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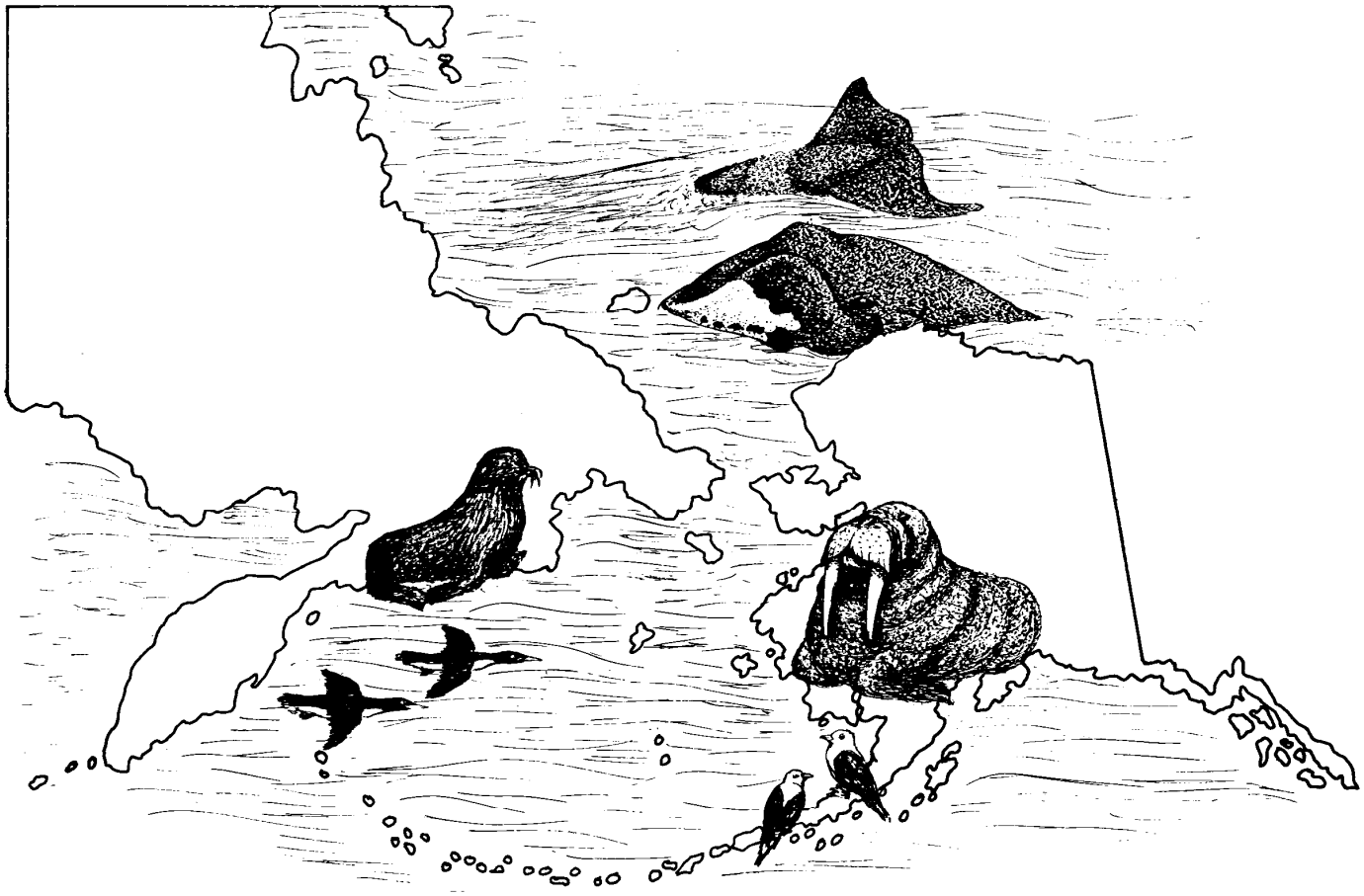
MMS 90-0041

Alaska OCS Region

Third Information Transfer Meeting

Conference Proceedings



U.S. Department of the interior
Minerals Management Service
Alaska OCS Region

June 1990

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OCS Study MMS 90-0041

ALASKA OCS REGION

THIRD INFORMATION TRANSFER MEETING

CONFERENCE PROCEEDINGS

January 30 to February 1, 1990
Anchorage Hilton Hotel
Anchorage, Alaska

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CONTENTS

PREFACE

This Proceedings volume presents summaries of the presentations and transcripts of the discussion sessions of the Third Information Transfer Meeting (ITM) held on January 30 to February 1, 1990, in Anchorage, Alaska. These ITMs are sponsored by the Minerals Management Service (MMS), Alaska OCS Region to provide a means of exchange of information among federal and state agencies, industry, academia, and the general public. The ITM included thirteen talks on marine mammals, seven talks on sea birds, and eight social and economic presentations. At this third ITM, we were fortunate to have as speakers Drs. Arkady Alekseev and Boris Bessonov of the Pacific Oceanological Institute, Far Eastern Branch of the USSR Academy of Sciences, Vladivostok, USSR.

MBC Applied Environmental Sciences (MBC) of Costa Mesa, California, under contract to MMS provided the logistical coordination and report preparation for the ITM. MBC would like to thank the speakers who gave their time and effort to share information with all attendees; to Roman and Tanya Bratslavsky who provided Russian translation and interpreting services; the Marguerite Grau and Russ Seppi who ably assisted in registration; to the staff of Imig Video Company who provided audio-visual expertise; and the staff of the Anchorage Hilton Hotel who helped the meeting run smoothly. MBC would also like to thank Chrie Quesnel of Travel Travel of Eagle River, Eagle River, Alaska, for making the travel arrangements for our Soviet visitors (no easy task!).

INTRODUCTION

Jerry Imm
Chief, Environmental Studies Section
Alaska OCS Region
Minerals Management Service
949 E. 36th Avenue
Anchorage, Alaska 99508

Good morning ladies and gentlemen. I would like to introduce myself and some of the guests here. I am Jerry Imm, chief of the Environmental Studies Section in the Alaska OCS Region. Mr. Alan Powers is the Regional Director of the OCS Region in Alaska. I would like to welcome you to the third Information Transfer Meeting (ITM) held by the Alaska OCS Region of MMS since 1985. The first ITM focused on the Bering Sea Region and the second focused on the Arctic Region and this, the third, has a general focus on the biota of concern in the marine, coastal and human environments of and around Alaska, consisting of marine mammals, seabirds and waterfowl, and last but certainly not least the human and socioeconomic studies, either recently completed or still underway. I wish to extend a special welcome to our Russian colleagues, Drs. Alekseev and Bessonov from the Pacific Oceanological Institute, Far Eastern Branch, USSR Academy of Sciences. They can discuss on an individual basis the trials and tribulations of international air travel. The Regional Director of MMS, Mr. Alan Powers, will deliver the keynote address. After Al's address, we will hear from Drs. Cowles and Montague from MMS to discuss scientific cooperation with the USSR Academy of Sciences to date, followed by an address on the research activities of the Pacific Oceanological Institute to be presented by Dr. Alekseev. After that we will take a short break and then begin the session on marine mammals, to be chaired by Dr. Montague from MMS. If you have any housekeeping questions or need something for a presentation, Chuck and Kathy Mitchell of MBC Applied Environmental Sciences who arranged the meeting and did most of the organizing can be of help. Thank you, and I trust that the meeting will be informative and useful. With that, I give you Al Powers.

KEYNOTE ADDRESS

Alan Powers
Regional Director
Alaska OCS Region
Minerals Management Service
949 E. 36th Avenue
Anchorage, Alaska 99508

Thank you Jerry. The keynote address is probably a bit of an overstatement. It is not going to last for 30 or 40 minutes as it shows in the agenda. We did initially have a bona fide keynote speaker lined up, Ed Cassidy, our Deputy Director from Washington, D.C. He had really planned on being here up until the point in time when the President's budget message was delayed one week. I guess either he was not able to work that out with the President or was able to work that out with the President, however you view that. Anyway, he had to stay in Washington. Ed does send his apologies. He had hoped to come to this meeting.

As with Jerry, I am especially pleased to greet our guests from the Soviet Union. We have a common border with the Soviet Union that is over 1500 miles long and runs through the Bering and Chukchi Seas. We share a common interest with the Soviet Union over the living marine resources in that area and the common responsibility for their protection. As you will learn later this morning MMS scientists made two visits to the Soviet Union and this is their first visit here.

It is my hope that our common interests and on-going discussions will lead to scientific collaboration in the Bering and Chukchi Seas. That is what we are really striving for. The development of sound scientific information is important for the uses that we make of it in the Minerals Management Service. We put high priority on making new results available to others. We are always glad to share our scientific information with others and hope that others have the same interest in quality as we do. Most studies, as most of you are aware, are conducted by contractors to MMS or NOAA's Outer Continental Shelf Environmental Assessment Program. The Studies Program started in 1975 and since then we have spent about $230 million for the Alaska portion. It has covered a very wide range of subjects: Pollutant transport, living resources, endangered species, ecosystems, potential and fates and effects of spilled oil, social and economic effects. We have also monitored the chemical and biological indicators of hydrocarbons in the environment. It is not quite as well known that in addition to the Studies Program about which this meeting centers, that MMS finances an engineering and oil spill research program on containment and clean-up technology. In fact, at the time of the Prince William Sound oil spill last spring, MMS was the only federal agency sponsoring research on this subject. Other agencies had in the past, but stopped for a variety of reasons. Of course there has been a bit of a rush to that subject since the oil spill, so we are not the only ones in the game any longer.

Yesterday, the President's budget for Fiscal Year 1991 was released. For Minerals Management Service it reflects an emphasis towards expanded environmental studies and enhanced supervision of operations on the Outer Continental Shelf. The budget effects of that emphasis on studies and regulation of operations will not be as strong for this region as it will be for other regions. That is principally because the Studies Program has received strong financial and policy support for the Alaska OCS Region for some time. Also in our regulatory

program, we have had a strong compliance effort for a long period of time. Both of those programs will remain strong for the Alaska OCS Region. In the new budget, $3.6 million is earmarked to support the Administration's Global Climate Change Indicators Initiative MMS wide. MMS will be involved in that initiative along with other federal agencies. A good share of the $3.6 million will be coming to the Alaska OCS Region.

A unique aspect of the Alaska Studies and Operations Program has been the coordination with our neighbors to the East, Canada. We meet with Canadians annually on a formal basis, and informally whenever we need to. We have good personal communications with our Canadian counterparts. It is my goal that through this meeting and subsequent meetings that we establish that kind of regular attentiveness and coordination with our neighbors to the West, the Soviet Union. We hope that this relationship goes further. Thank you very much.

OVERVIEW OF RECENT SCIENTIFIC COOPERATION BETWEEN MMS AND THE FAR EASTERN BRANCH, USSR ACADEMY OF SCIENCES

J. Jerome Montague and Cleve J. Cowles
Alaska OCS Region
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Anchorage, Alaska 99508

Initial contact between the MMS Environmental Studies Program and Soviet research agencies was in March 1989 under the auspices of the US/USSR Interacademy Exchange Program administered jointly by the National Academy of Sciences and the Academy of Sciences of the USSR (ASUSSR). At that time information on the bowhead whale was exchanged with scientists at institutes of the ASUSSR in Moscow, at institutes of the Far Eastern Branch of ASUSSR (FEBAS) in Vladivostok as well as with the Pacific Institute of Fisheries and Oceanography (TINRO). In terms of cooperation the visit resulted in a promise from TINRO to do aerial surveys on the Soviet side of the Navarin Basin and an invitation by the Pacific Oceanological Institute (POI) of FEBAS to attend a conference to discuss possible cooperative research on issues of shared ocean resources.

As a result of the second meeting at Nakhodka, USSR, in September 1990, we identified the following three areas of potential cooperation between MMS and POI: 1) participation in the 1991 research cruise of the *Akademik Aleksandr Nesmeyanov* in the North Pacific and Chukchi Sea; 2) initiation of a program of scientific information and personnel exchange; and 3) cooperative aerial surveys of cetacean distribution and abundance in the Soviet and American side of the Chukchi Sea in the fall.

RESEARCH ACTIVITIES OF THE PACIFIC OCEANOLOGICAL INSTITUTE

A.V. Alekseev
Pacific Oceanological Institute
Far Eastern Branch
USSR Academy of Sciences
7 Radio Street
Vladivostok 690032

The Pacific Oceanological Institute of the Far Eastern Branch of the USSR Academy of Sciences (POI FEB USSR Academy) was founded on January 1, 1973, in Vladivostok. The main tasks its staff investigates are fundamental science and applied studies aimed at exploration and exploitation of the Pacific Ocean and its adjacent seas. The director of the Institute is Academician Viktor Ilyichev. The following investigations are carried out by the scientists:

- complex hydrophysical studies of water masses; their physical fields (acoustic, optical, electromagnetic, temperature) and such characteristics as ocean disturbances, energy exchange, ocean-atmosphere interaction, ocean currents and circulation;
- geomorphology and geology of the Pacific Ocean floor;
- development and construction of new techniques and equipment.

In the following aspects the Institute is among the leading USSR Academy institutions: acoustical sounding of stratified water masses, radar sounding of near-water atmosphere, computer modeling of gyreformation in the ocean, wave processes in unhomogeneous mediums.

The main experiments and studies are carried out in the Pacific Ocean and its adjacent seas (Okhotsk, Bering, Japan, East China, Philippine and South China Seas). Modern scientific vessels are equipped with up-to-date devices and navigational facilities enabling the scientists to accomplish complex investigations in the ocean. The Institute also has a station to carry out experiments in the coastal zone situated on an island not far from Vladivostok.

The staff of the Institute is composed of the following departments:

1. Department of Thermodynamics of the Ocean. The main studies are of the regularities of oceanic fields formation, thermohaline structure and dynamics of seawater in the Pacific Ocean and the adjacent seas. Special attention is paid to structured peculiarities of frontal zones in the northwestern Pacific as well as to the interaction mechanism of currents, turbulence and internal waves.

2. Department of Acoustics. Studies meso- and microscale variability of hydrophysical oceanic fields, develops hydroacoustical devices and facilities for ocean exploration, and deals with fine structure distribution of hydrophysical fields.

3. Department of Electrodynamics of the Ocean. Investigates dynamic phenomena, surface disturbances including internal waves. The department uses methods utilizing lasers to study the dynamics of ocean-atmosphere mass exchange, applies radiospectroscopy to study the

dynamics of chemical composition of the seawater. They actively develop techniques and facilities to investigate dynamic processes with emphasis on tritium distribution in the ocean and atmosphere.

4. Department of Geophysics. The main trends of investigations are the study of structure, physical properties, dynamic state of the earth crust, and the upper mantle of the western Pacific and its marginal seas by geophysical methods to decide the problems of genesis and evolution of the ocean-continent transition zone.

5. Marine Geology Department. Studies the geological structure of the ocean floor, island arcs and oceanic troughs in the northwestern Pacific to work out models of structure and evolution of the earth crust in the Asian Continent-Pacific Ocean transition zone and to identify useful minerals in the ocean.

6. Department of Computer Investigations. Carries out the works on automatization of research, application of computer complexes to process a large amount of oceanological data and develops the methods for operative processing of information.

7. Department of Geochemistry. Studies ocean-atmosphere chemical exchange, works out the recommendations to determine the consequences of ocean pollution by petroleums and toxic elements; investigates the processes of contemporary sedimentation and geochemistry of lithologenesis; develops techniques and devices to measure physico-chemical parameters of seawater.

8. Department of Wave Processes (in the ocean). Carries out theoretical studies of wave fields with ocean and atmosphere, topographic cyclogenesis in the ocean, and experimental research on applied radio-physics.

9. Department of International Problems. Its activity is aimed at broader international cooperation in the world ocean research. Its staff studies the experience of oceanological institutions in other countries, the possibilities of informational exchange and international cooperation within the framework of the Marine Sciences Committee of the Pacific Sciences Association.

MAIN RESULTS OF THE RESEARCH ACTIVITY

In the field of ocean physics, complex hydrological, hydro-optical, and hydroacoustical investigations in the northwestern Pacific have been carried out. Time variability of statistical characteristics for fine structure stratification of water masses in the area of subarctic fronts has been investigated. A number of complex experiments to study anticyclone gyres in the Kuroshio zone has been accomplished.

Thermohaline characteristics of deep waters for the South China Sea have been determined as well as the diagrams of water circulation for summer and winter periods have been fulfilled.

Acoustic measurements of absolute gyre intensity have been conducted. A method to study the fine structure of waters in the ocean has been tested. It was proved that a deep depositing of layers is modulated by long-period internal waves. The experiments have been accomplished

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to investigate the peculiar nature of sound signal penetration through the frontal zone of the northwestern Pacific.

A new submarine sound channel of wave-type has been found on the basis of the hydro-acoustic data in the interfrontal zone of the northwestern Pacific.

New methods of theoretical hydrophysics have been developed, among them:

- method of invariant submersion in the theory of wave spreading (acoustic, electromagnetic, inner, etc.);
- method of contour dynamics.

Methods of numerical calculation of wave field characteristics in interlayered mediums, a numerical model of unstable axisymmetrical two-layer gyres in the upper and lower layers of the ocean have been developed.

Data on characteristics of electric and magnetic fields of coastal waters have been received. Sea water cavitational stability have been studied.

Ocean Geochemistry

Our scientists have determined changeability of the Ca/Chlorine ratio in dynamically active zones of the world ocean. They determined experimentally the change of the surface tension, velocity of film spreading and evaporation in photochemical and bacterial oxidation of hydrocarbonate film in the air-water interface. New methods of complex investigations of sea-water pollution by oil hydrocarbons and heavy metals have been developed on the basis of the field experiments and observations in the coastal zone and in the river-estuaries of the Japan and South China Seas.

Geophysics

Area (surface) and profile studies of gravitational and geomagnetic fields and natural heat flow have been carried out in the western and southwestern Pacific, in the Sea of Japan, in Philippine and South China Seas. Thickness and structure of sediments, relief of acoustic basement and velocity section of the earth-crust have been studied by seismic method in the regions mentioned above and on the submarine Shatsky and Obruchev's rises.

Gravitational, heat and seismic models of the investigated morphostructures have been built. Genetic and development (evolutionary) models of separate regions and transition zones in the whole are under completion on the basis of the data received.

Geology

Geological maps of the Sea of Japan and the Okhotsk Sea, of the Tatar Strait, Kuril-Kamchatsky arch-trough system have been completed and described. The section of the oceanic crust in the southwestern Pacific has been accomplished. Our scientists have

established the phenomenon of clustering of the oceanic crust on the island slope in the Tonga trough region.

Technique Development and Means of Ocean Studies and Exploration

Energetic resources (heat, salinity, tides, waves) have been studied in various regions of the Pacific. A submersible sounder has been developed on the basis of the laser interferometer to measure the index change of sea water refraction and density. An optical lidar has been developed for distant determination of the oxygen, nitrogen, water steams, and hydrogen. Samplers have been constructed to take the ground samples up to the drilling of the 6th category. Our scientists have developed highly sensitive methods of inner waves registration in a broad band of amplitudes and periods.

In recent years better developed and more exact equipment is required to investigate all characteristics of the ocean. Fast development of oceanology and its new aspects demand corresponding technical means.

QUESTIONS AND DISCUSSION

Frank Williams: Does your group work with fish population?

Arkady Alekseev: Our institute works mainly with physical oceanographic processes rather than biological.

Jerome Montague: How many people work in your institute?

Arkady Alekseev: 1100.

Jerome Montague: How many institutes are in the Far Eastern Branch of the USSR Academy of Sciences?

Arkady Alekseev: Twenty six.

Jerome Montague: Would these be similar in size?

Arkady Alekseev: The Pacific is the largest one.

DISTRIBUTION AND MIGRATION OF CETACEANS IN THE U.S. CHUKCHI SEA IN THE FALL OF 1989, WITH A SUMMARY OF DATA COLLECTED FROM 1980-89

Sue E. Moore
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2845-D Nimitz Blvd.
San Diego, California 92106

INTRODUCTION

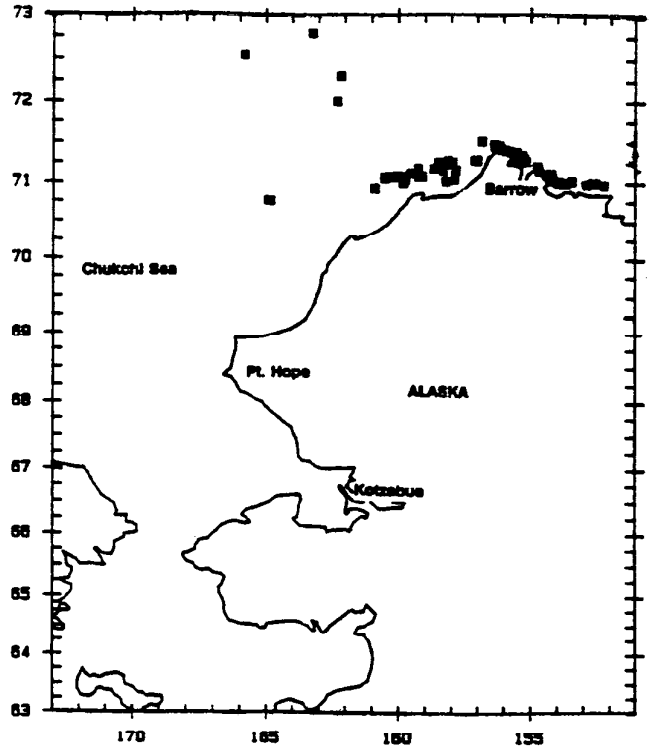
Aerial surveys were conducted over the Alaskan Chukchi Sea from 20 September through 3 November 1989. Over 135 hours of surveys were flown comprising roughly 18,000 km of transect flight and 13,000 km of search effort. This was the first of three planned survey seasons in the Chukchi Sea conducted under the auspices of the U.S. Minerals Management Service (MMS), Alaska OCS Regional Office. Some fall aerial surveys were flown in the Chukchi Sea between 1980 and 1988, with more concerted effort there between 1982 and 1988. Data collected on this three year study will be integrated with the 1980 to 1988 data to provide the largest possible data base for describing seasonal distribution, migration route, abundance and habitat relationships of cetaceans in the Alaskan Chukchi Sea.

Cetaceans commonly seen in the Chukchi Sea each fall include bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*) and belukha or white whales (*Delphinapterus leucas*). All cetaceans are protected under the U.S. Marine Mammal Protection Act, and bowheads and gray whales are also protected under Federal Endangered Species legislation. The distribution and migratory timing of bowhead whales is of particular concern to MMS because of the whale's endangered status and the desire by MMS that projected oil and gas development not interfere with fall whaling activities conducted by Alaskan Eskimos from Barrow, Alaska.

Bowhead Whales

Sixty-nine sightings of 131 bowhead whales were made in the Chukchi Sea study area (from the Bering Strait to 73°N, between 154° and 169°W) from 20 September through 29 October 1989 (Figure 1). Six whales were seen in September and 125 whales were seen in October, 14 of which were east of 154°T. Relative abundance was highest in waters northeast of Barrow. Sighting rate peaked on 5 October, with a second smaller peak on 14 October. All but four whales were seen along a migratory route near the coast between Smith Bay and Barrow, along a route centered roughly 30 km offshore between Barrow and Wainwright, and to about 120 km offshore northwest of Icy Cape. Swimming direction was significantly clustered about a southwesterly heading (252°T) from 21 to 31 October and westerly headings (268°T) over the course of the 1989 season (Figure 2). Most bowheads (>50%) were swimming, although feeding, milling, resting, log play and bouts of aerial displays were also observed.

Bowhead distribution, migratory timing, and route observed in 1989 was similar to that described by the 1980 to 1988 data set. There were 221 sightings of 494 bowheads from 1982 to 1989; no bowheads were seen in the study area in 1980 to 1981 (Figure 3). Sighting rate peaked each year in early October, with a second smaller peak later in the month. Swimming direction east of Barrow (154-157°W) was significantly clustered about 276°T and west of Barrow about 247°T. The four whales seen north of 72°N in 1989 add significantly to the small data set of whales seen well offshore and suggest there may be a 'secondary' migration route across



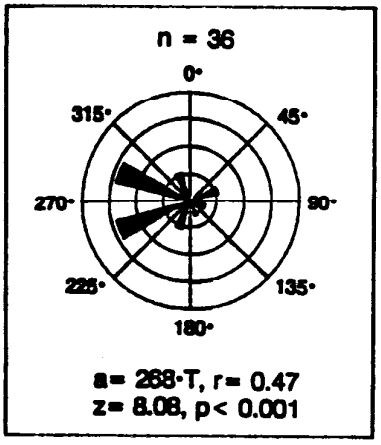


Figure 2. 1989 bowhead whale swim direction.

Figure 1. Distribution of 69 sightings of 131 bowhead whales, 1989.

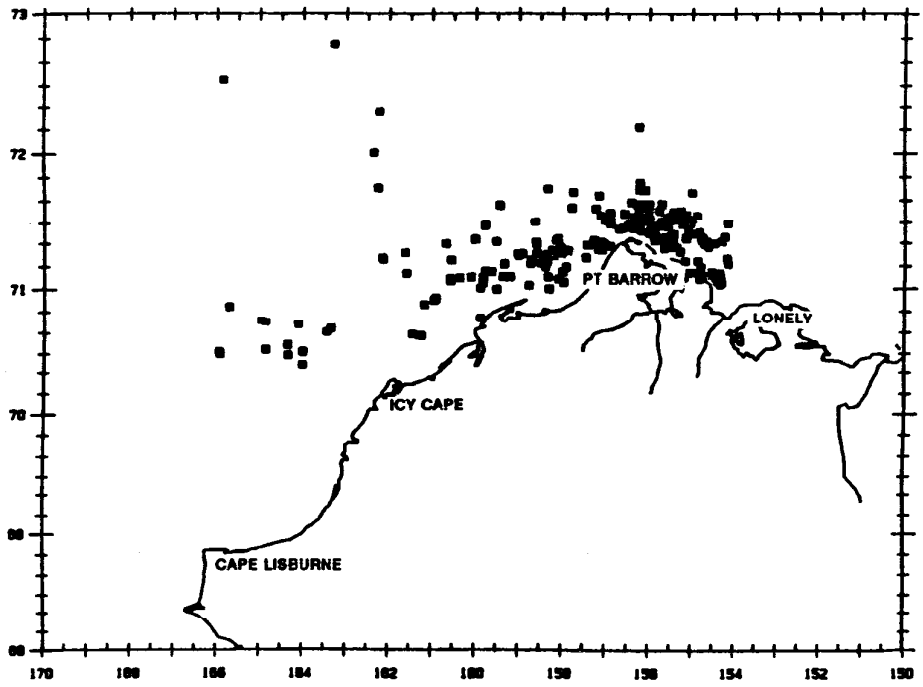


Figure 3. Distribution of 221 sightings of 494 bowhead whales, 1982-89.

the Chukchi Sea north of the route described by the southwest dispersion pattern seen closer to shore.

Gray Whales

There were 59 sightings of 170 gray whales in the Chukchi Sea in 1989 (Figure 4). Grays were seen nearshore at Point Franklin southwest of Barrow and in a localized area roughly 160 km northwest of Barrow near Hanna Shoal (*ca.* 72°N, 162°W), as in past years. Notably, a large assemblage of grays was also seen in the southern Chukchi Sea in late October; this group extended as far as observers could see west of the International Date Line. Gray whale abundance was an order of magnitude higher in waters southwest of Point Hope in the southern Chukchi Sea, than for offshore and coastal areas in the northeastern Chukchi Sea. All but 18 gray whales were feeding, inferred by their association with mud plumes. Swimming direction for whales not feeding was not significantly clustered about any direction (Figure 5).

Gray whale distribution in the northeastern Chukchi Sea in 1989 was similar to that observed in past years (Figure 6). Grays are commonly found along the coast between Point Hope and Barrow and in offshore waters near Hanna Shoal, where they are also seen in summer months (July-August). Relatively dense aggregations of grays were seen feeding in the southern Chukchi and northern Bering Seas in 1989 and 1980, respectively. Grays do not seem highly directed in their swimming in these waters even in late fall.

Belukha, or White Whales

There were 83 sightings of 421 belukhas in the Chukchi Sea in 1989 (Figure 7). Whales were seen relatively nearshore southwest of Barrow and well offshore north and west of Barrow. Belukha abundance was an order of magnitude higher in waters north of 72°N latitude than for coastal areas. Swimming direction was significantly clustered about a westerly heading (273°T; Figure 8).

The pattern of belukha distribution observed in 1989 was similar to that for years 1982 to 1989; no belukhas were seen in 1980 to 1981 (Figure 9). Most belukhas appear to take a more northerly route across the Chukchi Sea, although some whales migrate southwest across the Chukchi Sea closer to shore. This pattern of distribution is similar to, but the inverse of, that described for bowhead whales.

In summary, the distribution, relative abundance, and migratory patterns of cetaceans in the Chukchi Sea indicate that:

a) bowhead whales reach the Chukchi Sea by the latter half of September, with major pluses of whales through the area in early and mid-October;

b) bowheads are sometimes seen nearshore between Smith Bay and Barrow where they may linger for several days to mill, feed, and rest, resulting in highest relative abundance indices being calculated for these waters;

c) most bowheads swim in a southwesterly direction across the Chukchi Sea on a migratory course that crosses roughly south of Herald Shoal (*ca.* 70°30'N, 170°W), although some whales may migrate along a more northerly route (*ca.* 72°30'N) to Herald and Wrangel Islands before heading south along the Chukotka coast;

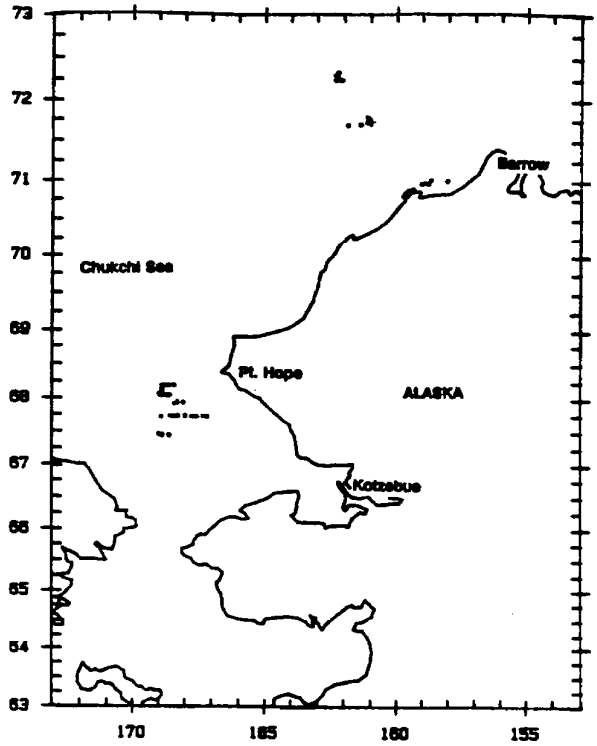


Figure 4. Distribution of 59 sightings of 170 gray whales, 1989.

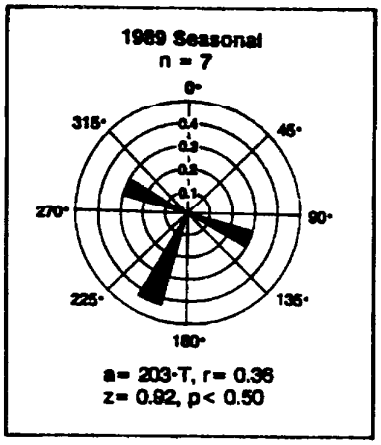


Figure 5. 1989 Gray whale swim direction.

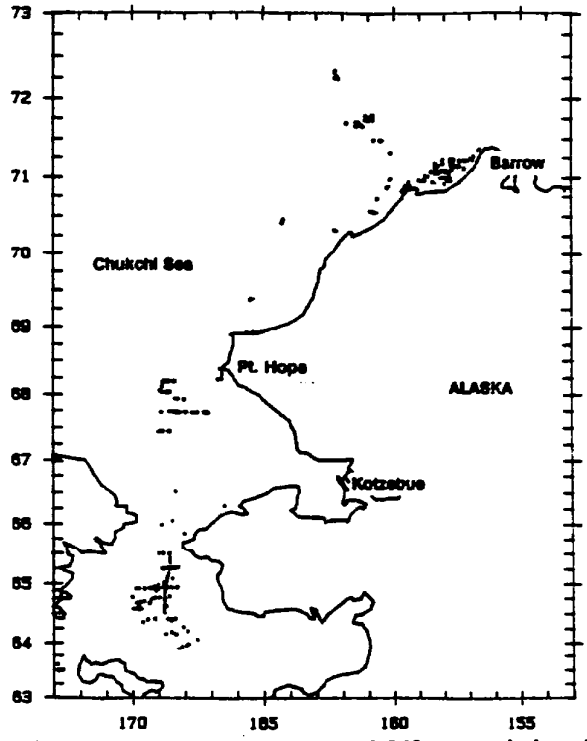


Figure 6. Distribution of 245 sightings of 673 gray whales, 1980-89.

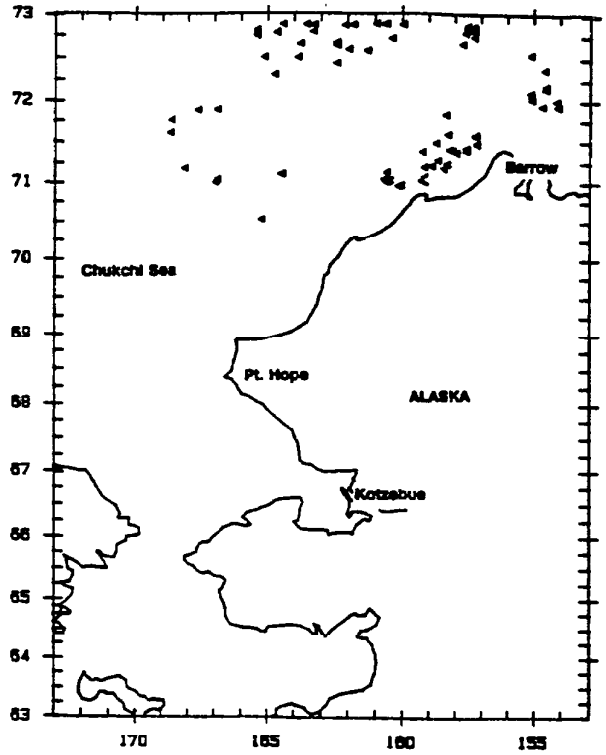


Figure 7. Distribution of 83 sightings of 421 belukhas, 1989.

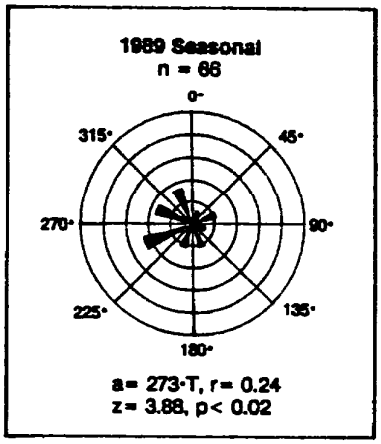


Figure 8. 1989 belukha swim direction.

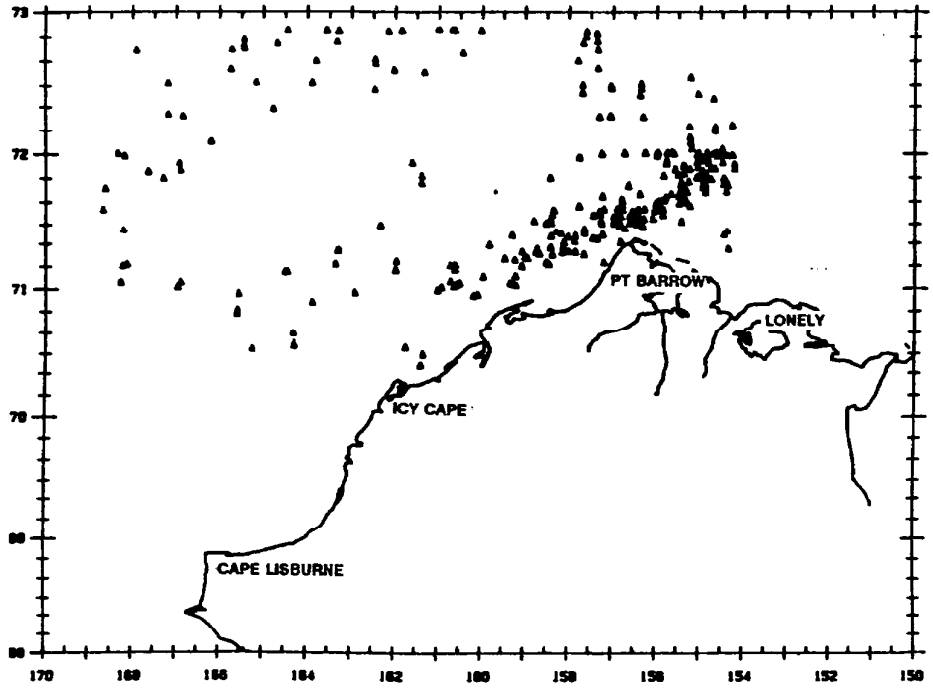


Figure 9. Distribution of 294 sightings of 3,291 belukhas, 1982-89.

d) gray whales feed nearshore and near Hanna Shoal in the northeastern Chukchi Sea and southwest of Point Hope in the southern Chukchi Sea; grays are not strongly directed in their movements even in late October and early November in the southern Chukchi and northern Bering Seas;

e) belukhas, or white whales are seen in relatively offshore areas, with a component that disperses across the Chukchi Sea in a manner similar to bowheads; belukhas are strongly directed in their movements with swimming direction significantly clustered about westerly headings;

f) although analyses are incomplete, the distribution pattern for bowheads and belukhas suggests that currents may play a role in determining the migratory route through the Chukchi Sea. The nearshore distribution generally follows the pattern of the Alaska Coastal Current along Alaska's northwest coast, while the offshore component may more closely align with the Bering Sea Water Current which flows northward to the west of Herald Shoal and through Herald Canyon east of Wrangel Island. These associations will be investigated in future analyses.

REFERENCES

Clarke, J.T., S.E. Moore, and D.K. Ljungblad. 1989. Observations on gray whale (*Eschrichtius robustus*) utilization patterns in the northeastern Chukchi Sea, July-October 1982-1987. Can. J. Zool. 67: 2646-2654.

Ljungblad, D.K., S.E. Moore, J.T. Clarke, and J.C. Bennett. 1988. Distribution, abundance, behavior and bioacoustics of endangered whales in the eastern Beaufort Sea and northeastern Chukchi Sea 1979-87. Final Report to MMS, Alaska OCS Region, OCS Study MMS-87-0122, prepared by the Naval Ocean Systems Center (NOSC TR 1232) and SEACO/SAIC, 231 pp.

Moore, S.E., and D.K. Ljungblad. 1984. Gray whales in the Beaufort, Chukchi and Bering Seas: distribution and sound production. Pages 543-559 *in* M.L. Jones, S.L. Swartz and J.S. Leatherwood, (eds.), The Gray Whale. Academic Press, Inc., San Francisco, CA. 600 pp.

Moore, S.E., J.T. Clarke, and D.K. Ljungblad. 1986. A comparison of gray whale (*Eschrichtius robustus*) and bowhead whale (*Balaena mysticetus*) distribution, abundance, habitat preference and behavior in the northeastern Chukchi Sea, 1982-84. Rep. Int. Whal. Commn. 36:273-279.

Moore, S.E., D.K. Ljungblad, and D.R. Van Schoik. 1986. Annual patterns of gray whale (*Eschrichtius robustus*) distribution, abundance and behavior in the northern Bering and eastern Chukchi Seas, July 1980-83. Rep. Int. Whal. Commn. Spec. Issue No. 8:231-242.

QUESTIONS AND DISCUSSION

_____: I am curious about the timing of the southward movement of gray whales. I have seen a lot of gray whales moving south along the coast, like past Cape Lisburne and Cape

Thompson in late July through mid-August. I am wondering if we are seeing the beginning of it and you are seeing the end, or if you are seeing the bulk of it?

Sue Moore: Well, a point that I was trying to make is that we are not seeing the movement. The whales that we are seeing are still primarily feeding. We don't see strong directed movement, even late in October. We do have some whales that do seem to be moving in a direction, but overall, the bulk of the data shows animals that are still feeding even late in October.

_____: But are those the last few in the population or is that characteristic of the population?

Sue Moore: The last few, the ones that I am looking at? Well, if you are seeing animals that are swimming by in summer, yes I would say so, but we haven't really done surveys in summer. Our surveys don't start until the end of September.

Mark Fraker: The observations you had of gray whales northwest of Barrow, in Hanna Shoals, what is the depth in there?

Sue Moore: That is relatively shallow, but then the whole shelf is. I am not real certain, 20 fathoms or something. I should really check that.

Mark Fraker: Twenty fathoms? You had two little clusters up there and both of those were in some of that water, about 20 fathoms. Then the belukha sightings, the symbols you showed were sightings of...

Sue Moore: X number of animals. Each symbol represents one or several animals.

Mark Fraker: But the majority of animals were in the more northerly...

Sue Moore: Correct. When we looked at sighting rates, which takes all animals just over the time that we spent surveying, those sighting rates were a ten-fold difference with more animals north.

Mark Fraker: How did they relate to ice conditions?

Sue Moore: Well, again this year the ice was very far offshore. For a good part of the season, through mid-October, the ice edge was up around 73N°. So most of those animals were in open water because most of our study area was in open water. There just wasn't any ice this year for a good part of the time.

Mark Fraker: So the belukha sightings weren't associated with ice edge in particular?

Sue Moore: Not *per se* because the ice edge was right along the northern boundary of our study area.

John Richardson: Would you comment on the timing of the sightings of both belukhas and the few bowheads that were up in the northern-most area that you surveyed? Were they at the same times as all of the others?

Sue Moore: They were over the course of the season. One of the little bowhead boxes there was actually the first sighting of the season, the 20th of September. So the very first day we flew, we saw one bowhead up in the northern areas. For belukhas, basically we were seeing animals both nearshore and offshore in the same time periods, over the course of the season. There was not a clear separation.

_____: I do a lot of beach combing and this past summer I noticed probably twice as many dead gray whales on the beaches in Bristol Bay as I normally do. Have you noticed anything similar?

Sue Moore: No, we didn't. I believe the North Slope Borough put out a memorandum about some carcasses that were south of Barrow this year. They noted, I believe, seven carcasses south of Barrow. But we did not notice any number of carcasses.

Boris Bessonov: What would you say about autumn migration of bowheads from Alaska across the west part of the Chukchi Sea in June, August, or September?

Sue Moore: Basically our data shows that migration proceeds in a southwest dispersive pattern around Barrow. So the animals swim across the Beaufort Sea to Barrow and then most animals seem to take up a southwesterly heading that would have them swim across the basin and then over to the Chuktoka Peninsula. We have only a few data points that suggest some whales may stay further north, going over roughly to Herald Island, Wrangel Island, and then encounter the coast and swim down. All of our information is late September and early October that we have looked at, not earlier in the season. The data that I summarized here was collected under the auspices of MMS since 1982. That is the data that I am showing that suggests those patterns.

Boris Bessonov: What is the size of the Alaska bowhead population?

Sue Moore: The current estimate of the size of the population is 7800 whales. That population size was accepted by the International Whaling Commission in 1988. Prior to that, in 1984 we were down to 4400 whales. But the current estimate is 7800 bowheads.

Boris Bessonov: What would you say about the number of bowhead that migrate to our part of the Chuktoka Sea?

Sue Moore: At this point, we are assuming that they all do, which may be a rash assumption.

Jerome Montague: Since our primary objective with the surveys was to find out exactly what pathway the bowhead whales do use, I am particularly fascinated by your suggestion that there is a two-pronged migration path that essentially leaves the central Chukchi for the very low concentration of whales.

Sue Moore: I wouldn't say that is what it suggests. Really most of the whales we are seeing are rounding the corner and heading south-southwest. So that would bring the whales right across the center of the basin going over to the Chuktoka Peninsula. But the sightings that we have to the north, I am suggesting, may be another route, a route maybe less used. But there are some animals doing basically what Braham suggested years ago and stay north. So all of the animals might not be doing the same thing.

Jerome Montague: Maybe I misunderstood you. You showed an overhead of the belukha migration which looked like one path along the Alaska coast and one path along the ice edge, and said that you thought that the bowheads might follow a similar path.

Sue Moore: I guess that I am misinterpreting what you are indicating about the center of the Chukchi Sea. That is really just an area around Hanna Shoals, fairly localized, that I believe that the animals might be going around. That is what I am suggesting.

Jerome Montague: So you are not suggesting that some follow the ice edge and some follow the southwest coast?

Sue Moore: I think it might be more current driven than ice edge driven that is why I showed the graphic with the currents. But our data show that most of the animals that we have seen, and again we have only this one year of effort north of 72N°, but most of the bowheads we have seen are going around Barrow and dispersing southwest across the basin.

Jerome Montague: Evenly southwest, spread out evenly?

Sue Moore: The heading is 247°, so it is a southwest heading west of Barrow.

David Boyce: I have a question regarding the utility of aerial surveys. You indicated about 135 hrs of survey hours during some 40 days which comes to a little over three hours per day. Can you comment on the number of days during that period that you were able to fly; and, part two of this question, you indicated that at least for bowheads that one group that you saw had a tagged individual in that group, was your survey in any way connected with finding groups via the tagging procedure?

Sue Moore: The answer to the first question is over the years we have found that we fly roughly 66% of the time. So a third of the time we can't fly due to the weather. And that means we've either gone out and tried and have had to come back or we just haven't gone out, because sometimes you just can't see the plane. The second question: we were outfitted in the later part of the season to attempt to listen for tagged whales. We were not involved in the tagging process at all but because we were there we were used as a platform to try to listen for tagged whales. As it turned out the tagging team came to Barrow and we talked with them. That is how we knew that a whale in the aggregation that we had seen offshore had a tag in it.

DISTRIBUTION AND MIGRATION OF CETACEANS IN THE SOVIET CHUKCHI SEA
Summary of Data Collected from 1960 to 1989

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The bowheads wintering in Soviet inshore waters begin to move along the coast of the northern Anadyr Gulf, the northwestern Bering Sea, and through the Bering Straits from mid-April to early June. The tracks of migrating animals pass within 100 to 200 m offshore at definite points of the coast (Nunligran, Sireniki, Chaplin Cape, Dejnev Cape, etc.). The number of animals in the migrating group is from one to five. Part of the bowheads from the Bering Straits turn to the northwest and reach (as an average from year to year) 179° E Longitude and Wrangel Island in July - August, but sometimes they are observed near Ayon Island. In August they turn back. Probably part of the Alaskan population of bowheads migrates along the ice border to the western part of the Chukchi Sea and reaches Chukotka near Vancarem in September - October. There is the possibility of migration in the opposite direction too in this region during the same period. In the last ten days of October to the first ten days of November they pass through the Bering Straits and return to the south coast of Chukotka. Part of this population (from 1 to 5 animals) winter in the Sireniki Polynya. Probably that is where they give birth (Bogoslovskaya et al., 1984). This hypothesis was supported by the archeological discovery of whale bones in Chukchi villages. Bowhead subsistence hunting in the winter used to be the major activity of native people. Hunting restrictions on bowhead in 1978 negatively affected natives' well-being and culture. It would be very beneficial to allow the native people in the Sireniki region to harvest 2 to 3 bowheads a year.

Gray whales pass through the Bering Straits in the second half of May, and part of them turn to the northwest. They reach along the coast and pack ice border to Wrangel Island in summer. This species migrates both in singles and small groups of 3 to 5 animals. Pregnant females migrate first. They represent up to 80% of the gray whales hunted by natives in July; this number goes down to 3% in August - September. Generally most of the gray whales are harvested in August (more than 50%). In August and September gray whales turn back. Their spring and autumn migration track is not more than 35 km offshore. They pass through the Bering Straits as do bowheads in the last ten days of October to the first ten days of November.

White whales and killer whales were observed as singles and in small and large groups (to 150 animals) in the Russian part of the Chukchi Sea in the summer and autumn offshore and in the open sea and in broken ice. They reach latitude 75° N.

Minke whales and humpbacked whales have been observed in the Russian Chukchi Sea from the Bering Straits to the pack ice border.

Between 1990 and 1993, we plan investigations in three different directions:

1) Censusing from shore stations at Sireniki, Chaplin, Paak Capes and other points. These stations will mostly employ native (Chukchi) people;

2) Carrying out whale census from airplanes, including radiotracking;

3) Cooperative research cruises in the Chukchi Sea on ships of the Academy of Sciences, USSR.

Filming and videotaping will be a valuable and necessary part of the work in all three types of investigations listed above.

REFERENCES

Belikov, S.E., Yu.A. Gorbunov, and V.I. Shilnikov. 1984. Distribution and migration of some seals, cetaceans, and white bear in eastern Arctic Seas. Pages 233-252 *in* Marine Mammals. Nauka, Moscow.

Belikov, S.E., Yu.A. Gorbunov, and V.I. Shilnikov. 1989. Winter distribution of Pinnipedia and Cetacea in the Soviet Arctic Seas and Bering Sea. Biology of Seal. 4:33-41.

Berzin, A.A., and A.A. Rovnin. 1984. Distribution and quantity of Balaenidae in the Pacific Ocean. Pages 147-162 *in* Marine Mammals. Nauka, Moscow.

Blohin, S.A. 1984. State of gray whale population. Pages 223-233 *in* Marine Mammals. Nauka, Moscow.

Blohin, S.A. 1986. Survey of the distribution, quantity, and behavior of gray whales near the coast of the Chukchi Peninsula. Pages 36-41 *in* NIR on marine mammals of the north Pacific in 1984-1985. VNIRO, Moscow.

Blohin, S.A. 1988. Cruise results of research vessel *Tungus* on surveys of cetaceans along the coasts of the Far East seas, June-October 1986. Pages 24-37 *in* NIR on marine mammals in 1986-1987. VNIRO, Moscow.

Bogoslovskaya, L.S., L.M. Votrogov, and I.I. Krupnik. 1984. Bowheads near the Chukchi Peninsula, history and news. Pages 191-212 *in* Marine Mammals. Nauka, Moscow.

QUESTIONS AND DISCUSSION

Jerry Imm: Dr. Bessonov did you indicate that the third aspect of the study was radio tagging or satellite tagging of whales? Did you mention the COPAS satellite in your talk?

Boris Bessonov: We designed the equipment for radio tracking of whales by COPAS channel in our Sputniks. Now our engineers are working on the problem and maybe the first part of this work will be finished in June or August. We will try to tag this year.

Jerry Imm: Thank you. We are working with the ARGOS satellite, the French satellite, with Dr. Bruce Mate who will give a presentation later on satellite tagging as well. So we are quite interested in your connection with satellite tagging.

Boris Bessonov: Dr. Montague has talked to me about it and we may compare our two systems.

Mark Fraker: You have sightings of bowhead whales in the western Chukchi Sea in June and July?

Boris Bessonov: No, I didn't see them myself, but I reported the results of an investigation by my colleagues. They reported that in the western part of the Chukchi Sea the earliest observation of bowheads was near the end of July or the first part of August. Near Ayon Island, (there were observations in) the last part of August and the first part of September when these regions were free from ice. From year to year the ice condition changes. When this region is free from ice in the first part of September we have regularly observed bowheads in this area.

Mark Fraker: But you do not see them there in June or July?

Boris Bessonov: No. In June or July they reach Cape Vancarem. Vancarem may be very rare. Cape Billings is the furthest area where we have observed these animals. But when ice conditions are good they move to Ayon Island.

Mark Fraker: Do you have an idea of how many bowheads there might be there?

Boris Bessonov: I have calculated and summarized the data from the literature and agree with this data. This population may be near 1000 animals. But in Sireniki Polynya near 200 animals regularly winter and the remainder of this population goes south. It is a very useful problem. Dr. Bogoslovskaya began work to return to our Chukchi people the right to hunt one or two bowheads a year because they had been prohibited to hunt in 1978. This was very bad for the Chukchis, they are a very poor people now. It is a very difficult situation in this region of our country.

Jerome Montague: You indicated that the whales that winter in the Sireniki Polynya are a separate group that also spend the summer on the Soviet side of the Chukchi?

Boris Bessonov: No, in the summer only single animals stay in this region, but most of this population goes to the north.

Jerome Montague: I know they go to the north, but do they go to the north and stay on the Soviet side or travel to the American side?

Boris Bessonov: Without radio tracking it is impossible know which animals go to the Bering Straits from St. Lawrence and from Sireniki Polynya. To answer your question, it would be necessary to radio track them.

Jerome Montague: Could you repeat why you need a video camera and what you propose to use it for?

Boris Bessonov: Unfortunately for us, we have only a large airplane, an Ilyushin 18. It flies very fast and we may only see a whale for 6 seconds. Without observations it is impossible to identify the species of these animals. In the field it is very difficult to work with cinecamera (movie camera). But with video camera it simplifies that.

Jerome Montague: I don't know if anyone in the audience has better information, but from our experience so far using a video camera from an airplane at high speed doesn't result in an image that is useful for counting whales. Can anyone contradict that?

Boris Bessonov: I have had consultation with the pilots who will help us. They said that it is better than by eyes. We may try out this type and see if it works better.

Jerome Montague: We would be interested in finding out how you are able to do that successfully.

Boris Bessonov: To us too.

_____: I have a question for both Sue Moore and for you, Dr. Bessonov. Earlier you had said that you estimated that there were 7800 bowheads, do you believe that this includes this group on the western side of the International Dateline or are you talking only about the animals on the eastern side that you have been able to survey?

Sue Moore: First all, ... calculations of Judy Zeh done during the spring census at Point Barrow. That is where 7800 whales comes from. We do not census the whales. Those are obviously animals that have crossed over and are passing Point Barrow in the spring time and so it would not include animals on the western side.

I have a question for Dr. Bessonov. Just a clarification on the type of survey aircraft that you would be using, it is something that flies quite fast, would you have several observers on the plane or are you just going to try and do the video recording?

Boris Bessonov: In each plane, we will have some observers and the pilots of this plane have a lot of experience in ice reconnaissance. They told me that here are whales, but very often may locate them at broken ice. They told me there is no problem, only money is the problem.

Jerome Montague: Can you describe an Ilyushin 18?

Boris Bessonov: It is a four turbo-engine airplane made especially for ice reconnaissance. It can stay nearly 12 or 15 hours in the air, a very long distance. The minimal speed of this plane is 300 - 400 km/hr which is very fast.

Jerome Montague: What altitude?

Boris Bessonov: From 100 meters and up.

Jerome Montague: Propeller or jet?

Boris Bessonov: Propeller, turbojet.

Jerome Montague: What is the capacity for passengers?

Boris Bessonov: Near 100 in the air-liner, if necessary.

Ken Dean: I just wanted to make an observation. I have been working with Peter McCroy in the past on satellite observation of the Bering Sea on the ISHTAR Project. Some of the distributions I have seen in the whale patterns appear to coincide with some of the water masses we have seen in the satellite imagery. There is a highly saline upwelling that occurs nears the Soviet coast between St. Lawrence and the Soviet coast that extends along the Soviet coast up into the Chukchi Sea. There is also a fairly warm, I believe, current that came down the northern side of the Soviet coast that would interact with this cold upwelled water that was flowing into the Chukchi and both of them seem to go due north into the Chukchi. Also the Alaskan coastal water as Sue Moore pointed out diverges north of Cape Lisburne and seems to mix with that Anadyr or cold upwelled water that we looked at. Most of our project was focused on the Bering Sea, but we did look at some of the southern Chukchi because the imagery extended that far north. I think it would be real interesting to pursue it further at some point in the future.

_____: Is that polynya repeatable from year to year? You may have addressed that but it didn't come through clear to me. If so, are there regular oceanographic measurements made in the winter time in that polynya?

Boris Bessonov: Chukchi tales talk about years when this polynya is covered by ice, after which some 1000 Chukchi died from starvation. This is very rare. In the 18th and the 17th century and earlier the largest population of Chukchi lived near this polynya. This fact supposes that this polynya is not often covered by ice. If you would like I can send you information about oceanographic investigations of this polynya.

Bruce Mate: I would like to offer some hope on the possibility of using video tape from the air. The new high density formats available now can be shot at high speed and played back on machines with fly erase heads, which make a very good still frame reproduction. Older vcrs or still frame produced a snowy and lined image. The new technology is very good and I would be glad to share that information.

Boris Bessonov: Thank you. We will use this too, we have this equipment. In field conditions it is very difficult to work with cinecamera. We must work some two or three months on the Anadyr airport without conditions to work with this equipment. We find out the results of our observations with photo equipment at the end of the year, in December or January. But if we use a video camera, we will know the results this evening, this day, this minute. It would be possible to identify the species of whale easier. We will also use ships in this investigation.

_____: I have been working with the remote sensing group at the University of Alaska on a statistical study on polynya distribution in the Chukchi and the Bering Seas. For the most part we have been concentrating on polynyas that form off the Chukchi coast and in what are solidly Alaskan waters, but we have also looked at what we term the Anadyr Polynya, which has been referred to here as the Sireniki Polynya. I have looked at it for four springs and it is huge. It is always there. From the preliminary results that we may have seen from satellite imagery it is a very common, persistent feature. One of the things that I find interesting looking at the Sireniki Polynya in relationship to the St. Lawrence Island one, is that there always seems to be some sort of little barrier of ice extending southward off the west coast of St. Lawrence Island and at certain times one sees not the solid open water status that typifies many polynyas, but in that strait between St. Lawrence and the Chukchi Peninsula, there would be little floes of ice just sort of sitting there statically and not moving anywhere. That could be evidence of the upwelling that Ken Dean mentioned appearing in this Bering in the summer, persisting in the Bering in

the winter and in the fall. It looks like it may be worthwhile pursuing satellite imagery of polynyas in the western Chukchi and the Bering too.

Boris Bessonov: That is a good method for us. We plan to use satellite information too but we plan to unite the investigation of our Far East Scientific with the Institute from Moscow to investigate this phenomenon. And maybe it is advisable to introduce a Reservation State for this area. It is a unique area, this region. Unique underwater. If it is interesting for you, we may be able to have a united expedition in this region.

AERIAL SURVEYS OF ENDANGERED WHALES IN THE BEAUFORT SEA IN THE FALL, 1988 AND 1989

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INTRODUCTION

Every year since 1979, the U.S. Department of the Interior, through the Minerals Management Service (MMS), has funded aerial surveys to monitor endangered whales in arctic waters. Since 1987, MMS staff scientists have conducted the surveys of the fall migration of bowhead whales across the Beaufort Sea.

The goals of the ongoing endangered whale survey program are to:

1) Provide real-time data to MMS and the National Marine Fisheries Service (NMFS) on the fall migration of bowhead whales for use in implementing overall seasonal drilling restrictions and seasonal limitations on geological and geophysical exploration;

2) Provide real-time, site-specific data on endangered whales for use by MMS Resource Evaluation in day-to-day regulation of seismic exploration operations;

3) Continue collection of data to describe temporal and spatial trends in the distribution, relative abundance, habitat, and behaviors of endangered whales in arctic waters;

4) Continue data collection and between-year trend analysis of the median depth (or north-south positioning) of the migration axis for bowhead whales; and

5) Record and map belukha whales and other marine mammals observed incidentally to endangered whale surveys.

METHODS

The aerial survey program is based on an annual sample design of randomized transects within established blocks in the Beaufort Sea (Treacy 1989). The study area, which includes Survey Blocks 1 through 11, is between 140 and 154°W longitude south of 72°N latitude. Survey effort was from 1 September through 20 October in both 1988 and 1989, covering the fall migration of bowhead whales for those years.

Beaufort Sea surveys were based out of Deadhorse, Alaska, utilizing a deHavilland Twin Otter Series 300. The aircraft was equipped with bubble windows aft for an observer and a data recorder-observer. A third observer-navigator occupied the copilot seat and was afforded good forward and side viewing from that position. Observers and pilots communicated through an onboard intercom.

During 1988, a portable computing system (Hewlett Packard 85) was used aboard the aircraft to store and later to analyze flight data. The computer was interfaced to a Global

Navigation System (GNS) for automatic input of entry number, time, latitude and longitude and to the radar altimeter for precise input of altitude.

During 1989, a faster computer (Mitsubishi MP286L), also linked to the GNS and altimeter, was used for both onboard data entry and onboard analysis. The same data were collected as in 1988 but were entered using computer programs developed by project staff for rapid data entry, preliminary analysis of data, and mapping of flight tracks.

RESULTS

1988

A total of 37 bowhead whales, 4 gray whales, 180 belukha whales, 16 bearded seals, 51 ringed seals, 34 unidentified pinnipeds, and 21 polar bears were observed in 1988 during 121.44 hours of survey effort that included 54.75 hours on randomized transects. The overall average number of bowhead whales observed per hour of survey effort, or whales per unit effort (WPUE), in 1988 was 0.30.

The initial sighting of bowhead whales occurred on 14 September 1988. Half (median) of the bowheads observed had been counted by 30 September, with the peak daily count (mode) of 8 bowhead whales occurring on 9 October 1988. The last sighting in the Beaufort Sea study area occurred on 13 October 1988 in an ice lead.

1989

A preliminary total of 216 bowhead whales, 104 belukha whales, 9 bearded seals, 84 ringed seals, and 32 unidentified pinnipeds were observed in 1989 during 98.70 hours of survey effort that included 38.10 hours on randomized transects. The overall WPUE in 1989 was 2.19.

The initial sighting of bowhead whales occurred on 8 September 1989. Half (median) of the bowheads observed had been counted by 29 September, with the peak daily count (mode) of 53 bowhead whales occurring on 28 September 1989. The last sighting in the Beaufort Sea study area occurred on 19 October 1989 in open water.

DISCUSSION

The difference in the total count and WPUE of bowhead whales between 1988 and 1989 was probably a function of an extreme difference in general ice cover for these two years. The year 1988 was the second heaviest ice year since 1975 (USDOD, Navy Polar Oceanographic Center 1989) whereas 1989 was almost totally ice-free during the navigation season. There appears to be some relationship between the general ice cover in a given year and the number of bowheads observed per hour (Treacy 1989). Restricted aerial visibility in heavy ice years is likely to affect observer productivity.

Although the rate at which bowhead whales were observed (WPUE) varied greatly in these years representing extremely different ice conditions, it is interesting to note that the midpoint (median) of the migration in both years was almost identical. This would suggest that the timing of the fall bowhead migration is not linked proportionately to ambient ice cover. The migration corridor was located in slightly deeper water during the heavier ice year (1988).

Twenty-one polar bears were observed in 1988 compared with none in 1989. We attribute this to the known association of the polar bear with the presence of ice floes, which were ubiquitous during the 1988 survey.

Daily summaries of field information from this and other arctic surveys were transferred daily by the project to MMS Field Operations in Anchorage. This real-time information was shared with MMS Resource Evaluations and NMFS in implementing area-wide permit restrictions on high-energy seismic operations, seasonal drilling restrictions, and ensuring that bowhead whales were successfully migrating past drillsites.

LITERATURE CITED

Treacy, S. D. 1989. Aerial surveys of endangered whales in the Beaufort Sea, Fall 1988. OCS Study MMS 89-0033. USDOI, MMS, Alaska OCS Region, 101 pp.

USDOD, Navy, Naval Polar Oceanography Center. 1989. U.S. Navy-NOAA Joint Ice Center seasonal outlook western arctic ice 1989. Rpt. for Navy Oceanography Command. Washington, D.C., 4 pp.

Any use of trade names is for description purposes only and does not constitute endorsement of these products by the Minerals Management Service.

QUESTIONS AND DISCUSSION

Mark Fraker: I have several concerns about the median depth analysis that you do. Do you count both feeding and migrating whales in calculating this median depth analysis?

Steve Treacy: The ones that we have seen to date that have gone in to the median depth analysis since 1987 have almost all been migrating whales anyway. The data would not have been skewed by the addition of any of the feeders that we may have seen. There were just so few feeders.

Mark Fraker: I think that may be true for these last couple of years, but there have been earlier years where there have been large numbers of animals seen in the area just to the east of Barrow. The whole analysis then is very sensitive if there happens to be a large number of whales that occur inshore, in shallow water feeding at some point. That is going to be reflected in the median depth analysis. So that in fact the migration corridor might not change at all, but what may change is simply the number of feeding whales in close to shore will show big differences in median depth.

Steve Treacy: As it turned out, that was the case this year, just east of Barrow a number of whales were reported in late August. They were actually outside our study area.

Mark Fraker: But nevertheless, for example it could be Camden Bay or other locations. I am suggesting that it is quite sensitive to whether or not there are large numbers of feeding animals seen within your study area.

Steve Treacy: I would agree.

Mark Fraker: I have always been concerned about one of the things that you were mentioning here, too, the sightability of whales according to ice conditions. So when ice conditions are heavy in seaward areas, you may not be able to detect whales as easily there. So median depth may change according to ice conditions. Are you computing survey effort into the median depth analysis as well?

Steve Treacy: Geographic effort. It is broken up into geographic sections.

Mark Fraker: If you have more effort say beyond 50 m depth contour...

Steve Treacy: Part of what we did there, I think I see where you are coming from, was we used the historic data that we have built up since 1979 to try to focus the effort. As you know, it is an expensive program and you want to put your planes where whales are known to be. We have enough information, and we over-shot it to make sure we were going far enough north, so that it wouldn't skew the median depth analysis. And the other thing we have done to avoid skewing of the median depth analysis is that we went back and reanalyzed all of the historic data, limiting the study area to what you saw there. Within those blocks, for the median depth analysis, you can compare between years.

Mark Fraker: I am not clear then, did you compensate in depth increments how much effort went into the surveys? Because if you have a lot of effort beyond 30 m for example you can change your median depth without changing....

Steve Treacy: We try to allocate the effort geographically according to what we already know about the timing of the migration and the location of the migration, I don't think the median depth analysis would be skewed by that. If anything it might be improved because we have more effort where 99% of the whales are. There are only just a few outliers, just a handful of outliers outside the area that we cover. We don't guarantee equal coverage for each block. It is not done that way. Part of the reason is that the median depth is not the only thing that we are looking at. Also, it is very difficult when you are out there. If you want to fly in Block 7 and find out you can't get out there, you have to do a different block. And a lot of the drilling activity is in Block 5 so we tend to put more effort in Block 5 because we have half a dozen goals that we are trying to manage at the same time.

Mark Fraker: It seems that the more important question or more important information is something about minimum depth. If the migration corridor is being shifted offshore then there should be changes in where these animals show up inshore. I am not quite sure how to make a good analysis of that.

Steve Treacy: We can look at the general scatter of the points and you can calculate a median. We also calculate a mean. The range is calculated with standard deviations. I think that is addressed in the table for median depth.

Boris Bessonov: Does the periodic observation in hours show that there is a certain distance between animals in the sea?

Steve Treacy: No, if I understand the question right, that is an independent phenomenon. Sometimes the whales will go by in clumps and if you are there when they are going by in clumps you will try and write them all down.

Boris Bessonov: Did you observe an interchange between the Pacific and Atlantic bowhead populations?

Steve Treacy: That is far enough out of our study area that our particular study has no evidence to bear on that question.

Jerome Montague: But current knowledge would indicate that they don't.

Boris Bessonov: Did you observe any reactions of the bowheads to seismic surveys?

Steve Treacy: Jerome might be able to handle that one a little better, he does a lot of the acoustic work with bowheads. This particular study involves no acoustic measurements or sonic devices of any sort. There will be another speaker who will address this.

INDUSTRY-SPONSORED BOWHEAD WHALE MONITORING AND RESEARCH IN THE U.S. AND CANADIAN BEAUFORT SEA

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Bowhead whales were radio tagged during both the 1988 and 1989 field seasons. The tags provided individual recognition of the whales, allowed long-term monitoring of behavior, activity and movements of individual whales, and facilitated playback experiments and feeding studies on tagged animals and their companions.

Whales were tagged from the M.V. *J. Mattson*, a 32 meter tug with limited maneuverability. In 1988 nine whales were tagged with detailed tracks obtained on two of these animals. In 1989 five whales were tagged with detailed tracks obtained on four of these animals. The markedly improved success of tracking tagged animals in 1989 was attributed to two factors: first, the length of the antenna on the radio tag was increased from 45 cm to 58 cm; and second, the aircraft directional receiving antenna was completely redesigned. The increased transmitting antenna length was particularly important because bowheads often would shift their behavior from a pattern of blowing with a full roll to blowing with only the area around the blowhole exposed and then sinking, exposing little or none of their backs. The longer antenna cleared the surface during even the latter type of blows.

The response of the bowheads to tagging was basically the same as that seen in other species. They were startled by the noise associated with rapid acceleration or sharp turns of the tagging vessel and tried either evasive moves or attempts to outrun the ship. None of the tagged animals showed any reaction to the actual tag implant. As in other species, a whale swimming with a close companion prior to tagging usually rejoined its companion within minutes after tagging. Also, the disturbances of tagging were quite localized. Whales greater than one km away appeared to ignore the tagging attempts.

In 1988 one whale was tracked for 1,291 km during 17 days as it moved about at an average speed of 5.1 km/hr in a local ice-free area never more than 81 km from the tagging site. A second whale was tracked for 915 km as it migrated west at an average speed of 6.5 km/hr in ice-free water which yielded a course-made-good speed of 4.1 km/hr in ice-free water and 2.9 km/hr over the entire track in open and ice-covered waters (Figure 1). In 1989 individual whales were tracked for 18 to 36 days during which time they migrated 954 to 1,347 km at average speeds of 1.5 to 2.5 km/hr (Figure 2). All four whales were tagged near the 20 m contour. One followed the 20 m contour for most of its migratory route; one spent much of its time outside the 100 m contour; and two covered a substantial portion of the migratory path between the 20 and 100 m contours.

Playback studies were conducted in 1988 when whales were presented with recorded sounds of the *Kulluk* drilling barge at source levels of 168 dB re 1 μPa at 1 m. These playbacks were made to groups of 15, 30, and 35 whales, always including a radio tagged animal. Observed behavioral changes were slight. A total of 119 orientation observations were made during these experiments. Chi-square analysis of the orientations showed no significant differences of orientations relative to the sound playback source during any of the playback experiments. Compared to control periods, the whales moved more slowly during one

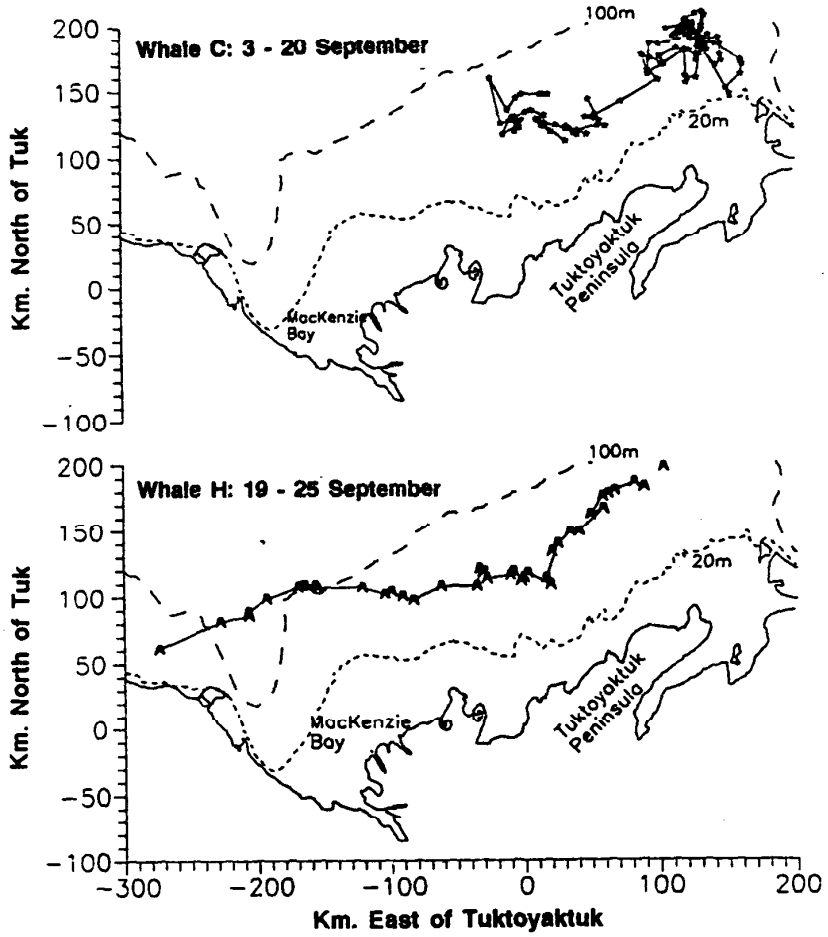

Figure 1. 1988 radio tracks. (Projection centered on Tuktoyaktuk.)

experiment, faster in a second, and not different from control in a third. More social interactions were seen during sound playbacks and fewer incidents of rest and travel. During playback disturbance, blow intervals decreased whereas blow intervals increased during aircraft disturbance (Figure 3). The minimal response shown by the whales to the playbacks and the number of playbacks performed precluded an investigation of habituation.

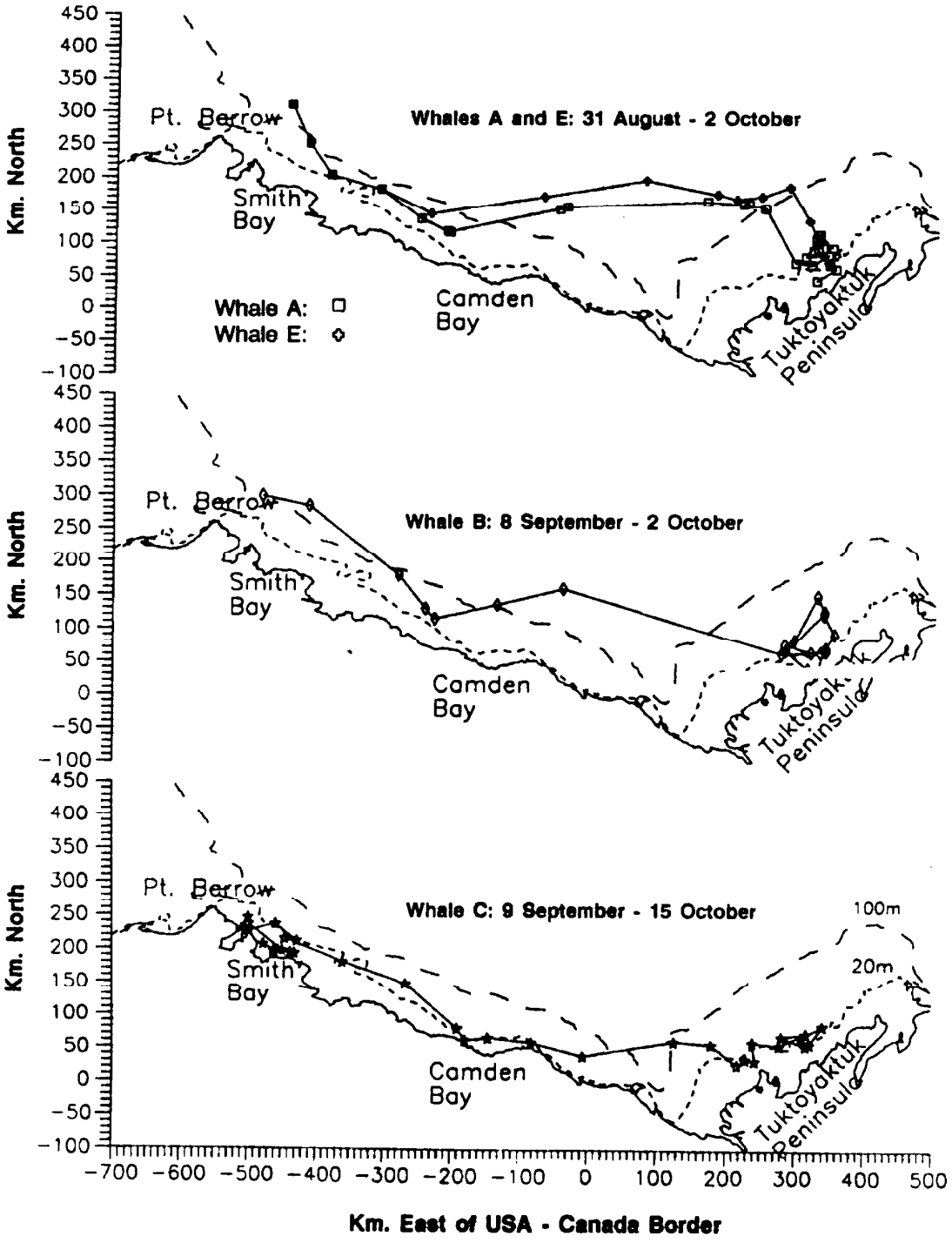

Figure 2. 1989 radio tracks. (Stereographic projection centered on U.S. - Canadian Border.)

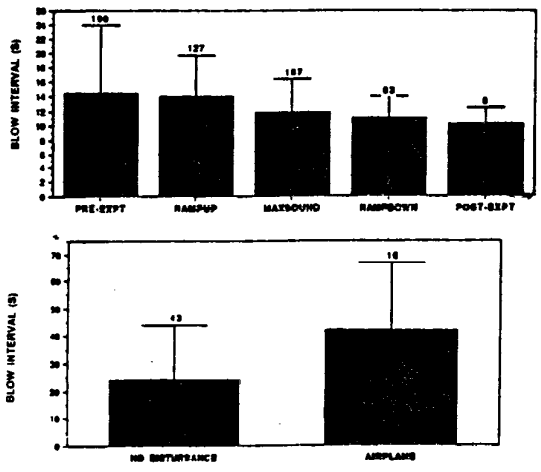

Figure 3. Blow intervals during playback and aircraft disturbance.

The ship itself was a known sound source. Excluding whales that were within ±30° ahead of the ship, we calculated received sound levels for whales that voluntarily maintained a course parallel to or intersecting that of the ship. Nineteen whales thus encountered sound levels between 110 and 115 dB, 42 between 105 and 109 dB, and 71 between 100 and 104 dB, all values relative to 1 μPa at 1 m for a frequency bandwidth between 20 and 3000 Hz.

In 1988 we observed primarily adults north of the Tuktoyaktuk Peninsula. We observed more calves in 1988 than in 1989 and more sexual activity among the adults. The difference in whale distribution between 1988 and 1989 was reflected in aborted tagging approaches. In 1988, 4 of 22 approaches were aborted when the target whale was discovered to be accompanied by a calf and 2 were aborted when the target whale turned out to be too small. In 1989, 1 of 15 approaches was aborted because the whale was accompanied by a calf and 6 were aborted because the whale was too small.

The same ecological and social features that attract other whales also attract the radio tagged whale and so tracking the tagged whales led us to, or kept us near, whale concentrations. We were able to sample prey densities at the site where the whales were feeding and at the time the whales were feeding. This synchrony in place and time was important; sampling within a few km of where the concentration of whales was feeding yielded lower prey densities than did sampling in the midst of the feeding whales. Furthermore, we were able to associate feeding patterns with prey type. In areas where mid-water tows yielded high densities of copepods (up to 1562 mg/m^3 wet weight), the whales were feeding in the water column. In areas where surface tows yielded high densities of krill (up to 2800 mg/m^3), the whales were feeding at the surface. On 20 September, the whales were on either side of a transition zone between clear and muddy water. Sampling along the transition zone yielded prey densities of 69.6 mg/m^3 of mysids and 299.0 mg/m^3 of copepods. Sampling 5.8 km away from the transition zone yielded mysid densities of 26.8 mg/m^3 and copepod densities of 91.5 mg/m^3. Not surprisingly, the whales are feeding so as to maximize their nutrient intake. Diving in an area where whales surfaced with mud streaming from their baleen revealed little benthic fauna. However, mysids and copepods were found in the muddy water near the bottom. Although these whales had mud flowing from their baleen on surfacing, they were near-bottom feeding rather than bottom feeding.

A video tape showing surface-feeding bowheads was shown as part of this presentation. The whales lay on their sides at the surface and moved slowly forward by sculling with their flukes. Their mouths were opened wide, and the baleen on the upper side was flared in the air. How this foraging behavior was effective in capturing euphausiids awaits further study. On at least three occasions feeding whales ran into the idling ship.

REFERENCES

Bradstreet, M.S.W., D.H. Thomson, and D.B. Fissel. 1987. Zooplankton and bowhead whale feeding in the Canadian Beaufort Sea, 1986. *In*: Environmental Studies No. 50. Canada Department of Indian Affairs and Northern Development, Ottawa.

Carroll, G.M., J.C. George, L.F. Lowry, and K.O. Coyle. 1987. Bowhead whale (*Balaena mysticetus*) feeding near Point Barrow, Alaska, during the 1985 spring migration. Arctic 40:105-110.

Greene, C.R. 1987. Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea. Journal of the Acoustical Society of America. 82:1315-1324.

Griffiths, W.B., D.H. Thomson, and G.E. Johnson. 1987. Zooplankton and hydroacoustics. *In*: Importance of the eastern Alaskan Beaufort Sea to feeding bowhead whales, 1985-86, edited by W.J. Richardson. Unpublished Report from LGL Ecological Research Associates, Inc. Bryan, Texas for U.S. Minerals Management Service, Washington, D.C., 547 p.

Lowry, L.F., and K.J. Frost. 1984. Foods and feeding of bowhead whales in western and northern Alaska. Scientific Reports of the Whales Research Institute 35:1-16.

Richardson, W.J., M.A. Fraker, B. Würsig, and R.S. Wells. 1985. Behavior of bowhead whales *Balaena mysticetus* summering in the Beaufort Sea: reactions to industrial activities. Biological Conservation 32:195-230.

Wartzok, D., W.A. Watkins, B. Würsig, and C.I. Malme. 1989. Movements and behaviors of bowhead whales in response to repeated exposures to noises associated with industrial activities in the Beaufort Sea. Unpublished Report submitted to Amoco Production Company, Denver, CO.

Watkins, W.A. 1978. A radio tag for big whales. Oceanus 21:48-54.

Watkins, W.A. 1979. A point for penetrating whale blubber. Deep-Sea Research 26:1301-1308.

Watkins, W.A. 1981. Reaction of three species of whales, *Balaenoptera physalus, Megaptera novaeangliae,*and *Balaenoptera edeni* to implanted radio tags. Deep-Sea Research 28:589-599.

Watkins, W.A., K.E. Moore, J. Sigurjonsson, D. Wartzok, and G.N. di Sciara. 1984. Fin whale (*Balaenoptera physalus*) tracked by radio in the Irminger Sea. Rit Fiskideildar 8:1-14.

Watkins, W.A., K.E. Moore, D. Wartzok, and J.H. Johnson. 1981. Radio tracking of finback (*Balaenoptera physalus*) and humpback (*Megaptera novaeangliae*) whales in Prince William Sound, Alaska. Deep-Sea Research 28A:577-588.

Watkins, W.A., D. Wartzok, H.B. Martin, III, and R.R. Maiefski. 1980. A radio whale tag. Pages 227-241 *in* F.P. Diemer, F.J. Vernberg and D.Z. Mirkes (eds.), Advanced Concepts in Ocean Measurements. University of South Carolina Press, Columbia, SC.

Würsig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne, and W.J. Richardson. 1985. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: A description. Fisheries Bulletin 83:357-377.

Würsig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne, W.J. Richardson, and R.S. Wells. 1984. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: Surfacing, respiration and dive characteristics. Canadian Journal of Zoology 62:1910-1921.

Würsig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne, and W.J. Richardson. 1986. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: a summary. Reports of the International Whaling Commission (Special Issue 8):167-175.

Würsig, B., E.M. Dorsey, W.J. Richardson, and R.S. Wells. 1989. Feeding, aerial and play behavior of the bowhead whale, *Balaena mysticetus*, summering in the Beaufort Sea. Aquatic Mammals 15:27-37.

QUESTIONS AND DISCUSSION

Bruce Mate: The animals looked very involved in what they were doing. Did you have any bump the boat?

Douglas Wartzok: Yes, there were several; on at least three occasions whales just bumped into the side of the boat. Part of the time we were moving slowly doing some tows in front of them. Other times, we were just stationary, filming and "oohing and aahing" about all of these whales that were around us. The engines were running, there was a lot of noise in the water column.

Jerry Imm: When you were moving or when you were stationary, it didn't seem to make much difference?

Douglas Wartzok: As it turned out, none of them ran into us when we were moving. We were never moving very fast. we were moving slowly with the surface tows.

Jerry Imm: They must have been very intent in their feeding.

Douglas Wartzok: Right, that is not the sort of behavior one would expect.

John Richardson: I have two unrelated questions. First, in our playback work with drilling and dredge sounds, we found that some bowheads reacted when the sounds were less than 20 dB above the background levels. Others didn't seem to react even when the sounds were 30 or 40 dB above background. I don't think you commented on the estimated received levels near the specific whales that you were observing.

Douglas Wartzok: It depended on where they were and we calculated levels ranging from 8 to 30 dB depending on the distance the whales were from the sound source. We pooled the data and have not broken it down into different levels in order to have larger numbers.

John Richardson: Are those figures broad band levels or are those third octave levels?

Douglas Wartzok: Those are third octave levels.

John Richardson: The other unrelated question is that I noticed you had one oblique zooplankton tow containing 1.5 g/m^3 of copepods at a whale feeding station. I think that 1.5 g/m^3 is far higher than has been found previously in an oblique tow in the Beaufort Sea near bowheads. Do you recall over what range of depths that tow was taken? If it was over a broad range of depths, it would suggest that the density of plankton on which those whales were feeding was probably far higher than anything that has been found before, given that the plankton were probably all concentrated in one shallow layer.

Douglas Wartzok: Right. The feeding aspect of the study was a preliminary study. We certainly would love to use radio tracking to investigate feeding further. As you saw we had only bongo nets. We didn't have nets that would open at various depths, etc. The tow was taken where we thought the animals were feeding in the water column. What we tried to do was take it from the surface to the bottom and back up as quickly as we could. It was a V tow, that went twice through any particular layer. There were very high densities there. Most of the other densities are ones that you are familiar with from your earlier reports, except the euphausiids were higher than the previous reports have shown. We basically attributed it to the fact that we were in essence taking the food right out of the whale's mouth, since we were right there where they were. That is why we tried to do some of the ones moving a short distance away and finding that densities were much lower. There seemed to be one area where there were lots of whales compared to 500 m away where there were smaller numbers. Again we got different densities from where the largest number of whales were compared to half a kilometer away where there were smaller numbers.

_____: In your photograph you showed the interface between the brown water and blue water. You just mentioned the whales were feeding along the interface. When you were doing your plankton sampling, did you do any other water mass characterizations where the plankton levels were highest versus the other areas?

Douglas Wartzok: It was a preliminary study. If we were really doing it right, we would have had people that knew a lot more about plankton sampling than what we did. But we did take a sample that was right at that interface where most of the whales were. The whales were also out into the blue water. Then we took a sample in the darker water and found about a third of the density of planktonic organisms. At this stage, those studies were really more to whet one's appetite as to what one can do when you've got tagged animals that lead you to a group of animals that are feeding and use it as part of a broader feeding study.

_____: Was the maximum density along the interface?

Douglas Wartzok: The maximum density of whales was there. We didn't take that many samples. We did sample at the interface, in the darker water, and one in the bluer water out where the whale density was less. The plankton density followed in essence the whale density. It was higher at the interface; it was less further off in the blue water. It was only about a third in the darker water.

_____: In 1988 you noted a weak orientation away from your playback sounds from the *Kulluk*. In 1989 apparently the critters were paralleling the tagging vessel without making an attempt to divert. Based on these studies, do you think there is any scientific evidence to support or

refute the need for a seasonal drilling restriction based solely on acoustical effects of drilling activity?

Douglas Wartzok: Well, I might respond somewhat by repeating what I said. We measured a number of different things, in this case, with 80-some whale encounters in terms of the playbacks and a number of others, 100 or so in terms of encounters with the ships and with the aircraft, etc. We did find some changes in behavior that had statistically significant differences. But one time it might have gone one way; another time it might have gone another way. My feeling is that these differences are not significant in the common parlance of significance which says are they significant for the natural history, the behavior, the well being of the population? I don't think they are significant. These results are not any different than the ones that have come from all the other previous studies that have been done. They have all shown that there have been some changes. But I have yet to see any of them that have shown something that I would say in the common parlance is significant for the ultimate well being of the whales. I don't make the rules, but if I did I probably would think that we had done enough of proving that point.

Boris Bessonov: How long does the transmitter last in one season.

Douglas Wartzok: The transmitter itself will last for about 15 months. We don't know how long that transmitter is going to stay on the animal. If we go back to some of our earlier work in the mid-1970s, we know that with the transmitters we were using then and the particular design as to the way they were being implanted, that within a couple of weeks we could see the transmitters were moving out. The picture that I showed here was after more than two weeks, about 16 days, and there was absolutely no movement of the transmitter in that period of time. Eventually it would be acted upon like any other foreign body and expelled. But how quickly that is going to happen, we don't have any good feel for. So we are going to try and monitor at Little Diomede Island with the spring migration to see if by any chance any of these four animals will be able to be picked up then. It would certainly give us a big jump in the length of time that we know the transmitters stay in.

Boris Bessonov: I understand. We have the same problems. Does your system have pressure sensitivity to turn on the transmitter when the bowhead surfaces?

Douglas Wartzok: We get the electronic 15 month-life because there is a salt water switch that turns it on only when it is at the surface.

Boris Bessonov: Did your video camera help in your work?

Douglas Wartzok: Oh, yes it helped very much. As you can see we were able to replay instantaneously the tag implants, for instance, and know exactly how they went in. Also we were delighted to have it when the animals were feeding at the surface on their sides. It was between 9:00 and 10:00 at night, so that 35 mm shots didn't turn out, but the video did.

EFFECTS OF OIL PRODUCTION SOUNDS ON ARCTIC WHALES IN SPRING ICE LEADS

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Underwater sound is important to marine mammals in sensing their environment and in communicating with one another. Sound attenuates rather slowly in seawater, and is often audible many kilometers away. Some whales are known to respond to calls from other members of their species at distances of several kilometers. Marine mammals no doubt also listen to natural sounds from other sources that are important to them, including ice noise, surf noise and calls of predatory killer whales.

Many activities associated with offshore oil and gas exploration and production introduce man-made noise into the sea. This noise has the potential to interfere with the abilities of marine mammals to hear some important natural sounds. In addition, man-made noise can cause disturbance. Marine mammals, like other wildlife, often interrupt their normal activities and move away in response to man-made noise. Migrating gray and bowhead whales have been observed to divert to the left or right to avoid a noise-emitting industrial site (simulated or actual) on their original course. However, the long-term significance of short-term behavioral disturbance is poorly known.

In the case of bowhead whales, *Balaena mysticetus*, all previous studies of reactions to underwater noise from oil industry activities were done during late summer and autumn in open water or light ice conditions. Under those conditions, we and others have studied the short-term behavioral reactions of bowheads to aircraft, ships, seismic exploration, dredging and drillships. In general, bowheads, like other cetaceans, react more strongly to rapidly changing sounds like those from approaching boats than to steady sounds like those from a drillsite. Bowheads often exhibit some tolerance of industrial sounds. Many bowheads continue their normal activities in the presence of weak industrial noise. However, when the received sound level is high enough, bowheads often move away. There is considerable variation in their sensitivity to noise under different circumstances.

In the case of white or belukha whales, *Delphinapterus leucas*, studies in various areas have revealed great variability in sensitivity to man-made noise. For example, white whales in Bristol Bay tolerate very high levels of boat traffic. At the other extreme, white whales migrating in the Canadian high arctic during spring begin to show strong avoidance reactions at extraordinarily long distances--tens of kilometers--when the first ship of the season approaches.

Spring migration of bowheads and white whales around northwestern Alaska is often confined to narrow leads of open water through waters that may otherwise be impassible. If whales are reluctant to pass a noise source in or near a lead, their spring migration might be blocked. At present, there is no oil exploration in or near the leads during spring. However, within the next few years the oil industry may want to begin exploring near leads during the spring migration season.

The Minerals Management Service is funding LGL to conduct experiments to test the reactions of spring-migrating bowheads and white whales to sounds from several sources, including a drilling or production platform, icebreaker, and helicopter. LGL is assisted in this project by two companies specializing in underwater acoustics work: Greeneridge Sciences Inc. and BBN Systems & Technologies Corp. The first field season was in the spring of 1989, and fieldwork is to continue at least in 1990.

The specific objectives are 1) to determine the natural ambient noise levels and sound transmission loss rates in spring leads, including the specific attenuation of platform and icebreaker noise, and 2) to determine the short-term behavioral responses of bowheads and (when possible) white whales to platform and icebreaker noise. An additional important requirement is to co-ordinate with other studies and hunters to maximize data collection and avoid interference.

Study Area and Methods

The primary method used in the study is to project recorded industrial sounds into the sea using a U.S. Navy J-11 underwater sound projector. Measurements of received sound levels at various distances from the projector provide data on sound propagation in spring lead conditions. Observations of the behavior of whales approaching the projector provide data on the disturbance effects of the sounds.

After consultation with the Alaska Eskimo Whaling Commission, Barrow Whaling Captain's Association, and North Slope Borough, it was agreed that the spring disturbance project could be done if the sound projector were set up about 60 km northeast or east of Point Barrow. This was sufficiently far east to avoid interference with spring whaling, which occurs as far north and east as Point Barrow, and with the bowhead census conducted near Point Barrow. This area was along a migration corridor for bowheads and white whales, although it was not the exact area that we would have chosen if interference had not been a concern.

The 1989 fieldwork extended from 25 April to 30 May. One crew, supported by a helicopter, worked from the ice to operate the sound projector and to record and measure underwater sound. They also used a surveyor's theodolite to observe and map the movements of whales near the projector. A second crew used a Twin Otter aircraft to search for whales, to observe their behavior at varying distances from the sound projector, to drop sonobuoys to monitor underwater sounds reaching whales, and to photograph bowheads.

All projector sites used in 1989 were on the pack ice northeast of Point Barrow. For much of the 1989 migration season, there was no open water along the edge of the landfast ice. Even when a nearshore lead did form after 20 May, the whales traveled through the pack ice rather than along the landfast ice edge. For this and other reasons, conditions in 1989 were suboptimal, and sample sizes were smaller than desired. However, we did obtain at least some data of most of the types desired.

Characteristics and Propagation of Drilling Sounds

The industrial sounds used in all 1989 playback work were recorded under the ice near a drillrig operating on an ice platform off Prudhoe Bay in March 1989 (Chevron's *Karluk* site). Most of the energy was at low frequencies, from as low as 10 Hz up to about 350 Hz.

On five occasions, we projected a sample of the drilling sounds into the sea NE or ENE of Point Barrow, and measured the received levels at distances ranging from 100 m to ~18 km. The received levels of drilling noise diminished from about 165 dB near the projector to ~120 dB at 100 m and ~105 dB at 1 km. By about 5 to 10 km, the received levels of drilling noise decreased to equal the level of the natural background noise, and were no longer detectable. As predicted before the field season, there was no danger that the projected drilling sounds would reach the whale census or hunting areas near Barrow from the projector sites about 60 km to the NE.

In addition to the sample of drilling sounds, various other test sounds were projected during each of the five propagation experiments. Their frequencies ranged from 50 Hz to 10 kHz. The measured received levels 100 m to 18 km from the projector provided additional data on sound attenuation. These data are being used to investigate the factors affecting sound attenuation in spring lead conditions.

Behavior of Bowheads Exposed to Drilling Noise

Because of the unusually difficult field conditions in 1989, there were only five days when we were able to observe bowheads that were exposed to projected *Karluk* drilling noise. All data had to be collected from holes and leads amidst the pack ice rather than along the landfast ice edge. The number of bowheads seen near the sound projector in 1989 was too small to allow detailed statistical analysis of acoustic effects on distribution or movements. However, some noteworthy data were obtained.

Several bowheads were observed migrating east past the projector while it was broadcasting continuous drilling sounds. The closest observation was on 19 May, when one bowhead swam almost directly toward the operating projector until it was only 100-120 m away. This whale then dove. On the same day, another bowhead swam almost directly toward the projector until it was 720 m away, whereupon it dove and disappeared. Two more bowheads swam past with a closest point of approach 1 km away. All of these positions were determined by theodolite. During this period the sounds received 1.1 km from the projector were monitored via sonobuoy. The drilling sounds were quite prominent there, well above the natural background noise. Hence, it seems inevitable that all of these whales were able to hear the drilling sounds.

Similarly, on 14 May, at least three migrating bowheads passed as close as 500 m to the side of the projector while it was broadcasting continuous drilling sounds, and a fourth passed 900 m to the side. Two of these whales were observed from the circling aircraft for about 1½ hours as they swam NE and N, generally toward the projector. Again, the drilling sounds were monitored 1 km from the projector, and confirmed to be well above background noise levels there.

The bowheads mentioned so far were migrating northeast past the operating sound projector, with no evidence of hesitation or diversion. However, other bowheads may have been diverted when they came that close. On 23 May, we saw two bowheads swimming north and then west, directly away from the projector, while it was emitting drilling noise. They were 1 km away when first seen, and were still heading away when last seen 5 km west of the projector. Below 350 Hz, the drilling noise was quite prominent 1 km from the projector. However, it was barely detectable 5 km away, where the whales were still heading west away from the projector.

The westward direction of travel by this pair of bowheads was inconsistent with the normal NE, E or SE movements of bowheads migrating in the study area in spring, and was suggestive of a disturbance reaction. However, we cannot be certain that these whales were reacting to the sound projector, since other bowheads occasionally traveled west in the absence of drilling noise. It is well known from previous studies that the sensitivity of bowheads to man-made noise varies. Thus, it would not be surprising if some individual whales migrated past the projector at relatively close distances while other bowheads showed avoidance reactions even to quite weak industrial sounds.

In summary, the data on bowheads acquired to date are limited. However, some bowheads migrating through the pack ice east of Point Barrow in spring tolerated some low-frequency drilling noise without interrupting or diverting their migration. Other individuals *may* have reacted strongly to drilling noise no stronger than that tolerated by certain other bowheads. It would be premature to generalize these few observations. In particular, it should not be assumed that bowheads migrating in spring would behave in the same way when exposed to other types of industrial sounds.

Behavior of White Whales Exposed to Drilling Noise

We observed migrating white whales close to the source of drilling noise on four dates in 1989. On three of these dates, at least a few white whales came within about 200 m of the operating projector, including a few within 50 to 75 m of the projector. White whales that were migrating toward the projector appeared to travel unhesitatingly toward it until they came within a few hundred meters. Some white whales that came within a few hundred meters of the projector continued past it without apparent hesitation or turning. However, others definitely did react temporarily at distances on the order of 200 to 400 m.

On 14 May, a substantial proportion of the white whales that came within 200 to 400 m of the projector slowed down, milled, and in some cases reversed course temporarily. This interruption of migration was very obvious to the observers, but lasted only several minutes. Then the whales continued past the projector, in some cases passing within 50 to 100 m of it.

We saw no evidence of reactions by white whales at distances greater than 200 to 400 m. We suspect that this was related to the poor hearing sensitivity of white whales at the low frequencies where the drilling sounds were concentrated. The low-frequency hearing sensitivity of captive white whales has recently been measured by F.T. Awbrey, C.S. Johnson, and their colleagues. On most days during our study, the received levels of the drilling sounds (on a 1/3-octave basis) were less than the measured hearing sensitivity at corresponding frequencies at all distances beyond about 200 m. This suggests that white whales may have been unable to hear the low-frequency drilling sounds at distances much beyond 200 to 400 m, even though the sounds were detectable by hydrophones (and audible to humans) as much as several kilometers away.

These results provide preliminary evidence about the seemingly low sensitivity of white whales to the one type of continuous drilling sound used in the 1989 experiments. However, the sample sizes were small. Also, the results refer to a particular *experimental* situation. It would be premature to generalize them to an actual ice-based drilling platform let alone to other types of industrial operations. Some oil industry activities have higher source levels than we could

simulate with a J-11 sound projector. Reaction distances are expected to be greater in such cases.

Also, sensitivity of white whales to other types of oil industry sounds probably differs. The hearing sensitivity of white whales improves greatly with increasing frequency. Thus, reaction distances are likely to be greater in the cases of industry noises containing higher frequency components. As mentioned above, in the Canadian high arctic, spring-migrating white whales react strongly to noise from vessels tens of kilometers away. To understand the effects of industrial noise on spring-migrating white whales in the Beaufort Sea, we need to test their reactions to additional types of noise whose characteristics differ from those studied in 1989. We expect to do this in 1990.

After additional data are collected, the results of this study should be useful in assessing the acoustic effects of oil exploration and development near spring lead systems on migrating bowhead and white whales. These results should help resolve questions about possible jeopardy to bowheads if oil development proceeds near spring leads.

REFERENCES

Greene, C.R., Jr. 1987. Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea. J. Acoust. Soc. Am. 82:1315-1324.

Johnson, C.S., M.W. McManus, and D. Skaar. 1989. Masked tonal hearing thresholds in the beluga whale. J. Acoust. Soc. Am. 85:2651-2654.

LGL and Greeneridge. 1986. Reactions of beluga whales and narwhals to ship traffic and ice-breaking along ice edges in the eastern Canadian high arctic: 1982-1984. Envir. Stud. 37, Indian & Northern Affairs Canada, Ottawa. 301 p.

LGL and Greeneridge. 1987. Responses of bowhead whales to an offshore drilling operation in the Alaskan Beaufort Sea, autumn 1986. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Shell Western E & P Inc., Anchorage, AK. 371 p.

Miles, P.R., C.I. Malme, and W.J. Richardson. 1987. Prediction of drilling site-specific interaction of industrial acoustic stimuli and endangered whales in the Alaskan Beaufort Sea. BBN Rep. 6509; OCS Study MMS 87-0084. Rep. from BBN Labs Inc., Cambridge, MA, and LGL Ltd., King City, Ont., for U.S. Minerals Manage. Serv., Anchorage, AK. 341 p. NTIS PB88-158498.

Richardson, W.J., ed. 1985. Behavior, disturbance responses and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1980-84. OCS Study MMS 85-0034. Rep. from LGL Ecol. Res. Assoc. Inc., Bryan, TX, for U.S. Minerals Manage. Serv., Reston, VA. 306 p. NTIS PB87-124376.

Richardson, W.J., M.A. Fraker, B. Würsig, and R.S. Wells. 1985. Behaviour of bowhead whales *Balaena mysticetus* summering in the Beaufort Sea: reactions to industrial activities. Biol. Conserv. 32:195-230.

Richardson, W.J., C.R. Greene, J.P. Hickie, R.A. Davis, and D.H. Thomson. 1989. Effects of offshore petroleum operations on cold water marine mammals: a literature review, 2nd ed. Am. Petrol. Inst., Washington, DC. 385 p.

Richardson, W.J., B. Würsig, and C.R. Greene, Jr. In press. Reactions of bowhead whales, *Balaena mysticetus*, to drilling and dredging noise in the Canadian Beaufort Sea. Mar. Envir. Res.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski, C.I. Malme, G.W. Miller, M.A. Smultea, and B. Würsig. In prep. Acoustic effects of oil production activities on bowhead and white whales during spring migration near Pt. Barrow, Alaska--1989 phase. Rep. from LGL Ltd., King City, Ont., for U.S. Minerals Manage. Serv., Herndon, VA. [due 30 July 1990]

Urick, R.J. 1983. Principles of underwater sound, 3rd ed. McGraw-Hill, New York.

QUESTIONS AND DISCUSSION

Bill Gusey: I am here for Shell. John, your information is encouraging and I can feel very comfortable with everything you have said. A couple of things that I think we need to keep in mind: you indicated earlier in your presentation that the considerations here were related to production and development. Apparently you are using data from an ice island, and I am assuming that is a grounded ice island. I think if we are really going to consider production and development, that the sound source that we might use for this has got to come from some kind of a bottom founded structure other than an ice island. Production/development work will undoubtedly center around gravel islands, maybe, and most likely some kind of a steel, concrete structure. I suggest that the sound transmission characteristics from something other than ice needs to be used in any further studies of this nature.

John Richardson: Yes, we are well aware of those problems. Of course one of the things that we are faced with is that there presently is no production activity in spring lead conditions. Therefore there is no way to record sounds characteristic of those that will come from a production source useable under those conditions. Hence we are working with what we can get. We did not last year have access to sounds from a caisson structure drilling in winter conditions. We think that we will soon receive a recording of that type of sound through cooperation with the Hubbs Sea World group that monitored the CIDS structure near Prudhoe Bay this past fall. It certainly is our intention to use other types of sounds during future playback work. One related point is worth mentioning. People have questioned why we are using a drilling sound during these experiments. One of the reasons is that a production platform is in fact, not just a production platform but a drilling platform. Wells have to be drilled before production is done. Well drilling may occur from a production platform for quite some time because many wells are likely to be drilled directionally from the same platform. Thus, additional wells may continue to be drilled long after production from that platform has started. The use of sounds from a platform engaged in drilling is consistent with MMS's interest in testing the reactions of whales to a production platform.

Jerome Montague: Can you address, relative to the same question, whether the sounds you used last year are louder or less loud than what you might expect from an actual concrete or steel structure?

John Richardson: I don't think we can really address that because, as Bill Gusey points out, sound propagation characteristics from a concrete or steel caisson that will probably be surrounded by a grounded, rubble ice field are unknown. At present we do not know either the source or the propagation characteristics of sounds from such a caisson. One thing that I can comment on is the question of the received sound level as a function of distance from our sound projector compared with that near the actual drilling on an ice platform, where we recorded those sounds. Within a few hundred meters, the sounds from our projector were comparable in level to those at a corresponding distance from the actual platform. At distances beyond a few hundred meters, the sounds from the projector were in fact stronger than those at the corresponding distance from the actual platform. The projector was operating in deeper water than that near the actual drilling, so the sound propagation conditions were better near the projector than near the actual drilling. Thus, the sound levels 5 km away from our projector operating in deep water were somewhat higher than those 5 km from the original rig operating in shallow waters.

TROPHIC INVESTIGATIONS OF THE ARCTIC OCEAN AND BERING SEA VIA STABLE ISOTOPE ANALYSIS

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INTRODUCTION

The natural history investigations of bowhead whales (*Balaena mysticetus*) have been hampered by the extreme environmental constraints placed on observational studies and the relatively scant knowledge about the supporting ecosystem processes. As a result, until recently, very little was known of the habitat requirements and of the details concerning growth and reproduction. Over the past few years studies using the natural ratios of carbon isotopes ($\delta^{13}C$)[1] within the arctic marine ecosystem have provided much new insight into the interactions of bowhead whales and their environment. We have used $\delta^{13}C$ techniques to establish tracer "signatures" in zooplankton of arctic waters and to address critical questions about feeding and growth rates of the whales. This summary provides an overview of the results of our studies. Readers seeking more detail are referred to Schell *et al.* 1987, Saupe *et al.* 1989, and Schell *et al.* 1989.

Dunton (1985) showed that the zooplankton (copepods and chaetognaths) collected across the Alaska Beaufort Sea coast shifted markedly in $\delta^{13}C$ with the most depleted organisms occurring at his easternmost stations near the US-Canadian border. Saupe *et al.* (1989) expanded the investigation and detailed the remarkable change in $\delta^{13}C$ evident over most of the range of the Bering Sea stock of bowhead whales. The heavier isotope is thus progressively less abundant moving northward from the Bering to the Beaufort Sea and across the coast toward the Canadian Arctic. In addition to the isotopic gradients within a taxon, the shifts in taxonomic abundance across the range of the bowhead whale also contribute to the overall isotopic gradient. Saupe *et al.* (1989) showed that the differences in biomass fractions across the coast were marked. The average $\delta^{13}C$ gradient across the Beaufort Sea would be increased to near 4 °/oo if a whale fed on the zooplankton in the same biomass ratios as were captured in net tows.

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[1] To avoid the necessity of expressing the small changes in isotope ratios as long decimal numerals, convention has the differences between the isotope ratios of a sample and a standard designated as δ (del) in parts per thousand. For carbon the standard is the Pee Dee Belemnite limestone and for nitrogen, air.

$$\delta^{15}N_{air};\ \delta^{13}C_{PDB} = \frac{R_{sample} - R_{standard}}{R_{standard}} \times 1000$$

where R is the isotope ratio, $^{13}C/^{12}C$ or $^{15}N/^{14}N$ of sample and standard, respectively. Since almost all biological materials contain less ^{13}C than the standard, the numbers are negative. Substances enriched in ^{13}C or ^{15}N are said to be "heavy"; those depleted are termed "light".

ISOTOPE RATIO OSCILLATIONS IN BALEEN PLATES

Figure 1 shows the variations in carbon and nitrogen isotope ratios along baleen plates from four whales ranging from two to greater than 20 years of age (from Schell *et al*, 1989). In each case there are evident oscillations along the length of the plates and in most instances, there are positive correlations between the changes in both isotopes. At equivalent locations in different plates from the mouth of the whale, the $\delta^{15}N$ and $\delta^{13}C$ values are very similar, if not identical (Schell *et al.* 1987).

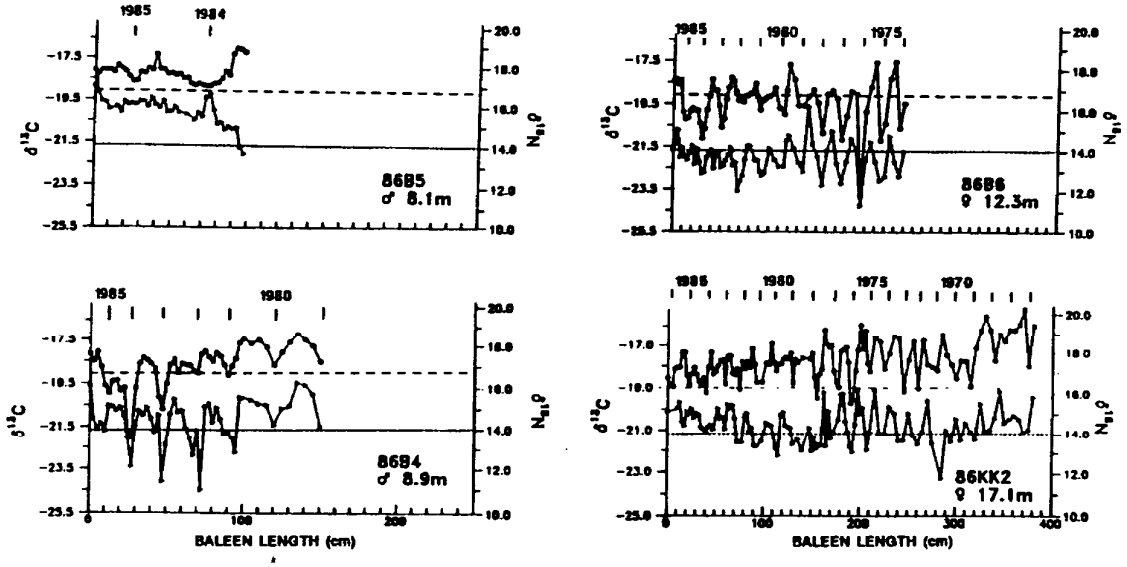

Figure 1. Body length, sex, $\delta^{13}C$ (upper) and $\delta^{15}N$ values (lower) along baleen plates from four bowhead whales ranging from 2 to over 20 years of age. Annual markers are located in the approximate areas of summer/fall baleen in the plates. The three smaller whales were killed in the spring; 86KK2 was killed in the fall.

Baleen growth rates were determined by comparing the distance intervals between one summer's growth to the next as indicated by the isotope data. The isotopic evidence indicates that during the first year of life, baleen grows in excess of 50 cm and growth rates rapidly diminish over the next few years. By year two, the baleen growth rate is between 35 to 45 cm and by year three, 27.5 to 35 cm. In older animals, the annual segment is typically 20 cm or less. The decreasing baleen growth rates allow estimation of how much has worn from the distal end of the plate and correction to the true age in young animals. By the time about three years' growth has eroded from the tip, however, the uncertainty as to the amount lost prevents accurate age determination by direct estimation.

AGE VS. BODY LENGTH

In Figure 2, the uncorrected and corrected ages have been plotted against body length. The results suggest that following birth at ~ 4.5 m, growth is very rapid during the first year of life, but is followed by a period of several years in which little or no growth occurs. If weaning

occurs at about one year, (Nerini *et al.* 1984) this apparent diapause may be due to a period in the life of the whale when the baleen plates are still too short for effective filter feeding and skills at capturing more mobile prey such as euphausiids are being developed. The young whales may be largely dependent upon fat reserves acquired during the first year of nursing to subsidize suboptimal feeding during this period. By year five, the baleen plates have lengthened to where feeding results in a sufficiently positive energy intake to allow body growth to resume. Growth rates after year five appear to be much slower than the estimates by Nerini *et al.* (1984) and average about 0.4 m/yr. We conclude that if sexual maturity occurs at near 13 to 14 m, (Richardson *et al.* 1987; Nerini *et al.* 1984), bowhead whales may require 17 to 20 years to reach that length.

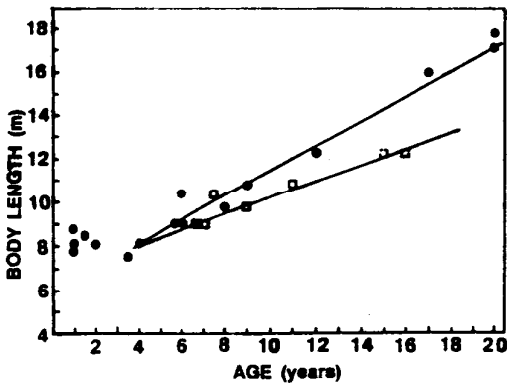

Figure 2. Body length vs. age for bowhead whales based on $\delta^{13}C$ in baleen. Length at birth is ~4.5m. Uncorrected isotopic age (circles) represent actual measured count of annual cycles. Subadult whales are shown with ages corrected for wear from distal ends of the baleen plates (squares). For whales less than four years old, corrected and uncorrected ages are the same. Dotted values in lower curve reflect uncertainty as to the loss of three or four years of baleen growth. Corrected ages for the largest whales cannot be determined because of baleen wear (from Schell et al. 1989).

ISOTOPE RATIOS IN MUSCLE AND VISCERAL FAT

The bulk isotopic compositions of bowhead whales taken during the annual harvest were estimated from samples of muscle tissue and internal fat. The results, from the isotope ratios in the baleen and especially in the muscle and visceral fat of animals killed in the spring compared to those killed in fall show that the greatest abundance of points along the traces from the whales correspond to $\delta^{13}C$ typical of prey species in the western and southern areas of the migratory range. The average $\delta^{13}C$ in visceral fat and muscle tissue from spring-killed bowheads was enriched by 2.1 ppt relative to two fall-killed animals implying that a major fraction of the total carbon of the animal was derived from the western and southern parts of their annual range.

The isotopic data from the three adult whales analyzed indicated that large whales have an average isotopic composition derived from prey obtained almost entirely in the western and southern parts of their range. The adults may not feed to a significant extent in the eastern Beaufort Sea or they may be feeding in areas as yet unsampled where prey are ^{13}C-enriched or selectively feeding on enriched prey species not sought by subadults. The findings listed above are based on a limited number of whale samples although the isotopic records in baleen total a span of approximately 140 whale-years.

The use of isotope ratio gradients has been extended to the separation of polar bear stocks in the Chukchi and Beaufort Seas. The food webs that lead to the isotope ratio gradients in bowhead whales also provide an effective marker in polar bears. By measuring the isotope abundances along the length of a polar bear claw, it is possible to obtain a feeding record of the bear for about a year previous. This work is proving to be an excellent way to determine the source stocks of animals taken by native hunters in the Alaskan Arctic and as an indicator of seasonal movement patterns.

LITERATURE CITED

Dunton, K.H. 1985. Trophic dynamics in marine nearshore systems of the Alaskan high arctic. Ph.D. dissertation, Univ. Alaska, Fairbanks, AK. 247 pp.

Nerini, M.K., H.W. Braham, W.R. Marquette, and D.J. Rugh. 1984. Life history of the bowhead whale, *Balaena mysticetus* (Mammalia:Cetacea). Journal Zoology, London. 204:443-468.

Richardson, W.J., R.A. Davis, C.R. Evans, D.K. Ljungblad, and P. Norton. 1987. Summer distribution of bowhead whales, *Balaena mysticetus*, relative to oil industry activities in the Canadian Beaufort Sea, 1980-84. Arctic 40(2):93-105.

Saupe, S.M., D.M. Schell, W.B. Griffiths. 1989. Carbon isotope ratio gradients in western arctic zooplankton. Marine Biology 103:427-432.

Schell, D.M., S.M. Saupe, and N. Haubenstock. 1989. Bowhead whales (*Balaena mysticetus)* growth and feeding as estimated by $\delta^{13}C$ techniques. Marine Biology 103:433-443.

Schell, D.M., S.M. Saupe, and N. Haubenstock. 1987. Bowhead whale feeding: allocation of regional habitat importance based on stable isotope techniques. Pages 369 to 415 *in* Richardson, W.J. (ed.), Importance of the eastern Alaskan Beaufort Sea to feeding bowhead whalers, 1985-86. U.S. Minerals Management Service Report MMS 87-0037, NTIS PB88-150271/AF, National Technical Information Service, Springfield, VA.

QUESTIONS AND DISCUSSION

Mark Fraker: This is kind of a dangerous question perhaps to ask a chemist but why do right whales as calves grow so well and why don't bowhead calves do better?

Donald Schell: That is an excellent question. That is a real puzzle. In fact that growth scenario that I posed there really bothered a lot of biologists and still does bother a lot of biologists. I was very happy to find from the fellows that work on elephant seals off California, that they see an analog in nursing of those pups. A big female investment is dumped into the pups which then just sort of shrink for the next year and a half or two years, until they finally get their "fins under them" so to speak and learn how to hunt effectively and begin to gain. The little bit of aerial photogrammetry data that is now beginning to appear seems to validate this scenario that I posed. The age-length data for less than age 5 is worthless. If you look at an animal in the water and he is 8.5 m you don't know whether he is one year old or five years old. What does provide excellent measure of whale age is the length of the baleen. The correlation as I recall is 0.97. I am sorry I don't have the curve with me but if you take the growth rate of baleen and plot that length versus age, it is a beautiful smooth curve, it is real tight. So a good field measure of the age of a bowhead whale is to just measure the length of the longest baleen plate. This is for young animals.

Dale Kenney: If the feed is so good in the Bering, what is, in the evolutionary sense, the reason for migrating then? What is the advantage of using the ice edge?

Donald Schell: Well if you listen to people like Mark Fraker tell you about this, the only reason those animals go back and forth is because they are probably a remnant stock. Originally bowhead whales filled that entire ecological niche so to speak up there. There were summer populations in the Bering, and the Chukchi and the Beaufort Seas. But as the whalers extirpated the stocks, what was left were those animals that had a fidelity to the eastern Beaufort Sea and now go back and forth. It is not because that is the best feeding ground. In fact, from what I hear of the historical records, the biggest animals were in the Bering-Chukchi. I was quite interested to see Dr. Bessonov's points in the Bering Sea again, summer populations appearing in the Bering Sea and in the western Chukchi.

Tom Newbury: I would like to follow up on this. It is not a direct question. You mentioned the remnant stock. Dr. Bessonov mentioned the number of whales along the Chukchi coast, the Siberian coast during the late spring. I think that there is some evidence that there are some animals spending the summer in the Chukchi. Bockstoce discussed it. It is an old population, it used to be a substantial one that was hunted out. I know Mark Fraker has talked about at times looking for remnants of it. I think there may be some animals there. The animals have turned up in Barrow in mid-summer that may have come from the west. I was talking with Sue Moore about this. I think we have a chance to get some better information on that. There are some operations going on in the Chukchi this year. They went on last year, they will be going on this summer. It may provide an unusual opportunity to get some information. It would be a tremendous help if we got some cues, some information from Shell Oil when they saw whales out there, black and white whales as opposed to gray whales. Maybe the identification can't be that good. But if there was a number that they could report to so that a person like Sue Moore could go out on a flight. There would be an opportunity to begin documenting whether or not there are bowheads there, what they are doing, how many there are, what the distribution is. I think it is a rare opportunity that might take advantage of.

Donald Schell: Either that or strandings from the Soviet side in the summer. A baleen plate from those animals could readily be tested to see if they are resident animals or a migrant that has gone astray.

BOWHEAD WHALE BOOK
INTRODUCTION AND PROGRESS REPORT

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CONCEPTION OF THE BOOK

In the recent past, Bill Gusey and Mark Fraker have written review publications about the bowhead whale. These useful publications, first attempts at synthesizing what was already an extensive database, were not intended to be scientific reference books, and did not include the voluminous information resulting from bowhead whale research conducted from 1983 to 1989. A bowhead reference list, including citations through 1985, contains over 560 sources. It is realistic to assume that the number of publications on bowhead whales exceeds 600 by now. With that many references to search, it seemed important that a single-volume scientific reference book be available to describe the species as it is presently understood.

Many people closely associated with the bowhead issue viewed this intensive research effort spanning 15 years and costing over $45 million (Table 1) as a benchmark achievement in the methodologies employed and the results obtained on this difficult-to-study species. They felt it was a logical point to pause, review progress to date, and assess how far we had come. Although it was apparent that a great amount of information remained to be evaluated, a summary effort was still timely, in that incremental increases in knowledge of the species are likely to be made at a reduce rate, compared to the rapid accumulation of data from this major initial effort. Recognizing a need for a scientific reference volume about the bowhead, the United States, Department of the Interior, Minerals Management Service (MMS) acted as a catalyst to encourage support for a cooperatively sponsored book on the subject. The MMS set aside "seed" money, and invited all organizations in North America and the Soviet Union that had supported bowhead research or were otherwise interested in bowhead issues to participate in supporting the project, both financially and scientifically. The following organizations joined MMS to fund this book: Alaska Eskimo Whaling Commission; American Petroleum Institute; AMOCO Production Company; Canmar (US), Inc.; EXXON Company USA; Fisheries and Oceans Canada; Indian and Northern Affairs Canada; National Marine Fisheries Service; North Slope Borough; Shell Western Exploration and Production, Inc.; Standard Alaska Production (now BP Exploration) Company; Union Oil Company of California; and Western Geophysical Company. With their additional commitment of funds, the feasibility of the project was ensured.

Technically qualified representatives of the sponsors constituted a Management Review Board (MRB) that met initially in January 1988. At that meeting, chapter topics and scope were discussed; suggestions for lead, contributing and alternate authors for each chapter were advanced based primarily on who was responsible for doing the original research pertinent to an identified chapter; scientists capable of providing peer review for each chapter were discussed; a review process was outlined; potential coeditors and alternates were nominated; and the mode of publication and potential publishers were discussed. Based largely upon MRB input, MMS contracted for the services of authors and editors. Authors were paid a modest honoraria to compensate for word processing, copying, and postage costs, while the coeditors were paid wages. The MRB felt that the goals and objectives of the book could best be achieved by publication through a professional society. The Society for Marine Mammalogy

Table 1. Expenditures on bowhead whale research through 1989, listed in order of the amount of organizational expenditure.

Organization or Group	Numbers of Projects	Cost (U.S. $)
U.S. Minerals Management Service	29	22,137,217*
U.S. Oil Industry	15	6,313,000
U.S. National Marine Mammal Laboratory	17	5,000,000
U.S.S.R. Ministry of Fisheries	15	4,134,483**
North Slope Borough	53	2,676,572
State of Alaska	9	1,992,000
Indian and Northern Affairs, Canada	16	1,314,448
Canadian Oil Industry	8	1,000,000
U.S. Bureau of Indian Affairs	3	516,763
Alaska Eskimo Whaling Commission	6	415,068
World Wildlife Fund Canada	2	305,110
Fisheries and Oceans Canada	2	110,000
Total	175	$45,914,658

* The Environmental Studies Program, includes funds from the Bureau of Land Management, former administrative agency for the program.

** At the offical Soviet exchange rate of 1 ruble = $1.61.

(SMM) seemed especially appropriate for the task. The SMM viewed the project favorably and agreed to publish this book as Special Publication Number 2.

GOALS AND OBJECTIVES

The goal of this book is to be a scientifically authoritative reference on the bowhead whale to serve the information needs of scientists, managers and natural resource policy makers responsible for the welfare of the species and its habitat. The breadth of content (e.g., coverage of all stocks) and the terminology employed make the book suitable for worldwide readership. Although the book is not specifically written for a lay audience, those interested in the great whales, bowheads in particular, will hopefully find it useful. The primary objectives of the book are to: 1) place much of the information about bowheads, now scattered in approximately 600 publications, into one volume; 2) place the abundant information now contained in contract reports and unpublished data into peer-reviewed scientific literature; 3) provide new insight on bowhead ecology; and 4) provide an available and affordable source of information on the species.

The first and second objectives were achieved by the breadth of content and authorship and the explicit requirement for authors to consult all known references, whether published or

Table 2. Editors and authors for the bowhead whale book. Editors: J. Burns and J. Montague.

	Chapter	Author	Suggested Page Length*
	Foreword	To be named	1
I.	Introduction	J. Montague	8
II.	Physical Environment	J. Neibauer	10
III.	Phylogeny and Taxonomy	L. Barnes and S. McCleod	5
IV.	Anatomy and Physiology	J. Haldiman and R.J. Tarpley	23
V.	Behavior	B. Würsig and C. Clark	40
VI.	Feeding Ecology	L. Lowry and D. Thomson	43
VII.	Reproduction	R. Davis	20
VIII.	Morbidity and Mortality	M. Philo, H. Casey, E. Shotts, and C. George	17
IX.	Distribution and Movement	S. Moore and R. Reeves	50
X.	Historic Population Size	D. Woodby and D. Botkin	10
XI.	Current Population Size and Dynamics	J. Zeh, C. Clark, C. George, G. Carroll, D. Withrow, W. Koski	40
XII.	New Study Techniques - Stable Isotopes	D. Schell	8
XIII.	Commercial Whaling - Bering Sea	J. Bockstoce	15
XIV.	Commercial Whaling - Other Stocks	G. Ross	25
XV.	Aboriginal and Contemporary Whaling	S. Stoker and A. Brower	35
XVI.	Responses to Acoustic Disturbance	J. Richardson and C. Malme	45
XVII.	Presence and Effects of Contaminants	G. Bratton, B. Spainhour, W. Flory, and M. Reed	29
XVIII.	Epilogue	M. Tillman	5
		Total	429

* These are final book pages including figures and tables. There are approximately 2 1/2 double spaced typewritten pages per book page.

not. Extensive peer review was obtained from the following source: the coeditors' review; at least two and sometimes three autonomous peer reviews by scientists selected by the coeditors, largely based on recommendations by the MRB; review by the scientific editor for the SMM; and, for some chapters, additional autonomous reviews selected by the SMM editor. The third objective was achieved by virtue of pulling all of the existing information together and interpreting it as a whole. The fourth objective was achieved through book preparation and initial publication costs borne by the 14 cosponsors.

This book is intended to be a cohesive species account, not a bound collection of individual papers within the narrow expertise of one author. In order to achieve this end of cohesiveness, many chapters were written by several authors, scientists who would not normally have worked together. Although author selection was based largely on who was responsible for conducting the original research, most chapter titles include some unique aspects that were outside the realm of personal research by the authors (Table 2). Hence, lead authors were requested to ensure that all subtopics relating to their titles were addressed, even through an extensive library search, if necessary. As a result, authors used a broad approach, considering information not only from the fields of marine mammal science or wildlife ecology but also from those of oceanography, veterinary science, physics, ethology, anthropology, and other fields, as appropriate.

PROGRESS

Of the 18 chapters first drafts have been prepared for all but the epilogue. Two chapters have undergone peer and editorial review, have been revised accordingly, and are ready for the preparation of galley proofs. It is anticipated that the last manuscript will be submitted to the SMM by April 1990 with final publication scheduled for December 1990. The book will have a 6 7/8" X 10" trim size. The first edition (hardbound) will be purchased by the sponsors and distributed by them. The second edition (paperback) will be available from SMM for $19.95.

REFERENCES

Bean, N. 1983. The evolution of national wildlife law. Praeger Publishers. New York, NY. 449 pp.

Bockstoce, J. 1986. Whales, ice and men: the history of whaling in the western Arctic. Univ. of Washington Press. Seattle, WA. 400 pp.

Fraker, M. 1984. *Balaena mysticetus*: Whales, oil and whaling in the Arctic. Sohio Alaska Petroleum Co, Anchorage, AK. 62 pp.

Gusey, W. 1983. Bowhead *Balaena mysticetus*. Shell Oil Co. Houston, TX. 153 pp.

Huntley, A., D. Costa, G. Worthy, and M. Castellini. 1987. Approaches to marine mammal energetics. Society for Marine Mammalogy. Special Publication Number 1. 253 pp.

Oliver, G., E. Setzler-Hamilton, and D. Ludwig. 1987. Bowhead whale, *Balaena mysticetus*, bibliography. Rpt. for U.S. Minerals Management Service, Alaska OCS Region, Anchorage, AK. by Univ. of Maryland, Eastern Shore. Unpaginated. (Available from National Technical Information Service, Springfield, VA 22161 as PB88-120688).

Tomlin, A. G. 1957. Mammals of the USSR and adjacent countries, Vol. 9, Cetacea. Academy of Science, USSR, Moscow. 756 pp. (in Russian), translated by Israeli Program of Science Translation, Jerusalem, 1967, 717 pp. (Available from National Technical Information Service, Springfield, VA 22161 as TT 65-500867).

Townsend, C. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19(1):1-50.

QUESTIONS AND DISCUSSION

No questions.

MOVEMENTS AND DIVE PATTERNS OF A RIGHT WHALE MONITORED BY SATELLITE

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INTRODUCTION

The North Atlantic right whale, *Eubalaena glacialis*, is the most endangered large whale in the world region with a population estimated at less than 350 individuals (Kraus, pers. comm.). Up to a few dozen are observed annually in Cape Cod Bay during April and May. By June, right whales are most common in the Great South Channel (GSC), 100 km southeast of Cape Cod. By late August the largest annual concentration is found off the southern tip of Nova Scotia and in the Bay of Fundy. The summer is considered the primary feeding season. Little is known of the winter distribution of right whales except for the sightings of small numbers of females with calves off Georgia and northern Florida.

METHODS AND OBSERVATIONS

Right whale field studies and radio tagging activities were conducted from August to mid-October off Nova Scotia in the North Atlantic Ocean and in the Bay of Fundy. Conspicuous breeding behavior was the major activity observed and feeding behavior was seldom seen. Hydrophone recordings in the presence of a single female and a single male revealed low frequency "moans" which attracted large numbers of males from all directions. This resulted in vigorous surface activity, during which the female spent most of her time at the surface with her ventral side up to avoid mating. The males competed for proximity to the female and attempted to copulate with her when she rolled over to breathe. We saw many such groups through the whole field season. In one group of 27 whales only one female was identified and the breeding activity lasted six hours before observations were terminated.

Significance: This area appears to be an important right whale breeding habitat.

Most whales had conspicuous scars. Several animals were observed with a rope or net caught through the mouth or wrapped around the flukes. Several large ships were observed in close proximity to right whales with no apparent reaction from the whales. Serial lacerations and scars characteristic of boat propeller strikes were evident on a few whales.

Significance: Although right whales did not appear to react adversely to boat and ship noise, this may expose them to greater risk of collision. Personal observations and photographs by other right whale study groups suggest a significant number of right whales are scarred by boat collisions and fishing gear entanglements.

RESULTS

Movements: In October 1989, an adult male right whale in the Bay of Fundy was tagged with an Argos-(satellite) monitored radio transmitter. It was tracked between 71 locations (Figure 1) over a 22 day period (mean = 3.2 locations/day) and traveled at least 1,523 km (mean =

69 km/day). Prior to tagging, the animal was observed in surface-active breeding encounters. Within 10 days, it had visited all four of the known fall aggregation sites for right whales. (Gran Manan Channel, Brown's Bank, Baccaro Bank, and the western Gulf of Maine).

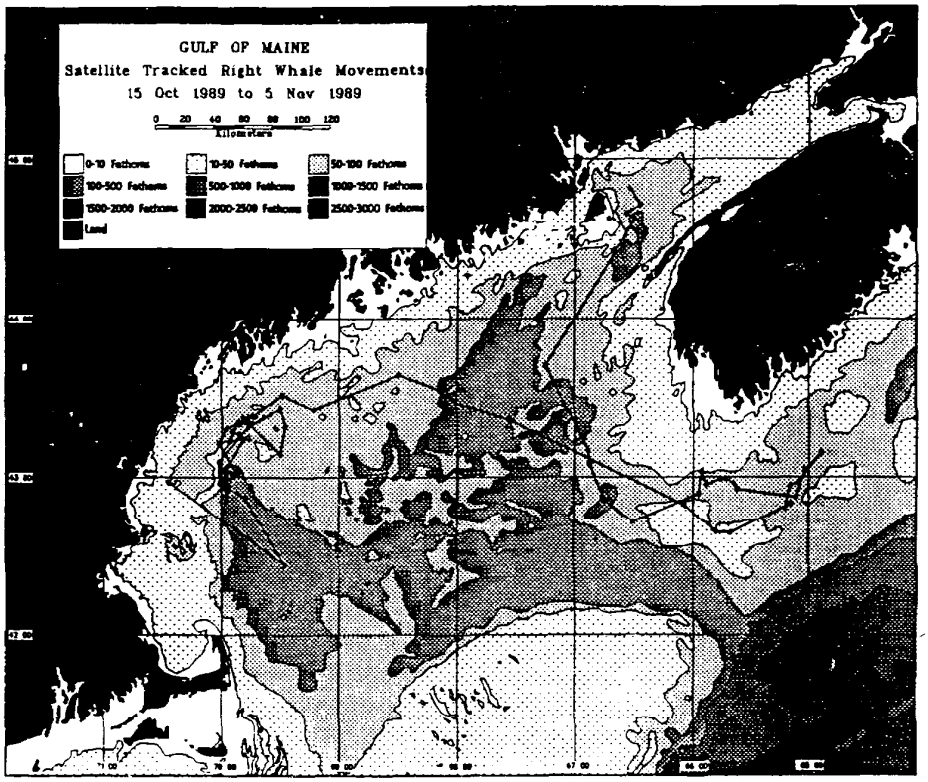

Figure 1. The 22 day track of a satellite-monitored radio-tagged right whale in the Bay of Fundy, North Atlantic and western Gulf of Maine showing dive depths.

Significance: Right whales move faster and range more widely than previously known. The movements of even one breeding male suggests that the entire population is likely a single breeding stock.

Dive Depths: The radio tag sent satellite-monitored dive duration, pressure and temperature data which indicated dives to the bottom occurred routinely in water up to 272 m deep. This is a significant finding as right whales have typically been considered surface and shallow water skim feeders. During the last 11 days, the tagged whale dove regularly to the bottom in two areas: 1) along the 200 m contour along a steep slope near Jeffrey's Ledge in the Gulf of Maine adjacent to deep water in an area of upwelling, and 2) in an eddy known to concentrate plankton northeast of Jeffrey's Ledge. Both areas are considered excellent habitat for the

Calanus copepods on which right whales feed. Calanoid copepods can be diurnal migrators but the extent of this activity varies from year to year and geographically. It is not known whether the tagged right whale's deep dives constituted searching all levels of the water column for prey or was specifically for bottom feeding. Other whales were observed surfacing in the Bay of Fundy trailing mud plumes in water over 100 m deep.

Significance: Right whales routinely dive to the bottom (up to 272 m). Data from tagged whales determined temperature-depth profiles to describe the whale's physical environment. A tagged right whale concentrated its deep diving activities in areas typically associated with high productivity. These physical oceanographic parameters are important because high productivity areas can be difficult to identify and sample in real time.

Dive Patterns: Four hour summaries revealed variation in the number of dives (mean = 182 ± 57) and their duration (mean = 74 s ± 18). Two percent of all dives were monitored directly. The longest monitored right whale dive was 14.1 min. The 15 minute passage time of the polar-orbiting satellite over the tagged whale could provide some bias in collecting data on longer dives.

Significance: The frequency of right whales surfacing makes them easy to locate by satellite. Although right whales are thought to take "long" dives, their average respiration rate is close to that of gray whales, humpback whales and even some smaller species.

DISCUSSION

The attachment system used in 1989 was designed around a transmitter technology which was too large and too heavy to be deployed as a projectile tag. No specimens of adult right whale skin or blubber were available for testing attachments so gray whale and humpback whale skin and blubber were used as models. These proved to be inappropriate models and the attachment system did not work well. Darts with folding barbs did hold well even with strain up to 500 pounds on a trailing line.

Significance: Right whales may have less connective tissue in the blubber layer than most other species of large whale. Future systems may have to rely more heavily on the tough facia between the skin and blubber, go deeper into the blubber, or utilize materials which develop adhesions with soft tissues.

Late in 1989, a miniaturized transmitter was developed which puts out less power than previous models and thus uses less energy. An analysis of the signal strength from 1987 pilot whale data suggest this transmitter will still put out a strong enough signal to meet right whale tracking requirements. This system has been hybridized and will be available by March 1990. Although we will not be able to add sensory functions for pressure and temperature like those we used in 1989, the new transmitter can be packaged in one-fourth the volume and be one-fifth the weight of the 1989 tag. This will allow a fully projectile application and greatly reduce drag.

Significance: The folding barb dart developed during the 1989 field season should be a successful subdermal attachment for this small surface-mounted transmitter for tagging right whales in 1990. This technology may also be applicable to bowhead whales in the future.

QUESTIONS AND DISCUSSION

Cleve Cowles: The histograms on dives are very interesting to us. We see that same sort of thing from aerial observations. Since you have had this information, have any investigators who have done studies of right whales and have data from airborne visual observations had an opportunity to react to your statistics on dive times and dive durations as compared to theirs? Or is there a problem with that kind of data for the right whale?

Bruce Mate: Yes, it is difficult on an animal that dives for such a long period of time and as far offshore to make (observations), well those of you doing bowhead work have the same problems. So far it appears that the dive duration information that other people have collected falls neatly within this. If anything, there is a bias in their data showing fewer long dives. Because when dives appear to go past about 7 minutes I think there is probably some observer fatigue and the options of the animal surfacing out of viewer range start to increase. So if anything, I would say that we have more information about longer dives than do most visual observers. Although there are many people who have visual observations who would swear that animals they have been watching have disappeared from the face of the earth for extended period of time.

_____: Can you translate your numbers into percent time at surface and percent time underwater, have you been able to do that yet?

Bruce Mate: Yes, we have done that. The one graph that showed the amount of time spent submerged has been translated into that. Basically the animal spends about 85 to 92% of the time underwater. Does that meet with your satisfaction, Mike? Does that fit your hypothesis?

A METHOD OF RANKING THE DISTURBANCE POTENTIAL OF NOISE SOURCES IN THE ENVIRONMENT OF MARINE MAMMALS IN ALASKA

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BACKGROUND

A number of studies have been made of the responses of marine mammals to various types of noise produced by the oil and gas industry. In these studies the existing ambient noise levels in the study areas have necessarily been used as a control stimulus. The noise exposure history of the subject mammals has not been known. The Alaskan marine environment contains a diverse variety of noise sources including marine biota, natural seismicity, vessel noise, and sources associated with the oil and gas industry. A better understanding of the numbers, locations, and intensities of these noise sources is needed in order to determine the normal levels of natural ambient noise and the "normal" levels of background noise, including extraneous human noise, to which marine mammals are exposed in the usual habitats. To that end, the purpose of this study is to provide an up-to-date comprehensive synthesis of available information about the relative magnitudes and effects of noise from other sources in Alaska OCS and coastal waters. Figure 1 indicates the Alaska OCS Planning Areas and the four areas of high current interest (the focus of this acoustic study) in the context of environmental impact due to oil and gas industry and other source activities.

OBJECTIVES

1. Identify the major sound sources in the Alaskan OCS and coastal marine environment and quantify their numbers, distributions (temporal and spatial), and acoustic characteristics.

2. Summarize the geographic zones of the potential acoustic influence on important marine mammals habitats and, for each noise source, postulate the magnitude of overall interactions with Alaskan marine mammals.

3. Quantify and rank the relative seasonal magnitude of sound "loading" of the Alaskan marine environment produced by each major sound source.

4. Depict the major sound sources and their geographic zone of influence as graphic overlays on displays of regional and temporal marine mammal distribution.

STUDY DESCRIPTION

The procedure followed to meet the requirements incorporates the source, path, receiver concept used frequently in acoustic analysis. The receiver characterization includes a review of marine mammal distributions in Alaska and a map of the distribution of each major species. A total of 30 species known to occur in Alaska were considered in the study. Alaska is a significant part of the range of 18 of these species. Alaska is a relatively unimportant part of the range of eight of the species, and four of the species are rare or accidental in Alaskan waters.

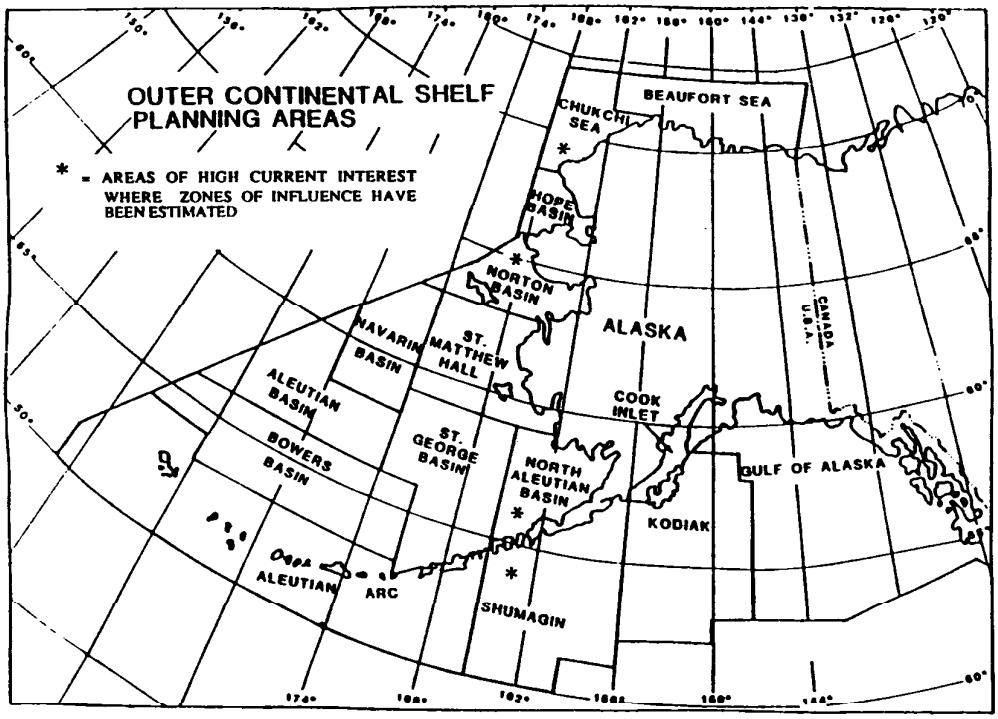

Figure 1. Alaska OCS planning areas considered in the study of potential acoustic disturbance of marine mammals.

The final report of this study[1] also reviews information on sound production by each species, hearing sensitivity (when known), and observed responses to noise sources.

The analysis of noise sources found in the Alaskan marine environment includes natural, industrial, transportation, and cultural sources. Information on their output spectra is presented in graphs and tables of 1/3 octave source level (dB re 1 μPa at 1 m). When available, information on the temporal characteristics of the sources is also included.

Acoustic transmission loss characteristics are obtained from measurement and model predictions. These characteristics, along with the above source level data, are used to estimate the effective acoustic ranges of sound sources. Both airborne and underwater transmission loss characteristics are required. However, empirical information on underwater acoustic transmission loss in Alaskan marine environments is sparse. As a result, it was necessary to use sound

[1]Malme, C.I., P.R. Miles (BBN); G.W. Miller, W.J. Richardson, D.G. Roseneau, D.H. Thompson (LGL); C.R. Greene (Greeneridge Sciences). 1989. Analysis and Ranking of the Acoustic Disturbance Potential of Petroleum Industrial Activities and Other Sources of Noise in the Environment of Marine Mammals in Alaska, BBN Report No. 6945, OCS Study MMS 89-0006.

propagation models to obtain estimated transmission loss characteristics for several areas studied.

Information on species distribution was combined with information on source distribution, source level, and transmission loss to determine the most significant sources in terms of their acoustic ranges and the numbers of mammals potentially affected. This was done by developing a Standardized Noise Contribution Model which is based on the acoustic energy density contributed to the environment by a specific type of source in a defined reference area. The source rating is combined with a Standardized Exposure Rating Model for a specific species. The latter model takes into account the degree of matching between the source bandwidth and the species' hearing sensitivity, and the number of animals present in the reference area. The output of this procedure provides an indication of which source - species combinations have the highest potential for acoustic interaction in a given area. Zones of influence for the loudest and most widely distributed sound sources, as determined by the modeling procedure, are estimated for four selected OCS planning areas of high current interest - Chukchi Sea, Norton Basin, North Aleutian Basin, and Shumagin.

STUDY RESULTS

Table 1 summarizes the results of the study for the potential acoustic disturbance of 12 marine mammals in the four planning areas of interest. The loudest sound sources in the Alaskan marine environment are seismic arrays (both air gun and vibroseis), icebreakers, large ships, and dredges. Sound levels produced by the smaller vessels used for cargo hauling, fishing, and recreation become significant when several vessels are operating in a relatively small area. Earthquake events produce high underwater sound levels sporadically in active seismic areas such as the Aleutian arc. Sound produced by aircraft is the loudest airborne noise component. The primary impact of this noise is near airports and landing strips and along routes where low level operations are prevalent.

Baleen whales are believed to have hearing sensitivity characteristics which include the frequency range of most of the man-made sources described above. As a result, the exposure model showed that the gray, bowhead, fin, and humpback whales which frequent Alaskan waters are species with high probabilities of acoustic interaction with most of the sound sources studied. The model predicted that killer whales, harbor porpoise, Dall's porpoise, harbor seals, and fur seals would be influenced primarily by the loudest sources since their hearing sensitivity does not extend to the low frequency range estimated for baleen whales. The other species studied, including walrus, white whale, and Steller sea lion, were all predicted to have medium to low probability of acoustic influence from the sources considered. This is primarily a result of the fact that their optimal hearing sensitivity is at frequencies above the dominant output frequencies of most man-made sources.

CONCLUSIONS

The modeling procedure developed in the study provides a means of ranking source - species encounter situations using acoustic principles. The principles employed have been used in similar ways, and to some extent validated as meaningful, to predict human annoyance as a function of industrial noise exposure. These predictions should be useful as hypotheses about some of the species and situations where noise impacts are most and least likely. However, the

Table 1. Summary of standardized exposure rating results for selected OCS planning areas.

Area	Seas./ Cond	Source	Walrus	Gray Whale	Fin Whale	Humpback Whale	Killer Whale	White Whale	Ringed Seal	Harbor Seal	Fur Seal	Harbor Porpoise	Dall's Porpoise	Steller Sea Lion
Chukchi Sea	Sum.	Seismic Array	(Med.)[1]	High[2]				Medium						
	"	Icebreaker	(Medium)	High				Medium						
	"	Kulluk	(Medium)	Medium				Low						
	"	Tug/Barge	(Low)	Medium				Medium						
	Wint.	Vibroseis							Medium					
Norton Basin	Surf.	Seismic Array	(Medium)	High										
	"	Outdrive	(Medium)	Medium										
	"	Dredge	(Medium)	Medium										
	"	Tug/Barge	(Medium)	Medium										
	"	13' Whaler	(Low)	Medium										
	Neut.	Seismic Array	(Medium)						Medium					
	"	Icebreaker	(Medium)						Medium					
	"	Dredge	(Low)						Medium					
	"	Tug/Barge	(Low)						Low					
North Aleutian	Surf.	Seismic Array		High						(Medium)		(Medium)		(Medium)
	"	Outdrive		Medium						Medium		Medium		(Medium)
	"	13' Whaler		Medium						Medium		Medium		(Medium)
	"	Tug/Barge		High						Medium		Medium		(Medium)
	"	Trawler		(High)						(Low)		Low		(Low)
	Neut.	Outdrive		(Medium)						Low		Medium		(Low)
	"	Seismic Array		(High)						Medium		Medium		(Medium)
	"	Tug/Barge		(High)						Low		Medium		(Low)
Shumagin	Surf.	Seismic Array		(High)	High	(High)	Medium			(Medium)		(Medium)		(Medium)
	"	Outdrive		(Medium)	Medium	(Medium)	Medium			(Low)		(Low)		(Low)
	"	Large Tanker		(High)	High	(High)	High							(Medium)
	"	Ferry/Cargo		(Medium)	Medium	(Medium)	Medium							(Low)
	Neut.	Seismic Array		(High)	(High)		(Medium)			(Medium)	Medium	(Medium)	Medium	(Medium)
	"	Large Tanker		(High)	(High)		(High)			(High)	High	(High)	High	(Medium)
	"	Ferry/Cargo		(Medium)	(Medium)		(Medium)			(Medium)	Medium	(Medium)	Medium	(Low)

1 Rating enclosed in parenthesis are inferred from ratings form similar species and source output spectra.
2 The ratings are based on area SER values using the following criteria:
High, SER >=180; Medium, SER = 179 to 141; Low, SER <=140
Surf. = Surface Layer
Neut. = Neutral Gradient

application of these models to marine mammals has involved the use of several untested hypotheses. It has been necessary to use estimated and inferred values for many of the required model inputs where measured data are not presently available.

QUESTIONS AND DISCUSSION

Cleve Cowles: One of your goals was to rank the relative contributions and exposures, I presume, of different categories of sources. For example, oil and gas sources, fishing sources, etc. Do you have any summary statements as to your results there?

Paul Miles: The slide that I showed earlier giving the sound levels relating to the various sources demonstrated that the seismic array generated the highest acoustic level and, indeed, there has been some observation that there is acoustic/mammal interaction. Ice breaker noise (propeller cavitation noise associated with working with ice and moving it away from a site) is also a very important source in the northern areas. The geographic density of these sources is low, obviously. Depending on the area, the source/mammal interaction may not be too significant, except for short periods of relatively close encounter. The smaller or lower level sources (e.g. fishing vessels, recreation smallcraft) are lower on the priority list depending on their space density and activity in proximity to marine mammals. Earthquakes can be important natural sources, but the large events are not only infrequent (having associated high acoustic levels), they are impulsive in character, lasting for very short periods. There has been some anecdotal

experience, however, that implies that migrating gray whales may react to earthquakes along the coastline by moving further offshore.

Warren Matumeak: I am just curious as to what the false killer whale looks like? Is it like the regular killer whale?

Paul Miles: No, I am afraid I can't answer that. John, can you describe a false killer whale?

John Richardson: Well, not really very well. It is a member of the dolphin group. So in terms of its hearing it is going to be typical of the other toothed whales with good hearing sensitivity at moderate and high frequencies, not at low frequencies, within that same range of curves that all the other toothed whales were in with the exception of the killer whales which is quite different.

MODELLING EFFECTS OF OIL SPILLS ON POPULATION DYNAMICS

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INTRODUCTION

There are several approaches that need to be considered in attempting to evaluate the likely effects of some impact on a natural population. The simplest approach depends on judgments arrived at by professionals with good knowledge of local conditions. A second route to predictions is that of the statistician, who largely depends on regression analyses. These require good historical data on the variables of major interest, along with suitable auxiliary variables on which to base the regression equation. Such data are frequently not available, and there is the further difficulty that the required predictions usually need to cover circumstances well out of the range of the available data. A third route is via simulation models. This is the most flexible and risky approach.

Our experience with simulation modelling of the effect of oil spills on population dynamics suggests a number of issues that need attention if the technique is to remain useful. By definition, computer models eventually produce output. To make a model run, one must obtain numerical values for the parameters used in the program. Hence some very questionable estimates are used in models. Often it is necessary to simplify functional relationships, and a conscientious modeller records various caveats and tries sensitivity analyses, but eventually the program prints out data presumably representing the system under study. If stochastic elements are present, along with just a little complexity, most models will give plausible outputs even though there may be a major error present due to a mistake in programming or in logical structure of the model. Consequently, there is a real prospect that simulation models will fall into disrepute, as more people come to appreciate these shortcomings.

APPROACHES TO MODELLING

Our main actual experience in simulation modelling relative to prospects of an oil spill is with sea otters in California and along the Alaskan Peninsula. For the California situation, a stochastic model was developed, with monthly updating of the fate of individual otters. The California sea otter population inhabits a narrow belt of close-inshore habitat along the coastline. Most individuals seldom stray more than a kilometer from the shoreline. In contradistinction, otters along the Bering Sea side of the Alaskan Peninsula and Unimak Island appear at times to adopt virtually a pelagic existence, being found as much as 40 to 50 km out to sea. Distributional data in California are available from some 30 to 40 individual censuses and counts over a long span of years, most of which suggest a relatively stable pattern of distribution, with some seasonal shifts. The available data on the Bering Sea population amounts to relatively few transect counts. A very substantial array of demographic and biological data has been accumulated on the California population over two decades of study, and extensive telemetry data have been obtained in recent years.

With these substantial differences in the two areas, it did not seem sensible to attempt to adapt the California model for the Alaskan situation. It would be quite feasible to construct a similar model, but the dramatic difference in spatial configuration of the two populations would require extensive restructuring of the entire model, going from essentially a linear structure to one operating in two dimensions. A much better use of time and other resources was thus to

construct a simpler model designed to operate with the much more limited data set available in Alaska.

We have been involved in modelling and analysis for a number of other populations of large mammals, including such diverse populations as bowhead whales, a variety of species of seals, wild horses, and grizzly bears. This experience has suggested a conceptual approach to such problems.

The conceptual approach for the Alaskan study was essentially a three-step process (Figure 1). The first stage is devoted to testing assumptions and hypotheses based on the available data. The next stage utilized that data shown to be internally consistent in stage 1 as a basis for generating parameter estimates, and the final stage is a simplified Leslie matrix model used to generate outcomes for various oil spill scenarios. The key features of this approach have largely to do with assessment of data that may serve to approximate the reproductive and survival rates for the population under consideration. Along with the age structure, this information serves to determine the likely future trend of the population. Where direct or indirect measurements of historical population trends are available, they can be used to supplement the basic birth and death data.

NEEDED IMPROVEMENTS

If one starts to structure a model along the lines suggested above, the information needed about population dynamics immediately becomes painfully apparent. However, this is not the worst problem which is that present-day knowledge of the effects of oil spills on marine mammals is dismally inadequate. Two routes to improving such knowledge are presumably available. One is experimental. Relatively little information is available on the impacts of oil on sea otters in terms of actual mortality rates. Developing such information experimentally via standard bioassay methods would undoubtedly require the exposure of literally hundreds of sea otters to varying degrees of contamination by oil. A generally-held opinion is that any substantial contact with oil is likely to result in death of the affected individual, unless immediate steps can be taken to remove the majority of the oil. Thus it seems likely that a small range in degree of contamination will correspond to a very wide range of survival. Under such circumstances, it is probable that an "all or none" kind of impact model may be adequate for practical purposes. The incursion of oil into an occupied area may be assumed to remove a fraction of the otter population corresponding to that proportion of the otter range traversed by the oil spill.

The other possible approach is via experience with actual oil spills. So far as sea otters are concerned, the obvious opportunity along those lines is the *Exxon Valdez* spill and its impacts on Prince William Sound. In the studies described above, we assumed that any significant incursion of oil would destroy most of the otters present, but that recovery of the population would largely be governed by basic population dynamics parameters, i.e., by survival and reproductive rates for a population in good habitat, ignoring possible effects of the oil spill on the food base of the otter population. The spill in Prince William Sound provides an opportunity to learn a great deal about these two major assumptions. Does an extensive spill kill nearly all of the animals present, and how important are the effects on the food base in determining recovery times? There is a further important feature that may be added, and this takes the form of the question of whether or not attempts should be made to "rescue" otters from the spill zone. It will be very unfortunate if extensive efforts are not made to utilize this actual experience with an oil spill to learn as much as possible about what really happens, as opposed to what can be done by way of modelling.

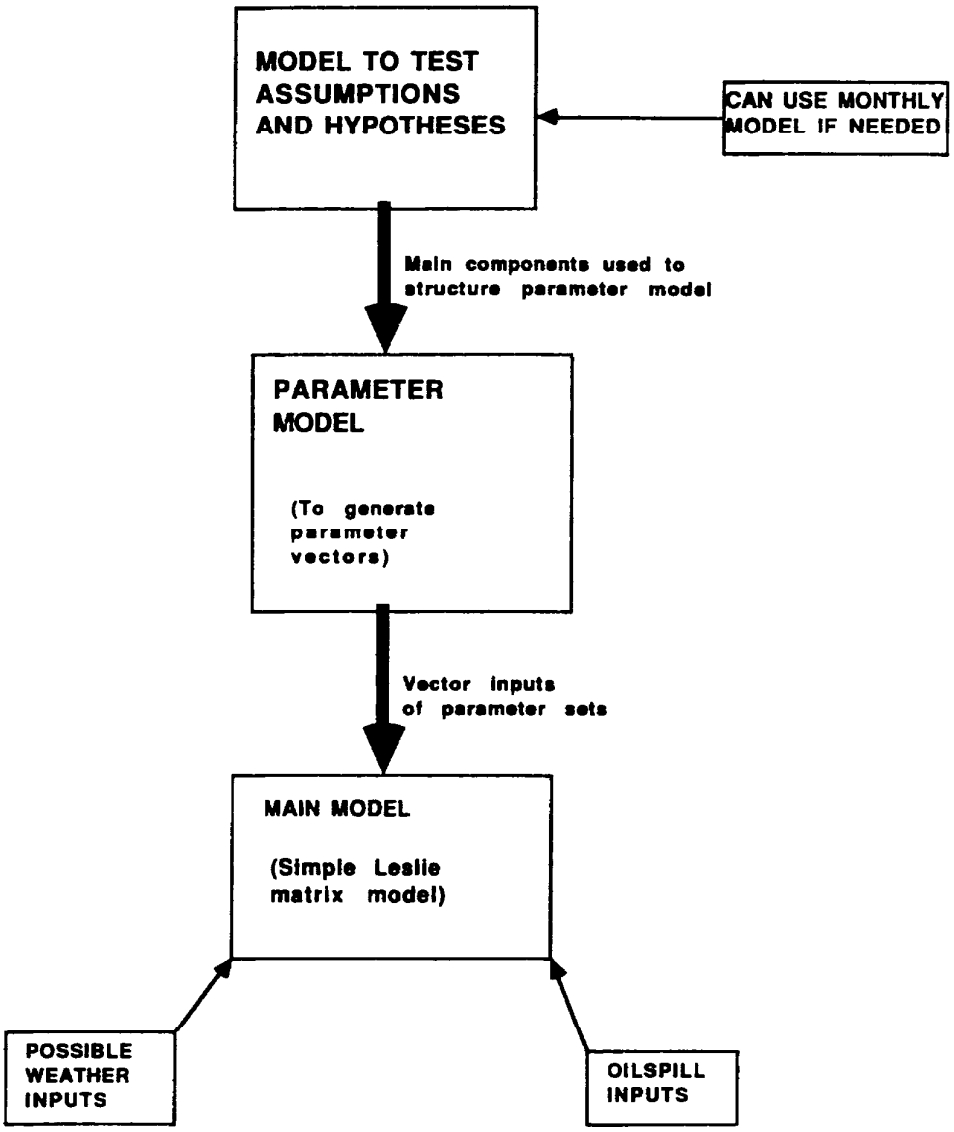

Figure 1. Conceptual approach for sea otter modelling study.

REFERENCES

Breiwick, J.M., L.L. Eberhardt, and H.W. Braham. 1984. Population dynamics of western Arctic bowhead whales. Can. Jour. Fish Aquat. Sci.

Eberhardt, L.L. 1981. Population dynamics of the Pribilof fur seals. Pages 197-220 *in*: Fowler, C.W. and T.D. Smith, (eds.), Dynamics of large mammal populations. J. Wiley and Sons, New York.

Eberhardt, L.L., and D.B. Siniff. 1988. Population model for Alaska Peninsula sea otters. OCS Study, MMS 88-0091, Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior.

Innis, G.S., ed. 1977. Applied systems ecology: models, data, and statistical methods. Pages 43-55 *in*: New directions in the analysis of ecological systems, Part I. The Society for Computer Simulation, La Jolla, CA.

Knight, R.R., and L.L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. Ecology 66.

Siniff, D.B., and K. Ralls, eds. 1988. Population status of California sea otters. OCS Study, MMS 88-0021, Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior.

QUESTIONS AND DISCUSSION

_____: Do you have a working model and have you had a chance to verify it yet? Or do you plan to do so in the future?

Lee Eberhardt: Well, that was the whole burden of my last message. Yes, we have a working model. We have two of them, one of them for California and one developed for the Bering Sea. I would like to see it verified via what we learn from the Valdez spill. I don't know when we will get at the data.

Warren Matumeak: Do you have any plans to do any modelling for the Alaskan Beaufort or Chukchi Seas? MMS is having a lot of sales over there. It seems like there should be some modelling done over there.

Lee Eberhardt: That is a question they will have to answer. I might say we did work with bowheads some years ago and know something about the problems. But the physical aspects of talking about oil spill exposure is something that I know very little about. The last I know there were some things that we didn't know about bowhead population dynamics that might hamper us. Chances are we can do something there if the need and opportunity arises.

Terrie Williams: What type of data did you need for your model?

Lee Eberhardt: As far as the Valdez experience is concerned?

Terrie Williams: Right.

Lee Eberhardt: Anything we can get a hold of. Particularly one thing we can look at, of course, is what happened in the rehabilitation situation. The survival of oiled animals that were brought in there. I think we can get that data fairly clearly, don't you?

Terrie Williams: Yes, I just wanted to clarify that concerning the data. It was divided up into the response data and the damage assessment data. So as far as response goes, particularly during the rehabilitation effort, that data is available through U.S. Fish and Wildlife Service, as well as through our laboratories.

Lee Eberhardt: I feel reasonably confident we can get at that experience after the animals came in, after they were handled. What worries me, of course, is what happened in the field. There are stories about people trying to catch them and chasing them back into the oil and that sort of thing. I don't know how we will ever get at that. The longer we wait, the less chance we have. It depends on what is happening with the carcasses for example. When will we know what the evidence is of the contaminant levels in the individual animals, etc.?

Terrie Williams: From the federal side, I can't tell you. From the Exxon side, the stuff is being analyzed but we haven't gotten the results back. It won't be a five, ten year thing.

Lee Eberhardt: This is the sort of thing that I am worried about. The food chain, I suppose, we will infer something about. The basic problem as far as I am concerned in an oil spill of that sort is the impact on the food base of the population. If there is no major impact on the food base and we have a realistic background, then we can project something about what the population is likely to do. But if the food base is seriously impacted, really anything you do about analysis is driven by the response to the food supplies. I assume we will know something about that in time.

DEVELOPMENT OF A METHOD FOR MONITORING THE PRODUCTIVITY, SURVIVORSHIP, AND RECRUITMENT OF THE PACIFIC WALRUS POPULATION

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Walrus (*Odobenus rosmarus*) populations throughout the Arctic were over-exploited by commercial hunting in the past, primarily for ivory and hides. Some populations still require intensive protection, and they all need intelligent, multiple-use management. To achieve that, methods for accurately monitoring the current status of those populations and predicting their future trends are required. We developed such a method for the Pacific walrus population early in the 1980s. We and several colleagues field-tested it six times with support from a variety of sources. The present project, supported by the MMS, was an analysis of data from those tests, primarily to determine how well the method worked, how it might be improved, and the minimal required sample size.

The method involves observation from ships, in which each animal encountered is classified to a specific sex-age class, based on the shape, size, and coloration of the head and tusks. Since the ability to classify the animals quickly and accurately is partly a function of observer experience, a thorough training program for inexperienced observers is essential. The main purpose of the sampling is to determine the numbers of individuals in each of the youngest age classes from 0 to 5 years, in relation to the number of adult females in the population. All of the tests were conducted in the Chukchi Sea in summer, since nearly all of the adult females and immature animals reside there at that time.

Our objective was to sample all of the groups encountered and to classify every individual in each group. That objective was not attainable for a variety of reasons. Although the animals sighted in the water were almost always in groups of less than 15 and mainly of 1 to 3 individuals, they were difficult to classify, because they usually were visible only briefly, and most of their diagnostic characters were out of sight, underwater. Hence, the majority of the animals sighted in the water were not classified at all, and those that were classified were not a random sample of animals encountered. More than twice as many of them were in groups of two than would have been expected from the overall frequency of occurrence of the different group sizes. Furthermore, most of those classified animals were cow-calf and cow-yearling pairs, because such pairs are the easiest of all to identify. This led to overrepresentation of the two youngest age classes in the in-water samples, hence they were not representative of the population as a whole and could not be used for estimating the composition of the population.

The groups on the ice tended to be larger than those in the water (up to 250 but mainly 3 to 9 individuals), and they were easier to classify, because they usually were in view for a longer time and could be seen in their entirety. Nonetheless, it was not possible to classify every individual in every group, because some individuals were hidden from view and others slipped into the water and swam away before they could be observed closely. In general, the larger the group, the more difficult it was to classify completely, even by the most experienced observers. The proportion of on-ice groups completely classified, however, was much higher than of the in-water groups and was more representative of the overall group size frequency.

The data from on-ice groups that were not completely classified were found to be biased in the same way as those from groups in the water (though to a lesser degree), evidently because the calves and yearlings are easier to identify than any others. Hence the data from the incompletely classified groups were judged to be not representative of the composition of the population. Only the data from the completely classified on-ice groups could be relied on as being representative, and we used those to test further for other potential biases in the sampling.

We found no consistently significant relationship of group composition with group size on the ice, though some general trends were indicated. In each of the samples, calves of the year tended to be somewhat more common in medium sized groups (15 to 50 animals) than in larger or smaller ones. In most of the samples, juveniles 3 to 5 years old tended to occur slightly more often in small (1 to 14 individuals) than in larger groups. Whether those tendencies are ever expressed strongly enough to influence the composition of the samples is not yet clear.

The samples showed some geographic heterogeneity, mainly greater numbers of subadult and adult males in the western Chukchi Sea, near Wrangel Island, and in the eastern Chukchi, near Barrow, than anywhere in between. The proportions of females and young were comparatively homogeneous from east to west and showed no consistent pattern of geographical variation. From the north-south aspect, the juvenile age classes tended to be slightly more common in or near the edge of the pack than they were farther inside it. This was testable for only one of the six samples, however, as the others were conducted only in the edge.

The potential for variation of group composition with time of day was testable for only two samples, and the results from those were not consistent. In the first, there was no significant variation in the representation of the juvenile age classes with time, and in the second, only the 2-year-old young varied significantly. We assume that this latter was due to sampling error and not to any real variation.

Three samples were testable for potential variation of group composition with depth of water, but there was no consistency among them. Since the water depths in the Chukchi Sea are comparatively uniform, this probably is not a factor of major importance there.

The optimal time and place for sampling appear to be in July in the outer part of the Chukchi Sea pack ice. At that time, most of the females and young are situated there, and the modal group size is small enough (3 to 15 animals) to favor completely classifying a high proportion of the groups. Assuming that the number of animals summering in the Chukchi Sea is ordinarily about 180,000, the composition of that population can be estimated with 95% confidence limits of ±3% from a sample of 2,500 animals.

Application of this method will allow composition sampling, useful for estimating calf production, juvenile survival, and the rate of entry of adolescents into the adult population. The method itself appears to be readily adaptable for use on walrus populations throughout the Arctic.

QUESTIONS AND DISCUSSION

Warren Matumeak: A few years ago there were a lot of pups that were lost. We wondered what happened when they were separated from their mothers?

Brendan Kelly: It is hard to say. We suspect such influxes of calves onto shore may relate to some particular storm event or ice condition that separates a lot of individuals. We know that at least in 1980 when we had a very large natural mortality in the Bering Strait region, the individuals were very lean. That seems to have been a poor year in general for foraging for reasons that we don't know. Something like that surely could relate to a high abandonment rate.

Mike Castellini: You said that as the observers got better, their description of the young and adults and the age classes got better and better relative to what the truth is. How did you decide what truth was in the first place, by the best observer or?

Brendan Kelly: Yes, by Fay's observations. Fay was our standard.

Cleve Cowles: In that same vein, you essentially described a simple one-way design of experience versus inexperience. Without telling a lot about how you essentially assigned observers into those categories, what you did during the cruise to assure that they remained in that category, that there wasn't perhaps interaction with other survey variables, such as time spent, weather, etc? Also you haven't said much about the analysis in terms of whether or not your results were a potential correlate? Did you look at any interactions? Because although you have come up with a one-way design, it could be that at least a two-way concern might also exist. I was just curious to see what you have done to address that in your study?

Brendan Kelly: We certainly went into more detail as to how we defined these classes and the distribution of different observers with respect to the other variables. That is in the MMS report. We didn't have all of one person's observations from a particular area or a particular time of day. They were spread nicely. In terms of interactions we did attempt to look at interactions on some of these things. The problem is that we get into some sample size problems very quickly when you try to divide it up too finely. We have a lot of data based on six cruises. But you don't want to take a cruise from July 1983 and lump that with another cruise in another year or season.

Ray Emerson: In terms of your monitoring methodology, are we going to be going back then and doing a wholesale look-see or are we refining it now to where we can have an index or indicator site or maybe the best observer on the best place to give us an indication of the population without this massive effort each time?

Brendan Kelly: Well I don't think it takes a massive effort anymore. What it does take is a cruise across the ice edge in July. As I say, I think you can accomplish all of the scoring that you need to do in about two days of work. You have to allow of course for weather and transit time, but the actual scoring can be done in two days. So I don't think it takes a particularly massive effort. I also think it would yield a tremendously greater amount of data about the status of this population than you would get from aerial surveys or from the harvest sampling which indeed

are much more massive efforts than what we are proposing here. So I think the gain is tremendous, you get a lot of "bang for your buck."

Ray Emerson: You were talking about a cruise a few years back, maybe from your database here, you can look at that smaller database, that one-time cruise and now would that give you an index of the population size? Can you compare that now to this database and work back?

Brendan Kelly: Yes, you certainly can make back-comparisons. What we would do is compare it to our on-ice completely scored groups in those previous cruises. Population size isn't a parameter that we are proposing to estimate, but productivity, recruitment, and survivorship are things that we can get. One of the things that happened, somewhat fortuitously for us, not so fortuitously for the walrus, was that there was that large mortality that I mentioned in 1980. We started composition counts in 1981; that the 1980 cohort was lost showed up in all of our samples. There was almost no calf survival that year. That showed up in our data very consistently. You could track that cohort and see that it wasn't there. Sampling should be on a regular basis, annually would be ideal, but it wouldn't necessarily have to be that frequently. It is a pretty sensitive indicator to what is happening in different parts of the population.

Ray Emerson: So we are working toward an optimum time and place where we can get an indication of the walrus population.

Brendan Kelly: Absolutely and that optimum time and place we are suggesting is July - August on the ice edge in the Chukchi Sea.

Jerome Montague: You indicated at the beginning of the talk that there is maybe some decline in the population and it might be somewhat attributable to hunting. I gather from a population of 180,000, the harvest is about 5%?

Brendan Kelly: The population isn't about 180,000. That was the estimate of the number of animals in the Chukchi Sea at that time of year. The only significance here was that we had to factor that into calculating the sample size needed in our composition estimates. In fact, that calculation is not very sensitive to differences in population anywhere between 100,000 and 200,000 animals. We could get the kind of accuracy we wanted out of a sample of about 2500 animals. The overall population estimate is higher than 180,000. Most of the males are in the Bering Sea at that time of the year. The 180,000 referred to the estimate of Chukchi Sea animals.

Jerome Montague: So the harvest would be quite a bit less than 5%?

Brendan Kelly: Well, remember those harvest figures I showed only depicted the numbers of retrieved animals which we estimate to be 60% of the kill.

SYNTHESIS OF INFORMATION ON THE EFFECTS OF NOISE AND DISTURBANCE ON MAJOR HAULOUT CONCENTRATIONS OF BERING SEA PINNIPEDS

MMS Contract No. 14-12-0001-30361

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INTRODUCTION

This study investigated the use of terrestrial haulout sites in the eastern Bering Sea by four species of pinnipeds: northern fur seal, northern sea lion, harbor seal, and Pacific walrus. Historical information on the use of each site was summarized and the potential vulnerability to noise and disturbance of each site was evaluated. For a few sites there was little or no information about the number of animals present and consistency of use of the site; we were unable to properly evaluate these sites.

The importance and vulnerability to disturbance, i.e., the sensitivity of each haulout site used by each of the four species, was computed and an Inter-site Population Sensitivity Index (IPSI) was generated for each site using a series of eight variables or factors related to: 1) the status, composition, and trend in numbers of the population being considered; 2) the location and major physical characteristics of the haulout sites being considered; and 3) the species being considered and its general response to disturbance (based on the literature).

Available information on the effects of airborne and waterborne noise, and human disturbance (from stationary and moving sources) on marine mammals in and/or near terrestrial haulout sites was reviewed. We also conducted a detailed analysis of the acoustic environment of eight haulout sites. These eight sites were representative of others used by each of the four species studied. The analysis included investigations of 1) characteristics of airborne and underwater ambient noise; 2) characteristics of industrial noise sources, including aircraft, small boats, fishing trawlers and commercial cargo traffic; and 3) sound transmission loss in air, water and trough the air-water surface.

Ambient noise characteristics for the eight sites were estimated using data obtained from studies of similar areas. The noise source characteristics were obtained from data reported in the literature and from BBN archives. Transmission loss characteristics for airborne and underwater sound were estimated using standard analytical procedures and computer models. An analytical procedure was developed for prediction of transmission of sound from aircraft into shallow water, since an existing procedure was not available.

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SENSITIVITY OF PINNIPEDS TO DISTURBANCES AT TERRESTRIAL HAULOUT SITES

Norton Basin Planning Area

There are 14 haulout sites in this planning area (Figures 1 and 2); they are used by two of the four species of pinnipeds studied. No northern fur seals or harbor seals haul out in significant numbers here. Twelve of the 14 sites are used by Pacific walrus. Two haulout sites, the one on North Punuk Island, and the one on King Island ranked high in their overall importance and potential vulnerability to possible OCS activities. Northern sea lions have occasionally hauled out at Southwest Cape on St. Lawrence Island and on nearby South Punuk Island. However, there is no current information concerning the use of these sites by sea lions.

St. Matthew-Hall Planning Area

In this planning area 24 haulout sites are used by three of the four pinnipeds studied; there are no northern fur seal haulout sites. Most of the sites (11; 46%) are used by northern sea lions, however none ranked high in the overall evaluation of importance or potential vulnerability. Pacific walrus sites were second in abundance (8; 33%) and four of these, all on St. Matthew or Hall Islands, ranked high in our evaluation of overall importance and potential vulnerability. Harbor seal sites were least abundant (5; 21%) in this planning area, but the site in Kuskokwim Bay ranked relatively high in importance and potential vulnerability to possible OCS development. This area, and the areas to the east near Avinof Point, may be the most northerly major harbor seal pupping areas in the eastern Bering Sea.

North Aleutian Basin Planning Area

The planning area contains 44 haulout sites used by three of the four species studied. Harbor seals use 22 (50%) of the sites including 9 important and potentially vulnerable sites. Twelve (27%) sites were occupied by northern sea lions, and at least six of these sites were ranked high. Ten sites (23%) are occupied by Pacific walrus, and five of these were ranked very high.

St. George Basin Planning Area

This planning area supports 54 haulout sites used by three species; this is the largest number of haulout sites in any of the four planning areas in the eastern Bering Sea. There are no consistently used Pacific walrus haulout sites, but all 22 (100%) northern fur seal haulout sites in the eastern Bering Sea are found here (Pribilof Islands and Bogoslof Island). These 22 sites represent about 40% of the total 54 sites. Seventeen sites (32%) are occupied by northern sea lions, and 6 of these were ranked very high in our evaluation of importance and potential vulnerability to possible OCS activities. At least 15 sites (28%) are used by harbor seals, and three of these (two in the Fox Islands and one on Otter Island) were ranked very high in our evaluation of importance and potential vulnerability to possible OCS activities.

Overall, we evaluated 120 of 136 terrestrial haulout sites in four different OCS Planning Areas in the eastern Bering Sea. Of the 44 sites in the North Aleutian Basin Planning Area, almost half (20 sites; 45%) were ranked high in our evaluation of their importance and potential vulnerability to possible OCS activities. This number represents almost half of the total 41 most highly ranked sites in the study area. Of the 54 sites in the St. George Basin Planning Area,

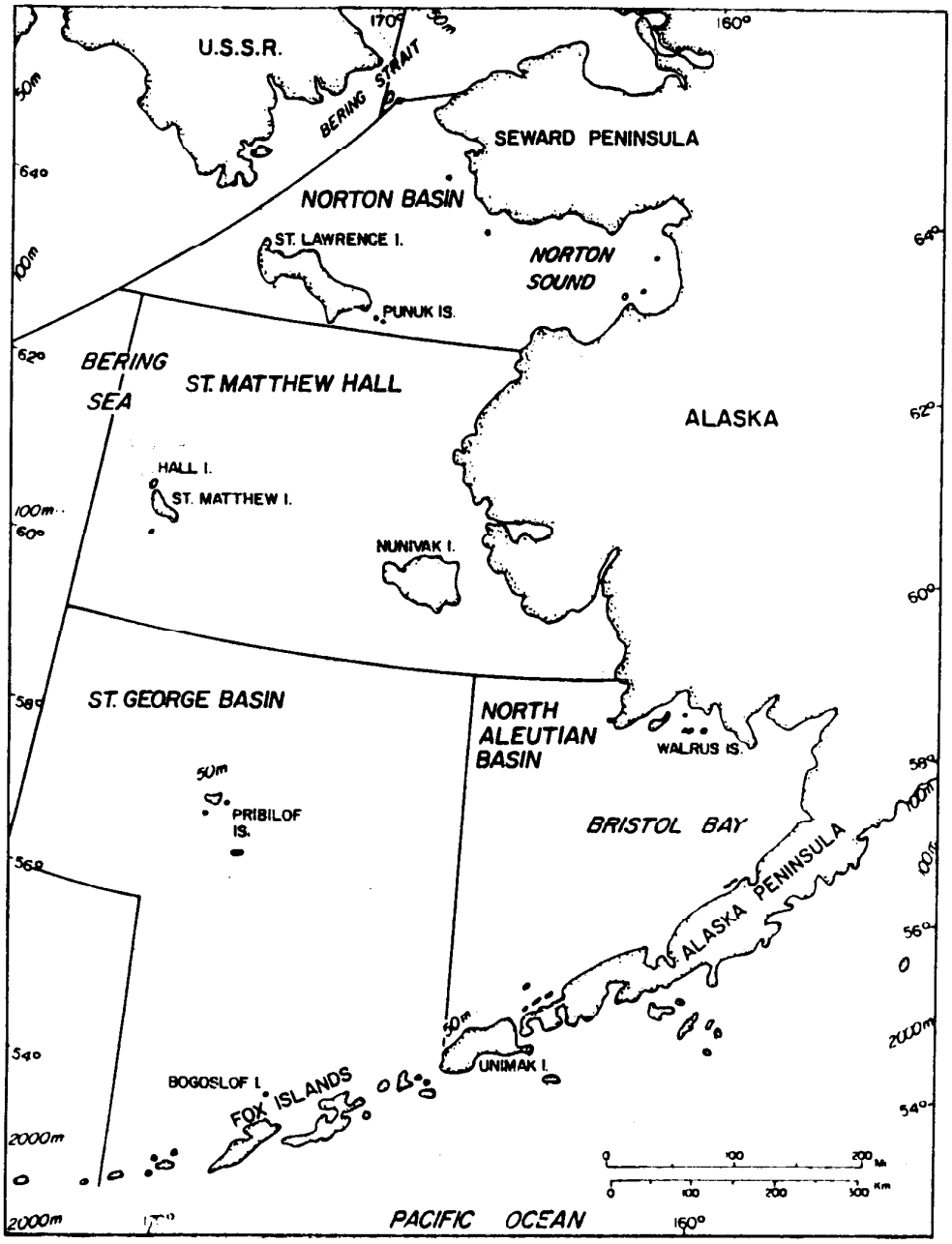

Figure 1. Map of Bering Sea, Alaska study area showing OCS planning areas.

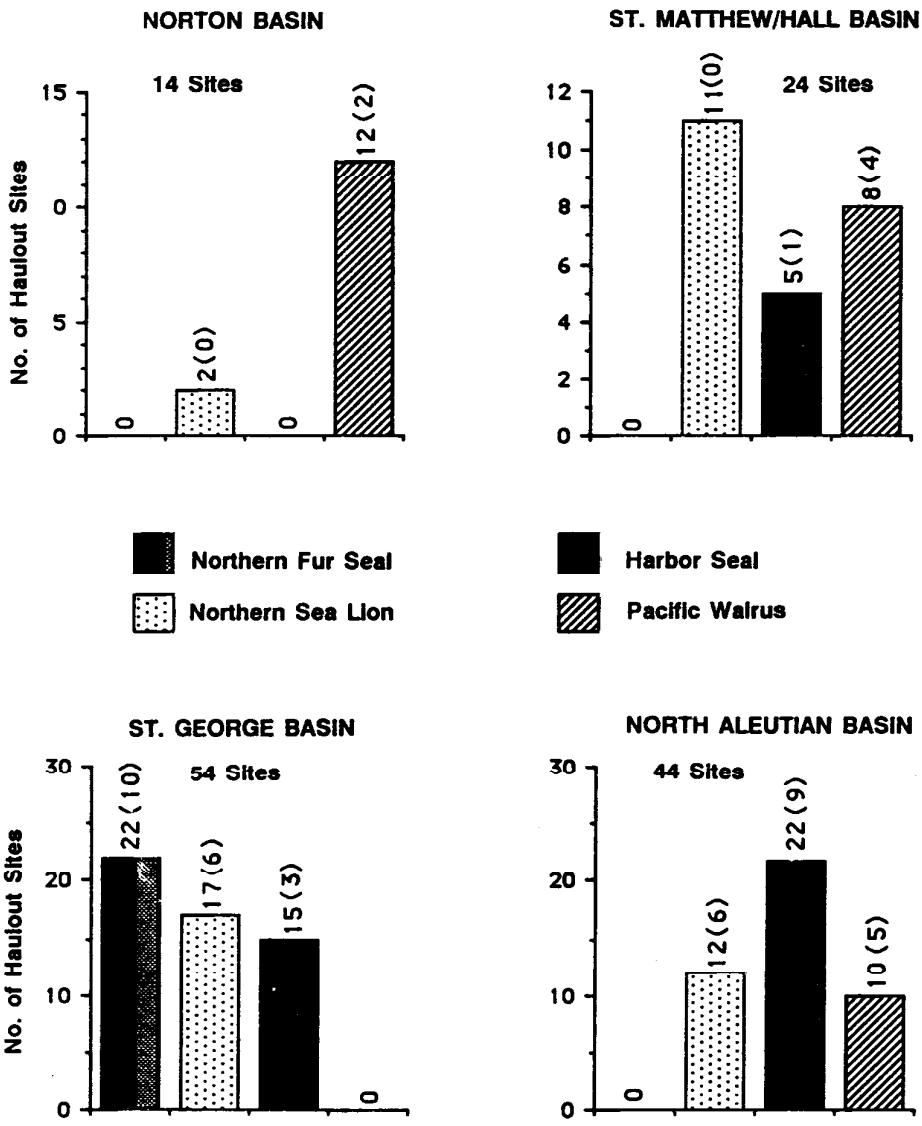

Figure 2. Summary of haulout sites in various OCS planning areas in the Bering Sea, Alaska. The number of sites that rated high in our Inter-site Population Sensitivity Index evaluations are shown in parentheses.

19 (35%) were ranked high; this number was strongly influenced by 10 highly ranked northern fur seal sites on the Pribilof Islands. Of the 24 sites in the St. Matthew-Hall Planning Area, 5 (21%) were ranked high in our evaluation of importance and vulnerability, and most (4 of 5; 80%) were sites occupied by Pacific walrus. Of the 14 sites in the Norton Basin Planning Area, only 2 were determined to be important and vulnerable to OCS activities; both of these sites were also occupied by Pacific walrus.

ANALYSIS OF ACOUSTIC ENVIRONMENT

The usual location of pinniped rookeries on beaches and rocky shorelines results in this habitat having levels of ambient noise that are closely related to the sea state. Both airborne and underwater ambient noise spectrum levels near haulout sites are expected to be similar because the airborne surf noise is transmitted directly into the water.

The noise sources which may affect pinniped behavior in rookeries are 1- and 2-engine aircraft, helicopters, small boats, fishing vessels and cargo vessels. The sound source levels produced by these types of aircraft and vessels have a maximum of about 160 dB re 1μ pa at 1 m in the 1/3 octave band. All of these sources present a transient, rise and fall type of noise signature to the rookery area.

The underwater acoustic transmission properties of the sloping beach found at most rookery sites provide high attenuation of sound arriving from seaward. Rocky sites provide somewhat greater attenuation for distant (>6km) noise sources than do sandy beaches. Noise from close to shore (<3km) and travelling over a rocky beach are attenuated less than over a sandy beach at the same distance. Frequencies less than 200 Hz are attenuated more rapidly than higher frequencies.

The underwater sound levels produced by direct aircraft overflight of shallow water areas are comparable to the high levels produced in air near the water surface. There appears to be some enhancement of high frequency sound energy which may be produced by bottom reflection effects. A significant amount of underwater sound energy is transmitted away from the region below the direct path of an aircraft by bottom and surface reflections. Sound transmission characteristics for this propagation follow a 25 Log Range slope, which is appropriate for transmission in shallow water from a source located near the surface.

Using several propagation models we determined the characteristics of sound transmission from different potential industrial noise sources in air and water under conditions similar to those at pinniped haulout sites. Sound transmission loss curves, i.e., sound attenuation with increasing distance from the source, were computed for situations prevalent at various pinniped haulout sites (e.g., various bottom types, water depths, source types, and distances from sources). Given the appropriate source sound levels, actual received sound levels at different distances from the source, (i.e., at the haulout site) may be computed directly from the transmission loss curves. For example, considering sound near 100 Hz, at an offshore location with a specific bottom type, a 160 dB source sound level, which is the maximum expected from most individual sources, attenuates by 90 dB at a distance of 2 km from the source.

By taking into account typical ambient noise levels, one can also calculate the distance at which a received level drops below ambient and becomes inaudible. Unfortunately, however, there is no quantitative information describing threshold sound levels which cause disturbance

in pinnipeds. This limitation prevents a quantitative determination of the actual zones-of-influence of different sounds produced near haulout sites. Attempts to compute zones-of-influence based on qualitative or anecdotal information would be misleading. Carefully designed studies that simultaneously measure sound (noise) and behavior at active pinniped haulout sites are needed to provide the kind of quantitative data necessary to make zone-of-influence computations. Such studies have been conducted or are in progress for some cetaceans, but to our knowledge none have been conducted for pinnipeds.

REFERENCES

Allen, S.G., D.G. Ainley, G.W. Page, and C.A. Ribic. 1982. The effects of disturbance on harbor seal haul out patterns at Bolinas Lagoon, California. Fish. Bull. 82(3):493-500.

Anderson, S.S., and A.D. Hawkins. 1978. Scaring seals by sound. Marine Mammal Rev. 8:19-24.

Bonner, W.N. 1982. Seals and man: a study of interactions. Univ. Wash. Press, Seattle, WA. 170 pp.

Braham, H.W., R.D. Everitt, and D.J. Rugh. 1980. Northern sea lion population decline in the eastern Aleutian Islands. J. Wildl. Manage. 44(1):25-33.

Brodie, P.F. 1981. Energetic and behavioral considerations with respect to marine mammals and disturbance from underwater noise. Pages 287- 290 *in* N.M. Patterson (ed.), The question of sound from icebreaker operations: the proceedings of a workshop. Arctic Pilot Project, Calgary. 350 pp.

Calkins, D.G. 1983. Marine mammals of Lower Cook Inlet and potential for impact from outer continental shelf oil and gas exploration, development and transport. *In*: Environ. Assess. Alaskan Cont. Shelf, Vol. 20. Final Rep. Princ. Invest., BLM/NOAA, OCSEAP. Juneau, AK.

Cowles, C.J., D.J. Hansen, and J.D. Hubbard. 1981. Types of potential effects of offshore oil and gas development on marine mammals and endangered species of the northern Bering, Chukchi, and Beaufort Seas. Tech. Pap. No 9, Alaska OCS Office, BLM. Anchorage, AK. 23 pp.

Cummings, W.C., D.V. Holliday, and G.J. Lee. 1986. Potential impacts of man-made noise on ringed seals: vocalizations and reactions. *In*: Environ. Assess. Alaskan Cont. Shelf, Vol. 37. Final Rep. Princ. Invest. MMS/NOAA, OCSEAP. Anchorage, AK.

Fay, F.H., B.P. Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1986. Modern populations migrations, demography, trophics and historical status of the Pacific walrus. *In*: Environ. Assess. Alaskan Cont. Shelf, Vol. 37. Final Rep. Princ. Invest. MMS/NOAA, OCSEAP. Anchorage, AK.

Fowler, C.W. 1985. Status review: northern fur seals (*Callorhinus ursinus*) of the Pribilof Islands, Alaska. Unpub. Rep., Nat. Marine Mammal Lab., Nat. Mar. Fish. Serv., NOAA, U.S. Dept. Commerce. Seattle, WA. 48 pp.

Frost, K.J., L.G. Lowry, and J.J. Burns. 1983. Distribution of marine mammals in the coastal zone of the Bering Sea during summer and autumn. *In*: Environ. Assess. Alaskan Cont. Shelf, Vol. 20. Final Rep. Princ. Invest. BLM/NOAA, OCSEAP. Juneau, AK.

Herter, D.R., and W.R. Koski. 1988. The effects of airport development and operation on waterbird and northern fur seal populations: a review from the perspective of the St. George airport project. Unpub. Rep. by LGL Alaska Research Associates, Inc., Anchorage, AK, for Alaska Dept. of Trans. and Public Facilities, Anchorage, AK. 201 pp.

Johnson, B.W. 1977. The effects of human disturbance on a population of harbor seals. *In*: Environ. Assess. Alaskan Cont. Shelf, Vol. 1. Ann. Rep. Princ. Invest. BLM/NOAA, OCSEAP. Juneau, AK.

Lewis, J.P. 1987. An evaluation of a census-related disturbance of Stellar sea lions. Unpub. M.S. thesis. Univ. Alaska, Fairbanks, AK. 93 pp.

Loughlin, T.R. 1987. Report of the workshop on the status of northern sea lions in Alaska. Unpub. Rep. Nat. Mar. Mammal Lab., NMFS, NOAA, U.S. Dept. Commerce. Seattle, WA. 49 pp.

Loughlin, T.R., and R. Nelson, Jr. 1986. Incidental mortality of northern sea lions in Shelikof Strait, Alaska. Marine Mammal Science 2(10):14-33.

Loughlin, T.R., D.J. Rugh, and C.L. Fiscus. 1984. Northern sea lion distribution and abundance: 1956-1980. J. Wildl. Manage. 48:729-740.

Loughlin, T.R., P.J. Gearin, P.L. DeLong, and R.L. Merrick. 1986. Assessment of net entanglement on northern sea lions in the Aleutian Islands, 25 June-15 July 1985. Unpubl. Rep., Nat. Mar. Mammal Lab., NMFS, NOAA, U.S. Dept. Commerce. Seattle, WA. 50 pp.

Mate, B.R., and J.T. Harvey, eds. 1987. Acoustical deterrents in marine mammal conflicts with fisheries. Proc. Workshop 17-18 Feb. 1986, Newport, OR. Oregon State Univ., Corvallis, OR. 116 pp.

Merrick, R.L., T.R. Loughlin, and D. G. Calkins. 1987. Decline in abundance of the northern sea lion, *Eumetopias jubatus*, in Alaska, 1956-1986. Fish. Bull. 85:351-365.

Murphy, E.C., and A.A. Hoover. 1981. Research study of the reactions of wildlife to boating activity along the Kenai Fjords Nat. Park coastline. Final Rep. to Nat. Park Serv., Anchorage, AK. 125 pp.

Osborne, L. 1985. Population dynamics, behavior, and the effects of disturbance on haulout patterns of the harbor seal *Phoca vitulina richardsi*. M.Sc. Thesis, Univ. Calif., Santa Cruz, CA. 75 pp.

Pitcher, K.W. 1986. Assessment of marine mammal-fishery interactions in the western Gulf of Alaska and Bering Sea. Unpub. Rep. by ADF&G for Nat. Mar. Mammal Lab., NMFS, NOAA, U.S. Dept. Commerce. Seattle, WA. 12 pp.

Renouf, D., L. Gavorko, G. Galway, and R. Finlayson. 1981. The effects of disturbance on the daily movements of harbour seals and grey seals between the sea and their hauling grounds at Miquelon. App. Anim. Ethol. 7:373-379.

Richardson, W.J., C.R. Greene, J.P. Hickie, and R.A. Davis. 1989. Effects of offshore petroleum operations on cold water marine mammals, a literature review. Rep. by LGL Limited., King City, Ontario, for Amer. Petroleum Inst., Washington, D.C. 248 pp.

Salter, R.E. 1979. Site utilization, activity budgets, and disturbance responses of Atlantic walruses during terrestrial haulout. Can. J. Zool. 57:1169-1180.

Sease, J.L. 1986. Historical status and population dynamics of the Pacific walrus. MS Thesis, Univ. Alaska, Fairbanks, AK. 213 pp.

Sease, J.L., and D.G. Chapman. 1988. Pacific walrus - *Odobenus rosmarus divergens*. Pages 17-38 *in* J.W. Lentfer (ed.), Selected marine mammals of Alaska. Mar. Mammal Comm., Washington, D.C.

Shaughnessy, P.D., A. Semmilink, J. Cooper, and P.G.H. Frost. 1981. Attempts to develop acoustic methods of keeping cape fur seals *Arctocephalus pusillus* from fishing nets. Biol. Cons. 21:141-158.

Stewart, B.S. 1981. Behavioral response of northern elephant seals and California sea lions on San Nicolas Island, California, to loud impulse noise. J. Acoust. Soc. Am. (Suppl.1)70:S83 (Abstract).

Taggert, S.J., and C.J. Zabel. 1985. Long term changes in abundance of Pacific walruses *Odobenus rosmarus divergens*, at Round Island and Cape Peirce. Unpubl. Rep. in files of ADF&G, Dillingham, AK. 18 pp. and figures.

Terhune, J.M., R.E.A. Stewart, and K. Ronald. 1979. Influence of vessel noises on underwater vocal activity of harp seals. Can. J. Zool. 57:1337-1338.

Withrow, D.W. 1982. Using aerial surveys, ground truth methodology, and haul out behavior to census Stellar sea lions *Eumetopias jubatus*. Unpub. M.S. Thesis, Univ. Wash., Seattle, WA. 102 pp.

Yochem, P.K., B.S. Stewart, R.L. Delong, and D.P. DeMaster. 1987. Diel haul-out patterns and site fidelity of harbor seals (*Phoca vitulina richardsi*) on San Miguel Island, California, in autumn. Marine Mammal Sci. 3:323-332.

Yoshida, K., and N. Baba. 1985. Results of the survey on drifting fishing gear or fish net pieces in the Bering Sea. Far Seas Fish. Res. Lab. Shimizu, 424. Japan.

QUESTIONS AND DISCUSSION

Brendan Kelly: You said that you thought that these behavioral studies were needed in conjunction with known source levels. It seems unrealistic to think that you could ever conduct enough trials to account for the tremendous variability in the animals' responses. In every pinniped that I have ever looked at on a haulout, behaviors in response to natural events are hugely variable. It is just real troubling. How would you ever think of a design such that when you were all done, you wouldn't say well it is more variable than we could deal with?

Steve Johnson: That is true. Right now all we really have, as you say, are various anecdotal bits and pieces of information. An aircraft flies over a haulout site one day and thousands of fur seals stampede into the sea. On other days, aircraft will fly over, maybe in different weather conditions, in different wind conditions, and nothing happens at all. We have found a lot of evidence of that in our literature review. It is frustrating. However, as we heard yesterday from John Richardson, the proper kinds of disturbance studies are in fact being conducted with some species of marine mammals, cetaceans. I think we have to start thinking about making our observations in a more quantitative way.

_____: Over the past ten years, I believe there has been quite a change in the population of walrus on Walrus Island and that has decreased quite dramatically and that the Cape Peirce population is relatively new or at least has increased in recent years, and this is concurrent with a large herring fishery having been established inshore of Walrus Island recently. Do you have any information on this?

Steve Johnson: I don't have any information specifically about the relationship, why one has gone up and one has gone down. In our analysis of this and going back through the various historical information, you can see that in the Walrus Islands areas, on Round Island and various islands, that the numbers of adult males that use that area in the summertime have been going down. The number of animals in the last 6 or 8 years has been going up in Cape Peirce. From what I understand from talking to John Burns, historically, there were fair numbers of walrus that used Cape Peirce, and then there was a period when not many walruses used that area to haul out. Now we are back into a phase when walrus are hauling out there in large numbers. But I don't know about this relationship with the herring fishery. Maybe someone else can comment on that.

Kathy Frost: Actually the animals probably alternate between Round Island and Cape Peirce. A radio-tagged walrus hauled out on Round Island some of the time and on Cape Peirce some of the time. There has been a decline in the last couple of years in the number of walruses hauled out at Round Island. That decline has not been connected with the herring fishery but with the groundfish fishery, specifically the yellowfin sole fleet. Boats fishing offshore for yellowfin sole meet their halibut by-catch limits before they catch their quota of yellowfin sole. So they have moved into Bristol Bay and fished adjacent to or in the vicinity of Round Island. It was suggested by Round Island Sanctuary personnel that the noise had perhaps caused the reduction. The North Pacific Fisheries Management Council acted in 1989 to implement seasonal groundfish fishing closed zones 6 or 12 miles around Round Island, the Twins, and Cape Peirce. Last year, whether it was fortuitous or not, the numbers of walruses were back up, almost double the previous two years. There is a lot of circumstantial evidence right now. Hopefully in the next couple of years the data will be more quantitative. Last year as I

understand it, Al Burch can probably tell you, but I think the yellowfin sole quota was reached before the fleet needed to move into the Round Island area. They didn't actually not fish there because of the new regulation. But without the boats the walrus numbers did approximately double. The change in walrus numbers is thought to be connected with the groundfish fishery not with the herring fishery.

Ray Emerson: We have some data from the California coastline where there are some haulout areas. Those areas are probably exposed to aircraft noise, fishing, etc., quite a bit more than we would expect up here. Do we see anything in terms of conditioning by these populations to some of these sounds? Down the road, let's say we have more and more exposure to sound with the possible development activities occurring, are we going to see conditioning by these critters to show less response?

Steve Johnson: I would guess so. Habituation is an interesting topic. It hasn't really been studied to any great degree. I think it is a very good question. Habituation is a key in a lot of the kind of work that we are all doing. In frontier areas, in particular, that are going to be developed over the next few years. We are all familiar with the experiences of studying geese or pinnipeds or some other species in the north and then going south to a highly developed area, like coastal California, and finding the same species. They seem to be very disturbed by certain kind of noises or human activities in the north, but appear to be habituated down south. Again that is a topic that hasn't really been investigated in a quantitative way, but such studies are needed.

Steve Treacy: One other question. You mentioned a number of these haulouts were rated high, medium, low, etc. and some of the factors that went into that. What were some of the more sensitive factors that would tend to bring a colony up to the high category in your rating system?

Steve Johnson: The whole ranking scheme is really complicated. There are a whole series of interactive tables in the report. It probably would be worthwhile talking about the eight variables a little bit. They are basically:

1) The peak count of a particular species of pinniped recorded at a site since 1980. This peak basically emphasizes the most current counts, either the 1980s count, which was a peak count during the decade, or the most current count. We went through the literature and tabulated all of the various counts of all pinnipeds at Bering Sea haulout sites. We tabulated the peaks counts by decade, 1950s, 1960s, 1970s, and 1980s. We also tabulated the most current count, which was the most recent count of a particular species of pinniped at the site since 1980. Then we computed the mean-maximum, which included all of the counts. It provided an indication of peak use of a haulout site over the past 30 years.

2) The proportion of the current total estimated Bering Sea population present at a particular site. This was simply the overall percentage of the population considered. If a site had a very large proportion of the total Bering Sea population, then it had a higher percentage and ranked higher in our rating scheme.

3) Age and sex composition and the kinds and amounts of behavioral activities that have been recorded at a site. We felt that a large and complex site that is used for pupping and nursing and for breeding was considered to be more important to a species and potentially

more vulnerable and sensitive than a site that was used only for resting or used only by subadults. As you begin to see, some of these factors begin to overlap with some of the other factors. So the factors are not all absolutely discrete or distinct. Some of the factors involve several variables. I have discussed this with a number of people, and it wasn't considered to be a problem. But it did definitely skew the ranking scheme towards the larger, more heavily used sites that were used for pupping and rearing, rookeries, as opposed to sites that were used just by subadults or were used sporadically.

4) The duration of use of the site. Basically a site that was used for a larger proportion of the year was thought to be more important and more sensitive, more vulnerable, than a site that was used for a very brief period by transient portions of the population. Again sites that are used for longer periods of time tend to be rookeries, where there is defense of territories, courtship, pupping, and nursing. So this again relates back to some of the other variables.

5) The consistency of use of a haulout site. A site that is used every year was considered to be more important than a site used only sporadically. Again, rookeries are used most consistently from one year to the next. In some cases that is not the case, but in general the larger, more important rookeries are used consistently from one year to the next.

6) Site characteristics. The physiography and associated susceptibility of a site to disturbance. This factor was based on major physical characteristics of the site, such as substrate, vertical relief, bathymetry, some of the things that went into the classification of Bottom Type 1, Bottom Type 2, or rocky versus sandy areas, flat areas with no cliffs behind them versus rocky areas with steep cliffs that reflect sound back down into the pinniped haulout site.

7) Proximity to disturbance source. A site that was located within 5 km of a source of noise or disturbance such as a shipping lane, an airport, air traffic lane, or settlement was in this category; like some of the northern fur seal haulout sites in the Pribilofs that are located quite close to airports, and are near settlements. These were ranked high in our evaluation scheme. Some information about this was given to me by marine mammal specialists at the Marine Mammal Lab in Seattle, Washington. They had concerns about expansion of airports and aircraft routes over some of the haulout sites. So this brought some of those concerns into the ranking scheme.

8) The species characteristics, or susceptibility of the species to disturbance. This was difficult because we had to make a judgment based on what we found in the literature about the susceptibility of the species to disturbance. There was some information in some areas that, as Brendan Kelly pointed out, animals were extremely sensitive to certain kinds of activities, and there was evidence that mortality had occurred as a result of disturbance. And then at the same site in a different year or at a different time of the year, there were examples of no disturbance at all after the same type of activity. So we used a simple ordinal scale of 1 through 4, based on the number of references or publications that we found that related to severe disturbance or moderate disturbance versus not much disturbance at all.

That describes all the variables we used in our rating system. Again, as for the details of how these variables were used, it would be much easier and more efficient for me to sit down with you and go through the report. I have a copy of the report with me if you want to have a look at it and talk about it.

Tom Newbury: Steve, a factor that you might add to that is distance to an alternate site. A while ago there was a discussion about the use of Round Island and Cape Peirce, the animals use them interchangeably. A factor that might be added to that is whether or not the site is an isolated one, the distance to an alternate site.

Steve Johnson: That is a good point. I didn't consider that as a variable when we were putting this report together. It's an interesting point.

USE OF KASEGALUK LAGOON BY MARINE MAMMALS

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Belukha whales (*Delphinapterus leucas*) and spotted seals (*Phoca largha*) are seasonally the most abundant marine mammals in the Kasegaluk Lagoon region of the northeastern Chukchi Sea. Belukhas regularly utilize the coastal zone to feed, calve, and probably to molt. Spotted seals may feed in nearshore waters or on anadromous fishes in the lagoon. Both species are important subsistence resources for local residents. In order to acquire better information for planning purposes on the numbers of marine mammals using this area, and the times and areas of peak use, the Minerals Management Service in 1989 funded a 3-year study by the Alaska Department of Fish and Game (ADF&G), under contract to LGL Limited, to conduct aerial surveys of belukha whales and spotted seals in the Kasegaluk Lagoon region during summer.

Previous studies of spotted seals in Alaska have been conducted during pupping and molting in the spring when the seals are associated with the ice front of the Bering Sea. As the ice melts and recedes north, spotted seals also move north and to the coast, first appearing in the Chukchi Sea in June and July. From then until freeze-up in late October or November spotted seals haul out on land to rest, much as harbor seals do, and they feed in coastal waters and in the mouths of rivers and estuaries.

The spits and passes of Kasegaluk Lagoon are the largest known haulouts for spotted seals in Alaska. Local residents and biologists have reported sightings of 1000 or more seals hauled out at a single pass. The seals typically haul out on sandy spits and bars at the mouths of passes into the lagoon and at constrictions in the large inlet northeast of Icy Cape.

Although Kasegaluk Lagoon is clearly an important area for spotted seals, the details of their distribution and abundance in the region are poorly known. In order to better delineate important areas and times of use, ADF&G initiated surveys of spotted seals in Kasegaluk Lagoon in late summer 1989. Surveys were flown between Naokok Pass at the south end of the lagoon and Pingorarok Pass at the northeast end from 23 to 28 August and 11 to 14 September. In August, seals were present at three locations: Utukok Pass (maximum of 300), Akoliakatat Pass (up to 700), and Avak Inlet (up to 530) (Table 1, Figure 1). Water level, influenced predominantly by wind direction, had a substantial effect on the numbers and distribution of seals. East winds resulted in low water and high numbers of hauled out seals and west winds in high water and low numbers of seals. Seals were found to be quite sensitive to aircraft noise, with some of the seals going into the water when the aircraft was 0.5 miles away and at 1000 ft altitude. Although seals went into the water quite readily when aircraft flew over, they also appeared to haul back out within a short period of time.

In September, seals were hauled out near the same three passes and inlets. No seals were seen hauled out at the other passes. A maximum of 700 to 750 seals were observed at Utukok Pass, 40 to 50 at Akoliakatat Pass, and 370 to 395 at Avak Inlet. The water was high for all surveys. Point Lay residents reported that larger numbers of spotted seals were still present in October, with over 400 hauled out at Utukok Pass in early October.

Table 1. Numbers of spotted seals hauled out on spits and at passes in Kasegaluk Lagoon during August and September 1989, based on aerial surveys conducted by ADF&G.

Date	Utukok	Akoliakatat			Avak Inlet			
		West	Pass	East	#1	#2	#3	#4
Aug 23	50 - 100	0	0	0	150	70	8	0
Aug 24	80	75	38	1	-	-	-	-
Aug 26a	166	90	6	300	0	30	500	0
26b	75	40	0	700	-	-	-	-
Aug 27a	120	0	25	10	0	0	1	0
27b	145	75	50	10	0	5	0	0
Aug 28	290	10	0	1	0	2	20	0
Sep 1	845 - 895	350+	0	550	0	15	20	0
Sep 3	305	0	0	117	-	-	-	-
Sep 8	300	0	0	0	0	0	55	100
Sep 11	600 - 700	25	2	18	6	28	190	35
Sep 13	500 - 600	0	0	2	0	75	85	30
Sep 14	700 - 750	35	0	3	0	120	250+	0

Surveys for spotted seals will be conducted again in 1990 and 1991, at three-week intervals between mid-July and mid-September. A field camp will be established in August 1990 to describe the haulout behavior of the seals, in order to facilitate interpretation of aerial survey data.

Belukha whales, like spotted seals, also winter in the sea ice of the Bering Sea and move to the coast in summer to feed and/or molt. Four major summering concentration areas have been identified in Alaska: Bristol Bay, Norton Sound, Kotzebue Sound, and the waters off Kasegaluk Lagoon. Belukhas using Kotzebue Sound and Kasegaluk Lagoon are thought to be part of the same stock, arriving first in Kotzebue Sound in June and later moving north to Kasegaluk Lagoon in July.

Belukhas are an important subsistence resource to coastal residents of the Chukchi Sea. At Point Lay, the annual harvest of belukhas has ranged from 0 to 40 over the last 13 years, with an average of about 20. Depending on the year, this may represent over 50% of the harvest of wild foods at Point Lay. The same stock of belukhas is also harvested by residents of Kotzebue Sound and Wainwright.

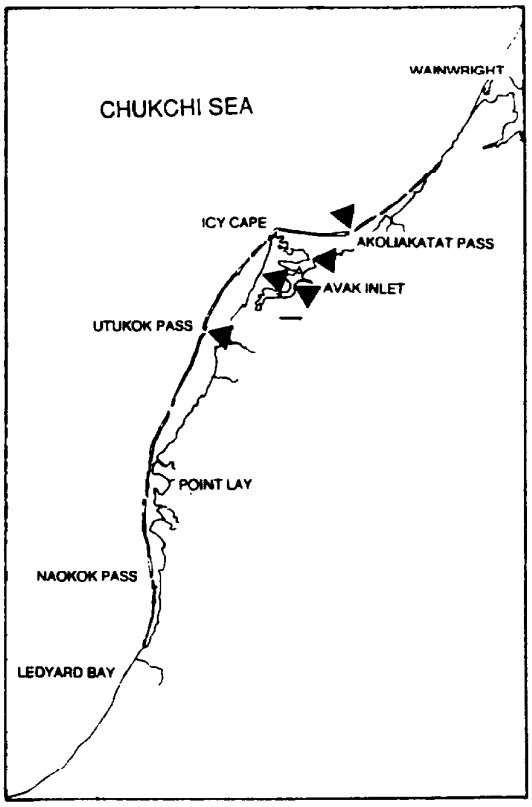

Figure 1. Locations in Kasegaluk Lagoon where spotted seals were hauled out during aerial surveys conducted by ADF&G in August-September 1989.

Based on our previous experience in Kasegaluk Lagoon, we know that belukhas concentrate at the mouths of all major passes in the area (Figure 2). Over 2000 belukhas may use the coastal waters adjacent to the lagoon. In 1979, approximately 2300 belukhas were present at Akoliakatat Pass. In 1987, 1400 to 2100 belukhas were estimated to be present west of Point Lay. Belukhas characteristically appear in the southern part of this region near Ledyard Bay and gradually move northward and eastward. The details of their movements between passes, or between the coast and the pack ice, are poorly known.

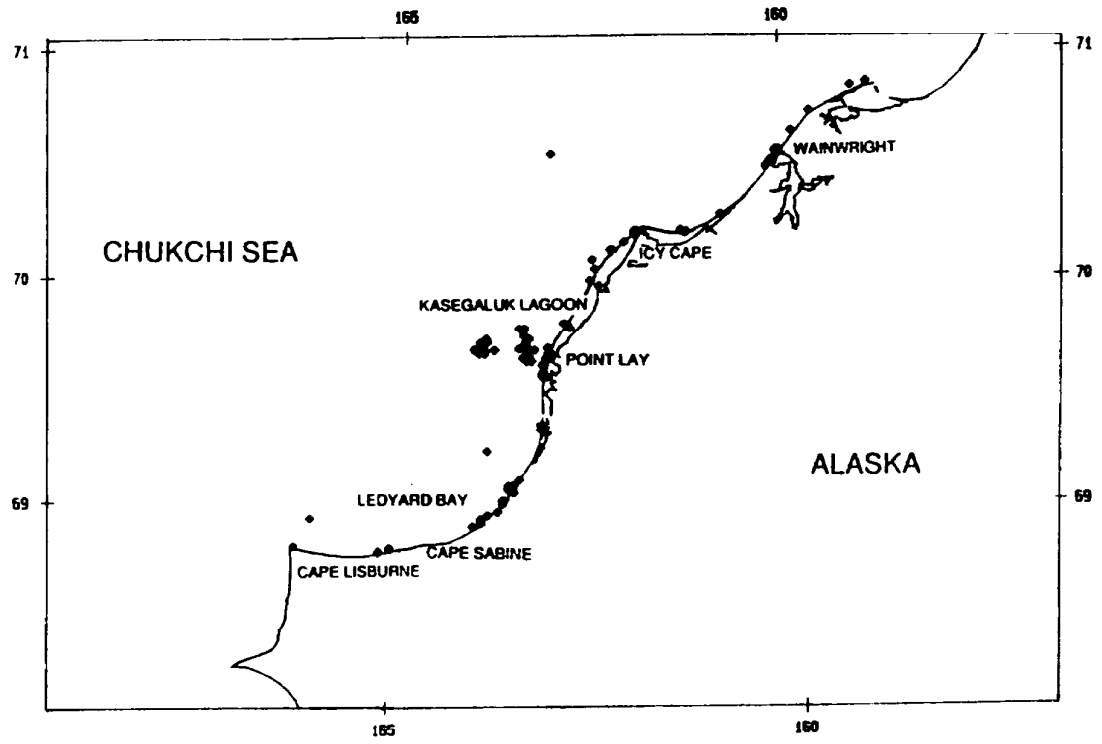

Figure 2. Sightings of belukha whales along the Chukchi Sea coast of Alaska, based on information collected by ADF&G through 1987.

Aerial surveys of belukha whales will be conducted by ADF&G in 1990 and 1991 from 1 to 15 July and at intervals thereafter throughout the summer in order to better describe their distribution and abundance in coastal waters adjacent to Kasegaluk Lagoon. The surveys will locate and enumerate concentrations of belukhas along the coast and at the mouths of passes. While aerial surveys will provide an overview of distribution and abundance, they will not provide answers to important questions about stock discreteness and movement of belukhas within the area. In order to address these questions it will be necessary to conduct genetic (DNA) studies and to follow animal movements through the use of satellite telemetry.

REFERENCES

Burns, J.J., and G.A. Seaman. 1986. Investigations of belukha whales in coastal waters of western and northern Alaska. Part II: Biology and ecology. U.S. Dept. Commer., NOAA, OCSEAP Final Rep. 56 (1988): 221-357.

Frost, K.J., L.F. Lowry, and J.J. Burns. 1983. Distribution of marine mammals in the coastal zone of the eastern Chukchi Sea during summer and autumn. U.S. Dept. Commer., NOAA, OCSEAP Final Rep. 20:563-650.

Quakenbush, L.T. 1988. Spotted seal. Pages 107-124 *in* J.W. Lentfer (ed.), Selected marine mammals of Alaska: Species accounts with research and management recommendations. Marine Mammal Comm., Wash., D.C. 275 p.

Seaman, G.A., and J.J. Burns. 1981. Preliminary results of recent studies of belukhas in Alaskan waters. Rep. Int. Whal. Comm. 31:567-574.

Seaman, G.A., L.F. Lowry, and K.J. Frost. 1982. Foods of belukha whales (*Delphinapterus leucas*) in western Alaska. Cetology 44:1-19.

Seaman, G.A., K.J. Frost, and L.F. Lowry. 1986. Investigation of belukha whales in coastal waters of western and northern Alaska. Part I: Distribution, abundance and movements. U.S. Dept. Commer., NOAA, OCSEAP Final Rep. 56(1988):153-220.

QUESTIONS AND DISCUSSION

Warren Matumeak: These belukhas that are in Canada, they are not the same stock are they?

Kathy Frost: We are pretty sure not, Warren. That is one of the things those DNA studies are going to tell us. The Canadians have been taking small skin samples in the Mackenzie and at Point Hope. Rex Tuzroyluk, Jr. collected some of the skin samples, and now at Point Lay we have samples. When they do the chemistry tests in the lab hopefully that will tell us if they are the same or if they are different. But we are pretty sure that Point Lay belukhas are different from the Canadian belukhas.

Warren Matumeak: This Cook Inlet stock, they are pretty tough. I tried eating them and they are pretty hard to chew.

Kathy Frost: Is the skin tougher on those?

Warren Matumeak: Yes it is. Maybe they gave me the toughest one, I don't know they look alike.

Kathy Frost: It could be. Although they must not be too bad to eat because a few years ago the Kotzebue hunters had very poor hunting years and they ended up going to Cook Inlet and hunting with their friends down there, so that there was at least some muktuk in town.

Jon Lewis: Kathy, I am wondering, you said that you were going to try to correlate water level with the number of seals that were hauled out. Would you have the ability to measure any other environmental parameters so that you could correlate those parameters with the haulout behavior as well?

Kathy Frost: At this point, we don't have a lot of opportunity. The study isn't geared to do that. I guess right now the thing that I am most interested in is water level. It would be interesting to look at water temperature. We don't have a boat right now. Some of the things you would want to do in terms of looking at the plume would require getting out into the plume and measuring those interfaces. It could certainly be done. We don't have plans to do those extensive studies at this point.

_____: As I spoke to you on the plane on the way down, I think there is the potential in water quality studies and also some water temperature studies using satellite data. Because of the shallow depth of the lagoon there probably ought to be a pretty good correlation on sea surface temperature and general temperature within the water column. One other thought that I had in your presentation is that the noise level of the aircraft in frightening the seals, I was wondering if there was any possibility of using higher flying aircraft and photogrammetric means of vertical area photography, taken with a lot of lenses so you could minimize the disturbance and get very valid photogrammetric means of investigative counting maybe even doing some size measurements.

Kathy Frost: When you get into high level aerial photography there is a real trade-off. I have talked with my Canadian counterparts on this on flying belukha surveys. They fly at 3000 ft and they can indeed take aerial photographs from 3000 ft and take them home and count them under the microscope. But they lose any sense of what is going on in the environment. Those of us who fly around in airplanes all day and forget to get on the ground have lost an awful lot of the picture already. You become very insensitive to some of the small things that matter. The higher you get the worse that gets. A lot of pinniped surveys are done at 500 ft. We flew as high as 1500 ft with spotted seals last summer and they were still going into the water. Initially I was very surprised. I am not so surprised now. One of the ways the local aircraft navigate in the notoriously poor and foggy weather on the northwestern Chukchi Sea coast is to fly down the barrier islands. Many times a day when aircraft fly from Barrow to Point Lay or on down to Point Hope, they fly down those barrier islands at 100 ft or 150 ft. The seals go into the water when the planes fly over, even thought plane traffic is quite common. The other phenomenon is they haul back out very quickly. In Prince William Sound, if harbor seals are disturbed on the haulouts they probably won't haul out again for the remainder of the tidal cycle. At Point Lay, you can fly over Utukok Pass and most of the seals may go into the water. However, when the bird survey crew goes back to survey an hour later, there may be 600 seals hauled out again. The seals are clearly used to having aircraft go over. They haven't accommodated in the sense that they still go into the water, but they have accommodated in the sense that they haul back out almost immediately. That is something that we are going to have to think about in conducting future surveys.

Mark Fraker: It is kind of exciting stuff that you are able to do now with the DNA and the belukhas, we are looking forward to the results.

Kathy Frost: Not half as much as I am.

Mark Fraker: The notion that there might be different reasons why whales are coming into warm water or into the shallow water areas, of course, they are not mutually exclusive. They could be coming in for all or any combination of those. Certainly the Mackenzie where you receive most of the stomachs empty, it doesn't look like and we don't see much feeding behavior, it looks like they are not coming in there to feed. We do see them wallowing around in the mud, which could well be related to shedding.

Kathy Frost: You have the same problems in the Mackenzie as we do in Alaska in the turbid water. It is difficult to make those kinds of observations.

Mark Fraker: We also see periodically that animals move out of the concentrations into the offshore area and appear to return again. Of course we don't know that it is the same individuals but large scale departures and then returns again suggest that it is many of the same animals that are doing that.

Kathy Frost: And in fact, we have some data on what Mark is referring to. We had five different belukhas radio-tagged in northern Canada a couple of years ago. We found that those animals did indeed move in and out of the lagoon. On succeeding days there would be large numbers of whales present. But of the five radio-tagged animals, only a few would be present on any given day. What appeared to be happening was that groups of animals were coming and going on a daily basis. We speculated that they were going out into the pack ice and feeding and then coming back in to rub on the bottom as part of the molting process. On several occasions we located our radio-tagged animals out in the ice with whales that were apparently feeding in the ice. I think that the same thing may be happening in Alaska. I have spent a lot of time scratching my head trying to figure out what the different concentration areas have in common. On the surface you look at them and they appear very different. In Bristol Bay the belukhas are obviously eating red salmon. In Kotzebue Sound they are probably going in there to eat saffron cod or maybe to calve in the warmer waters. Then you get to Point Lay or the Mackenzie and it's a little different still. Most of those areas look to me to be suitable for molting. Some of them are suitable for feeding, some of them are not, but all appear suitable for molting. What may be happening also, if you look at Kotzebue-Point Lay stock, is that the animals apparently are able to just bypass Kotzebue Sound. The numbers that go in there vary considerably. Some years it is none, some years it is a lot. But they always, to date anyway, have come into Point Lay. It may depend on ice conditions, feeding conditions, and when they get started through the Bering Strait whether or not all or part of them take a loop through Kotzebue Sound to feed. They then move north to Point Lay where they may use the gravel bars near passes for molting purposes. They may be feeding either close the lagoon or in the ice offshore. Some belukhas may take the loop into Kotzebue Sound and feed. Others may get started later, bypass Kotzebue Sound, and arrive at Point Lay at about the same time the others do. It is going to take satellite tagging to accurately document these movements.

Mark Fraker: Are you planning that for some of these animals?

Kathy Frost: I am dreaming about it, Mark. OCSEAP funded the first belukha tagging effort in 1982 and 1983. We have been working away on a shoestring since then. Lloyd and I pay for some of the modifications out of our modest Fish and Game budget. The Canadians have helped us to put them on. The North Slope Borough funded some of the modifications. I think with enough persistence we will eventually get there. A satellite tag was put on in the Canadian Arctic two years ago and produced 14 days of excellent locations. Last year, unfortunately, they

got only one location. We have people in different parts of the world working on the technology and getting closer and closer.

Mark Fraker: I also think it is useful to draw a distinction between what I refer to as stocks, which means showing fidelity to a particular geographical area and populations which are genetically defined as interbreeding animals. Because even if the animals are genetically the same, if they show geographic fidelity, then that has important management implications. I try to maintain a distinction between the terms population and stock for that reason.

Kathy Frost: Well, I think all of us are pretty careful. I do not consider that there are multiple populations of belukhas in the Bering Sea. I consider that there is one population and that there may be different management stocks. We don't know precisely how those stocks sort themselves out. We don't know very much about fidelity to a particular sites. We assume that the animals coming back to Bristol Bay are the same animals every year. We base that on the fact that the animals in Bristol Bay behave similarly from year to year: they are very accustomed to nets and seldom get caught, and they are very tolerant of boat noise. In contrast, the animals in Kotzebue Sound are not. By inference we think the Bristol Bay animals are the same year after year. They are used to this situation. We need to conduct satellite tagging studies to verify movement patterns.

Mark Fraker: But if they are genetically mixing then your DNA studies are likely to show that they are all the same bunch of animals and yet they may well be divided up into different stocks which show geographical fidelity.

Al Burch: I am with the Alaska Draggers Association in Kodiak. I want to thank Kathy and the previous speakers. The work you folks are doing will become more and more important to the fishing industry. I would urge you to pay special attention to the sea lion. That is a real joker in the deck. That is going to have major, drastic repercussions both for the oil industry and for the fishermen. I think we will probably get the first notice within two or three weeks. That will be the major item for the Gulf of Alaska and from the data I saw this morning also the Bering Sea. I didn't realize there were that many haulouts up there. That has a potential of closing us all down, 100%. I urge you to come up with good data. As Kathy said, we were closed down in Round Island because of circumstantial evidence. That was a small area, probably one of the cleanest fisheries in the Bering Sea. It didn't really affect us. This sea lion problem has the potential of closing the entire Gulf of Alaska and the Bering Sea. Thank you.

Kathy Frost: I am going to say something real quick since I have the podium. It is a plea to the agencies to hear what Al said. I moved to Alaska in 1975. When my friends in California said, "What is going on with marine mammals in Alaska? "We said, "Gee we are really lucky to be in Alaska, everything is healthy, high and stable. "When we went to meetings and people said, "What is going on in Alaska?" we said, "We've got healthy populations there, high numbers, it looks like they are stable, everything is great." And then when we went to the funding agencies and said, "we really need a study of spotted seals," the agencies said that seals were not endangered, and that there was no money for species that were not endangered or were not undergoing a crisis. The irony is that now in 1990, when people ask, "What is going on with marine mammals in Alaska?" we tell them that sea lions have declined 80%; harbor seals have declined 40 to 60%; and we have no idea about spotted seals because we haven't looked. I think the world shouldn't wait until things are endangered or depleted before we put the money

into conducting good baseline studies. It sure makes it hard to do your job and it makes people like the fishermen and the oil industry pay for the lack of data.

THE POPULATION STATUS OF SEABIRDS ON ST. MATTHEW AND HALL ISLANDS, 1985 AND 1986 OCS Study MMS 87-0043

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We studied the cliff-nesting seabirds on St. Matthew and Hall Islands in the eastern Bering Sea in the summers of 1985 and 1986. The study was funded by the Minerals Management Service (MMS) in anticipation of possible oil-related activity in the Navarin Basin and on St. Matthew Island. Of particular concern to MMS was a plan to construct an airstrip at the southeast end of the island.

The primary goal of the study was to assess the variability in numbers of seabirds on these islands, and in so doing, to further develop field and analytical protocols for the monitoring of the population status of seabirds in very large colonies. Information on the reproductive success and food habits of certain species was gathered in order to help evaluate the biological significance of numerical fluctuations.

The islands were divided into three study areas: St. Matthew Island - South, St. Matthew Island - North, and Hall Island. Within each area, census plots were established or relocated from earlier studies. The plots included ones visible from above on land, and ones visible only from below at sea. Counts of the land-based plots were emphasized both because of the greater accuracy and precision that can be obtained when counting from above on a stable platform and because repeated counts of land-based plots could be conducted easily. Three species of seabirds were chosen for intensive study: common murres, thick-billed murres and black-legged kittiwakes. Data also were collected on northern fulmars and pelagic cormorants.

The land-based census plots were counted by observers using binoculars or telescopes at standard times on several days. Additional data on numbers were obtained by the use of time-lapse photography, which was useful in assessing the levels of daily and day-to-day variability. The boat-based plots were counted less frequently and only in 1985.

On certain land-based plots, the numbers of pairs, nests, eggs and chicks of various species were mapped and counted to determine breeding chronology and performance. To assess food habits and trophic relationships, murres and kittiwakes were collected at intervals during both summers as they returned to the colonies from feeding.

The numbers of murres and kittiwakes varied markedly within years, and we could account for only a small portion of that variability. When analyses of the time lapse data were restricted to counts of photographs taken between 0800h and 2200h ADT there was no diurnal pattern of variation in the counts. In general, various weather variables accounted for little of the variation in the time lapse counts but numbers on the cliffs were low when wind speeds were high (>7m/sec). Because land-based counts were conducted during the daylight hours on days when winds were calm to moderate, analyses of the time lapse data suggested that variation in time of day and in weather conditions when land-based counts were made contributed little to within-year variation in those counts.

In general, numbers of murres and kittiwakes increased between 1985 and 1986 by about 2 to 7%. The numbers of kittiwakes and thick-billed murres were about 10 to 30% higher and common murres about 20% lower on census plots overall in 1985 than in 1983. Numbers of kittiwake nests increased much more, by about 40%, between 1985 and 1986, but were generally lower in 1985 than in 1983.

Other elements of the breeding biology of murres and kittiwakes also showed a positive response between 1985 and 1986. In 1986, egg-laying by all species was advanced, kittiwake clutch sizes were much larger, and a greater number of murres laid eggs. For an overall comparison of the breeding performance of birds in the three areas we assigned ranks of from 1 to 3 for chronology, clutch size, proportion of adults with chicks, and chick survival. The overall rank was lowest for St. Matthew Island - South, intermediate at St. Matthew Island - North and highest at Hall Island, suggesting that suitability for breeding might not be equal for these three areas.

Murres fed on a variety of fish and invertebrates, particularly young age classes of walleye pollock. Sand lance were taken in both years at the north end of St. Matthew Island, but not the south end, and were possibly important in early summer. In 1982 or 1983 sand lance were not present among prey remains of murres collected at the north end. Pricklebacks were caught by some adult murres and were fed to chicks in 1986 but not in any previous year. Besides pricklebacks, pollock apparently were the other important food given to chicks. Pollock did not dominate the diets of kittiwakes as they apparently did with murres. Kittiwakes took relatively more invertebrates than murres, including crab offal discarded by commercial processors operating near the island in 1986. A comparison of the food habits for all three species at the two ends of the island suggested that both prey diversity and abundance were higher at the north end, which could account for generally earlier and more successful breeding at St. Matthew Island - North and at Hall Island than at St. Matthew Island - South.

The increased numbers of eggs laid by kittiwakes in 1986 did not lead to proportionally higher production, as chick mortality was extremely high. In both 1985 and 1986, as well as in 1982 and 1983, the reproductive success of kittiwakes was poor, either because few eggs were laid, or because chicks died before they were old enough to leave the nests. The cause of death apparently was starvation. Black-legged kittiwakes and red-legged kittiwakes on the Pribilof Islands also generally have had poor reproductive success in recent years. Pollock are important prey of kittiwakes and murres on the Pribilof Islands, as they are on St. Matthew Island, and a low availability of pollock is possibly the cause of the low reproductive success of kittiwakes.

The analytical technique we used to census murres and kittiwakes was sensitive to changes of a few percent and appear to be very promising by comparison to methods used in previous seabird studies. To most effectively use this technique to monitor changes in numbers between years, a large sample size of plots and of plot counts is desirable, with a mean number of birds per plot of 50 to 100. The use of time-lapse cameras was extremely helpful in determining the level of within-season variability in numbers, and should be a part of any monitoring study.

In June 1987 this study was completed and a final report was submitted to MMS.

QUESTIONS AND DISCUSSION

Steve Treacy: There was reported to be some sort of a vessel stuck at Glory of Russia Cape, is that a feeding area?

Edward Murphy: Yes, actually Sarichef Strait (between Hall Island and St. Matthew Island) seems to be very productive and may be a principal feeding area. If a spill got into that area that would be the most important effect. I haven't seen any information on trajectories of any spill that may have occurred.

Steve Treacy: I don't know that there has been that much of a spill. I don't know if it was a fishing vessel or cargo vessel, it wasn't an oil and gas vessel of any sort, but it was something that was stuck there. I can't remember the details of it. It sounds like it was in a sensitive spot.

Steve Johnson: Ed, I noticed you plotted wind speed versus number, did you plot wind direction at any point?

Edward Murphy: We had the idea that wind direction would be important and so we looked at whether wind was blowing towards the cliffs or away from the cliffs. We really found inconsistent effects of wind direction on numbers; these analyses are included in our final report.

MONITORING ST. LAWRENCE ISLAND AND CAPE THOMPSON SEABIRD POPULATIONS

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About 1.8 million seabirds of 12 species breed on St. Lawrence Island (Figure 1) -- one of the largest aggregations of breeding seabirds in the subarctic Pacific. Colonies of least and crested auklets alone, totaling 1.5 million birds, contain a substantial proportion (perhaps 20%) of these species' world populations. Large seabird colonies occur also at Cape Thompson (Figure 2), where thick-billed and common murres (*ca.* 360,000) and black-legged kittiwakes (*ca.* 26,000) are the numerically dominant species. Although critical nesting and foraging habitats of Cape Thompson and St. Lawrence Island seabirds have so far remained mostly free from disturbance or alteration, there is a possibility of adverse effects on either or both components of the birds' environment from the exploration, production, or transport of oil and gas in the region.

Studies of seabird populations, productivity, and feeding habits were conducted at St. Lawrence Island in 1987 and Cape Thompson in 1988. The objectives were similar in both studies: 1) establish land-based study plots for monitoring long-term trends in populations and productivity of selected species (murres, kittiwakes, and auklets at St. Lawrence Island; murres and kittiwakes at Cape Thompson), 2) obtain population indices and assess the breeding productivity of auklets and/or murres and kittiwakes, 3) determine the food habits of auklets, murres, and kittiwakes and identify key foraging areas in the vicinities of St. Lawrence Island and Cape Thompson, and 4) review historical data on seabird populations at both study sites and identify trends.

On St. Lawrence Island, a field camp was established at Kongkok Bay and occupied continuously from 24 May to 2 September 1987. Permanent study plots were selected for cliff- and crevice-nesting species, and regular observations were made throughout the breeding season to document attendance patterns, breeding phenology, and success. Periodic collections of adults offshore and of chick meals in the colonies were used to determine the food habits of study species. Additional plots for population monitoring of murres and kittiwakes were established in colonies near Savoonga on the north side of the island, and counts were made there between 23 July and 1 August. Shore-based work was supplemented with offshore studies of seabird foraging conducted from the U.S. Fish and Wildlife Service vessel *Tiglax* between 18 August and 3 September 1987 (Figure 3).

At Cape Thompson, a field camp was established at the mouth of Ikijaktusak Creek on 2 July 1988 and occupied continuously until 31 August. Permanent study plots were selected for murres and kittiwakes in four of the five discrete colonies comprising the Cape Thompson complex. Collections of adults were made from a small boat to assess food habits near shore, and the *Tiglax* supported offshore surveys of bird and prey distributions in the Cape Thompson vicinity from 24 to 31 August 1988 (Figure 4).

Mean attendance on study plots of several species in the Kongkok Bay area increased since the last study of seabirds there (in 1976). Murres increased by an estimated 20%, least auklets by 8%, and crested auklets by 44%. Common and thick-billed murres had average breeding success at Kongkok in 1987 (about 0.6 young/pr), whereas black-legged kittiwakes

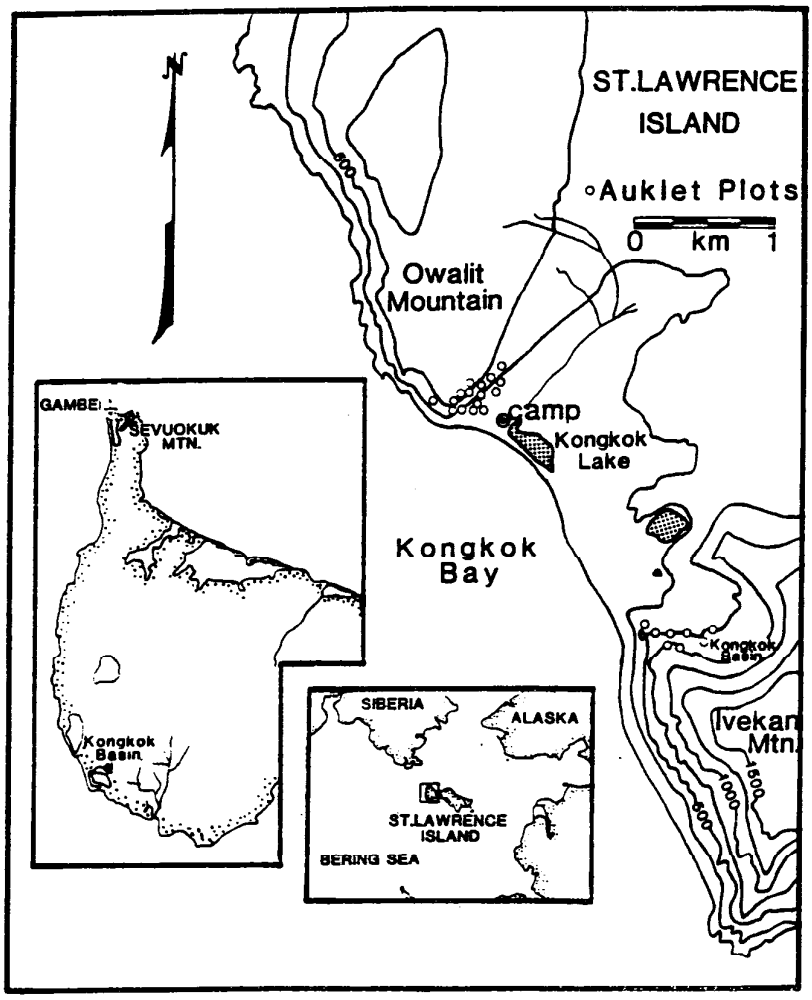

Figure 1. Location of the main study area on St. Lawrence Island and distribution of auklet census plots on Owalit Mountain and in Kongkok Basin.

exhibited near-total breeding failure. Crested and least auklets had high levels of breeding success after the effects of observer disturbance were taken into account.

Feeding concentrations of auklets and murres were found primarily north of Gambell in the Anadyr Strait and western Chirikof Basin. Kittiwakes were dispersed widely over the study area. Both murre species fed predominantly on arctic cod near St. Lawrence, but thick-billed murres also took substantial quantities of invertebrates such as amphipods and krill. Least and crested

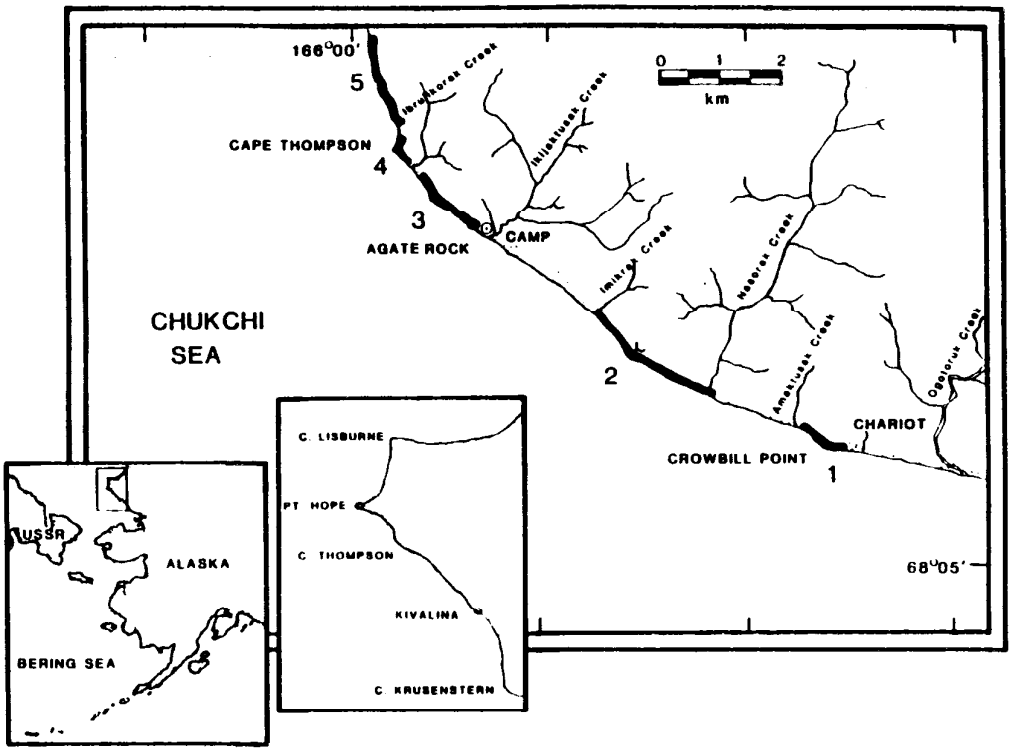

Figure 2. Map of the Cape Thompson study area showing the locations of the five cliff areas occupied by seabirds. The position of the 1988 base camp at the mouth of Ikijaktusak Creek is also indicated.

auklets fed entirely on planktonic crustacea but exhibited clear differences in their foraging habitats and prey species. Least auklets fed mainly on the copepod *Neocalanus plumchrus*, while most crested auklet stomachs contained euphausiids, *Thysanoessa* spp.

Investigations on seabird population sizes and breeding biology were carried out at Cape Thompson from 1959 to 1961 under the Atomic Energy Commission's pre-development studies for "Project Chariot." Beginning in 1976, the Outer Continental Shelf Environmental Assessment Program (OCSEAP) supported efforts to recensus the seabirds of Cape Thompson and determine whether changes had occurred since the 1959 to 1961 period. Investigators reported that the combined populations of common and thick-billed murres declined markedly between 1961 and 1976 and continued to decline through 1982 in some portions of the Cape Thompson complex. Our analyses confirmed the negative trends in murre attendance at all Cape Thompson colonies between 1960 and 1982 or 1988, significantly so for 3 of the 5 colonies. Based on apparent changes in species composition within the colonies, common murres declined at a more rapid rate than thick-billed murres between 1960 and 1988. Combining information from all colonies, it appears that murre populations have been relatively stable since about 1979. In contrast to murres, the kittiwake population showed no significant trends between 1960 and 1982 or between 1960 and 1988. All fluctuations in kittiwake numbers between years were within the limits of variability expected within years. Breeding productivity

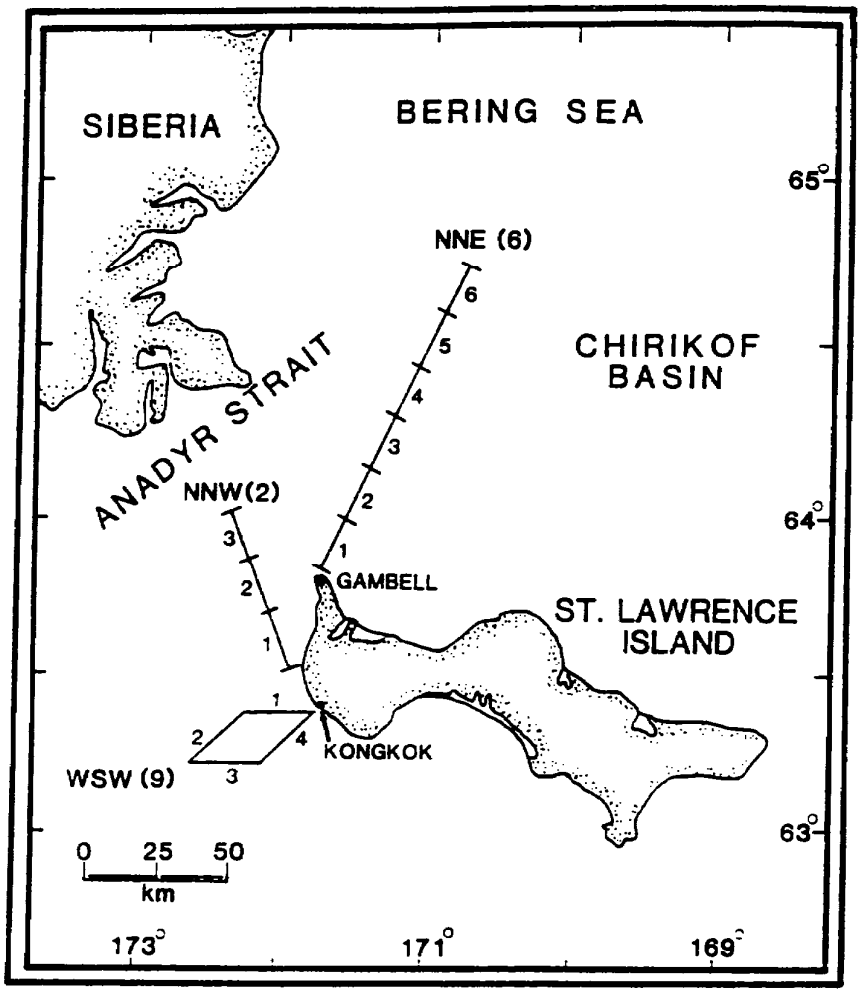

Figure 3. Orientation of transects used for shipboard surveys of seabirds near St. Lawrence Island in August - September, 1987. Tracks are numbered sequentially along the transect lines, and the number of replicates completed for each transect is indicated in parentheses.

of murres was about average in 1988 (0.47 young/pr), whereas the productivity of kittiwakes was poor (0.15 young/pr).

Black-legged kittiwakes fed extensively on pre-spawning schools of Pacific herring near Cape Thompson. Offshore, murres and kittiwakes fed mostly on arctic cod and sand lance, which were distributed widely but in low concentrations (e.g., 0.1 to 10 g/m^3) up to 120 km north and northwest of the Cape. In the total area surveyed (225 km^2), only two major feeding aggregations were observed where fish school densities exceeded 15 g/m^3. Forage fish

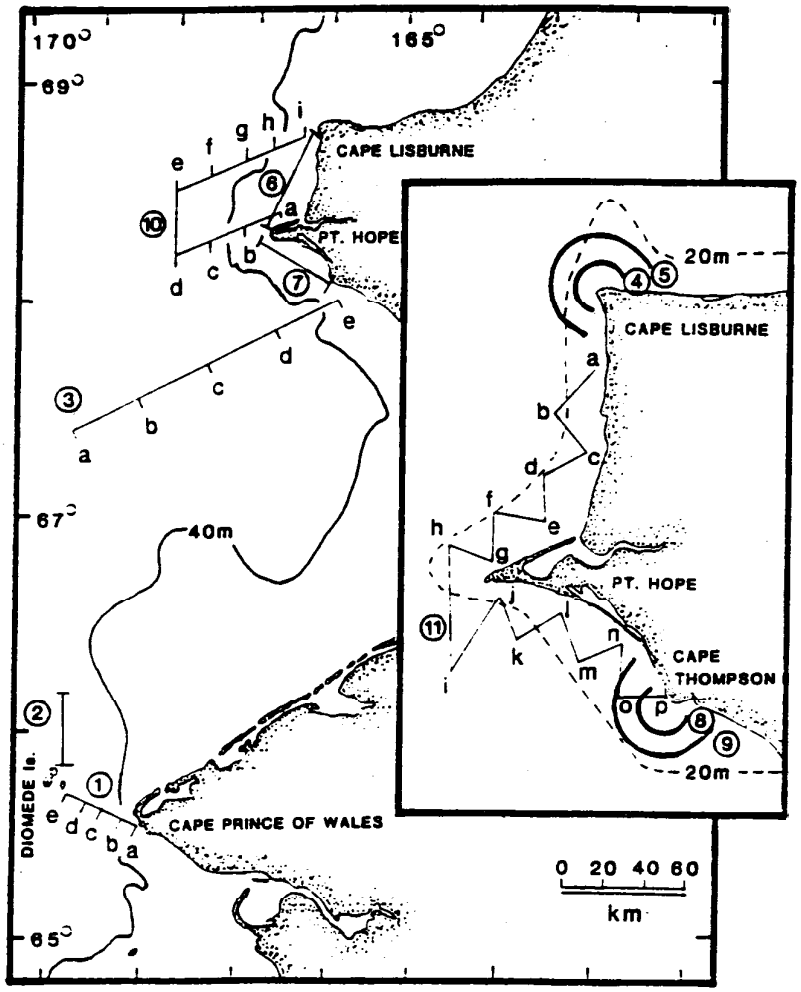

Figure 4. Surveys conducted in the southeastern Chukchi Sea in August 1988. Numbers in circles indicate survey number. Lower-case letters along surveys 1, 3, and 10 indicate location of CTD stations, and along survey 11 (inset) indicate location of waypoints.

densities were higher in shallow Alaska Coastal Current waters than offshore in Bering Sea waters, and piscivorous seabirds such as murres and kittiwakes fed mostly in coastal waters. Reduced numbers of fish in murre and kittiwake stomachs in August and low breeding success of kittiwakes suggested that forage fish densities observed around Cape Thompson in late August were sufficient to sustain murres but were insufficient for, or inaccessible to, kittiwakes. Planktivorous least and crested auklets foraged almost exclusively in Bering Sea waters as far north as Point Hope.

Land-based plots established in 1987 and 1988 are recommended for future population monitoring of cliff-nesting birds at St. Lawrence Island and Cape Thompson. Based on the coefficients of variation among counts observed at Cape Thompson, we estimated that 10

replicate counts per year would detect an 8% change in numbers of thick-billed murres between years and a 12% change in common murres, with 75% certainty of statistical significance at the 0.05 level. Similarly, a 9% annual change in the population of black-legged kittiwakes should be detectable at the 0.05 significance level given samples of 10 replicate counts of the land-based plots.

The breeding failures of black-legged kittiwakes observed in both years of this study are part of a broader pattern of failure observed in this species throughout the Bering/Chukchi seas and Gulf of Alaska in recent years. The causes of recurrent widespread breeding failure need to be identified if kittiwakes are to have a role in area-wide population monitoring during the period of Alaska outer continental shelf development by the oil and gas industry.

Because seabirds are most vulnerable to oil pollution while they are at sea, studies of offshore distributions and habitat requirements are an important element of pre-development and monitoring studies. Our results indicated the feasibility of systematic surveys of foraging habitat use, and the utility of hydroacoustic data for interpreting patterns of seabird distributions and productivity.

REFERENCES

Bedard, J. 1969. The nesting of the crested, least, and parakeet auklets on St. Lawrence Island, Alaska. Condor 71:386-398.

Fadely, B.S., J.F. Piatt, S.A. Hatch, and D.G. Roseneau. 1989. Populations, productivity, and feeding habits of seabirds at Cape Thompson, Alaska. Final Rep. Minerals Management Service, Anchorage, AK. OCS Study MMS 89-0014. 429 pp.

Piatt, J.F., S.A. Hatch, B.D. Roberts, W.W. Lidster, J.L. Wells, and J.C. Haney. 1988. Populations, productivity, and feeding habits of seabirds on St. Lawrence Island, Alaska. Final Rep. Minerals Management Service, Anchorage, AK. OCS Study MMS 88-0022. 235 pp.

Piatt, J.F., B.D. Roberts, and S.A. Hatch. 1990. Colony attendance and population monitoring of least and crested auklets on St. Lawrence Island, Alaska. Condor 92:97-106.

Piatt, J.F., B.D. Roberts, W.W. Lidster, J.L. Wells, and S.A. Hatch. In press. Effects of human disturbance on breeding least and crested auklets at St. Lawrence Island, Alaska. Auk.

Piatt, J.F., J.L. Wells, A. MacCharles, and B.S. Fadely. In press. The distribution of seabirds and their prey in relation of ocean currents in the southeastern Chukchi Sea. Can. Wildl. Serv. Occ. Pap.

Searing, G.F. 1977. Some aspects of the ecology of cliff-nesting seabirds at Kongkok Bay, St. Lawrence Island, Alaska, during 1976. U.S. Dept. Commerce, NOAA, OCSEAP Ann. Rep. 5:263-412.

Springer, A.M., E.C. Murphy, D.G. Roseneau, and M.I. Springer. 1985. Population status, reproductive ecology, and trophic relationships of seabirds in northwestern Alaska. U.S. Dept. Commerce, NOAA, OCSEAP Final Rep. 30:127-242.

Swartz, L.G. 1966. Sea-cliff birds. Pages 611 to 678 *in* N.J. Wilimovsky and J.N. Wolfe (eds.), Environment of the Cape Thompson region, Alaska. U.S. Atomic Energy Comm., Oak Ridge, TN.

QUESTIONS AND DISCUSSION

Tom Newbury: You mentioned the relationship between successful fledging and disturbance. What was the disturbance, was it people, researchers, just moving around the sites?

Scott Hatch: Yes. Basically you locate a least or crested auklet nest by searching in the talus with flashlights. You locate those nests that tend to be close the surface in the talus layer, mark them, and revisit them to look at survival rates of eggs and chicks. Disturbance depends upon how frequently you revisit them, because each time you do, if there is a bird on the nest it will tend to move off and is aware of your presence. Our three levels of disturbance were that at a high level of disturbance observers visited the nest essentially every day, weather permitting, once an egg or chick was located. And also those chicks were handled for regurgitations and chick growth rates. At a medium level, they visited the nests weekly and did not handle the chicks. At a low level, we located the nest and then didn't go back to that nest until the very end of the summer, or the projected hatching time, just to determine whether or not a chick was being fledged. So yes, it was entirely observer or investigator disturbance. It is just something that you can't get around. I would suggest that if you want to know what auklet breeding success is, you ought to use the third model - simply locate as many eggs as you can and make one visit at the end of the nest cycle to determine fledging rates. Don't worry about trying to get other information.

MONITORING SEABIRD POPULATIONS AT THREE COLONIES IN THE BERING SEA

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This project is similar to others discussed here in that we are monitoring seabird populations in western Alaska. In our study, however, instead of doing intensive work at a single colony in a given year, we are studying several colonies simultaneously. By monitoring colonies throughout the Bering Sea each year, we hope to obtain a broader picture of how whole populations of marine birds respond to environmental conditions. Continuous monitoring at several sites will also improve our ability to assess threats from oil development in all regions of the Bering Sea. This report covers the first field season of the multi-colony study.

We selected three colonies in the Bering Sea for monitoring in 1989 (Figure 1). We chose colonies for which several years' data were already available so that we could begin to analyze trends immediately. A number of large seabird colonies in the Bering Sea have been studied during the last 15 years. Major colonies on the coast include Cape Peirce in Bristol Bay and Bluff in Norton Sound. Large colonies on islands in the Bering Sea include those on Nunivak, St. George and St. Paul in the Pribilofs, St. Matthew, St. Lawrence, King Island, and Little Diomede in the Bering Strait. We selected the colonies of St. George, Cape Peirce, and Bluff for this study. St. George, with over 2,500,000 birds, is the largest seabird colony in Alaska, and it also contains almost the entire population of the red-legged kittiwake, a species unique to the Bering Sea. Cape Peirce may contain as many as 700,000 birds, and Bluff has approximately 50,000.

The species we selected for monitoring are relatively easy to observe and are present at many colonies and thus provide convenient comparisons between colonies. The species in our study were the common murre, thick-billed murre, black-legged kittiwake, and red-legged kittiwake. Murres and kittiwakes differ in feeding ecology and therefore respond differently to environmental conditions. Murres feed by pursuing prey underwater, while kittiwakes pick food from the surface. Both groups feed on small fish and on plankton.

The objectives of our work at each colony were to record the number of birds and to observe the reproductive success of murres and kittiwakes. We used the same methods at each colony as far as possible so as to allow comparisons between colonies. We looked at reproductive success from the time birds first begin breeding in May or June to the time the young birds leave the cliffs in August; birds were counted (on sample plots rather than whole colonies) during the middle of the summer when most were incubating eggs. Another objective was to compare our data with those of previous years, which meant assembling many observations from old files.

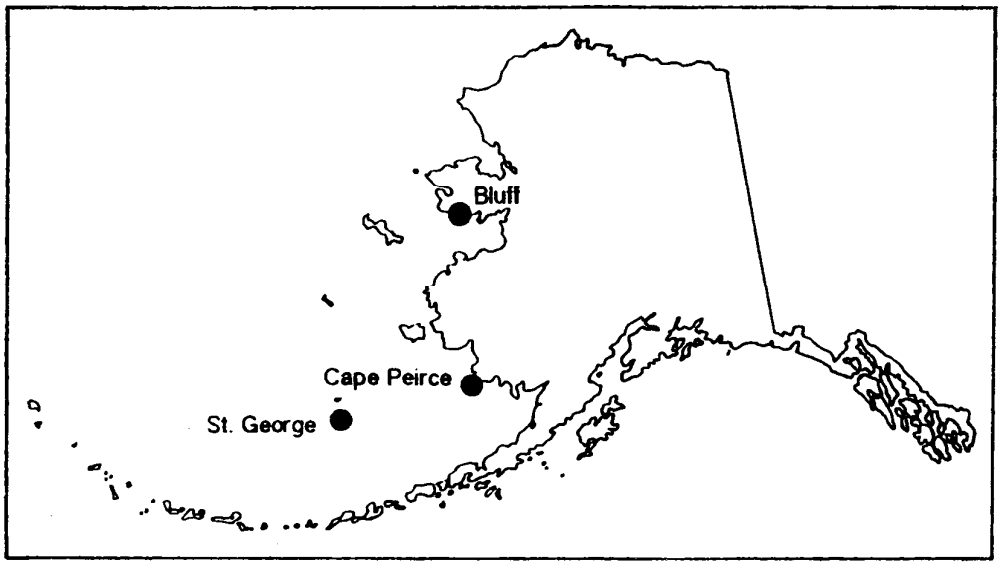

Figure 1. Map of Alaska showing colonies monitored in 1989.

Reproduction in 1989 was about average for murres but was very poor for kittiwakes in all three colonies. Among murres, approximately 40% to 50% of breeding pairs succeeded in rearing a chick to the age when it could leave the cliff. Kittiwakes failed to rear any chicks at St. George or Bluff, however. Many birds that built nests did not bother to lay eggs in them. No eggs hatched at St. George, and the few chicks at Bluff died before they were fully grown. Kittiwakes at Cape Peirce mustered a better breeding effort, but even there, only 6% of pairs raised a chick. Other studies have shown that kittiwakes at Bering Sea colonies may raise 0.25 to 0.45 young per pair in an average year.

We have no direct evidence to indicate the reason for kittiwake breeding failure in 1989, but there is a little circumstantial evidence that appropriate food was not available near the colonies. Kittiwakes were observed to abandon their nest during the breeding season, and flocks of birds were seen less often than usual feeding on fish offshore. Murres are considered better able than kittiwakes to compensate for year-to-year changes in prey fish and to raise young even in adverse years.

Populations of birds that were counted on our sample plots appear to have been stable during the 1980s in most cases. Kittiwake populations were lower than normal in 1989, but this is often found in years when breeding fails. Two populations should arouse concern because they appear to be declining consistently: common murres have decreased for four years at Cape Peirce, and red-legged kittiwakes show a steep and significant decline at St. George over a period of 13 years (Figure 2). We need a few more years' data for Cape Peirce before we can analyze population trends there reliably.

We hope that in future years we can continue regular monitoring of these colonies and possibly expand the area covered by the study. We also hope to collect data on diets of the

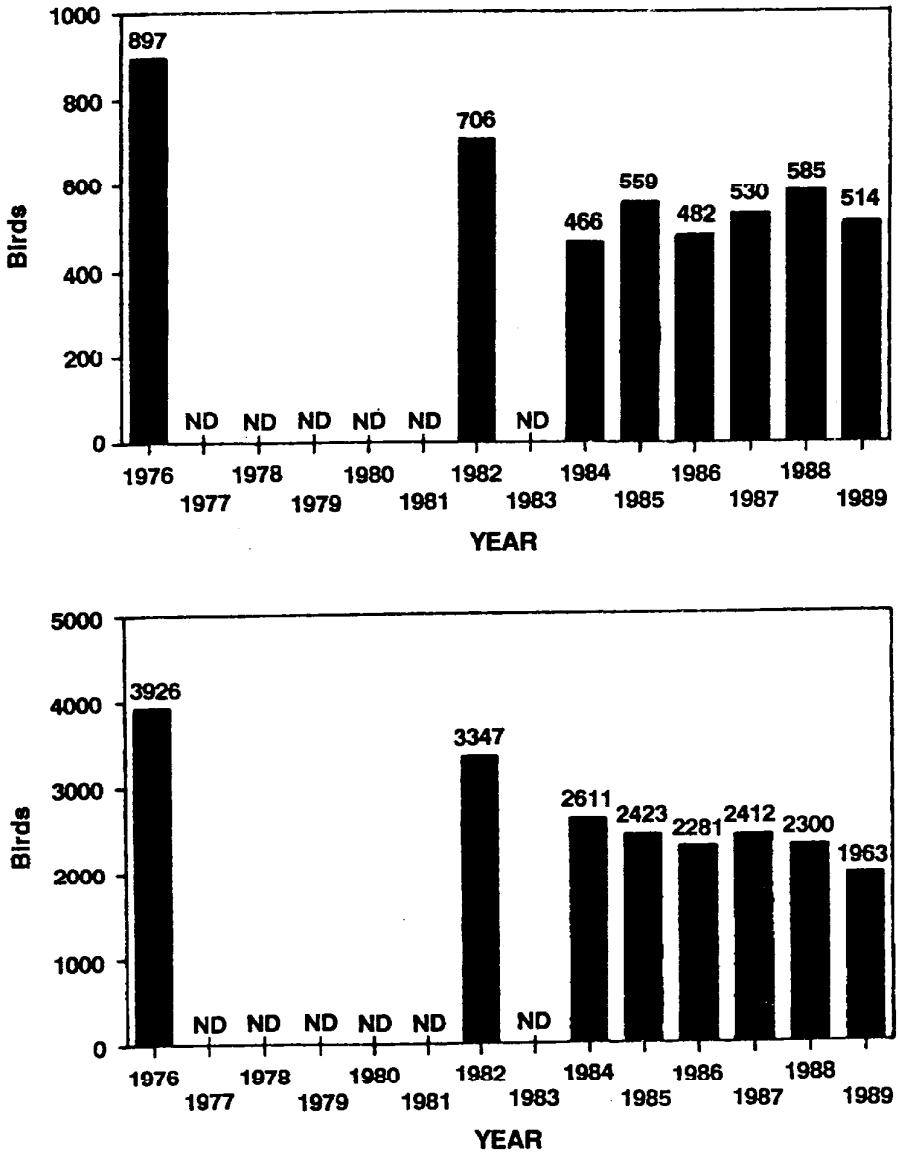

Figure 2. Population trends in kittiwakes on St. George Island. Top, black-legged kittiwake; bottom, red-legged kittiwake. ND=no data for that year.

birds in each year. This work will improve our understanding of normal fluctuations in seabird breeding ecology and populations and will help us detect any impacts of oil development on populations or breeding success.

REFERENCES

Byrd, G.V. 1987. The status of ledge-nesting seabirds in the Pribilof Islands, Alaska, 1976-1987: an executive summary. Unpublished report, U.S. Fish and Wildlife Service, Homer, Alaska.

Dragoo, D.E., B.K. Bain, A.L. Sowls, and R.F. Chaundy. 1989. The status of cliff-nesting seabirds in the Pribilof Islands, Alaska, 1976-1988: a summary. Unpublished report, U.S. Fish and Wildlife Service, Homer, Alaska.

Drury, W.H., C. Ramsdell, and J.B. French. 1981. Ecological studies in the Bering Strait region. OCSEAP, Final Rep. Princ. Invest. 11:175-486.

Hatch, S.A. 1987. Did the 1982-1983 El Niño-Southern Oscillation affect seabirds in Alaska? Wilson Bull. 99:468-474.

Hunt, G.L. Jr., Z. Eppley, and W.H. Drury. 1981. Breeding distribution and reproductive biology of marine birds in the eastern Bering Sea. Pages 649-687 *in* D.W. Hood and J.A. Calder, (eds.), The eastern Bering Sea: oceanography and resources. University of Washington, Seattle.

Murphy, E.C., A.M. Springer, and D.G. Roseneau. 1986. Population status of common guillemots, *Uria aalge* at colony in western Alaska: results and simulations. Ibis 128:348-363.

Troy, D.M., and J.S. Baker. 1985. Population studies. Pages 34-190 *in* S.R. Johnson, (ed.), Population estimation, productivity, and food habits of nesting seabirds at Cape Peirce and the Pribilof Islands, Bering Sea, Alaska. Report by LGL Ecological Resource Associates, Inc. to Minerals Management Service, Anchorage.

QUESTIONS AND DISCUSSION

Brian Lawhead: The monitoring protocol that Scott Hatch alluded to originally proposed working, I think it is, seven colonies with two teams. Is the level of effort you described for 1989 roughly similar to what you would hope to accomplish at all of the sites? How does the 1989 work mesh with the monitoring protocol that was originally proposed? Would double the amount of money be required? Is it something that is feasible, or was there more effort invested in these three colonies that you would propose to invest in more colonies over a larger area? Could you fill us in a little bit on that? And is there any colony work proposed for St. Matthew this year by either Fish and Wildlife Service or MMS in an area in which there is good baseline data?

Vivian Mendenhall: The answer to the last question is not at the moment as far as I am aware. But we have been discussing it. MMS is interested in having people work out there. As far as the first question, it is a good question. The proposal that Scott originally made, which I am sure that I am not summarizing correctly, was to move between colonies and make maximum use of the number of people. So as to visit once during a period when population counts should be made, which is the last half of incubation for many species, the first part of chick

rearing, and then go to other colonies and do the same thing. Because as you move north, the phenology gets later. Then to come back to the south and start picking up the number of chicks that are about to fledge. If you get there after they have fledged you are out of luck, of course. The biggest problem with that is that unless it is a good year for weather which happens but not very often, the lag time required to move between colonies is a couple of weeks. You can't even go from St. Paul to St. George in most years without completely losing out on some of the data. The phenology is very similar and the two are only 45 mi apart, but that also means that the trip shouldn't take that long. But in fact you could be fog bound for a week on either island. To go from one of those islands to say Cape Thompson you have to go to Anchorage not directly to Kotzebue and then up to Kotzebue and then out to your field site. All stages of which, except the trip from I believe Cape Thompson, have instrument approach. Cape Thompson to Kotzebue is affected by the possibility of fog, etc.

So we cannot see any way you can move people around from one place to another at the sites that we have chosen. If you could do that you could probably get meaningful data relatively easily on kittiwakes, where you know how many adults nested. If you can get there early enough to count nests, which would require staying and then to count the population or else making three visits. Mike Harris in Britain showed that the estimate you would get if you went away and didn't study them the whole season, would probably be only about 13% different than if you stayed the whole season and looked at every phase of breeding success. You would miss some of the details on exactly what part of the stage they failed, if they failed, but that isn't so important for monitoring.

For murres, the problem is a little bit different. It is such a labor intensive project to determine which murre has an egg and which one doesn't. If you don't map the sites, you can't tell which ones you are seeing over again. It takes several days to determine on any given plot which ones have eggs and which ones don't because you have to wait for them to move. If you are only going to get chicks, you still need to do this in a fairly dedicated way. You don't know how many nesting sites there were as you would know for kittiwakes. The estimates you get, if you do it or not count the eggs to begin with in the early part of the season with murres are very different. So we are thinking of ways to reduce the effort but it doesn't appear to us right now to be feasible to reduce it as much as we would have liked to be able to move around.

THE MOVEMENTS AND POPULATION STATUS OF ROSS' GULL

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Ross' Gull (*Rhodostethia rosea*) is one of the least studied of northern hemisphere seabirds. Known only from scattered individuals until the latter part of the last century, it was not observed in numbers until 1881 when a large fall migration was observed at Point Barrow. Its breeding grounds were not discovered until 1905 when large numbers were found nesting in eastern Siberia on the wet tundra of the Kolyma and Indigirka river deltas. The discovery of the breeding grounds indicated that the initial post-breeding movement was east through the Chukchi Sea to Point Barrow but additional information about the annual migration pattern and the size of the population has remained unknown until research conducted in the last fifteen years.

With the onset of oil and gas exploration in the arctic there was a need to obtain information on the distribution, movements and population size of Ross' Gulls in Alaskan waters. The possibility that the majority of the world's population might be in a restricted area of the Chukchi or Beaufort seas meant that a single environmental impact associated with oil and gas development could have a much greater effect than for more widely distributed species. Additionally, without an adequate estimate of the population, the relative magnitude of any impacts that did occur would be difficult to assess.

All observers of the fall migration of Ross' Gulls at Point Barrow have noted an easterly or northeasterly direction of movement. The direction of movement was remarkable since essentially all late summer and fall bird migrations at Point Barrow are west and south as species leave the arctic and move to Pacific Basin wintering grounds. The eastward migration of Ross' Gulls coupled with a lack of an observed westward movement gave rise to speculation that the species winters in the Arctic Basin. This hypothesis gained credibility with the continued lack of winter observations of substantial numbers of birds. The belief of an Arctic Basin wintering area persisted despite the almost complete ice cover and lack of daylight in the region for most of the winter.

Initial observations in the Chukchi and Beaufort seas in the 1970s demonstrated that Ross' Gulls were associated with the edge of the arctic pack ice and were common in much of the Chukchi Sea, but limited to the extreme western portion of the Beaufort Sea. This distribution was similar to what was found for surface-feeding seabirds as a group (terns, gulls and phalaropes), with moderate densities in the majority of the Chukchi Sea, high densities in the extreme western Beaufort Sea and exceptionally low densities in the central and eastern Beaufort Sea. Unlike diving species, which have access to prey populations in the water column, surface-feeding species are limited to those organisms they can obtain while sitting on or hovering over the water. For this reason surface-feeding species are most abundant in areas where oceanographic features bring prey to the surface. In the waters directly east of Point Barrow, Bering Sea and Arctic waters come into contact and populations of fish and zooplankton near the surface are increased. The high densities and feeding flocks of Ross' Gulls observed in the extreme western Beaufort, combined with the paucity of sightings to the east, indicated that the species might be entering the Beaufort Sea primarily to feed in an area of high prey abundance rather than moving to an Arctic Basin wintering area.

To examine this hypothesis as well as obtaining other essential information on this species, an investigation of Ross' Gull movements at Point Barrow was initiated in the 1980s. The objective of this work was to determine the magnitude and nature of the autumnal movement at Point Barrow in order to allow a more accurate determination of the geographic areas of importance to the species and those time periods when it is most vulnerable to perturbations associated with oil and gas development.

Systematic migration watches were conducted at Point Barrow in September and October 1984, 1986 and 1987. In all years, migration began in late September with an eastward movement into the Beaufort Sea followed approximately two weeks later, by a westward movement back into the Chukchi. The timing of the return movement appeared to be related to the freezing of the offshore waters in the Beaufort. The three years of observations demonstrated that Ross' Gulls are not passing Point Barrow in route to an Arctic Basin wintering area and that they leave the Beaufort Sea when the open water available for feeding has been greatly decreased by the formation of new ice. Shipboard observations in the Chukchi Sea in late fall, after the return from the Beaufort, demonstrated that Ross' Gulls are associated with the ice edge as it moves south toward the Bering Sea. These findings indicate that what previous observers thought were vagrant birds in the northern Bering Sea in December were probably part of a movement to a Pacific Basin wintering area. This is most likely in the sea of Okhotsk, where the species is regularly recorded in small numbers in winter.

Estimates of the population of Ross' Gulls in Alaskan waters were obtained from the observations of the passage at Point Barrow and from the cruises at the ice edge conducted in September and October. It appears that 20,000 Ross' Gulls enter the Beaufort Sea in late September and early October. Following the westward movement at Point Barrow the population at the Chukchi Sea ice edge could be as high as 40,000 birds. Earlier speculation had estimated a population of less than 10,000 birds.

These observations demonstrate that Alaskan waters are more important to the species than was previously thought. Ross' Gulls now appear to occupy the Chukchi Sea from mid-September until ice cover is nearly complete in November or December. In addition, it appears that most of the birds in the Alaskan arctic in fall enter the Bering Sea, although they appear to be in the Alaskan Bering Sea for a short period of time. While in Alaskan waters a substantial part of the world's population is concentrated in two fairly restricted areas: the extreme western Beaufort Sea and the Chukchi Sea ice edge. The species would be especially vulnerable to perturbation in those areas. The population estimates obtained through this research, however, show the world's population to be substantially larger than previously thought and thus less apt to being decimated by one pollution event. Knowledge of the timing of Ross' Gull movements in Alaskan waters and those areas and habitats where the species is concentrated will allow resource managers to schedule and locate activities to minimize potential impacts or, at least, anticipate those times and areas when Ross' Gulls are most vulnerable to pollution events.

REFERENCES

Bailey, A.M. 1948. Birds of arctic Alaska. Colorado Mus. Nat. Hist. Pop. Ser. No. 8. 317 p.

Divoky, G.J. 1976. The pelagic feeding habits of Ivory and Ross' Gulls. Condor 78:85-90.

Divoky, G.J., G.A. Sanger, S.A. Hatch, and J.C. Haney. 1988. Fall migration of Ross' Gull (*Rhodostethia rosea*) in Alaskan Chukchi and Beaufort Seas. Final Report to Minerals Management Service. OCS Study MMS 88-0023.

QUESTIONS AND DISCUSSION

Tom Newbury: You mentioned that the animals may stage over on the Siberian coast and move to Barrow, what evidence is there that they may come in on the coast south of Barrow? The plume that you show moving into the Beaufort, and I believe it exists, is actually only as rich as the water moving out of the Chukchi. In other words, they may be able to feed in the northeastern Chukchi. Is there any evidence that they come in at Wainwright or Peard Bay?

George Divoky: They actually do come in at Wainwright. But it is more the frontal system that is created when that water mass hits the Beaufort water moving westward that creates the zooplankton wash-ups that we saw. So that has always been a question with regard to why the Chukchi sea, if the Bering Sea water is coming up, doesn't have higher densities of seabirds and it is basically that prey comes to the surface only at areas like the area of the Bering Sea intrusion in the Beaufort Sea.

Tom Newbury: What percentage of the population is it that moves into the western Beaufort?

George Divoky: Well, based on the Chukchi Sea densities it seemed as if 40,000 birds were present at the ice edge in the one year that we had a good census there. The birds that move past Point Barrow, and of course, there may be birds moving offshore, seems to be close to 20,000. Actually we did one cruise in the Beaufort Sea after the passage took place and found close to 20,000 there. It seems like it certainly isn't the whole population. Actually I would be surprised if it were. It may well be that as the population moves into the Chukchi, there is only food there to support a certain number and other birds move off to this other area in search of prey.

Tom Newbury: Together the percentage that are in the western Beaufort and the Chukchi, is that the total Ross' gull population or are there some that have stayed over on the Siberian coast?

George Divoky: That is also the other thing that would be very worthwhile to do with the Soviets. And this is one of the problems of having a boat one year, having someone at the Point the next year, things like that, rather than having all of those things happen in the same year. Because we don't know what going on at the Chukchi Sea ice edge when we saw the 20,000 birds pass Point Barrow. Nor do we know what was going on at Point Barrow when we saw the 40,000 at the Chukchi Sea ice edge. If the Soviets have any sort of platforms at all, or any sort of way that they can be censusing their waters during the same period, you could get a much better idea of the population. But my feeling is now that since the population seems to be, there were these early estimates of 10,000 or so, large enough to probably not be wiped out with one pollution event that there may not be that much drive to try to get a really accurate total, unless it seems that the population is in trouble.

Tom Newbury: Your statements about them moving into the western Beaufort is based a lot on that plume, on the temperature, on Don Schell's productivity data. Do you have some observations of birds that they actually don't move further east, that they don't feed outside of that area?

George Divoky: We actually have observations that some of them do. We have from one year, 1976, when we did shoreline transects from Point Barrow down to Canada that the Plover Islands and the area just east of Barrow were basically covered with Ross' gulls and they stopped basically at Smith Bay. One of the things that also happen in the summer, in terms of arctic terns, Sabine's gulls, and other surface feeding species that go through the Beaufort, in terms of flight directions from all cruises that we have done you see a westward movement, up unto that point you get to that area where the plume comes in and then it becomes basically a random movement, as if they were searching for prey.

Warren Matumeak: Can you describe to me what color these birds are, are they pink or white?

George Divoky: They are pink, though some of them have lost the pink by the time they get to Point Barrow so that they look almost white. Actually the color fades with time. So that if you look at any specimens in specimen drawers, they turn white. A number of places have tried to keep pink Ross' gulls in their collection which means you have to keep going out and shooting more Ross' gulls. They didn't actually realize in the past that somebody hadn't in the past shot only white ones.

Warren Matumeak: Will they turn pink again after a season?

George Divoky: Yes prior to breeding they turn pink, during their molting and show up on the breeding ground being pink.

Warren Matumeak: My grandfather used to eat these birds. He would take his shotgun and shoot them to get his supply of food. I don't know what they taste like, I guess they liked them.

George Divoky: Charlie Brower says they are excellent. That is his favorite bird up there. Actually at a time of year when bird resources are running down at Point Barrow, the passage of Ross' gulls in the past was not a minor food source. That was when the village was out at the Point. Actually one of the first things published on Ross' gulls was an article called "Ross' Gulls for Dinner." A scientist was there and had them for dinner.

Brendan Kelly: George you had on one of your slides an indication there were some reports of breeding in the Canadian Arctic.

George Divoky: Yes, at Churchill there was a famous site.

Brendan Kelly: That far over to the east?

George Divoky: And also there have been other scattered observations. Early ones were kind of written off, and now that they are realizing that there are these scattered breeding, usually it is somewhat episodic, it is not like a long term colony being established. And I don't believe the birds at Churchill have ever been successful at breeding though they are successful in bringing up every bird watcher who wants to see a Ross' gull.

Brendan Kelly: So there are scattered birds not just scattered observations.

Steve Treacy: Has there been much feeding habits work as far as prey species analysis on Ross' gulls?

George Divoky: In 1970 we collected a large number at the ice edge and have a pretty good idea of what they are eating at the ice edge. It was also clear that the zooplankton wash-up that I showed you, the bulk of that was cleaned up by Ross' gulls. Actually I should mention, there were a lot of agencies that have been tied in with this, but this work was done through the U.S. Fish and Wildlife Service with Scott Hatch, being in charge of Fish and Wildlife Service's work. Over the years a wide range of other agencies that I probably can't take the time to mention now have paid for various cruises and thing like that.

MONITORING BEAUFORT SEA WATERBIRDS/DETERMINING USE OF KASEGALUK LAGOON BY MARINE BIRDS
MMS Contract No. 14-35-0001-30491

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INTRODUCTION

This is a 2-part study. One part is being conducted in the Central Beaufort Sea (Figure 1), and the other is being conducted in the Kasegaluk Lagoon area of the Chukchi Sea (Figure 2). The Beaufort study involves the design and implementation of a monitoring protocol for waterfowl and marine birds, with emphasis on the Oldsquaw duck (*Clangula hyemalis*), the dominant bird species in this area. The Chukchi study is more descriptive, and is the first intensive and systematic program of aerial surveys of marine birds in this region of Alaska. Marine mammals also are being studied in this project, through a subcontract to the Alaska Department of Fish and Game (K. Frost and L. Lowry, see description elsewhere in this volume).

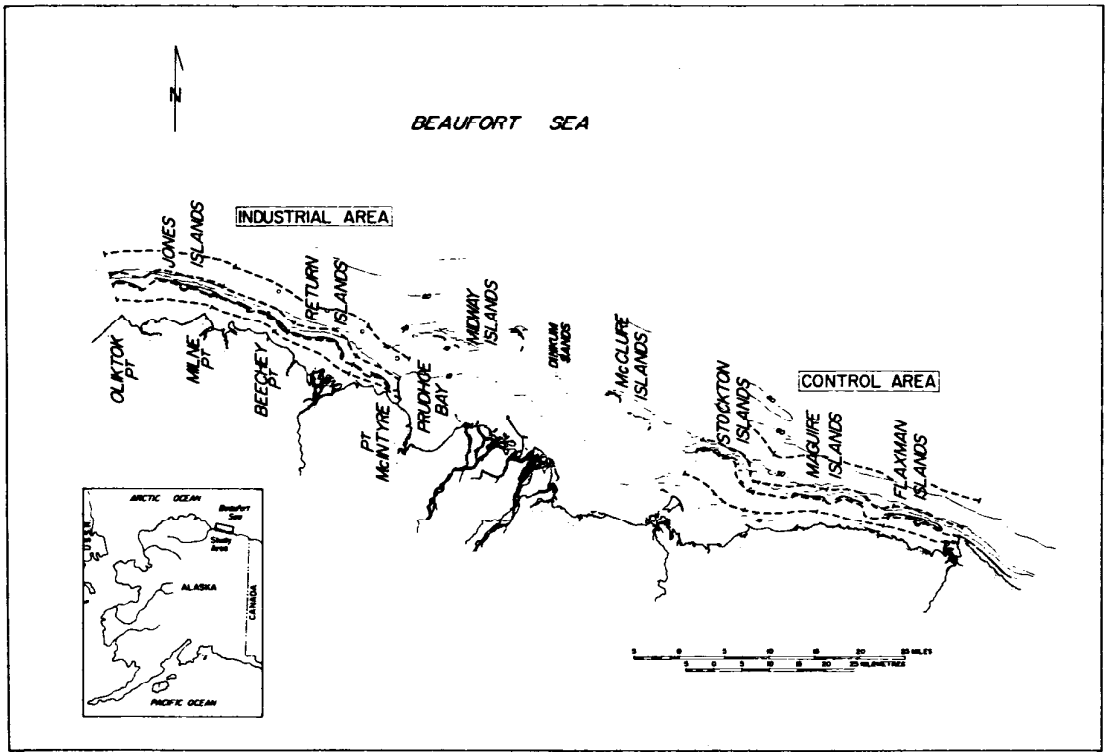

Figure 1. Study area for Beaufort Sea marine bird monitoring program.

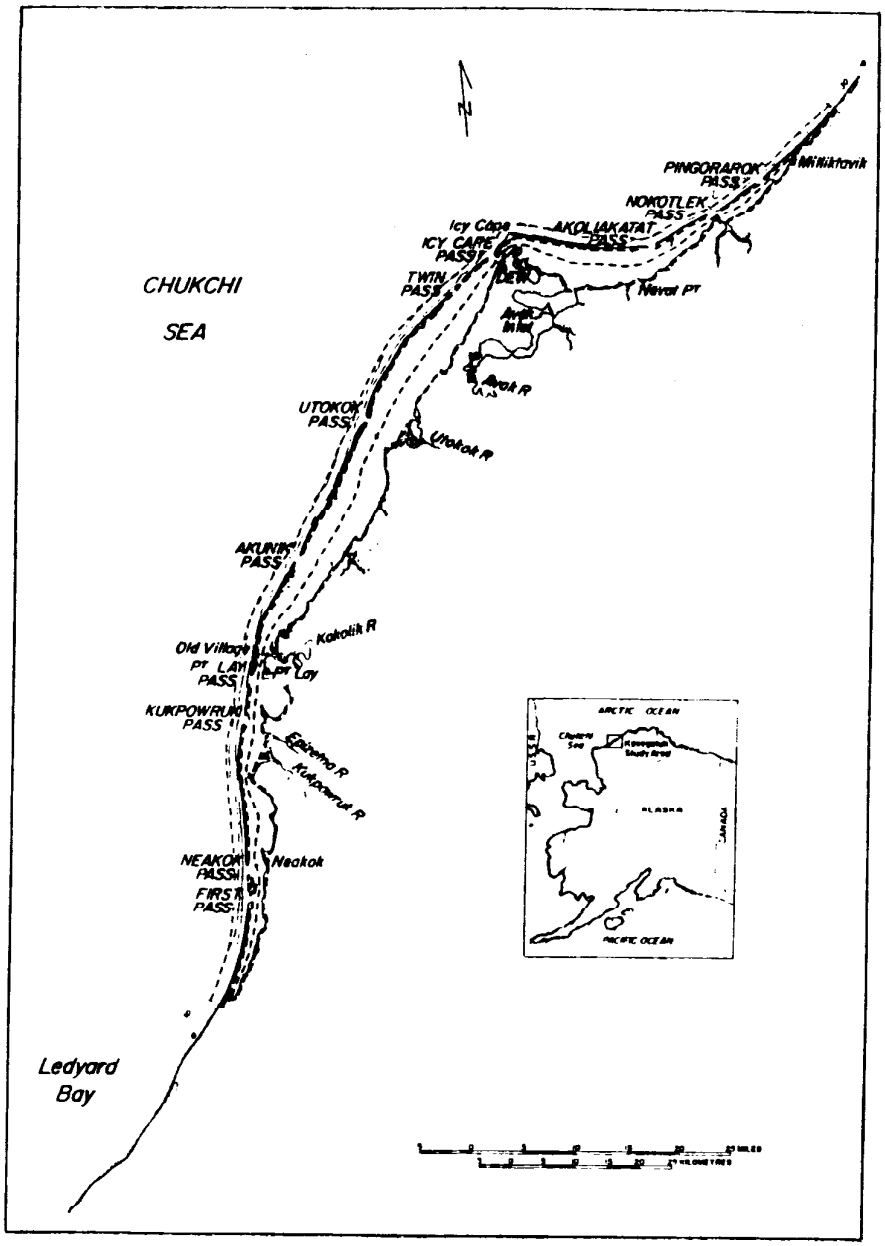

Figure 2. Kasegaluk Lagoon study area in the Alaskan Chukchi Sea.

MONITORING BEAUFORT SEA WATERFOWL

In late September 1983, a MMS/NOAA-sponsored workshop was held in Girdwood, Alaska, to develop a monitoring strategy for the Alaskan Beaufort Sea. That workshop identified several potential waterbird species for monitoring. Oldsquaw ducks were selected over other species because they are the most abundant and widespread local waterfowl in coastal waters. During the open water period, they represent over 90% of birds present (Figure 3). Oldsquaws molt their wing feathers and are flightless during July and August. At this time they are relatively confined to nearshore lagoon systems which provide food, shelter and roosting habitat, and they are particularly vulnerable to contaminants and disturbance.

MMS is committed to developing a monitoring protocol for marine waterfowl and seabirds in the Alaskan Beaufort Sea area. The concept of monitoring marine birds in this area is based on the following information:

- Marine birds are abundant and are a biologically and socially important component of the nearshore Beaufort Sea ecosystem.

- Some species of Beaufort Sea marine birds, e.g., the Oldsquaw duck, are ubiquitous, relatively easy to count, and have been well studied prior to industrial development; therefore, they are appropriate candidates for monitoring.

- A monitoring protocol should be designed to insure that industry-related influences on marine birds are discernable from other natural influences, i.e., should involve a rigorous design and statistical approach that includes both experimental and control areas and draws on all relevant historical information collected in the study area.

In this study we are developing and implementing a monitoring protocol that is based on a series of low-level aerial surveys. It accounts for the fact there are several complex and interactive natural variables (i.e., timing of migration, time of year, time of day, wind speed and direction, location of transect) that may significantly influence the behavior of marine birds and therefore the results of aerial surveys of marine birds in the nearshore Beaufort Sea (Johnson 1982, 1983, 1985); Johnson and Richardson 1981; Dames and Moore 1984). Thus, a monitoring program that is designed to detect the influences of industry activities on the birds must test specific hypotheses that relate to:

1) the birds chosen to be monitored, and 2) specific industry activities in the study area.

The following hypotheses have been constructed with such factors in mind:

H_o1: There will be no detectable change in relative densities of molting male Oldsquaws in selected Beaufort Sea index areas.

H_o2: Changes in male Oldsquaw distribution patterns are not related to OCS oil and gas development activity.

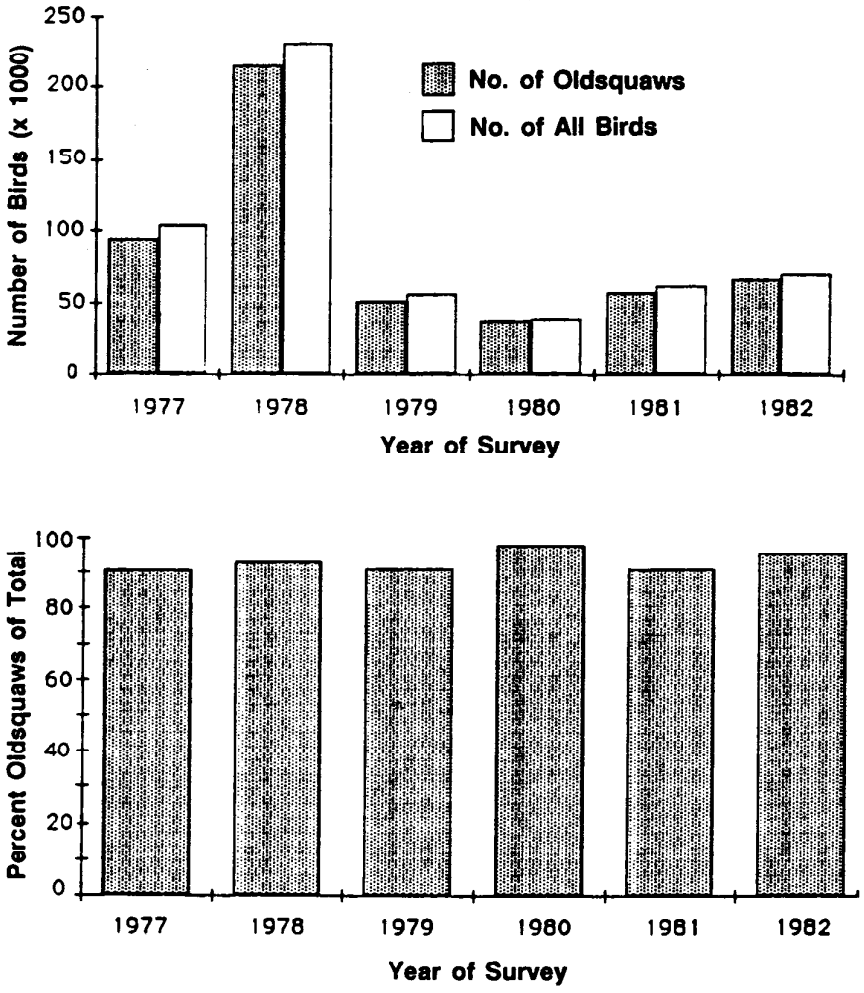

Figure 3. Relative number and percent Oldsquaw ducks of all birds recorded during aerial surveys in the Jones-Return Islands area.

These two hypotheses are being tested through a review and evaluation of an 8-year base of information on the distribution and abundance of Oldsquaws (primarily molting males) in the Jones-Return Islands area and adjacent areas.

The two study areas tentatively selected for this study are the Jones-Return Islands for the Industrial or experimental area, and the Stockton-Macguire Islands for the Control area. There is historical information on the distribution and abundance of marine birds in both of these areas (8 years in Industrial area and 4 years in Control area), and the Stockton-Macguire Islands currently are not faced with imminent industrial development. We have established a set of four survey tracklines, each composed of 4 transects (i.e., 16 total transects) in each study area, and have tentatively designed a survey protocol that involves the survey of each set of transects on three consecutive days four times each summer season in each study area. In summary, the various strata in the survey design proposed was as follows: 1) Four survey periods; 2) Three aerial surveys during each survey period; 3) Two study areas (Industrial and Control); 4) Four survey tracklines in each study area; 5) Four transects in each survey strip; and 6) Many intervals (30 sec time periods) in each transect. This survey design was tested during one set of flights during early August 1989 and found to be feasible.

BIRD USE OF KASEGALUK LAGOON

Literature from previous studies in Kasegaluk Lagoon, Peard Bay and other lagoon systems indicated that Kasegaluk Lagoon was generally similar in form and function to other lagoons, such as Simpson Lagoon and Beaufort Lagoon in the Alaskan Beaufort Sea. At the same time, there appear to be significant differences in the Kasegaluk Lagoon area that have influenced our design of this part of the study. These differences are:

1. The Alaska Coastal Current flowing into the Chukchi Sea from the Bering Sea probably influences ecological processes in the Kasegaluk Lagoon area.

2. The major passes leading into Kasegaluk Lagoon appear to attract many species of vertebrates, which suggests that these areas are of special importance in this lagoon system; such large concentrations of vertebrates at passes are not typical of Beaufort Sea lagoons.

3. Much of Kasegaluk Lagoon, especially the southern portion, appears to be quite shallow (<1 m) and may not support key species of invertebrates or vertebrates to the same extent as deeper lagoons elsewhere.

4. Unlike the situation in most Beaufort Sea lagoons, temperature and salinity regimes in the Kasegaluk Lagoon system appear to be greatly influenced by periodic heavy rainfall in the western Baird Mountains and resultant increased discharges from the Utokok, Kokolik and other rivers that feed into the lagoon. These changes in temperature and salinity no doubt influence the distribution of invertebrates and perhaps some of their vertebrate predators (e.g., birds and marine mammals).

Our approach to this study includes maximum use of existing relevant information and a very focused program of research on the key birds in the lagoon system. The main purpose of the field program in the Kasegaluk Lagoon area is to provide up-to-date information on the relative use of the Kasegaluk Lagoon area as summering habitat for waterfowl and marine birds. We have constructed a working hypothesis to structure our study design and to allow comparisons between Kasegaluk Lagoon and other arctic lagoon systems:

H_0: Kasegaluk Lagoon supports special habitats used by vertebrates, uses that are not duplicated in lagoon habitats elsewhere in the Alaska Arctic.

Aerial surveys of bird habitat in Kasegaluk Lagoon include four tracklines through various bird habitats in the following four areas: mainland coastlines and river deltas, mid-lagoon areas, barrier island shorelines, and nearshore marine areas. Each of the four tracklines is subdivided into six separate transects of approximately equal length, and each transect is further subdivided into shorter strips by using an intervalometer.

Based on aerial surveys during three periods in 1989 (24 to 26 August, 3 to 4 September, and 11 to 14 September 1989), the following important results were recorded:

1. Kasegaluk Lagoon, especially the mainland shoreline and adjacent lagoon area between Nevat Point and Nokotlet Point supported about 40,000 Brant (*Branta bernicla*) during the late August sampling period. This represents about 30% of the total Pacific Flyway population of this species. The geese were apparently feeding in this area prior to migrating south in early September.

2. The barrier islands in the southern part of Kasegaluk Lagoon are unlike those in the northern part of the lagoon complex, and also are unlike those found in the Beaufort Sea area. They support a variety of lush wetland vegetation that attracts waterfowl such as tundra swans, northern pintails, greater white-fronted geese, Canada geese and other waterfowl.

3. The extensive mudflats in the southern part of the lagoon complex and in the Icy Cape area appear to support large numbers of shorebirds, especially small sandpipers (probably Western sandpipers and/or dunlins).

4. The nearshore marine system supports relatively large numbers of molting diving ducks, such as Pacific eiders (*Somateria mollissima v-nigra*) and scoters (*Melanitta* spp.), that are not found in similar habitats in the nearshore Beaufort Sea.

LITERATURE CITED AND OTHER REFERENCES

Craig, P.C., W.B. Griffiths, S.R. Johnson, and D.M. Schell. 1984. Trophic dynamics in an arctic lagoon. *In*: P. Barnes, E. Reimnitz and D. Schell (eds.), Alaskan Beaufort Sea Ecosystems and Environment. Academic Press, N.Y. 427 p.

Dames and Moore. 1984. Beaufort Sea monitoring program workshop, synthesis and sampling design recommendations. Rep. to Nat. Oceanic and Atmos. Admin. Juneau, AK.

Derksen, D.V., T.C. Rothe, and W.D. Eldridge. 1981. Use of wetland habitats by birds in the National Petroleum Reserve-Alaska. U.S. Fish and Wildl. Serv. Res. Publ. No. 141. 27 p.

Divoky, G.J. 1983. The pelagic and nearshore birds of the Alaskan Beaufort Sea. Pages 397-573 *in* Envir. Assess. Alaskan Cont. Shelf, Final Rep. Prin. Invest. Vol. 23. BLM/NOAA, OCSEAP, Juneau, AK.

Garner, G.W., and P.E. Reynolds. 1986. 1985 update report, baseline study of the fish, wildlife, and their habitats, Arctic Nat. Wildl. Refuge. U.S. Fish and Wildl. Serv., Anchorage, AK. 361 p.

Gill, R., C. Handel, and P. Connors. 1985. Bird utilization of Peard Bay and vicinity. Pages 244-323 *in* P.J. Kinney (ed.), Environmental characterization and biological utilization of Peard Bay. Envir. Assess. Alaskan Cont. Shelf, Final Rep. Princ. Invest. Vol. 35. MMS/NOAA, OCSEAP. Juneau, AK.

Hanson, W.C. 1988. Environmental assessment, Appendix B. Unpubl. rep. for Western Arctic coal development project, Arctic Slope Consulting Engineers, Anchorage, Alaska.

Johnson, S.R. 1982. Continuing investigations of oldsquaws (*Clangula hyemalis* L.) during the molt period in the Alaskan Beaufort Sea. Rep. by LGL Alaska Research Associates, Inc., for Office of Marine Pollution Assessment, Nat. Oceanic and Atmospheric Admin., Juneau, AK.

Johnson, S.R. 1983. Investigations of nesting and molting birds in the vicinity of Long Island, Alaska, 10 July to 2 August 1982. Rep. by LGL Ecol. Res. Assoc.,Inc., for Shell Oil Co., Houston, TX.

Johnson, S.R. 1984. Prey selection by oldsquaws (*Clangula hyemalis* L.) in a Beaufort Sea Lagoon. Pages 12-19 *in* Marine Birds: their feeding ecology and commercial fisheries relationships. Can. Wildl. Serv. Special Publ. Ottawa. 220 p.

Johnson, S.R. 1985. Adaptations of the long-tailed duck (*Clangula hyemalis* L.) during the period of molt in Arctic Alaska. Proc. Int. Ornithol. Cong. 16-25 Aug. 1982. Moscow, USSR. 18(1):530-540.

Johnson, S.R., and W.J. Richardson. 1981. Barrier island lagoon ecological process studies: Final Report, Simpson Lagoon. Part 3, Birds. Pages 109-383 *in* Environ. Assess. Alaskan Cont. Shelf, Final Rep. Prin. Invest. Vol. 7. BLM/NOAA, OCSEAP. Boulder, CO.

Johnson, S.R., and W.J. Richardson. 1982. Waterbird migration near the Yukon and Alaskan coast of the Beaufort Sea. II. Moult migration of seaducks. Arctic 35(2):291-301.

Lehnhausen, W.A., and S.E. Quinlan. 1982. Bird migration and habitat use of Icy Cape, Alaska - 1981. Rep. for U.S. Fish and Wildl. Serv., Office Spec. Studies. Anchorage, AK. 298 p.

Martin, P.D., and C.S. Moitoret. 1981. Bird populations and habitat use, Canning River delta, Alaska. U.S. Fish and Wildl. Service, Arctic National Wildlife Refuge. Fairbanks, Alaska.

Richardson, W.J., and S.R. Johnson. 1981. Waterbird migration near the Yukon and Alaskan coast of the Beaufort Sea. I. Timing, routes and numbers in spring. Arctic 34(2):108-121.

Roseneau, D.G., and D.R. Herter. 1984. Marine birds. Pages 81-116 *in* J.C. Truett (ed.), The Barrow Arch environment and possible consequences of planned offshore oil and gas development. Proc. Synth. Meet., Girdwood, AK, 30 Oct - 1 Nov 1983. U.S. Dept. Commer., NOAA, and U.S. Dept. Interior, MMS. Anchorage, AK. 229 p.

Troy, D.M., and S.R. Johnson. 1982. Prudhoe Bay waterflood project, lagoon bird monitoring program 1981. Final Rep. by LGL Alaska Research Associates, Inc., for Dept. of the Army, Alaska District, Corps of Engineers, Anchorage, AK.

Troy, D.M., D.R. Herter, and R.M. Burgess. 1983. Prudhoe Bay waterflood environmental monitoring project, lagoon bird monitoring program. *In*: U.S. Army Corps of Engineers. Prudhoe Bay waterflood project environmental monitoring program 1982. Vol. 4. U.S. Army Corps of Engineers, Alaska District, Anchorage, AK.

Troy, D.M. 1984. Prudhoe Bay waterflood environmental monitoring program 1983, lagoon bird monitoring program. Appendix C. *In*: U.S. Army Corps of Engineers. Prudhoe Bay waterflood project environmental monitoring program 1982. Final Rep., Append. and Proc. Manuals, Vol. 3. U.S. Army Corps of Engineers, Alaska District, Anchorage, AK.

QUESTIONS AND DISCUSSION

Tom Newbury: I appreciate that you got the data near Jones Island. I think it is a question of when we need the data not whether or not we are going to need the data to assess the consequences of OCS development in the area. You mentioned that you are doing it in a way so that you can repeat the study, go back and do it in a subsequent year. When it is done, invariably there will be some variation, just the way there is in the Bering Sea. It would be nice if there was a way that we could begin to explain the reason for the variation, whether it is up or down. I think a good source of information will be the causeway studies that are going on. There is a lot of work being done on currents, on winds, on productivity, on coastal, alongshore upwelling. I think it would be interesting if you could relate somehow the observations that you make to the characteristics of the year using that information and eventually explain some of the variation using that data.

Steve Johnson: In fact, we already have. Luckily, a lot of the people who have conducted or are conducting the studies of Beaufort causeways are in our offices, and we have already gone to them on a number of occasions to get relevant information on wind and other environmental variables. We certainly intend to do more of that if necessary.

Tom Newbury: You mentioned that the wind was a particularly influential factor. Perhaps not only in local distribution, but it may be over all. I think they tend to characterize years as west wind years or east wind years. They plot kind of a cumulative vector diagram for the wind direction.

Steve Johnson: That is a good point. But there are some aspects of Oldsquaw distribution that we are probably never going to be able to understand fully. Oldsquaws molt in lagoons over a broad area, from the Chukchi essentially all the way across the Alaskan Beaufort into the Canadian Beaufort. There are a variety of factors that could be affecting the timing of migration to these areas, and thus the overall distribution of birds, such as when the lagoons become ice-free. For example, if lagoon systems east of those in the central Beaufort become ice-free earlier than those in the central Beaufort, does that mean that westward molt migrants stop in the east rather than continue west to the central Beaufort lagoon systems that we are monitoring? Unfortunately, there are factors which we will probably never be able to understand fully because of the scale of the phenomenon. There are no similar monitoring programs going on in the Canadian Beaufort; these studies would be needed to detect such a broad scale phenomenon.

Glen Seaman: You indicated that this year you started later, around mid-August and that next year you were going to start your surveys in mid-July. How did you pick mid-July as opposed to June or earlier in June when the lagoon becomes ice-free?

Steve Johnson: It was basically a matter of logistics and having to trade off aircraft and personnel with different parts of the study. There will be surveys going on in late June through mid-July primarily oriented towards marine mammals. The two parts of the study are cooperative. We get information from Kathy Frost on marine birds and we give her information on marine mammals. So we will have some information on birds for the first of July through the 15th of July, after which we start our bird surveys.

Glen Seaman: Would that include nesting on the barrier islands?

Steve Johnson: No. There is virtually no ground-based bird work going on as part of our study. But a concurrent NOAA-funded study will include some ground-based biological work near Icy Cape during summer 1990. We are working closely with that study, and will continue to share information as long as the two studies are being conducted.

BEHAVIOR AND ENERGETICS OF PACIFIC BLACK BRANT IN RESPONSE TO AIRCRAFT OVERFLIGHTS AT IZEMBEK LAGOON, ALASKA

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Every fall and spring Pacific black brant (*Branta bernicla nigricans*) fly to Izembek Lagoon near the western end of the Alaska Peninsula. While at Izembek Lagoon, brant feed almost exclusively on eelgrass (*Zostera marina*), to accumulate fat reserves needed for egg production and incubation in spring and for migration to wintering grounds in fall. In 1984, staff of Izembek National Wildlife Refuge observed flocks of brant, Taverner's Canada geese (*Branta canadensis taverneri*), and emperor geese (*Chen canagica*) fly in response to helicopter overflights associated with Outer Continental Shelf (OCS) petroleum exploration. There was concern that disturbance caused by aircraft may be harmful to brant. Other studies have shown displacement of waterfowl from feeding areas or reduction of foraging efficiency and feeding time in response to disturbances. If brant spend less time feeding, or if caloric expenditures increases due to additional flight, rates of fat deposition and storage of critical nutrients may be reduced.

From 1985-88, the Alaska Fish and Wildlife Research Center conducted research to assess the impacts of increased human disturbance to fall staging geese at Izembek Lagoon. Extensive field observations were made to determine the spatial distribution, foraging ecology, and normal behavior of brant. Additional studies were conducted to quantify the response of flocks to planned aircraft overflights. Behavioral data from this study along with physiological data taken from the literature were integrated into a model to explore the potential impact of disturbance on the energetic requirements of staging brant.

Brant use Izembek Lagoon and surrounding estuaries during spring, winter, and fall. Fall is the period of greatest number (mean= 143,000; this study) of brant and longest stay. At least 10% of the total number of brant was present from 28 August to 20 November. Duration of stay for individual brant averaged 54 days and may be influenced by breeding origin (Alaskan vs. Canadian colonies) and breeding status (Adults with young vs. failed or non-breeding birds). The period of use in spring is approximately 5 weeks, during April and May. The peak count of brant in spring averaged 54,000. Winter populations of brant at Izembek have historically been low (<100), but since 1981 the number has averaged 5,400.

Izembek Lagoon, the largest of the 7 lagoons surveyed, was used to the greatest extent by brant in spring (99%) and fall (83%) in all years (1975-1988) of aerial surveys. Although 17% of the brant were counted in adjacent lagoons in fall, these areas do not contain adequate habitat to provide alternative staging areas for most of the population. The pattern differed in winter when only 42% of all brant were observed within Izembek. The lower proportion of geese using Izembek Lagoon in winter may in part be explained by the presence of ice. Within Izembek Lagoon, the south and north-central sections were used by more brant. Overflight corridors directly crossing the lagoon between Grant Point and Round Island coincident with an extension of the present Instrument Flight Rules (IFR) corridor, would affect fewer birds compared to most other corridors examined.

The proportion of time brant spend in behaviors during undisturbed conditions provided the baseline against which added disturbance was evaluated. Tide dominated brant use of eelgrass beds and roosting areas throughout the lagoon. When observed nearshore during low and flooding tide stages, brant spent about 85% of their time foraging. At high tide about half the birds moved to non-vegetated roosting areas on shallow sand flats inside the barrier islands. While at roost sites brant were mostly engaged in resting (51%) and maintenance (42%) behaviors. We incorporated the observed time budget of brant with age, percent time in flight, relative number of birds using roosting versus foraging habitats at each tide stage, and the relative duration of each of the daylight and night tide stage periods to determine a 24 hr behavioral time budget. On a 24 hr basis, 46% of the time was spent foraging, 23% in maintenance, 27% at rest, 2% in alert posture, and 1% in flight.

Response to disturbance usually involved an alert behavior followed by flight. Often flocks circled and returned to the same location or moved to adjacent eelgrass beds. Brant remained alert, shifted positions, and engaged in maintenance behavior before they resumed foraging. Incidental potential disturbance occurred at 1.07 events per hour of daylight observation; little disturbance occurred at night. Aircraft accounted for 0.57 events/hr, eagles 0.25/hr, people 0.08/hr, and boats 0.03/hr. The entire flock (greater than 95%) responded to 48% of all events (N=2,038) and took flight in 35% of these. Eagles and boats caused the greatest response in flocks of brant. Incidental aircraft caused less response from brant than other incidental stimuli, however, response was highly dependent on aircraft type and proximity to the flock. Depending on stimulus type, average duration of response ranged from 1 to 4 minutes with about half that time in flight. An average of 89 seconds per hr, 2.5% of the total daylight time, was spent responding to incidental disturbance events of all types.

Experimental flights by aircraft along planned flightlines allowed precise determination of aircraft altitude and lateral distance to test flocks. Multiple regression on logistic transformation of the proportion of birds that responded provided three dimensional surfaces relating brant response to aircraft altitude and lateral distance for each aircraft type. The percent response by flocks was least with the Piper Navaho twin-engine aircraft and greatest for the Bell 205 helicopter. In contrast to fixed wing aircraft, the response of brant to helicopters did not diminish with increased altitude up to 1800 m.

An energetic model was developed that accounted for the average weight gained by adult male brant during a 54 day fall staging period at Izembek. If 10 disturbance responses occurred daily, an adult male brant would depart at 1,869 g or 96% of their expected weight of 1,943 g. For each additional aircraft disturbance that occurred daily throughout this time period, the predicted total weight gain would be reduced by 7.4 g. This was equivalent to 53 minutes of migratory flight or 73 km of the 5000 km flight to San Quintin, Mexico. Any number over 11 daily disturbance flights caused average weight gain to fall below 5 g/day. This arbitrary value of 5 g/day is a convenient point for the comparison of model responses. Predictions of body weight were most sensitive to change in the amount, quality, and assimilation of the food. A 10% increase in forage intake caused a 34% increase in weight gain and 2-fold increase in number of disturbances tolerated. It is equal to the average weight gain of an adult male brant at Izembek. If brant are able to compensate for the foraging time lost or increase forage intake because of disturbance, energetic balance will be restored because predicted weight was highly sensitive to any increase in total forage intake. In this case, more frequent aircraft disturbances would be needed to severely alter behavioral time budgets and/or energetic balance of brant at Izembek Lagoon.

REFERENCES

Davis, R.A., and A.N. Wiseley. 1974. Normal behavior of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behavior, September, 1973. Pages 1-85 *in* W.W.H. Gunn, W.J. Richardson, R.E. Schweinsberg, and T.D. Wright, (eds.), Studies of snow geese and waterfowl in the Northwest Territories, Yukon Territory and Alaska, 1973. Arctic Gas Biol. Rep. Serv. 27. 85 p.

Derksen, D.V., K.S. Bollinger, M.R. North, D.H. Ward, M.W. Weller, K.C. Jensen, and E.J. Taylor. 1988. Effects of aircraft on the behavior and ecology of molting brant near Teshekpuk Lake, Alaska. U.S. Fish and Wildl. Serv. Rep. Anchorage, Alaska. 80 p.

Derksen, D.V., D.H. Ward, M.R. North, K.S. Bollinger, M.W. Weller, K.C. Jensen, E.J. Taylor, K. McKnight, and D. Esler. 1989. Effects of aircraft on behavior and ecology of molting brant near Teshekpuk Lake, Alaska. U.S. Fish and Wildl. Serv. Rep. Anchorage, Alaska. 141 p.

Herter, D.R., and W.R. Koski. 1988. The effects of airport development and operation on waterbird and northern fur seal population: a review from the perspective of the St. George airport project. Final report to Alaska Dept. of Transportation and Public Facilities. Prepared by LGL Alaska Research Associates, Inc. Anchorage, AK. 201 p.

Ward, D.H., and R.A. Stehn. 1989. Response of brant and other geese to aircraft disturbances at Izembek Lagoon, Alaska: Final Report to Minerals Management Service. U.S. Fish and Wildl. Serv. Rep. Anchorage, Alaska. 265 p.

RESPONSE OF MOLTING PACIFIC BLACK BRANT TO HELICOPTER NOISE NEAR TESHEKPUK LAKE, ALASKA

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In 1983, the U.S. Bureau of Land Management (BLM) developed an Environmental Impact Statement which outlined stipulations and deleted leasing in parts of the Teshekpuk Lake Special Area (TLSA) of the National Petroleum Reserve - Alaska (NPR-A) to protect fish and wildlife resources. The BLM initiated the TLSA study in 1984 to address public concern regarding the proposed leasing schedule and protection for Pacific black brant (*Branta bernicla nigricans*) and other waterfowl that use wetland habitats within the area.

Petroleum exploration and potential future development in NPR-A include activities that may be detrimental to staging and molting brant and other birds dependent on habitats in the TLSA. Exploration on the Arctic Coastal Plain during the months of May through September usually requires aircraft support, particularly helicopters, for staging materials and transport of personnel. Helicopters are used to protect tundra habitats from damage that would occur if tracked and other ground vehicles were employed during the thaw period. Aircraft flights near molting geese often elicit escape behavior, but quantative data is limited. Displacement of molting brant and Canada geese (*Branta canadensis*) from one lake in the TLSA occurred as a result of aircraft activity in 1979, but the threshold for avoidance of such stimuli is unmeasured. The implications of additional stress associated with these behaviors are unclear. Further, it is unknown whether molting brant may become habituated to repetitive disturbances from aircraft, thereby minimizing impacts on the population.

In the summer of 1987, the Alaska Fish and Wildlife Research Center initiated a 5 year research program on the potential effects of helicopters and other aircraft activity on the behavior and energetics of brant that molt in the TLSA. The objectives of this program are to: 1) determine the effect of aircraft overflights and other human-induced activities on brant behavior, distribution, and habitat use in the TLSA; and 2) examine nutritional and energetic requirements for completion of molt as these relate to habitat use and potential disruption by incidental and controlled disturbance events.

In the first two years of the program, research was initiated to better understand the behavioral response of brant to aircraft noise. We investigated components of aircraft noise, such as the sound level, duration and frequency spectrum that may cause disturbance to brant. In 1987, acoustical equipment was tested and methods were developed for simultaneously measuring the noise levels of aircraft and recording the corresponding response to geese. In

1988, we continued studies to measure noise produced from aircraft and correlate these levels with the behavioral response from brant. Further emphasis was placed on determining threshold response levels (noise level at which brant initiate a disturbed behavioral response) to aircraft overflights.

Noise measurements and behavioral observations were made simultaneously with overflights of Bell 412 and Bell 206-B Jet Ranger helicopters. Noise levels were recorded on 20 flights with the Bell 412 and 33 flights with the Bell 206 between 14-16 and 17-19 July, respectively. Flights were conducted at various altitudes (500-5,000 ft) and lateral distance (0.0-4.0 mi) to a flock along prescribed flight lines.

The Bell 412 helicopter produced 6-7 dB more noise (L_{max}) than the smaller Bell 206 at similar altitudes and lateral distances to the microphone. The sound energy levels (SEL) of the Bell 412 also were consistently greater (about 4 dB higher) than the Bell 206. The difference remained relatively unchanged with increasing altitude and constant lateral distance, but was reduced slightly with increasing lateral distance and constant altitude. As expected, noise produced by the aircraft attenuates with increasing distance from the microphone.

Maximum background noise levels were low, rarely reaching above 40 dBA. Because of these favorable conditions for sound measurement, aircraft noise was audible from a long distance. Typically, helicopers were audible at any altitude up to 4 miles away. On occasions when the Bell 412 was at altitudes >1500 ft and upwind to the microphone, aircraft noise was heard up to 6.0 mi away.

The first observed response of disturbed birds was an alert posture with necks stretched and heads raised. This is probably an orienting response to locate the source of the disturbance. If the disturbance continued to increase, brant responded by walking, running, or running with flapping wings towards the water. Peak response occurred if the flock entered the water and swam to the safety of open water. In all cases, members of a molting flock responded synchronously. This differed from flocks of brant staging in fall at Izembek Lagoon. There, brant were capable of flight and flocks sometimes displayed a partial response to a disturbance. Threshold response levels ($L_{eq,4s}$) were highly variable, ranging from 33 to 64 dBA. Mean threshold level of noise ($L_{eq,4s}$) for alert and swim responses was 49 dBA. Even though the mean noise levels did not differ between alert and swim responses, when both responses were recorded during a passby, threshold $L_{eq,4s}$ for swim was on average 5 dB greater than the prior alert response. The threshold levels for alert and swim responses for flights with the Bell 412 were higher than levels for the Bell 206 helicopter. Most (80%) alert responses occurred before peak noise of the aircraft was recorded. Conversely, over 60% (n=17) of the swim responses were initiated at peak noise and often at closest approach of the aircraft. The duration of response to helicopter overflights increased with increasing L_{max} and SEL levels.

Preliminary analyses indicate that brant respond to low levels of aircraft noise. Greater than 90% of the brant flocks reacted to aircraft noise at or above a L_{eq} of 62 dBA and SEL of 76 dBA. These levels are lower than other A-weighted noise levels reported in the literature. The fact that brant responded to higher threshold levels of noise for the Bell 412 indicates that other factors may be influencing their behavior. Flock sizes were small (<50) for overflights of the Bell 412 and these birds were more likely to react for shorter periods of time than larger flocks. Threshold levels may also be influenced by flock size. Further analyses are needed to better

identify other factors that may influence the response such as direction of travel, flock size, and habituation. Also, because the hearing sensitivity of brant is unknown, we plan to investigate the threshold levels of noise in the C- and Flat-weighted scales.

REFERENCES

Derksen, D.V., M.W. Weller, and W.D. Eldridge. 1979. Distributional ecology of geese molting near Teshekpuk Lake, Alaska, National Petroleum Reserve-Alaska. Pages 189-207 *in* R.L. Jarvis and J.C. Bartonek, (eds.), Management and biology of Pacific Flyway geese: a symposium. Oregon State Univ. Book Stores, Inc., Corvallis, Oregon. 346 p.

Derksen, D.V., D.H. Ward, M.R. North, K.S. Bollinger, M.W. Weller, K.C. Jensen, E.J. Taylor, K. McKnight, and D. Esler. 1989. Effects of aircraft on behavior and ecology of molting brant near Teshekpuk Lake, Alaska. U.S. Fish and Wildl. Serv. Rep. Anchorage, Alaska. 141 p.

Fletcher, J.L. 1980. Effects of noise on wildlife: a review of relevant literature 1971-1978. Pages 611-620 *in* J.V. Tobian, G. Jansen, and W.D. Ward, (eds.), Proceedings of the third international congress on noise as public health problem. Am. speech-language-hearing assoc. Rockville, Md.

Madsen, J. 1985. Impact of disturbance on field utilization of pink-footed geese in West Jutland, Denmark. Biol. Conserv. 33:53-63.

Manci, K.M., D.G. Gladwin, R. Villella, and M.G. Cavendish. 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: a literature synthesis. U.S. Fish and Wildl. Serv. Rep. NERC-88/29. Ft. Collins. Co. 88 p.

QUESTIONS AND DISCUSSION

Don Hansen: Did you do any of your experimental fly-overs under fog conditions just to see whether there would be any response where you didn't have any visual stimulus.

David Ward: We would have liked to have done that but none of the pilots would fly in those conditions. It would be interesting, it would be one way of separating audio and visual responses.

Scott Hatch: I am interested in the habituation question because you mentioned it a couple of times. You said in the Izembek case you had an energetics model and you plugged in a 10 or 20% habituation factor. I know from seabird studies - there isn't a great deal of data - everybody worries a great deal about flying by seabird colonies. The first few times you do it, it can be fairly disastrous. It seems that either you don't want to do it at all or do it a lot. Because once you start doing it a lot the birds habituate virtually totally. We have a good example of that here in Alaska on Middleton Island where there is an airport that gets fairly regular use, not extreme frequency but at least several times a week - well not even that often. But you have planes coming out, and the birds become totally habituated, so it really doesn't seem to matter what you do. You can fly C130s right over their heads and they pay no

attention at all. I wonder whether these brant would get to the point eventually that you are just not going to have a response, so the problem is solved.

David Ward: The actual design of the project didn't include habituation because of the constraints and costs of flying helicopters daily over prescribed flight lines. We did however look at our data, we did fly the helicopter, we had it for about four days and flew it consecutively on days and looked at the response values. There was about a range from about 5 to 20% decrease in response. Now whether brant are going to have 100% habituation factor, I don't know if that would be the case. I think brant in a way are different from other waterfowl. There are other birds that we are looking at, Canadas and emperor geese. There is a wide range of separation between the response of brant versus Canadas and emperors to aircraft. Brant were certainly at the high end. Whether they would stick around and actually habituate rather than displace altogether, that is our concern. Whether they would actually try to migrate out of Izembek to another area or use another lagoon adjacent to Izembek, that is a concern.

Scott Hatch: The other thing that is related, I suppose, is that birds will redetermine priorities. If they are pretty fattened up and doing well they might be more inclined to fly when an airplane flies over. Once they start really getting hungry (because you were extrapolating to a point where the bird didn't gain any weight over 54 days), when in fact the bird is getting into trouble, it is going to need a lot more time to sit there and feed regardless of what is going on overhead, I would think. So I think those factors in the end may be the overriding points. The change in behavior depending on their condition and over the long haul, over multiyears - these birds are fairly long lived, they are traditional - they are going to pass on the knowledge that when a plane flies over, don't worry about it. The older birds will pass on that kind of behavior to younger birds, I would assume. It seems to me that is likely to be the crux of it.

David Ward: Yes, very possibly. As it is right now, in our model, the habituation isn't a factor. But we plan to add that into it and see how that affects the output.

Cleve Cowles: The response surface comparison was very interesting. I was wondering if you did any kind of multivariate analysis to determine their statistical significance. Obviously in terms of your multi-regression plots they look different, but statistically were they truly different in a test of hypothesis sense?

David Ward: It was difficult to compare response surfaces between aircraft. Statistically we had a large sample size and it was difficult to compare between aircraft types within fixed wing or rotary wing. It was hard to interpret that. But we feel there was a separation between rotary wing and fixed wing as far as the response surfaces. They were very different. That part came out very significantly.

Steve Treacy: How did you factor in the wind speed and wind direction?

David Ward: It was just one of the parameters used in the multivariate regression. Again part of the large sample sizes, it was difficult to really separate that out. We would like to look at it a different way and see if we can come up with a correlate. The main factors that came out in it were flock size, to a certain extent habituation was a factor, and social facilitation, which was another strong factor.

Steve Murphy: Are you going to be able to incorporate the work that Eric Taylor is doing at Texas A & M into your model and have a little more empirical data and upgrade your modeling?

David Ward: Yes, I think the emphasis of the model was really what data was lacking. Eric is certainly getting at some of these questions with basal metabolic rate. We have no data on brant. Information on thermal regulation of brant would come out of his study from Teshekpuk as well.

Steve Murphy: A second question from Brian Lawhead, he was wondering if these brant had been banded using helicopter and if you think that might have any effect on their response to helicopters?

David Ward: As far as I know, none of the birds were banded with helicopters. I wasn't at the location during banding. I am fairly certain that there weren't helicopters present during banding.

Brian Lawhead: Were they ever used during a banding operation?

David Ward: No. The only time a helicopter was present was during disturbance overflights and it was present for three or four days. Usually banding occurs before and after the overflights.

Brian Lawhead: You see that in the Sag River Delta area where the snow geese in the Howe Island colony have been banded using helicopters, they react much more strongly to helicopters at other times.

Scott Robertson: What were the different altitudes tested at Izembek with the different aircraft?

David Ward: We flew as high as about 2000 ft. We ran into problems with the cloud cover at altitudes above 2000 ft.

Scott Robertson: Did you fly the same altitudes with all different aircraft?

David Ward: We varied that quite a bit. Initially we started high and moved down. Because of constraints, we wanted to get the most from our buck. We started at high altitudes and tried to get a response from the birds and dropped the altitude until they responded. We had a considerable amount of response. Then we stopped our overflights for the day. That was in the first year, first and second year. The third year we just did random overflights, we just randomly picked an altitude and overflew the birds to see if there was a difference.

Scott Robertson: Were the altitudes of the fixed wing the same as the rotary?

David Ward: Yes. They were comparable. Comparable altitudes and lateral distances.

SOCIAL INDICATOR SYSTEMS FOR COASTAL VILLAGES IN ALASKA

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AIMS

In late 1986 the Social Indicators research team set out to develop valid systems of social indicators sensitive to changes in social and/or economic conditions among 31 coastal villages located from Kodiak on the south to Nuiqsut on the north. Following the *Exxon Valdez* oil spill (March 1989) we expanded the study to include eight villages in the area directly affected by the spill. Longitudinal data are collected by questionnaire, protocol, and focused discussions. The research design, commonly called the 'Solomon Four Group,' allows us to exercise controls for internal and external threats to validity in several ways by using multi-methods, multi-data sets, and random sampling without replacement. Several panels[1] are nested within a separate sample pretest/post-test[2] design which allows us to gain statistical power while controlling for threats to validity. Upon completion of the research following the 1990 field sessions we will have administered 2640 questionnaire and protocol interviews and reinterviews at four points in time among 1220 respondents.

We have tested the validity, reliability and sensitivity of the variables in our hypotheses about the structure of village societies in coastal Alaska and the directions and kinds of changes that are occurring there, with multiple regression, confirmatory factor analysis, unidimensional hierarchical cluster analysis, time series analysis and non-metric multidimensional scale analysis. Our analyses have demonstrated high inter-instrument and inter-researcher reliability on several sets of variables from the Questionnaire Informant (QI) and Key Informant (KI) data sets for 1987, 1988, and 1989. Tests have been conducted on data from several sets (different samples) collected during the same years and different years.

SOME RESULTS THUS FAR

Some QI Questionnaire Results

Table 1 is based on data collected in 1987 - 1988 among all Schedule A and Schedule B respondents during their initial interviews.[3] It organizes 11 quantitative variables by the theoretical contrasts employed in the study design. Thirty-four of 55 contrasts are significant at

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[1]The panels, nested in both the questionnaire and the protocol designs, control for the 'ecological fallacy,' a specification error in which the results from group 1 are attributed to group 2 if groups 1 and 2 are separate or commingled (sampling with placement) target populations.

[2]Separate questionnaire samples drawn without replacement in 1989 (Schedule A) and 1990 (Schedule B) control for 'testing effect,' that is, the threat of reactivity when a person's response to a question is conditioned by an earlier response to the same question. Thus, if a reinterview response is influenced by the response to the initial interview, the influence is called 'testing effect.'

[3]Because the sampling traits proved reliable between the two samples (Schedules A and B), the data are merged in many subsequent analyses of theoretical distinctions. **Initial (I)** interviews are distinguished from **Reinterviews (R)** throughout.

$p \leq .04$ (t-test for the significance of difference between means). The Borough/Not Borough contrasts measure the differences attributable to local governments and the revenues to which they have access and which they, in turn, redistribute. Borough governments provide benefits not received by many Not Borough respondents. Hub/Village contrasts (villages with regular transportation services and well-developed infrastructures and villages without either) demonstrate that costs are higher but so are benefits in the hubs, where residents earn more and have more education. Test/Control contrasts yield significant differences that overlap with the Borough/Not Borough and Hub/Village contrasts but are not identical with either. Some villages are 'test' because of their proximity to Outer Continental Shelf (OCS) developments--underway, planned, or anticipated. Thus, the infrastructures of some test villages are similar to those of hubs, some have only a portion of the infrastructure present in hubs, and others have very little infrastructure. As infrastructure increases, services normally increase. Test/Control contrasts are interesting specifically because the difference between the number of meals eaten with relatives outside the household is not significant, and because the Test respondents invest more in commercial fishing or other business than do respondents in Control villages. Because Test villages have higher rates of residents engaged in private businesses, particularly fishing, than do control villages, certain oil-related activities can have greater consequences for Test villages than for Control villages. The commercial fishing industry, in particular, was considerably influenced by the *Exxon Valdez* spill. The Mixed/Native contrasts are especially powerful, demonstrating the differences between villages in which the population is 25% or more non-native and villages in which the population is more than 75% native. Mixed villages have greater employment, greater income, more services, and greater infrastructure. Respondents in Mixed villages reside in smaller households, have smaller proportions of naturally-occurring meat and fish in their annual diets, have more education, pay more for utilities and housing, have higher incomes, invest more in commercial fishing or other businesses, and reside in larger homes than do respondents in Native villages.

The contrasts by traditional language areas provide significant differences on all variables but 'number of days visited friends last week,' 'number of public meetings attended last month,' and 'the amount invested in commercial fishing or other personal business.' Traditional language areas are powerful reflectors of historical continuity, much more so than Alaska Native Claims Settlement Act (ANCSA) regions. The F-test for the one-way analysis of variance discriminates among all four languages. Inupiaq and Yupik have higher means on the 'traditional' subsistence measures than do respondents in the Aleut area. This is to be expected because: 1) the variety of resources in the Aleut area are fewer, and 2) income is generally higher there. But on the other 'traditional' measure, 'visiting with friends,' differences are not significant. The language contrasts were not created to discriminate among OCS and non-OCS effects that bear directly on jobs or dislocations. But we anticipate, particularly in light of the results of the traditional measures, that these contrasts will prove useful in detecting differences on cultural variables that are peculiar to specific, historically-related people. The clearly interpretable responses on the items here suggest that responses to dislocations or to increased employment will be reflected in culture-specific variables.

Regional contrasts are not so powerful as the theoretical contrasts (24% significant as compared with 62% significant). Nevertheless, regional differences are reflected in naturally occurring resources whose distributions (abundance and location) affect the organization of extraction, including labor and distribution practices. This is a function of the continuous geographic boundaries of regions. Resources harvested in one may not be available in another

Table 1. Significance of differences between theoretical contrasts, 11 quantitative variables, QI instrument (N=548), 1987 - 1988[1]

Theoretical Contrasts	HHSize[2]	A32	A33	C1	D1C	D1E	D2	D3A[3]	D8	D13	D16	
Borough/		2.90*+	1.69	2.94	3.08	2.51*+	4.06*+	4.27	5.30	1.75*+	2.60	1.67
Not Borough	4.11	1.69	2.77	3.20	3.14	2.77	4.19	4.40	1.91	2.51	1.61	
Hub/	3.47	1.60*+	2.65*+	3.34*+	3.33*+	3.61*+	4.77*+	5.08	1.98*+	2.55	1.61	
Village	3.98	1.81	3.06	2.92	2.36	2.86	3.52	4.11	1.68	2.54	1.67	
Test/	3.52	1.64	2.70*+	3.24*+	3.12*+	3.54*+	4.60*+	5.26*+	1.95*+	2.54	1.61	
Control	3.96	1.78	3.05	3.01	2.53	2.86	3.61	3.58	1.68	2.55	1.66	
Mixed/	3.32*+	1.62	2.62*+	3.24*+	3.12*+	4.60*+	4.26*+	5.26*+	1.95*+	2.54	1.61	
Native	4.05	1.78	3.06	2.96	2.59	2.82	3.47	4.16	1.75	2.56	1.60	
Aleut/[4]	____	1.46*	2.40*	3.41*	1.84*	1.44*	4.85*	____	1.68*	2.54	1.61	
Yupik/	3.37*	1.68	2.75	3.17	3.77	4.18	4.26	4.65	2.17	2.40	1.52	
Inupiaq/		4.08	1.81	3.06	3.05	2.63	3.35	4.06	4.85	1.65	2.70	1.75
Siberian Yupik		1.68	3.33	2.76	1.10	1.32	2.60		1.33	2.61	1.85	
Means		1.69	2.84	3.15	2.89	3.28	4.22		1.85	2.55	1.62	

[1]Significance of differences are derived from the t-test. Means for each sample on each variable appear in the columns. The means are determined from the class intervals. Probabilities of separate variate estimates ≤.04 are designated with *. Probabilities of pooled variate estimates ≤.04 are designated by +.

The variables in this analysis are HHSize=Household size, A32=Number of meals eaten with relatives outside the household last week, A33=Percent meat and fish eaten last year, C1=Number of years education completed, D1C=Housing costs, D1E=Utilities cost, D2=Household income, D3A=Amount invested in the fishing business, D8=Number of rooms in house excluding bath, D13=Number of days visited friends last week, D16=Number of public meetings attended last month.

[2]Incomplete ratings for the majority of Schedule A respondents (N=185).

[3]Amount invested in fishing or business is a subsample of respondents (N=195).

[4]F tests for the one-way analysis of variance are employed for the language contrasts. *The variance between groups is significant ≤.04.

and vice versa. Percentage differences aside, the theoretical contrasts allow for concluding hypotheses whereas the regional contrasts (which are administrative artifacts) do not.

Some KI Protocol Results

The KI protocol data for 1987-1988 (N=169) and 1989 (N=108) are analyzed with multidimensional scale analysis, a step along the way toward developing an indicator system.

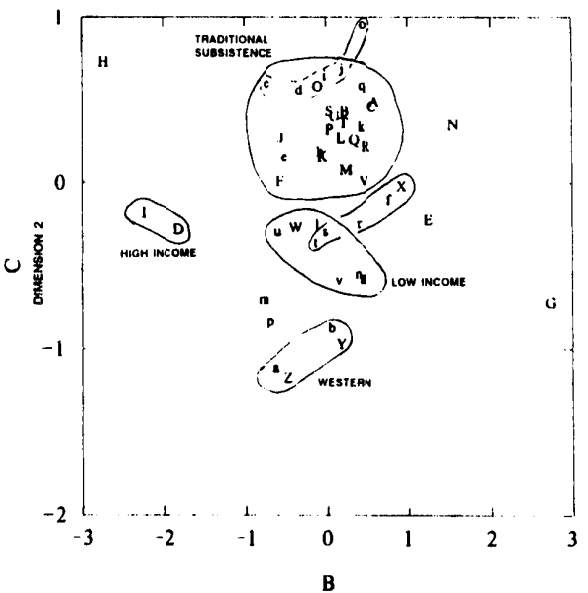
A Theoretical Contrast: Mixed vs. Native

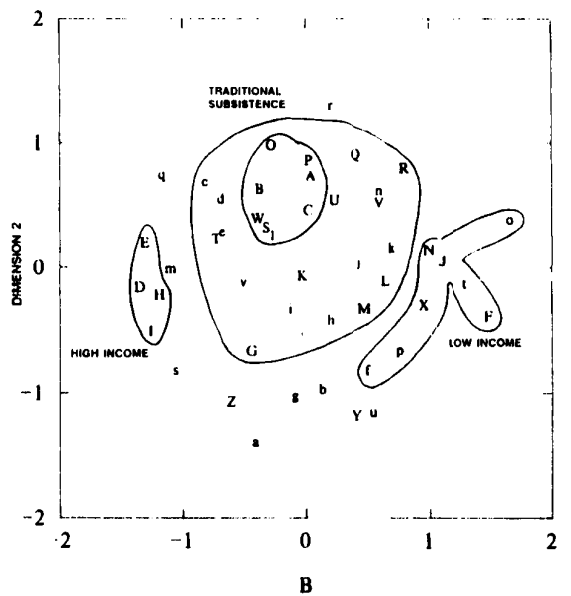
In the interest of space only one theoretical contrast among KI variables is demonstrated. The Mixed (ethnic)/Native contrast is especially powerful. The 1987-1988 initial interview solution (Figure 1) and the 1989 reinterview solution (Figure 2) are significantly similar to restrict most discussion to Figure 1.

MIXED 1987-1988
COORDINATES IN 2 DIMENSIONS
VARIABLE PLOT DIMENSION

		1	2
K1	A	.59	.49
K2	B	.21	.43
K3	C	.56	.46
K4	D	-1.81	-.28
K5	E	1.24	-.22
K6	F	-.57	.01
K7	G	2.72	-.72
K8	H	-2.76	.73
K9	I	-2.24	-.18
K10	J	-.56	.27
K11A	K	-.05	.16
K11B	L	.17	.27
K12A	M	.23	.08
K12B	N	1.54	.35
K13A	O	-.11	.58
K13B	P	.03	.32
K14A	Q	.33	.26
K14B	R	.48	.22
K15A	S	.03	.43
K15B	T	.20	.36
K16A	U	.09	.40
K16B	V	.45	.01
K17	W	-.38	-.27
K18	X	.92	-.02
K19	Y	.17	-.97
K20	Z	-.48	-1.17
K21	a	-.62	-1.11
K22	b	.05	-.87
K23	c	-.73	.60
K24	d	-.33	.56
K25	e	-.51	.16
K26	f	.77	-.10
K27	g	.44	-.57
K28	h	-.08	.19
K29	i	-.03	.65
K30	j	.17	.69
K31	k	.42	.34
K32	l	-.12	-.25
K33	m	-.77	-.70
K34	n	.38	-.55
K35	o	.44	.96
K36	p	-.69	-.83
K37	q	.43	.59
K37B	r	.39	-.24
K38	s	-.02	-.29
K39	t	-.14	-.36
K40	u	-.60	-.29
K41	v	.14	-.59

Guttman-Lingoes Coefficient of Alienation (K) = .382 (6 iterations)





Outliers in the figures are not enclosed in areas. These variables are either redundant, are appropriate for only one region, or participate in one or less r ≥.50.

Figure 1. KI mixed/native contrast. (Guttman-Lingoes MDS solutions (2-D), 48 variables, N=169 (initial interviews), Schedules A&B, 1987-1988.)

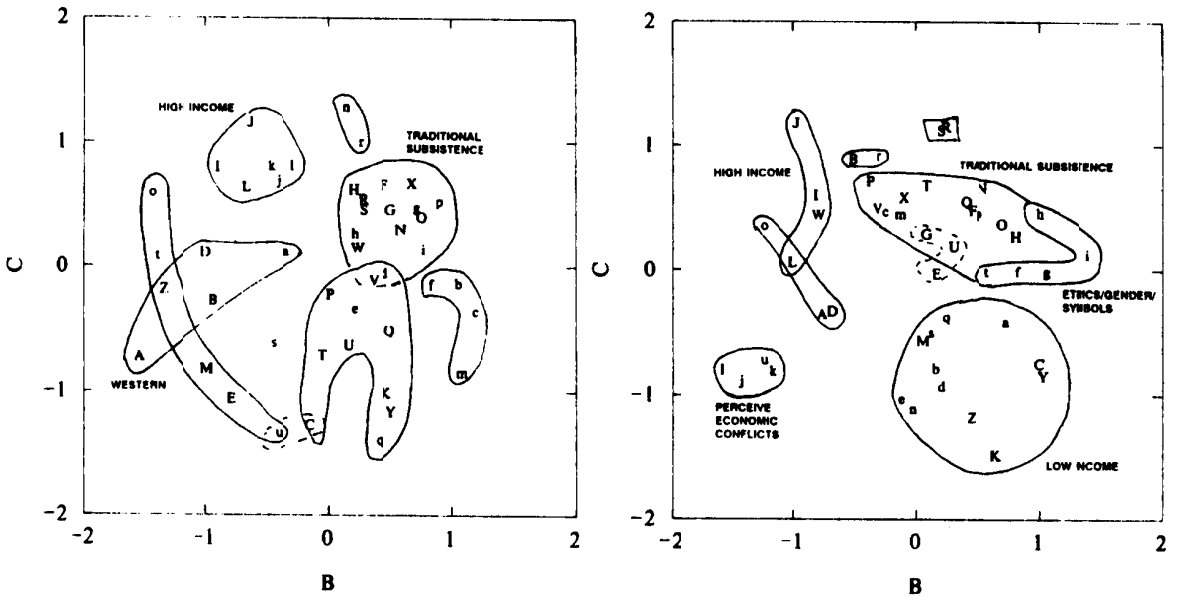
NATIVE 1987-1988
COORDINATES IN 2 DIMENSIONS
VARIABLE PLOT DIMENSION

		1	2
K1	A	.04	.74
K2	B	-.38	.63
K3	C	.02	.44
K4	D	-1.35	-.16
K5	E	-1.31	.20
K6	F	1.48	-.39
K7	G	-.44	-.67
K8	H	-1.19	-.22
K9	I	-1.26	-.51
K10	J	1.10	.05
K11A	K	-.03	-.07
K11B	L	.65	-.11
K12A	M	.48	-.33
K12B	N	.99	.14
K13A	O	-.28	.98
K13B	P	.02	.86
K14A	Q	.41	.91
K14B	R	.80	.80
K15A	S	-.32	.32
K15B	T	-.73	.25
K16A	U	.23	.54
K16B	V	.60	.52
K17	W	-.39	.39
K18	X	.95	-.30
K19	Y	.42	-1.18
K20	Z	-.61	-1.07
K21	a	-.41	-1.39
K22	b	.13	-.97
K23	c	-.82	.69
K24	d	-.69	.55
K25	e	-.68	.29
K26	f	.51	-.82
K27	g	-.09	-1.02
K28	h	.20	-.42
K29	i	-.13	-.33
K30	j	.43	.04
K31	k	.70	.15
K32	l	-.27	.25
K33	m	-1.10	-.01
K34	n	.60	.62
K35	o	1.66	.39
K36	p	.76	-.66
K37	q	-1.17	.75
K37B	r	.20	1.30
K38	s	-1.06	-.82
K39	t	1.29	-.15
K40	u	.55	-1.15
K41	v	-.51	-.12

Guttman-Lingoes Coefficient of Alienation (K) = .326

MIXED 1989
COORDINATES IN 2 DIMENSIONS
VARIABLE PLOT DIMENSION

		1	2
D28	A	1.55	-.72
OCC	B	-.94	-.27
RACE	C	-.15	-1.27
RNEX	D	1.00	.11
PERP	E	-.79	-1.06
K1	F	.45	.66
K2	G	.51	.46
K3	H	.20	.62
K4	I	-.90	.80
K5	J	-.64	1.16
K6	K	.47	-1.01
K9	L	-.67	.64
K10	M	-.99	-.82
K11A	N	.59	.30
K11B	O	.76	.40
K13A	P	.01	-.22
K13B	Q	.50	-.51
K14A	R	.28	.54
K14B	S	.28	.46
K15A	T	-.05	-.71
K15B	U	.16	-.63
K16A	V	.36	-.11
K16B	W	.23	.15
K17	X	.68	.67
K18	Y	.51	-1.16
K19	Z	1.35	-.18
K22	a	-.34	.12
K24	b	1.05	-.13
K25	c	1.19	-.35
K26	d	.46	-.05
K27	e	.21	-.33
K28	f	.84	-.14
K29	g	.72	.48
K30	h	.21	.27
K31	i	.77	.14
K33A	j	-.42	.69
K33C	k	-.47	.81
K33G	l	-.29	.81
K34	m	1.08	-.84
K35	n	.14	1.29
K36	o	-1.44	.60
K37	p	.90	.53
K37B	q	.41	-1.38
K38	r	.26	1.01
K39	s	-.45	-.61
K40	t	-1.40	.09
K41	u	-.41	-1.33



Outliers in the figures are not enclosed in areas. These variables are either redundant, are appropriate for only one region, or participate in one or less r ≥.50.

Figure 2. KI mixed/native contrast. (Guttman-Lingoes MDS solutions (2-D), 47 variables, N=108 (reinterviews), Schedules A&B, 1989.)

NATIVE 1989
COORDINATES IN 2 DIMENSIONS
VARIABLE PLOT DIMENSION

		1	2
D28	A	-.77	-.35
OCC	B	-.52	.89
RACE	C	.99	-.75
RNEX	D	-.69	-.33
PERP	E	.16	-.03
K1	F	.45	.48
K2	G	.08	.29
K3	H	.81	.27
K4	I	-.82	.60
K5	J	-.98	1.18
K6	K	.65	-1.48
K9	L	-1.01	.06
K10	M	.05	-.57
K11A	N	.54	.66
K11B	O	.70	.37
K13A	P	-.38	.71
K13B	Q	.40	.55
K14A	R	.24	1.15
K14B	S	.20	1.12
K15A	T	.08	.68
K15B	U	.30	.19
K16A	V	-.32	.49
K16B	W	-.80	.44
K17	X	-.10	.58
K18	Y	1.02	-.85
K19	Z	.44	-1.18
K22	a	.73	-.41
K24	b	.15	-.79
K25	c	-.25	.47
K26	d	.20	-.95
K27	e	-.12	-1.03
K28	f	.83	-.01
K29	g	1.05	-.01
K30	h	1.00	.46
K31	i	1.39	.13
K33A	j	-1.43	-.89
K33C	k	-1.17	-.81
K33G	l	-1.58	-.80
K34	m	-.13	.45
K35	n	-.03	-1.11
K36	o	-1.24	.36
K37	p	.51	.46
K37B	q	.24	-.37
K38	r	-.31	.92
K39	s	.12	-.50
K40	t	.58	-.01
K41	u	-1.24	-.72

The Mixed solutions are more complex than the Native solutions, reflecting greater heterogeneity and variation in the former than in the latter[4]. Higher income variables form a cluster in the left center, but because high income is not an exclusive feature of non-traditional, non-native households, it is separated from the 'Western' and 'Traditional' regions.

The region labeled 'Western' in the bottom center includes stable marriages, stable household composition over several years, clear expectations for the observation of household rules by old and new members alike, the use of informal solutions and, if deemed necessary, formal external agents to resolve conflicts within the household. It also includes small households, personal ethics that promote competition, Western enculturation practices (directive, stipulations attached to requests, formal demands, encouragement for success, manipulation, etc.) and gender distinctions (marked differences in the treatment of sexes), the belief that formal schooling is strongly associated with financial success, and the informant and his/her spouse are migrants to the village. The resource extraction variables correlate negatively with the Western set. This cluster represents households in the village, but not of the village in a traditional sense.

The Western/Traditional household and ethics distinctions that occur in the Mixed subsample are not so obvious in any other contrast, almost surely because no other contrast requires that the informants be sampled from villages composed of 25% or more non-natives. One question that stimulated the development of our theoretical contrasts was whether Native household organization, ethics, enculturation practices and opinions about the value of schooling would change toward those generally measured among non-natives in the presence of stable, high earned income, education, and political participation at the state and federal levels. From these synchronic data it is not evident that they have changed because of employment, education, income, or all three combined. The second measure taken in 1989 suggest no changes. To the contrary, increased education and political savvy often correlates with better jobs and higher pay, as well as with traditional customs and great skepticism of any positive correlation between education and success. Our longitudinal (three waves) QI data provide similar results. Only when controlling for non-natives in any of our contrasts are correlations between high income, high education, and the like positive with expectations for success from education.

An area labeled 'Low Income' is complex in its details because most of those variables correlate highly with the subsistence extraction, sharing and Native ethics variables in the larger traditional region. The 'Low Income' area fits together large households and informants spouses who were born or reared in the local community with, on the right, older household heads whose households have several active religious communicants and who avail themselves of most of the social and health services that are available in the village. These respondents are doubtful of a strong correlation between schooling and success and think that local economic development will be controlled by and will disproportionately benefit persons or corporations outside the village.

Although low, stable unearned incomes correlate highly and positively with variables in this area, they correlate with more items in the large 'traditional' region. So many variables are

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[4]Outliers are variables that participate in one or less $r \geq .50$ and that do not scale. Outlier are bracketed [] in Figure 1.

fitted so closely together in the traditional region it will be helpful to describe the relations within this radex (the circle of variables that form around the resource extraction and use variables).

Whereas both high earner households and low earner households are fitted in the region, high earners are bigger givers than receivers, it is the reverse for the low earners. Yet the high and low earners are tied together through sharing and through a large variety of traditional beliefs and practices. Central to the radex is the variable measuring the variety of resources harvested. The variables in the radii extending from the variety of resources harvested are the other subsistence extraction variables, the variable measuring the practice of traditional enculturation and the maintenance of traditional gender distinctions and the variables measuring giving and receiving of resources. The relations scale in this fashion: the more varieties of resources that a household harvests, the larger the proportion of protein from naturally-occurring species in the diet. Harvest expenses increase as well, but the proportion is greater for the lower income households than for those with higher incomes.

Correlated with these variables is that the informant usually hails from the local community or one nearby, and also the ethical belief that a person should work to develop skills so as to assist one's family and wider network of kinspersons, the belief that the environment is endowed with spirits and that Natives have special relations to their environment, and the belief that a person is ethically obligated to cooperate with others, especially in sharing in a communitarian fashion.

Multivariate relations in the Native subsample are very different from those in the Mixed subsample. There are a few differences between the initial solution and the reinterview solution that are worthy of mention. In the initial solution the variables measuring household dynamics, rules, and conflict resolution and marriage stability are outliers (bottom of hyperspace). Except for household dynamics and household rules they do not even correlate strongly and positively within the set. The variables measuring length of residence of informant and spouse are, unexpectedly, positioned as outliers (weak correlation). In the reinterview solution (Figure 2), the perception of economic conflict variables are redefined. Those variables are fitted with the high income region, suggesting that as income increases in amount and stability, perceptions of economic conflicts between natives and non-natives and non-native corporations increase. The informant and spouse are fitted into the traditional cluster.

The Native subsample does not bristle with high PRE coefficients and variation is considerable, a product of the wide range of variation among 23 villages representing five different languages and several dialects from Kaktovik in the high arctic to Old Harbor in the subarctic. Nevertheless, the data structure for Native villages, in general, lend empirical warrant to our expectations for family household structures, ethical codes and subsistence practices that are much different from non-natives and even different from some of the practices of natives in the Mixed villages.

Three strong regions emerge, all of them reflecting traditional culture. A fourth, a simplex comprising high, stable earned income from private sources is unrelated to the traditional regions and stands by itself to the left of several outliers, again showing that persons with high incomes in the Native villages represent a sufficiently wide range of behaviors, sentiments and household organizations to be set apart from any of the variables that measure those phenomena. Yet the Native solution is similar to the Mixed solution in that the variables in the

traditional region are organized into higher income (the variables in the top area of the radexes) and lower incomes (the variables in bottom area of the radexes).

The structure of the largest traditional region is a radex whose core is the subsistence extraction variables, large households, the giving and receiving of labor locally, and the giving of resources locally. Radiating in two circles around the core to the left are the variables measuring political activity and to the right variables that measure the sharing of labor outside the village and resources outside the village. Completing the structure, as we have come to expect, the variables that measure giving cash locally and beyond the village and the receipt of cash are located close to the variables that measure need and impoverishment (the region to the right).

Of equal importance in both Native solutions are the variables with which the giving of cash are fitted into a cluster. They correlate with the ethic of personal responsibility for attainment so as to assist others, a belief that the environment is endowed with spirits, the espousal of a communitarian ethic and the practice of traditional enculturation and maintenance of traditional gender distinctions. Native ethics, sentiments and beliefs fit Native practices in this contrast.

The region on the far right is composed of older household heads dependent on stable unearned income, cash assistance, and social services, whose goals and locus of control they perceive correctly.

COGNITIVE ATTITUDES ABOUT TRADITIONAL ACTIVITIES AND NATURALLY OCCURRING RESOURCES

Because questionnaire questions on the availability of natural resources proved to be unreliable and invalid, we began gathering information on attitudes about natural resource availability and management by protocol among Schedule B respondents in 1988. Our stability tests were restricted to reinterviews conducted in 1989 of informants in the Schedule B KI sample although all Schedule A and B protocol informants were interviewed in 1989. Every question proved to be stationary, and the multivariate relations have proved to be high and significant.

In 1988 and 1989 we inquired about more than 75 types of sea mammals, fish, marine invertebrates, land mammals, birds and plants (including marine plants). The responses to similar questions posed about the various groups of fauna and flora are so highly consistent that the analysis of sea mammals will provide reasonably accurate generalizations about the respondents' attitudes about other species.

Through our protocol we sought information on respondents' cognitive attitudes (knowledge) of the availability and management of these many resources. We sought to learn whether (and why) respondents favored third-party management of resources (e.g., so as to avoid conflicts over commodities?); whether they thought third parties should manage the resources, even if they considered the third-party incompetent or less than competent and considered some party other than the one they selected more competent; who they considered most knowledgeable about resources; who they thought had the greatest practical understanding of the resources; and whether they thought that management agencies were responsive to their concerns and were influenced by their requests. These questions were driven by field experiences among natives and non-natives in which state and federal organizations were castigated for their lack

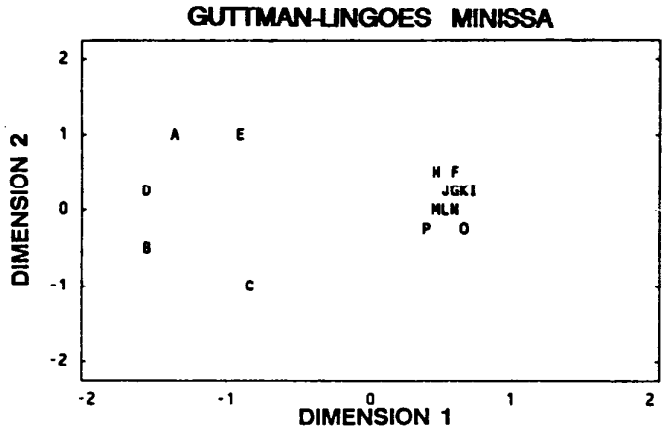
of knowledge, mismanagement, and the failure to heed advice offered by locals. And also by reservations and fears expressed by many village residents--natives and non-natives--about the consequences of oil-related operations to naturally occurring resources on which village life was based.

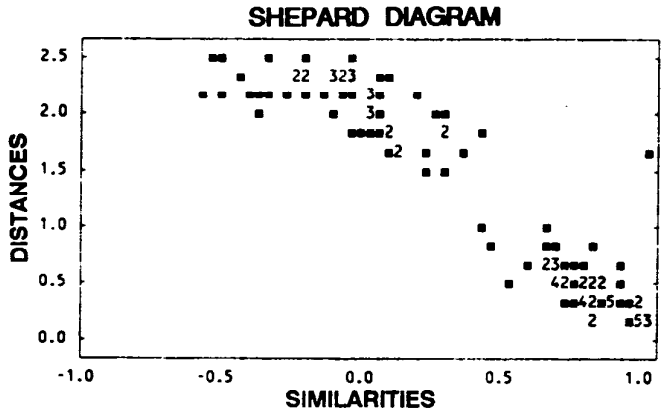
The design of the questions makes it possible to measure consistency in responses. If a person thinks a resource can be managed, that respondent thinks some persons, groups of persons, or institution (agency) knows most about that resource, is (or would be) the best manager of the resource, and should manage the resource. If respondents think that they, or that local persons and organizations influence the management of the resource, they think that the agency currently managing the resource should continue doing so. Conversely, if persons think that they exert no influence, or that their influence is rarely felt, they do not think that the agency currently managing the resource should continue to do so.

Let us focus brief attention on sea mammals. The subsistence and economic importance of walrus and seals is considerable to natives, but not to non-natives. Sea mammals and the polar bear are ultimately controlled in U.S. waters by the Federal Government through provisions of the Marine Mammals Protection Act. Figure 3 provides a two dimensional solution for the protocol questions about sea mammals.

We interpret Figure 3 thus: informants perceive the availability of sea mammals (the crescent shaped simplex on the left hand side of the figure) as similar--sufficient to insufficient for their needs. The distribution places the animals to the left hand side, meaning that they correlate negatively with the variables which measure whether respondents think that the resource can be managed, and whether those resources should be managed, who should manage them, who influences their management, and who understands them best. So, the resources do not fit closely with ideas about their management. The very tight distribution in the right center of the hyperspace demonstrates the consistency of all of the cognitive responses about management. A majority think that sea mammals can be managed only by God (i.e., cannot be managed) or can be managed by some persons (not institutions), that natives know the most about them and understand them best, that natives seldom or never influence their management, that natives would manage them better than do government regulators, and that natives (or natives in conjunction with government agencies) should manage them. If persons think that sea mammals can be managed by institutions, they think scientists and government employees know the most about animals, would manage them best, are influenced by local persons, and should manage them. Persons who think natives know the most and would manage best, are more apt to think a balance of natives and government agencies should manage the resources than are persons who think institutions manage best and institutional employees know most. Although these data are ordinal, they behave like normally distributed, rectilinearly related, interval variables.

Focusing specifically on walrus, more respondents think that walrus are insufficient for their needs than think they are sufficient and most respondents think that either persons or institutions can manage them. But the question of who should manage them is answered in a fashion that recurs for almost every type of resource. The majority of respondents in the sample are natives, reflecting the composition of the 31 villages in the pre-*Exxon Valdez* spill portion of the study. The modal responses are that respondents think natives would manage them better than the federal government; natives or natives and some scientists possess the greatest knowledge about walrus; natives seldom or never influence policies regulating sea mammals;





COORDINATES IN 2 DIMENSIONS

VARIABLE	PLOT	DIMENSION 1	DIMENSION 2
WALRUS	A	-1.41	.76
BOWHEAD	B	-1.57	-.58
BELUKHA	C	1.85	-1.14
BEARDED	D	-1.60	.07
SPOTTED	E	-.96	.81
Q2A1	F	.59	.37
Q2A2	G	.68	.08
Q2B1	H	.49	.29
Q2B2	I	.71	.12
Q2C1	J	.51	.21
Q2C2	K	.66	.21
Q3A	L	.56	-.17
Q2B	M	.49	-.20
Q2C	N	.63	-.14
Q51G	O	.66	-.40
Q52G	P	.41	-.28

Figure 3. Sea mammals. Guttman-Lingoes MDS solution: 2-D, 16 variables, 108 KI reinterviews, Schedules A&B, 1989.

natives understand walrus better than do government employees; and that natives should manage them. Many respondents think natives know more, understand more, have little influence on policies affecting walrus, and would manage walrus better, or would be equivalent to government managers, but opt for a management balanced between natives and government. About a quarter of the respondents think that government agents know most, are the best managers, and should managers.

In order to discover the attributes of the persons who held these opinions, attitudes about who would manage best ('Q3A') were correlated and held constant with attitudes about who should manage ('Q52A2') and several control variables with introduced. This subclassification and partialling technique produced some interesting results. Normally sex, age, and income are factors that influence correlations. Men more frequently think natives would be better manages and should manage walrus than do women, but the difference is not significant and demonstrates the often demonstrated fact that native women are more conservative than men (they are less apt to seek or vote for change). Income exercises no influence on the relation at all. Age had an interesting influence: persons under the age of 29 think that natives would be better managers (5:4 with 6 thinking that natives and government regulators are equivalent) but split 6:6 as to whether natives, alone, or the government, alone, should manage walrus. Persons 60 and over think that the government is a better manager by 3:1, but think that government should be the sole managers by a ratio of 2:1. Persons between the ages of 30 and 59 think that natives are better managers and should be the sole managers at ratios

of 3:1. It is not likely that youth and the elders have wisdom whereas persons in middle age do not. Sea mammals hunters are predominantly middle-aged native men.

The factors that most influence the relation between who should manage and who would manage best are race/ethnicity (native or non-native) and whether persons reside in regions in which commercial fishing dominates the private sector economy (Kodiak, Bristol Bay, Aleutian Pribilofs). Persons residing in commercial fishing areas think that the government is the better manager and should be the sole managers at a ratio of 2:1 whereas persons residing in non-commercial fishing areas think that natives would be better managers and should be sole manages at a ratio of 6:1. It is significant that residents of the commercial fishing areas harvest very few walrus. Upon controlling for race/ethnicity, non-natives think that the government is a better manager than natives at a ratio of 12:0 and that the government should be sole managers at a ratio of 9:1 (there is a bit of reserve expressed toward government regulators). Natives think natives are better managers at a ratio of 3.5:1 and that natives should be sole managers at a ratio of 3:1.

Natives, throughout, think that natives know most and would manage best, but are aware of native powerlessness and skeptical that natives could manage without adequate resources. Their responses, then, appear to be conditioned by the actual prospects of managing, rather than their wishes alone. Natives, much more often than non-native, temper their thoughts by opting for joint management of natives and government.

QUESTIONS AND DISCUSSION

Charles Degnan: Has anyone thought of doing a similar study from the perception of the Alaska Native viewpoint rather than a "scientific" or educational point of view?

Joseph Jorgensen: Not that I know of. It is something that we tried to accommodate in two ways but because as a social scientist, you are always co-opting somebody, you walk in as you perceive your subjects and ask them a number of questions that you have framed rather than they have framed. They assist you in the work but you are not true collaborators because they didn't tell you how or what to study in the first place. We try to accommodate native cognition and perceptions through the protocol. The protocol is a focused discussion through which the native provides information that helps the social scientist form questions from which variables are created. But it still is not a native-initiated study from any native points of view. So far as I know nobody has put out money for that or suggested it. The closest we can get to such a study is through persons who enter the villages, stay quite a bit of time, and collect information from focused discussions and through general conversations.

Charles Degnan: In your interviews are interpreters used, even though Alaskan Natives can speak English? Is that a common practice for you to use interpreters?

Joseph Jorgensen: We work it this way, the questionnaires are administered in the native language if the natives prefer it. So we had all of the questionnaires translated and back translated into the various Inupiaq dialects and Yupik dialects and languages. All of the questionnaires are administered by trained natives. All of the KI protocols are administered by seasoned anthropologists, some of whom are natives. We weren't using interpreters, but if a

person chose to have the questionnaire or any interview discussed in their native language we did so. That was surely the case in the Calista region and elsewhere. So we translate interviews conducted in the native language. It is difficult every time we have to make changes to the questionnaires. Changes are sometimes proposed by questionnaire interviewers who write summaries of things that people respond to that are not on the questionnaire with which they take issue. The KI's do the same thing when they administer protocols. The first year we tested, we tried to determine whether our questions were measuring what we thought we were measuring. We rejected many questions at the end of the first field session. The questions we have retained are valid.

Tom Newbury: I was wondering how you adjusted for changes in language groups within a community? You have an attitudinal measure for a group. But sometimes those groups change in relative importance in the village. I think sometimes it includes groups that aren't considered part of a village. An example might be the DEW Line workers in Kaktovik. Some of these persons, like Walt Audi, became very influential in the village. How do you balance your tests so that you test what you would consider non-residents?

Joseph Jorgensen: The only way you can deal with that right away, and the way we have tried, is each year in which we return to the village, the person responsible for administering the protocols also is responsible for talking to the village leaders. By leaders we mean, elected, appointed, businessmen, and church leaders. We are dependent upon the techniques that are traditional in anthropology at that point. Interviewers must talk to specific people, key people in a village. Their responses come into our interpretation in this way: after each visit, researchers such as Dr. Robbins, have to write a summary of their observations and compare them with their earlier observations in the village. We seek to identify important issues in the village. That is the key to the KI summary. Otherwise we are really not able to interpret changes from responses to the questionnaire or changes from the responses to the protocol. We think we have variables that are sensitive to changes that occur. The influence of a single person, let's say like one person that worked on the DEW Line, really has to come from the discussions that take place over several years, perhaps chance discussions. Because we are developing a monitoring methodology, we go back year after year to the same panel of respondents and because all of the new independent interview samples have demonstrated conclusively that there is no testing effect on the variables we are using in the panels, we think we have sensitive measures. And if a person makes a difference on some of these variables in the village, the difference will pop up because we return annually to ask the same questions of the same people. That is the beauty of the Solomon Four Group Design. It allows us to measure the effect of an impact between the last visit and this visit.

Ray Emerson: I guess I am not too surprised with the correlations that you are seeing in your statistical treatment, the sharing, the concept of income and that sort of thing. Were you concluding basically that in the three years that we aren't seeing much change and there is a holding of the traditional pattern?

Joseph Jorgensen: On those variables, yes. The only real change, well we measured a few changes, but the big one has been the dramatic increase in stable unearned income from all forms of state and federal welfare transfers since 1987.

Ray Emerson: I guess my concern is are we really looking at that level of stability when we have the influences of television in the villages? I think that is a tremendous effect. It is a "no-

no* to mention, but alcohol isn't supposed to be there, but it does get there somehow. The fact that even though the birthrate is up for the native villages, higher since the 1980s significantly, there is definitely an out-migration of your youth and the possible draw away from traditional values to what television and multimedia sort of things are introducing them to. I think this is really the core at which a study like this should be focusing on. Not something that we are more or less expecting to see in terms of traditional or textbook classic subsistence values.

Joseph Jorgensen: We have measures of household size and so we can monitor the change every year. We also take the names and ages of every person in the household. So we have real measures of out-migration. We can control out-migration by age. Three years is a methodological device. It allows us to determine the stability of correlations and to control for external and internal threats to validity. Three years is seldom enough time to measure many changes, particularly the kind that you suggest. Your suggestion requires a monitoring methodology that is stretched out more than three years. On the other hand if something cataclysmic occurs, particularly if there is a spill of some oil across the water surface, the direct effects are dramatic and immediate -- some of the very things about which MMS was concerned. We are certainly interested in the longer term effects.

There are some problems in studying the issues you raise. For instance, your questions about suicide, and, let's not call it alcoholism, but rather alcohol-related crimes and alcohol-related deaths, can be studied only from statistics that are highly suspect in Alaska, elsewhere in the United States, and around the world. Statistics on suicide are suspect for obvious reasons: some suicides are reported as not suicides, and some are so reported. Suicide rates are notoriously suspect. As for alcohol-related crimes, some are reported, but others either are not reported or are not recognized as alcohol-related. Secondary data are the major sources for these statistics. Believe me we have analyzed the secondary data seeking to develop stable indicators for our time series analysis since the first study we undertook in 1982. In that study we came up with three indicators that made any sense. One was the commercial fish harvest. Another one was school enrollments. When we got down to variables that a lot of people would think are the most important indicators, the social pathologies of sucidies, mental health visits, homicides, alcohol-related crimes, the very ones to which you referred, they are the most unstable and the most difficult measures with which we have tried to work. Believe me we have tried and I agree that they are important measures, they are also very unreliable measures.

Ray Emerson: On your questionnaire, for example, did you ask the question how much time is spent by that individual and their respective family members just watching television?

Joseph Jorgensen: No we didn't ask that. We tried it the first year.

Ray Emerson: Why?

Joseph Jorgensen: I'll explain why. We tried to collect such information during the first year with a question on the questionnaire that conflated several issues. The question dealt with television as recreation and asked how much time the respondent spent watching television or in other recreational pursuits such as fishing? The question posed a false conjunction of two types: one is whether television-watching, fishing, hunting, and other items on the list were interchangable recreation pursuits. The Office of Management and Budget (OMB) wouldn't let us create other questions to investigate television-watching and its possible effects. So we don't have information. In order to gain information on the topic we must be allowed to develop a set

of questions on how people spend their time when they are not working, sleeping, eating, and the like. Such questions require OMB approval.

Ray Emerson: Well with such a powerful study that this is supposed to portray in terms of village stability and you can't address television and the influence on its culture, how are you going to possibly come up with anything meaningful that is really the driving force out there that is causing this change? I don't see how OMB can have that kind of influence on your questionnaire. I can see maybe with alcohol, but for television. They all watch television.

Joseph Jorgensen: What you and I are doing is engaging in a series of unwarranted generalizations. You are making claims about the effects of television that aren't true and you can't demonstrate to be true. The best study that I know of on the effects of television is Conrad Kotak's study of 3000 villagers in Brazil over three points in time. He demonstrated that they watch more television after they got television sets then they did before they had them.

INSTITUTIONAL CHANGE AND STABILITY IN ALASKAN COASTAL COMMUNITIES[1]

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INTRODUCTION

The Minerals Management Service Alaska Outer Continental Shelf Social Indicators System (AOSIS) is a multi-year multi-method research program designed to measure changes in the quality of life that are due to offshore mineral exploration, development or production. The research began in 1987. The methodological framework of the study is generally termed "triangulation," the "multi-trait, multi-method" approach, and "multiple operationalism." This framework suggests that any datum is an approximation to knowledge that is likely flawed as a result of the means used to collect it. As such, our confidence in information should increase if we employ several methods to converge on that knowledge. The strengths of some types of information (or methods dedicated to data collection) should compensate the weaknesses of others, yielding increased reliability and validity through the use of a battery of techniques and constructs that are operationalized in more than one manner.

The AOSIS program routinely collects and analyzes several data types: structured forced-choice questionnaires (which may optimize reliability at the expense of validity); semi-structured open-ended interviews (which may offer great validity at the expense of reliability); anthropological observations and anecdotal journal records collected by researchers; and secondary institutional records, such as health, education, and employment-related time series. A panel design is used to sample residents in several waves at three points in time for the questionnaire and two points in time for the semi-structured interviews with institutional officials and a subsample of household respondents. The staggered panel design permits analysis of change over time while controlling for threats to validity, such as reactivity, testing artifacts, and instrument error.

This presentation describes interim findings of our institutional research. At this point selected institutional leaders or staff members in virtually all community and regional agencies have been interviewed twice in a sample of 31 one coastal communities, and once in a new sample of nine communities added to the program in the wake of the *Exxon Valdez* oil spill. The presentation will address only the original sample, since our analysis of the new sample is incomplete. Several key theoretical contrasts were used to stratify the sample: Native versus non-Native community; hub versus village; test versus control; regional governance (borough) versus none; Native linguistic affiliation; fishery economy versus non-fishery economy; and open water access versus closed winter harbors. We have determined that these contrasts generally have predictive utility, hence it is possible to address the institutional implications of the contrasts. These implications are discussed, with an emphasis on illustrating those institutional features that seem to be changing and those that appear to be most stable and what those features entail for quality of life.

[1]The data cited here are preliminary only. Please secure a revised version of the analysis through the Minerals Management Service before citing these data.

IMPLICATIONS OF "QUALITY OF LIFE"

Quality of life is not a simple concept, and without doubt it must be assessed as a complex multidimensional construct. To some extent, quality of life is an individual phenomenon that must be measured at the level of the individual and the household. But in other respects, quality of life is a feature of civic, social and economic institutions -- schools, governments, hospitals, churches, and so on. Certainly these features of life quality are related: adept leadership, efficient government, and quality services often translate into perceived life satisfaction at the individual and household levels. It is in fact the function of those institutions to meet life needs, and institutions are generally the bodies charged with the responsibility for addressing social needs. To the extent that a connection exists between institutional performance and "quality of life" at individual and household levels, we should expect the social changes we are analyzing to be evident at the institutional level.

This connection between life quality and institutional performance is actually quite problematic, and not only for empirical reasons. The main body of social science literature concerned with "life quality" has not yet arrived at a consensus regarding what quality of life means, but the term refers more often than not to perceived life quality or subjective satisfaction (Andrews and Withy 1976; Colby 1987; Levy and Guttman 1975). The broader ecology of life satisfaction -- the environmental and institutional features that sustain or complement it -- is only occasionally addressed in a systematic manner because the empirical links between the two domains are often tenuous or even counter-intuitive. An enormous literature in anthropology, psychology, and sociology demonstrates that expectations and subjective attitudes -- the ideas that people have about what they need, what they deserve, what makes their life condition and the conditions of their neighbors seem fitting and proper -- change in accordance with their perceptions of other circumstances. Over the last century, most of that literature would generally fall into the domain of "relative deprivation" or, in bald terms, the tendency to measure your situation in terms of what you think about other situations rather than in terms of objective conditions.

In short, we are compelled to ask if "life quality" can really increase or decrease if people perceive that there has been no change? Similarly, is "life quality" stable if people perceive that it is not? Since perceptions of life quality vary from society to society and on the basis of gender and age (among many other factors), all other things being equal, is there in fact an objective basis for life quality? Consider these examples: nationwide, the elderly and females typically feel themselves to be more vulnerable to crime, yet young males are far more often victims of crime; expressed fear of crime generally grows in proportion to arrests and successful prosecutions; and, based on a large survey sample here in Alaska, residents with the highest incomes and most stable jobs are more apt than others to express dissatisfaction with local economic conditions and institutional performance (McNabb 1989). In short, people tend to assess their life quality differently, using variable standards and based on different expectations. Many social scientists who investigate quality of life identify only one objective dimension of interest: physical health.[2]

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[2] Health is subject to the same problems, however. Since perceptions of health, actual health, and use of health services vary on the basis of class, ethnicity, age, gender, and other factors, and since these factors may intercorrelate, it is a serious empirical challenge to disentangle the factors and relate them to "life quality."

The solution to this dilemma is as much political as it is scientific. We don't seek a scientific justification for a premise like "life, liberty, and the pursuit of happiness," although we can examine if that goal is achieved by specific programs. Similarly, we have rights and guarantees, for example to vote, to go to school, and to be reasonably safe from epidemic diseases and criminal mischief, for which we seek no scientific justification.[3] The premises of most social goals, such as literacy, access to uncrowded housing, decent jobs, and basic health services are ideological. "Quality of life" in the AOSIS program is, in part, an ideology. For this reason it is crucial to determine what those ideologies are in the coastal, mainly rural, portions of Alaska in which this program operates. One aim of the program during its initial stage was to document those ideologies through open-ended discussions of these and related topics with household residents as well as institutional officials. The aim is actually two-fold: we sought to discover what the life quality goals were, and simultaneously sought to determine what means were employed to achieve them. Our subsequent waves of data collection monitored changes in those means, and their results, during intervening sample periods.

For the purposes of this discussion I will concentrate on only a handful of important local goals or ideologies. These are:

(1) local political control, or non-interference; most rural, coastal residents and their institutions seek to diminish sources of state and federal domination in local decision-making.

(2) access to renewable natural resources for commercial and subsistence use; this item overlaps with the first, insofar as limited entry rules, federal and state quota and season regulations, and other federal and state laws or international treaties are seen as sources of interference.

(3) economic equity, which entails unencumbered access (or even special privileges) to jobs, revenues, services, and fair prices.

Please notice that these are very general and comprehensive desires that, to a great extent, may typify resident goals and institutional agendas anywhere in Alaska. Those are useful features of a framework which, by definition, should be generally applicable. There are special nuances in particular regions that accord with the prevailing economic climate, history, and local culture. Non-interference and resource access are generally couched in an idiom of subsistence preservation (and key subsistence values, such as sharing) and cultural heritage in Alaska Native communities, for instance.

HIGHLIGHTS OF AOSIS DATA ANALYSIS

Background

If desirable life quality was in place now or was easily achievable, the issues identified above would be trivial. But existing life quality is seen to be vulnerable to existing demographic,

[3] The assertion that universal education is guaranteed in the United States in order to create an informed voting population may be a myth; the historical evidence for that goal as a conscious strategy is problematic. It is probably a rationalization, similar to scientific "explanations" for religious dietary prohibitions, hence more ideological than scientific.

fiscal, and political pressures that are intensifying, hence not only are they in jeopardy but the risk is perceived to be growing. For this reason, a demographic, economic, and political context should be briefly sketched so that AOSIS results and rural quality of life can be set in proper relief.

The demographic pressures stem chiefly from growth patterns of the Alaska Native population, and probably affect the future economic prospects of that population more than any other. The average number of children born to Alaska Native mothers dropped from 3.8 in 1970 to 2.5 in 1980, but fertility may have increased slightly after 1980. But because the size of the young adult Alaska Native cohort has increased dramatically, the birth rate is rising rapidly. Alaska Natives in rural census areas posted a birth rate of less than 30 per 1000 between 1970 and 1980, but that rate has risen to almost 40 per 1000 in 1986. The effects of a large and growing young adult cohort on overall rates of growth are depicted in Figure 1 (see McNabb 1988).

At rates of growth calculated for 1980, the Alaska Native population will double every 26 years. The post-1980 rate is probably higher. Based on census data and more recent population, mortality, and birth data, it seems likely that the youngest Native cohort (age 0 to 9 years) will grow by about 40% between 1980 and 1990. These children will place increasing demands on institutions for essential services -- housing, education, health care. Since the growth rates for small Native villages are virtually identical to the rate of growth for the entire population (2.2% compared to 2.4% through 1980), the populations of tiny, remote villages are not collapsing. Instead, as this decade draws to a close, it appears that population pressures are great and will become more intense just where facilities are least able to absorb that pressure.

Constraints on public sector spending introduce another source of pressure. As a rule, revenues derived from government spending sustain the major share of economic activity in rural Alaska. In some regions, estimates of direct and indirect government contributions to the economy exceed 80%. Although direct income transfers to residents (in the form of welfare and other unearned income) are important to many households, they pale in comparison to in-kind transfers in the form of subsidized public goods and services. For instance, the proportion of unearned income to total income in rural Alaska ranges from about 20 to 40% (compared to the U.S. average of 14%) (Impact Assessment 1988). But those transfers seldom comprise more than 5% of all transfers. Using one community from the sample as an example, in the Yup'ik village of Alakanuk the annualized per capita subsidy for public education alone exceeds per capita income. Other in-kind transfers for which no payments are received in excess of federal income taxes include some housing programs, health and social services, energy and utility subsidies, public safety, communications and postal services, and most costs of capital improvements projects.

Hence rural Alaska Natives pay little or nothing for services that are generally underwritten through property taxes in most of the U.S. But the proportion of income expended in other categories counterbalances this disparity, and extraordinary costs in some categories mute the effects of very large subsidies. For instance, the U.S. urban household will pay about 20% of household income for housing while the rural Alaska Native in our sample generally pays between 3 and 8%. But even with substantial subsidies the rural Native pays 15 to 40% of household income for utilities, whereas the urban household pays about 10% (see U.S. Department of Commerce 1987). Per capita income in study areas ranges from about 70 to

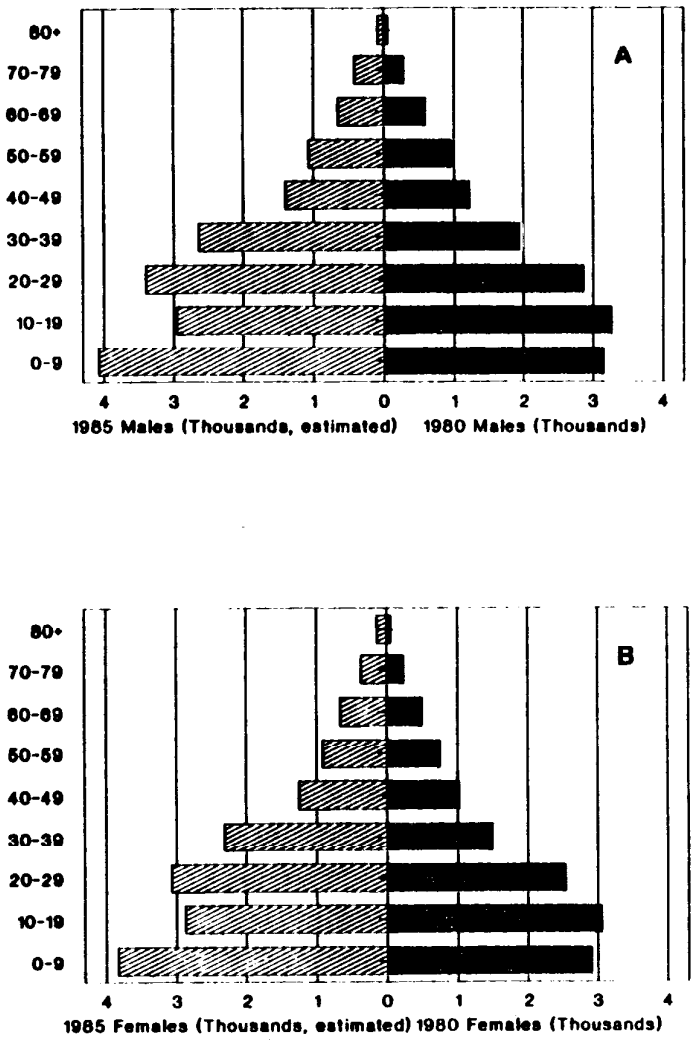


Figure 1. Population pyramid, rural census areas, Alaska, 1980 to 1985: a) native males, and b) native females. (Source: U.S. Census, Alaska DOL)

150% of the U.S. average, but the cost of living exceeds 125% and may reach 180% of the national mean (McNabb, Mulcahy and Robbins 1988). Rural Alaska Natives have very little disposable income. Since unrestricted Alaska State revenues in real dollars are declining from about $4.108 billion in 1982 to an estimated $1.048 billion in 1989 (Flanders 1989), and since federal transfers are decreasing, the economic picture in rural Alaska looks increasingly bleak.

Political pressures that introduce additional social and economic problems arise through direct challenges to rural or Native entitlements and through judicial decisions that weaken or extinguish rural economic strategies. For example, at the federal level Indian Health Service privileges and salaries and support funds for Community Health Aides were slated for drastic cuts over the last two years. The proposal was temporarily shelved subsequent to what Senator John Melcher (D-Montana) called a "firestorm" of protests from Native groups. The administrative proposals would have constrained funding for Aides, 85% of whom qualified for welfare at that time, and curtailed subsidized health services for youngsters who are in the highest risk groups for notable traumatic injuries and infectious diseases. These issues are now under review in the Senate and studies may be funded to investigate the potential impacts of budget cuts and service curtailments (see McNabb, In Press. and 1990 for detailed reviews of these issues).

Furthermore, two recent Alaska State Supreme Court decisions struck down both local-hire preferences and the State subsistence preference law (see Alaska State Supreme Court 1989). Both were supported diligently by virtually all institutions in rural Alaska, by rural residents, and by Native advocacy groups such as the Alaska Federation of Natives. Local-hire preferences would have permitted local hiring targets as special privileges in economically distressed regions where municipal funds were being used in capital projects. The subsistence preference law provided a subsistence priority (not right) for certain rural residents when resources were sufficiently limited that unrestricted use was infeasible.

Institutional Forms

In institutional analyses, it is customary to examine both institutional organization (including structure as well as rules and procedures) and institutional performance and strategies. This discussion addresses forms of organization. Several examples are described that bear most directly on the first two ideologies (local control and access to natural resources), although the third (economic equity) is seen to be a natural outgrowth of the first two, since political power, self-determination, and natural resource uses have very dominant economic ramifications throughout Alaska. The examples are:

(1) ANCSA corporations
(2) co-management regimes
(3) regionalization (including municipal and new, innovative organizations)

ANCSA Corporations. When Congress passed the Alaska Native Claims Settlement Act (ANCSA) in 1971, 200 corporations (13 of them regional, the others village) were formed as vehicles for carrying out the intent of the Act. To date, relatively few corporations have prospered. One regional corporation filed for Chapter 11 bankruptcy in 1986 and reorganized over a two year period. Several surveys by the General Accounting Office show that in the post-1980 period, nearly half of the corporations lost money. Only one regional corporation has consistently reported profits. Estimates of total losses for one year alone, 1983, reach $150

million (Flanders 1989). Because statewide economic conditions have worsened since the time of these surveys, it is unlikely that the prospects of ANCSA corporations have improved.

Much analysis of these problems ensued after the first pessimistic observations surfaced, and some analysts have argued that these and other difficulties can be traced to the foreign nature of corporations (cf. Anders and Langdon 1989; Flanders 1989). Incorporation was an entirely new instrument of federal-Native relationships,[4] the argument asserts, and corporations do not integrate well with prevailing modes of Native social organization. This may be true, but consider only the financial problem. ANCSA stipulated corporations but left open the entire issue of organization and procedure. The corporations could have invested all their money in safe, relatively modest-yield portfolios. If so, every one would have shown a profit every year. Some opted to do so; most opted to go into business (Flanders 1989).

The origins of this decision are unclear, but it is notable that a pro-development political posture that encouraged capital investment in Alaska so as to develop vast untapped resources was very strong when ANCSA was passed and, in fact, was probably an important impetus for ANCSA itself. The new corporations possessed capital but they did not secure that capital as a means to exploit a resource or market that had already been identified. As a result, the corporations tended to invest in diverse business activities that were not necessarily related. At least in the case of the regional corporations, this led to the development of multi-industry conglomerates with multiple divisions (Flanders 1989).

Decentralized multi-divisional corporations have certain advantages: distinct, different markets can be tapped by relatively independent companies in charge of their own production and distribution, but some resources (specifically money) can be allocated rationally among and between the companies. This usually entails the creation of a new management class of organizers who are not involved in production itself. But conglomerates are difficult to manage (in part because of the cleavage between financial management and company management) and seem to work best only in times of economic expansion (Flanders 1989). These problems have been especially acute for ANCSA corporations. The problems are intensified by the fact that ANCSA corporations typically desire to promote economic benefits for their shareholders through local employment, which may be incompatible with more general profit-maximization goals.

Shareholders and corporation managers have mixed opinions about a key feature of ANCSA: alienation of stock. When ANCSA was passed, shares were slated to become alienable in 1991. Some, particularly shareholders who sought the right to sell their shares on an open market and step away from corporate enterprises they had only limited confidence in, favored those original rights. Others saw alienation as a threat to the integrity of key Native institutions and resources, and sought to limit or prevent the sale of shares on an open market. The ANCSA Amendments of 1987 require all corporations except for Bristol Bay and Aleut to vote on alienation before it can occur. The Bristol Bay and Aleut exemption requires those corporations to vote on extensions to the 1991 deadline and, in general, is interpreted as more

[4] Older Indian Reorganization Act (IRA) business cooperatives may be an exception, but note that those operated under the administrative oversight of the Secretary of the Interior.

"pro-alienation."[5] Those regions possess a rich economic base centered on commercial fisheries, and this alternative source of income, combined with corporation conflicts over several years, suggest that changes in ANCSA forms may correlate with economic factors already identified in the AOSIS program, specifically the distinction between fisheries economies and non-fishery economies that have proven salient in many ways.

Co-Management Regimes. Although ANCSA corporations are often charged with land protection and social or cultural goals by shareholders, other bodies exist in each region that undertake these roles. Conflict resolution over competing interests in local renewable resources is often carried out through co-management arrangements that involve local residents, policy makers, and government agencies. In some cases the arrangement is relatively informal but organized around existing institutional procedures, and in other instances the arrangement is established by policy or law. The brief examples described here illustrate both.

On several occasions, conflicts between resource users led to deliberations by Boards of Fish and Game that considered proposals to limit sport fishing and guided hunting access to resource areas used intensively by subsistence users. Wolfe (1989) compares two cases and identifies the differences that yielded success for the proposal in one case but failure in the other. One instance involved caribou hunting in the vicinity of Noatak in Northwest Alaska. The other focused on sport fishing near Togiak in Bristol Bay. In both cases the proposals originated in local communities and involved collaborative support among several administrative and advisory bodies, such as traditional or IRA councils and Advisory Fish and Game Committees. Data collected and analyzed by the Alaska Department of Fish and Game, Division of Subsistence, were presented as evidence in both cases. In the Noatak example, a broad coalition of resident and government groups secured unified and substantial support for a proposal to limit guided hunting during certain periods; the proposal was successful. In the Togiak example, the coalition organized in support of a proposal to limit sport fishing was matched by an equally or more persuasive coalition of business interests. The Togiak proposal was unsuccessful.

Northwest Alaska possesses a unique political structure since it is highly unified, and in addition is sufficiently powerful to dissuade competing interests from mounting challenges to the regional status quo in numerous cases. Institutional arrangements in the Togiak area lack these features. In the Noatak case, broad support was secured on a regional basis, and from Kotzebue, the hub. In addition, Northwest Alaska possesses a regional form of governance (Borough) which underlines an existing unification and permits even greater unification. The AOSIS program distinguishes between borough and non-borough, and hub and village communities, and finds that these distinctions denote important economic and political differences on a broad front. We suggest here that these distinctions may be salient in terms of general prospects for political recruitment and conflict resolution.

Differences in the relative success of conflict resolutions are also revealed in more formal co-management arrangements. For instance, a recent comparison of two cases, the Iditarod-George Block Planning Review of 1983-1984 and the Kuskokwim Area Plan of 1985-1988, notes substantial differences in the means employed in the federal case (Iditarod-George) and the

[5] The matter is far more complex than this, but the general interpretation offered here is sufficiently accurate to convey the main sense of the matter.

state case (Kuskokwim Area Plan) (Brelsford 1989). In both instances, government agencies (Bureau of Land Management and Alaska Department of Natural Resources, respectively) were required to consult with local residents to facilitate a process by which competing land uses were examined and then prioritized so as to identify an optimal use plan. In both cases the issues were volatile because local subsistence users reacted negatively to the mere idea of mineral exploration and some other consumptive uses in traditional lands; the meetings were contentious; and the proposed plans were eventually shelved to the relief of local residents.

But the state procedure for local hearings was spread out over three years, whereas the federal parallel was carried out over one year. The state procedure accommodated residents with bilingual translators; the federal procedure did not. State officials met often enough with villagers that personal relationships were established, which did not occur in the federal example. Local satisfaction with the procedure was greater in the state case.

Examples such as this may be idiosyncratic and may thus prohibit generalizations. But to the extent that these procedures reflect a relatively uniform method of consultation and review, land use reviews may engender greater hostility in areas now facing or eventually facing federal planning processes. Federal holdings in the state are immense and so no clear distinctions can be drawn, but overall this would entail slightly greater exposure to federal procedures in areas classified in the AOSIS program as Native and village.

Regionalization. The mixed success of ANCSA corporations in meeting regional needs has already been noted, but there are other forms of regional institutions that exist in rural Alaska. Their success is also mixed. There has been a strong trend toward regionalization in Alaska over the last two decades, since regional organization offers some of the same benefits noted for conglomerates. Several interrelated conditions that permit strong regional organization have been identified (see Anders and Langdon 1989; Gaffney 1982):

(1) cultural and linguistic uniformity
(2) coherent transportation and communications systems
(3) coterminous institutions (i.e., limited overlap)
(4) substantial local residence of regional ANCSA shareholders

The NANA region (Northwest Arctic Borough) is a paradigm case. Other attempts at regional organization have shown ambiguous achievements, due mainly to inabilities to satisfy conditions 1, 3 and 4.

Yet regionalization does not only entail the development of umbrella institutions with comprehensive aims. Evidence shows that regionalization occurs when specialized interests may be served by specialized organizations; when economic incentives are great; and when regionalization is sufficiently established that current organizational arrangements amplify themselves repeatedly (as in the NANA region).

The first two conditions are illustrated by the rapid incorporation of municipal borough governments in Southwest Alaska (Aleutians East, Lake and Peninsula, and a proposed Aleutians West) and commercially-oriented coalitions such as the Southwest Alaska Municipal Conference (SAMC). In these areas, many residents and institutional leaders express the belief that, due to rich commercial fisheries that provided large if unstable incomes and revenues, state transfers have been traditionally modest compared to other more impoverished regions.

But during the current economic decline, those transfers are more at risk and more than ever needed. Borough incorporation provides several benefits, one of which is a large share of state funds. In addition, increasing competition from factory ships has placed the key economic resource -- fish -- at risk. Although linguistic, cultural, and institutional fission has characterized these areas for decades, economic incentives that encourage regionalization are now very great. Commercial coalitions, such as SAMC, fulfill a similar but non-governmental need. The areas noted here fall into the AOSIS classifications for test and fishery communities and, of course, many now fall into the borough category.

Institutional Strategies

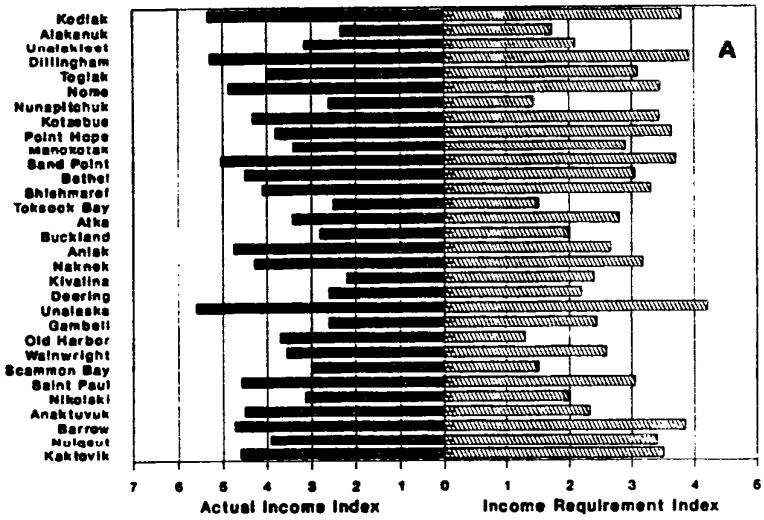
This section will examine only one issue: cost (and standard) of living. It relates most closely to the goal of economic equity that was introduced earlier. Here we move from administrative and corporate institutions to local commerce, specifically local retail trade.

The idea of "standard of living" is subject to the same problems raised in considering perceived life satisfaction. How much is enough? Attitudes about living standards vary, and tend most often to reflect past experiences and subjective comparisons to other people rather than objective conditions. Consider Figure 2, which compares actual income to expressed income needs, and expressed income needs to levels of subsistence consumption. These data, based on the AOSIS structured questionnaire, illustrate that respondents desire income at levels that are closely linked to their actual incomes. Expressed income needs weakly correspond to levels of subsistence consumption, but in the opposite direction: villages rated higher on the consumption index tend to rate a bit lower on the income need measure, and vice versa, probably because subsistence foods are to some extent "substitutable" for store-bought commodities.

But by and large, local costs vary dramatically, correlate poorly, and bear little relationship to distance from sources of supply which are typically invoked to account for price differentials. Certainly distance is an important factor, but in a comparative sense it explains relatively little about price differentials between rural villages, whereas it may in a comparison of Anchorage versus rural villages. Figures 3, 4, and 5 compare market basket costs for food and assorted retail hardware goods with income; expressed income needs; heating costs; electricity costs; rent and mortgage costs; and other utility costs. The sample villages are listed in order from lowest market basket costs (Kodiak) to highest (Kaktovik). Note that distance from sources of supply is a relatively trivial factor. Kodiak retail costs are followed by Alakanuk costs, yet Old Harbor is far more expensive despite the fact that it is closer to both Anchorage and Kodiak than is Alakanuk.[6]

So if the simplest explanation is too simple (because price patterns appear independent of distance *per se*), other factors must be considered. These include commercial scale (large operations being potentially more efficient and hence less costly than smaller ones), management skill, warehousing space, access to credit and revenue flow in general (low cash flow acting to impede prompt deliveries and inhibit bulk purchases), and transportation arrangements. By and large, it is likely that hub communities are better positioned to optimize

[6] The market basket costs are calculated on the basis of store surveys conducted in all or most retail outlets in each village. A standardized list of high-volume commodities is tabulated in each case.



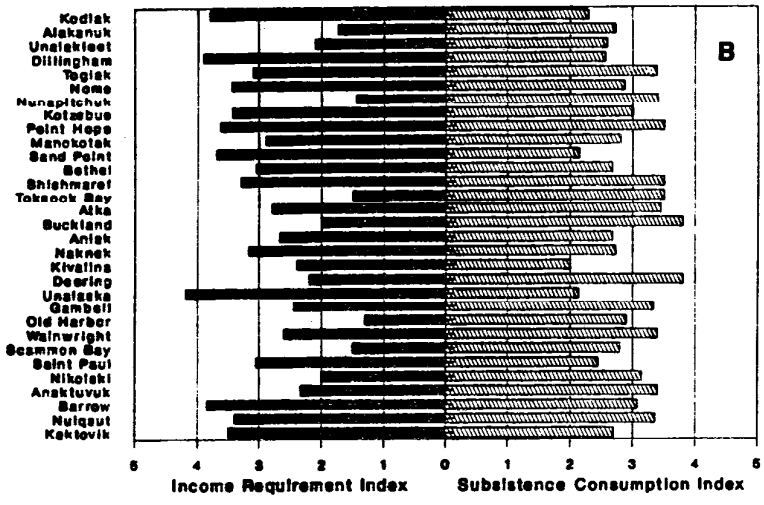


Figure 2. Standard of living comparisons: a) actual income and perceived income need and b) perceived income need and subsistence consumption.

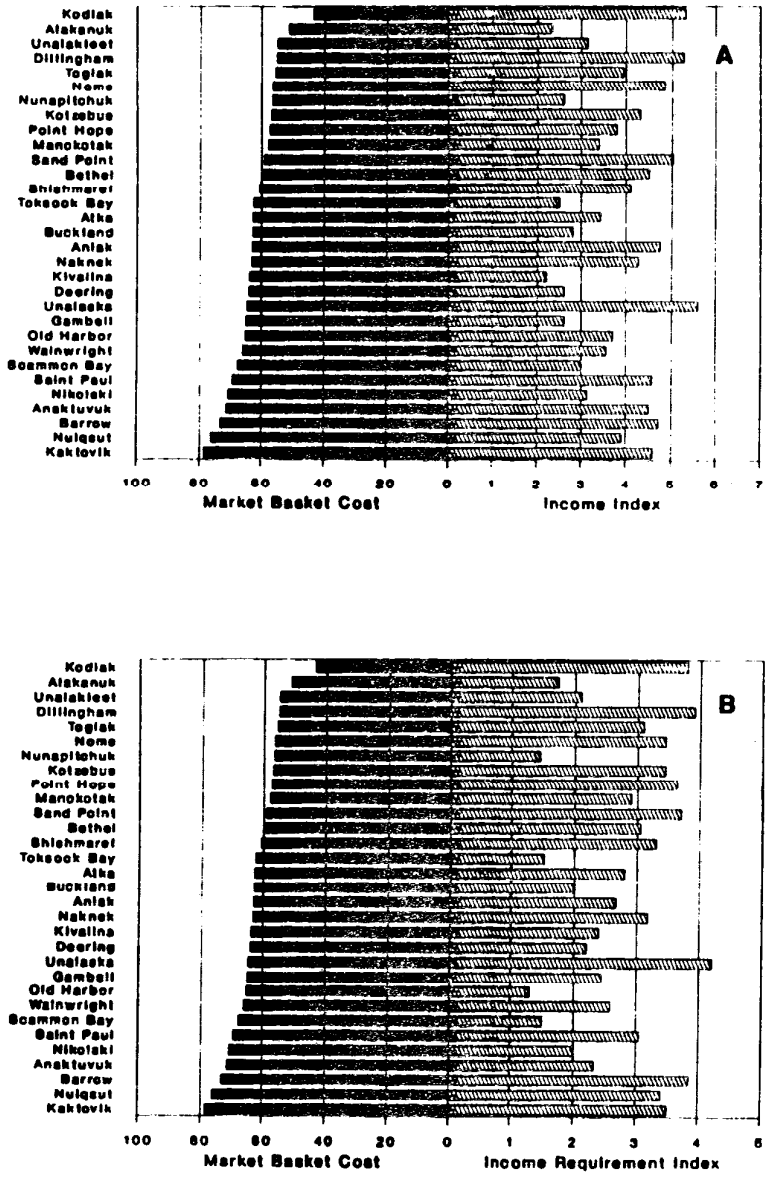


Figure 3. Standard of living comparisions: a) market basket and household income and b) market basket and perceived income need.

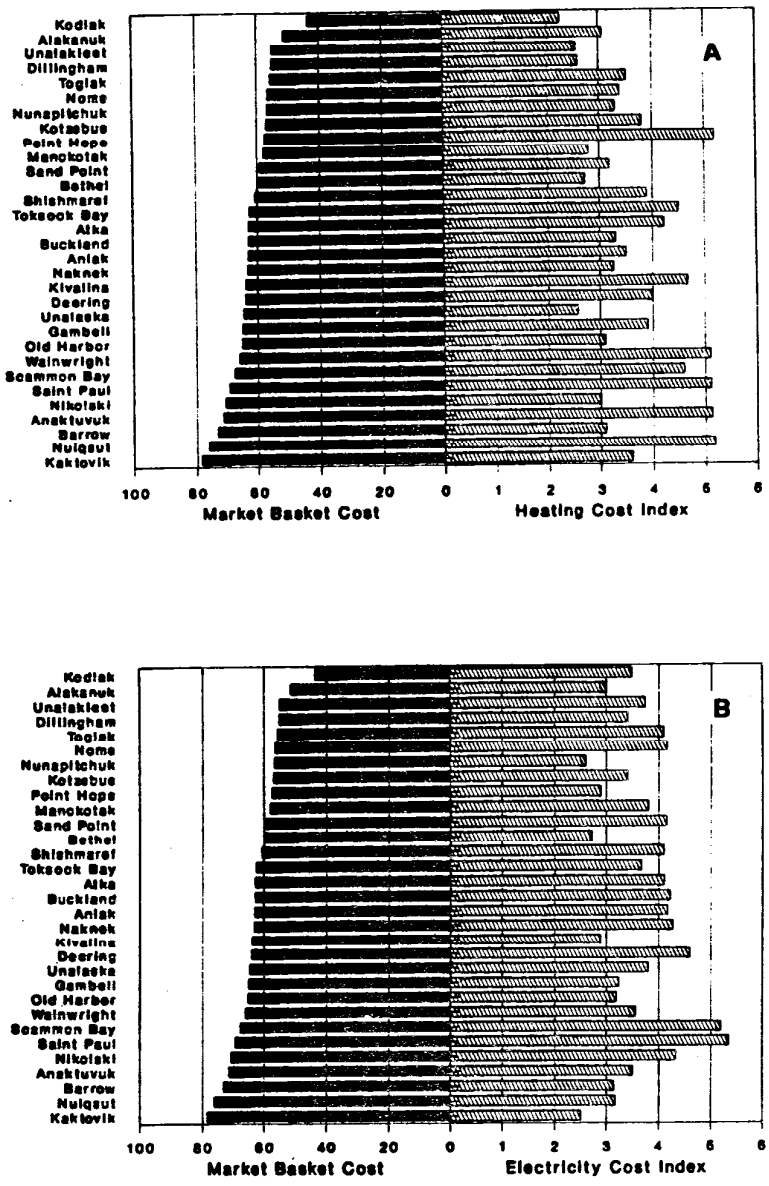


Figure 4. Standard of living comparisions, market basket and actual expenditures: a) heating cost index and b) electricity cost index.

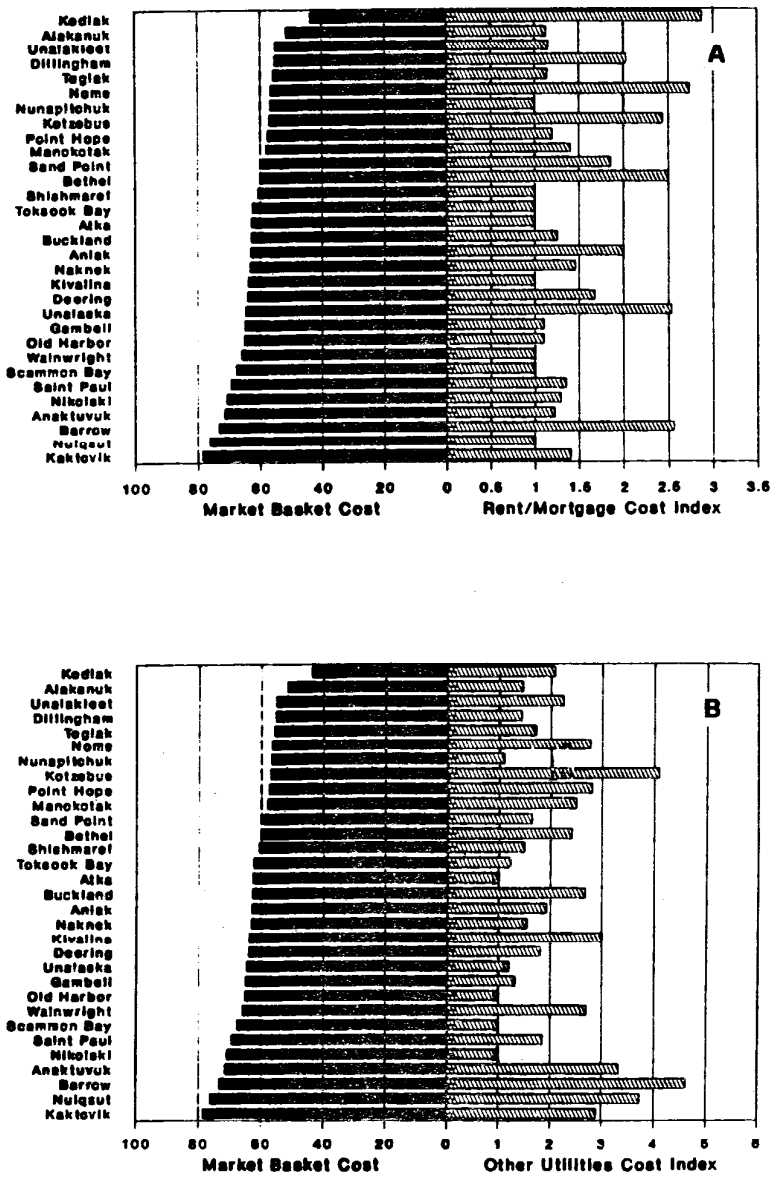


Figure 5. Standard of living comparisions, market basket and actual expenditures: a) rent/mortgage cost index and b) other utilities cost index.

these factors than villages. Similarly, communities with ethnically mixed populations, which tend to be hubs, may be positioned well. AOSIS data support these inferences only sporadically. Figures 6 and 7 compare selected costs by stratifying the sample along the dimensions used in the AOSIS sample design.

Borough village costs are somewhat higher except in the housing category; hub village costs are higher other than in the heating and repair categories; except in the case of heating, test village costs are higher than or equal to expenditures in control communities; and the mixed-Native comparison is similar to the test-control case. These comparisons do not address food and hardware expenditures, but they are sufficiently compelling to encourage some re-thinking of conventional premises about rural standards of living. Bear in mind that heating, rent and mortgages, utilities, and repairs are dominant expenditures everywhere in Alaska. These results suggest that standard (and cost) of living in rural Alaska is not explained by uniform rules. Specifically, the results suggest that, to the extent that economies of scale in hubs offer real cost of living advantages, other communities may behave like hubs and thus contaminate simple comparisons.

During the first two years of the study, team members examined these data and sought to combine them in multivariate analyses that would permit a unified examination of cost of living. To this end we undertook unidimensional cluster analyses that sought to identify homogeneous groups of cases (villages). That homogeneity was determined by examining all cost variables, including retail market costs, two variables that measured subsistence consumption, and income jointly. We knew case membership: village. We did not know group membership. On the basis of common interrelationships among all variables, cluster analysis produces a taxonomy of groups. We infer that those similarities correspond to similar costs of living.

Figure 8 displays the unidimensional solution for the first panels of data. Cluster analysis typically produces some self-evident groups and others that are less intuitive. For instance, note that several remote Arctic Coast villages produce a cluster: Point Hope, Nuiqsut, Anaktuvuk Pass, and Wainwright. Kivalina, just south of Point Hope, joins that cluster at a higher level. Please draw your attention to a large cluster toward the bottom which begins with Shishmaref and ends with Nome. Most of the hubs are found here, and the other common denominator is that the remaining communities were aggressive and consistent recipients of bypass mail. Bypass mail permits the direct shipment of goods, such as groceries and hardware, as airmail. Transshipment fees, warehousing in hubs, and other assorted costs are eliminated when bypass mail is employed. Other communities in the sample used bypass mail as well, but more sporadically than those identified in the lower cluster. Based on initial analyses, we hypothesized that "bypass mail" communities enjoyed relatively lower costs of living and acted like hubs in a taxonomic sense. Bypass mail may then be one factor that evens out variance among communities and complicates the item-by-item comparisons shown earlier.

But bypass mail was severely restricted at the close of the second year of field research. New federal transportation policies stipulated that carriers providing bypass mail service must eliminate service to hubs in proportion to their bypass loads. Since hubs are generally the most lucrative markets, these circumstances placed bypass mail in jeopardy. Aggressive advocacy efforts aimed at reversing the policy were mounted in some bypass villages, such as Togiak, but those efforts were unsuccessful. The team has completed another wave of research

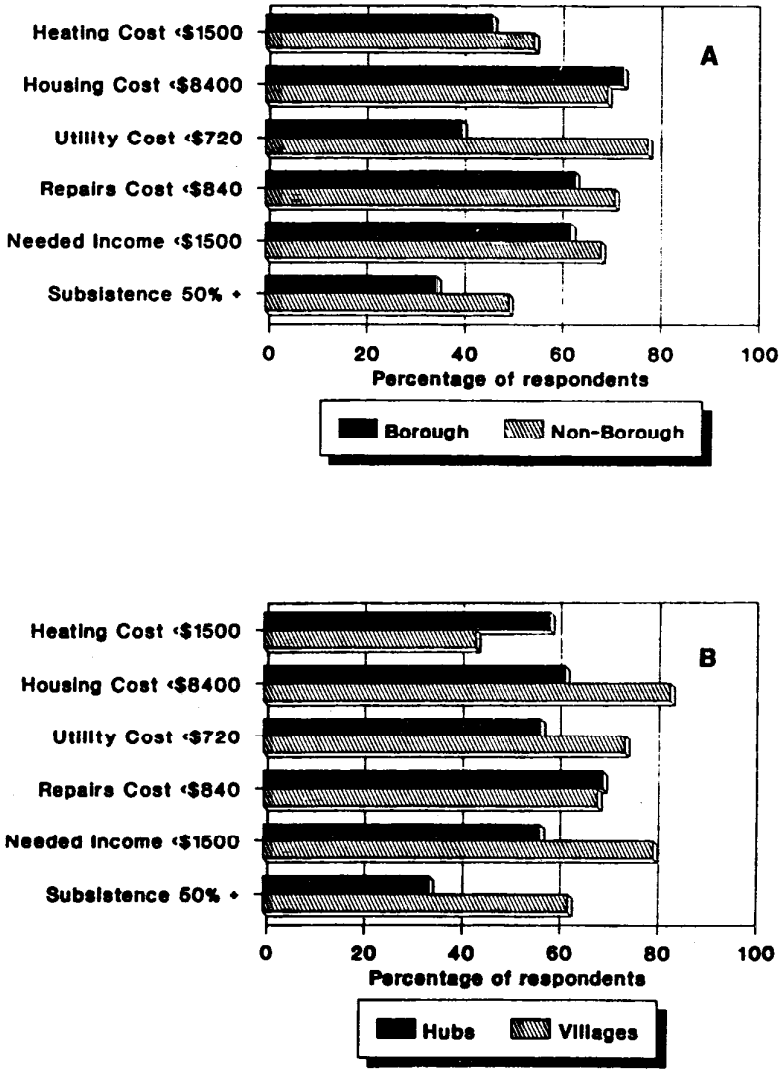


Figure 6. Stratified cost and income comparisons: a) borough and non-borough governance and b) hub and village communities. (Source: AOSIS data files.)

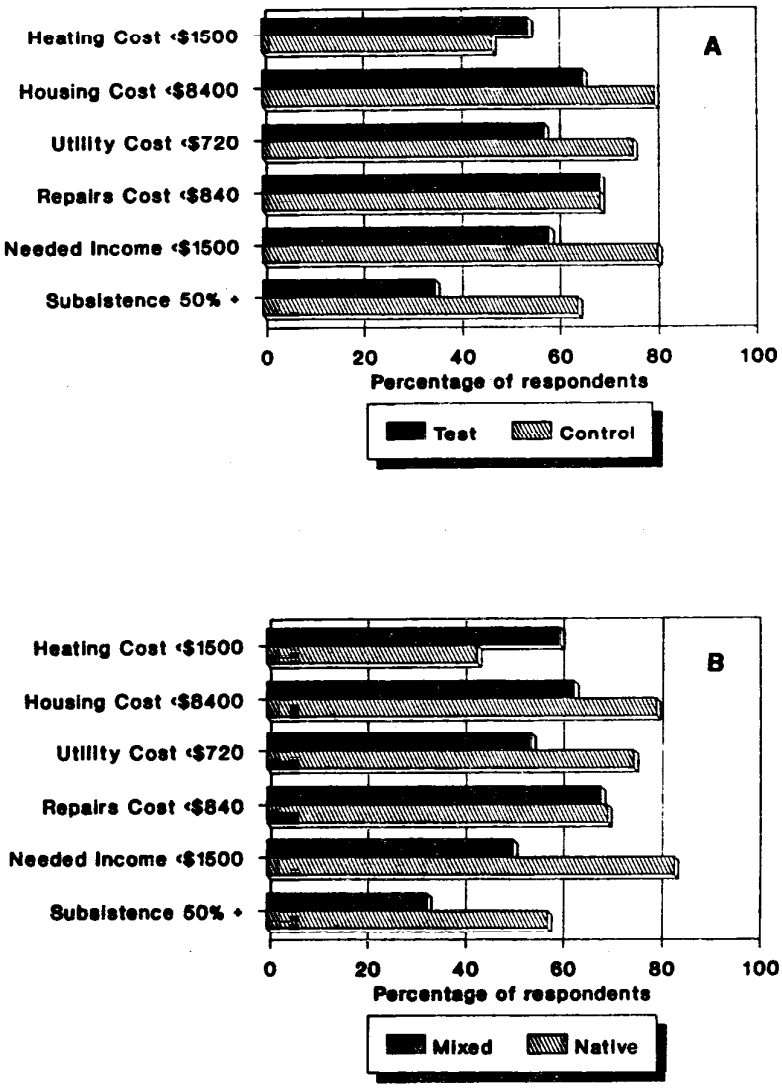
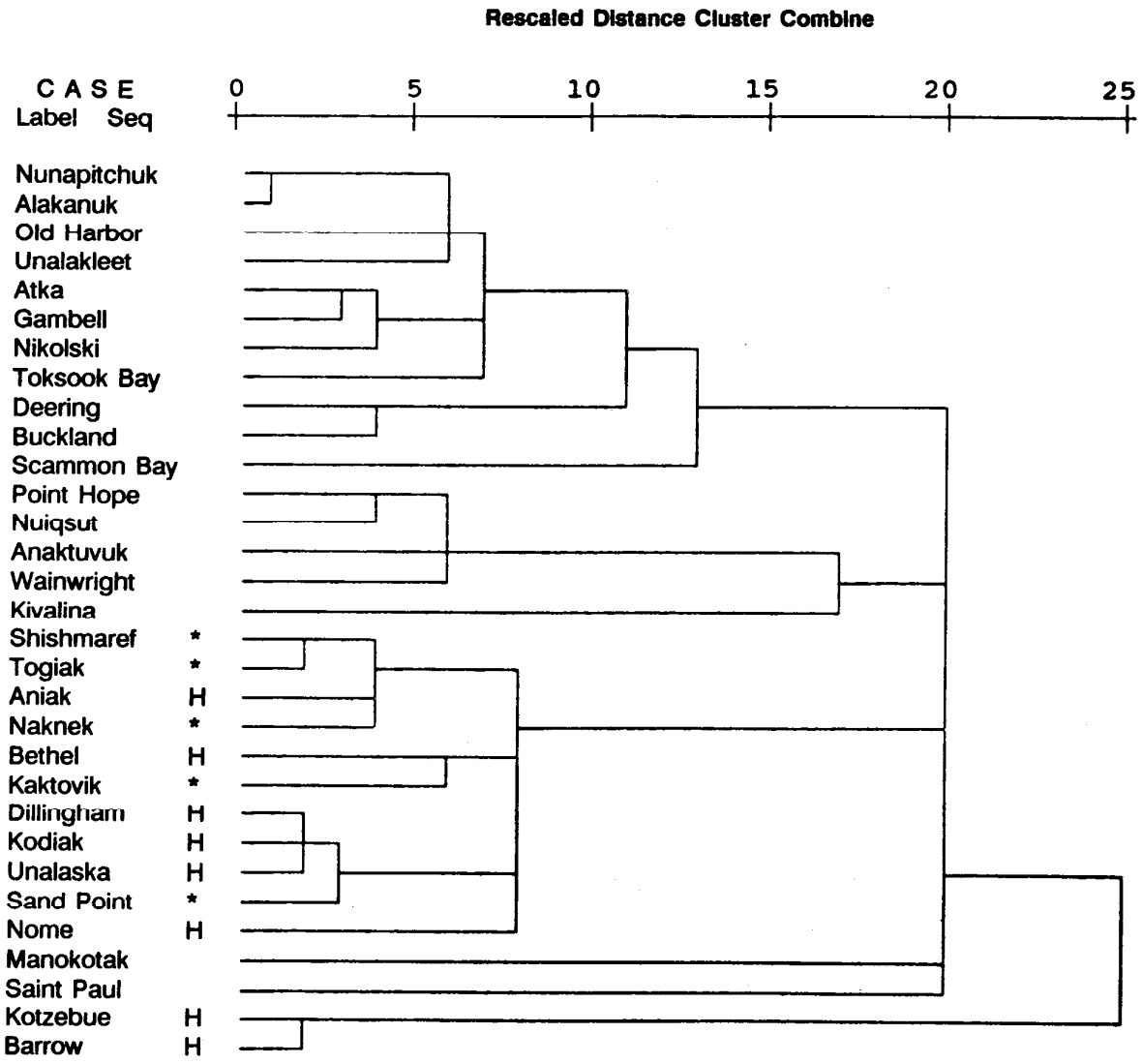


Figure 7. Stratified cost and income comparisons: a) test and control communities and b) mixed and native communities. (Source: AOSIS data files.)



* = bypass mail communities
H = hub communities

Figure 8. Schedule A and B cluster dendrogram. Ordinal categories for expenditures, income, and harvests (Standard of Living Index) for 1987 - 1988 initial interviews. (Dendrogram using Centroid Method).

in these communities, and the analysis described below seeks to illustrate the impacts of changes in this federal policy.

Figure 9 displays the cluster solution for 1989. A single large cluster at the top classifies the hubs and bypass mail communities as homogeneous with respect to these cost of living variables. Shishmaref and Kaktovik have been eliminated from that cluster due to declines in bypass mail use which, we infer, are related to cost of living changes that now remove those communities from their previous positions. Specific cost data disclose enormous price fluctuations, both up and down, in those communities over the sample interval. For instance, the cost of one perishable item, butter, increased in price by 140% in Shishmaref over one year. Note also that Unalakleet now clusters in the hub/bypass category. We had anticipated that it would have appeared there during the first year, had restrictions on a key carrier (Ryan) not terminated flights that would have boosted bypass reliance in that town. Ryan flights have been reinstated, and Unalakleet has changed cluster membership.

These analyses are incomplete and cannot fully reveal the mechanics of cost of living in rural communities. But their suggestive and supportive value is high. The results show that cost of living, and, we believe, standard of living and quality of life, covary with a broad range of political, economic, and social conditions. That covariance must be assessed with multiple tools for in fact the problems under analysis are multivariate and multidimensional. This does not mean that they are overly abstract. Although the effects of other variables, such as access to credit and cash flow in general, are not clear now, the impacts of one policy decision are very concrete and immediate. One aim over the next year is to continue to test hypotheses about standard of living with additional data derived from summer research in Prince William Sound and Cook Inlet, which will broaden the base of comparisons and permit careful analysis of standard of living subsequent to the *Exxon Valdez* spill.

LITERATURE CITED

Anders, G. and S. Langdon. 1989. Alaska Native regional strategies. Human Organization 48(2):162-172.

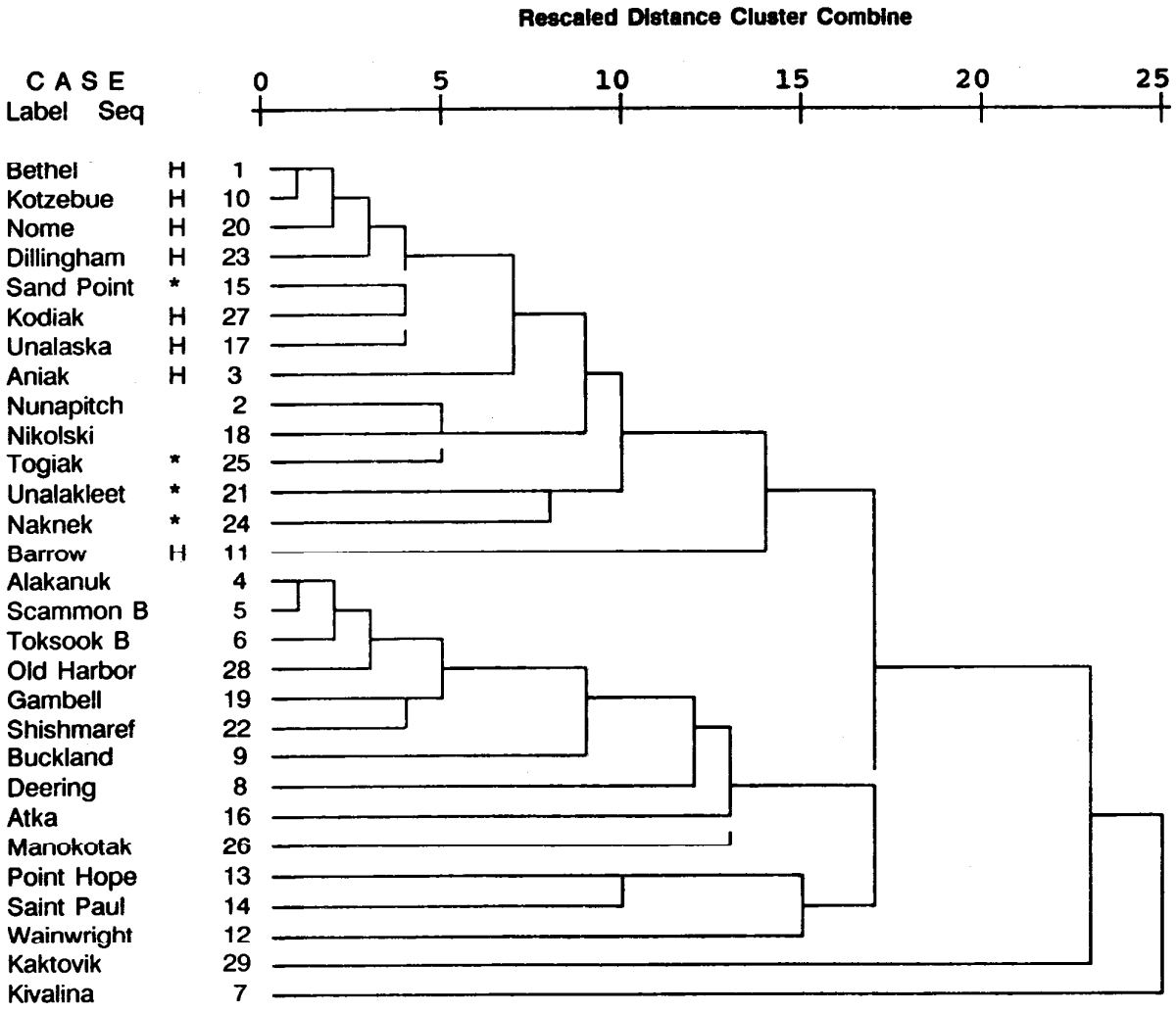
Andrews, F. and S.B. Withy. 1976. Social Indication of Well-Being. New York: Plenum Press.

Alaska State Supreme Court. 1989. Opinion. Supreme Court File No. S-2732, Trial Court File No. 3AN-83-1592 Civil. Sam E. McDowell, Dale E. Bondurant, Ronald Mahle and Harold Eastwood v. State of Alaska *et al.*

Brelsford, T. 1989. Alaska natives and public resource management. Paper presented at the Symp. on Collabortive Applied Anthropology in the North at the 1989 meeting of the Soc. for Applied Anthropology. Santa Fe, NM. April 1989.

Colby, B.N. 1987. Well-being: a theoretical perspective. American Anthropologist 89(4):879-895.

Flanders, N. 1989. The Alaska Native corporation as conglomerate: the problem of profitability. Human Organization 48(4):299-312.



* = bypass mail communities
H = hub communities

Figure 9. Schedule A and B cluster dendrogram. Ordinal categories for expenditures, income, and harvests (Standard of Living Index) for 1989 reinterview data. (Dendrogram using Centroid Method).

Gaffney, M. 1982. The human resources approach to Native rural development: a special case. Pages 15-24 *in* P. Cornwall and G. McBeath (eds.), Alaska's rural development. Boulder, CO: Westview Press.

Impact Assessment.1988. Village Economics in Rural Alaska. Technical Report No. 132. Anchorage: Alaska OCS Region, Minerals Management Service.

Levy, S. and L. Guttman. 1975. On the multivariate structure of wellbeing. Social Indicators Research 2:361-388.

McNabb, S. In Press. Native health status and Native health policy: current dilemmas at the federal level. Arctic Anthropology, summer 1990 (in press).

McNabb, S. 1990. Impacts of federal policy decisions on Alaska Natives. Journal of Ethnic Studies. 18 (1): 111-126.

McNabb, S. 1989. Northwest Arctic Borough Survey Results: Survey Analysis for 1987, 1988, and 1989. Anchorage: Social Research Institute.

McNabb, S. 1988. Alaska Native demographics: a growing "at risk" population. Pp. 15-24. In Nan Elliot (ed.), Alaska Natives At Risk. Anchorage: Alaska Federation of Natives and the Institute of Social and Economic Research.

McNabb, S., J. Mulcahy and L. Robbins. 1988. Alaska OCS Social Indicators System: secondary data and key. Informant Summary for Schedule B Communities. New Haven: Human Relations Area Files.

Wolfe, R. 1989. Territorial control of contemporary hunter-gatherer groups in Alaska: case examples of subsistence and recreation conflicts. Paper presented at the Society for Applied Anthropology Meeting, Santa Fe, New Mexico, April 5-9.

QUESTIONS AND DISCUSSION

George Edwardson: I am the president of the regional tribal government for the North Slope. Concerning your graph from 1980 to the 1985, it bothered me because I see a decline in my population. Does it put into consideration the state-abducted children? Personally I am sitting on 540 court orders that were served on people and their children were taken from them. It that included in your draft on the decline?

Steve McNabb: No that wouldn't be because on the far right, this represents people who are residing in those rural regions at the time of the census in 1980. The 1985 information are only estimates and what the state has done is that they have worked from the 1980 figures and then estimated with what they know about population growth and so on. This is probably how many people there are. They are very rough.

George Edwardson: Okay, so it never put in that consideration. So our growth rate continue like it was.

GAMBELL AND KENAI, ALASKA: COMPARISONS OF SOCIAL AND ECONOMIC CHARACTERISTICS

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INTRODUCTION

The purpose of the paper is to contrast two disparate communities to show the extremes in social and economic characteristics in the villages and cities selected by the Social Indicators Study (SIS), Gambell and Kenai, Alaska. Gambell is unique in possessing an Yupik-Eskimo clan system, depending heavily on a large variety of subsistence foods, isolated geographically from the Alaska mainland, and offering unusual opportunities for studies in social change. Kenai is urban, mobile, 97% non-Native, well developed economically, and a particularly suitable population for comparisons with the 38 villages and cities sampled by the SIS during the past few years.

This paper describes Gambell and Kenai, contrasts Kenai with Gambell and with aggregate data on the traits of the 31 communities in seven regions in western Alaska comprising the study areas of the SIS. The seven regions are: Nana, North Slope, Bering Sea, Calista, Kodiak, Aleutians, and Bristol Bay. There are some observations about the social and economic effects of the *Exxon Valdez* oil spill based on interviews of community leaders and others.

GAMBELL

Gambell is located on St. Lawrence Island and has been well studied by MMS social science contractors since 1982. Representative and complete samples for certain social and economic variables were obtained in 1982, 1987, and twice in 1989. Gambell has a population of 520 persons (about 5 persons per household), 95% of whom are Yupik-speaking Eskimos. Gambell is dependent on a wide range of naturally occurring species for 75% of its food and depends heavily on State of Alaska and federal monies for employment, capital projects, energy and other expenditures. Gambell's population has increased an annual average of 2%, despite limited economic opportunities.

Gambell has 11 patrilineal clans, making it unique in the SIS samples in processing this kinship system. The clans and their sub-systems, patrilineages, share money, equipment and labor to pursue whales, walruses, seals, birds, and fish. These resources are shared among clans, patrilineages in Gambell, Gambell's sister community on the island, Savoonga, and many wild foods are sent to mainland relatives and friends. One household may give to as many as 315 in a year. Gambell households average $26,000 per year from all sources of income, chiefly earnings from employment and sales of walrus ivory carvings and fossil ivory.

The majority of Gambell residents view nature as an important part of their heritage and history and to which many special meanings are attached. They also conceive nature as a source of livelihood from which one makes a living. Gambell is located in a strategic area for furthering relations with Yupik-speaking Eskimo in Siberia, advancing trade and tourism. The residents of Gambell regard energy developments with mixed feelings, but for the most part

Sharing (giving) money to kinspersons and friends within communities occurred at about four times as often in Gambell, twice as often in the seven regions (90 and 43% respectively) compared with Kenai (23%). Sharing money regularly occurs in 10% of Kenai households, 50% of the Gambell households and 16% in the households in the seven regions. In Kenai and Gambell there is a nearly one-to-one relationship between those who give money and those who receive it.

Seventy-nine percent of Kenai give labor assistance to other households in the city occasionally (62%) or regularly (17%), which compares closely with the seven regions' figure of 78% (47% occasionally, 31 regularly). The figures for Gambell are 25% occasionally and 63% regularly. The household rates giving labor to other households is very high in Gambell compared with Kenai and the other samples. In Kenai and Gambell there is a very high correlation between giving and receiving labor.

Thirty-six percent of Kenai households receive earned income from government sources, in contrast to nearly 50% in Gambell and 45% in the seven-region sample.

The Kenai residents are searching for ways to stimulate further economic development. The major divisions are between those who want more government (borough and city) controls over land and regulation of toxic wastes and those who do not.

THE SOCIAL AND ECONOMIC IMPACTS OF THE *EXXON VALDEZ* OIL SPILL

The major social and economic consequences of the oil spill to Kenai, according to the interviews conducted in August 1989 were:

1. The estimated net loss to the Peninsula's economy from the spill is about 20%. Its adverse effects will likely prevent the peninsula's economy from growing at a pre-spill rate of 2.8%, despite the large sums spent by Exxon on the clean-up.

2. The driftnet fishermen were and remain in great uncertainty about the amount of compensation they will receive from Exxon; as of fall of 1989 they had received about $30,000 each, a sum far below their gross annual income from commercial fishing. In January 1990 Exxon had agreed to much higher compensation than this.

3. Setnet fishers earned much larger sums than usual because of the closure of fishing to the driftnet fishers.

4. Because the central portion of the Cook Inlet channel was closed to commercial fishing, red salmon run was a record high in the Kenai River and its tributaries. The Kenai River had a run of about 1.4 million reds, about double the usual number. Dipnet fishing was also permitted on an unprecedented scale, increasing the larders of townsfolk.

5. Tourism increased over 1988, once travellers learned that Cook Inlet streams had not been contaminated by the oil spill.

6. Many businesses in the Peninsula were severely strained by losses of experienced and skilled employees to employment on the clean-up. Some businesses were on the

verge of closing and some owners and managers suffered from working long hours and from mental strain. Wages rose for all workers because of competition from the clean-up wages.

7. Most of the persons interviewed believed Exxon, the State of Alaska and the federal government were equally remiss in allowing the spill; all were at fault to some degree, according to interviewees; complacency and greed were the common causes cited, but nearly everyone believed similar accidents are inevitable wherever oil is transported in large sea-going vessels.

8. Most of those interviewed support oil exploration in Alaska National Wildlife Refuge; none supported oil exploration in Bristol Bay.

9. Fish processing plants lost many erstwhile workers to higher wages paid on the oil spill clean-up and the adverse publicity about environmental degradation caused by the spill. Some processors had to ship fish at great cost to plants in Kodiak because they lacked employees to keep up with the numbers of fish brought in by setnet fishers. Processors did not turn away setnetters because they need them as steady suppliers from year to year.

10. Suppliers of fishing equipment and fishing gear repairs lost a great deal of business with the driftnetters.

11. Crime rate in Kenai dropped slightly because some of the troublemakers left the community to work on the spill.

12. Energy companies in the Cook Inlet have been subject to new fuel transport regulations imposed by the State Department of Environmental Conservation since the spill; they also took initiatives to improve environmental safeguards on their own.

13. Many persons who worked on the oil spill believed that the effort was wasteful and perhaps damaging to ecosystems.

14. The spill caused adverse mental effects that are difficult to measure but are real nonetheless; apart from the wrenching effects of monetary loss for fishers and businesspersons, there was the loss of opportunity to enjoy some of the restful effects of commercial fishing.

CONCLUSION

The Kenai and Gambell studies made it possible to make important social and economic comparisons of very different populations. Despite its full immersion in the world economy, the Eskimo people of Gambell are in some respects classically traditional, with firm beliefs in symbolic and spiritual characteristics of nature, a deeply-rooted kinship system of great antiquity, considerable dependence on subsistence foods, and extensive sharing among households within the village and with other villages.

The seven regions, judged from the simple distribution figures presented here, fall between Gambell and Kenai in frequency of sharing money and labor, income, and meanings given the

natural environment. (We recognize that the seven-region, aggregated data include communities that are much more like Gambell in one extreme than Kenai, and others are more like Kenai than Gambell in another extreme).

Kenai is a modernized community with a fully-developed, diverse, fisheries, commercial and industrial economy which is resilient to some of the shocks of the fortunes of the state's economy and prices for commercial species of fish. It is nonetheless subject to adversities caused by rapid changes in state funds. Kenai practices a considerable degree of sharing money and labor among households and local use of wild species. Its household size is small and many persons are flexible and able to leave the community if the economy worsens. Gambell residents, on the other hand, usually stay in their home community despite changes in economic conditions.

The *Exxon Valdez* oil spill caused many adverse effects on the Kenai economy and in the personal lives of many of the people. Most of the people believe that responses to the spill will result in greater safeguards on the part of industry and government and fewer such accidents, but they believe spills of large magnitude are inevitable. They also believe that all parties involved in the spill, government and industry, were at fault to some degree in contributing to the accident.

REFERENCES

Impact Assessment, Inc. 1988. Village economics in rural Alaska. Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

Little, R.L, and L.A. Robbins. 1984. Effects of renewable resource harvest disruptions on socioeconomic and sociocultural systems: St. Lawrence Island. Alaska Outer Continental Shelf Office, Minerals Management Service. Tech Rep. 89. Anchorage, Alaska.

Robbins, L.A., and R.L. Little. 1988. Subsistence hunting and natural resource extraction: St. Lawrence Island, Alaska. Society and Natural Resources, Volume 1(1).

VORCO Consultants. 1989. Oil spill economic impact on the Kenai Peninsula Borough: An Early Assessment. The MEDD Group, Kenai Peninsula Borough.

QUESTIONS AND DISCUSSION

Ray Emerson: I was wondering why we would have a comparison between Gambell, an isolated island up north, and the community in Kenai, which is probably at the other extreme end of the spectrum? Is there some relationship we might draw between the spill effects to Kenai and what we might expect with Gambell? I really question how we could make that comparison.

Lynn Robbins: I did the comparison just to show you the extremes in the range of social characteristics of two communities in our total array of communities. That is the only reason I did. I really didn't do that to give you some guideline about differential effects of an oil spill on two different kinds of communities. Does that answer your question?

Ray Emerson: I guess, but if we were to make that kind of a comparison, you probably had a village or a community more similar to Kenai that was not affected by the spill which would be your control?

Lynn Robbins: I am not in a position to answer that. I think Don Callaway might.

Don Callaway: That is correct, Ray. Part of the problem is the research conducted directed specifically to the oil spill has caused an interruption in the natural flow of the project. So that the data processing and computerization of a lot of the data has suffered while we have done this additional field work. We are still trying to clean the data and enter it for the communities involved in the special research on the oil spill. But we have controls for Kenai. One of the interesting things was, as Joe mentioned, a number of communities were surveyed three weeks prior to the spill. A number of others were surveyed in our normal sample afterwards. So that we will certainly make comparisons between the changes in their perceptions, for example, before and after the spill. And we will make comparisons between the Kenai and communities in Prince William Sound, the Inlet, Kodiak, and the Peninsula, the smaller Native communities and Kenai. So we have a number of contrasts, comparisons, and controls. We just simply don't have the data now to present that. Anecdotally, I can mention, as I am sure all of the others on the table up here, but I remember stepping into Nunapitchuk three or four weeks after the spill. The vice-chair of the IRA coming up and saying: "The spill is 100 square miles. We are concerned about the migratory birds we depend on in the spring that come through the Copper River Delta and Prince William Sound." My own personal experience in Kaktovik had indicated that people were still reluctant to agree to offshore oil development, but were more than willing to deal in some respects with Arctic National Wildlife Refuge (ANWR). I think that attitude has changed and may be reflected in our research. So that the Prince William Sound oil spill has reverberations throughout all of Alaska. People are intimately aware of some of its effects and are concerned. But I am afraid those comparisons will have to wait until the data has been processed.

THE PERSISTENCE OF SUBSISTENCE AND THE STATUS OF NATIVE ELDERLY IN ALASKA COMMUNITIES

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Based on a sample of 716 informants in 31 rural Alaska communities (Table 1) this paper describes how subsistence activities vary by ethnicity, age, and marital status. Based on the total contribution of subsistence products to the informant's diet dramatic differences were found between Native and non-Native populations. Two out of three Native informants depend on subsistence products for the majority of the meat protein in their diet, less than one in five non-Natives had a similar dependence.

Table 1. The sample.

N=716, 31 communities, 7 regions

1)	Calista	135
2)	Nana	113
3)	North Slope	133
4)	Aleutians	129
5)	Bering Straits	82
6)	Bristol Bay	74
7)	Kodiak	50

Sample Size by Ethnicity

Alaska Native	543 (76%)
White	149 (21%)
Other	24 (3%)

Table 2. Alaska native sample by age category.*

Age Group	Sample Number
18 - 30	170 (24%)
31 - 40	209 (29%)
41 - 64	275 (38%)
65+	62 (9%)

* Note: Informants were selected from individuals 18 years old and above. Those under 18 represent about half the total population. Thus, those 65+ are about 4.5% of the total population but represent about 9% of the sample population.

SUBSISTENCE USE BY AGE CATEGORY

When one breaks the Native sample into age categories (Table 2) it is evident that increasing age brings increasing dependence on subsistence foods. Does this increasing dependence signal a real change in cultural behavior? Can one infer that younger Natives are switching their food preferences, while older individuals, more conservative in their habits, continue to rely on traditional foods? Analysis revealed that this is not necessarily the case. Within Native culture, gifting and reciprocal relations span lifetimes. Gifting at one point during the life course, usually during the most productive middle aged years, is complemented by receiving during other stages childhood, adolescence, and old age. It appears that the youngest age groups are learning subsistence skills or are engaged in establishing themselves, either through schooling, wage employment, and/or marriage. Thus, the youngest (51%) and oldest (50%) informants depended on others outside their household to provide subsistence products. In contrast, over two-thirds of those established household heads in the middle of the family cycle provide for their own subsistence products.

LEVEL OF INCOME AND SUBSISTENCE USE

The total amount of income available to household has no association with dependence on subsistence products; and while the technology to obtain subsistence products is expensive, Native households through a variety of social and cultural practices, share the means to obtain or receive subsistence foods.

SUBSISTENCE USE AND NATIVE LANGUAGE RETENTION

This preliminary investigation also revealed two areas of social change that may be independent of the effects of the "family cycle." There is a clear and strong relationship between age and the use of Native language at home (Table 3). In addition, 80 to 90% of those under 40 years of age who don't speak their Native language are clearly dissatisfied with this inability. As Table 4 indicates, there is a significant relationship between not speaking one's Native language and lack of involvement in subsistence activities. The relationship between Native language use and subsistence is not necessarily causal, in fact both outcomes are most likely related effects of other complex causal processes. In addition, various panel members pointed out research that indicates some Native language acquisition by individuals over the age of 40. Nevertheless, I believe the high degree of association between the two phenomena warrants close attention and further investigation.

Table 3. Native language use by age category that never/sometimes spoken at home.

Age Group	Sample Number
18 - 30	70%
31 - 40	60%
41 - 64	37%

Table 4. Native language use and dependence on subsistence.

Subsistence part of meal yesterday		No	Yes
Native Language Use:	Never	50%	50%
	Sometimes	30%	70%
	Most of Time	17%	83%

Table 5. Marital status of Alaskan natives by age group.

	Married:	No	Yes
Age of Respondent:	18 - 30	50%	50%
	31 - 40	33%	67%
	41 - 64	25%	75%
	65+	50%	50%

GENDER, ETHNICITY, AND MARRIAGE PATTERNS

Table 5 reveals a marital status profile one would expect from a common "family cycle." Younger household heads have lower rates of marriage, middle-aged respondents tend to be more stable with long-term established households, and elders face higher rates of single person households due to mortality of spouses. However, analysis also revealed that younger households (half of whom are unmarried) marry spouses of different ethnic groups at a rate four times that of older household heads. Our results seem to imply that very few people "married out" 50 years ago, and those that did were men. During the last 20 years, one in four females marry a non-Native spouse while few men under 40 and almost none under 30 marry outside their ethnic group.

The reasons that young women marry non-Native spouses are complex. Women tend to have better educational skills and more often migrate to "hub communities" which have greater demand for "white collar" skills, the basis of much of their employment. Younger men on the other hand tend to be employed locally at seasonal or construction jobs. Learning the local area for subsistence pursuits also ties them to their natal community. Finally, younger men have higher rates of substance abuse which makes them less attractive spouses during this period of their life.

As one might expect, intermarriage brings two sets of cultural expectations to the relationship. Will this have some influence on subsistence activities? As we have discussed previously, only about a quarter of non-Natives actively engage in subsistence pursuits. Thus, Native women married to non-Native men may have less access to subsistence foods from their spouse although the household might have access through her extended family. However, preliminary analysis of the Social Indicator's data indicates that gender, ethnicity, and intermarriage does have some impact on the consumption of subsistence products. Table 6 shows a reversal in subsistence utilization. Only one-third of young informants married to non-Natives had subsistence products as part of their meals, while nearly 60% of informants of the same age married to Natives utilized subsistence products as part of their previous day's meal.

Table 6. Spouse's ethnic affiliation and subsistence use.

		Subsistence Products Part of Meal Yesterday:	No	Yes
Alaskan Native Spouse		18 - 30	41%	59%
		31 - 40	23%	77%
	(N=301)	41 - 64	18%	82%
		65+	15%	85%
Anglo Spouse		18 - 30	67%	33%
		31 - 40	56%	44%
	(N=39)	41 - 64	50%	50%

THE STATUS OF NATIVE ELDERLY

Health

As one might have expected, there is an inverse relationship between an assessment of health and age. Seventy-five percent of those 18 to 30 describe their health as being good or very good. Less than 35% of those 65 and above (regardless of gender) report themselves to be in good or very good health. There is a strong (gamma= -0.69) and significant relationship between health status and dependence on others for subsistence products in those 65 or older. Elderly informants who report themselves in poor or fair health depend on others outside of the household for subsistence foods. Those in good health usually rely on household members, while those males in very good health rely on themselves. Unmarried elderly women in poor health are the most dependent on others for their supply of subsistence products.

Income

While the elderly are unlikely to be in the higher income brackets (>$40,000), there is no statistically significant difference between the age of a Native informant and household income. For those 65 and above, about one-third of the males and one-half the females have incomes of less than $10,000. Surprisingly, two-thirds of rural Alaskan Natives 65 and older live in households that earn less than $20,000 a year. In contrast, 81% of the elderly living in Juneau earn more than $20,000 per year.

While 10% of Native elders (65+) are involved in commercial fishing or their own businesses, nearly one-third of all Native informants under the age of 65 have such an involvement.

QUESTIONS AND DISCUSSION

Lynn Robbins: When you said that beyond age 40 the range of subsistence foods that people eat seems to widen. Do you think that those who are now 40 and younger are likely to have a diet similar to those who are over 40 in the years to come?

Donald Callaway: Yes, with the exception of the mitigating factors of intermarriage and language loss, although that occurs way before the age of 40. But it seems to me that certainly a number of the processes and intrusions that we worry about: wage economy and dependence upon that, taking away from time for subsistence activities; wage income reducing the more toward the protestant ethic aren't evidenced in the kind of distributions that we have seen. So it is my anticipation with those exceptions, that people as they move into the older age categories will depend more upon subsistence and will be donors until they reach the age of 65. Now I still don't have an answer for why the 18 to 30 year olds in our sample are receivers rather donors, because that really is at variance with a lot of the ethnographic literature.

Joseph Jorgensen: You have to control for employment and education.

Donald Callaway: I control for employment, marital status, education, a number of things, with partial table analysis and really couldn't ferret it out.

Ray Emerson: I just want to answer that one question about why the 18 to 30 year olds are still receivers. I have actually two of those in my household at this time. One is approaching 28 and I am hoping that I will start to be on the receiving side here soon. However, in my case, I am not sure that 30 is going to be the break off there, Don. It doesn't look good right now.

Donald Callaway: And you are facing an ethnic shortfall, too, Ray.

Ray Emerson: Well, we are working on that in one particular case. I wonder do you see along that same line with the receiver, the donor, and the receiver concept in a later age, there are some similarities to our more urban cultures here. I think there are also similarities, say in Anchorage, with Hispanics, etc. I think we can find studies throughout the country, where the kids especially in a peer pressure situation do not want to recognize their cultural heritage and possibly will not pick up when the language is maybe spoken in the home by the parents. So when you are bringing these things out, we are probably not discovering anything that is not too new. It is reinforcing some basic behavioral patterns within growing up in a pressurized, multimedia environment.

Donald Callaway: Well that is not true. It is really complex and really varies by region. But historically, Natives, especially those over the age of 40 that were sent away to St. Mary's or Edgecombe or wherever, were dissuaded from speaking their native language, even in non-schoolroom settings with their friends, and so forth. As a matter of fact, physical abuse of one kind of another was used to deter them from doing that. Later on as they came back to the communities, and I will use the North Slope as an example, they were told that for their children to succeed, the children must be monolingual in English because that is the language of employment. So they were faced with the uncomfortable dilemma of trying to do the best for their children and at the same time watch, something their children now regret, the language

begin to disappear. But that is the North Slope, it doesn't work that way in the Yukon-Kuskokwim (Y-K), it doesn't work that way in NANA.

Ray Emerson: That was a mistake and I don't think we are doing that anymore. But we are still seeing the trend where the lower age groups are still denying the native language.

Donald Callaway: It is not a denial, it is a recognized and heart-felt need. As I mentioned Y-K is doing something about it, the North Slope has discussed innovative programs where child care is conducted by grandparents so that the children are put in an immersion setting. But from what I read from the literature it seems that those above 55 years tend to be fluent in their native language. Those in their 40s to 50s or 38 to mid-50s tend to be bilingual.

Ray Emerson: Which goes with your dietary shift possibly with age too. We are not picking up on the subsistence food sources until later when maybe we have more of a secure position of where we are in life.

Donald Callaway: Let me put a big caveat in here. These are very preliminary findings and I have been wrong already, but I didn't control for the differences between Native and hub communities or borough and so forth. And many of these findings that I have here may disappear upon closer examination. In other words this phenomenon may be restricted to hub communities and non-Native, I simply don't know.

Steve McNabb: Actually I think you've got a point and it is one that linguists are only starting now to understand. That is the problem of delayed acquisition in languages that have minority status. The problem that you have in looking at previous studies is that they are cross-sectional. So you see people who are 55 years old speak the language, people who are 18 do not. You assume it is going to disappear. When in fact the problem is there is delayed acquisition, they don't speak it very well at 18 but they speak it much better at 30 and much better at 40. So the acquisition is much delayed. Whenever you find lots of language change occurring it is usually because of delayed acquisition. Because the kids are learning it from their parents who are 25 who haven't finished learning the language yet. That is a possibility.

Donald Callaway: That is a possibility. I am not sure, I mean I need to see the studies on that. My experience in southern Ute don't indicate that to be the case.

Joseph Jorgensen: My experience in northern Ute do.

Donald Callaway: They are two very different communities.

Joseph Jorgensen: I think that these two people are the ones that are going to follow Don. That in fact the language acquisition for person under 30 occurs after 40 and also vigorous activities in traditional customs of all kinds increases after 40. Furthermore in cross-racial marriages, persons who out-migrate are almost invariably white males, when the job dries up. So to control for the use of subsistences resources and the use of the language and other customs that are traditional customs, you really have to control employment with white males, in cross-racial marriages. Even if they increase the number of subsistence goods that they harvest annually. I think that is a real crucial part in the analysis that you've done. The importance of the male, to knowing the territory...

Donald Callaway: Maybe you have misunderstood me. There were no white males in these tables.

Joseph Jorgensen: Non-Natives. If you have cross-racial marriages, and if most of the marriages you record, which fit with everything that we have done, are between Native women and non-Native men, a much larger proportion, if they reside in a Native village, a village-village as opposed to a hub, the male is employed. He has less time to pursue subsistence resources and they leave if the job is terminated. And that might mean that they leave in droves from the North Slope if their bonding rate drops from a AAA to a B and so forth.

Charles Degnan: In the study of Alaska native groups and their dependence upon subsistence resources, you have to take into account the historical bias of the governing bodies that want to extract the resources from the area. The patterns of hiring, the patterns of employing Alaska Natives by sex. I have noticed the practice of hiring Native women over Native men. The pressure is put on the communities to extinguish culture and the discriminatory practice against the native group as a whole by people in the government. It would be interesting to see whether that was a institutional discrimination and if that was subconscious or overt.

Johnson Eningowuk: I had a couple of questions for you. One is that you mentioned the decline in the subsistence hunting and usage. The question I had was did you put into consideration when the Alaska Fish and Game starts telling my communities, I have eight communities: Point Hope, Point Lay, Wainwright, Barrow, Atqasuk, Anaktuvuk, Nuiqsut, and Kaktovik. Like for Point Hope for example, I have a Park Service over there that goes in and takes subsistence sites away from my members over there. In Point Lay I have the same problem from the same Park Service. In Anaktuvuk Pass I have Gates of the Arctic employees who come in to burn cabins and forbid my subsistence users from using their historical hunting sites. In Kaktovik, I have ANWR enforcers from the federal government that stop people from going to their historical sites. In Nuiqsut, I have the oil field that comes in and cuts my hunting sites in half. Have these been put into consideration in your studies?

Donald Callaway: Well first let me correct what I hope was not a misapprehension. I haven't said subsistence activities have declined in Native groups. In point of fact, I think that the data I presented shows that it is a strong force in all of the communities that we surveyed. I simply mentioned declines in certain areas in very small subpopulations. And some of them I explained as part of the natural family cycle. So I would not say that subsistence as an activity, as a cultural value, as an engagement in life has decreased in Native communities based on the data that we have collected. We are concerned and I think Joe could probably address this better, but we are concerned about the intrusion of outside agencies that in fact require adjustments and certainly what we are facing now in the state with the striking down of the current subsistence law is a time of turmoil and concern.

Johnson Eningowuk: I am not trying to discredit what you are trying to say, I am just trying to find a way to use it for my talking with the federal government. The other subject that I wanted to point out is in my eight communities I have unemployment that sometimes gets up to 97%. Where you see heavy subsistence usage is, myself personally, out of each community, I'll order two of the best hunters out to go catch whatever they catch and their catch is mine. Then I aim them toward the people that need the usage. Another thing to put into consideration, is that 18 to 30 trending away from the use of the language and subsistence usage. That age group has left in order to obtain higher education in the western society. That is the age group that

is going to the higher schools and going to school away from home and don't have time to learn their normal subsistence life styles that will come to them later on.

Joseph Jorgensen: We capture the young men and women who are away from the village at school only because they are a member of the household away at school. For the people that Don Callaway has been recording, the 18 to 30 are those who are actually in our samples. We have talked to them in the villages. We have evidence to show from our study over the past three years that the take of subsistence resources has increased in some North Slope villages. We have known that however since times got hard in 1984. There is a big difference just in the way in which income has been used between 1982 and the present in some North Slope villages. We have systematic information however for only three points in time. That is why a monitoring study like this when we deal with 18 to 30 year old people and we find that they are receivers rather than givers, it doesn't mean to me that they are not going to be givers at age 40. One of the things that you will see if you look through those subclassified tables, the partialing tables in my paper, is that with age, youngest people throughout the sample are about split on who they want to manage resources. Men under 30 and women under 30 are about fifty-fifty, it is the state. Women and men between the ages of 40 and 60 are about three to one to four to one, regardless of ethnicity, for the Natives. They are the people who are hauling in the resources, processing the resources and distributing them out. People over 65 think that scientists know the most and the state should manage. I think that there is the same cycle that Don was talking about earlier as a family household cycle that operates in language acquisition, traditional customs and the importance to maintaining resources, people who complain about the regulations of resources by state and government, probably since 1971, but I've only been coming to Alaska since 1981, are persons who are actively and daily engaged in the acquisition or extraction of naturally occurring resources.

POINT LAY CASE STUDY

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Very little is known about the village of Point Lay and oil exploration is currently underway in the area (Figure 1). Point Lay is the smallest of the North Slope Borough (NSB) Native communities and thus may be more sensitive to developmental effects, or may differ from other NSB communities in other respects. The objectives of this study were: 1) to conduct an ethnographic study of Point Lay and a smaller parallel study of Point Hope; and 2) to analyze similarities and differences between North Slope communities, specifically Point Lay and Point Hope, focusing on certain key issues.

This study was designed to be based primarily on fieldwork. The design of the study was rather complex, as a secondary aim was to assess how representative Point Lay is of other NSB villages. That is, can the results of this study be generalized to other NSB contexts?

For this purpose, short periods of fieldwork in Point Hope were built into the project which allowed for a limited direct comparison between the two villages. Fieldwork periods in Point Lay were September 1987 through early January 1988, March 1988 through June 1988, and April 1989 through May 1989. This research was conducted by a single researcher who was also in Point Hope for part of the September 1987 and June 1988 periods. Less field time was devoted to Point Hope and was primarily the responsibility of a second researcher, who was in Point Hope for all or portions of September 1987, November 1987 through December 1987, March through April 1988, and April 1989. Dr. Sverre Pedersen of the Alaska Department of Fish and Game conducted a subsistence survey in Point Lay in January of 1988, the results of which were written up as part of this project and incorporated into the "subsistence" section of the report. Dr. Pedersen is responsible for survey data, but not necessarily the conclusions we have drawn from these data. Ms. Yvonne Yarber conducted the "oral history" portion of the research in three visits to Point Lay in May 1988, May 1989 and July 1989. The result of this work appears in the *Point Lay Biographies* volume. Dr. Lawrence Kaplan wrote most of the section on "language" which appears in the case study, but the examples of language use in the villages are drawn from the fieldnotes of the primary researchers.

Point Lay, with a 1988 population of 158, is the smallest village on the North Slope. It is about 83% Inupiat, which is typical for the villages outside of Barrow. The population pyramid is quite irregular and the upper age groups are greatly underrepresented. The age groups of 6 to 10 and 11 to 15 are also small, especially compared to the large cohort less than six years of age. Adults of ages 26 to 30 and 31 to 35 are also fewer than would be expected in an ideal population model. Sex ratios for certain cohorts are also quite extreme, but can change rapidly from year to year due to movement into and out of the village. The most serious problem in the recent past seems to have been the scarcity of teenage girls, especially given the small number of teenagers overall.

Point Lay Inupiat households are the smallest, on average, of all the NSB villages. The predominant household structure is that of the nuclear family. A significant number of households are single-person or single-parent households. Many nuclear households contain adults who have been previously married. Nearly all households contain at least one wage

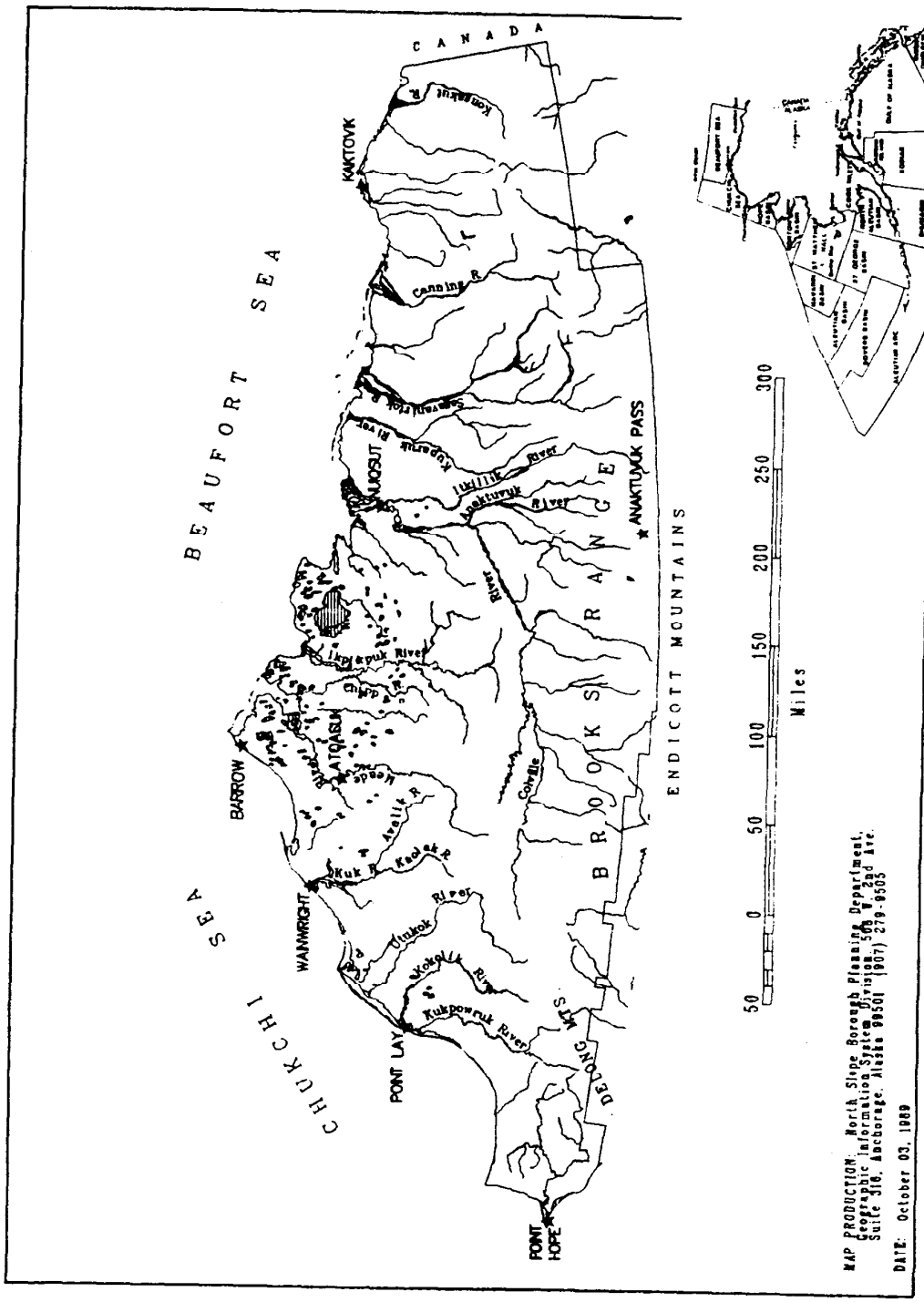

Figure 1. Map of Study Area.

earner. Most households are economically independent of other households, although this does not mean that sharing is not a common practice. Rather, the sharing of harvested subsistence resources occurs often but is undependable. The amount given to any one household is small and the frequency irregular. There are few hunters who actively harvest more than their household can consume on a regular basis. Many people attribute this to the fact that all able-bodied adults in Point Lay are employed, which limits time available for subsistence activities. Added to this are the leadership responsibilities for the various village organizations which must be shared among a relatively small pool of able adults.

Practically everyone in Point Lay is related in one way or another to everyone else. Point Lay is one of the few (and perhaps only) NSB village where community conflicts are not expressed or recast in kinship terms. In this respect it contrasts directly with Nuiqsut, Point Hope, and Barrow (information for other communities is lacking). Rather, the explicit community ideology is "We are one family," and this is consciously compared with the scrabbling that Point Lay residents perceive as typical of affairs at the NSB level. This is especially interesting in regard to Point Hope, where conflicts are often expressed along kinship lines but where interhousehold sharing networks (structured along those same kinship lines) are more obvious and of more everyday importance than in Point Lay.

Leadership constitutes one of the central quandaries of life in Point Lay. The model for decision-making within the village is that of consensus. The fact that Point Lay has the only Federally recognized Indian Reorganization Act (IRA) on the North Slope and is the only unincorporated Native community contributes to this ideology. Many of the organizations that deal with the village - the NSB, the state, and the Federal government - are often impatient with such a process. Many times those placed in leadership positions must choose between being seen as "pushy" by their neighbors or as "ineffective," "uninterested," or even "incompetent" by outside authorities. Often, of course, these perceptions are held by the two different reference groups at the same time, creating a situation whereby the functioning leader may not be able to satisfy either group. In such a system it is not surprising to find that most capable adults have no interest in serving, and if convinced to do so, find themselves frustrated within a very short time. This only aggravates the severe shortage of trained and skilled personnel within Point Lay.

Few young Inupiat in Point Lay are learning Inupiaq with any degree of fluency. This is typical of the North Slope, and is unfortunately also true of Alaskan native languages in general. Socialization in Point Lay is problematic. Adults are not familiar with most of the life experiences of their children. These adolescents are the first generation to attend school within the village through graduation from high school. Their parents in some cases did not go to school at all or went outside the village for school. Television and modern music make the reference group for these young people that of "mainstream" America, for the most part. The contrast within the village can be stark, and helps explain the teacher perception that elementary students attend nearly every day and are quite happy in general while high school students miss school frequency and are quite morose as a group. This is true elsewhere as well, but not to this extreme. This may well vary in Point Lay from year to year, being quite dependent on the high school teacher's relation to his students. Teacher turnover has recently been high in Point Lay.

Subsistence is quite important in Point Lay, although it is difficult to quantify in terms of the harvest. Belukha whales are the single most important resource in terms of weight harvested, but much is sent out of the village and a great deal is consumed at public feast. Perhaps the

most commonly consumed resource on a day-to-day basis is caribou, followed by fish. More research would be needed to make any more definitive statements. There are a few hunters who are extremely active in harvesting resources (see above). Actual harvest levels aside, subsistence lies at the core of Point Lay's identity as a village. Subsistence articulates with attitudes toward development differently in the villages of Point Lay and Point Hope. In the case of Point Lay, where there is full employment, the village as a whole tends to regard development, such as OCS lease sales, as exposing subsistence resources to substantial risk in return for no benefits to the village. In Point Hope, where increased employment opportunities are strongly desired, there is a much more ambivalent attitude toward development in general and OCS development in particular. There is a conscious weighing of risks of development to subsistence resources against the benefits of increased employment opportunities. This weighing of risks and benefits has been and continues to be a very trying process for village leaders, because both potential risks and potential benefits are seen as very high indeed.

The data and conclusions of this study are the content of the *Point Lay Case Study*. In addition, as part of the first objective, a limited number of life histories were collected. As there is likely to be widespread interest in these life histories beyond the facts incorporated into the case study itself, they are being published in a separate volume entitled *Point Lay Biographies*. This will facilitate the distribution to a wider audience than is likely to request the full technical report.

Point Lay cannot be taken as representative of other North Slope villages, at least in the normal sense of the term "representative." Point Lay is, however, a component of a shared cultural and economic system and so is subject to the same economic and social pressures as the other communities. Differences between Point Lay and other NSB Native communities are understandable in terms of many of the same dynamics working with a different set of conditions. Chief among these is the small size of Point Lay, its lack of a large number of Elders, and the nearly full local employment of its resident population. As these conditions change to approach the NSB norm (larger size, more Elders, lower rate of employment), it can be expected that Point Lay will behaviorally become more representative as well. Conversely, if other villages become more like Point Lay in regard to these factors, they can be expected to behave more like Point Lay.

Leadership patterns in Point Lay demonstrate the difficulty of balancing the demands of modern bureaucratic institutions with those of institutions based on principles of kinship. The result is a reluctance on the part of most local Inupiat to hold responsible leadership positions, and the rapid frustration of those who do. The ideology of common kinship and sharing is perhaps more explicitly stated in Point Lay than any other NSB village. The actual incidence of observed sharing behavior is less in Point Lay than in other NSB villages because of the lack (or underdevelopment) of household sharing networks with regular patterns of exchange. Because of a number of factors, there are relatively fewer harvested subsistence resources to distribute and kinship networks are not used as much as in other villages as a mechanism to express or conceptualize village conflicts. Subsistence remains important because of its contribution to the economy of individual households as well as its ideological role as the basis for a Point Lay identity based on an ethos of sharing one's harvest with anyone and everyone in need in the village.

Inupiaq as a language is declining in Point Lay, being used in relatively few public forums. Young Inupiat converse in English. They may understand some Inupiaq, but seldom (if ever)

speak it. Other cultural forms, such as Eskimo dancing, were absent for a time but are apparently now rebounding. The school is still perceived as an outside institution, beneficial for the most part, but out of the control of local people. Substance abuse, physical violence, and alienation of the young are problems that seriously affect village life.

REFERENCES

Impact Assessment, Inc. 1989. Point Lay case study. Technical Report No. 139, Alaska OCS social and economic studies program, Minerals Management Service. Anchorage, Alaska. Contract No. 14-12-0001-30364.

Impact Assessment, Inc. 1989. Point Lay biographies. Technical Report No. 140, Alaska OCS social and economic studies program, Minerals Management Service. Anchorage, Alaska. Contract No. 14-12-0001-30364.

QUESTIONS AND DISCUSSION

Leona Okakok: You mentioned that there was little subsistence activity by the male population at some point, somewhere, do you know whether any of those would go off to Barrow or Wainwright or Point Hope for the annual whaling time or any other bigger hunting activities?

Michael Galginaitis: Yes, there a significant number of people from Point Lay did go to whale especially in Wainwright. One year when I was there one of those crews harvested a whale in Wainwright. So that in that year, I guess two or three sled loads of whale meat and muktuk came from Wainwright to Point Lay. I don't mean to give the impression that there is not subsistence activity in Point Lay because there most certainly is. The percentage of "very active" subsistence harvesters in Point Lay is much smaller, however, than in other North Slope Borough villages. I think that that is an artifact of the particular circumstances in Point Lay. Point Lay is part of a similar system that operates in the other village, but because of its small size, because the people are busy doing employment opportunities as well as many other things, they feel they simply do not have enough time. They are stretched too thin. It is also a fairly new village, so that some people, a significant portion of the younger people do not know the land as well as the might like to. For whatever reason, the "very active" subsistence harvesters are absent from Point Lay or are very few in the group.

NORTHERN INSTITUTIONAL PROFILE ANALYSIS

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MMS had conducted a good deal of research on the North Slope prior to this study, but the results of this work were scattered among the various reports which were the final products of each project. This study was to collect the published results of previous research in order to make them more accessible.

The objectives of this study were: 1) to collect previously published information on each of the communities of the North Slope of Alaska and to write a descriptive chapter about each such community using this information; 2) to analyze similarities and differences between North Slope communities; and 3) using (1) and (2), to discuss regional dynamics on the North Slope.

The study was designed to be primarily synthetic, using the published (and where available, unpublished) results of previous studies. The collection of new data or the reprocessing of preexisting data sets was kept to a minimum. The major exception was a formal agreement with the North Slope Borough (NSB) allowing Impact Assessments, Inc. (IAI) to use the results of their then ongoing regional census, when it was competed. A review of the literature and the construction of a fieldplan occupied the first five months of the contract. The fieldplan was actually a planning device detailing what information it would be necessary to collect in the field in order to update the information most currently available in the literature as well as a projected schedule for the integration of this information with the published information already (or in the process of being) processed. All eight North Slope Native villages were visited in the course of fieldwork, for a period ranging from five days to about two weeks each (Figure 1). All fieldwork was focused on specific informational needs and was not intended as standard ethnographical work. Kaktovik, Anaktuvuk Pass, Nuiqsut, and Point Hope were each visited by a team of anthropologists consisting of one IAI employee and a senior consultant. Atqasuk, Wainwright, and Point Lay were less intensively studies by a single anthropologist each (although Point Lay was also the subject of an ongoing MMS case study). Several of the fieldworkers collected information in Barrow. An additional four months was spent processing the field-collected information and the NSB census results and integrating them into the existing (published) information. Work also continued on extracting information from the literature during this period as well.

The North Slope Borough is clearly the dominant entity on the North Slope in terms of government and economy. This also appears to be the case ideologically and culturally, at least in a regional sense. Each village still maintains an identity very much its own, but because of the centralization imposed by the form of the NSB there is an almost inevitable process of cultural homogenization. Most decisions that affect more than single individuals are made at the NSB level (in Barrow or perhaps even off-slope in Anchorage, Fairbanks, or Juneau). There is no purpose in speaking of separate "cash" and "subsistence" economics on the North Slope, as all Native people of necessity and by choice incorporate both wage activity and subsistence pursuits into their daily lives. While each village has a different resource base to drawn upon, there is some evidence to suggest that increased wage activity (higher earnings combined with more time constraints) has resulted in a simplified subsistence yearly round that is more similar from village to village than was true in the past.

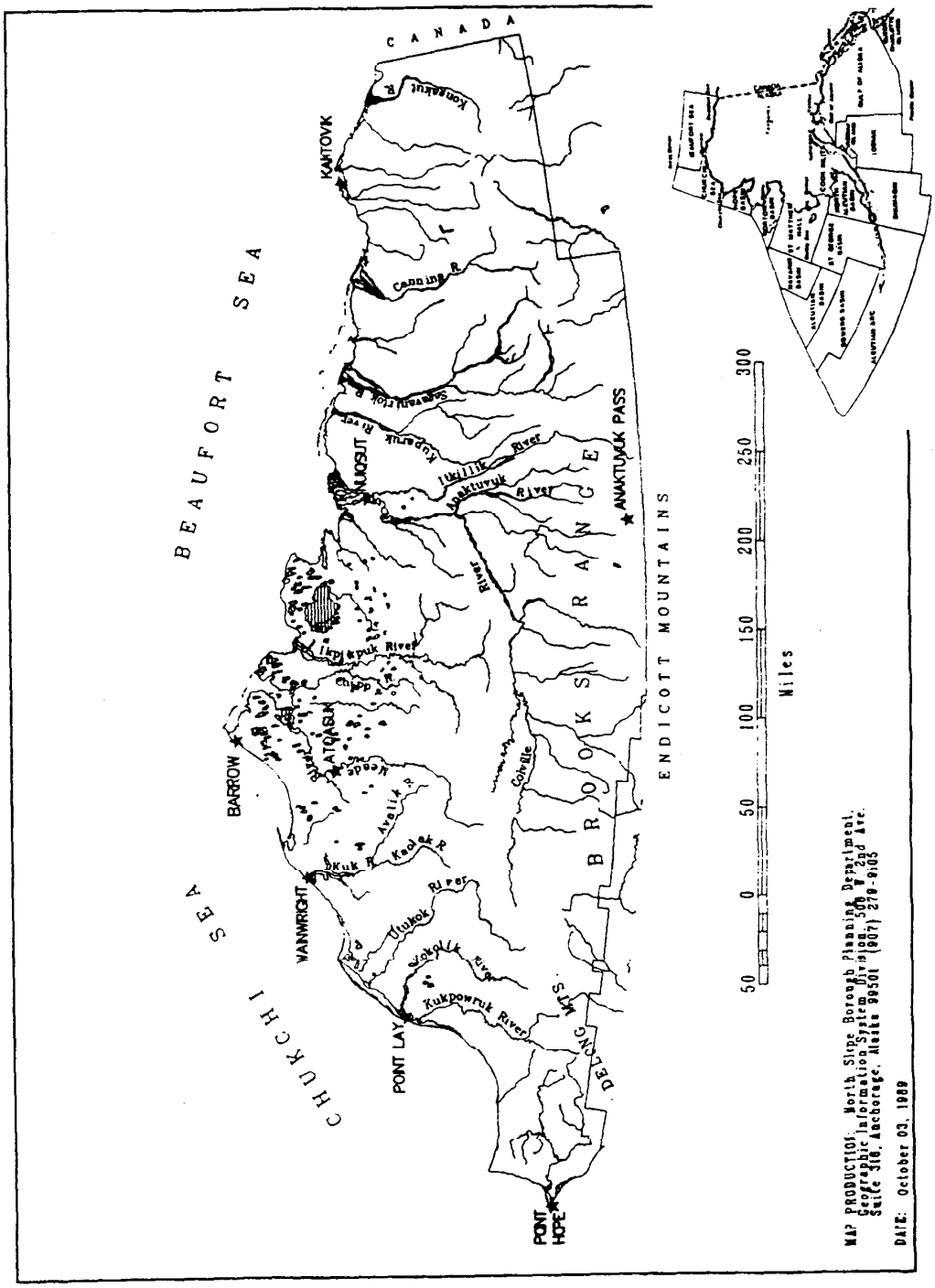

Figure 1. Map of Study Area.

All four of the main topical areas of concern (population, economy, formal institutions, and cultural issues and informal institutions) demonstrate a clear difference between Barrow on the one hand and the other seven NSB Native communities on the other. This is not to deny that there are differences among the outer villages, but these are dwarfed by the gulf between the outer villages and Barrow. Because of the unique (at least in terms of the United States) political organization of the North Slope, the standard regional model of a hub city with outlying "villages" is not really appropriate. Rather, the NSB is functionally a united municipality where only Barrow has effective formal representation in the decision making process.

In terms of population, the outer villages are nearly totally Native while Barrow is 39% non-Native. Fifty-nine percent of the total NSB population lives in Barrow. Forty-nine percent of the total Native NSB population lives in Barrow, whereas 82% of the total non-Native NSB population lives in Barrow. There are very few non-Native children in the outer villages, whereas Barrow now has a significant number of non-Native children. This is commonly interpreted as meaning that non-Native families are now taking up at least short-term residence in Barrow whereas this is still very rare in the outer villages. There are few minorities, other than whites, in the outer villages, whereas Barrow has significant populations of Blacks, Filipinos, and Hispanics. Barrow is clearly much larger than the other villages and differs markedly in other population characteristics. Residents of the outer villages readily perceive these differences.

In terms of formal institutions, all are centered in Barrow and many limit their sphere of effective service to Barrow. Those that are not effectively limited to Barrow often are still often characterized as unresponsive to local (outer village) needs. Barrow is the seat of the NSB government and so is the headquarters for all NSB functions - government, schools, public safety, fire protection, municipal services, and so on. All of course have a presence in each of the villages, with some degree of freedom of action. In all cases, however, all resources and policy ultimately derives from the administration in Barrow. Only to the degree that it is pragmatically necessary, and even then not all the time, do the local representatives of NSB institutions have freedom of action. Programs for which the NSB is only partially responsible, such as health care, exhibit even more of a contrast. In terms of facilities, which the NSB funded through its Capital Improvement Program (CIP), the villages would be more than adequately served by their clinics which just fall short of the facilities at the hospital in Barrow if they were visited more regularly by specialized medical personnel. Doctors based in Barrow are supposed to visit each village clinic four times a year, but it is reported that at times the intervals between visits is eight months. The clinic and the NSB-paid health aide does insure a minimal level of health care. For services where the NSB has no formal responsibility, such as child welfare, food stamps, and other social programs, the disparity between the level of service available in Barrow and in the outer villages is especially great. The NSB has built a facility in Browerville for abused women and children, so that they may live for a time outside of the abusive environment. No such facilities exist in the outer villages except for "safe houses" which are seldom used.

The North Slope economy is also dominated by Barrow, at least in terms of cash flow. There is a dual nature to the labor force on the North Slope that, while it is obvious, is little remarked upon. Most of the people working in the extractive industries, the productive foundation of practically all non-subsistence economic activity on the North Slope, are non-Native transients. To all intents and purposes they form part of an "invisible economy" as far as North Slope residents are concerned. Practically all Inupiat who work for wages (and

unemployment is low on the North Slope) are in the service sector and are in some way paid with money from the NSB derived from the taxes on oil production facilities. There is practically no private sector economic activity in the outer villages (confined for the most part to a few small-scale retail stores). Barrow does not support a growing private sector, but mainly in the service areas - retail stores, a gas station, engine repair shops, restaurants, "real" hotels, and so on. In the summer, several Barrow businesses cater to tourists. While Kaktovik and Anaktuvuk Pass also receive summer visitors, it is nowhere near the scale of Barrow's traffic.

In terms of cultural issues and informal institutions, the NSB is also taking a high-profile role in promoting and funding such celebratory cultural gatherings as the newly revived Messenger Feast and periodic Elders' Conferences. The NSB Commission on Language, Culture, and History is an integral part of the NSB Planning Department and has representation from each of the villages. The NSB also reinforces many "traditional" Inupiat values through official NSB policy and program statements. For example, Elders have priority for most new housing. The NSB pays for people to assist Elders with housekeeping and other tasks. At the same time these programs manifest an official endorsement of Inupiat values, they also may be subtly undermining them. Fewer non-kinsmen now volunteer to do such tasks without being paid. In general, tasks in the past that were performed as part of a "net of mutual obligations" are now seen as appropriate labor-for-cash transactions (sewing a whaling boat cover, putting the sewn skins on the boat). At the same time, kinship and sharing are still the fundamental values of Inupiat life. Their behavioral manifestations are constantly changing, but use these values as their most common referents.

Each of the seven outer villages has unique characteristics relating to historic and environmental factors. Point Hope and Barrow are older villages. Point Hope is characterized as the most traditional whaling village, whereas Barrow has become a much larger and diversified hub community. Wainwright also maintains a whaling identity and a commitment to the value implicit in hunting whales, but does so using explicitly "non-traditional" equipment. A somewhat smaller population and a more difficult whaling site are used to partially explain this. Kaktovik is a fairly isolated community which whales in the fall and has always (since permanent settlement) been associated with non-Native institutions (trading post, DEW Line, NSB). Nuiqsut also whales in the fall, but is a "new" community, refounded after the formation of the NSB. It is surrounded by oil development and has a mixed terrestrial/sea orientation. Atqasuk and Point Lay are also refounded communities. Atqasuk is in many ways an extension of Barrow, as it is not very far away by either snow machine or plane. Point Lay is the only coastal non-whaling community (it is too small) and is the village closest to full wage employment. Point Lay has a mixed terrestrial/sea subsistence orientation, but because of environmental conditions spend much more time on the land than the sea. Point Lay is the prime location for the harvest of belukha on the North Slope, however, so that this one marine resource is, in terms of weight harvested, the single most important species. Since the harvest occurs within a span of about a week, the belukha harvest is understandably important in Point Lay. Anaktuvuk Pass is the only village with an almost exclusive terrestrial orientation.

REFERENCES

Impact Assessment, Inc. 1990. Northern institutional profile analysis: Chukchi Sea volume. Technical Report No. 141, Alaska OCS social and economic studies program, Minerals Management Service. Anchorage, Alaska. Contract No. 14-12-0001-30414.

Impact Assessment, Inc. 1990. Northern institutional profile analysis: Beaufort Sea volume. Technical Report No. 142, Alaska OCS social and economic studies program, Minerals Management Service. Anchorage, Alaska. Contract No. 14-12-0001-30414.

QUESTIONS AND DISCUSSION

Ray Emerson: In terms of the factors that you looked at: employment, economics, and some of these institutional effects that vary from village to village, do you make any correlation or set up any type of proposed effects that offshore oil and gas activities might have with respect to these particular parameters?

Michael Downs: No, not *per se*. One thing that was not our job on this and we sort of steered clear of were projected effects of offshore development. Now that doesn't mean that there isn't information in there related to that topic. One of the things that Michael Galginaitis touched on in his talk about Point Lay is that we talked to people about offshore development and what they think about things. And what varies from community to community on the Slope, as he mentioned, are employment opportunities. So in Point Hope for example, the feeling, at least last year, pre-*Exxon Valdez*, was a very strongly ambivalent feeling towards offshore development. Point Hope is a community that has had a relatively stable wage labor base for a number of years. That is declining right now in terms of overall dollars into the system from the CIP program and that sort of thing. In Point Hope it is very strongly felt that there is a shortage of jobs, and people talk about very high unemployment rates. That is a very strong concern locally. Also, the reason it is such an ambivalent thing, so you think well gosh they would want anything that would bring employment into the area, however, Point Hope is also, they would say, the most traditional of the villages in terms of whaling. They are extremely proud of their whaling heritage and we go into some detail of how relationships within whaling structure other relationships within the community. The captain-crew relationships, the relationships between crews, the relationship between whalers and elders, etc. So that whaling is seen as what Point Hope is, it is seen as a whaling village, in a very fundamental identity sense. So Point Hope is in the relatively awful position of, on the one hand, valuing more employment opportunities because of the perceived unemployment and on the other hand, if offshore development is the key to get those jobs, risking that thing which is most important to them, which is the identity as whalers and as a traditional whaling village -- a village that has arguably the longest, continuously occupied settlement in North America. So on the one hand you have the desired objective for employment and on the other hand a great risk to the fundamental identity of the community which offshore oil development represents. Now in Point Lay, the situation is quite different, where it is full employment, there is relatively no desire for more jobs at the present time, jobs *per se*, and there are only risks associated with offshore oil developments, not benefits, from the local perspective. So in terms of what effects there would be for any particular type of development, be it offshore development or onshore, that analysis is implicit but it was not within the scope of this project to project if there is level A of offshore development or level B or so on what the particular effects would be.

Charles Mitchell: In the latter part of November we were all gathered at a similar meeting here. We were discussing body burden levels of mercury in food items and centered on the population of Nome. I remember there was a tremendous discrepancy between the prey item values and what was being reported for women of child bearing age in their hair analysis. It

seems to me that that age class that we saw in those women, was very similar, almost identical to the age class that we see here that are not eating traditional foods, not living the traditional life styles. Do you remember that tremendous controversy we were having, because it didn't seem like the two databases meshed together at all? On the one hand we had stories of them being the greatest fish eaters in the world and at the same time their body levels weren't showing. So maybe we were looking at the wrong age class.

Michael Downs: I would like to respond to that in a couple of different ways. Your questions is addressing reported valuation of subsistence versus actual amount of consumption? Is that the gist? By age group?

Charles Mitchell: It was age group sampling. They had looked at hair level of women of childbearing age which I think was 18 to 39 or something like that, and the values were extraordinarily low. As I recall they were typical for a midwestern central US downtown city.

Karen Gibson: Since then there has been further research and there isn't a strong correlation, and correct me if I am wrong, Don, with mercury in the hair and the eating of subsistence resources.

Donald Callaway: Helen Armstrong do you want to talk about the calculations that you did for the mercury burden in fish and so forth?

Helen Armstrong: We were kind of hoping that we could keep mercury out of this. There is a correlation between what people eat and the levels of mercury and what appears in their hair. But it is how much mercury is in what they are eating and how often they eat it. So you have to look at not only how much mercury is in the food but how often they eat it. We don't have any further information. We don't know how often they eat subsistence foods in Nome. We have some guesses, but nobody really knows because we haven't done that research. We don't know in great detail the levels of mercury in the subsistence foods in Nome. We know some resources. But if the level is no more than, I believe it was, 0.03 ppm of mercury in the seafood, they could eat a meal eleven times a week and still have only 1 ppm in their hair. That is what we calculated out. If they are that low in the seafood. So then if it is a little bit higher than that in the mercury, then maybe they are not eating that often. So it is possible that the level could be 1 ppm in the hair and they could be eating it quite a bit if it is still quite low. But we really don't quite know that yet.

Michael Downs: I would like to respond to what I think your question is, which probably isn't what your question is, but it is an interesting point anyway, so I will say it. One of the things that we found with subsistence, in terms of sort of the meaning of subsistence in the villages, is that a lot of subsistence studies have looked at subsistence harvest quantities and they have looked at consumption quantities. So if you look at the percentage of meat and fish consumed in a household, for example, and then looked at and tried to read into that a valuation of subsistence. So if a household for example reported that 10% of meat and fish consumed within that household, those would be low subsistence users for example. But what we found in the villages, and not just for this study obviously, is a question of not only quantity, but it is a question of frequency, in terms of how people value subsistence use, subsistence consumption. So for example, in a typical Point Hope household that I am familiar with, let's say that a person eats mostly store-bought food that day, but during the afternoon you are out working on your umiak frame getting ready for whaling and you come in and you eat some

frozen fish. And with dinner you use seal oil as a little bit of seasoning with your store-bought food. Well maybe in terms of measuring grams of things, that person didn't eat very much subsistence food that day, but they did eat it that day. Let's say the next day goes by and again there is a pot of caribou stew going on the stove, maybe that person didn't make that a main meal, but that was part of the eating that day. So there are a lot of households for which if you look at percentage of subsistence consumption, maybe the quantity isn't all that great, maybe it wouldn't show up in trace elements or whatever, but the frequency of consumption is very high. So that households eat subsistence foods virtually every day, and it is a preferred food, that is a very difficult thing to look at, you are getting into valuation there. Obviously subsistence is an extremely important collection of formal and informal institutions, sharing relationships, and production relationships all the way from whaling crews to ice fishing. The thing that is constant in virtually all of the villages is high frequency consumption and high value being attached to that frequency of consumption. So questions about gross quantity per day really don't make all that much sense in terms of the overall importance of subsistence. The high frequency of subsistence food whether it just be for seasoning or a snack or a preferred food that maybe isn't even available, like Mike was saying, at particular periods, that is a difficulty in that analysis.

Warren Matumeak: It is interesting to know that I am being studied. I am aware of that. I have been studying MMS myself and you other oil industry people. The way I see MMS operating offshore leases is that they learned from the Valdez spill, it took a lot of money to clean up that spill. But there was not one animal being replaced. There were a lot of animals that died from that spill. But MMS is still pursuing lease sales offshore which the North Slope Borough doesn't get any benefits to speak of. We were able to put people to work on the ships, but that is all. We don't get any tax money from offshore operations beyond six miles. The big scare is that after Valdez that since we knew all of the time that they couldn't clean up any oil spill in ice invested waters. Valdez proves it. It was spilled in relatively warm weather, in March. We also noted that they couldn't go out one day because the weather was cold, and this was in spring time. The big thing that hit us is that if the oil spill were to occur the size of the Valdez spill, they could not clean up any oil spill offshore. They could not replace any animals that were lost out there because of the spill. So the North Slope residents would be deprived of this valuable subsistence food which includes whales, polar bears, seals, belukhas, and some birds. If there was a spill in there all they would do is try to clean up the spill. They would not even think of replacing one animal that may be lost. That is very scary. I just wanted to point this out. I just want to let everybody know this is what we are seeing. I could say a lot more about some oil industry people but that is for another time.

Dale Kenney: Nuiqsut and Point Lay are new communities, what is the age and gender structure of these two, how do they compare? And secondly, why does Point Lay have such a high employment rate? Where are they finding the work?

Warren Matumeak: I can answer that. Point Lay being very small are given the CIP Projects are distributed to each village. Because it is small, a small project will take almost all of the labor force in Point Lay. Point Hope, Wainwright, you've got projects but there is a lot of work force there and only a few people would get to work.

Michael Downs: Thank you for answering that so articulately. I was going to do that not so well. In the formal institutions we look at that a bit. Basically as you say, the projects are similar in the villages. It is just a matter of size.

Johnson Eningowuk: My last question is that you are basically doing a baseline line study before any OCS occurs. Does your baseline study include looking at how the people are? Because at Prudhoe Bay, when we started there was no base study done, and therefor whatever the industry did there was no way to correct it or to see how much damage was done. Are you going to do this before you even start looking at offshore up north? The sicknesses, the food consumption, I see you are doing a real good job on the food consumptions, but are you in your studies looking at the people to see what is in them before you start?

Michael Downs: I can't answer for the whole MMS. For our particular study, we worked very closely with the North Slope Borough Department of Health and Social Services. They have compiled a very large information base on the health care programs on the Slope now and rates of illnesses for the different villages. We did include that information from the Borough in our report. That is in the regional analysis.

RURAL VILLAGE ECONOMIES

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The goal of this study is to describe and analyze relationships between the subsistence and commercial use of resources in three rural Alaskan coastal villages. This study was conducted for the Environmental Studies Program (ESP) of the Department of Interior, Minerals Management Services (MMS).

The orientation of this study is significantly different from recent MMS studies of village Alaska. Earlier sociocultural studies distinguished subsistence from the market economy. Relatively minor attention was given to the linkages between subsistence and market economic activities. The MMS study design notes that these earlier studies narrowly emphasized the intrusion of outer continental shelf (OCS) development upon subsistence through disruptions of harvests or work patterns. Similarly, previous socioeconomic studies of village cash or commercial economies have used employment and income data and other conventional indicators of economic activity to develop a picture of the local cash economy, but largely ignored the interplay between subsistence and commerce.

That subsistence and commercial economic activities are separately important in rural coastal villages is now well established. However, they are understood primarily in isolation. Less well documented are the pervasive and dynamic interactions between subsistence and commercial endeavors that, together with public sector transfers, comprise the village economy. This study is a pioneering attempt to distinguish and inter-relate the subsistence, commercial, and public sector aspects of rural village economies.

The ideological orientation of this study has been to view the village economy ultimately as a single economy characterized by shifting uses of a common set of money, labor, and natural resources. This is in contrast to conventional analysis which stresses the incongruities between village subsistence and market economic behavior and resource utilization as a whole, without creating arbitrary distinctions between types of economic activity or classes of resources.

Contemporary economic theory recognized that the modern national economy is a mix of private and public sector economic activities. The customary definition of the term - "mixed economy" stresses the respective roles of the market and governmental sectors. Thus Samuelson offers this definition of "mixed economy" in his standard textbook *Economics*:

> "an economy that relies primarily on the price system for its economic organization but uses a variety of governmental interventions to cope with macroeconomic instability and market failures. Thus, it is a mixture of market and collective (or public) choice. (Samuelson, 1985)."

The concept of a "mixed economy" is central to this study of rural village economies. However, for analysis of Alaska's rural village economies, it is appropriate to reintroduce an aspect of private economic activity --subsistence-- that has become vestigial in most modern

economies but is still a vital element of village livelihood. Here, we will briefly sketch out a broadened conceptual scheme of the village "mixed economy" that we have developed as a framework for the study.

In the requirements for this study, MMS's use of the term "mixed economy" contrasts the roles of subsistence and the cash economy in rural Alaskan villages omitting an essential distinction between the market and governmental components of the village non-subsistence economy. This imprecision in the central theme of the study tends to blur some important empirical distinctions and analytic relationships within the village economy. We have devised a simple schematic model to clarify the roles of subsistence, commerce, and government in the village economy.

First, for working purposes, we propose the following definitions of the economic domains of subsistence, commerce, and the public sector (here simply called government).

- Subsistence: household production of goods and services for domestic consumption or sharing. In its ideal form, subsistence is autarkic and precludes extra-local trade or cash markets for goods and labor services. (This definition contrasts with statutory and global definitions of the term "subsistence.")

- Commerce: production of private goods and services for cash sale or exchange in the market, typically accompanied by work for cash income and commercial entrepreneurship. Basic production of goods and services for export may be distinguished from non-basic production for local consumption. The distinctive function or goal of commerce is market efficiency in the allocation of productive resources and distribution of production.

- Government: production and/or redistribution of goods and services through government, typically financed by taxes, user charges, or other forms of public revenue. The distinctive economic functions of the public sector are production and allocation of collective goods; equitable distribution of production; and setting of laws and rules for the conduct of economic affairs.

Figure 1 portrays an abstract model of the village mixed economy. The three circles represent the three economic domains or regimes of subsistence, commerce, and government respectively. Each circle encompasses all the properties or attributes belonging to its economic domain. The hatched areas of overlap among the circles imply that the three domains may share some common attributes, while the unhatched areas imply that each domain may posses some unique properties.

This simple analytic model has three appealing features for our study. First, it focuses on the typological attributes of the MMS's central concept for this study: the "mixed economy." Second, it is logically complete. Even in this minimal form, the model exhausts the universe of possible formal relationships among the properties of these three economic domains. Third, the pictorial model is intuitively expressive and versatile. It can be configured or adapted to express graphically many static and dynamic relationships among the properties of the three economic domains. For example, different configurations can express: successive phases of progressive economic development; areas of exchange or material fungibility between domains; and relative

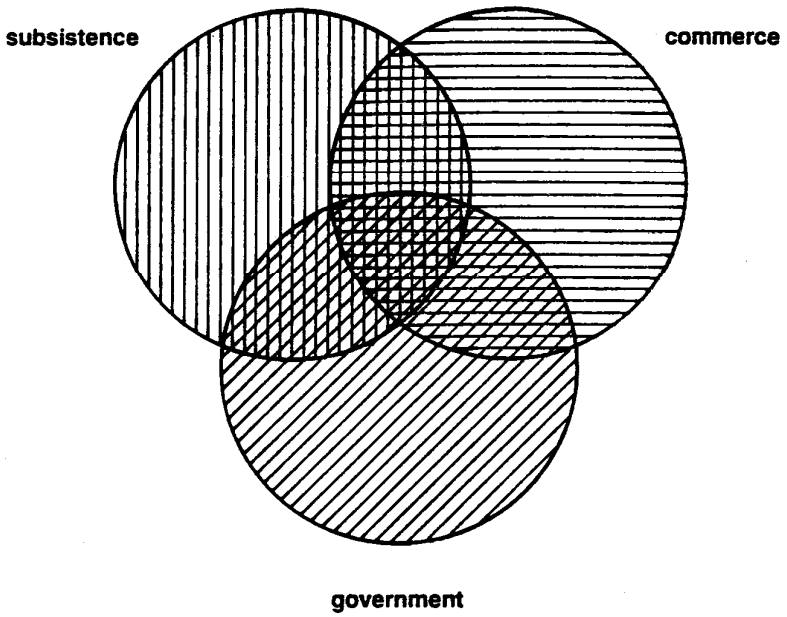

Figure 1. Abstract model of the village mixed economy.

magnitudes and distributions of particular variables among the domains.

This skeletal model of the mixed village economy is empty of preordained content. It remains to identify the empirical variables that will be employed to describe and analyze key features and relationships in the village economies.

The interactions between subsistence, commerce, and government may also be viewed at three analytic levels: 1) micro-economic, 2) macro-economic, and 3) political-economic. The chief characteristics of each level are:

- Micro-Economic: At the level of the individual family or household economic unit, personal decisions are continually made about the commitment of time and resources to subsistence and commercial enterprises. The outcome of these micro-economic decisions can be aggregated to comprise the village economy.

- Macro-Economic: The requirements of the market economy give rise to local institutions that mediate between the village economy and society and the economic and political institutions of the outside world. At this level, the "market economy" encompasses the full array of public and private institutions that provide the framework within which the market economy operates and through which the village participates.

- Political-Economic: Finally, economic and political decisions largely originate from non-local political and economic institutions. Outside circumstances frequently influence the course of the village commercial economy and, in turn, the balance between local commercial and subsistence economic activity. This political-economic level has a profound influence in the structure of the villages examined in this study.

These three analytic levels are intended as a convenient device for sorting and grouping the complex body of empirical data about the institutions to be addressed in the study. The levels do not necessarily imply any hierarchic pattern of dominance or subordination, nor do they define paths of interaction between micro-economic, macro-economic, and political-economic institutions. That is, for example, individual families and households may interact directly and freely with political-economic institutions and vice-versa.

QUESTIONS AND DISCUSSION

Helen Armstrong: This is really just a comment. I thought it was sort of interesting that a little earlier we had heard Michael Galginaitis talk about how Point Lay people didn't do as much subsistence hunting because they were 100% employed and Point Hope people did. I was sitting there thinking wait a minute that is not what I've usually heard. Usually the people who are employed are the ones who are doing all of the hunting. Then you say that, in fact, that is what you have found in St. Paul and Alakanak, but not in Gambell. It makes me wonder if maybe we look at this too simply. That it is not just a cash or employment issue, but what other factors are involved? How much alcoholism is there? How much education? There are lots of other factors that we don't talk about. I don't know that much about Point Lay, but there may be some other things that may be contributing, not as strong an elder community that is reinforcing these values. Who knows? I think that sometimes we look at those things too simply.

Will Nebesky: Just to expand on that a little bit, the whole question of the composition of the household members, their involvement, their participation in the labor market versus subsistence production activities is a very important one. One that we didn't address in enough detail to speak to here. But it does raise the question of what is the division of labor in the typical village household? How are the decisions to allocate so much human resources in the household to subsistence activity versus market activity? What factors influence those decisions? That is a study in itself.

Charles Degnan: Perhaps it is a matter of perspective of how you define your cash economy and subsistence economy. My grandmother told me that she thought it was strange that people would look for gold because you couldn't eat it. Yet you had people going after it and they are still going after it. So it is a matter of historical perspective. Your traditional values and how you relate to your environment and what is there available to harvest for you to use immediately. It is a very basic thing that we as humans relate to. You have a different educational background from us. It is hard for each of us to understand each other's perspective. Even though, I am fairly well educated in western culture, I can see there is some confusion about how Alaskan natives live.

Will Nebesky: A point well taken. The anthropologists at Impact Assessments, Inc. continue to pound the same point into me on almost a daily basis. There is more to subsistence production, hunting and fishing than strict economic activity. There are other value systems, other cultural factors that may vastly overwhelm the relative importance of the economic.

Charles Degnan: And you have the government's interest in educating the natives to change to fit your preconceived notions of how people should live. That should include religious activity, and all factors of economic life also.

Lynn Robbins: I have a comment, Will. I am the person who coordinated the field work on Gambell for this study. The generalization that I arrived at from this work is that it is true that people who work full time put in less time in subsistence, just as you just showed, than those who didn't work full time on average. But in Gambell, there is an unusual circumstance there and it is cultural in character. That is people who work full time, males I am speaking of primarily, underwrote the subsistence activities of younger, closely related male kinsmen. So though these men in their 40s were fully employed and not hunting as often as they usually did, they were still contributing importantly to subsistence activities. Furthermore those same people made a very important qualitative contribution to subsistence apart from the monetary contribution. That is when it came time to go after the bowhead, there they were. They went walrus hunting whenever it was possible to do that. But if you add up all of the time they were engaged in subsistence, it wasn't as much as their younger counterparts who weren't fully employed. So I think we are still seeing a similar way of life actually in all three communities. There is just a little different twist in there for Gambell.

Will Nebesky: Thank you, Lynn. I think that helps to illustrate a number of important things. In fact, I didn't bring the results to present here, but in the case of the North Slope Borough census, we asked a similar question in the eight North Slope Borough villages. The results were quite consistent with what we found in the case of Gambell. That is, there seemed to be a fairly clear pattern of involvement in either labor force participation or in subsistence activity by the respondent. Again that glosses over the varied points Lynn has raised about the role of different members of the household underwriting subsistence activity that other household members may be engaged in. I think it points at the need to find a better mechanism for trying to. Then what I feel was what was a very interesting approach to look at the relative time involvement in subsistence versus labor market activity. But I think to really understand all the dimensions of those interrelationships it has to go further.

NORTH SLOPE SUBSISTENCE STUDY

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INTRODUCTION

This study has two main objectives: First, to collect, analyze, and report generalizable subsistence harvest data by species for Barrow and Wainwright; and second, to provide accurate mapped harvest location information for these communities. The study is being conducted for three years in Barrow and two years in Wainwright, and an annual report for each community is written at the end of each study year. This summary presents preliminary findings from Years One and Two (April 1, 1987 through March 31, 1989) of the study in Barrow, and Year One (April 1, 1988 through March 31, 1989) of the study in Wainwright.

The study team conducted periodic harvest discussions throughout both years with 110 Barrow households (a disproportionate stratified probability sample) to obtain the date, location, and amount of each harvest by species. The first two years of data, weighted to represent the entire community (population 3,223; 988 households), indicated that Barrow residents collectively harvested an average of approximately 622,280 pounds of edible resource product per year, equal to 664 pounds per household or 206 pounds per capita. (Variation in harvest amounts between years will not be addressed until the final study year.)

The study team also conducted subsistence harvest discussions throughout Wainwright's Year One to obtain the date, location, and amount of each Wainwright harvest by species. Due to the relatively small population in Wainwright, participation of every household in the community was sought. In Year One, 128 Wainwright households participated in the study. The data show that Wainwright residents collectively harvested approximately 256,325 pounds of edible resource product, averaging 2,031 pounds per household or 417 pounds per capita.

SUMMARY OF FINDINGS

Study findings are presented in the annual reports in several ways. The species harvested are organized by major resource category (e.g., marine mammals) and discussed both at that level and at the level of individual species. Monthly totals are presented by species in both pounds (of edible resource product) and number of animals harvested. Yearly totals for the community are also presented in pounds and number of animals harvested, along with pounds per household and per capita. Percentage of households participating in the harvest of each species and the percentage each species contributed to the total pounds harvested are included in the annual reports along with an analysis of harvests and household characteristics by harvester level. Harvest locations were entered in a Geographic Information System and appear in the annual reports as maps showing where study participants harvested resources. The following information summarizes only a portion of the data generated from this study.

Barrow

Harvest Amounts. Barrow residents harvested over 54 species of mammals, fish, birds, and other resources during the first two years of the study (Table 1). In terms of edible pounds harvested, bowhead whale and caribou contributed the most subsistence food to local households. Barrow landed seven whales in Year One and 11 whales in Year Two, amounting

Table 1. Average harvest estimates for major resources and major resource categories - all Barrow households.

RESOURCE	CONVERSION FACTOR (Edible Weight Per Resource in lbs)	COMMUNITY TOTALS		AVERAGE POUNDS HARVESTED		PERCENT OF TOTAL EDIBLE POUNDS HARVESTED	PERCENT OF ALL BARROW HOUSEHOLDS HARVESTING RESOURCE
		NUMBER HARVESTED	EDIBLE POUNDS HARVESTED	PER HOUSEHOLD	PER CAPITA		
Marine Mammals	n/a	n/a	337,225	360	111.8	54%	40.7%
Bowhead Whale	11,612.0	9	209,015	223.1	69.3	33.6%	32.4%
Walrus	772.0	88	67,623	72.2	22.4	10.9%	9.0%
Bearded Seal	176.0	213	37,467	40.0	12.4	6.0%	16.9%
Terrestrial Mammals	n/a	n/a	204,547	218	67.8	33%	27.3%
Caribou	117.0	1,523	178,195	190.2	59.1	28.6%	25.0%
Fish	n/a	n/a	59,237	63	19.6	10%	25.1%
Whitefish (spp.)	n/a	23,797	45,604	48.67	15.1	7.3%	16.7%
Birds	n/a	n/a	23,959	26	7.9	4%	32.8%
Other Resources	n/a	n/a	161	0.2	0.1	**	2.5%
Total *	n/a	n/a	622,280	664	206.3	100%	53.4%

* 'Total' refers to the total of all the major resource categories.
** represents less than 0.1 percent
n/a means not applicable

Source: Stephen R. Braund & Associates, ISER and Beringia, 1989

to an estimated average of 209,015 edible pounds per year or 34% of the average yearly harvest. During Years One and Two combined Barrow residents harvested an average of 1,523 caribou, or 178,195 edible pounds, forming the second largest component (29%) of the total harvest.

Walrus was the third most important resource by weight during Years One and Two, with an average of 88 walrus yielding 67,623 pounds of subsistence food, 11% of the entire harvest. The fourth most heavily harvested species by weight during Years One and Two combined were whitefish (spp.) averaging 54,604 pounds or 7.3% of the overall Barrow harvest.

The above four species combined contributed an average of 80% by weight of the total Barrow subsistence harvest during Years One and Two. The remaining 20% consisted of (in order of importance by weight): bearded seal, moose, birds (all species combined), ringed seals, and less than 1% each of polar bear, Dall sheep, brown bear, porcupine, ground squirrel, and various other fish species. Barrow residents also harvested wolverine, red fox, and arctic fox for their furs in Years One and Two. (Because these species are not eaten, weights were not calculated for their harvests).

Seasonal Harvest Patterns. An average of 95% of the Year One and Year Two harvests by weight occurred during the seven month period from April to October. Bowhead whale harvests dominated the months of April, May, and June. Whalers harvested occasional seals, birds and polar bears from whaling camps while some families went inland to spring camps to harvest geese, caribou and fish. May yielded the highest average harvest of spring bowheads by weight and the highest average annual bird harvests. Bowhead whale harvests again represented the major share of June's harvests, while bird harvests were declining and fish harvests were on the increase from May. During both years, July was characterized by considerable walrus and

seal hunting, as weather and sea ice conditions were favorable for hunting by boat. July harvests consisted of nearly equal amounts of walrus, bearded seal and caribou, and July was the peak month for bearded and ringed seal harvests. August, September and October were the most productive months in terms of the average total edible pounds harvested, contributing 56% of the average annual take. Walrus and caribou were the main resources in August, supplemented by sizeable amounts of bearded seal and fish. Walrus and bearded seal harvests subsided in September, while fall whaling provided the main September harvest in addition to caribou, fish and moose. October was the month in which the peak fish and caribou harvests occurred as families went to fall camps to stock up on these important resources. Bowhead whales were also harvested in October. The remaining five months (November through March) were lean harvest months during which the most active hunters traveled onto the pack ice for seals and inland for caribou and furbearers.

Harvest Locations. In Years One and Two, the study sample of hunters traveled along the coast in either direction from Barrow, harvesting resources as far west as Peard Bay and as far east as the Colville River. Marine mammals were harvested over 25 miles offshore. Rivers provided summer travel routes inland, and harvest locations tended to be concentrated along the main waterways: the Inaru, Meade, Usuktuk, Topagoruk, Chipp, and Ikpikpuk rivers.

Wainwright

Harvest Amounts. Wainwright residents harvested over 40 species of mammals, fish, birds, and other resources between April 1, 1988 and March 31, 1989 (Year One of the study in Wainwright) (Table 2). Marine mammal harvests dominated the Wainwright harvest, providing 70% of the edible pounds harvested, followed by terrestrial mammals (24%). Fish and birds provided only 4% and 2% (respectively) to the overall harvest.

As in Barrow, bowhead whale contributed the most edible pounds (108,416) followed by caribou (59,094) and walrus (45,038). The four bowheads landed by Wainwright crews produced 42% of the total subsistence harvest, caribou constituted 23%, and walrus provided 18% of the total harvest. With bearded seal (7%), these four species combined yielded 90% of the total harvest. The remaining 10% consisted of (in order of importance by weight): white-fronted geese, least cisco, polar bear, ringed and spotted seals, belukha whale, moose, brown bear, ground squirrel, and various bird and fish species. Coal and ice were also collected by Wainwright residents, and fox, ermine, wolf and wolverine were harvested for their furs.

Seasonal Harvest Patterns. Eighty-seven percent of the year's harvests by weight occurred in the six month period from April through September. Four bowhead whales were harvested in April and May, when whalers also harvested seals and geese from their camps on the ice. Families traveled inland in May and June to hunt geese, ptarmigan and a few caribou from their spring camps. Walrus and bearded seal were harvested June through September, though predominantly in July and August. The most intensive caribou hunting occurred from August through October when 81% of the year's caribou were taken. Ringed and spotted seal harvests began in April and continued through November. Most of the fish were harvested in September (46%) and October (21%). Harvests during the quiet months from November through March included caribou, polar bears (the only marine mammal harvested from December through March), a few November seals, fish caught under the ice, and furbearers (sought in deep winter when their coats are thickest).

Table 2. Total harvest estimates for major resources and major resouce categories - Wainwright, Year One.

RESOURCE	CONVERSION FACTOR (Edible Weight Per Resource in lbs)	COMMUNITY TOTALS		AVERAGE POUNDS HARVESTED		PERCENT OF TOTAL EDIBLE POUNDS HARVESTED	PERCENT OF ALL WAINWRIGHT HOUSEHOLDS HARVESTING RESOURCE
		NUMBER HARVESTED	EDIBLE POUNDS HARVESTED	PER HOUSEHOLD	PER CAPITA		
Marine Mammals	n/a	n/a	179,574	1,395.9	358.1	70%	40.4%
Bowhead Whale	27,104.0	4	108,416	847.0	217.2	42.3%	78.9%
Walrus	772.0	58	45,038	346.5	89.0	17.6%	18.4%
Bearded Seal	176.0	96.54	16,991	124.8	32.1	6.6%	33.3%
Terrestrial Mammals	n/a	n/a	60,696	500.6	128.5	24%	54.4%
Caribou	117.0	505	59,094	486.6	124.9	23.1%	53.5%
Fish	n/a	n/a	9,895	83.5	21.4	4%	64.0%
Birds	n/a	n/a	6,161	51.0	11.0	2%	50.9%
Total *	n/a	n/a	256,325	2,031.0	416.8	100%	86.8%

* 'Total' refers to the total of all the major resource categories.
n/a means not applicable

Source: Stephen R. Braund & Associates, ISER, 1989

Harvest Locations. Marine mammal harvests were concentrated within a 15 mile radius offshore from Wainwright, with additional harvests extending northeast to Peard Bay and southwest to Icy Cape. Terrestrial mammal harvests were widespread, occurring along the coast southwest to Cape Sabine and northeast almost to Barrow, as well as inland to the Brooks Range. Fish harvests occurred principally along the Kuk River system which extends far inland from Wainwright, while bird harvest areas were split between this river system and the coastal areas near Wainwright.

CONCLUSION

This study is one of the most comprehensive, long term subsistence harvest studies conducted in Alaska and provides valuable baseline data, both numeric and mapped, for assessment of development impacts and for other future studies. Reports from this study can be obtained, as they become available in final form, from the U.S. Department of Interior, Minerals Management Service, Alaska Outer Continental Shelf Region, 949 E. 36th, Anchorage, AK 99508.

REFERENCES

Braund, Stephen R. & Associates, and Institute of Social and Economic Research. 1988. North Slope subsistence study - Barrow, 1987. Tech. Report No. 133. Prepared for USDOI, Minerals Management Service, Alaska OCS Region. Anchorage, AK.

Braund, Stephen R. & Associates, and Institute of Social and Economic Research. 1989. North Slope subsistence study - Wainwright, 1988 (Draft). Prepared for USDOI, Minerals Management Service, Alaska OCS Region. Anchorage, AK.

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QUESTIONS AND DISCUSSION

Tim Holder: How was the measure of pounds determined? Did you ask them how many pounds?

Stephen Braund: No, we took each individual species and we primarily relied on Alaska Department of Fish and Game (ADF&G) published edible pounds per species. We did that except with bowheads. We have a long discussion in both of our appendices in both years' reports of how we did bowheads. And we worked with the North Slope Borough Department of Wildlife. They were trying to get the weight of a bowhead. We were weighing crew shares and crew member shares. From that we were coming up with our edible pounds of bowhead. After we took these findings of the first year back to Barrow and people looked at them, they looked at fish and the reaction we heard a number of times was "Gee, we seem to eat more fish than that 10%." "It seems that we eat fish more than 10% of the time." They weren't really taking issue so much with the amount of fish that we had come up with that was being harvested as much as the proportion. So I think that you must bear in mind that we are measuring edible pounds not necessarily eaten pounds. And for the bowhead and walrus there is a lot of weight there that is taken back, the blubber. It seemed to have gotten out of scale in a sense that we are measuring edible pounds. In our appendix we have a long discussion on how we came up with the edible pound of bowheads. The other ones are all published ADF&G reports.

Tim Holder: So what you are really directly counting is the number of animals?

Stephen Braund: Yes, we are asking them how many caribou? Then we use a multiplier for edible pounds and it is on the table by species. So you can look at each one and then go to the appendix and look at where we got that multiplier.

John Petterson: Extracting the non-native population out of Barrow, and just doing the native Barrow, native Wainwright, can you characterize that? You had a 2:1 ratio with the total population. I am wondering if you ran native to native?

Stephen Braund: It was probably something like 2:3. Year One Barrow natives harvested approximately 1,200 pounds per household and Wainwright households (most are 89% Inupiat), harvested approximately 2,031 per household.

Mark Fraker: In the harvest figures, you showed quite a high level of harvest of marine mammals all through the summer period for Barrow. There was a bit of a blip in the spring, but the amount continued to be quite high through out the summer. How do you account for that?

Stephen Braund: Actually April, May and June were dominated by bowhead; in July, it was walrus.

Mark Fraker: It was surprising to me to see that the amounts that were taken after the whaling season were so large.

Stephen Braund: I guess walrus would be the one that you are looking at in July. And actually August, September and October were the most productive months in terms of the annual total edible pounds harvested. So it was 56% in those three months. Again that was walrus and caribou, and bearded seal.

Mark Fraker: Also are belukhas not being taken?

Stephen Braund: In Years One and Two, we didn't have a belukha take in Barrow, but two were harvested in Year One in Wainwright. Primarily because of the bowhead quota as I understand it. Some people here can correct me. They only have a finite number of bowhead and they didn't want to startle any bowheads by trying to take a belukha when they were at whaling camps. They would have rather waited for the bowhead. So there wasn't a harvest of belukha in the first year at Barrow that we know of.

Mark Fraker: Then you showed a small number of other resources, maybe you explained it earlier before I got here, but what made up these "other" resources?

Stephen Braund: That would include drinking water, ice, berries, and greens.

APPENDIX A

AGENDA

MINERALS MANAGEMENT SERVICE
INFORMATION TRANSFER MEETING
JANUARY 30 TO FEBRUARY 1, 1990

ANCHORAGE HILTON HOTEL
ANCHORAGE, ALASKA

Tuesday, January 30, 1990 - Alaska Room

8:30 am **Registration**

9:00 am **Welcoming Remarks** - Mr. Jerry Imm, Chief, Environmental Studies Section, MMS Alaska OCS Region

9:10 am **Keynote Address** - Mr. Al Powers, Regional Director, MMS Alaska OCS Region

9:50 am **Overview of Recent Scientific Cooperation Between MMS and the Far Eastern Branch, USSR Academy Sciences** - Dr. Cleve Cowles, Dr. Jerome Montague, MMS Alaska OCS Region

10:10 am **Research Activities of the Pacific Oceanological Institute in the North Pacific and Arctic Regions** - Dr. Arkady Alekseev, Deputy Director, Pacific Oceanological Institute, Far Eastern Branch, USSR Academy of Sciences

10:30 am **Break**

MARINE MAMMAL SESSION

10:45 am **Distribution and Migration of Cetaceans in the U.S. Chukchi Sea in the Fall of 1989** - Ms. Sue Moore

11:15 am **Distribution and Migration of Cetaceans in the Soviet Chukchi Sea in the Fall of 1989** - Dr. Boris Bessonov

11:45 am **Lunch**

1:30 pm **Aerial Surveys of Endangered Whales in the Beaufort Sea in the Fall, 1988 and 1989** - Mr. Steve Treacy

2:00 pm **Industry-sponsored Bowhead Whale Monitoring and Research in the U.S. and Canadian Beaufort Sea** - Dr. Douglas Wartzok

2:30 pm **Effects of Oil Production Sounds on Arctic Whales in Spring Ice Leads** - Dr. John Richardson

3:00 pm **Break**

3:30 pm **Trophic Investigations of the Arctic Ocean and Bering Sea via Stable Isotope Analysis** - Dr. Donald Schell

4:00 pm **Bowhead Whale Book** - Introduction and Progress Report - Dr. Jerome Montague

4:30 pm **Satellite Tagging of Right Whales** - Dr. Bruce Mate

5:00 pm **Adjourn**

5:00 to 6:30 pm **Reception for all speakers and attendees in the Chart Room**

AGENDA

MINERALS MANAGEMENT SERVICE
INFORMATION TRANSFER MEETING
JANUARY 30 TO FEBRUARY 1, 1990

ANCHORAGE HILTON HOTEL
ANCHORAGE, ALASKA

Wednesday, January 31, 1990 - Alaska Room

MARINE MAMMAL SESSION (continued)

9:00 am **A Method of Ranking the Disturbance of Noise Sources in the Environment of Marine Mammals in Alaska** - Mr. Paul Miles

9:30 am **Modeling of the Effects of Oil Spills on the Population Dynamics** - Dr. Lee Eberhart

10:00 am **Development of a Method for Monitoring the Productivity, Survivorship, and Recruitment of the Pacific Walrus Population** - Dr. Brendan Kelly

10:30 am **Break**

10:45 am **Synthesis of Information on the Effects of Noise and Disturbance on Major Haulout Concentrations of Bering Sea Pinnipeds** - Dr. Steve Johnson

11:15 am **Use of Kasegaluk Lagoon by Marine Mammals** - Ms. Kathy Frost, Dr. Steve Johnson

11:45 am **Lunch**

SEABIRDS AND WATERFOWL SESSION

1:15 pm **The Population Status of Seabirds on St. Matthew and Hall Islands, 1985 & 1986** - Dr. Ed Murphy

1:45 pm **Monitoring St. Lawrence Island and Cape Thompson Seabird Populations** - Dr. Scott Hatch

2:15 pm **Monitoring Seabird Populations at Three Colonies in the Bering Sea** - Dr. Vivian Mendenhall

2:45 pm **The Movements and Population Status of Ross' Gull** - Mr. George Divoky

3:15 pm **Break**

3:30 pm **Monitoring Beaufort Sea Waterbirds/Determining Use of Kasegaluk Lagoon by Marine Birds** - Dr. Steve Johnson

4:00 pm **Behavior and Energetics of Pacific Black Brant in Response to Aircraft Overflights at Izembek Lagoon, Alaska** - Dr. David Ward

4:30 pm **Response of Molting Pacific Black Brant to Helicopter Overflights near Teshekpuk Lake, Alaska** - Dr. David Ward

5:00 pm **Adjourn**

AGENDA

MINERALS MANAGEMENT SERVICE
INFORMATION TRANSFER MEETING
JANUARY 30 TO FEBRUARY 1, 1990

ANCHORAGE HILTON HOTEL
ANCHORAGE, ALASKA

Thursday, February 1, 1990 - Katmai/King Salmon/Iliamna Rooms

SOCIOECONOMIC SESSION

8:30 am **Social Indicators**

8:30 am Dr. Joseph Jorgensen
9:45 am Dr. Steven McNabb

10:30 am **Break**

10:45 am Dr. Lynn Robbins
11:30 am Dr. Don Callaway

12:15 pm **Lunch**

1:30 pm **Point Lay Case Study** - Dr. John Petterson, Mr. Michael Galginaitis

2:10 pm **Northern Institutional Profile Analysis** - Dr. John Petterson, Dr. Michael Downs

2:50 pm **Break**

3:05 pm **Rural Village Economies** - Dr. John Petterson, Mr. Will Nebesky

3:45 pm **North Slope Subsistence Study** - Mr. Stephen Braund

4:45 pm **Adjourn**

APPENDIX B

ATTENDEE LIST
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INFORMATION TRANSFER MEETING
JANUARY 30 TO FEBRUARY 1, 1990
ANCHORAGE, ALASKA

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.