys, passive acoustic monitoring, photo-identification, genetic sampling, satellite tagging, habitat characterization and foraging ecology studies. This research program has been providing much-needed baseline data about the distribution, movements and migration, and ecology of the right whale, both in general and with respect to the planned oil and gas development activities in the North Aleutian Basin. A vessel survey conducted in August 2007 found no right whales in the southeastern Bering Sea, a result that was likely linked to cold-pool effects on prey distribution. In contrast, right whales were found within their critical habitat during ship and aerial surveys conducted in July-September 2008. Photo-identification data and biopsy samples were collected and one satellite transmitter was deployed. In addition, important information on acoustics and oceanographic habitat was obtained. This presentation will provide an overview of the 2008 surveys and will describe their preliminary results.

SEASONAL MOVEMENTS, HABITAT SELECTION, FORAGING, and HAUL-OUT BEHAVIOR OF ADULT BEARDED SEALS IN THE CHUKCHI SEA

Peter L. Boveng, Ph.D and Michael F. Cameron

National Marine Mammal Laboratory, NOAA Alaska Fisheries Science Center

Bearded seals (*Erignathus barbatus*) are one of the most important subsistence resources for the native people of coastal northern and western Alaska, as well as key ecological components of Arctic marine ecosystems, yet relatively little is known of the seals' numerical abundance, seasonal distribution, movements, and foraging behaviors. Ice-associated seal populations may be negatively impacted by offshore oil and gas development as well as by climate change. Our ability to predict impacts, however, is limited by inadequate knowledge of seal population structure and foraging ecology. By working cooperatively with Alaska Native subsistence hunters we will develop methods for capturing live adult bearded seals in the Chukchi Sea and fitting them with satellite-linked data recorders (SDRs). SDRs provide data on a seal's location, and on the timing and depths of its dives. These data can be analyzed to: 1) provide haul-out correction factors for existing abundance and distribution sightings surveys, 2) assess the seasonal movements, distribution, and diving/foraging behavior, and 3) identify and determine the priority of importance for specific marine habitats associated with key bearded seal life history events such as whelping, breeding, foraging, and molting.

This project is being conducted in two phases. The objectives of the first (current) phase include: 1) to work with Alaska Native communities to identify local interest and priorities for research questions that could be addressed through satellite telemetry, 2) to identify the locations and seasonal timing of particular situations with the most promise for encountering and capturing bearded seals, 3) to work with Alaska Native partners and scientific colleagues on development and refinement of techniques for capture and safe handling of subadult and adult bearded seals, and 4) to refine the study plan for the field portion (second phase) of the study. Initially, the first two of these objectives are being pursued individually with communities to identify local interest and prepare for a workshop on the latter objectives.

The project has been introduced and discussed at meetings of the Alaska Native Ice Seal Committee and the North Slope Borough Fish and Game Management Committee. Additional discussions about possible collaborations have been held with Alaska Native colleagues in Kotzebue and Gambell. Follow-up meetings in North Slope communities, Kotzebue, and on St. Lawrence Island are being planned to further develop the prospects for a successful workshop. A site in the Gulf of Anadyr has been identified where adult bearded seals haul out and are very approachable on land during July and August; this situation could facilitate development of methods for restraint and handling of adult seals, as well as providing opportunities to track seals that are known to inhabit Russian waters for at least part of the year. New methods for capturing and handling bearded seals are being explored, based on modifications of methods used for other large marine mammals such as Steller sea lions, beluga whales, and narwhals.

A COOPERATIVE APPROACH TO WALRUS RESEARCH—HUNTERS AND SCIENTISTS WORKING TOGETHER

Lori Quakenbush, P.I.

Affiliate Assistant Professor, Institute of Marine Science, University of Alaska, Fairbanks, and Alaska Dept. of Fish and Game, lori.quakenbush@alaska.gov

Pacific walruses (*Odobenus rosmarus*) are an important subsistence and cultural resource for coastal people of western Alaska and they are an important component of the Bering and Chukchi Seas ecosystem. Walruses winter together in the Bering Sea, however; sub-adults and females with dependent young summer in the Chukchi Sea while most adult males remain in the Bering Sea. The rapid retreat of sea ice in recent years is changing walruses summer habitat and may be changing their summer distribution and haulout behavior, requiring that walruses haul out on land instead of ice. Oil and gas activity has recently increased in the Chukchi Sea and may compound the impact to walruses elevating the importance of understanding walrus movements, feeding behavior, and habitat requirements necessary of the conservation and management of the species. Satellite transmitters placed on walruses near the communities of Little Diomede, Wales, Nome, King Island, Point Hope, Point Lay, Wainwright, and Barrow in spring would provide information on migration route, speed of travel, feeding areas and haulout behavior. Working cooperatively with the Eskimo Walrus Commission and walrus hunters from these communities, we are designing a study to deploy satellite transmitters and conduct counts and observations on haulouts that are encountered near villages in spring and fall. These data will provide information that will help identify important habitats. The study is designed to involve walrus hunters and other local people in walrus research without interfering with subsistence walrus hunting activities.

RINGED SEALS AS INDICATORS OF CHANGE: HARVEST-BASED SAMPLING NEAR ULUKHAKTOK (HOLMAN) (1997-2007) AND SACHS HARBOUR (2003-2007), NT, CANADA

Harwood, L.A., J. Alikamik, and H. Melling

Dept. of Fisheries and Oceans, Arctic Science Division, Dept. of Fisheries and Oceans, Institute of Ocean Sciences

The ringed seal (*Phoca hispida*) has a circumpolar distribution, and is the most abundant pinniped in the Arctic Ocean. They are reasonable indicators of ecosystem productivity due to their position near the top of the food chain. They are ubiquitous and important prey of polar bears (*Ursus maritimus*), and as such, changes in seal distribution and abundance can have long-term survival consequences for polar bears. Ringed seals are a valued subsistence resource by the subsistence harvesters. Past research on ringed seals of the Western Arctic revealed downward trends in seal abundance, reduced ovulation rates among mature females, reduced pups in the subsistence harvests, and reduced number of birth lairs in association with heavy ice during the winter/spring of 1974/1975.

Long-term, consistent sampling and measuring of ringed seals taken in the subsistence harvests, by the same monitor each year (John Alikamik), is the cornerstone of this program. The data have revealed changes in seal body condition and reproduction that appear to be linked to changing ice conditions. The parameters examined in this study at two community sites in the Canadian Arctic included: ovulation rate of adult females, proportion of pups in the subsistence harvest, year class strength, body condition (blubber thickness, body mass index) of harvested seals, and the recording of unusual observations and events by harvesters.

During years with a longer open water period ('light' ice years), such as 1998, 2001, 2006 and 2007, ringed seals were in better body condition than in other years in the data series, and pup production and ovulation rates were high. The opposite was the case in 'heavy' ice years (e.g. 1974, 2005). The mechanisms are not clearly understood, but appear related to the influence of timing of break-up of the sea ice on primary and secondary production, and thus the quality and quantity of seal prey items. Funding for the Ulukhaktok site was provided by the Fisheries Joint Management Committee (FJMC) since the program's inception in 1992. Funding for the Sachs Harbour site was provided by the US Minerals Management Service and the FJMC.

MONITORING MARINE BIRDS OF CONCERN IN THE EASTERN CHUKCHI NEARSHORE AREA (LOONS)

Daniel J. Rizzolo and Joel A. Schmutz

USGS Alaska Science Center

Yellow-billed Loons (*Gavia adamsii*) and Red-throated Loons (*G. stellata*) are species of waterbird which spend the majority of their annual cycle on marine habitats, moving inland only to nest on lakeshores during the summer months. Both species are currently of conservation concern: the Red-throated Loon due to population decline, and the Yellow-billed Loon due to small population size and limited range. Despite the reliance of these species on the marine environment, little is known regarding where and how they use marine habitats. Both Red-throated and Yellow-billed loons are migratory and individuals nesting along the Arctic Coast of Alaska must move through the Chukchi Sea during spring and fall migrations. Additionally, both species are long-lived with prolonged non-breeding juvenile periods and little is known of the movements and habitat requirements of non-breeding birds. Further, during the summer, nesting Red-throated Loons feed themselves and provision their young from nearshore marine areas, unlike other species of loons that feed primarily from their nest lake.

Better understanding of how these loons use the marine environment is relevant to how exploration and development of oil and gas resources may proceed in the Chukchi Sea. To address this data gap, we began an effort in the summer of 2008 to deploy satellite radio tags on adults of both species (Red-throated Loon n=3, Yellow-billed Loon n=8) nesting along the Arctic Coast. Satellite radio tags were also deployed on Red-throated Loon chicks (n=5) to document movements of juvenile birds. Additional tags (n=15) will be deployed on both species in 2009 and 2010; these data will augment information from the few individuals of these species that have been satellite-tagged in previous studies. Patterns emerging from the sum of data from satellite-tagged loons reveal that virtually all locations have been within 20 miles of the coast, with most closer than 10 miles. During spring and fall migrations, individual loons

used Chukchi Sea habitats for periods ranging from a few days to more than a month. Red-throated Loons initiated fall migration about a month earlier than Yellow-billed Loons, and time of departure from breeding sites was generally related to the amount of time loons used coastal marine habitats in northern Alaska before migrating longer distances. By the end of the study, the sample of satellite tagged birds should be sufficient to begin to relate loon locations to marine habitat features. In addition to satellite telemetry, studies of nesting Red-throated Loons were also initiated in 2008 to better understand how this species uses marine resources during the breeding season. Body condition was measured and time-depth recording tags were deployed during incubation and chick rearing periods. These data will elucidate the energetic demand associated with the marine foraging behavior in this species and are relevant to understanding how their dependence on marine resources may be associated with their numeric decline.

DISTRIBUTION AND MOVEMENTS OF STAGING SHOREBIRDS ON ALSAKA'S NORTH SLOPE

Audrey R. Taylor, Abby N. Powell, Ph.D, and Richard B. Lanctot

Department of Biology and Wildlife, U.S. Geological Survey Alaska Cooperative Fish and Wildlife Research Unit , UAF, U.S. Fish and Wildlife Service Office of Migratory Bird Management

Shorebirds, collectively, are the most abundant birds on the North Slope of Alaska, but prior to this study substantial knowledge gaps existed with respect to distribution, species/age composition, timing of use (phenology), and movement patterns during migration staging. This information is essential for evaluating the potential impacts of industrial development and environmental change to this important species group. We conducted aerial surveys from 2005-2007 to examine the distribution of staging shorebirds along the Chukchi and Beaufort coasts of northern Alaska. We also collected data on species/age composition and staging phenology at six field camps located at Kasegaluk Lagoon; Peard Bay; Barrow; and the Colville, Sagavanirktok, and Okpilak river deltas. Camps were operational between late July and early September in 2005 and 2006 (except Kasegaluk which was active in 2006 only). Data were collected by repeatedly surveying transects distributed throughout a 10-km study area throughout the staging period. In addition, we deployed radio transmitters on five species of shorebirds (semipalmated sandpipers, dunlin, western sandpipers, red phalaropes, and red-necked phalaropes) captured at several locations during the breeding season as well as at our six field camps during postbreeding. These birds were monitored within and between sites using manual and remote telemetry methods to estimate length of stay, and to describe movement patterns of shorebirds to and between staging areas. The distribution of shorebirds across surveyed coastal areas was non-uniform: higher bird abundance occurred at Peard Bay, Elson Lagoon, bays near Cape Simpson, Pogik Bay, and near Beaufort Lagoon. Semipalmated sandpipers, dunlin, and red-necked phalaropes were common at all six field camps; western sandpipers and red phalaropes were common at field camps in the western part of the study area but generally not present in the east. Of these five more common species, semipalmated sandpipers exhibited the earliest peak of abundance (1-3 August along the Chukchi Sea coast; 4-6 August along the Beaufort Sea coast). Dunlin and western sandpipers peaked in abundance later in the staging period, and their peaks were more protracted. Adult shorebirds of all species tended to leave staging areas on the North Slope earlier than juveniles. Of the less common species we observed at the field camps, long-billed dowitchers were more common along the Chukchi coast whereas stilt sandpipers and American golden-plovers and black-bellied plovers were more common

along the Beaufort coast. Pectoral sandpipers were present in small numbers at all camps, while Baird's sandpipers, ruddy turnstones, and semipalmated plovers were mostly observed in Barrow. Shorebird species diversity was generally higher at Beaufort Sea coastal locations than at Chukchi Sea locations. Species differed in the length of time radio-equipped shorebirds remained at staging areas after capture (ca. time to departure). Times to departure were ~4.3 days for semipalmated sandpipers, ~4.5 days for red and red-necked phalaropes combined, ~7.9 days for western sandpipers, and ~12.9 days for dunlin. Radio-equipped shorebirds moved widely across the ACP during the staging period, thus concentrations of birds at a given staging location may represent birds from beyond the local breeding community. Semipalmated sandpipers tended to move north and east along the coast, whereas dunlin moved southwest along the Chukchi toward western Alaska. Our research will help pinpoint where and when environmental change and industrial expansion may have the most impact on staging shorebird populations, and may be useful for development of a long-term monitoring program for Alaska's shorebirds.

RADIO-FREQUENCY IDENTIFICATION (RFID) TAGS FOR GRIZZLY AND POLAR BEAR RESEARCH

Richard Shideler, Co-P.I., Lori Quakenbush, P.I., Geoffery York, Co-P.I.

Alaska Dept. of Fish and Game, Institute of Marine Science, U.S. Geological Survey

Grizzly bears (*Ursus arctos*) and polar bears (*Ursus maritimus*) are important species for subsistence communities along the Beaufort Sea coast for food, fur, and for their cultural importance. Both species are also important components of Arctic terrestrial, nearshore, and marine ecosystems, which are changing rapidly due to changes in climate. Much of our current knowledge about bear populations, habitat use, movements, and interactions with oil and gas activities on the North Slope has been the result of repeated observations of telemetrically collared bears (VHF and satellite). For polar bears in particular, much of the information comes from females and subadults because adult male bears have a low retention rate for collars due to their neck anatomy. Application of existing and emerging Radio Frequency Identification (RFID) technology, currently used for military and commerce, has the potential to significantly increase the sample size of marked bears by decreasing the cost and providing a way to mark male bears. The goal of this research and development project was to test the feasibility of the RFID system for grizzly and polar bear research and management by modifying the tags so they could be attached to bear ears and by modifying the reader and antenna system for use in aircraft and land vehicles. RFID tags were placed on 52 polar bears and 22 grizzly bears in 2006 and 20 polar bears in 2007. Signals from tags were received from ~400 m at ground level and up to 1.6 km from an aircraft at 1000 m elevation. Although RFID range exceeded our expectations, tag retention, especially for females with dependent young, was a major limitation. Recommendations for potential future applications include subcutaneous implantable RFID tags.

SEASONAL VARIATIONS IN CIRCULATION AND WATER PROPERTIES IN THE NEARSHORE BEAUFORT SEA

Thomas Weingartner, Ph.D

Institute of Marine Science, University of Alaska Fairbanks

This talk provides an overview of seasonal variations on the inner shelf (inshore of the ~20 m isobath) of the Alaskan Beaufort Sea. The seasonality is driven by the annual thaw/melt cycle, which modifies the influence of the predominantly along-shelf (and upwelling-favorable) winds and river runoff. For up to 8 months (October-May) of the year a nearly immobile lid of landfast ice covers the inner shelf thus inhibiting the direct influence of the wind on mixing and circulation. Hence, the underice circulation is weak and appears to be a response to offshore winds, underice friction, and perhaps, spatial variations in the offshore extent of the landfast ice. In June, the inner shelf remains ice-covered but receives a large, impulsive influx of river runoff. The river discharge strongly stratifies the inner shelf and creates underice river plumes whose dynamics are likely influenced by frictional contact with the ice cover and a surface buoyancy flux from the melting ice cover. By late June the ice retreats from the coast, so that winds directly affect the inner shelf. However, the wind-driven response is substantially altered by the stratification. Moreover, the accumulation of freshwater from ice melt and runoff, along with relatively weak winds, likely results in energetic mesoscale motions associated with frontal instabilities. By mid-September, strong storm winds force vigorous along-shelf flows that can easily replace the volume of the inner shelf prior to the onset of the landfast ice. Consequently, storm winds are probably instrumental in establishing the water mass properties on the inner shelf at the onset of the landfast ice season.

ONGOING AND SUGGESTED RESEARCH EFFORTS IN UNDERSTANDING THE OCEANOGRAPHY OF THE ALASKAN BEAUFORT SEA

Thomas Weingartner, Ph.D, Robert Pickart

Institute of Marine Science, University of Alaska Fairbanks, Woods Hole Oceanographic Institution

This talk provides an overview of existing studies and suggestions for future research directions on the physical oceanography of the Alaskan Beaufort Sea (ABS) shelf in terms of needs pertinent to offshore marine industrial development and discusses some of the technologies and collaborative efforts being applied to or suggested for the future. The ongoing and suggested efforts focus on issues pertinent to forcing along the boundaries if the BS and include:

1. circulation and exchange between the landfast and pack ice influenced portions of the ABS;
2. river plumes and ice melt as these affect stratification, frontal formation, mesoscale variations, the wind-forced response of the shelf, and under ice flows:
3. inflow of Chukchi Sea waters onto the western ABS;
4. forcing along the continental shelfbreak and slope;
5. interannual variability;
6. the surface wind field;

7. the influence of the Mackenzie River and shelf on the eastern ABS;
8. thickness distribution and motion, and;

Ongoing moored and shipboard hydrographic programs are making progress on the first five issues, while a combined modeling and retrospective data analysis effort is examining the surface wind field. However, substantial gaps remain with respect to year-round current measurements in the western ABS and detailed measurements of the spreading and mixing of under-ice river plumes. Future studies need to consider how the Mackenzie River and shelf influence the ABS; an influence that is likely large and persistent. Progress in understanding the dynamics of the landfast ice zone and its interaction with the pack ice is hampered by a lack of information on the thickness distribution and motion of ice in these areas. Moreover, there appears to be a dearth of theoretical guidance on the dynamics of the landfast ice zone and how this is shaped by the pack ice.

Several promising technologies are being applied to the existing studies including the use of autonomous underwater vehicles (AUVs), profiling moorings, ice-profiling sonars, and sea ice deformation derived from satellite measurements. We suggest that rapid progress on the seasonally- and spatially-varying ice thickness distribution of the ABS could be achieved with a helicopter-mounted electromagnetic sensor and laser altimeter.

The ongoing efforts are being pursued collaboratively with several federal and state agencies and the oil industry. Future efforts should continue this collaboration and build upon mutual interests in many of these topics with the government and scientific institutions of Canada.

CHUKCHI/BEAUFORT SEAS MESOSCALE METEOROLOGY STUDY

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Arctic Region Supercomputing Center, Geophysical Institute, UAF

Oil development in the Chukchi/Beaufort Seas is accompanied by the potential threat of oil spills. It is therefore of critical importance to be able to predict dispersal and movement of oil spills, and to assess the potential impacts on the environment if a spill should occur. Surface wind, primarily determined by prevailing local weather patterns and prominent underlying geographic features, is a crucial parameter for assessing and predicting dispersal and movement of oil spills. As such, the U.S. Department of the Interior, Minerals Management Service (DOI/MMS) has initiated and sponsored an environmental study of the Chukchi/Beaufort Seas mesoscale meteorology, specifically the surface wind, aiming to ensure accurate simulation and prediction of ocean and sea ice circulation and correct assessment of oil spill risk.

The Chukchi/Beaufort region comprises a complex geographical environment, largely covered by sea ice on a seasonal basis over the ocean and bounded by the Brooks Range in the south on land. The complex orographic effects caused by the Brooks Range, along with Arctic sea breeze effects due to the land-sea ice/ocean thermal contrast along the coast, significantly complicate mesoscale weather systems and associated surface winds in this region. In this study we have investigated these mesoscale features of the Chukchi/Beaufort Seas surface winds through data analysis and numerical model simulations.

Numerical simulations for a domain encompassing the Chukchi/Beaufort region with a 10-kilometer resolution have been performed with the Weather Research and Forecasting (WRF) model. The model's performance in simulating the Chukchi/Beaufort Seas wind field was analyzed against observations, with emphasis placed on evaluating the capabilities of WRF in simulating the sea breeze and topographic effects. Overall, the model performed reasonably well in estimating the surface winds as well as capturing the timing of the wind shifts and the magnitude of the surface wind speed. The capability of the WRF model in simulating the sea breeze-influenced surface wind fields for the study areas was confirmed. The topographic effects of the Brooks Range were found to exhibit complicated impacts under different types of weather systems. There were also found to be strong interactions between the sea breeze circulation and the Brooks Range.

MAPPING RIVER OVERFLOOD ON SEA ICE USING REMOVE SENSING—SMITH BAY TO CAMDEN BAY

Greg Hearon and David Dickins

Coastal Frontiers Corporation and D.F. Dickens Associates, LLC

River overflood on the sea ice occurs annually in the nearshore region of the study area during a brief period in the spring when river break-up precedes the break-up of the landfast sea ice. The river water floods out over the top of the sea ice, spreading up to 10 km offshore. River overflood constitutes a potential hazard to offshore oil and gas development, as it relates to facilities access, oil spill spreading, and the associated phenomenon of strudel drainage and potential seabed scouring.

The U.S. Department of Interior, Minerals Management Service (MMS), Alaska Outer Continental Shelf Region has commissioned a study designed to map the extent of peak river overflooding onto the landfast ice in the nearshore region of the Alaskan Beaufort Sea during the 13-year period between 1995 and 2007 as part of the MMS Alaska Environmental Studies Program (Contract Number 1435-01-06-CT-39664). The study findings will be used by MMS for environmental assessment and hazard mitigation for present and future oil and gas facilities that may be located within or adjacent to the areas of overflooding influence.

The overall goal of this study is to improve the knowledge of the spatial and temporal variability in overflooding, and related pipeline and facility siting concerns. Specific study objectives are to 1) document maximum river overflood boundaries from Smith Bay to Camden Bay between 1995 and 2007 using remote sensing and historical helicopter-based surveys, 2) assess and compare different remote sensing platforms for mapping river overflood, 3) investigate environmental factors contributing to river overflood, 4) assess hazards associated with river overflood, and 5) incorporate the overflood and strudel mapping information into a GIS database.

Overflood boundaries were mapped using several remote sensing platforms, including NOAA visible and I/R imagery, Landsat imagery, and radar imagery. Visible satellite imagery has been used successfully to document river overflood limits in the past. Weather-independent radar satellite imagery has not been used extensively prior to this study owing to the lack of commercially available historic archives. In addition, industry provided overflood limits mapped by helicopter were used in the study.

Available satellite imagery covering the period from 1995 to 2007 were gathered to create a database of peak overflood boundaries for as many river systems as possible in the study area. Before mapping the overflood boundaries, a number of different band combinations (in the case of Landsat) and image stretching techniques were used to highlight or improve the discrimination of the overflood boundaries. The image files were entered into ArcGIS v. 9.1 and the boundaries were digitized as closed polygons. To increase the probability of capturing the peak overflood, a maximum composite overflood limit was developed for each river by integrating all of the mapped overflood limits for a given year.

The radar imagery was found to offer the highest potential for both historical mapping and future monitoring. When the 14 major rivers in the study area are considered, overflood limits were mapped for 147 out of 182 possible river and year combinations, resulting in a mapping success of 81%. This result exceeded expectations, and would not have been possible without the radar imagery. Overflood limits were mapped for all 13 possible years for the Colville, Canning, and Sadlerochit Rivers. The lowest mapping success occurred at the Topaguruk River (1 out of 13 years) and the Ikpikpuk River (5 out of 13 years).

MODELING CIRCULATION IN THE LANDFAST ICE ZONE

Jeremy Kasper

University of Alaska Fairbanks

Immobile, landfast ice covers the region inshore of the 20 meter isobath over arctic shelves and prevents the direct transfer of wind stress to the inner shelf in winter. Thus the outer shelf circulation is directly wind-forced whereas inner shelf dynamics are controlled by remotely-established pressure gradients and frictional coupling of the flow field to the bottom and the under-ice boundaries. To demonstrate the first order effect of landfast ice on the shelf circulation, an analytic description of the mean coastal flow beneath the landfast ice was developed following Csanady's "arrested topographic wave" model. For comparison, the Regional Ocean Modeling System (ROMS) was used to investigate the effects of landfast ice on an imposed sea surface height gradient and on winds offshore of the ice edge along a straight coast with friction applied at the bottom and at the surface to mimic frictional coupling between the landfast ice and the ocean. The ice-water friction coefficient was varied spatially to examine three cases: constant, linearly increasing offshore, and random. The numerical model was forced with different offshore wind profiles to investigate the response of the inner and outer shelves to offshore winds. The circulation response to winds differs markedly between the inner and outer shelf with the transition between the inner and outer shelf marked by a sharp velocity front suggesting limited exchange across the landfast ice edge throughout winter implying that dissolved and suspended materials may be trapped on the inner shelf throughout winter. The underice flow field is sensitive to the magnitude of the ice-water friction but less sensitive to the spatial structure of the frictional coupling.

MULTI-DECADAL COUPLED SEA-ICE/OCEAN NUMERICAL SIMULATIONS OF THE BERING SEA

K. Hedstrom, Ph.D, E. Curchitser and S. Danielson

Institute of Marine and Coastal Sciences/Rutgers; Institute of Marine Sciences, Arctic Region Supercomputing Center, University of Alaska Fairbanks

A coupled, regional sea-ice/ocean model has been developed to examine the interannual to interdecadal variability of circulation, sea-ice extent, thickness and concentration within the Bering Sea for the period 1958-2004. In particular, we examine the variability induced by El Nino and the warm/cool phase in the Northeast Pacific, and identify the dominant physical terms (e.g. incoming shortwave radiation, sensible heat flux, advection of sea ice) leading to this variability. Our coupled model is based on the Regional Ocean Modeling System (ROMS), implemented at 10 kilometers (kms) resolution for a Northeast Pacific domain, which includes the Gulf of Alaska and the Bering Sea.
Ice dynamics are based on the efficient elastic-viscous-plastic rheology of Hunke and Dukowicz (1997), ice thermodynamics are based upon Mellor and Kantha (1989) and include a single ice layer, a snow layer, and a molecular sublayer at the ice/ocean interface. Atmospheric forcing is derived from CORE reanalysis fluxes and boundary conditions are based on a global ocean driven by the CORE reanalysis. Regional model results for recent years are compared with satellite derived products based upon Pathfinder SSM/I, sea surface temperature and transports through Unimak Pass.

The existing simulation was run without tides. We have plans to carry out a new simulation with tides, an improved bathymetry, new initial and boundary conditions, a coupled ecosystem, and countless other changes. Early trials are being run and compared to tidal observations.

UPDATES TO THE FAULT TREE APROACH TO OIL SPILL OCCURRENCE ESTIMATORS FOR THE BEAUFORT AND CHUKCHI SEAS

Frank G. Bercha, Ph.D.

Bercha Group

Probabilistic estimates of oil spill occurrences are required for the development of environment impact assessments for possible future developments in the US Chukchi and Beaufort Seas. Due to the embryonic state of offshore oil development in this region, it was not possible to base these oil spill probability estimates on empirical data. Rather, statistically significant non-Arctic empirical data from the US Gulf of Mexico and world-wide sources, together with their variance, were used as a starting point. Next, both the historical non-Arctic frequency distributions and spill causal distributions were modified to reflect specific effects of the Arctic setting, and the resultant fault tree model was evaluated using Monte Carlo simulation to adequately characterize uncertainties treated as probability distribution inputs to the fault tree. This paper summarizes the methodology and gives results of its application to

the prediction of oil spill probabilities and their characteristics for the Chukchi and Beaufort Seas region for typical future offshore development scenarios.

ALTERNATIVE OIL SPILL OCCURRENCE ESTIMATORS FOR THE BEAUFORT/CHUKCHI SEA OCS (STATISTICAL APPROACH)

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This study analyzes GOM statistics for pipeline and platform oil spills, and with statistically appropriate techniques, develops Poisson models for spill rates. These models are tested through analysis of exponential inter-spill intervals for several exposure variables. These exposure variables include time, oil production, pipeline mile-years, and platform-years. Weibull and lognormal models for spill volumes are developed and used to support analyses at spill thresholds of 50, 100, 500, and 1,000 barrels. In each case, confidence limits are calculated and reported. The stability of the results has been confirmed for different time periods. Significant differences from past MMS publications include Poisson confidence intervals, exact binomial confidence intervals, detailed analyses for the exposure variables of pipeline mile-years and platform-years, the use of the larger spill data set of spills exceeding 50 barrels to estimate rates at higher thresholds, and the inclusion of more recent data (through 2005). A declining rate of platform spills is statistically verified, so that platform results are generally based on spills during 1990 to 2005, while pipeline results are based on data from 1972 to 2005. Spill causes are analyzed to identify spills with GOM-specific causes, such as hurricanes and fishing trawl gear. This is modeled as a binomial proportion for GOM-specific and applicable to the Arctic spills at the spill size thresholds. These results are extended to the Arctic with a method that provides a conservative confidence interval and a method that provides a minimum width confidence interval – both at each spill size threshold. For extension from the GOM data to the Arctic using a Beaufort development scenario, spill rates per production volume are found to be unreliable as compared with spill rates per pipeline mile-year and per platform-year. There was insufficient data on the Beaufort development scenario to estimate the spill rates for ice keel gouging, but a rough approximation for strudel scour suggested that this was less significant than applicable causes, such as corrosion, human error, and operational impacts. The estimated rates of Arctic applicable pipeline spills per pipeline mile-year and of platform spills per platform-year at spill thresholds of 50, 100, 500, and 1,000 barrels are presented with minimum and conservative confidence intervals. Thus, the existing data from the GOM is extended through statistically supported techniques. Preliminary results from a new approach to modeling pipeline spill rates based on “platform-related” spills and pipeline mile-years are presented with the conclusions and recommendations.

ARCTIC CISCO GENETICS AND OTOLITH MICROCHEMISTRY

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U.S. Geological Survey, Alaska Science Center

Arctic cisco (*Coregonus autumnalis*) harvested from the Colville River subsistence fishery are thought to be anadromous, overwintering migrants from the Mackenzie River, Canada. Our study used genetics to test population-of-origin hypotheses for Colville River Arctic cisco by comparing data derived from fish captured in the subsistence fishery on the Colville River with anadromous spawning populations collected in the Arctic Red and Peel rivers, both tributaries of the Mackenzie River. We analyzed genetic variation at eleven polymorphic microsatellite loci and direct sequence information for a 594 nucleotide fragment of the mitochondrial ATPase subunit VI gene. Microsatellite allelic frequencies revealed no significant differences in pairwise F_{ST} among these populations supporting the hypothesis that the Mackenzie River watershed is the primary source of Arctic cisco recruiting to the Colville River fishery. Differences in mitochondrial DNA haplotypes suggest some fish within the Colville River sample collection may be misidentified to species or are hybrids with other Arctic coregonids.

Otolith microchemistry was used to investigate migration patterns and analysis of otolith structure was used to reconstruct growth histories and investigate environmental correlates for young-of-the-year (YOY) growth in Arctic cisco collected in the Colville River. Otolith growth was a good predictor of fish growth and transects of otolith elements strontium (Sr) and calcium (Ca) showed patterns of marine migrations reflecting the conceptual model for anadromy in this species. Sr/Ca values associated with the second winter were often as low as Sr/Ca values associated with early freshwater residence indicating that these fish may over-winter in non-saline habitats. Early growth increments in Arctic cisco (1986-2007) exhibited significant variation both within and among age classes. YOY growth was positively correlated with the winter Arctic Oscillation Index (Nov-Mar, $r^2 = 0.19$), mean summer air temperatures at Inuvik (June-July, $r^2 = 0.15$), and mean Mackenzie River discharge at Ft. Simpson lagged two years (April-June, $r^2 = 0.50$). The lagged discharge relationship may reflect marine food web dynamics and productivity associated with nutrient distributions resulting from increased river discharge.

Sampling of additional possible source populations of Arctic cisco at higher elevations in the Mackenzie River on the Mountain, Carcajou and Great Bear Rivers took place in August of 2008. Data from these collections have not yet been analyzed but will be critical to a comprehensive understanding of the population dynamics and behavior of Arctic cisco in the Beaufort Sea and the sustainability of the Colville River fishery.

EPISODIC UPWELLING OF ZOOPLANKTON WITHIN A BOWHEAD WHALE FEEDING AREA NEAR BARROW, AK

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Woods Hole Oceanographic Institution

The shelf near Barrow, Alaska is a critical feeding area for migrating bowhead whales, particularly during the fall migration (e.g., Lowry et al., 2004). Results from biophysical sampling conducted during August-September 2005-2007 demonstrated that the oceanography of the shelf is complex, dynamic, and highly variable and that advection is closely coupled to the direction and magnitude of the winds. These results also suggested that oceanographic and atmospheric conditions impact the composition, distribution, and availability of plankton prey for the bowhead whale. Based on these results, we advanced a conceptual hypothesis regarding the availability of prey for the bowhead whale near Barrow. The present project continues the 2005-2007 field studies to explicitly identify and document the occurrence, frequency, and persistence of wind-driven shelf-slope exchange events at the Barrow Canyon and the Beaufort shelf breaks during the summer and early fall in association with the presence of ice cover, water column stratification, and the presence of bowhead whales. To this end, two long-term (annual) moorings, equipped with acoustic recorders and oceanographic sensors, were deployed on the shelf break in August 2008. One short-term mooring, equipped with oceanographic sensors, was deployed along the edge of Barrow Canyon from mid-August to early September, 2008. Boat-based oceanographic sampling was conducted from mid-August to early September to describe short-term and interannual variability in ocean conditions and whale prey availability. The work will lead to a greater understanding of the shelf environment, of the bowhead whale feeding environment, and of the potential impact of climate change on this Arctic shelf ecosystem.

CONTINUATION OF ARCTIC NEARSHORE IMPACT MONITORING IN DEVELOPMENT AREA (cANIMIDA): INTRODUCTION AND OVERVIEW

Gregory Durell

Battelle

The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA), a five-year study started in 1999, provided baseline data and monitoring results to evaluate potential effects from site-specific production in the Beaufort Sea OCS, in the vicinity of the Northstar and Liberty development sites. Northstar is in State waters, but includes production of some OCS oil through directional drilling. Liberty may be the first offshore OCS development project in the Beaufort Sea and the Alaska OCS. ANIMIDA monitoring for Northstar included pre-construction, and construction, and early production periods. The last field sampling for ANIMIDA was conducted in 2003.

In 2004 the five-year *Continuation* of Arctic Nearshore Impact Monitoring in Development Area (cANIMIDA) study began, and included spring and summer field surveys. The cANIMIDA technical task objectives include the following:

- Characterize hydrocarbon and metal distribution in sediments in the study area.
- Determine sources, concentrations, and dispersion pathways for suspended sediment, and associated chemicals, and their partitioning between dissolved and particulate phases.
- Characterize potential anthropogenic chemicals in amphipods, bivalves, and fish, and determine bioaccumulation and biological effects of those chemicals.
- Monitoring the Boulder Patch ecological system.
- Annual assess the subsistence whaling near Cross Island.

Field logistics included helicopter support and small vessel (e.g. MMS Launch 1273) support in the "open" water summer season and snow machine support for winter/spring sampling. Turbidity, total suspended sediment, and current velocity measurements were made in the water column in the vicinity of off- and on-shore potential sources, including local rivers and in the Boulder Patch. Sediment and suspended sediment samples were analyzed for PAH, saturated hydrocarbons, chemical tracers, trace metals, and supporting geophysical measurements. Biota sampling included similar chemical measurements in clams, amphipods, deployed mussels, and fish, and also measurement of biological effects markers in fish bile and organ tissue. Kelp productivity was monitored in the Boulder Patch and uses the inherent optical properties of the ice and water to evaluate the effect of sediment resuspension on kelp productivity. Optical-related measurements included spectral irradiance, light scattering coefficients, and total suspended solids. The reporting program for Cross Island whaling, which records information on whaling locations, success, and whaler perceptions, was also supported. Field programs were conducted in 2004-2006 (2007 for some aspects). The current and last year of the Program is devoted to reporting and communication of monitoring results, and compilation of the data into a Program database.

Monitoring results will be presented in detail in the separate technical task presentations in the Alaska 2008 ITM cANIMIDA session. The monitoring techniques that have been employed are providing high

quality impact assessment information that can be used with a high level of confidence for the management of this unique environment.

HYDROCARBON CHARACTERIZATION OF SEDIMENTS OF THE NEARSHORE BEAUFORT SEA

John Brown, Linda Cook, John Trefry, Ph.D, and Greg Durell

Exponent, Inc., Florida Institute of Technology, Battelle

Hydrocarbons are a key component of the multidisciplinary Minerals Management Service (MMS) cANIMIDA Program for monitoring potential impacts of offshore oil development in the Arctic. During the summers of 1999-2006, surface sediments were collected in the nearshore Beaufort Sea, including stations adjacent to the Northstar and Liberty oil development prospects. The samples were analyzed for a full suite of hydrocarbons to identify potential trends and inputs of petroleum contamination in the development areas and region-wide.

The pre-Northstar development 1999 results reveal that the area sediments generally contain low levels of naturally occurring background hydrocarbons, consistent with historical data from 1989 and earlier Beaufort Sea Monitoring Programs. The post-Northstar development data generally revealed no differences in sediment hydrocarbon concentrations or composition between the 1999 and 2000, 2002, and 2004 - 2005 data sets. However, a subset of Northstar stations showed an increase in several key hydrocarbon parameters from 1999 to 2000. Detailed evaluation of the Northstar station data indicated that the observed trend was likely due to the depletion of fine-grained sediments from storms in 1999, and not due to anthropogenic inputs related to the development at Northstar Island. The 2001 and 2005 sediment core results revealed low sedimentation rates in the study area (~0.1 cm/year to no recent deposition), supporting previous findings that the overall nearshore study area is a net erosional environment. The data from a subset of sediment cores where deposition rates can be well established, generally show uniform levels and distributions of background hydrocarbons extending back some 50 years and greater, with no discernable increases from recent offshore development activities.

cANIMIDA: TRACE METALS AS INDICATORS OF HUMAN ACTIVITIES IN THE COASTAL BEAUFORT SEA

John H. Trefry, Ph.D, Robert P. Trocine, Carrie M. Semmler, Matthew B. Alkire, Robert D. Rember, and Mark A. Savoie

Florida Institute of Technology, Louisiana Universities Marine Consortium, College of Oceanic and Atmospheric Sciences, Oregon State University, IARC, University of Alaska, Kinnetics Laboratories, Inc

Trace metals can be useful indicators of contamination in the coastal ocean because they are commonly enriched in the raw and finished materials used by modern industry. During the cANIMIDA Project, concentrations of trace metals were determined for bottom sediments, water, suspended sediments and biota from locations along the coastal Beaufort Sea from Camden Bay to Harrison Bay. Metal values for sediments were quite variable as a function of mineralogy and grain size. However, metal concentrations showed strong linear correlations with aluminum and a series of templates were developed that defined natural metal concentrations. These templates were then used to identify locations where anthropogenic inputs of metals may have occurred. For the 3078 data points obtained for metals in bottom sediments during the ANIMIDA and cANIMIDA Projects, 21 data points (0.7% of total) showed a possible anthropogenic source for a fraction of the total metal concentration. None of the sediment metal concentrations were above the effects range low (ERL), meaning that adverse effects to benthic organisms due to metals would be rarely observed.

Concentrations of dissolved trace metals were low and seemed to be at background values. For example, concentrations of dissolved mercury averaged 0.8 parts per trillion (ng/L) and concentrations of dissolved lead averaged 8 parts per trillion (ng/L). These concentrations of dissolved mercury and lead are characteristic of clean coastal seawater and are ~30 and ~1000 times lower, respectively, than values established by the U.S. Environmental Protection Agency for chronic impacts in marine waters.

Concentrations of total suspended solids (TSS) in the coastal Beaufort Sea were directly related to wind velocity and duration or proximity to river runoff. During the open water season, TSS values were typically 1-4 mg/L during calm winds, 3-8 mg/L during 5-10 knot winds, 5-15 mg/L during 10-20 knot winds and 50-100 mg/L when >20 knot winds prevailed for several days. Concentrations of metals in suspended solids were variable due to scavenging by iron oxides, uptake by plankton and possibly anthropogenic inputs. Some elevated values for lead in suspended sediments were found in nearshore areas such as near Northstar Island and Endicott. This observation, although not consistent, may indicate atmospheric inputs of anthropogenic Pb. Because of the generally low concentrations of TSS in the study area, suspended particles may provide a sensitive indicator of anthropogenic inputs of metals.

Concentrations of metals in benthic biota, such as clams, have been reasonably uniform from year to year and at background values. For example, average annual concentrations of mercury and lead have been very low and relatively uniform at 0.06 ± 0.02 and 0.6 ± 0.1 parts per million (μg/g, dry weight). In addition, concentrations of cadmium, mercury and lead in mussels collected in Port Chatham (Kenai Peninsula) and placed in cages in the Beaufort Sea did not change significantly during deployment.

Overall, metal concentrations in sediments, water and biota from the coastal Beaufort Sea were at background values and show no or minimal indications of anthropogenic inputs of metals. Furthermore,

the background data and techniques for identifying anthropogenic inputs of metal that were developed during the cANIMIDA Project are very sensitive and, with continued monitoring, will be useful for detecting problem locations well before the onset of adverse impacts to the environment.

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cANIMIDA: INTEGRATED BIOMONITORING AND BIOACCUMULATION OF PETROLEUM HYDROCARBONS IN MARINE ANIMALS FROM THE cANIMIDA STUDY AREA

Jerry Neff, Ph.D, John Hardin and Greg Durell

Neff & Associates LLC, Battelle

Concentrations of saturated hydrocarbons (SHC), polycyclic aromatic hydrocarbons (PAH), and sterane/triterpane (ST) petroleum biomarkers were measured in soft tissues of benthic crustaceans (amphipods, isopods, and mysids) and bivalve mollusks, and concentrations of PAH and exposure biomarkers (CYP1A and bile fluorescent compounds (FAC)) were measured in fish collected from the area of offshore oil development in the Alaskan Beaufort Sea during the summers of 2004, 2005, and 2006, in order to determine if contaminants from offshore oil and gas development were accumulating in the coastal marine food chain. PAH concentrations in all biota were higher in 2004 and 2006 than in 2005. Northstar is the only offshore area with oil production. PAH concentrations usually were lower in resident marine animals near Northstar than at other stations, particularly in 2004. All species of benthic invertebrates and fish sampled contained low concentrations of PAH, similar to concentrations in similar species from uncontaminated environments. Demersal fish species, such as four horn sculpin tended to contain higher concentrations of PAH than the more pelagic species. The anadromous fish, arctic char, tended to contain lower concentrations of PAH than the other species did, perhaps because they are more migratory. CYP1A staining of fish tissues and analyses of bile FAC in fish were in agreement with the tissue residue analyses in showing that fish were being exposed to very low concentrations of PAH in their natural environment. The PAH and ST assemblages in invertebrates were consistent with mixed petrogenic, pyrogenic, and biogenic sources. The saturated hydrocarbon assemblage in crustaceans was dominated by pristine, probably derived from consumption of phytoplankton or members of the trophic chain from phytoplankton, such as calanoid copepods, and arctic cod. There was no evidence that marine fish and invertebrates in the area of offshore development in the Beaufort Sea are being exposed to petroleum hydrocarbons from development/production activities. Concentrations of PAH in all species were at background levels, well below concentrations associated with health risk to marine animals.

CREATION OF LEADS AND RIDGES: WHAT IS THE ICE BEHAVIOR?

Max Coon[1], Ph.D.

NorthWest Research Associates

The behavior of sea ice depends on the problem being solved. We are developing a model to explicitly model the creation and evolution of leads and ridges. The models and proprieties of sea ice needed for crushing ice on a structure are very different from those needed to calculate the location of the "ice edge", or for use in a large scale climate change calculation. The most striking features of the arctic ice as seen from ice level, over flying, or from satellite images are the leads and ridges. Within the Arctic sea-ice, stresses are formed from wind, ocean currents and other sources. These stresses are continuously changing and cause the opening and closing of cracks (leads) in the pack ice that may be thousands of kilometers in length. Leads are important for climate modeling because an open lead provides an avenue for heat transfer from the ocean to the atmosphere. The formation of new ice within leads upon refreezing is also noteworthy because of the large amounts of energy required to create ice and of brine injected into the ocean. Another obvious feature of the Arctic landscape is ridges formed when leads are forced to close, crushing new ice within the lead.

Existing constitutive equations used for modeling pack ice are primarily continuum based and, as such, do not incorporate specific information about leads such as orientation, length and width. Instead, such models generally give an indirect measure of lead opening through an integration of the divergence of velocity, and infer the direction of leads through plots of divergence over the spatial domain. However, these models provide a computationally efficient scheme to predict the motion of Arctic ice as well as an indication of the area of open water and the amount of new ice created over a winter season. For the original purpose, these models work admirably well. However, a more precise constitutive equation can bring significant improvements to detailed predictions of the formation of leads and new ice and, consequently, corresponding improvements in the prediction of ice motion and deformation.

The modeling was a joint effort by NorthWest Research Associates, University of New Mexico, Jet Propulsion Laboratory, and Technical University of Denmark. A first formulation of the model has been completed together with a solution procedure. We have developed a new metric for comparing simulated and measured lead orientation. Also, we have a new data simulation procedure. At this time the present project is complete and the final report is in preparation. Together we will examine results of model runs for the ice in the Beaufort and Chukchi Sea with comparison to leads measured with SAR. This model should be verified, validated and made operational.

This work was sponsored by MMS, NASA, ONR, and NSF.

[1] Max Coon presented at the Forum and his talk was under the heading of Physical Oceanography.

EMPIRICAL WEATHERING PROPERTIES OF OIL IN ICE AND SNOW

Ian Buist[2], Randy Belore, David Dickins, Alan Guarino, Dan Hackenberg & Zhendi Wang

Ross Environmental Research Ltd

A considerable amount of field research was done in the 1970's and 1980's on first order processes of oil weathering in ice. Additional studies continued in the laboratory in the late 1980's and 1990's, but were generally limited to low-viscosity, low-pour point oils. It is now recognized that oil weathering is strongly dependent on the specific chemical composition and characteristics of individual crudes. The physical and chemical data required by modern state-of-the-art computer models are scarce, of poor quality, or nonexistent for oil-ice interaction. The objective of this study was to generate experimental data to validate and refine oil spill weathering algorithms for computerized models for spills in ice and snow.

The emphasis for the research was extensive laboratory testing with meso-scale verification to investigate the fate, behavior and interactions of fresh crude oil spilled with first-year, land-fast sea ice. Six series of experiments were conducted over a four-year study:

1. Spreading on Ice and in Snow
2. Evaporation in Ice and Snow
3. Slick Thickness on Cold Water
4. Migration Rates through Brine Channels
5. Formation of Water-in-Oil Emulsions
6. Full Spill-Related Characterization of Crude Oil Samples

These experiments were conducted at three facilities:

1. An outdoor test facility near Ottawa, ON constructed using insulated, IBC shipping containers as the test tanks each containing 1 m^3 of salt water.
2. An indoor, 11-m^3 wind/wave tank at SL Ross in Ottawa, ON specially modified: to incorporate a refrigerated cold air system to allow precise air temperature control to –30°C; to allow the growing of substantial thicknesses of sea ice; and, to generate under-ice water currents.
3. The 10,000-m^3 Ohmsett Facility in Leonardo, NJ, outfitted with large-capacity industrial water chillers to ensure freezing water temperatures.

Four crude oils from Alaska, representing a wide range of physical properties, were used in the research: Alaska North Slope, Northstar, Endicott, and Kuparuk.

Algorithms were recommended, based on the best fit of the experimental data from the experiments to various theoretical equations, for the following oil spill processes:

- The equilibrium thickness of oil on quiescent cold water.
- The spreading of oil on cold water.
- The equilibrium thickness of oil on ice.
- The spreading of oil on ice.
- The spreading of oil in snow**.**
- The stripping velocity for small oil forms under ice.

[2] Ian Buist presented at the Forum and his talk was under the heading of Fate and Effects.

- The evaporation of oil on ice, under snow and among drift ice.

It was not possible to develop algorithms for emulsification or brine channel migration but significant new information was obtained through the experiments.

VARIABILITY IN CROSS ISLAND (ARCTIC ALASKA) SUBSISTENCE WHALING: AN EXAMINATION OF NATURAL AND ANTHROPOGENIC FACTORS

Michael Galganitis[3]

Applied Sociocultural Research

Humans constitute an important and complex, but surprisingly often overlooked and neglected, element of Arctic ecosystems – except, perhaps, as the cause of perturbations in the more "natural" parts of the ecosystem. Monitoring changes in this human component of the ecosystem, whether such changes are due to natural or anthropogenic causes, presents substantial challenges, but can be successful when focused on especially significant socioeconomic aspects of local human activity. Contemporary subsistence (aboriginal) whaling constitutes one such nexus for Native communities in northern Alaska. One task of the ANIMIDA/cANIMIDA program gathered data and information to assess the potential effects of oil and gas (industry) activities, weather and ice conditions, and non-industry vessel and aircraft activities on subsistence whaling near Cross Island, Alaska. This presentation uses project data for 2001 to the present to discuss how year-to-year variability in subsistence whaling can be related to these factors, natural fluctuation, or other factors. Additional factors potentially accounting for changes in subsistence whaling such as changes in whale behavior, whaling technology, and climate change, will also be addressed using longer-term data. Weather and ice conditions, and the distance of whales from Cross Island, appear to be the most important factors affecting bowhead whale harvest near Cross Island. Anthropogenic factors are much more difficult to document, for a variety of reasons that will be discussed during the presentation.

A discussion of methods (GPS/GIS data combined with systematic observation and informal interviews with whalers) and a general overview of subsistence whaling at Cross Island will also be part of the presentation. Due to the limits of time, this portion of the presentation will necessarily be brief, but questions and discussion after the presentation are welcome.

[3] Michael Galganitis presented at the Forum and his talk was under the heading of Social Environment.

THE STUDY OF ECOSYSTEM SERVICES AND SHARING NETWORKS TO ASSESS THE VULNERABILITIES OF COMMUNITIES TO OIL AND GAS DEVELOPMENT AND CLIMATE CHANGE IN ARCTIC ALASKA

Gary Kofinas[4]

School of Natural Resources & Agricultural Sciences and Institute of Arctic Biology, University of Alaska Fairbanks

Rapid change in Arctic raises many questions about how research can improve our understanding of the dynamics social-ecological systems and inform decision making at local, regional, and national scales. What is the capacity of local communities which are highly dependent on harvesting wild food resources to cope with change? What are the implications of oil development with climate change to indigenous communities of the North? What information is needed to represent the subsistence economies of small villages and understand future changes? How do local residents perceive their future in a rapidly changing world? This presentation outlines two in-progress research projects that are together examining the resilience and vulnerabilities of communities of northern Alaska to the combined effects off- and on-shore oil and gas development and climate change. The project involves one interior and two North Slope partner communities and an interdisciplinary team of researchers. We are projecting change in ecosystem services using spatial models, analyzing social networks of subsistence sharing, and documenting local perceptions of resilience and vulnerability to change. Projections of changing ecosystem services are undertaken by the Scenarios Network for Alaska Planning and based on downscaled GCM models of the IPCC, as well as the best available knowledge on resource ecology. Social network analysis examines the structure and flows of household exchanges in foods, cash, and information to provide insight into social processes that are typically absent from studies focused only on harvesting levels. A participatory approach involving community residents and drawing on local knowledge helps to integrate findings and facilitate an exchange between researchers and community residents. Although the ecosystem services approach is a useful in the study of changing availability of subsistence resources, a social network approach captures social conditions that reflect cultural constructs and are important for understanding human adaptation. The two approaches used together serve our project as the basis for the integrated understanding of a highly coupled social-ecological system.

[4] Gary Kofinas presented at the Forum and his talk was under the heading of Social Environment.

POPULATIONS AND SOURCES OF RECRUITMENT IN POLAR BEARS: MOVEMENT ECOLOGY IN THE BEAUFORT SEA

Andrew E. Derocher[5], Gregory Thiemann, & Seth Cherry

University of Alberta, York University

Polar bears are distributed throughout the Beaufort Sea. Changes in the dynamics and distribution of sea ice have resulted in concern about the long-term conservation and management of this species. The primary objective of this study is to examine the movement ecology of juvenile polar bears born in, or near, the southern Beaufort Sea population to test the established hypothesis that polar bears are divided into discrete populations. Of particular concern is the historic emphasis on the movements and distribution of adult females to delineate population boundaries and thus, this study aims to examine how representative such an approach may be by studying the movements of juveniles. Further, the study will enhance analysis of oil-spill/polar bear models and provide direct input to population-recovery models currently under development for the Beaufort Sea region.

The project was initiated in spring 2007 and aims to continue for a five year period. Satellite linked geographic positioning system collars are deployed on subadult polar bears (aged two to four). Adult females are used as controls for movement patterns and for comparison with data collected in the 1980's. Six locations per day are obtained for each study animal for a period of one to two years. Automatic release mechanisms are built into each collar to minimize risk to study animals.

Low recruitment in the Beaufort Sea population, changes in sea ice distribution, and extended periods of inclement weather have slowed the progress of the study. However, preliminary results indicate that subadults may be less restricted in their movements than adult females although the rapid changes that have occurred in the Beaufort Sea ice conditions have significantly altered the ecological conditions in the study area. Movement rates of juveniles are higher than those from concurrently monitored adult females but larger samples sizes are required before conclusions can be drawn. There is an indication of a northward shift in habitat use reflecting a reduced expanse of landfast ice in recent years.

Future plans are to continue monitoring subadults and to expand the study to adult males so that a full assessment of movement patterns, habitat use and fidelity can be examined.

This research is supported by Minerals Management Service, US Department of the Interior and Polar Continental Shelf Project, Natural Resources Canada.

[5] Andrew Derocher presented at the Forum and his talk was under the heading of Protected Species.

SATELLITE TRACKING OF THE WESTERN ARCTIC STOCK OF BOWHEAD WHALES

Lori Quakenbush[6], John Citta, Robert J. Small, John "Craig" George, Harry Brower, Jr. Mads Peter Heide-Jorgensen , and Lois Harwood

Alaska Dept. of Fish and Game North Slope Borough, Alaska Eskimo Whaling Commission, Greenland Institute of Natural Resources, Dept. of Fisheries and Oceans

Bowhead whales (*Balaena mysticetus*) from the western Arctic stock have been the focus of considerable research because they: 1) are critical to the nutritional and cultural health of Alaska Natives, 2) play a significant role as zooplankton grazers in the Bering, Chukchi, and Beaufort seas, and 3) are vulnerable to possible effects of oil and gas activities during migration and while on their summer range. General migration patterns are known from aerial surveys and from the timing of whaling in coastal villages, yet knowledge of movements during migration relative to bathymetry, ice cover, and important feeding areas is limited. Working with other researchers, subsistence whalers, and local hunters in Alaska and Canada we attached satellite transmitters to bowhead whales during 2006 to 2008. In 2006, we tracked a 45-foot (13.7 m) male bowhead over 2,500 km, from Point Barrow, Alaska, to Amundsen Gulf, Canada, and then to Chukotka, Russia. During the spring migration, between Point Barrow and Amundsen Gulf, this whale passed through seas with 90 to 100% sea ice cover. We also documented the movements of this whale during an active seismic survey offshore of the Tuktoyaktuk Peninsula in Canada. As the ship and the whale converged, the whale deviated course and maintained a minimum of 9.2 km from the ship. We found no statistical relationship between whale behavior and movement with distance from the seismic ship and suspect this was largely due to the ship shutting down seismic operations (as a mitigation measure for a different whale that had coincidentally entered the safety zone) when the tagged whale came closest. Two other whales tagged at Barrow in 2006 and 2007 were also tracked to the Chukotka coast in fall. Tracking data indicate that certain areas in Amundsen Gulf, Chukotka, and near Point Barrow appear to be important feeding areas, at least in some years. We are also analyzing dive behavior of three bowheads tagged near Barrow in August 2007. These whales spent the majority of their time between 10 and 20 m below the surface near the seafloor. One of these whales traveled northwest along the shelf break to the nearshore area of Chukotka passed through a variety of water depths. Over the shelf break, diving behavior was highly variable; within 6 hour intervals, the whale sometimes spent the majority of time at shallow depths (30 m) and sometimes at deeper depths (200 m). Near the Russian coast the whale spent the majority of its time between 20 and 50 m, and was near the bottom approximately half the time. While the three whales were near Barrow, they were within the study area of BOWFEST, another MMS funded project that includes aerial surveys to locate feeding whales and ship-based sampling of zooplankton and oceanographic conditions. Results from these two projects may increase our understanding of the prey types or prey densities bowhead whales selected in the Barrow area.

Cooperators: Alaska Dept. of Fish and Game, North Slope Borough, Alaska Eskimo Whaling Commission, Aklavik and Tuktoyaktuk Hunters and Trappers Committees, Canada Dept. of Fisheries and Oceans, Greenland Institute of Natural Resources. Funding: Minerals Management Service,

[6] Lori Quakenbush presented at the Forum and her talk was under the heading of Protected Species.

Fisheries Joint Management Committee, Polar Continental Shelf Project, and Panel for Energy and Research Development.

BOWHEAD WHALE FEEDING VARIABILITY IN THE WESTERN BEAUFORT SEA—FEEDING OBSERVATIONS AND OCEANOGRAPHIC MEASUREMENTS AND ANALYSES

Carin J. Ashjian, Ph.D[7]

Woods Hole Oceanographic Institution

The Alaskan Beaufort Shelf is a feeding region for planktivorous bowhead whales during their autumn migration. This feeding opportunity may be vulnerable to impacts both from climate change and human activities. Oceanography and bowhead whales on the shelf near Barrow, Alaska were investigated during August and September of 2005 to 2008 as part of an ongoing, multi-investigator study to describe oceanographic distributions, to identify and describe oceanographic conditions that produce a favorable feeding environment for the whales, to document short term and inter-annual environmental variability, and to describe whale distributions and feeding behavior. Oceanographic characteristics and whale prey distributions were described by surveys conducted from a small research vessel. Whale distributions were documented during aerial surveys. Whale feeding behavior was studied in 2008 using short-term whale tags and proximate oceanographic and prey sampling to characterize whale diving behavior and prey distribution and small scale oceanographic conditions that aggregate prey.

Multiple water masses were observed each year 2005 to 2008, with close coupling between water mass and biological characteristics. Considerable inter-annual variability was observed. Both 2005 and 2007 were characterized by little or no sea ice and warm surface water (~11 °C in 2007) while melting sea ice in 2006 and 2008 contributed to colder surface waters (<4 °C). Shorter-term variability in conditions on the shelf was intimately tied to the direction and strength of the wind. Based on stomach content analysis from harvested bowhead whales, the whales near Barrow feed primarily on Arctic copepods or on krill (euphausiids) that are advected from the Pacific in the prevailing currents of the Chukchi Sea. Modeling studies have demonstrated that Bering Sea krill introduced into the Chukchi Sea in spring can reach Barrow by early fall to provide an important food resource for the whales. Krill and copepods are upwelled onto the Beaufort Shelf from Barrow Canyon or the Beaufort Sea when winds are from the E or SE. A favorable feeding environment is produced when these krill and copepods are concentrated on the shelf near Barrow as the prevailing westward shelf currents converge with the strong Alaska Coastal Current that flows to the northeast along the eastern side of Barrow Canyon. In addition, krill may be retained in Elson Lagoon under upwelling winds and subsequently flushed out along the barrier islands, providing local krill aggregations as prey for the whales. To date, feeding bowhead whales were observed in association with elevated abundances of krill along the barrier islands of Elson Lagoon (2005) and on the shelf to the east of Barrow Canyon (2006) following wind conditions consistent with the proposed mechanism of prey aggregation.

[7] Carin Ashjian, Ph.D presented at the Forum and her talk was under the heading of Protected Species.

Funding for this ongoing study has been provided by the NSF, NOAA, MMS, ONR, the Coastal Marine Institute (UAF), and the WHOI Arctic Initiative. The support of the North Slope Borough Department of Wildlife Management, the Barrow Arctic Science Consortium, the Barrow Whaling Captains Association, the Alaska Eskimo Whaling Commission, the North Slope Borough, and the City of Barrow are gratefully acknowledged.

TIMING AND LOCATION OF KING EIDERS STAGING IN THE BEAUFORT AND CHUKCHI SEAS

Abby N. Powell, Ph.D[8] and Steffen Oppel

Alaska Cooperative Fisheries and Wildlife Research Unit, Department of Biology and Wildlife, University of Alaska Fairbanks

King eiders (*Somateria spectabilis*) use the Eastern Chukchi and Beaufort Seas as staging areas on their migration between breeding areas in Siberia and western North America and wintering areas in the Bering Sea. Little is known about the timing of migration, spatial extent of staging areas, or proportion of the population using these areas. We present data on king eider staging collected through satellite tracking of adult and juvenile eiders captured on breeding grounds on Alaska's North Slope from 2002-2007. In late summer, over 75% of satellite-tracked king eiders migrating south from breeding areas used the Beaufort and Eastern Chukchi Seas between mid June and mid November. On spring migration, king eiders used the same areas in the Beaufort and Eastern Chukchi Seas between mid-April and early June. The timing and distribution of use in both areas differed by sex, breeding status, and age. All birds migrating to breeding grounds in western North America, and 6 of 11 males migrating to breeding grounds in Siberia used the Eastern Chukchi Sea on spring migration, demonstrating that this is a crucial staging area for the entire western North American and the majority of the Siberian king eider population. Ledyard, Smith, and Harrison Bays were all important staging areas for king eiders for an extended portion of the annual cycle, from mid-April through early November. Use of these areas by North American and Siberian breeding king eiders need to be considered when evaluating the potential impacts of offshore oil and gas exploration.

[8] Abbey Powell presented at the Forum and her talk was under the heading of Biology.

SUBSISTENCE MAPPING OF NUIQSUT, KAKTOVIK, AND BARROW

Stephen R. Braund[9]

Stephen R. Braund & Associates

The purpose of this project is to develop and collect data for a GIS (Geographic Information System) capable of describing contemporary subsistence use patterns in Barrow, Kaktovik, and Nuiqsut and capable of measuring changes in these patterns over time. In 2004, Stephen R. Braund & Associates (SRB&A), in association with the North Slope Borough Department of Wildlife and under contract to Minerals Management Service, initiated a subsistence mapping study in Nuiqsut, Kaktovik, and Barrow. SRB&A interviewed 146 harvesters, systematically selected as active and knowledgeable harvesters, in Nuiqsut (33 harvesters), Kaktovik (38 harvesters), and Barrow (75 harvesters) to gather data relevant to subsistence uses of key species among the three communities. SRB&A gathered subsistence use data for multiple resources including caribou, moose, bowhead whale, Arctic cisco, Arctic char, broad whitefish, burbot, geese, eider, ringed seal, bearded seal, walrus, wolf, and wolverine. Geographic features collected during the interviews included subsistence use areas, most recent harvest locations, hunting camp and cabin locations, and travel routes. Associated information such as months of use, travel method, harvest gear, number of participants, and duration of effort were also gathered and provide additional context to the geographic features collected. The study team incorporated the data collected into a GIS system designed by the team to permit measurement of changes in subsistence patterns over time. The GIS system is being used to develop maps and tables to be included in the final report. The final report provides the results of the 146 subsistence mapping interviews in the three study communities and illustrates how the data collected may be used to measure changes in subsistence patterns over time.

[9] Stephen Braund presented at the Forum and his talk was under the heading of Social Environment.

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