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Proceedings of a Workshop on Beaufort Sea Beluga

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PROCEEDINGS OF A WORKSHOP ON BEAUFORT SEA BELUGA

FEBRUARY 3-6, 1992, VANCOUVER, B.C.

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PREFACE

The Fisheries Joint Management Committee was established in 1986 under the terms of the Inuvialuit Final Agreement to advise the Minister of Fisheries and Oceans and the Inuvialuit on fisheries management and related issues in the Inuvialuit Settlement Region. As one of its startup priorities the FJMC, together with the Department of Fisheries and Oceans and the Inuvik, Aklavik and Tuktoyaktuk Hunters and Trappers Committees, prepared the "Beaufort Sea Beluga Management Plan". That plan was ratified in 1991.

The goals of this Plan are:

1) to maintain a thriving population of beluga in the Beaufort Sea, and

2) to provide for the optimum sustainable harvest of beluga by Inuvialuit.

However, due to the data gaps related to the definition of the management unit and its reproductive parameters, the FJMC was not in a position to proceed with implementation of certain aspects of the Beluga Management Plan. For this reason, the FJMC, together with the Environmental Studies Research Funds and DFO, hosted a workshop to examine stock status and other aspects relating to Beaufort Sea beluga. Since current information suggests that this is a trans-boundary stock, it was essential to involve hunters and the appropriate agencies from both Alaska and the Inuvialuit Settlement Region of Canada.

Workshop participants were asked to reach consensus on the following specific goals:

1) to determine, based on available data, the present status of the beluga stock summering in the Beaufort Sea,

2) to identify the best methods for continued monitoring of the stock in response to human activities and environmental changes, and

3) to define research priorities.

Thirty-one participants, representing a cross-section of resource users, government agencies and technical advisors, met in Vancouver, B.C. from February 3-6, 1992. It should be noted that the Summary was prepared by the facilitator during the workshop, reviewed by all participants, and finalized on February 6, 1992. Thus, It represents the consensus of the participants at the conclusion of the workshop.

The organizers wish to thank the facilitator, and all participants for their insightful contributions during the workshop.

Robert K. Bell, Chairman, FJMC

SUMMARY

by Douglas Wartzok

Present Status

The provisional beluga stock summering in the Beaufort Sea is considered to be a healthy stock. This assessment is based on the estimated size of the population, the age structure of the population, the relatively low present harvest, and the absence of currently defined environmental threats. The stock is estimated to be 21,000 (confidence limits of 15,000 -- 27,000) based on the 1984 offshore survey which covered 5% of the survey area. This estimate is not inconsistent with results from other surveys.

These data were corrected using the line transect sightability function and a conservative estimate of 50% of the animals being below the surface. No variance was associated with the submerged animal fraction. Other factors which make the estimate a conservative one include the survey altitude of 300 m from which gray animals and small animals are difficult to detect, and the limitation of the survey to only a portion of the Beaufort Sea stock range; in particular, the inshore areas were not included. Unknown, but substantial, numbers of animals remained in the inshore areas at the time of the survey.

Continuing Assessment

The assessment of present status has indicated that the provisional Beaufort Sea beluga stock is currently healthy. Future factors that could influence the status of the stock include human activity that displaces beluga from favoured habitats (e.g., industry, fishing and unregulated tourism), major environmental changes (e.g., global warming) and harvesting in excess of sustainable levels. The harvest provides a unique opportunity to monitor the population on a continuing, cost-effective basis.

The harvest can provide accurate, long-term data on numbers and location of animals taken, hunting loss rates, age and size structure of the harvest, female reproductive history, and individual condition indices such as blubber thickness. This approach of continuing assessment is preferred for the following reasons: such data have tracked changes in other marine mammal populations (e.g., seals and walrus); there is a high probability of acquiring these data each year; this data set is less vulnerable to vagaries of funding; and the primary management tool becomes a cooperative venture with the users.

A harvest monitoring program is currently in place which provides the data indicated above on an annual basis. This program should be enhanced and the data thus obtained should be analyzed annually. In addition, samples should continue to be taken for toxicological and genetics studies. These samples are not as immediately critical for assessing stock status and thus the recommendation is for analysis on a timely basis, but not an annual requirement. Systematized ancillary observations of each individual in the catch can be of immeasurable assistance in interpreting collected data. To be an effective

tool, the on-going program of native participant training needs to be continued and supplemented with debriefing sessions at the end of the season and timely feedback on the interpretation of the data from the previous season.

Funding Priorities

The first priority is an emphasis on building the data base on the Beaufort Sea beluga stock through a better use of data already in hand, data readily available, and data easily acquired. This priority includes: an enhancement of the current native field monitor/collector training program; an intensified effort to maximize the current data return from the harvest; the processing of all currently held collections; a summarization of data already collected on distribution and movements; a comparison of the Beaufort Sea stock data with complementary data obtained on other stocks; and an effort to visit communities and record traditional knowledge about beluga, particularly from the elders.

The second priority is satellite tagging. Such a program could address the following outstanding issues of Beaufort Sea beluga management: movements of individuals between inshore and offshore habitats; movements of individuals through Canadian, Alaskan and Siberian waters; movements of individuals between provisional stock boundaries; survey correction factors such as the proportion of time at the surface in various habitats and at various seasons; and feeding inferences. This information can serve as an important adjunct to planning aerial surveys and photogrammetry studies. Components of the satellite tracking work will be complementary to the genetic analysis currently being funded under this unique opportunity.

The third priority should be an aerial survey of the inshore and offshore belugas in the eastern Beaufort Sea. This survey would be the first complete survey of the reported summering range of these animals. The survey should be planned to occur at the time of the year when distribution and behaviour of the whales would lead to estimates with minimum variances. The planning of the survey will benefit from the knowledge of the hunters as well as data from satellite tags. Offshore coverage should be 10% and inshore coverage 50%. Aerial surveys should include sufficient air time to determine observer bias. The resulting animal counts should be corrected for the proportion of whales visible, observer biases, decrease in detectability of whales with increasing distance away from the survey aircraft, and other quantifiable environmental and behavioural factors. Aerial surveys should be conducted on a seven year schedule with two consecutive years of surveys followed by a hiatus of five years. This schedule allows for continuity among experienced survey participants. Photographic and high-resolution video options should be explored as adjuncts to the visual surveys.

RÉSUMÉ

par Douglas Wartzok

ÉTAT ACTUEL

Le stock provisoire de bélugas qui passe l'été dans la mer de Beaufort est considéré comme un stock sain. Cette évaluation est fondée sur la taille estimée de la population et sa structure d'âge, sur la récolte actuelle relativement faible et l'absence d'une menace environnementale définie. Le stock est estimé à 21 000 animaux (limites de confiance de 15 000 - 27 000) d'après une enquête effectuée au large en 1984 et qui a porté sur 5 % de la zone faisant l'objet de l'enquête. Cette estimation n'est pas en désaccord avec les résultats d'autres enquêtes.

Ces données ont été ajustées à l'aide d'une fonction de correction (*line transect sightability function*) et d'une estimation prudente voulant que 50 % des animaux aient été sous l'eau. Aucune variance n'a été liée à la fraction des animaux immergés. D'autres facteurs ont contribué à faire que l'estimation soit prudente, notamment le fait que l'enquête a été effectuée à une altitude de 300 m qui rend les animaux gris et de petite taille difficiles à déceler ainsi que le fait d'avoir limité l'enquête à une fraction seulement de l'aire de répartition du stock de la mer de Beaufort; plus particulièrement, les zones longeant la côte n'ont pas été incluses. L'on sait qu'un nombre inconnu, mais non négligeable, d'animaux fréquentaient les zones côtières au moment de l'enquête.

ÉVALUATION PERMANENTE

L'évaluation de l'état actuel a indiqué que le stock provisoire de bélugas de la mer de Beaufort est un stock sain. Parmi les facteurs qui pourraient influer sur l'état du stock à l'avenir figurent l'activité humaine qui déloge les bélugas de leurs habitats préférés (p. ex. industrie, pêche, tourisme non réglementé), des changements environnementaux importants (p. ex. réchauffement de la planète) et une récolte qui dépasse les niveaux permettant le renouvellement du stock. La récolte nous fournit une occasion unique de suivre la population sur une base continue et d'une manière économique.

La récolte peut nous fournir des données précises et à long terme sur le nombre de bélugas capturés et l'endroit de leur capture, les taux de perte attribuables à la chasse, la structure d'âge et de taille des animaux capturés, les antécédents des femelles du point de vue de la reproduction et des indices de l'état individuel, comme l'épaisseur de la graisse. On préfère cette approche pour l'évaluation permanente pour les raisons suivantes : ce genre de données nous a permis de suivre les changements survenant dans d'autres populations de mammifères marins (notamment le phoque et le morse); il est fort probable que ces données peuvent être obtenues chaque année; cet ensemble de données est moins sujet aux caprices du financement et l'outil de gestion primaire devient une entreprise en collaboration avec les utilisateurs.

Il existe actuellement un programme de surveillance de la récolte qui fournit les données indiquées plus haut sur une base annuelle. Il faudrait donner plus d'ampleur à ce programme et les données ainsi obtenues devraient être analysées tous les ans. De plus, il faudrait continuer de prélever des échantillons pour les besoins des études en toxicologie et en génétique. Ces échantillons ne sont pas d'une importance critique pour l'évaluation de l'état du stock, c'est la raison pour laquelle il est recommandé que l'analyse se fasse de façon opportune, mais il ne s'agit pas d'une exigence annuelle. Les observations accessoires systématisées de chacun des animaux capturés pourraient s'avérer d'une aide extrêmement précieuse pour l'interprétation des données recueillies. Pour qu'il soit un outil efficace, le programme de formation permanente des participants autochtones doit être poursuivi et complété par des séances de compte rendu à la fin de la saison et des réactions opportunes sur l'interprétation des données de la saison précédente.

PRIORITÉS DU POINT DE VUE DU FINANCEMENT

La toute première priorité est la création d'une banque de données sur le stock de bélugas de la mer de Beaufort par le biais d'une meilleure utilisation des données existantes, des données facilement accessibles et des données faciles à acquérir. Cette priorité comprend : un enrichissement du programme actuel de formation des autochtones pour la surveillance/collecte sur le terrain; une intensification de l'effort pour maximiser la transmission actuelle des données sur la récolte; le traitement de tous les ensembles de données actuelles; une synthèse des données déjà rassemblées sur la répartition et les mouvements des animaux; une comparaison des données sur le stock de la mer de Beaufort avec des données complémentaires obtenues d'autres stocks; et un effort pour visiter les communautés et consigner les connaissances traditionnelles, surtout des anciens, sur le béluga.

La deuxième priorité est le suivi par satellite. Un programme à cet effet pourrait résoudre les questions suivantes qui sont importantes pour la gestion du béluga de la mer de Beaufort : mouvements des bélugas individuels entre les habitats côtiers et les habitats du large; les mouvements des individus entre les eaux du Canada, de l'Alaska et de la Sibérie; les mouvements des individus à travers les frontières du stock provisoire; les facteurs de correction des enquêtes tels que la proportion du temps passé en surface dans différents habitats et au cours des différentes saisons; des données sur l'alimentation. Cette information peut servir d'un complément important pour la planification des enquêtes aériennes et des études photogrammétriques. Les éléments du travail de suivi par satellite viendront compléter l'analyse génétique actuellement financée dans le cadre de cette occasion unique.

La troisième priorité devrait être la réalisation d'une enquête aérienne des bélugas habitant dans la zone côtière et au large dans l'est de la mer de Beaufort. Il s'agirait de la première enquête complète des aires d'été signalées de ces animaux. Elle devrait être effectuée à une période de l'année où la distribution et le comportement des bélugas donneraient des valeurs estimées dont la variance serait la plus faible. La planification de l'enquête bénéficiera de la connaissance des chasseurs ainsi que de l'apport des données obtenues par satellite. La couverture au large devrait être de 10 % alors qu'elle devrait être de 50 % dans le cas des zones côtières. Les enquêtes aériennes devraient comporter suffisamment d'heures de vol pour permettre la

détermination de l'erreur liée à l'observateur. Le nombre de bélugas obtenu devrait être corrigé en fonction de la proportion d'animaux visibles, des erreurs liées à l'observateur, de la diminution de la détectabilité des animaux au fur et mesure qu'augmente la distance par rapport à l'avion de surveillance et d'autres facteurs environnementaux et comportementaux quantifiables. Les enquêtes aériennes devraient être effectuées selon un calendrier de 7 ans comportant deux années consécutives d'enquêtes suivies d'un hiatus de 5 ans. Ce calendrier permet de maintenir une continuité chez les participants expérimentés. Il faudrait explorer les différentes options liées à la photographie et au vidéo haute résolution comme appoint aux enquêtes visuelles.

1.0 INTRODUCTION

Under the terms of the Inuvialuit Final Agreement (IFA), the Fisheries Joint Management Committee (FJMC) was established in 1986 to assist Canada and the Inuvialuit in administering the rights and obligations relating to fisheries within the Inuvialuit Settlement Region (ISR), and to advise the Minister of Fisheries and Oceans on all matters related to fisheries and the management of the fisheries in the ISR. In 1991, the FJMC in cooperation with the Hunters and Trappers Committees of Aklavik, Inuvik and Tuktoyaktuk and the Department of Fisheries and Oceans (DFO) finalized their Management Plan for Beaufort Sea Beluga. The purpose of this Plan is to ensure the effective long-term management of the beluga by DFO and the Inuvialuit. As stated in the Management Plan, its specific goals are to (1) maintain a thriving population of beluga in the Beaufort Sea and, (2) provide for optimum sustainable harvest of beluga by Inuvialuit.

The Bering Sea population of beluga whales has been estimated to contain a minimum of 25,000-30,000 individuals. After leaving their Bering Sea wintering areas in early spring, they are thought to separate into four different groups, often referred to as provisional management stocks. Genetic studies are currently underway to refine our understanding of these stocks and the management units.

During summer, the provisional stocks are found in (1) Norton Sound, (2) Bristol Bay, (3) the eastern Chukchi Sea near Kotzebue Sound and Point Lay, and (4) in Canadian waters of the eastern Beaufort Sea, Mackenzie Delta and Amundsen Gulf. This latter stock, believed to be shared with Alaska, is the subject of the workshop and is commonly referred to as the Beaufort stock.

Inuvialuit hunters conduct an annual subsistence harvest of beluga whales from the Beaufort stock during summer, when a portion of the stock concentrates in the shallow, warm waters of the Mackenzie Estuary. Hunters from several villages along the north coast of Alaska are believed to harvest beluga from this stock as well, during its spring and fall migrations to and from Canadian summer range. Harvests of beluga in both the Inuvialuit Settlement Region and northern Alaska are self-regulated to meet the subsistence needs of the hunters and their families.

In light of information gaps in the database for beluga in the Beaufort Sea, the FJMC, DFO and the Environmental Studies Research Funds (ESRF) sponsored a workshop to examine stock status and other important questions related to Beaufort Sea beluga. The workshop was held in Vancouver, B.C. on February 3-6, 1992, and was attended by 31 individuals representing various agencies from both Alaska and the Inuvialuit Settlement Region of Canada, technical advisors and resource users (Appendix A).

1.1 Structure of the Workshop

A poster session was held on the evening of February 3, 1992. The following participants presented poster displays describing recently completed or ongoing

research projects, management programs and activities of relevance to the workshop theme:

1. Cooperative Management in the Western Canadian Arctic, Fisheries Joint Management Committee (Lois Harwood)

2. Beluga Management in Alaska (processes, stakeholders and the AIBWC) and the distribution of the Bering Sea population of beluga, including maps on distribution of the four provisional management stocks (Kathy Frost)

3. Beaufort Beluga: Surveys to date and best estimates of abundance (Lois Harwood)

4. Summary of Subsistence Harvest of Beluga from the Beaufort Sea (Provisional) Stock (Lois Harwood and Kathy Frost)

5. Precision of Population Estimation Procedures (Stuart Innes)

6. Use of Satellite Telemetry as a Tool for Studying Beluga Behaviour (Tom Smith)
7. Hydrocarbon Exploration Activities in the Canadian Beaufort Sea Region (John Ward)

The workshop started the next morning with presentations by representatives of each agency present. This was followed by presentations on population estimates, dynamic response analysis, condition indices, life history analogies, and use of traditional knowledge to provide much of the background on the techniques and information necessary to achieve the workshop goals. On the second day, participants were assigned to one of two subgroups to discuss and reach consensus on the specific workshop goals defined below. A series of questions were developed to focus workshop discussions on what we know and how this information can be used to best manage the stock, and what research and monitoring programs are required to address deficiencies in the current database on the Beaufort Sea beluga for effective long-term management.

1.2 Workshop Goals

The workshop goals were to:

Goal 1 examine the status of the stock of beluga whales that summer in the Beaufort Sea;

Goal 2 identify the best methods of the continued monitoring of the stock in response to human activities and environmental changes; and

Goal 3 define research priorities for the future.

To satisfy these goals, organizers formulated two groups of questions that needed to be answered with respect to the present status of the beluga stock in the Beaufort Sea and continuing assessment requirements and preferred strategies.

Present Stock Status

- Is the provisional stock of beluga summering in the Beaufort Sea currently healthy?

- What is our best estimate of the size of the Beaufort Sea stock?

Continuing Assessment

- Should estimates of stock size be the measure of a continuing population assessment?

    - How frequently should such an estimate be undertaken?
    - What is the maximum acceptable variability in such an estimate?
    - How much does the population have to change before such a change can be detected?

- Should the assessment be directed to detecting changes in the population?

    - How many independent measures of relative population status should be conducted on a continuing basis?
    - What should these measures be?
    - How sensitive are these measures to population changes?
    - How should the data be collected?

- What new techniques need to be applied to Beaufort Sea beluga management?

1.3 Introductory Comments: Desired Workshop Outcome and Perspectives

During the plenary session in the first day of the workshop, several individuals presented their views on the desired workshop outputs, process and the factors and information that must be considered to meet the stated objectives of the workshop. The presentations were successful in stimulating discussion and helping to establish the group dynamics that would be important in achieving the meeting goals. Introductory presentations and/or comments were made by the following individuals.

NAME	AFFILIATION
Douglas Wartzok	University of Missouri (Facilitator)
Robert Bell	Fisheries Joint Management Committee
John Burns	Living Resources Inc.
Burton Ayles	Department of Fisheries and Oceans
Kathy Frost	Alaska Department of Fish and Game
Marie Adams	Alaska and Inuvialuit Beluga Whale Committee
John Ward	Amoco Canada Petroleum Company Ltd.
Billy Day	Inuvialuit Game Council
Susan Cosens	Department of Fisheries and Oceans
Alex Aviugana	Fisheries Joint Management Committee
Pierre Richard	Department of Fisheries and Oceans

The workshop facilitator (Douglas Wartzok) noted in his introductory comments that the workshop participants represent a knowledgeable group that would have the necessary expertise to assess the adequacy of the available data to examine projected and existing harvest levels. He stressed that models and data collection techniques must be examined in light of the goals of the workshop, and that emphasis should be placed on outputs rather than process in order to maximize the success of this meeting.

Bob Bell, Chairman of the FJMC, commented on the role of the Inuvialuit Final Agreement (IFA) in terms of future harvest levels and conservation related to the beluga population. If there is a potential for harvest of animals in excess of existing levels, the IFA provides the mechanism for this additional harvest provided that conservation of the resource is not compromised. He added that AFSAC (Arctic Fisheries

Scientific Advisory Committee, Marine Mammals Subcommittee, Department of Fisheries and Oceans, Stock Status Report for Beaufort Sea Beluga, August 1989) provided much of the stimulus for this workshop through its conservative estimates of the size of the beluga stock and suggestion that existing harvest levels may be too high. Concern has also been expressed that human and industrial activities outside of the Inuvialuit Settlement Region may be adversely affecting this stock and thereby harvest potential.

It was stated that substantial funding for research and monitoring will be available over the next two years to address these key questions. However, consideration will have to be given to financial constraints over the longer term in selection of appropriate research projects, as well as to any environmental constraints to data collection in the short-time frame (e.g., weather, ice). As a result of harvest-related research conducted over the past decade, considerable data on the Beaufort Sea beluga is now available. The FJMC is committed to the incorporation of local and traditional knowledge into further research activities to augment this existing database.

John Burns of Living Resources Inc. summarized some of the more contemporary views on the biology of the beluga throughout arctic waters. While all of the information presented by Mr. Burns assisted workshop participants in their evaluation of the aforementioned questions, only highlights of his talk are presented in this section -- relevant information on the biology of the beluga whale is referenced where appropriate elsewhere.

- While the beluga is distributed throughout much of the Northern Hemisphere, its distribution is not continuous and it is absent from some areas such as Siberia and the Canadian Archipelago. There is also a high probability of exchange of animals between the North Atlantic and North Pacific oceans during the open-water season. The present distribution of beluga is a reflection of recent climatic conditions and the activities of man, where the distinct stocks that now exist were at one time part of a continuous population. For example, it was suggested that some populations were decimated due to man's harvest activities such as the belugas that historically existed in the Sea of Japan.

- Belugas are well adapted to exploit seasonally ice-covered environments, occupy labile winter ice and expand their distribution from these wintering areas to coastal areas. The opportunity for interaction of animals exists during the winter and early spring breeding season.

- There appears to be some relationship between the distributions of beluga and bowhead whales, although it is poorly understood at the present time.

- The mean lengths of female and male beluga whales of the Bering Sea population are 3.6 m and 4.1 m, respectively. Based on growth rates, it appears that physical maturity of females occurs at 8-11 years of age, while maturity of males occurs at 10-14 years of age. The size-age structure of beluga stocks does not appear to vary geographically in arctic

waters.

- Mating is thought to begin in mid winter and extend into June, and calves are born about 14.5 months later. (The minimum gestation period is 14.5 months, but on average is more likely 15 to 16 months). Calves are born over a protracted period, which appears to peak during mid June to mid July. The first pregnancy may occur between age 4 and 7 (sexual maturity), with first births occurring between age 5 and 8. It is also thought that female beluga remain reproductively active throughout their lives. About 33% of the population is believed to be comprised of mature females, while the calf production rate based on Alaskan research is approximately 0.104. This Alaskan beluga research indicated that 50% of females over 21 years old were non-gravid; the oldest female and male found were 38 and 35, respectively, although tooth wear makes reading at these high ages difficult and less reliable than at the younger ages. Females probably have delayed implantation (of blastocyst) like many other arctic mammals.

- Mr. Burns characterized belugas as a highly-mobile group with a huge summer distribution and contracted winter distribution. He also stated that we are sharing the same population with the Russians, a fact which has significant implications to any resource management and harvest strategies.

- The estimated annual landed harvest of beluga averages 415 animals, with an estimated 220, 135 and 60 belugas being taken each year in the U.S., Canada and Russia, respectively. It is expected that the latter figure may rise significantly in the next decade with increased impetus of the Russians to recapture some of their local heritage.

- One of the primary areas of recent concern are the relatively high losses of beluga that occur during the hunt, particularly during spring harvests within ice leads off the coast of Alaska.

- While stock identification was not considered within the scope of the workshop, John Burns indicated that within the Bering Sea beluga population (group of reproductively interactive animals), there appears to be stocks or sub-populations and that these groups migrate to different areas in summer but are contracted into a much smaller area in winter. He further noted that beluga occupy seasonally ice-covered waters, and are not found outside this zone. They appear to be quite adaptable with respect to location within ice-covered waters over both short and long time scales.

Following his introductory comments, Burton Ayles of DFO provided an overview of the major conclusions of the AFSAC report. The two conclusions of greatest

interest to many workshop participants were that: (1) the minimum number of whales in the population is 7000-10,000; and (2) the safe harvest level is 177 animals for the southeastern Beaufort Sea/Mackenzie Delta region. AFSAC suggested that this harvest level could be a problem with respect to a sustainable yield if the Alaskan (and presumably Russian) hunts are considered. Other beluga populations in Canada (Ungava, St. Lawrence, Hudson's Bay, Baffin and High Arctic) are considered either endangered or threatened, in part because of historic harvest levels. While it is the view of AFSAC that the Beaufort provisional stock is currently healthy and can sustain the existing harvest levels, there would be increased risk to the stock with higher harvest pressures.

It was stressed that management of beluga is different in the Western Arctic than in other parts of Canada. With the signing of the IFA, DFO transferred many of its traditional responsibilities to the FJMC. While the Department still undertakes research on the beluga and its scientists are responsible for determining the sustainable removal levels, FJMC now allocates the beluga resource among various communities that participate in the annual harvest. In other words, DFO now provides advice on the risks of harvest levels determined by the FJMC to help ensure that the stock does not disappear.

Two further points were stressed in the introductory comments made by Dr. Ayles. Firstly, DFO would like harvesters to recognize that there are many uncertainties in the scientific information available on beluga whales. Secondly, the scientific community (DFO and other organizations) should try to explain the risks to the beluga population in a manner that can be understood by all.

Kathy Frost of the Alaska Department of Fish and Game (ADF&G) stated that the National Marine Fisheries Service (NMFS) is responsible for management of beluga in Alaska, while ADF&G has no formal management role but cooperates through responsibilities in protection of habitats. She also indicated that quotas are not presently imposed by the U.S. government, unless a stock is considered at risk. The North Slope Borough has taken the initiative to bring together experts to assist in beluga management along Alaska's North Slope. It was Ms. Frost's view that the Beaufort beluga stock is abundant and healthy, and a good example of how we can manage other stocks (e.g., those found in Norton Sound). She noted that there is good sampling information and harvest data for the Beaufort stock, and that this stock does not require as much future research effort and concomitant financial resources as other stocks in Alaska which are presently at greater risk.

Marie Adams presented the views of the Inupiat hunters of Alaska, who also believe that the Beaufort beluga stock is healthy. She expressed concern that more conservative actions in Canada with respect to stock management may affect Alaskan natives - there must be a balance between the goals of scientists/managers and the needs of people. Ms. Adams emphasized the low esteem problem that develops when hunters are unable to provide for their families. Concern also existed that there will be increased incidence of heart disease and cancer if Alaskan natives are forced to alter their diet of traditional foods. They believed that the AFSAC estimates of population size and

allowable harvest are too conservative and that beluga harvest levels do not need to be changed. It was stressed that the Inupiat would not overharvest a resource on which they depend for 50-60% of their diet. Finally, like representatives of other native organizations, Ms. Adams reaffirmed the need for proper communication of research results to local people and involvement of locals in all aspects of scientific research from planning to reporting.

John Ward of Amoco Canada Petroleum Company Ltd. stated that industry funded much of the research conducted to date on beluga in the Canadian Beaufort, due to concerns related to the potential interactions between the beluga and offshore hydrocarbon exploration activities in this area (approx. 1975-1985). Dr. Ward also mentioned that some of the current estimates of stock size (i.e., 7000-11,000) were based on the results of industry-funded research programs involving systematic aerial surveys in the southeast Beaufort Sea., and hoped that one of the outcomes of the workshop would be agreement on the current stock size and how it can be best measured in the future. He viewed one important objective of the workshop to be to reach consensus on these questions within the limits of uncertainty.

Billy Day, representing the Inuvialuit Game Council (IGC), opened his presentation by stating that the Inuit have been among the most effective conservationists in the world. If his people had overharvested the whales, they would not have any now. Historically, the Inuit were far more dependent on the beluga and would take up to 200-250 whales in a single hunt. This was required for survival long ago when the number of Inuit occupying coastal regions of the Beaufort beluga stock's summer range was 1500-2000. He expressed disappointment that the workshop was not held in the region where the harvest occurs, and that most participants had probably not even tasted beluga. Mr. Day stressed that local beluga hunters have a great deal of traditional knowledge on both historic and recent harvests, and that there is a need to integrate this experience with scientific information. He stressed the importance of observations from whaling camps, particularly with respect to the numbers of young beluga in the area, and questioned the use of surveys with aircraft to count whales.

In response to the comments of Billy Day, Douglas Wartzok reinforced the need to view different knowledge sources as being complimentary. John Burns reaffirmed that we have to understand the behaviour of beluga, particularly to account for whales missed during aerial surveys. He also strongly endorsed Billy Day's call for cooperation and feedback to the community.

Sue Cosens (DFO) felt it would be useful at the workshop to explore all options for management of beluga, and not necessarily focus only on knowing the absolute population size. Alex Aviugana (FJMC) emphasized the importance of accessing the wealth of information that has been collected over the past few years as part of the Inuvialuit Harvest Study. This program does not provide any evidence that harvest levels are increasing, and Mr. Aviugana questioned the view that the size of the beluga harvest was likely to increase.

Kathy Frost suggested that when taking biological information into

consideration, it is important not to forget how these estimates affect people. She stressed the need to place emphasis on what we need to know for effective long-term management of the beluga, and not on questions or levels of precision that will not bring us closer to that goal.

Pierre Richard of DFO concluded the opening presentations by reiterating the views of previous speakers that the focus of beluga management should be on the needs of the resource users, unless there is an apparent conservation-related problem. In other words, if there are enough whales to meet the requirements of local people, then the need for further scientific information is largely academic.

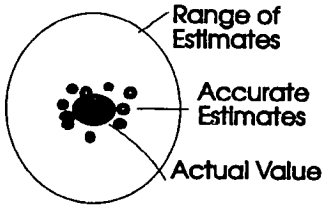
2.0 BACKGROUND INFORMATION ON MODELS

As stated in Section 1 of this report, presentations on population estimates, condition indices, life history analogies and use of traditional knowledge were made by various workshop participants to provide the necessary background information to address the workshop goals. The following sections identify the general nature and scope of these presentations.

2.1 Population Estimates

A review of population estimation procedures was presented by Dr. Rod Hobbs of the National Marine Fisheries Service. His presentation focused on the three different types of population estimates (total census, aerial survey sampling, mark-recapture techniques), the advantages and disadvantages of each approach, and other considerations related to inherent biases, accuracy and precision.

The actual value of a population in terms of its size can be depicted as the smaller circle within a much larger range of estimates as shown in the accompanying graphic. Accurate estimates of the population size will be clumped around the actual value and, in some cases, may actually overlap with the latter. When the estimates are not centered on the true number, the samples are said to be biased; this can result in over- or underestimates of population size.



In a **total census**, an attempt is made to count all animals within a region. In general, this is not a very feasible approach to obtaining a population estimate. If animals are missed, the census becomes biased low, while counting animals twice may also occur, thereby reducing accuracy of the estimate.

During **aerial survey sampling**, the second population estimation technique, encounter rates are used to determine the number of animals that would be seen in the whole region. Estimates can be improved by stratification of the study area, but the accuracy of these estimates will always be a function of the number of sightings and the size of the area surveyed. Estimates obtained through aerial surveys are inherently biased low because some animals on the surface, those submerged, or animals that dive in response to the approach of the aircraft are missed. In arctic waters, both visibility and the presence of ice are also significant constraints to aerial surveys. It was concluded that aerial surveys will contribute to Goal 1 (determination of present stock status), but do have limitations and problems related to accuracy and precision. Aerial surveys are particularly sensitive to missing data, behaviour of animals, and available funding levels.

Mark-Recapture is the third group of techniques that may be used to obtain a population estimate. These procedures involve dividing a population into "marked" and "unmarked" groups through the use of tags, marking, or natural identifying features. The

accuracy of the technique depends on the fraction of the population marked and should be about 10% to get a reasonable population estimate. In the case of the beluga, this could mean that 700-1700 animals would have to marked. Marking of this number of animals is not considered practical and would also represent a source of disturbance to numerous whales and possibly interrupt hunters or interfere with the harvest.

2.2 Dynamic Response Analysis

Stuart Innes of the Department of Fisheries and Oceans described the theory of Dynamic Response Analysis (DRA) including the concepts of carrying capacity, production curves, and maximum sustainable yield. DRA is the long-term monitoring of population parameters and can contribute to Goal 1 of the FJMC by helping to illustrate the risks of harvesting whales beyond the maximum sustainable yield. It may also be of some value in long-term monitoring (Goal 2), such as helping to resolve changes in carrying capacity due to global warming or other population pressures. However, the time period (30+ years of data) required to use the DRA model greatly reduces its practicality as an effective management tool.

2.3 Condition Indices

The use of condition indices was described by Kathy Frost of the Alaska Department of Fish and Game. These indices may provide a variety of clues related to the health of a population, and offer the advantage that much of the relevant information can be collected by harvesters. For example, analysis of reproductive tracts can show the number of pregnant and non-pregnant females, and this can be used to help estimate reproductive rate. Jaws (teeth) can be used to determine the age of an animal. Ms. Frost emphasized the value of looking for changes in the number of older animals in a population because this is an indicator of the health of a population. In particular, the importance of length and age data was stressed; the length of animals at a given age can be used to compare the adequacy of feeding habitats/opportunities available to different stocks.

It is important to obtain information necessary to evaluate condition from many different years and areas: while none of this information will actually provide evidence on the size of the beluga stock, it will assist in assessment of it's health. One of the most significant problems associated with evaluation of changes in condition indices is obtaining an adequate sample size. This problem can be alleviated to a large extent by the commitment of harvesters to supply non-edible beluga body parts for scientific research, and by an equivalent commitment of the scientific community to communicate research results back to the communities. Involvement of harvesters in the processing of samples is also desirable and would help in the communication of research results. It was stressed further that this approach to procurement of information is far less sensitive to changes in funding than other methods, since the collection of samples can even continue in the virtual absence of funding. In concluding her discussion, Kathy Frost stated that condition indices have historically been more useful than population estimates in assisting in the management of some other marine mammal populations (polar bear and walrus).

2.4 Life History Analogies

Michael Kingsley (Department of Fisheries and Oceans) presented background information on the value of life history analogies. Comparisons of birth rates, death rates, age at first reproduction etc. can be made among marine mammal species within the Arctic, or among whales both within and outside arctic regions. It was suggested that useful information might be gained through comparison of feeding rates of toothed whales, although seasonal differences in feeding may not be resolved by looking at other species. In contrast, too much variability would be expected in reproductive rates and age at first reproduction.

Three essential types of information for management are: (1) an index of population size; (2) an index of the condition of individuals; and (3) data on the condition of the population's range/habitat (including food species). There is no information on the latter for the beluga and it may not be practical to attempt to get this information. Catch per Unit Effort (CPUE) indices, used as an index of population size, are also unreliable for gregarious species such as the beluga. Mr. Kingsley suggested that recovery tagging and radio tagging could produce large amounts of information on stock structure, biology and behaviour, although he also believed that aerial surveys are still required for stock management purposes. While current harvest levels are not expected to pose a risk to the Beaufort beluga stock, the key question may be how to recognize the point at which harvest level increases may not be sustainable and scientists become uncomfortable with the available quantitative and qualitative information necessary for rational decision-making.

2.5 Traditional Knowledge

The opening comments on the value of traditional knowledge in beluga stock management and research planning were made by Marie Adams of the Alaska and Inuvialuit Beluga Whale Committee, although various participants lent support to the importance of this information source throughout the workshop. Traditional knowledge dates back hundreds of years and provides clear evidence that subsistence harvests have not harmed the Beaufort beluga stock. John Burns raised an example of where traditional knowledge may provide valuable insight. Kuskokwim Bay in Alaska was historically a harvest area but is no longer used by beluga. Traditional knowledge of local hunters may be able to help determine the factors (e.g., industrial activities, noise from outboard motors) that have contributed to the discontinued use of this area by beluga.

Traditional knowledge can also play an extremely important role in research planning and lead to a far better understanding of the resource. Scientific knowledge tends to be focused on regions and usually spans relatively short time scales, whereas traditional knowledge complements scientific data by reflecting local information over the longer term. Everyone agreed that traditional knowledge should become an integral part of future beluga research in the region as discussed later in the section addressing funding priorities.

3.0 SUBGROUP DISCUSSIONS

An underlying and very fundamental question existed in the minds of several participants after the opening comments and background presentations and this question helped focus the remainder of the workshop -- should we concentrate our efforts on determining stock size (despite all the shortcomings and expense of aerial surveys and difficulties in counting Beaufort belugas), or on the monitoring of trends in the stock (e.g., growth, health, reproduction), or is some combination of both necessary? This question provided much of the impetus for breaking the participants into two groups to address different questions and issues related to beluga management and associated future research requirements. The general approach favoured by the workshop organizers was to split into two groups to examine the following basic questions that followed from the workshop goals, and then to reconvene a plenary session to integrate the collective wisdom of the two groups.

SUBGROUP NO. 1	SUBGROUP NO. 2
Is the provisional stock of beluga summering in the Beaufort Sea currently healthy? What is our best estimate of the Canadian Beaufort Sea stock? Should estimates of stock size be the measurement of a continuing assessment?	Should the assessment be directed to detecting changes in the stock? What new techniques need to be applied to Beaufort Sea beluga management?

Subgroup No. 1 contained participants familiar with aerial surveys and population estimation procedures, whereas participants with expertise in sampling and harvest methods, and the life history and basic biology of the beluga were present in Subgroup No. 2. The following sections summarize the major conclusions and recommendations of each of these working groups in relation to the overall objectives of the workshop and aforementioned FJMC goals regarding management of the Beaufort Sea beluga stock.

3.1 Group 1 - Stock Status and Population Estimates

Burton Ayles of the Department of Fisheries and Oceans was the group leader/facilitator for discussion of the three questions related to stock assessment and the role of population estimates in continuing beluga population assessments. The rapporteur was Wayne Duval of the Axys Group Ltd.

3.1.1 Health of the Provisional Stock of Beluga Summering in the Beaufort Sea

It was agreed by all subgroup members that the provisional stock of beluga summering in the Beaufort Sea is healthy. This assessment is based on the estimated size of the stock, the age structure and condition of harvested animals, the relatively low present harvest levels, and the absence of currently defined environmental threats. It was noted that a large number of calves are observed with adults, and there are also large numbers of older whales present in the population.

While estimates ranging from 7000 to 17,000 have been published for this stock, these likely highly underestimate the true number because the estimates did not account for either surfaced whales missed by observers or submerged whales. It was suggested that the stock is probably much larger (one participant estimated at least 30,000), and everyone agreed that the stock could likely withstand both natural variation in abundance and the current harvests. To date, there have been no reports from hunters of any notable changes in the catch-per-unit effort (CPUE) as reflected in the harvest statistics, or unhealthy animals (e.g., thin animals with low fat content). From the harvester's perspective, availability, numbers and condition of whales all appear to confirm that the beluga stock is healthy. There is no evidence of any rapid changes in abundance or any major threats to the stock.

It was also suggested that there may be adequate habitat for this stock to increase further in size. The fact that there are areas where beluga are seen only in some years, compared to being found in the same areas in each year, was cited as evidence of a "booming" rather than contracted population.

3.1.2 Estimated Size of Canadian Beaufort Sea Beluga Stock

Several summers of systematic, visual aerial surveys were conducted in the Mackenzie Estuary (1976-1983) and offshore Beaufort Sea (1981, 1984, 1985) to document the distribution of beluga whales. While the surveys were not intended to determine the actual stock size, in some cases useful indices of abundance were produced. Aerial surveys of the Mackenzie Estuary were funded by industry, while the 1984 and 1985 beluga surveys in the offshore were funded by DFO under NOGAP (Northern Oil and Gas Action Plan).

The poster presented on February 3, entitled "Beaufort Beluga: Surveys to date and best estimates of abundance" provided the starting point for a thorough discussion of the various strengths and shortcomings of the existing aerial survey data and the associated indices of stock size. The subgroup reviewed the data as well as the assumptions, and discussed general concepts regarding the application of correction factors to aerial survey data.

One of the surveys, conducted in the offshore Beaufort from July 21-23, 1984, was particularly useful in terms of the data it produced since the survey was completed with a 48-h period and had no spatial or temporal interruptions in coverage. This survey produced an estimate of stock size of 7081 (standard error = 1584), based on a stratified systematic strip transect survey of the offshore Beaufort Sea (only). Review

of the detection distances of all sightings made by the observers showed that beluga were sighted less often at the outer portions of the 800 m wide strip than along the inner portions. There were also differences in detection distances for individuals and for groups.

This decreased detectability made this data set a candidate for the line transect method. A re-analysis of these data was completed, using line transect methods, and this yielded a negatively-biased (or conservative) estimate of 10,519 (standard error = 1478). This estimate is believed to be conservative because it still did not account for surfaced whales missed by observers, whales below the surface, or whales outside of the survey area (e.g., Mackenzie Estuary, Amundsen Gulf, and north of the 7-9+/10 ice edge).

After examination of paired counts obtained in an earlier 1984 survey by the same observers, and correction factors obtained in other areas using radio telemetry (Bristol Bay), it was agreed by the group that a factor of 2 was reasonable for correction of whales below the surface and for surfaced whales missed by observers. This yielded an estimate of 21,000. Assuming no variance associated with this correction factor, the 95% confidence region is 15,000-27,000 about the estimate. The subgroup members agreed that the correction factor of 2 was clearly an underestimate of even the time that whales spend below the surface. Hence, the estimate of 15,000-27,000 animals in the Beaufort Sea stock is still believed to be conservative.

3.1.3 Need for Aerial Surveys

Periodic surveys are important because decisions are often based on population size estimates. While they are imperfect and produce variable results, surveys are capable of detecting major trends in abundance, can provide indices of stock, and are of scientific interest for a variety of other reasons. Consequently, the subgroup agreed that an aerial survey of the Beaufort Sea, Mackenzie Estuary and Amundsen Gulf should be undertaken.

The frequency of surveys would be highly dependent on the available funding. It was suggested that they should be conducted frequently enough that personnel do not have to be re-trained in order to complete the surveys; this could happen if surveys are not conducted at least once every five years. The subgroup recommended that two consecutive years of survey followed by a period of five years without surveys would help define interannual variability and satisfy the aforementioned requirements. Large fluctuations in numbers would not be expected due to biological causes and, therefore, it should be possible to space surveys accordingly to allow interpolation of population size between surveys.

Participants discussed the maximum acceptable variability in population estimates and concluded that, due to inherent limitations in stratified sampling programs and biological variability, it was unlikely that Coefficients of Variation (CV) less than 25-30% could ever be achieved. This is equivalent to a factor of three difference between upper and lower confidence limits on a population estimate (e.g., 5000 to 15,000). Behavioural factors such as dive times (i.e., non-sampling errors) are effectively controlling how low we can get these CV values.

Based on a 25% CV value, it was estimated that the size of a population would have to change by 40% to be detectable. For this reason, it was concluded that surveys may be better suited to providing population size indices than actual estimates of the number of animals in a population, particularly when they are conducted as a time series. Multiple surveys in any given year would tend to reduce CV values, albeit with the requirement for substantially higher funding levels.

3.2 Group 2 - Continuing Assessment

Douglas Wartzok was the group leader/facilitator for discussion of questions related to continued assessment of the Beaufort Sea beluga stock. The rapporteur was Vic Gillman of the Department of Fisheries and Oceans.

3.2.1 Focus of Continuing Assessment

This subgroup worked on the premise that the beluga stock is healthy and capable of supporting present harvest levels. Participants then discussed the indicators that would be needed to detect if future harvests begin to have an impact on the stock, or if other environmental factors, such as pollution or global climate change, were to affect the beluga adversely.

Members of this group concluded that stock health and reproductive performance could be assessed by collecting: (1) teeth for age data; (2) reproductive tracts to determine reproductive capacity; (3) measurements of length, girth and fat content; and (4) information on animal condition from hunters. Any continuing assessment program would also have to take into consideration the pulse nature of funding of most environmental research. It was agreed that three areas of continued assessment activity would be least sensitive to pulse funding constraints; these are:

1. Summarization of available data on beluga distribution and movements in the Beaufort, and analysis of all samples and data collected to date;

2. Recording of traditional knowledge in villages and communities through a standardized interview procedure; and

3. Comparison of the Beaufort Sea beluga database with information available for stocks in other areas (particularly Alaska) to help confirm conclusions of workshop participants regarding the health of this stock.

Participants in Group 2 outlined the following continuing assessment program for later consideration by all workshop participants:

A. Yearly Collections and Analyses (Regular Basis)

   1. Age
   2. Length
   3. Body Condition (specific parameters to be determined)

4. Reproductive Performance

B. Yearly Collections and Analyses (Opportunistic Basis)

1. Samples for toxicological analyses
2. Samples for research on beluga genetics
3. Ancillary observations

C. Resource User Training and Feedback Program

3.2.2 Relevant New Technologies for Continuing Assessment

The discussion of new technologies for continuing assessment focused on the use of satellite tagging and photogrammetry. Information from satellite-tracked tags can be used to examine the movement and distribution of beluga, both in offshore and inshore waters, during migrations, and in wintering areas. The latter information may become critical if the harvest in the Russian part of the range increases. Diving patterns may also be investigated through the use of satellite tags, thereby allowing examination of feeding through inference and determination of correction factors for aerial survey data. It was also concluded that a satellite tagging program would be a useful adjunct to photogrammetric studies.

Opportunistic studies were also discussed by this subgroup. While it was recognized that there are often funding constraints, researchers and managers should be prepared to take advantage of unusual/rare events such as the entrapment of whales or oil spills to gain further information on this and other marine mammal species.

There was some discussion of the sensitivity of many of these parameters in terms of detection of change. It was generally agreed that a 5-10% change in any of these parameters would go undetected, and that a 20-25% change would be required in most cases. It was suggested that the use of multiple parameters would decrease the sensitivity of several condition indices to episodic events, while other indices will only be sensitive over a small range in population size. Maximizing sample size and removal of non-constant biases will help in the detection of changes in stock health and size.

The group stressed the value of obtaining as much information as possible during the beluga hunt and involvement of harvesters in the collection of this information - it is the most cost-effective and scientifically justifiable approach to continuing assessment.

4.0 FUNDING PRIORITIES

After the subgroup presentations, the groups rejoined and the workshop facilitator initiated discussions to reach a consensus on areas where available research funds should be directed. It was noted that pulse funding of $200,000 per year was available for the coming two years, with a possibility of $40,000 per year thereafter. Consensus was reached on the priority areas, as follows:

Priority 1: Summary of Existing Data: Workup of existing and easily acquired data to provide the focus for continued monitoring [estimated cost = $80,000];

Priority 2: Satellite tagging [estimated cost = $100,000 per year at 9 tags, continued for two years]; and

Priority 3: Aerial surveys [estimated cost = $200,000 per year at 50% and 10% inshore and offshore coverage, respectively, continued for two years].

Each of these areas is discussed in further detail below.

4.1 Summary of Existing Data

It was agreed that the first priority should be to build on the data base for the Beaufort Sea beluga stock through a better use of data already in hand, data readily available, and data easily acquired. This priority includes: an enhancement of the current native field monitor/collector training program; an intensified effort to maximize the current data return from the harvest; the processing of all currently held collections; a summarization of data already collected on distribution and movements; a comparison of the Beaufort Sea stock data with complementary data obtained on other stocks; and an effort to visit communities and record traditional knowledge about beluga, particularly from the elders.

A large number of studies in both the Canadian Beaufort and Alaska have focused on the beluga. Much of the age and reproductive data resulting from specimen collections have yet to be analyzed or reported. There is also a need for information on the sensitivity of condition indices to changes in stock size, and it is anticipated that the data necessary to do this analysis already exist. It was suggested that some of the funding for this priority might come from U.S. sources, or from the Alaska and Inuvialuit Beluga Whale Committee (AIBWC).

There is a need for ongoing training of harvesters in the collection and processing of harvest-derived data. The requirement for greater consistency in training was also emphasized, and training should be directed at field processing of samples to the extent possible (e.g., reproductive material). This would also help with the task of feedback to the communities.

4.2 Satellite Tagging

There was consensus among participants that the second funding priority is satellite tagging. Such a program could address the following outstanding issues of Beaufort Sea beluga management: movements of individuals between inshore and offshore habitats; movements of individuals through Canadian, Alaskan and Siberian waters; movements of individuals between provisional stock boundaries; survey correction factors such as the proportion of time at the surface in various habitats and at various seasons; and feeding inferences. This information can serve as an important adjunct to planning aerial surveys and photogrammetry studies. Components of the satellite tracking work will be complementary to the genetic analysis currently being funded under this unique opportunity.

One of the primary justifications for conducting a satellite tagging program is to provide the data necessary to determine correction factors for use with aerial survey data. Through the examination and comparison of dive times in offshore and inshore areas, a tagging study would make a major contribution to the interpretation of survey data. It was agreed that many assumptions about the behaviour of whales can be verified with data collected through satellite tagging. In fact, several participants suggested that correction of previous survey data with the results of a tagging program may be more useful than conducting further aerial surveys at this time, and that this information would also be of value in the future. For example, it was reported that data from only two tagged right whales have completely changed the interpretation of 20 years of earlier survey data because "resident whales" were found to have migrated 4800 km between two sampling periods (M. Kingsley, pers. comm).

There was a thorough discussion of the advantages and disadvantages of conducting a tagging program. For example, movement data from a tagging program will provide some data on stock identity and on the general ecology of the species. On the other hand, some participants questioned the amount of movement data that can be obtained from only 18 tagged animals and the value of the resultant information in terms of management decisions. The fact that the longest survival of a satellite tag to date is only 62 days should also be considered in relation to the cost-benefit of information obtained from this type of research.

The cost of satellite tagging programs may decrease in the future because 80-90% of the present costs are associated with purchase of the tags. One strategy might be to apply the tags over a number of years, to help resolve interannual differences in movements and behaviour of whales.

A minimum of four months lead time would be required for a satellite tagging program because of the need to have the specialized tags manufactured. Consultation with the communities and a permit from DFO would also be required. It was suggested that DFO would have to screen a project of this type, although this requirement is not expected to cause unacceptable delays in project initiation.

4.3 Aerial Surveys

The third priority should be an aerial survey of the inshore and offshore belugas in the eastern Beaufort Sea. This survey would be the first complete survey of the reported summering range of these animals. The survey should be planned to occur at the time of the year when distribution and behaviour of the whales would lead to estimates with minimum variances. The planning of the survey will benefit from the knowledge of the hunters as well as data from satellite tags. Offshore coverage should be 10% and inshore coverage 50%. Aerial surveys should include sufficient air time to determine observer bias. The resulting animal counts should be corrected for the proportion of whales visible, observer biases, decrease in detectability of whales with increasing distance away from the survey aircraft, and other quantifiable environmental and behavioural factors. Aerial surveys should be conducted on a seven year schedule with two consecutive years of surveys followed by a hiatus of five years. This schedule allows for continuity among experienced survey participants. Photographic and high-resolution video options should be explored as adjuncts to the visual surveys.

Aerial surveys were discussed in the context of providing an index of population size, with the above tagging program providing complementary information on the frequency of use of surveyed areas. In fact, it was stated that the tagging study should be conducted prior to the index surveys, as satellite tagging will assist with the planning of more effective aerial surveys.

The timing of future aerial surveys was also discussed. Because of typically high winds during the first two weeks of July, this may be an inappropriate time to conduct aerial surveys, in part due to poor visibility of whales when the sea state is high. Survey timing must consider the fact that belugas migrate into the Estuary very quickly, undergo a synchronous moult, and then leave and re-enter. Ideally, surveys should be conducted when the animals are most visible and when there are the least movements of individuals - a satellite tagging program may help define this period. It was noted that communication with hunters may also help determine the best time to initiate aerial surveys and this is possible because increasing numbers of harvesters carry single side-band radios.

4.4 Other Research Requirements

The need to address the implications of increased tourism was also raised during the discussion of future research requirements. The Government of the Northwest Territories is promoting this type of tourism and while DFO representatives suggested that increased tourism is unlikely to adversely affect the health of the beluga stock, potential impacts on the harvest are possible and should be considered. It was suggested that tourism may have to be regulated in some shallow areas to prevent impacts on the harvest. Since tourism and harvesting of animals are generally considered incompatible activities, it may be more appropriate simply to ensure that there is no overlap between tourist viewing and harvest areas.

Another area that should be monitored as part of continuing assessment

is the harvest itself, including the loss of animals during the hunt. This is a management issue, and is being considered and monitored by the North Slope Borough and by the Inuvialuit. Harvesting in excess of the sustainable yield remains a concern since harvest levels from the Bering Sea area by Russians are unknown and may increase.

APPENDIX A

LIST OF WORKSHOP PARTICIPANTS

February 3-6, 1992
Vancouver, B.C.

LIST OF WORKSHOP PARTICIPANTS

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