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REPORT OF THE SECOND WORKSHOP ON BEAUFORT SEA BELUGA, APRIL 22-24, 1996, INUVIK, NT, CANADA

by

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These proceedings are dedicated to
Titus Taktuk Allen
February 17, 1947 – February 21, 1997.
Known and respected beluga hunter,
beluga monitor, bowhead harpooner (1991)
and hunt captain (1996), Inuvialuit Game Council
and Aklavik HTC member,
father, grandfather, colleague and friend.

God itkasiksimaniagaatin

God be with you until we meet again.

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ABSTRACT

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Sixty-seven workshop participants representing harvesters, managers and scientists from Canada and the United States gathered in Inuvik in April 1996 to discuss the Beaufort Sea beluga. Participants were to exchange information on recent research and monitoring, discuss inter-jurisdictional concerns, examine future activities by the petroleum industry, and consider future research directions. Twenty-three presentations were given at the workshop, addressing stock size, range and movements; stock identity; harvesting in different hunting areas of Alaska and northern Canada; harvest-monitoring programs; reproductive rates, age, disease and contaminants in the belugas; and finally, an overview of plans by the oil and gas industry. The stock appears stable and beyond the size indicated by the most recent index of abundance. The range of the stock is more than twice the size of that previously known. The genetic relationships between beluga of the Beaufort Sea, Alaska and the eastern Arctic indicate that Beaufort Sea beluga constitute a distinct stock, with some mixing of larger males among neighbouring stocks. The most pressing issue for the communities at this time is that of contaminant loads in the whales and the potential impacts of these on whale and human health.

Key Words: Beaufort Sea beluga; harvesting; monitoring; health, condition, reproduction, stock size, range, status.

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En avril 1996, soixante-sept personnes, soit des exploitants pêcheurs, des gestionnaires et des scientifiques du Canada et des États-Unis, se sont rendues à Inuvik afin de participer à un atelier portant sur les bélugas de la mer de Beaufort. L’atelier devait permettre aux participants d’échanger des renseignements sur les récents projets de recherche et de surveillance, de discuter des préoccupations intergouvernementales, d’étudier les futures activités de l’industrie du pétrole et d’étudier la direction que doit prendre la recherche à l’avenir. En tout, l’atelier comprenait vingt-trois présentations. Ces dernières portaient sur des sujets tels que la taille des stocks, l’aire de répartition et le déplacement des stocks, l’identité des stocks, la récolte dans différentes zones de chasse en Alaska et dans le Nord du Canada, les programmes de surveillance de la récolte, les taux de reproduction, l’âge, la maladie et les contaminants chez les bélugas ainsi qu’un survol des plans de l’industrie du pétrole et du gaz naturel. Le stock semble être stable et semble dépasser le plus récent indice d’abondance. Le stock est plus de deux fois plus grand qu’auparavant. Les liens génétiques entre les bélugas de l’Alaska, de l’Arctique de l’Est et de la mer de Beaufort indiquent que les bélugas de la mer de Beaufort constituent un stock distinct, exception faite d’une petite partie de la progéniture qui est issue d’accouplements avec de plus gros mâles de stocks voisins. La charge de contaminants chez les baleines et l’impact potentiel de ces contaminants sur la santé des baleines et des humains constitue la question la plus importante à aborder.

Mots clefs : béluga de la mer Beaufort; récolte; surveillance; santé; condition; reproduction; taille du stock; aire de répartition du stock; état.

INTRODUCTION

There is a long history of utilization of the beluga whale by Inuit for food and dog food. For 500 or more years, the Inuvialuit of Canada's Western Arctic have harvested the beluga whale in the Mackenzie Estuary (McGhee 1988). Harvests in earlier times were considerably higher than the present day (Nuligak 1966). Present day hunters and their families from Inuvik, Aklavik, Tuktoyaktuk and Paulatuk NT (Fig. 1) travel to traditional whaling camps along the Beaufort Sea coast (Fig. 2). Inupiat of Alaska also hunt Beaufort Sea belugas during spring and fall migrations. Residents of the Chukotka Peninsula in Russia also hunt small numbers of beluga.

Along with the Fisheries Joint Management Committee (FJMC), the hunters have been active participants in the delivery of the annual "Beluga Monitoring Program". As well, the Inuvialuit harvesters have prepared and implemented their Beaufort Sea Beluga Management Plan (FJMC 1998). This includes guidelines for tourism operators in the region, community-specific beluga hunting by-laws, and guidelines for protection of beluga habitat according to beluga management zones.

In 1992, the FJMC convened a workshop on Beaufort Sea beluga, primarily to review the state of the existing scientific and traditional knowledge of this stock, identify data gaps, and to plan for research to address those gaps (Duval 1993). It was held in Vancouver, BC, February 3-6, 1992, and brought together a wide range of scientists, hunters and managers, from both Canada and the US. Since that time, the Fisheries Joint Management Committee (FJMC) and the Department of Fisheries and Oceans (DFO) have sponsored and co-ordinated a number of research projects which addressed the research recommendations tabled at that first workshop.

A second *Beaufort Sea Beluga Workshop*, sponsored by the FJMC, was held in Inuvik, NT, Canada on April 22-24, 1996. It was attended by community representatives from the Inuvialuit Settlement Region (ISR), Nunavut and the North Slope Borough of Alaska (NSB), and by scientists from Canadian and US government agencies, research organizations, universities, colleges and private companies. Participants presented the results of research programs that had been undertaken since the first workshop, and provided first-hand accounts of beluga harvest and harvest monitoring practices in the different hunting jurisdictions represented at the workshop. In addition, participants reviewed applicable or relevant results from research initiatives on stocks other than Beaufort beluga, described potential future oil and gas exploration and production scenarios, and suggested directions for future research efforts. The presentations and discussions of this second workshop on Beaufort Sea beluga are summarized in these proceedings. Dr. Michael Papst, Dept. of Fisheries and Oceans, and member of the FJMC, facilitated the workshop.

The workshop was attended by 67 participants, 34 of which were beluga hunters or their representatives. Government agencies represented at the workshop included DFO, Government of the Northwest Territories (GNWT) and the US National Marine Fisheries Service (NMFS). Co-operative management bodies represented included the FJMC, the Gwich'in Renewable Resource Board (GRRB), and the Nunavut Wildlife Management Board (NWMB). The Inuit Circumpolar Conference (ICC), the North Slope Borough Dept. of Wildlife Management, the Natural Environment Research Council's Sea Mammal Research Unit (SMRU, UK), the Canadian Circumpolar Institute (CCI), and Arctic College (AC) were also represented at the workshop.

These proceedings follow the general order of events at the workshop. Care has been taken to accurately report the contributions of the participants at the workshop, although additional information has been added in some cases to clarify and enhance understanding of information presented at the workshop.

WORKSHOP GOALS

The specific goals of the 1996 workshop were to:

- exchange information among hunters and researchers on beluga, particularly that which has been gained since the 1992 Vancouver workshop on Beaufort Sea beluga.
- explore and discuss the status of information on beluga reproduction and the general well-being of Beaufort Sea beluga, and to gather ideas on the types of studies that might be done in the future.
- exchange information with the oil and gas industry and to receive an update on their

plans so that these can be considered in the beluga management process.

- explore the need for more formal management arrangements between users in Nunavut, the ISR and Alaska.

INTRODUCTORY COMMENTS

Bob Bell called the workshop to order. Billy Day gave the opening prayer.

Bob hoped that the 1996 workshop would be as successful as the first Beaufort beluga workshop held in Vancouver in 1992. He emphasized the importance of two-way communication and felt this was key to the success of the present workshop. Bob explained that FJMC was particularly interested in receiving feedback from the Inuvialuit beneficiaries about recently completed and future research on Beaufort Sea beluga.

Each participant introduced him or herself, and provided comments on their particular area of expertise and interest with respect to the workshop agenda and beluga.

Larry Carpenter welcomed everyone to the workshop, and thanked the DFO Area Office and the Joint Secretariat staff for co-ordinating it. Larry noted the diverse experience of the workshop participants.

Mike Papst offered opening comments on behalf of DFO and reaffirmed that communication was the very foundation of the co-management process.

SESSION 1 - SETTING THE SCENE

Presenters: Don Dowler and Billy Day

There had been considerable debate prior to the first workshop about the size of the Beaufort Sea beluga stock. Research efforts during the oil and gas exploration period (1970's through early 1980's) were described, noting that aerial surveys done during this period covered only a small portion of the range of Beaufort beluga now known to be much larger. Harvesters felt that the estimates of stock size produced from those surveys, in the range of 7000 beluga, were very low compared with the actual (but unknown) number of whales in the stock.

Billy Day elaborated on the different management regimes in place during the 1970’s and early 1980’s. DFO was interested in obtaining an estimate of stock size and was considering whether or not the harvest of beluga in the Mackenzie Delta needed to be managed under a quota system. The local harvesters wanted to produce and implement a community-based beluga management plan, rather than a quota.

After the signing of the Inuvialuit Final Agreement (1984), the legislation and framework for preparing a community-based beluga management plan was finally in place. Work on the Plan began at that time and continued for several years. By 1990, the first edition of the community-based Beaufort Sea Beluga Management Plan was ratified by the beluga harvesters, completed and printed. The Plan is reviewed and updated every three years. Don emphasized that the success of the Plan was due to the establishment and compliance with community beluga hunting by-laws. Guidelines for beluga/tourism operators have also been prepared and implemented.

Don reviewed the outcome of the first (1992) Beaufort Sea beluga workshop, summarizing the three basic research recommendations that arose from that workshop:

- to construct a database for the Beaufort Sea stock through better use of the data at hand or that which is easily acquired, including maximizing the return from the continuing monitoring program, processing all currently collected samples and recording traditional knowledge of Inuvialuit elders.
- to conduct a satellite tagging program aimed at recording beluga movement patterns between inshore and offshore habitats and through Canadian, Alaskan and Siberian waters, to define the management unit, and beluga surfacing intervals, to determine correction factors for survey data collected on whales in different habitats.
- to complete as comprehensive a survey as possible of inshore and offshore areas of the Beaufort Sea stock's known summering range.

SESSION 2 - BEAUFORT SEA BELUGA: HOW MANY ARE THERE AND WHERE DO THEY GO?

2.1 Aerial Survey of Beaufort Sea, Mackenzie Delta and Western Amundsen Gulf, July 23-25, 1992

Presenters: Lois Harwood and Dave Macleod

Information on the relationship of four possible beluga stocks that summer in western Canada and Alaska was provided. All four of these stocks are believed to over-winter in the Bering Sea (Fig. 2). In spring, they migrate to summering areas in Bristol Bay, as well as through the Bering Strait to the eastern Chukchi Sea, Norton Sound and the south-eastern Beaufort Sea and Mackenzie Delta areas (the Beaufort Sea stock).

The Beaufort Sea stock travels the furthest of the four stocks, migrating through the Alaskan Beaufort Sea to Amundsen Gulf, and eventually to the Mackenzie Estuary. Residents of the Inuvialuit Settlement Region hunt Beaufort Sea belugas during summer when the whales are concentrated in nearshore waters. Residents of at least three coastal villages in Alaska (Kivalina, Point Hope and Point Barrow) hunt belugas during their annual migrations to and from the Beaufort summering areas (Fig. 2).

The 1992 Vancouver workshop recommended a comprehensive aerial survey of inshore and offshore areas of the stock's known range. This survey was within 55 h on 23-25 July 1992, and included the Mackenzie Estuary, the Beaufort Sea offshore to approximately 71^0 N and western Amundsen Gulf. This produced an index of stock size (adjusted for surfaced whales missed by observers and about-to-surface whales) of 19 629 beluga (95% CI 15 134 – 24 125). Methods used to conduct the survey were described, survey participants listed and results presented (Harwood et al. 1996).

During the survey, the largest concentrations of belugas were found in Kugmallit Bay in the Mackenzie Estuary and offshore of the Tuktoyaktuk Peninsula stratum. Most belugas were seen alone or in pairs, with the largest group consisting of 22 whales.

The index of stock size produced from this survey, which was greater than from any previous survey, is in itself very conservative. Beluga far below the surface and outside of the study area could not be accounted for. Also, the method used to calculate the adjustment factor for missed-at-surface and about-to-surface whales was calculated in a conservative manner.

A number of scientists who have worked with beluga in the eastern Canadian Arctic commented that they found the group sizes reported for the 1992 survey to be small compared with their observations in other areas and with other stocks. In particular, in the eastern Arctic, large groups (e.g. hundreds) of beluga have been found in areas of clear water near shore. This difference may be due to the muddy waters of the Mackenzie Estuary where it is not possible to see a whole group of beluga at once. Since some belugas are hidden, the size of the group cannot be estimated. In the Mackenzie, belugas are only visible when they break the surface and then are only seen for a few seconds. Large groups such as those seen in the eastern Arctic may occur in the Estuary but would not be seen with certainty. The group sizes observed during the 1992 surveys were similar to those observed during other surveys of the offshore Beaufort (e.g. in 1984, Norton and Harwood 1985) in the same area.

2.2 Satellite Telemetry Studies, 1993-1995

2.2.1 Capture of the beluga and attachment of the satellite tags

Presenters: Jack Orr and Ricky Joe

Both scientific and traditional knowledge was used to perfect the whale capture efforts. Over the three years of the study, approximately 60 people from DFO Winnipeg and from the communities of Inuvik, Aklavik and Tuktoyaktuk were involved in the project, 35 to 40 in an official capacity.

A minute of silence was observed in honour of two participants in the tagging project who had since passed away - Henry Chicksi and Narcisse Capot-Blanc.

Over the course of the study, the tagging team tried a variety of methods for capturing whales. Jack Orr explained the first method that was used to capture beluga at Churchill, MB (Fig. 1), for aquaria. With this method, the boat is brought close to the beluga and the person in the front of the boat jumps into the water and places a rope over the whale's head and around the flippers. The person in the back of the boat restrains the beluga’s tail. This method was dangerous since it was difficult to restrain the whale once it was captured. Tom Smith and Tony Martin improved the technique by using a seal net with copper or PVC tubing strung through it, to produce a hoop. Jack Orr further modified the hoop by using a more rigid tube frame, wrapping the tube in foam and using a smaller (15 in) mesh netting with no knots. This was the first method used in the Mackenzie Delta.

A Zodiac was used to help herd the animals and a rope inside a section of rubber garden hose was used to secure the captured whale's tail. Once the hoop net and tail rope were in place, the captured beluga became relatively calm quite quickly. Using this method, a total of four whales were caught and tagged in 1993. The same method was used in 1994, but no whales were caught, primarily due to adverse weather conditions.

The capture method was modified again in 1995, following a technique developed to catch dolphins in Florida. There were three herd boats and these were stationed at Kittigazuit Bay (Fig. 3). Each boat had a captain from one of the local communities (Norman Felix from Tuktoyaktuk, Hugh Rogers from Inuvik and Ricky Joe from Aklavik); a helper accompanied each captain. Three Zodiacs, each with a driver and two jumpers, followed the herd boats. When the weather was calm, the boats moved through Kugmallit Bay, keeping about 100-200 m apart and everyone searched for whales. Communication between boats was by CB radio.

When whales were spotted, the six boats worked together to slowly herd them into shallower water. As soon as the whales were in water about six feet (1.8 m) deep, the boats separated the whales into smaller groups, so fewer whales would be caught in the net. A net, 150 yards (137 m) long, 10 feet (3.0 m) deep with 12 inch (30 cm) mesh, was mounted near the stern of a 18 ft Lund (5.5 m) aluminium boat. The net was deployed to encircle a small group of whales in shallow water, and from these, one or two whales were selected for tagging. The criteria used for this selection included the presence of a calf, and the size and the sex of the beluga.

Once an animal was targeted, the Zodiacs were brought in quickly to ensure the hoop net and tail ropes were secured around the selected animals as soon as possible. This was done to ensure the process would not injure the whales. As soon as the animals were secure, they were brought into even shallower water, so the tagging team could apply the tag and take the necessary samples and measurements (Richard et al. 1997). Cow-calf pairs were released immediately. All other whales were released after tags were applied. A video was shown to the workshop participants that showed a sequence of the capture method used in 1995.

The tagging team followed a set procedure when handling each captured whale. First the whale was measured and sexed, and if acceptable for tagging, the satellite tag was applied. The satellite tags consisted of either one or two 1 1/2" (38 mm) diameter sealed aluminium tubes, which housed the sensors, microcomputer and batteries, and an antenna. To secure the tag, two straps of flexible material were laid across the whales back perpendicular to the dorsal ridge. The tag was held in place by nylon pins through the skin and connective tissue of the dorsal ridge, and secured with nylon washers and nuts. The pins were threaded so that the washers could be tightened and the nylon ends were then cut short and melted to the nuts so the pins would not come out. The process of applying the tag appeared relatively painless to the whales as they usually did not visibly react and there was very little blood loss in the process.

The next step was to attach an identification tag to the flipper. The results of tests on flipper tags in aquaria indicated an expected attachment period of three to four years. A skin biopsy and blood samples were taken, then the whale was injected with an antibiotic and released. Assistance was provided, if necessary, to get the whale to deeper water. In 1995, a total of 21 adults and four calves were captured and 16 adults were tagged.

2.2.2. Where did the satellite-tagged whales go?

Presenter: Pierre Richard

When a whale, fitted with a satellite tag, surfaces to breath in such a way that the dorsal ridge and satellite tag are exposed, the tag's transmitter sends a signal to the satellite which relays it to the receiving station in France. Data are then obtained by DFO, either by the Internet or by modem. The satellite tag sends two types of information. One is the geographic location of the whale at the time of the signal. The other is information on dive depth and duration.

Three males and one female were tagged in 1993, and 11 males and five females were tagged in 1995. Yearlings accompanied three of the females tagged in 1995. The effective life of the tags varied from nine to 91 days. In 1993, all of the tags applied were programmed to transmit daily.

In 1995, to extend battery life, some of the tags were duty-cycled to transmit every day for the first 30 days and every other day thereafter. Because of a software problem at the receiving station, signals from the modified tags were not recognized after 30 days, although they continued to transmit after this time.

The movements of the whales were similar in both 1993 and 1995, with males and females exhibiting different movement patterns. All females, except one, travelled between the Mackenzie Delta and Amundsen Gulf. The exception moved to the north-east, following the west coast of Banks Island (Fig. 3).

Males, however, showed a different and unexpected pattern. In 1993, one male, and in 1995, nine males travelled approximately 800 km from the Mackenzie Delta to the deep waters of Viscount Melville Sound (Fig. 1). They appeared to remain within 50 km of each other for a period of 2-3 weeks. Eight of nine males followed the same route, moving to the north east through the Beaufort Sea and entering Viscount Melville Sound via M'Clure Strait. However, one of the nine males travelled to Viscount Melville Sound via a different route, through Prince of Wales Strait. After several weeks in Viscount Melville Sound, the males returned to the south-east Beaufort Sea, and then westward on their return fall migration through Alaskan waters.

Not all the tagged males went to Viscount Melville Sound. In 1993, one male moved north from the Mackenzie Estuary into the pack ice to 80° N. In October, it moved west to the eastern Siberia Sea. In 1995, two of the tagged males did not go to Viscount Melville Sound, remaining in the Amundsen Gulf region. None of the females tagged in either year travelled to Viscount Melville Sound.

There are implications of these findings for the aerial survey completed in 1992 (Section 2.1). First, many of the whales' tracks were through areas of 9/10ths ice and/or in water 2 000 - 4 000 m deep, and these areas were far from shore and beyond the range of the survey aircraft used in 1992. Second, within the same geographic area that was surveyed in 1992, most of the movements by individual whales tagged in 1993 and 1995 were short and slow, suggesting double-counting was probably not a significant source of error in the 1992 survey. Third, assuming the tagged animals are representative of the stock and comparable among years, possibly 60% of the whales in the stock may already have moved out of the survey study area by the time the survey was flown on 23-25 July 1992.

2.2.3. What were the characteristics of the dives made by the tagged beluga?

Presenter: Dr. Tony Martin

The other type of information that is transmitted when a satellite-tagged whale comes to the surface to breathe is a record of the time spent at various water depths. The front of the satellite tag has a built-in pressure sensor, pressure being directly related to depth. The depth information that is obtained is particularly useful in determining correction factors for aerial survey data, as it reveals the amount of time that a whale spends at the surface (e.g. visible to surveyors) vs below the surface (e.g. invisible to surveyors).

Correction factors can be used to adjust aerial survey data to account for whales that are missed during surveys. Calculated from dive data gained in this study, the range of correction factors to account for the time that a beluga spends below the surface was estimated at 2.5 - 4.5 times the number of surface whales, for the Mackenzie Estuary. This correction factor would be appropriate for whales beneath the surface that cannot be seen by aerial observers, and assumes that only whales actually at the surface can be seen.

The correction factor ranged from 1.6 - 1.9 times the number of surfaced whales for the offshore Beaufort Sea area, and 1.9 times for Amundsen Gulf. These factors are higher than those used for estimating about-to-surface and missed-at-surface whales in the 1992 aerial survey analyses (determined using methods other than telemetry, 1.085 for the Estuary and 1.312 for the offshore Beaufort and Amundsen Gulf; Harwood et al. 1996).

Graphs were presented showing time-at-depth for individual tagged whales. Females in Amundsen Gulf made about 20 deep dives per day, spread throughout the day, to depths of about 800 ft (244 m) or to the seafloor. The dives lasted from 12 to 18 min each and it appeared that the females were feeding at the seafloor.

On their way to Viscount Melville Sound, the tagged males travelled through water greater than 13 000 ft (3 962 m) deep, much of it covered with heavy ice. Under these conditions, the whales travelled about 75 km per day and made a series of V-shaped dives down to 2 000 - 2 500 ft (610 - 762 m). These V-shaped dives were only made when the whales were in areas of heavy ice. The whales may have been diving to these depths to get below the layer of surface noise, in order to detect areas of open water in which to surface to breathe.

One large male was making V-shaped dives through an area of deep water when he reached the shallower shelf edge in M'Clure Strait (water depth = 3 500 ft or 1 067 m). At this point, he dove directly to the bottom and remained there for close to three minutes. This is one of the deepest accurately recorded dives for any whale anywhere in the world. This whale then continued on to Viscount Melville Sound, making progressively shallower dives, as the water became shallower.

The area where the tagged male belugas gathered in Viscount Melville Sound has water depths in the 1 500 - 1 700 ft range (457 to 518 m), heavy ice cover and presumably a plentiful food resource. The beluga’s diving behaviour in that area consisted of "flat-bottom" dives, with the seafloor portion lasting from six to eight minutes. These distinctive dives, which sometimes started as soon as the male reached M'Clure Strait, were not made by these same males when they were in the deep offshore waters of the Beaufort Sea. In fact, the tagged beluga did not make deep dives in the Beaufort unless there was heavy ice cover and then the dives were V-shaped.

2.2.4. Discussion of tagging studies and results

The satellite telemetry presentations raised a number of questions. One participant asked if there were differences in the diving behaviour of females with vs without calves. No apparent differences were found, suggesting that the females leave their calves at the surface when they make deep dives. Similar behaviour has been found in narwhals and sperm whales. Young narwhals have been observed at the surface in association with males, while the mother whale was not in sight.

An explanation for the lack of females in Viscount Melville Sound was sought. Sexual differences in lung capacity may provide some explanation. Males are larger and may be able to hold their breath for a longer period than females. While a female in Viscount Melville Sound may be able to dive deep enough to reach the bottom, there may not be sufficient time available for her to feed before having to surface to breathe. The energy that a whale expends in travelling to distant Viscount Melville Sound would have to be replenished by extensive feeding on rich food sources there. With males, the extra few minutes in lung capacity may *tip the scale* in favour of the trip.

The type and amount of food available to beluga in Viscount Melville Sound is not known. Participants speculated that Greenland halibut (turbot) and/or Arctic cod may be the food source attracting the beluga, but the seafloor biota has never been sampled in this region.

One participant asked if it was possible to tell the sex of beluga from a survey aircraft. Aerial surveyors find that making this distinction from an altitude of 1000 feet (305 m) and at a survey speed of 200 km/h is not reliable. Females can sometimes be identified on the basis of a calf being present and the calf's behaviour.

SESSION 3 - STOCK IDENTITY: HOW ARE THE DIFFERENT STOCKS OF BELUGA IN ALASKA AND THE EASTERN ARCTIC RELATED TO BEAUFORT SEA BELUGA?

3.1 Background and the Comparison of Alaskan stocks with Beaufort Sea beluga.

Presenters: Dr. Greg O'Corry Crowe

Hunters and scientists can make observations that contribute valuable information on

- annual and seasonal migration patterns of beluga.
- the relative non-uniformity of beluga distribution.
- daily changes in beluga distribution patterns.
- the number and location of wintering areas.
- the gregarious nature of beluga.
- segregation of beluga by age and sex at certain times of the year.
- the lengthy period of maternal care, and, the broad vocal repertoire characteristic of beluga.

Species characteristics, such as genetic structure, breeding patterns and social organization cannot be determined using traditional observational methods alone because beluga are difficult or impossible to recognize as individuals. An observer usually sees an animal only briefly before it dives and, with few distinctive identifying features, there is no way to determine when an animal surfaces if it is the same one as seen previously or a different one. Thus observers cannot get any continuity with behavioural observations.

To describe genetic variation, geneticists use two basic types of markers: mitochondrial DNA (mtDNA) markers, which are inherited from the mother, and micro-satellite markers, which are inherited from both parents. Other molecular techniques may be used to determine the sex of the animal.

Traditionally, beluga stocks have been defined according to their summering areas, which have been thought to be discrete units, rather than the wintering areas. All of the Alaskan and north-west Canadian stocks may share a common wintering ground in the Bering Sea. Breeding is thought to occur either on the wintering grounds or during spring migration. Under this scenario at least three hypotheses of stock discreteness exist:

- there is regular exchange of individuals among summering concentrations.
- interbreeding occurs among these concentrations on wintering grounds, or possibly during migration, but individuals remain philopatric to their summering grounds.
- there is no individual exchange or breeding among summer concentrations, either on the summering or wintering grounds.

The reality, however, is that little is known about the winter distribution of any of the proposed stocks, and the winter and spring interactions among beluga that aggregate during the summer in different locations may be quite complex.

Analyses of mtDNA from 320 beluga sampled from over 30 locations, including Cook Inlet, Bristol Bay, Norton Sound, the eastern Chukchi Sea and the Beaufort Sea (Fig. 2) found 28 different mtDNA markers. There were significant differences in the mtDNA markers in samples from beluga taken from the different summering areas, indicating limited movement among summering grounds.

There was a high level of genetic diversity in both the eastern Chukchi and Beaufort Sea stocks, but not in the Cook Inlet, Bristol Bay and Norton Sound stocks. Samples from the harvests at Point Hope and Kivalina are not significantly different from the samples taken in the Mackenzie Estuary region, so the hunters in those Alaskan areas appear to be harvesting animals from the Beaufort Sea stock. According to the mtDNA analyses, Cook Inlet is the most different of the five stocks.

The largest data set analyzed is from the harvest at Point Lay, Alaska (Fig. 2), and information on sex, reproductive condition and age is also available for these animals. The basic findings from the Point Lay samples are:

- few genetic differences in the samples from one year to the next.
- 11 different mitochondrial variants were found, indicating there are at least 11 maternal lineages present in this stock.
- associated animals may not all be related.
- most of the rare haplotypes were found in males, indicating there is more dispersal by males than by females.

Micro-satellite markers may be able to tell us more about breeding behaviour than mitochondrial DNA because both parents inherit them. If enough micro-satellites are examined, it may eventually be possible to identify individual whales. The micro-satellite analyses found fewer differences among the five stocks than did the mtDNA analysis. This indicates that there is probably some genetic exchange while the whales are on the over-wintering grounds or during the spring migration.

The social structure of the beluga whale has often been compared to that of both the killer whale and the long-finned pilot whale. However, our current knowledge of beluga indicates a very different social organization for this species than for the other two. Both killer whales and long-finned pilot whales travel in very stable pods that are essentially extended families. Conversely, there is good evidence of segregation by age and sex at certain times of the year, indicating that beluga pods are not stable.

3.2 Comparison of Stocks From the Western and Eastern Canadian Arctic.

Presenter: Dr. Jim Clayton

The genetic composition (mitochondrial DNA and micro-satellites) of beluga whales taken from Point Lay, Alaska, the Mackenzie Delta, Arviat and the Nastapoka River in Hudson Bay, the St.Lawrence River in Quebec, Pangnirtung on Baffin Island, Grise Fiord on Ellesmere Island and the west coast of Greenland (Fig. 1) was investigated.

The mtDNA analyses found many of the same haplotypes in both the Point Lay and the Mackenzie Estuary beluga samples but the proportions differed greatly. In addition, there were some haplotypes found in the Mackenzie Estuary whales that were not found in whales from Point Lay. It was not possible to determine for certain whether an animal was from the Mackenzie Estuary or from Point Lay, using mtDNA.

Whales from Arviat had some of the same haplotypes as whales from the western Arctic, however there were also some haplotypes that were not found in the western Arctic. These haplotypes were common in beluga from the Nastapoka River and St. Lawrence River areas. The St. Lawrence River animals showed the least genetic diversity. Based on the mtDNA analyses, the results indicated that Point Lay, the Mackenzie Estuary, Arviat, the Nastapoka River and the St. Lawrence River have different beluga populations.

A total of 16 micro-satellites were used for the analyses and more may be developed in the future. Some of the micro-satellites had 12 or more alleles (different forms of the same micro-satellite).
The micro-satellite analyses also showed that beluga taken at each of eight locations (the same used in the mtDNA analysis plus Pangnirtung, Grise Fiord and west Greenland) were genetically different from one another. There were fewer differences between some groups in the eastern Arctic (e.g. Arviat and the Nastapoka River) or between groups in the western Arctic (e.g. Point Lay and the Mackenzie Estuary) than between the eastern and western groups. The St. Lawrence River belugas were very different from any of the other beluga groups examined.

3.3 Discussion of Stock Identity Studies

More similarities were found by micro-satellite techniques than the mtDNA technique, suggesting more dispersal among male than among female belugas. If the migration routes of several stocks merge along the Alaskan coast in the spring, Beaufort Sea whales may be landed at Point Lay during the spring hunt. However, the whales taken at Point Lay during the summer are genetically distinct from those taken in the Mackenzie Estuary. An individual animal may not always be identifiable as being from Point Lay or from the Mackenzie Estuary, but about 95% of the time it is possible to identify an animal as being from either the Mackenzie Estuary or Arviat because there are many differences between those populations.

SESSION 4 - HARVESTING TECHNIQUES AND HARVEST MONITORING

4.1 History and Early Practices of Beluga Harvesting in the Inuvialuit Settlement Region

Presenter: Billy Day

The traditional methods for harvesting, landing and processing beluga whales in the Estuary region were described. Much of the information came from discussions Billy Day had with elders, particularly the late Felix Nuyaviak, with whom he travelled with as a young man. Much of what Felix described took place at Kittigazuit (Fig. 3), where Felix's mother was raised. That site is now only occupied during the summer, as a seasonal whaling camp.

When Felix was young, there was an organized community at Kittigazuit. There were camp leaders who assigned specific people to watch from the hill to see when the whales were coming in and where the whales were. Based on the information from the lookouts, the leaders would then decide if a hunt were possible (e.g. the weather was good and the whales were in the right place). Once a decision was made to start the hunt, kayaks would move quietly, one by one, from the shore towards the whales in Kugmallit Bay. Felix remembered times when a line of kayaks would extend to and encircle the whales far from shore, while there would be still others just leaving the shore at Kittigazuit.

Once the kayaks were in place, the hunters would make noise with their paddles to try to drive the whales into the shallower water at the mouth of the Mackenzie. As the whales were beached in the shallow water, they would be speared. This was done at low tide so that the whales that were not speared would be able to get out as the tide rose. Sometimes 250 to 300 whales would be taken in one day in this manner. Such hunts may have been the only opportunity to catch whales for food for the entire upcoming winter. Everyone in the community would help cut up and prepare the whales.

Felix remembered a time his father came back from a hunt towing five whales behind his kayak, and Felix wondered how this was possible. His father explained that the hunter made a short stick with a hole in it. When a whale was killed, they then made a hole in the skin and used the stick to inflate the whale and then sewed up the hole. This way, over half of the whale would float out of the water, so many could easily be towed by one kayak.

Traditionally every part of the whale was used. The stomachs and throats were used as containers. The stomachs were used to store berries, dried meat and muktuk, while the throats were used when travelling because they were easy to use and light to haul. People had to travel with light loads because they did not have many dogs to pull them. If you had three dogs, you were considered a rich man.

Some of the meat and muktuk were put into holes which had been dug in the permafrost, although most of the meat was dried. Blubber was made into oil that was used to preserve the muktuk.

Beluga whale hunting methods changed with the arrival of commercial whaling ships that came in the 1890's and early 1900's in search of bowhead whales. These ships brought whaleboats (lifeboats, which were also used to harpoon the bowheads). When the commercial whaling era was over, the whalers left and left behind many of these whaleboats. Local people started to use them, rather than kayaks, to hunt beluga. The boats would be rigged with a sail, and were thus quiet enough to allow hunters to get close to the belugas.

Schooners were the next type of boats used, and eventually motors were used on these. At about this time, hunters started the practice of shooting whales first to cripple and slow them down, so they could be harpooned. If a whale was shot and killed before it could be harpooned, and then sank, no more hunting was allowed until the sunken whale was recovered. There could be whales all around but no one was allowed to continue hunting until the sunken whale was retrieved.

The techniques for harvesting and processing beluga whales were passed along verbally, from generation to generation. This process stopped when people learned how to write. A lot of history was lost because old people died before the younger people realized that they were losing their history. Many of the elders with whom Billy spoke seemed "starved" to talk, and once they started, it was almost as if they could see pictures of what was happening as they spoke.

4.2 Recent History and Present Harvesting Techniques in the Inuvialuit Settlement Region

Presenter: Richard Binder

Modern day techniques used to hunt beluga whales in the shallow waters of the Mackenzie River estuary were described. In the 1960's and 1970's, motorized boats and high-powered rifles became readily and commonly available. Using this equipment, hunters tried to follow a whale to make sure a calf did not accompany it. Sex of a whale is difficult to ascertain, particularly in turbid waters of the Mackenzie. Hunters often shot a whale in the tail to slow it down, then moved in to harpoon and kill it. A large number of whales were struck but not retrieved with this method, and the hunters and the local Hunters and Trappers Committees decided that changes were needed.

Community-based beluga hunting by-laws, regulating beluga hunting in the community hunting areas, were drafted in 1990 and eventually adopted by each of the whale harvesting communities in the ISR. The by-laws require that each boat used for beluga hunting be equipped with the following:

- at least two harpoons with a line and float attached,
- a grappling hook with a long line that can reach the sea bottom, a smaller hook with a handle or a pole with a hook.
- a rifle with at least a .30 calibre bore.

By-laws also encourage people not to hunt alone.

A video depicting beluga whale hunting and processing was shown during this session. It was made in co-operation with the local Hunter and Trappers Committees, the IGC and FJMC. The video demonstrated how people hunt, capture, kill and process beluga whales, and how the meat, muktuk and blubber are cooked and stored. The video featured local people discussing and demonstrating the various techniques, and is available through the Inuvialuit Communications Society, Inuvik, NT, Canada.

Presenter: John Max Kudlak

Current hunting methods in deep water areas near Paulatuk were described. Most beluga hunting takes place at two locations, one off the Parry Peninsula and the other at the mouth of the Horton River (Fig. 3). Usually six to eight boats are involved, with an average annual take of 10 whales (Harwood et al. in press). Hunters have noticed that on calm days around the Parry Peninsula, the whales seem to sink easily. As the whales enter the freshwater of the Horton River estuary, their rate of movement slows and this makes them easier to hunt.

4.3 Harvesting Techniques in the Eastern Arctic

Presenters: David Aglukark, with Dan Pike

In Arviat, Nunavut (near Churchill, MB, Canada) on the coast of Hudson Bay, hunters pursue the beluga in shallow water. Equipment necessary for hunting beluga in this location includes a boat and motor, harpoons, lines and floats. The names for much of the hunting equipment are the same in Inuktuit and some Russian dialects.

There have been several changes in the type of boats used for whaling in the eastern Arctic. Many years ago the hunters would use 20-foot or 22-foot freighter canoes, but then they switched to larger boats and larger engines when those became available. There was considerable damage done to the larger engines, because of their larger draft, and so people have now reverted back to using smaller boats and 25-30 hp outboard motors.

The method of alerting hunters that the "whales are in" has also changed over time. In earlier times, children playing outside would act as lookouts. One of them would give a big shout, which was enough to notify the whole community that the whales were coming in, and everyone would race down to the shore. Now the community has grown to about 2 000 people and one person could shout and no one would hear, as they are inside watching television. So the message is passed along using CB radios.

Around Arviat, the whales are chased and harpooned before being shot. However, in Hudson Bay the water is clear and hunters can see the sea bottom in the shallow areas. Usually a .270 or .303 calibre rifle is used. In the Baffin area, where the water is deep, hunters usually try to wound and weaken the animal first by shooting it before they harpoon.

Both the muktuk and the meat are used and need to be preserved. Usually the muktuk is cut into smaller pieces, packaged and stored in a refrigerator or freezer for use in the winter. However, some muktuk is buried under rocks to age for the older people who like their muktuk prepared in this way. Although the hunters and their families consume some of the meat, much of it is still used to feed dogs. The use of dogs is increasing as some hunters have tried skidoos and decided they like dogs better. These people always need meat for dog food, so nothing is wasted.

David gave a passionate description of the importance of beluga to the local lifestyle and culture, and this was recognized during the land claim settlement. He urged giving a strong voice to caution about how the beluga resource is used. There is a need to conserve, preserve and protect any sea mammal so that there can be continued use of those animals for years to come.

4.4 Harvesting Techniques in Alaska

Presenters: Warren Matumeak and Jerry Norton

In Alaska, the terms "whales" and "whalers" usually refer to bowhead whales and not beluga whales. At the time of the workshop, 42 crews were out bowhead whale hunting off Point Barrow, Alaska. Beluga whales are seldom harvested during the spring bowhead hunt, because the hunters are waiting quietly for the bowheads to appear and they don't want to risk the sound of the shots frightening them away. Rules of the Barrow Whaling Association state that there must be a cease-fire after three bowheads have been landed, to give people time to cut up the whales and to distribute the food to the community. During these cease-fires, hunters will occasionally shoot beluga.

Spring hunting for beluga occurs along the ice edge in deep water areas. In that situation, the hunters shoot the beluga first to slow them down and then harpoon them. Some belugas will float and the hunters try to select for those animals. Beluga hunters from Wainwright, Alaska, southwest of Barrow (Fig. 2), use a drive hunt to force belugas into shallow water where they can be harpooned.

The skin and top layer of fat of the beluga is called maktaaq or muktaaq; muktuk refers to the bowhead equivalent. Some of the maktaaq is aged so it almost ferments and that is a delicacy for the older generation. However, it does not appeal to the younger people.

Belugas are hunted along the lead during the spring if the bowheads are not running. If there are bowhead there, then the beluga are allowed to pass through. During the summer, belugas also come near the coast about 18 miles (about 29 km) east of Kivalina. Belugas are not hunted at this time because the people cannot follow them when they go into deep water.

4.5 Monitoring The Beluga Harvests In The Mackenzie Estuary

Presenter: Matt Stabler

Matt reviewed the history of the Mackenzie River estuary beluga whale-monitoring program, which has been in existence, in one form or another, since 1972. Prior to that, collection of harvest information was incomplete. The program was started in 1972, when the search for oil and gas in the Mackenzie area extended to the waters of the Mackenzie Estuary and the habitats of the beluga whale. The oil companies established a program to monitor whale harvests, to collect biological information from the harvested whales and to monitor any possible interference with the whale harvesting by industrial activities. Systematic aerial surveys were conducted to determine where the beluga were and how many were there, and frequent visits to the whaling camps were made to determine possible problems with the harvest and harvest levels. Andrew Erigaktoak from Aklavik participated in the surveys and acted as liaison during the camp visits. Because hunters cut up the whales soon after landing, there was little opportunity to take measurements or samples and much of the information obtained was in the form of verbal reports by hunters.

In the early 1980's, when DFO assumed responsibility for the harvest monitoring aspect of the program, one significant change was made. Instead of observers visiting the whaling camps and talking with the hunters, the Dept. of Fisheries and Oceans hired two people from each of the communities of Aklavik, Inuvik and Tuktoyaktuk to be the beluga monitors. The monitors were regular residents at the whaling camps and collected the necessary information from the hunters and from the landed whales. On-site monitors provided an excellent opportunity for the collection of information on struck-and-lost animals, biological measurements and samples from the landed whales. In 1986, the aerial survey component of the program was concluded.

In 1987, FJMC assumed responsibility for the monitoring program and it continued much the same as under the guidance of DFO. In 1989, FJMC enhanced the training of monitors for the program by holding a workshop for the monitors at the beginning of each whaling season. The monitors and the program co-ordinator (FJMC staff biologist) met to discuss the program, review the data collection procedures, and issue/receive the sampling equipment and supplies. Many of the same hunters were appointed as monitors year after year, incorporating the important element of continuity to the program. Many requests for specific beluga whale samples have been received from government laboratories and universities over the years of the monitoring program, and most of these were accommodated. Monitors were trained in the various techniques required to preserve the different types of samples. At one point, as many as eight or ten samples were taken from the first ten whales landed in each camp.

In 1994, the FJMC delegated the administration of the monitoring program to the local Hunters and Trappers Committees. At first this was conducted on a trial basis, and later as a permanent arrangement because local administration of the study worked well. Each year, one of the monitors is appointed "Head Monitor" by consensus, and this person is responsible for solving any problems that may arise and co-ordinating communications, in addition to the regular monitoring duties. Billy Day was the unanimous choice for that position in 1993, and he has continued in that role since. The FJMC continues to be involved in the program by organizing the training workshop, maintaining equipment, and reviewing, analyzing and publishing the data. Basic information, such as the number of animals landed, the number of animals struck-and-lost, and the sex of the whales landed has been collected consistently throughout the monitoring study.

During the mid to late 1970's, when the oil and gas industry contractors monitored the harvest, the landed catch ranged from 113 to 177, averaging 139 annually. Loss rates ranged from 10-26%, and females comprised 22% of the catch. During 1980 to 1984, the annual harvest ranged from 86 to 152, and averaged 126 landed belugas per year. Although loss rates were similar to that recorded in the 1970's, the percent of females in the annual catch varied from 13 to 48%. From 1984 to 1991, the number of beluga whales landed per year ranged from 87 to 150, averaging 124 annually. Loss rates were higher, averaging 23%, and the annual percent females averaged 30%. For 1992 through 1995, the annual harvest ranged from 110 to 141 beluga, and averaged 123. Average loss rates declined to 9% per year, and percent females was within the range from 18-28%. Thus, over the 24 years of data collection, the number of whales landed has declined, loss rates have fluctuated but overall appear to be declining, and hunters continue to select males which is reflected in the sex ratio of the catch. The involvement and co-operation of the hunters from the start of this program has been fundamental to the delivery of this program.

4.6 Monitoring Beluga Harvests in Alaska

Presenter: Robert Suydam

Prior to the 1980's, little information was available on the Alaskan beluga harvest. There are a large number of villages involved in the harvest (40 to 50 villages may hunt beluga in any one year), that are widely dispersed and belong to different native organizations and political groups. Bringing this many hunters together to exchange and tabulate data was a formidable task.

This was addressed in 1988 when the Alaska Inuvialuit Beluga Whale Committee (AIBWC) was formed. One objective of the AIBWC was to provide a forum for beluga hunters, researchers and resource managers from Alaska and the Inuvialuit Settlement Region to meet and exchange data and ideas. This organization has changed in form and is now called the Alaska Beluga Whale Committee (ABWC) since 1994, but the objective of bringing Alaskan hunters together remains the same. The ABWC meets at least once per year. Subcommittees organized according to the different beluga stocks, have since been formed and these groups may meet more frequently than the ABWC.

All harvest information is now gathered at one central location and these data are organized by Kathy Frost of Alaska's Department of Fish and Game. Currently 250 to 350 belugas are taken each year in Alaska, with an estimated 20 to 80 of these from the Beaufort Sea stock. As the ABWC and subcommittees become more organized, other types of information, such as struck-and-lost rates, will be collected on a regular basis.

Each summer, the North Slope Borough undertakes a comprehensive sampling of Chukchi Sea beluga landed during drive hunts at Point Lay. Samples to assess reproductive rates and success, material for ageing, morphometric measurements, stomach contents and samples for contaminant analyses have been obtained since 1990.

To date, 350 animals (20-75 annually) have been sampled. Most of the animals are either large males or small females. If the animals are divided into relative age classes using colour, then the size differences related to sex are obvious only for the white (=adult) animals. For grey and grey-white animals, no significant size differences have been found between harvested males and females. The same results have been obtained using both standard length and fluke width measurements.

Age estimates indicate that both young and old females are taken at Point Lay. The sexes appear to have approximately the same growth rates, but the females stop growing sooner than the males, so there are few or no large females. Data from the 1970's, for a composite of several Alaskan locations including Point Lay, show a preponderance of older males in the samples. It is not known why the older males are no longer being landed at Point Lay. The lack of younger males in the harvest there may be explained by segregation on the summering grounds and/or during migrations.

Reproductive data for female beluga have been analyzed by John Burns, formerly of the Alaska Department of Fish and Game. He found that pregnancy rates are age-dependent. Females younger than five are usually not sexually mature. Of the females from five to seven y, about 80% are pregnant. This rate declines to 40-50% for females aged 8-19 y. Animals ≥20 y are seldom found to be pregnant. The results from examining the *corpora lutea* (scars produced in the ovary when an egg is released and a pregnancy ensues) are very similar to the pregnancy results. *Corpora lutea* start to appear in ovaries of females five and older; females that are 21 y and older have no *corpora lutea*. In fact females in the latter age group are starting to lose *corpora albicantia (corpora lutea* become *corpora albicantia* after the fetus is born), indicates senescence is occurring. This has not been observed in other beluga stocks.

Contaminant analyses have been performed by Ray Tarclay of Texas A & M University and Paul Becker of the Department of Commerce. The results varied, depending on which metal and tissue were examined. Both selenium and mercury levels in beluga liver increased with age, in both sexes. Mercury levels in liver were high (on the order of 150 parts per million or ppm), although it was noted that beluga liver is not eaten. Mercury levels in meat and muktuk, which are eaten, were considerably lower. Levels of organochlorines were increased with age in males, and decreased with age in mature females. Females release organochlorines in the milk they produce, so levels in their bodies' decline over time.

Discussion

Much of the discussion following this presentation was on the age and sex composition of the harvest at Point Lay, in particular the lack of older males. There was concern if the older males recorded in the 1970's were from Point Lay. Those data, with harvest location specified, are expected to be available for analysis in the near future. The importance of older males to breeding success is not known.

Several participants suggested that the lack of older males may be explained by segregation, which is known to occur at that time of year. Future surveys of the offshore may verify whether or not segregation is occurring. One participant said that the older males were not present in the sample because they had been eliminated from the stock. David Sergeant's work on beluga in Hudson Bay in the 1960's found that the older males quickly dropped out of the population if there was selection for them. In Kotzebue Sound (Fig. 2), hunters select for the large males first because the rest of the herd is more easily driven if the older males are gone.

Many older males frequent the Mackenzie Estuary, but few are landed, as they are not a preferred source of food due to toughness of the meat. Occasionally, however, a large animal will be caught. A male over 18 feet (549 cm) in length was landed in 1959, and two others of a similar length were landed in the past ten years. While some hunters try to select whales that are approximately 16 feet (488 cm) in length, most hunters select for smaller male beluga. Selection is not an important factor in explaining the lack of older males in the Point Lay harvest because it is a drive hunt.

With pilot whales, it has been found that the low incidence of older males in the fishery is due to a higher mortality rate for males than for females. This higher rate may result from fighting among the males for status in the group. Male pilot whales are more heavily scarred than are the females.

The lack of younger males in the Point Lay sample may be explained by hunter selection against grey animals, or by segregation. One person suggested that a female with a neonate plus one or two older calves, which could be females acting as attendants, may be the basic "unit" of the herd.

The lack of reproductive activity observed in older Point Lay females may not necessarily mean these individuals are inactive. In long-finned pilot whales harvested in the Faroe Islands (North Atlantic), for which a large sample is available, the interval between calves increases with age, rather than stopping altogether. This would not necessarily be evident in a small sample, such as the one for Point Lay.

The role of selenium in the body was also discussed. It is an essential trace element in small amounts, and ample supplies of vitamin E can balance large amounts. This metal can lower reproductive success, if levels become too high. Some work indicates that selenium may be associated with metal-binding proteins. This would mean that metal levels may appear high according to the tests, but are still not toxic to the animals (see next session).

SESSION 5 - BELUGA HEALTH AND REPRODUCTION

5.1 How Old Are the Beluga That Are Landed in the Mackenzie Estuary Harvest?

Presenter: Patt Hall

Patt Hall discussed the techniques used to estimate the age of beluga whales landed in the Mackenzie Estuary beluga harvest, and highlighted the strengths and weaknesses associated with this method.

Beluga whale monitors collect, clean and dry the lower mandible from as many of the beluga landed in the Mackenzie Estuary harvest as possible. The lower jaws are split in the field, with the right dentary being shipped to DFO Winnipeg for ageing and the left dentary being stored in a freezer in Inuvik for future reference or verification.

The right dentaries are boiled to loosen the teeth, and the second and fifth teeth are extracted for ageing purposes. Different teeth are substituted if the second and fifth teeth are not available or are too worn, and the substitution is noted. Each tooth is embedded in clear casting resin and after the resin hardens, a series of four to five thin long sections are made through the tooth.

The sections are then examined under a microscope and the alternating dark and light bands in the teeth, called growth layers, are counted starting at the neonatal line. It is currently believed that two dark and two light layers are laid down per year. The growth layers in a particular tooth section are counted three times in independent readings, without reference to the sex or length of the animal. If there are discrepancies in the three replicates, then additional readings are done until the results are within two growth layers. It is desirable if another reader makes a second independent set of readings to ensure similar results are obtained. The rigor of this procedure ensures precision, but accuracy cannot be determined, as there are no “known age” samples available.

There are several difficulties in estimating the number of growth layers from a tooth section. One is that the growth layers become thinner and harder to read as an animal ages (e.g. more layers are added to essentially the same space). Other difficulties include missing neonatal lines, excessive wear and lack of contrast between the dark and light layers.

The ages of 368 beluga harvested between 1988 and 1994 were available for 80 females, 286 males and 2 with sex unknown, representing 48.5% of the total landings (n=758) during that period. The age-frequency distribution shows a wide range of ages in the sampled harvest, with 92.9% (351/368) being $\geq$10 y (20 growth layer groups, or “GLG”). Females sampled from 1988-1994, for which age estimates are available, ranged from 0 to 49 y (0-98 GLG), with a median of 23.5 y (47 GLG). Males ranged from 3 to 57 y (6-114 GLG), with a median of 24 y (48 GLG).

However, since all of the aforementioned difficulties with the ageing technique tend to result in a downward bias, the age estimates produced are considered minimum estimates only and the actual ages are probably greater. The neonatal line was missing in approximately 95% of these samples.

It was noted that tooth wear proceeds at different rates in Greenland, Canada and Russia.

5.2 What Is The Reproductive Status Of Beluga Whales Landed In The Mackenzie Estuary Harvest?

Presenter: Dr. Stuart Innes

Knowing the reproductive rate of females is important for (1) calculating population growth rate (defined as the number of births minus the number of deaths in a stock), and therefore the yield rate of a stock, and (2) determining the status and health of a stock. Food supplies influence reproductive rate. If there are abundant food resources relative to the number of whales in a stock, then whales can take advantage of this food resource, grow quickly and reproduce early and often. On the other hand, if the relative food supply is limited, then there will be less food available, and growth and reproduction will be slower.

Information from several beluga stocks suggests that mating occurs in spring, with calves born in the summer of the following year. A 14-month gestation period is suggested by data from Cumberland Sound, where some landed females have been found to have two-month-old foetuses and others, full-term foetuses. The testes of males landed during the summer are regressed, indicating mating is not occurring during that time. For the Beaufort Sea stock, mating probably occurs in April and May, with calving in June and July.

It is believed that the length of the female reproductive cycle changes with age. When young, a two-year cycle is likely. In this cycle, the female gets pregnant one year, gives birth the next, and gets pregnant again while nursing the calf the following year. So the second calf is born two years after the first one. As the female ages, this changes to a three-year cycle (calves born every three years) and older females may even have a four-year or a five-year cycle. About one-third of the females landed are pregnant, indicating the three-year cycle is probably the average.

Survival rates are as important as reproductive rates, which was illustrated with an example of a typical female, ovulating first at 5.8 years of age, having her first calf at 7, with a two-year cycle for her first two calves and a three-year cycle after that, until age 35. Two sets of survival rates were used; the first set was 0.82 per year for the calves' first two years and 0.91 per year after that. The second set of survival rates used was 0.90 and 0.95, respectively. With the former example, the female produces only one female calf that survives to reproductive age to replace her. In this case the stock would not grow. In the latter example, 1.9 female calves are produced and the stock would grow at a rate of 4.4% a year. Although survival rates are very important in determining realistic yield rates, reliable data are not available for this on any stock.

Reproductive parameters for the Beaufort Sea beluga stock are based on limited data. A total of

50 complete reproductive samples (seven from belugas trapped in ice) have been obtained from the Mackenzie Estuary harvest between 1990-1995, and estimated ages are available for 41 of these samples. It is known that approximately 65% of the females landed are either lactating or are accompanied by a calf, and that the testes of males landed in the Estuary during the month of July are regressed. The age of first ovulation, the age of a female's first calf being born, and the fertility rate for females are not known. Part of the reason why so little information is available is that few females are landed in the Mackenzie harvest in any one year, and, hunters take mainly white animals, which are already sexually mature. Some of the samples obtained have been incomplete, although this may be corrected in the future with additional training. There have also been problems in preserving the samples. Ideally, the complete tract should be immersed in formalin, but this requires a large volume of the preservative. With testes, cuts must be made through the outer surface so the formalin can get inside or the cells start to break down and only the exterior of the organ is well preserved.

Discussion

Much of the discussion was related to the maximum sustainable harvest level. There was consensus that the current harvest (about 0.4% of the 1992 index of stock size) was well below the maximum, which several people suggested should be about 2.5%. Data from captive beluga appear to support the 14-month gestation period, although it is difficult to determine exactly when copulation occurs, even in aquaria.

Brief mention was made of the large number of calves that hunters have observed in Kugmallit Bay. Such traditional knowledge is important in determining when calving peaks.

5.3 The Mackenzie Estuary Beluga Monitoring Program- How Can It Be Improved?

Facilitator: Tom Smith

The discussion was started with a definition of the word "monitoring" – the process of observing something in order to be able to detect changes. Participants were asked to evaluate the current Mackenzie Estuary Monitoring Program by asking the following questions:

- If changes were occurring, would the program be able to detect them?
- Would changes in behaviour, movement patterns, number of calves, weight, etc. be detected?
- If there are changes, are they good or bad?
- What might be responsible for these changes?

At the outset of the discussion, the group focussed on what parameters should be measured, and how often. Most of the participants agreed that the number of whales landed, number of whales struck-and-lost, standard length, age and sex were essential. There were differences of opinion as to how often these data needed to be collected. It was suggested that to minimize risk to the stock, it was desirable to monitor stock size with an aerial survey as well as through data collected during the hunt-monitoring program. An aerial survey could be conducted every three to six years, and the monitoring program annually. If the monitoring program were to be down-scaled to once every two or three years, continuity would be compromised and this could affect the quality of the results.

Throughout the discussion, the question was raised regarding the invasiveness of taking measurements and samples. One participant who, through his work with people in the eastern Arctic, found that respect for the animal is very strong. Treatment of harvested animals must be carefully considered. The idea of research and monitoring programs for possible damage to the stock was suggested. The general feeling seemed to be that the current monitoring program was not invasive, and that perhaps it should even be expanded.

The importance of scientific versus local concerns emerged later in the discussion regarding areas for further research but no resolution was reached. Several participants expressed interest in the importance of various feeding areas to the Beaufort Sea stock. Many asked what the male belugas were eating while they were in Viscount Melville Sound. It was suggested that the importance of the Estuary for feeding may be underestimated. Although most of the whales landed in the Estuary have empty stomachs, whales appear to regurgitate their food when a hunter is chasing them. One elder described following a whale through a long trail of undigested cod.

It was suggested that more responsibility for the program should be transferred to the local people, as many have a strong desire to be more involved in the process. This needs to be done in such a way as to maintain quality control and standard protocols.

5.4 What Are The Signs Of Good Or Poor Health In Beluga, And What Are The Signs That We Can Watch For In Beaufort Sea Beluga?

Presenter: Dr. David St. Aubin

During the beluga satellite tagging project in 1993, blood samples were collected from 18 beluga whales (17 adults and 1 juvenile). Since there are no known normal ranges for beluga blood chemistry values from the Beaufort Sea stock, the values obtained from the Beaufort Sea animals were compared to values obtained from beluga in other areas. Comparisons were made for Hudson Bay at Churchill and Seal River (n=87, mostly juveniles); for High Arctic areas near Devon Island and Creswell Bay (n=9 adults); and for capture animals from the Mystic Aquarium (n=3 adults).

The blood analyses were completed in two stages. First, samples were examined microscopically in the field, to determine the levels of the different types of blood cells. The blood samples were then frozen in the field, with the remaining constituent analyses being completed later in the laboratory.

Beaufort Sea belugas were found to have lower white blood cell counts, including eosinophils, and higher red blood cell counts, than belugas from the other areas examined. The low white blood cell count indicates that the Beaufort Sea animals did not have any serious infection. The high red blood cell level indicates a greater capacity for carrying oxygen and is related to the ability to make long dives.

In the laboratory, the plasma was analyzed for 20-25 different constituents which indicate the functioning level of the liver, kidney, muscles, pancreas and endocrine glands, level of hydration (or dehydration) and the nutritional status of the animal. The combination of results of all the tests, rather than just one or two, are used to assess the overall health of the animal. For some of the tests the levels found in the Beaufort Sea animals were lower than levels for animals from other areas, but the differences were not statistically significant.

Discussion:

It is important that these tests are performed on fresh blood samples. In live animals, the blood is fully mixed as the heart is actively circulating the blood, but this stops once the animal is killed. Reliable results can be obtained with blood sampled from the heart after a delay of 10 - 20 min after death. Samples taken with longer delays may give false or misleading results. If animals are chased before the blood sample is taken, readings for a few substances, such as adrenalin, will not be realistic but many other constituents of the blood will not be affected.

5.5 What Do We Know About Levels Of Contaminants In Beaufort Sea Beluga And Where Do They Come From?

Presenter: Don Metner

Consistent with the DFO’s mandate, the focus of this presentation was on the effect of the contaminants on the health of the whales themselves, not on human health or on the implications of consuming contaminated beluga.

Levels of PCBs and other organochlorines were examined in tissues from beluga whales landed during 1983 and 1993 - 1995 Mackenzie Delta beluga harvests, as well as those removed from the Husky Lakes entrapment in 1989. Total PCB levels were on the same order of magnitude (5 500 parts per billion, or ppb) as levels found in other beluga stocks and in two narwhal stocks. The levels of organochlorines in the Beaufort Sea beluga tissues did not changed measurably during the 1983 to 1995 sampling period, however, further sampling is required to confirm this. Sampling methods have changed and it has been found that blubber is not the most appropriate tissue for examination of organochlorine levels.

In the Husky Lakes samples, liver microsomal EROD was high and was directly related to PCB levels, but no such correlation was found in samples from harvested animals. PCB levels in the blubber of Beaufort Sea belugas were high, but the reason for this is not certain because PCBs respond to many different environmental factors. This responsiveness makes PCBs a good candidate substance to sample, but interpretation of the results can be complicated.

Mercury levels in muktuk, muscle, liver and kidney have been analyzed for beluga whales landed during the past five years in the Mackenzie Estuary. Mercury levels are highest in liver and lowest in muktuk. Beaufort Sea belugas have higher levels of mercury than belugas in eastern Canada, when the same organs are compared. In fact, mercury levels in livers of Beaufort Sea beluga are similar to levels found in beluga in the Gulf of St. Lawrence, a highly industrialized and contaminated area. Mercury levels have increased throughout the Arctic in the last ten years but this increase has been more noticeable in the Mackenzie Estuary than in the Eastern Arctic.

Belugas taken in the Beaufort are much older than those taken in the Eastern Arctic, which may explain, at least in part, the higher accumulated levels of contaminants. It is necessary to get more samples and samples from different locations to determine if the high mercury levels are widespread, and to develop blubber-brain, liver-brain, muscle-brain and kidney-brain ratios. This would allow the comparison of some of the earlier data with more recent data, to determine the approximate year (or years) that the levels increased.

Whole blood from live Beaufort Sea beluga has also been examined for mercury and a wide range of values (200 to 700 ppb) were found. All levels that were found are higher than the minimum "at risk" value of 100 ppb for humans. Mercury in beluga whole blood is high in methyl mercury, one of the more toxic forms, and most of the mercury occurs in the red blood cells. The mercury levels in live and harvested animals differed by a factor of two, suggesting that mercury levels in the harvested samples may have been sampling artefact. There is a strong correlation between blood mercury and brain mercury.

Samples from the harvested animals were also analyzed for selenium because this metal is believed to provide some protection against the adverse effects of mercury. An experiment done during the 1970's showed that cats could appear to be very healthy, even with high levels of mercury in their bodies, if they received regular doses of selenium. All of the cats which were fed mercury and no selenium quickly showed symptoms of severe mercury poisoning and eventually died. An analysis of the tissues of the cats which were fed both metals, done after the experiment had concluded, showed that the live cats had higher levels of mercury than the cats which died, presumably because they lived longer and were thus fed more mercury. One of the cats in the mercury and selenium group stopped eating the meat (with the selenium in it) 50 days into the experiment and he quickly developed mercury poisoning. Selenium produced no adverse effects on the cats. With the Beaufort Sea beluga samples, a high correlation was found between the levels of selenium and mercury. The ratio was about 0.8 atoms of selenium to every atom of mercury.

Discussion

The finding related to mercury loads was the focus of the discussion following this presentation. One participant compared the mercury levels in Beaufort Sea beluga to mercury levels in ringed seals in Amundsen Gulf (they were very similar, 27.1 parts per million or ppm) and in bearded seals (bearded seals had higher levels generally; the highest recorded was 400 ppm). Because different forms of mercury have different toxicities, it is important that the type of mercury is identified, and this has not been done for many of the beluga samples.

Possible explanations were suggested for the increase in mercury levels in the estuary whales. Because mercury accumulates in the body, the mercury level should be correlated to the age of the animal. In other words, higher mercury levels would be expected in older animals. It was also suggested that regional differences might explain the apparent increase. There was some discussion on the possible source of the mercury. The marine environment appears to be high in selenium that protects against mercury.

5.6 What Are The Risks And Benefits To Human Health Of Eating Beaufort Sea Beluga?

Presenters: Jody Walker and Billy Day

This presentation started with a video on contaminants in country foods. Long-range contaminants include (1) particles from radioactive wastes, (2) organochlorines from pesticides, industrial wastes and electrical equipment, and (3) heavy metals, such as mercury, cadmium and lead which are released by mining activities and smoking. These long-range contaminants are carried by the air and water currents to the Arctic and become concentrated in successive trophic levels. This explains why animals that eat plants have lower levels of contaminants in their tissues than animals higher up the food chain.

The Government of the Northwest Territories Dept. of Health began testing contaminant levels in blood, hair and nails of pregnant women and their new-borns in 1994. They found that most of the contaminants present in the test subjects were due to lifestyle choices, primarily smoking. Eating a diet of country foods, such as caribou, was related to a minor elevation in cadmium levels, but at the same time, provided the definite benefit of a food source of exceptional nutritional value. Contaminants in the diet from the consumption of beluga products were not examined as part of this study.

After the video, Jody went on to explain that many levels of government are now working together, using information from contaminant studies, dietary surveys and other sources, to determine if (and how much of) a food is safe to eat. The margin for safety that is applied is usually inversely proportional to the amount of information that is available. The benefits of the food and of the steps taken to obtain the food (e.g. benefits of hunting) are included in the assessment.

All of the parts of the beluga that are consumed (the meat, blubber and skin or muktuk) provide a good or excellent source of protein. Beluga meat is also an excellent source of iron, and blubber is a good source of omega-3 fatty acids, which help prevent heart disease and, possibly, cancer. At the Northern Contaminants Program meeting in Ottawa on December 8, 1995, participants from across northern Canada and from all levels of government agreed that the benefits of eating beluga blubber outweigh the small known risks from consuming the contaminants in the blubber.

SESSION 6 - WHAT NEEDS TO BE DONE?

Facilitator: Dr. Michael Papst

This session sought ideas from harvesters and community participants, and scientists for future direction Beaufort Sea beluga research and management could take. Three topics were addressed in the plenary: inter-jurisdictional management, harvest monitoring, and research recommendations. An evening session held on April 23, 1996 addressing the specific topics of monitoring stock size and trends in Beaufort beluga, is included in this session.

6.1 Inter-jurisdictional Management

Management issues of local, regional and international concern were included in this discussion. The predominant theme throughout was the need for better communication. On the local level, participants suggested that more of the community should be involved in workshops such as this one. School children could attend the afternoon meetings so they could see first-hand how the process works. The need to distribute the proceedings of the workshop to the public, in print and on video was mentioned.

At the regional level, it was suggested that there be increased co-operation among the various co-management boards. Some of the areas that the Beaufort Sea beluga stock is now known to use, in particular M'Clure Strait and Viscount Melville Sound, are managed by groups with whom the FJMC has, to date, had little or no interaction. Although there is currently no hunting activity or tanker traffic in those areas, a mechanism is needed to protect the beluga habitat prior to any such activity being proposed or undertaken. About 15 years ago, the Polar Gas Project considered construction and use of a pipeline through the very area used by the satellite tagged male beluga during July 1993 and 1995. At the time, neither the proponents nor the government knew that Beaufort Sea beluga used this area. Although the Polar Gas Project is not moving ahead at this time, that could change in the next 15-20 years. It was agreed that mechanisms should be in place to ensure that users of the beluga resource have meaningful input to decisions regarding areas used by this beluga stock.

Problems with communication multiply at the international level, such as Chukotka (Fig. 2). That location is remote and difficult to get to. There is often a one or two week delay travelling to or from this area by a commercial airline. Mail service is not dependable, and phone communication is extremely costly. Currently, it is known that in the southern part of Chukotka, few beluga are taken. The harvest level is believed to be three or four whales/hunter/lifetime. The amount of beluga harvest in northern Chukotka is probably higher, as belugas are known to come into that area. Reliable information cannot be obtained. Beluga may be hunted to provide meat for the local fox farms, as this is known to occur with grey whales and walrus, but even this level of information is uncertain. Beaufort Sea belugas probably use the Chukotka area, but we do not know the number of belugas that may be harvested there.

6.2 Beaufort Sea Beluga Harvest Monitoring Program in the Mackenzie Delta and Paulatuk, NT

The consensus was that the existing beluga whale harvest-monitoring program should be continued in its present form. Much of the discussion that followed focussed on who should be responsible for what aspects, and there were several suggestions that the monitors' roles include more responsibility. In particular, the monitors could be trained to process some of the reproductive samples in the field, to take full advantage of the sampling opportunities associated with landed female beluga.

Reporting appears to be a bottleneck in getting the information back to the people, so it was suggested that graduate students become involved in the processing and reporting of the results. Another suggestion was that local people who are motivated but who do not necessarily have a degree could contribute. Arctic College students were also suggested as possible candidates for data analysis or reporting. It would be important in any of these cases to work toward, and meet, a target date for return of the information to the communities. Everyone who recommended more local involvement suggested that this would be a more cost-effective approach, would keep the expertise within the community and would make the program more sensitive to local needs.

There was limited discussion on the importance of determining the condition of the animals, using parameters such as girth and blubber thickness. Blubber thickness was included as a measurement in the monitoring program at one time, but the data were particularly prone to error so that parameter was dropped. Another participant said that all possible information should be obtained from all landed animals.

6.3 Research Priorities For Beaufort Sea Beluga

For the purpose of this discussion, research was interpreted broadly as any topic on which more information should be obtained. As with the earlier discussions, the importance of increasing community involvement in the planning and implementing of research projects was mentioned. The suggestion was also made that FJMC set up a scholarship fund to provide training for local people to do research, using the Inuvik Ageing Lab as a model.

Much interest was expressed in the Beaufort Sea stock's over-wintering site and the techniques, which could be used to define it. In other areas, new data have yielded surprising results regarding where belugas over-winter. For example, six beluga tagged near Devon Island were found to over-winter in Baffin Bay, rather than in Greenland as previously thought. The suggestion to use flipper band tags rather than satellite tags was ruled out because of the time and expense involved, and the large number of tags (e.g. 1000's) and associated handling of the whales that would be necessary to obtain reasonable results. Darting was also suggested and ruled out as the darts remain in place for a short period (e.g. a week). Satellite tagging in late August or early September in the Mackenzie region, or later in the season in Alaska, was supported as the most appropriate means for obtaining over-wintering information. Interest was also expressed as to whether or not the same beluga returned to the same locations year after year.

For several workshop participants from the beluga hunting communities, levels of contaminants in beluga tissues was the main issue they wanted to see addressed. Determining what levels of what contaminants lead to risk to human health was highlighted as being very important. Examining the possible connection between the high death rate of local people from cancer and contamination in country foods was also brought forward as being of paramount importance.

Genetic sampling can provide interesting information on the beluga's social structure. More samples are needed from the north coast of Alaska. Skin biopsies may be a suitable means of obtaining samples from live beluga. This technique will be tested in Alaska.

6.4 Monitoring the Size of the Beaufort Sea Stock (evening session, April 23, 1996)

Facilitator: Dr. Doug DeMaster

Thirteen participants, mainly scientists and people involved in the co-operative management process, were present at this evening session. There was considerable discussion on the nature and type of a survey that could be, or should be, used to monitor the size of the Beaufort Sea stock. One of the first suggestions was that local hunters conduct a passive survey, such as number of sightings per unit of time. This could be done very economically and on a continuing basis. However, this type of survey has been found to be insensitive to changes in stock size.

Monitoring age and length distribution of the catch was mentioned and rejected as this technique is dependent on hunter selection remaining consistent over long time periods. Also, studies on dolphins have indicated that age and length are not necessarily sensitive indicators of changes in stock size. Monitoring reproductive parameters was another possibility, however studies with other marine mammals have shown that these parameters generally do not respond quickly enough and/or are not accurate enough to reflect trends in the stock. Boat transects were suggested and rejected because of logistical difficulties and inherent biases.

Replicate systematic aerial surveys were agreed upon as the most appropriate method. There are fewer inherent biases with aerial surveys than with the other methods and they are more easily resolved. The minimum survey effort needed to provide a reasonable estimate of the stock's size can be determined by calculating the return on various percentages of the total survey effort expended. It is important to let sound experimental design dictate the design of a survey, and not available dollars.

Survey goals were included in the discussion of survey type. Estimating variance and obtaining data comparable among years (as opposed to estimating the absolute size of the stock) were noted as high priorities. Understanding what portion or component of a stock is available to be surveyed is essential for appropriate interpretation of the data. The 1993 and 1995 satellite tagging results indicate that the majority of the males may have been absent from the survey area during the 1992 survey of the Beaufort. It was agreed that the portion of the stock that was represented in the 1992 survey (females) was the most important in terms of reproduction.

Participants also discussed survey frequency. Suggestions ranged from conducting a survey once every three to 20 years. Factors to consider when determining how often an area/stock should be surveyed include: structuring within the stock (e.g. sub-stocks), the size of the harvest relative to the replacement yield,the detection of decreasing numbers of whales by hunters in their hunting areas; the presence of a commercial harvest; the level of certainty regarding the total harvest relative to the size of the stock or sub-stocks including harvest levels in other areas; and changes in the climate which may significantly affect stock size.

The consensus was that an aerial survey should be done every five to eight years. Resource users should be trained and participates in the aerial survey effort. An aerial survey program that produced a minimum estimate of abundance every 5-8 years would likely meet the management goals for the Beaufort Sea beluga stock. Over time, comparison of the estimates could be used to infer trends.

Rmax (the maximum rate at which a population can grow under most favourable condition) is likely to be in the 4-5% per year range. Therefore, maximum sustainable yields of up to 2.5%, where the kill is representative of all age and sex classes, are reasonable. Given that the current take of Beaufort Sea beluga is <1% per year, the current level of harvest is considered sustainable.

In general, harvest monitoring should include information on the number of whales landed, number of whales struck and lost, sex ratio of the harvest, and the age distribution of the harvest (based on teeth samples or length). In some cases, additional information on reproductive status and food habits would be helpful, but is likely not needed on an annual basis. Some forms of sampling (e.g. reproductive organs to determine pregnancy rates, or blubber samples to determine contaminant loads) might be incompatible with certain traditional practices or beliefs. Researchers and managers need to work with the local hunting representatives to avoid such problems.

SESSION 7 - OIL AND GAS INDUSTRY UPDATE AND FUTURE PLANS

Presenters: Nic Vanderkooy and Kevin Hewitt

Nick Vanderkooy gave a brief summary of CANMAR'S (Canadian Marine Drilling) activities since exploration ceased in the Beaufort region in the mid-1980's. He described CANMAR'S current concepts for future work in the Beaufort. Although CANMAR has down-scaled its Beaufort operations, they remain committed to oil exploration and production in the Arctic in the future.

CANMAR's present concept is for a year-round drilling platform to operate from successive fields in the Canadian and Alaskan Beaufort (small-scale discoveries coined a "string of pearls"), with the oil transported by vessel via Point Barrow to Pacific Rim countries. Using their past experience in Arctic operations and increased knowledge of the ice environment, CANMAR is suggesting the use of a 100 m^2 drilling platform, strengthened for a 100 000 t ice load, as compared with past platforms which were made to withstand a 1.5 x 10^3 t ice load. Oil from the platform would be transferred to a vessel, still in the planning stages but known as the "Arctic Shuttle" as it docks stern-first in a semi-circular loading area at a corner of the platform. CANMAR's plans specify that the Arctic Shuttle would have a spoon-shaped hull, such as was first introduced with the *MV Kigoriak* in 1979, a hull-wash system such as that introduced with the *MV Robert Lemur* in 1983, and a heating system such as was used on the *MV Oden* in 1989. Although the current concept is for year-round operations, there would be provisions for shutdowns while whales migrate through the area.

This concept is still at a tentative stage because of concerns on the part of other oil and gas companies and government about operations in the arctic environment. There is global competition for the amount of money necessary for such a project, estimated to be about two billion dollars, and funding tends to be allocated to projects where there are the fewest concerns. If production does proceed, the plan described by CANMAR would be carried out in phases and near the coast, as was specified by the 1982 Environmental Impact Statement (EIS), prepared by Dome, Esso and Gulf. Before any definite plans are initiated, the company would meet with local people and organizations to discuss concerns and issues, to be incorporated into any formal proposal.

There is renewed interest by the oil and gas companies in Alaska. British Petroleum has announced plans to proceed with their proposed North Star project and some projects have been proposed for the Kaktovik area (Fig. 2). This interest may spread to the nearby Canadian Beaufort in near future. Meanwhile, there are a number of planned joint projects with industry and government to examine various aspects of the concept presented by CANMAR. One possibility is a seasonal pilot project using a donut caisson, rather than the proposed new drilling platform, at Amauligak and South Kogyuk (Fig. 3) to prove those reserves and to assess the feasibility of marine transport of oil during the open-water period.

Discussion

Concerns for the environment highlighted the discussion and many comments were related to the marine transport of oil. One participant noted that in the eastern Canadian Arctic, it was found that icebreaking causes panic reactions in beluga at distances of up to 80 km. This would suggest that the pilot project would have to suspend operations during the time when ice and beluga are in the area, which is a significant portion of the potential drilling season. This problem could be solved if there were means to abate the noise, but there has been little research done in that area. Community participants from Alaska voiced their concerns about taking a tanker through bowhead migration areas, even at the suggested level of one shuttle trip per week.

Information on environmental concerns is not always readily available. One participant, who had done research in Alaska, had difficulties in getting his information to the public. The sponsoring company would not finalize his report and he suspected it was because the report concluded that bowheads did avoid areas with drillships.

Questions were raised regarding the protection afforded by the EIS. It was suggested that the EIS might not apply to CANMAR's concept because the drilling platform and the Arctic Shuttle were essentially newly designed, untested structures. The pilot project would be an opportunity to test the Arctic Shuttle, but the drilling platform donut caisson has been used in six other locations. One participant mentioned the Shetland Islands, where the Environmental Impact Statement (EIS) process was followed and there were assurances from the oil company operating there that safeguards were in place. When pumping went ahead, there was an oil spill six days later, and another spill the next year. All safety mechanisms failed and wildlife was killed. This participant suggested that the EIS should deal with what to do *when,* not *if,* an oil spill occurs.

Since the 1982 Beaufort Sea EIS was accepted by the Review Panel, Beaufort Sea oil production can proceed in phases, with monitoring at each phase to ensure problems are identified and corrected before proceeding to the next phase. Plans call for each phase of the review process to include people from many different disciplines.
There was scepticism regarding local long-term

benefits from oil production. In the 1970's and 1980's, most industry jobs went to southerners and there were few or no long-term benefits for northerners. This was acknowledged to be a definite problem with the oil and gas industry. However long-term, small-scale production would mean more opportunities for local people and businesses than short-term, large-scale activities. The discussion was concluded with a comment from a US government official that oil and gas production always involves "decision-making under risk", but the proposed CANMAR pilot project would be a good opportunity to study many relevant issues, such as noise abatement. There is not public pressure for these projects to proceed at the present time, but that is likely to change when oil prices increase. Addressing concerns on a small scale, such as with the pilot project, would be helpful in providing the necessary information to evaluate future proposed large-scale projects.

CONCLUDING REMARKS

Bob Bell concluded the workshop by expressing his satisfaction with the extent of feedback provided by the participants, particularly in regard to the directions that FJMC should take in the next few years. In addition to the specific issues that were addressed and identified, two strong messages came through. One, there is a desire for greater communication both within the ISR and with people in areas to the east and west of the ISR, and two, the HTCs are looking for involvement not only in the planning but also in the implementation phases of programs. There is much that can be done in both of these areas.

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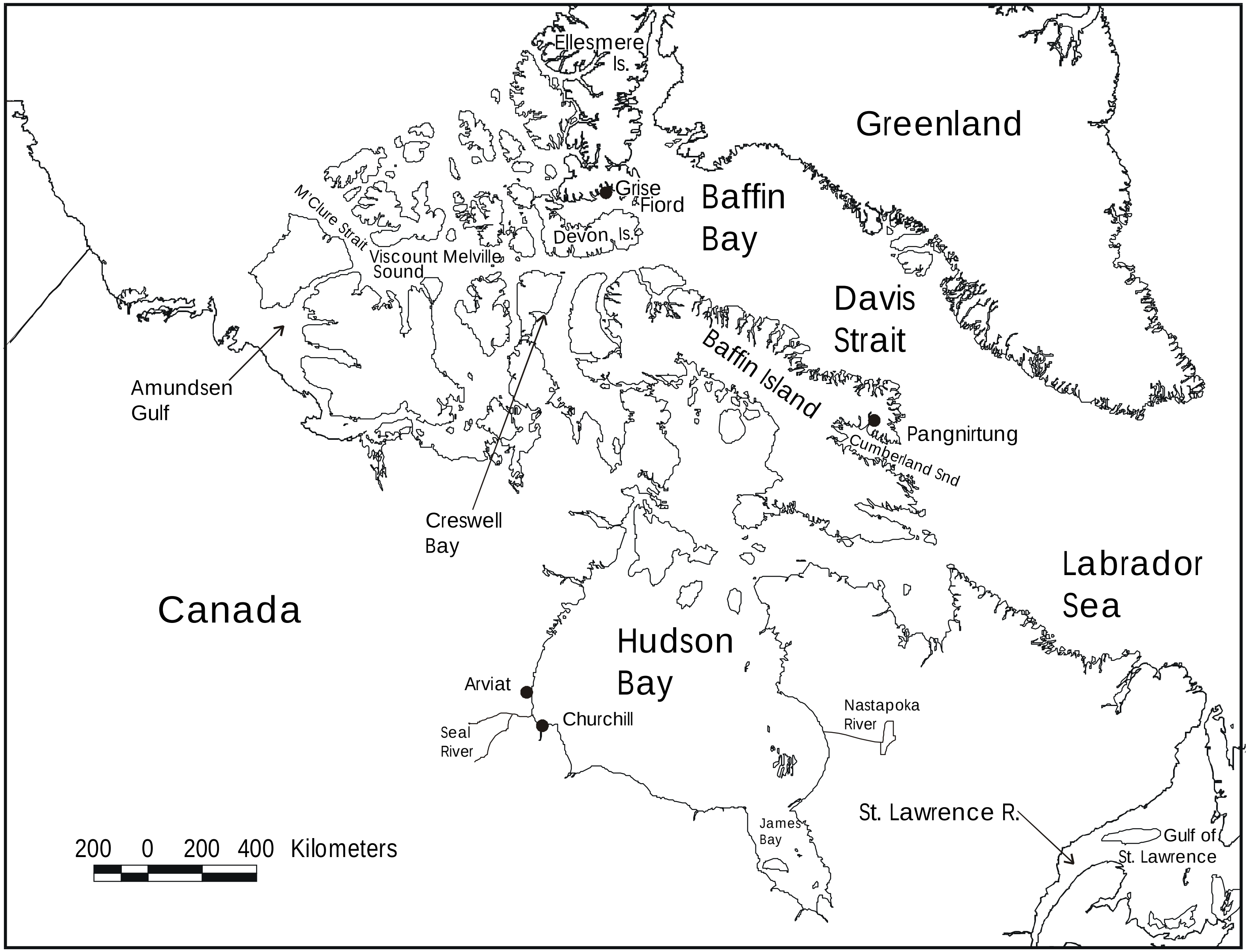

Figure 1. Canada's Arctic and places named in text.

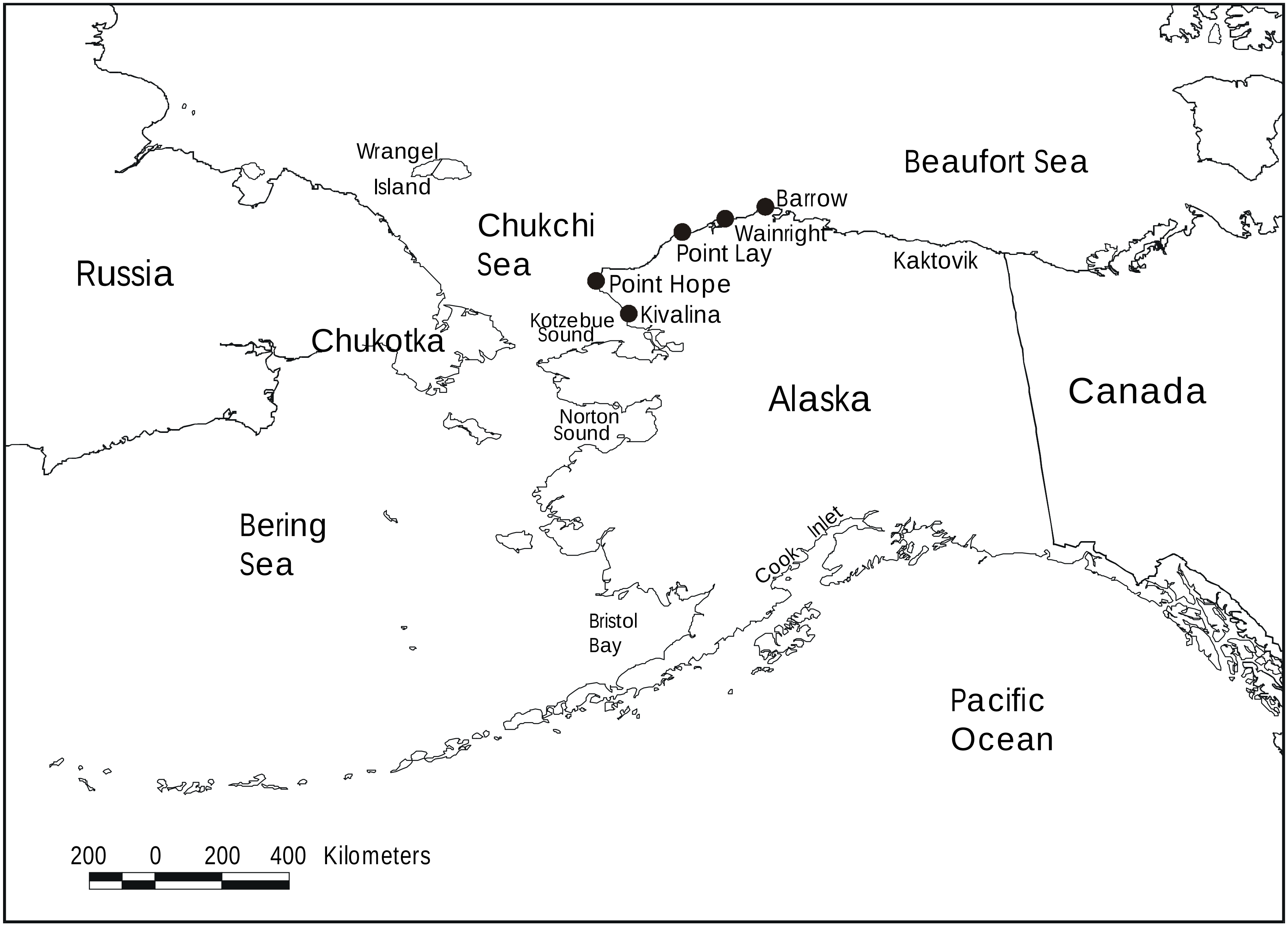

Figure. 2. Range of the Beaufort Sea beluga and places named in text.

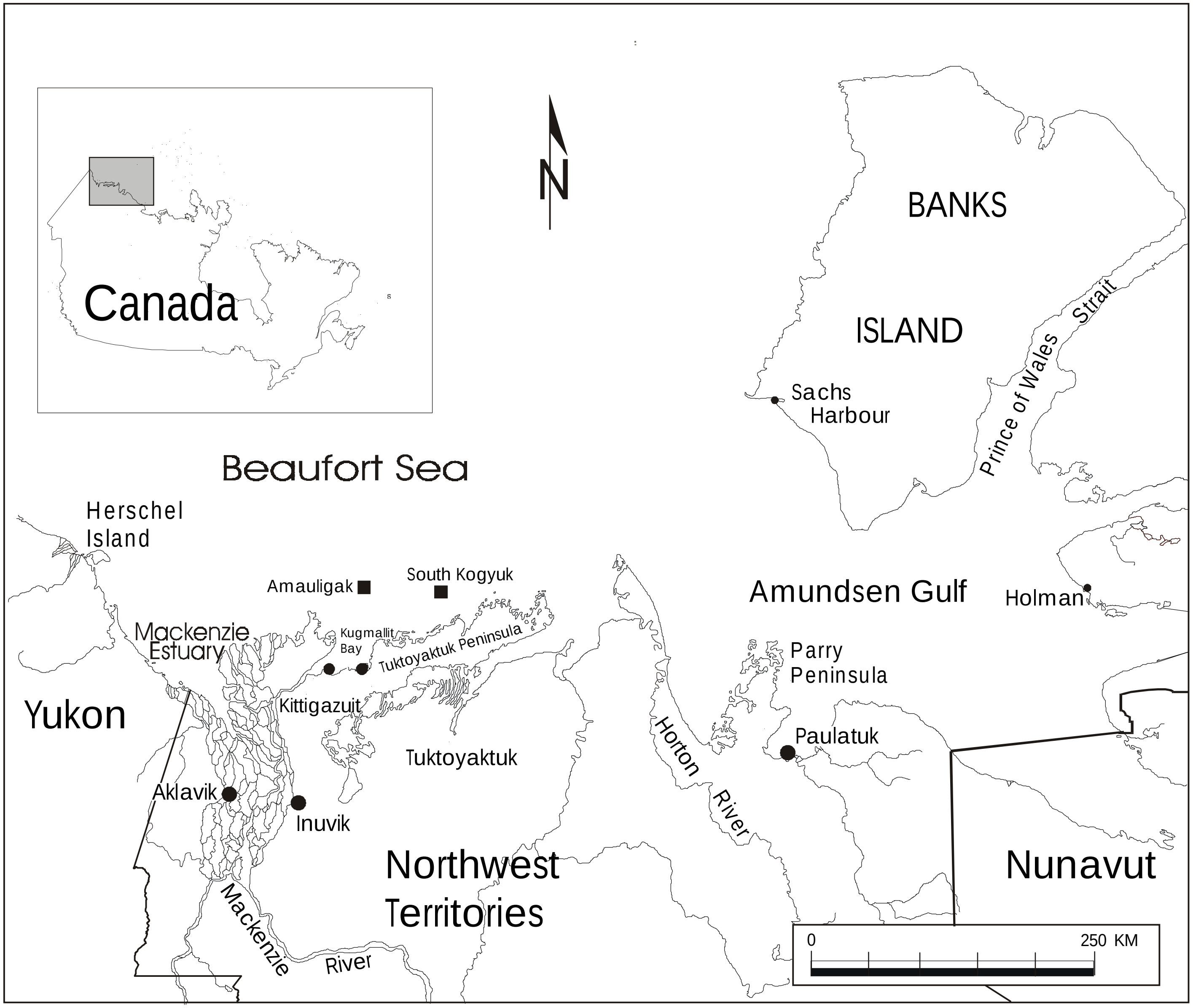

Figure 3. Summer range of the Beaufort Sea beluga and places named in text.