UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of General Counsel
P.O. Box 21109
Juneau, Alaska 99802-1109

April 30, 2004

ALJ Docketing Center, Attn: Ms. Gladys Kaitell-Paul
United States Coast Guard
40 S. Gay Street
Baltimore MD 21202

Re: Filing of NMFS Final Recommendation of Beluga Harvest Plan and supporting documents in In re: Proposed Regulation Governing the Taking of the Cook Inlet, Alaska, Beluga Whales by Alaska Natives, Docket #000922272-0272-01

Dear Ms. Kaitell-Paul:

Pursuant to Judge Parlen McKenna's Recommended Decision in this matter, and an Order for extension of time for filing NMFS proposed harvest regime, NMFS is submitting its Subsistence Harvest Management Plan for Cook Inlet Beluga Whales for filing with your office. Along with the Plan, NMFS is submitting additional, relevant documents. NMFS requests that these documents be entered into the record in this matter and assigned an entry number or other identifier:

1. Subsistence Harvest Management Plan for Cook Inlet Beluga Whales (11 pp.);
2. Technical Notes for NMFS Harvest Plan April 26, 2004 (4 pp.);
3. Interim Final Rule for Taking of the Cook Inlet, Alaska Stock of Beluga Whales by Alaska Natives, 69 FR 17973 (April 6, 2004);
4. Letter dated December 19, 2003, to Merryman, Blatchford and Stephan from James Balsiger (3 pp.);
5. Letter dated January 15, 2004, to Merryman from Balsiger with attachment of NMFS "White Paper" (7 pp.);
6. Letter dated January 26, 2004, from Stephan to Balsiger (1 p.);
7. Letter dated February 13, 2004, from Cottingham to Balsiger (8 pp.);
8. Letter dated March 23, 2004, from Starkey to Balsiger with attachment of Punt comments (11 pp.);
9. Report of the Cook Inlet Beluga Long Term Harvest Regime Working Group Meeting, September 25-26, 2003, (8 pp.) with appendices:
    - Appendix 1: agenda (2 pp.);
    - Appendix 2: List of participants (2 pp.);
    - Appendix 3: Abundance and distribution Powerpoint (26 pp.);
    - Appendix 4: Mortality table (1 p.);
    - Appendix 5: Strandings tables (10 pp.);
    - Appendix 6: Model basics Powerpoint (11 pp.);
    - Appendix 7: Decision Analysis notes Powerpoint (17 pp.);
    - Appendix 8: Evaluating Alternative Management Policies Powerpoint (13 pp.);

10. Report of the Cook Inlet Beluga Long Term Harvest Regime Working Group Meeting, Koloa Building, 1680 C Street, December 7, 2003, (9 pp.);
11. Minutes from Cook Inlet Marine Mammal Council, February 14, 2004 (6 pp.);
12. Minutes from "ALJ Science Committee Teleconference", July 8, 2003, (5 pp.);
13. Table for Abundance of Cook Inlet Beluga Whale, April 29, 2004 (2 pp.);

Unfortunately, because of the filing deadline and inability to finalize documents that cannot be completed until subsequent to completion of the filing herein, we anticipate we will file additional relevant documents to the record in the very near future. We have enclosed a copy of the certificate of service of these documents.

If there are any questions, please don't hesitate to contact our offices.

Very truly yours,

Thomas J. Meyer

Thomas J. Meyer, Attorney-Advisor
NOAA General Counsel, Alaska Region

cc: Chambers of Judge Parlen McKenna

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

IN THE MATTER OF:

PROPOSED REGULATION GOVERNING THE TAKING OF COOK INLET, ALASKA, BELUGA WHALES BY ALASKA NATIVES

Docket #000922272-0272-01

CERTIFICATE OF SERVICE

I hereby certify that I have this day served complete copies of the Subsistence Harvest Management Plan for Cook Inlet Beluga Whales; Technical Notes; Final Rule for Taking of the Cook Inlet, Alaska Stock of Beluga Whales by Alaska Natives; correspondence to or from James Balsiger to Merryman, Blatchford, Stephan, Cottingham, Starkey with attachments; Report of the Cook Inlet Beluga Long Term Harvest Regime Working Group Meetings for September and December, 2003, including all appendices; CIMMC minutes from February, 2004; and April 30, 2004, Abundance graph; by U.S. Postal Service mail upon the following persons:

Marine Mammal Commission, Mike Gosliner

Village of Tyonek, Sky Starkey;

Joel and Debra Blatchford

Alaska Oil and Gas Association, Judy Brady;

Trustees for Alaska

DATED this 30 day of April, 2004.

Thomas J. Meyer, Attorney-Advisor
NOAA General Counsel, Alaska Region

SUBSISTENCE HARVEST MANAGEMENT PLAN FOR COOK INLET BELUGA WHALES

The NATIONAL MARINE FISHERIES SERVICE (NMFS) has developed this plan for subsistence harvest management of the Cook Inlet (CI), Alaska stock of beluga whales. The Harvest Plan (Plan) was developed under a framework established in the July 2003, Final Environment Impact Statement: Subsistence Harvest Management of Cook Inlet Beluga Whales and the results of various legal and administrative actions, including a formal administrative hearing conducted in Anchorage, Alaska in December 2000, and follow up meetings with the Parties to that hearing. The Stipulations for Determination of Issues subject to the administrative hearing prescribe the development of harvest regulations that accomplish the following:

A) provide reasonable certainty that the population will recover, within an acceptable period of time, to the point where it is no longer considered to be depleted;

B) take into account the uncertainty concerning NMFS's knowledge of the population dynamics and vital rates of the CI beluga whale population;

C) allow for periodic adjustment of the allowable strike levels based upon the results of population abundance surveys and other relevant information, recognizing *that the strike level and allocation regime will not be reduced below (present) minimum (1.5 belugas/year) without substantial information demonstrating that subsistence takings must be reduced below this level to allow recovery of the CI beluga whale population* from its depleted status; and

D) can be readily understood by diverse constituencies.

NMFS believes this Plan meets these objectives. The Plan is intended to recover the stock while providing reasonable harvests for traditional subsistence needs[1]. Several Alaska Native groups have stated their minimum collective needs as no fewer than one and one half whales annually. This plan would meet or exceed this level of harvest, unless the population declines further. Harvests will decrease if population trends decrease. The harvest rates presented in the Plan are

---

[1]Pursuant to the Marine Mammal Protection Act (MMPA), NMFS' goals are to maintain marine mammal stocks at Optimum Sustainable Population (OSP) levels, recover depleted stocks, and allow for the continued subsistence use during this recovery.

based on the goal of not increasing time to recovery (when compared with zero harvest) by more than 25 percent, with 95 percent certainty. However, those rates assume a positive growth within the stock. When no growth or a decline in the population occurs, the 25/95 goal would require that the harvest be reduced to zero. NMFS must balance the recovery with the need to provide a harvest to Alaska Natives. As such, if the stock declines below the current level, strikes will be adjusted downward but not immediately eliminated

While the purpose of this Plan is to regulate subsistence harvest, regulation of other activities may become necessary to promote recovery of this stock. NMFS is currently examining these non-harvest factors separately within a broader Conservation Plan.

NMFS will cooperatively manage the subsistence harvest of CI beluga whales with one or more participating Alaska Native organizations. The cooperative management of subsistence species between the Federal Government and Alaska Native organizations follows provisions within section 119 of the Marine Mammal Protection Act, as amended. Co-management agreements will be developed for five year intervals, in which harvest levels will be derived from abundance estimates averaged over the previous five year interval. The co-management agreements will include specific limitations regarding the number and allocation of strikes, hunting periods, hunting practices (prohibitions on the taking of calves and juvenile whales, methods to improve efficiency of harvest), reporting procedures, mitigating measures, and enforcement. The agreements will also include measures for the preferential harvest of male animals. This measure could speed recovery and reduce recovery time, as current models assume a 50/50 gender ratio for subsistence harvest. Future co-management agreements will conform to this Plan and its terms and criteria:

I. The annual strike limitations for the interim planning period, years 2005-2009, are set as follows: two (2) strikes are allocated for 2005, one (1) strike for 2006, two strikes for 2007, one strike for 2008, and two strikes for 2009[2]. Similar (1.5 belugas/year) harvest levels were first established (2001-2004) under the Recommended Decision of Judge Parlen L. McKenna, Administrative Law Judge, subject to hearings conducted in Anchorage, Alaska in December 2000. The setting of interim harvest levels is necessary because existing data do not provide sufficient resolution on the population trends within this stock to support the management strategy which will be used in subsequent five year intervals. NMFS recognized the cultural, traditional, and nutritional importance of the CI beluga whale to Alaska Natives, and adopted these interim harvest limitations after extensive consultation with affected Native interests and other interested groups, individuals, and organizations. NMFS submits that these limits are consistent with the recovery of the CI beluga whale stock.

II. Strike/harvest levels

---

[2]This harvest strategy was proposed and adopted by motion by Cook Inlet Treaty Tribes, Native Village of Tyonek, and Native hunters attending the December 7, 2003 meeting.

a. Strike/harvest levels and trend for each five year planning interval, beginning in 2010 will be determined, in part, by the recovery of this stock as measured by the average abundance in the prior five year interval and the trend estimated for the previous 10 years. The harvest levels were fit to five year average population abundances in increments of 50 whales, except for the smallest and largest blocks. This increment was chosen to allow response to population changes that may occur in a five year interval, while not overburdening the parameter fitting routine. Harvest levels are set according to the 25/95 criterion for populations assuming that the population will be increasing in subsequent years. The established harvest/strike levels are presented in Table 1. The basis for and assumptions concerning these harvest levels are presented in Part IV, section f.

b. Because of the low abundance of this stock, additional caution is warranted in setting harvest levels when zero growth is detected or when a sustained decline is observed. Therefore, we have included columns in Table 1 that depict harvest levels for populations following periods of zero and declining trends. The trend is determined as the growth rate multiplier in a loglinear regression of the abundance estimates for the pervious 10 years. If the estimated growth rate is significantly greater than zero at the 95 percent level, the trend is considered to be increasing. If the estimated growth rate is significantly less than zero at the 95 percent level, the trend is considered to be decreasing. Otherwise, the population is considered to have a zero trend.

c. Table 1 relates harvest/strike levels to five year average abundance and trend over the previous ten years. Harvest/strike levels for populations greater than 300 are developed through a computer based model which seeks out the largest harvest in each block that meets the 25/95 criterion. Assuming that the table is used for each subsequent five year interval, the Rmax (maximum theoretical net productivity rate) for the population remains between 0.02 and 0.06. Harvest between 260 and 300 was set to five beluga whales in five years (which meets the 25/95 criterion as stated above and harvest levels for population with a five year average below 260 are zero as explained below (Part IV, section f)). Harvest levels are always subject to the Unusual Mortality Limit.

Table 1

Population (Five year averages)	Harvest Increasing Trend	Harvest Zero Trend	Harvest Decreasing Trend	Unusual Mortality Limit
<260	0	0	0	
260-299	5 belugas in 5 years	5 belugas in 5 years	0	16
300-349	9 belugas in 5 years	7 belugas in 5 years	0	19
350-399	9 belugas in 5 years	8 belugas in 5 years	0	22
400-449	10 belugas in 5 years	9 belugas in 5 years	1 belugas in 5 years	25
450-499	12 belugas in 5 years	9 belugas in 5 years	1 belugas in 5 years	28
500-549	12 belugas in 5 years	11 belugas in 5 years	4 belugas in 5 years	31
550-599	12 belugas in 5 years	11 belugas in 5 years	11 belugas in 5 years	34
600-649	12 belugas in 5 years	11 belugas in 5 years	11 belugas in 5 years	37
650-699	12 belugas in 5 years	12 belugas in 5 years	12 belugas in 5 years	40
700-779	12 belugas in 5 years	12 belugas in 5 years	12 belugas in 5 years	43
780 +	consult with co-managers to expand subsistence harvest levels while allowing continued growth of the population			

III. If, in any one year, observed mortalities exceed the Unusual Mortality Limit (Table 1), Emergency Restrictions will occur and the harvest rates will be reduced by the number of mortalities above that limit. Table 1 specifies Unusual Mortality Limits for different population levels where the future harvest(s) could be stopped. For instance, if the five year population average is 522 whales, the unusual mortality limit is 31 whales. If 34 whales were confirmed dead in one year, three whales would be subtracted from subsequent harvests within that five year block of time.[3] At the end of the five year interval in which the unusual mortality event occurred, any remaining mortalities not accounted for by reduction of harvest will be subtracted from the five year average abundance for the purpose of determining the harvest level in the next five year interval.

IV. Relevant scientific, legal and institutional guidance for this plan:

a. NMFS intends to conduct annual surveys of the CI beluga whales for at least the next two years (2004 and 2005)[4]. Future surveys may be scheduled for every other year, if it can be shown to meet the data requirements of this Plan.

b. A minimum of 8-10 years of abundance estimates are required to distinguish among an increasing, stable, or decreasing growth trend at a 95 percent level of significance. Consequently, a harvest policy that relies on trend analysis alone will inevitably lag behind the actual current behavior or the population.

c. Pursuant to the MMPA, NMFS' goals are to maintain marine mammal stocks at OSP levels, recover depleted stocks, and cause the least adverse impact to subsistence users. NMFS must use the best scientific information available in implementing the MMPA goals.

d. One of several management tools for recovering and maintaining the CI beluga whale stock is regulation of subsistence harvest, as authorized by the MMPA. NMFS also recognizes there are other potential impacts to the population. NMFS will continue to perform contaminant and disease analysis, and gather basic biological information. NMFS will develop a Conservation Plan on the CI beluga whales. NMFS also takes appropriate actions to protect habitat under the Fish and Wildlife Coordination Act and other Federal laws.

e. NMFS acknowledges that science and traditional knowledge contribute to the understanding of the CI beluga whales. NMFS will continue to confer with co-managers to insure both systems of knowledge are considered in the management

---

[3]Refer to Part IV, section g. on page 7.

[4]Presently, NMFS has been able to fund annual surveys in Cook Inlet and this funding is available through FY 2005. Funding for 2006 and beyond is not guaranteed at this time.

of the CI beluga whales.

f. The harvest levels (Table 1) were modeled under the following assumptions:

i) If the population is growing, harvest should delay the recovery of the CI beluga whale population to OSP by no more than 25 percent, with 95 percent certainty, when compared to time-to-recovery with zero harvest.

ii) It is desirable to provide for an allowable harvest for Native subsistence needs, including situations where the population is not growing or is declining.

iii) If the five year average population size is less than 260 animals, no harvest should occur. The lower limit of the estimated five year average population size for which a harvest would be allowed (260 animals) is set to insure that there is less than a 5 percent likelihood that a harvest is taken from a population of 200 or fewer beluga whales, with a breeding population of 60 females. The value of 260 was determined from the 95th percentile (rounded up to the largest 10) of the distribution of five year average abundance estimates, assuming that the estimates were drawn from a normal distribution with abundance projected backwards from 200 with Rmax chosen from a uniform random distribution between 0.00 and -0.06 and CV chosen at random from the estimated CV's of the most recent eight abundance estimates (1996-2003).

The projection model is written algebraically as:

$$N_{t+1} = (N_t\text{-}H_t)(1+(R_{max})(1-((N_t\text{-}H_t)/K)^z))$$

With:

Abundance (N_t) is calculated from the previous year;
Harvest (H_t) is drawn from Table 1 for the five year interval and each subsequent five year interval;
Growth rate (R_{max}) is drawn from a uniform distribution between 2 percent (0.02) and 6 percent (0.06) per year, for the years subsequent to the initial year of the five year interval;
and fixed values for other parameters (K =1,300 and Z =2.39).

NMFS considered three possible scenarios for the CI beluga whale population when determining the harvest levels:

Scenario 1: the population increases

Scenario 2: the population neither increases nor decreases

Scenario 3: the population decreases

With an increasing recovery rate (Scenario 1), these harvest levels allow a recovery to 780 animals with a 95 percent certainty that recovery would not be delayed more than 25 percent. However, the 25/95 goal would require a zero harvest under Scenarios 2 and 3. NMFS must balance the recovery of the CI beluga whale with the demonstrated needs of the Alaska Native community. Consequently, NMFS proposes to set minimum harvest levels which provide continued harvest opportunity, even with a declining stock (or low abundance), and recovery of this stock. No harvest will be allowed at population sizes below the numbers at which loss of an individual is thought to represent an irreplaceable loss to the population.

While considering these scenarios, NMFS acknowledges that:

i) as stated in Part IV, section b. a minimum of an 8-10 year time series of abundance estimates are required to distinguish among these three scenarios.

ii) even under Scenario 1, catastrophic short term events, longer periods of limited growth, a moderate decline in CI beluga whales, may occur that are unrelated to harvest

iii) research and management efforts will continue on other potential natural and anthropogenic impacts on this population which may result in changes in the growth rate of this population

iv) continuity of cultural practices (within Alaska Native subsistence communities), even at a minimum level, has intrinsic value to these communities

v) for the purpose of estimating the delay caused by alternative harvest strategies, NMFS used values of 1,300 and 780 for carrying capacity (K) and Maximum Net Productivity Level, respectively.

g. The Unusual Mortality Limit (Table 1) threshold (6 percent of the population average) represents the 95th percentile of the distribution of observed mortalities in the years 1999-2003. During that period an average of 13.8 mortalities (standard deviation = 3.7) occurred each year. The 95th percentile of this distribution occurs at 21.7 which is 6 percent of 359 (the weighed average population size of the CI beluga whales during those years). NMFS believes this is a reasonable index of excessive mortality, and that the 95th percentile represents a high probability that an event significantly greater than the typical level of mortality has occurred. The Unusual Mortality Limits (Table 1) are calculated by taking 6 percent times the median of each five year population range.

h. Recorded mortalities within the population are beach cast carcasses and carcasses found floating, reported to either NMFS or observed by NMFS personnel. Almost all reported dead beluga whales included in the totals were confirmed by NMFS personnel. Whales were measured and biological samples were taken. From dead beluga whales, biological samples include a lower jaw for ageing which positively marks whales that have been sampled. In a small number of cases, stranded beluga whales were reported by reliable sources that gave good descriptions and locations and confirmation that the whale had not been previously sampled by NMFS; these mortalities were also included in the total.

i. The abundance level below which this plan would prohibit harvests (260 whales) was set to insure that there would be a low likelihood of harvesting from a population of 200 or fewer animals. A population of 200 represents a point where the approximate *effective* population size may be as few as 60 beluga whales. That is, at a level of 200 animals, as few as 60 reproductively active females may be in the population. In determining this population size limit, NMFS considered 1) an Allee effect, 2) inbreeding depression, 3) loss of genetic variability, 4) vulnerability to environmental perturbations due to reduced range, 5) vulnerability to environmental perturbations due to reduced population size, and 6) vulnerability to demographic stochasticity due to reduced population size. Discussion of each is given below. From this review NMFS has concluded that maintaining a significant effective population size is the key issue and that 200 beluga whales represent a threshold below which irreversible changes may occur in the population and recommends that no harvest be allowed below this level.

1) Allee effect: The Allee effect has been defined as the impact of reduced social interactions and loss of mating opportunities in a small population. NMFS has considered this factor and concluded that this is not a relevant concern because the CI beluga whale population typically is distributed among a few large groups. Although these groups are smaller on average than in the past, they easily fall within the range of typical group sizes observed for this species. Tagging data indicate that whales move between these groups frequently (Hobbs *et al. In review*) so that if the population is reduced, mating opportunities are not reduced more than just by the fewer available individuals in the population. Therefore, it is reasonable for NMFS to conclude that an Allee effect would not act on this population until it was reduced to a point where the apparent group structure, currently observed, breaks down.

2) inbreeding depression: NMFS has based its determination on published scientific information, which indicates that populations with an effective size of a few dozen individuals are usually sufficiently large to avoid most of the deleterious consequences of inbreeding (Lande 1991). NMFS concluded that inbreeding depression would not be a relevant factor until the population dropped below 200 individuals. Population age structure models indicate that a CI beluga whale population of this size would include approximately 60 mature females, which NMFS has used as an approximation for the effective population size.

3) loss of genetic variability: NMFS relies on theoretical work that indicates that during a rapid decline in population size nearly all (i.e., >95 percent) of the

diversity in a population is maintained in an effective population of 10 individuals, and more than 99 percent of the diversity in a population is maintained in an effective population of 50 individuals (Ralls *et al.* 1983). In the case of CI beluga whales, the effective population size was assumed to be approximately equivalent to the number of mature females in the population: N (population) x X (fraction of females in population) x X (fraction mature) or if the population size is 200, 200 x 0.5 x 0.6 = 60. Thus, losses in genetic diversity in the current population are considered by NMFS to be insignificant, at least at the time scale over which management is concerned (i.e., decades). Losses in genetic diversity will occur if this population remains small for many generations. The rate of loss depends on the effective population size and is estimated to be approximately 0.8 percent per generation in an effective population of 60 (or an actual population of 200) (Meffe *et al.* 1997). Based upon the values used in the projection model, NMFS anticipates that this population will likely recover to a population of more than 780 individuals within 30 to 50 years, or approximately 3 to 5 generations. Thus, loss of genetic diversity during recovery is likely to be less than 4 percent. Loss of genetic diversity does not pose a significant risk to this population over the next few decades or until it is reduced to fewer than 200 animals.

4) <u>vulnerability to environmental perturbations due to reduced range</u>: A reduced population could result in further contraction of the range of the population resulting in increased vulnerability to small scale perturbations within that range. Although results from aerial surveys indicate a contraction in range during the summer months (Rugh *et al.* 2000), tagging and survey results indicate that individual beluga whales at other times of the year continue to use much of the range observed in aerial surveys in the 1970's (Hobbs *et al. In review*, Rugh *et al. In review*). As noted above, the CI beluga whales tend to be distributed in a few large groups. Although the sizes of these groups have declined in the period since NMFS began regular surveys, their distribution has not changed substantially. This suggests that this observed group structure is stable over a range of group sizes and that the group sizes would have to be substantially smaller by an unknown amount before a further range reduction would occur. NMFS concludes that significant range reductions resulting in increased vulnerability to small scale perturbations are not likely to occur until the population is substantially smaller than its current size, and further, the changes are likely to be incremental rather than have a threshold. However, this bears continued scrutiny and should be evaluated during the five year harvest reviews.

5) <u>vulnerability to environmental perturbations due to reduced population size</u>: A reduced population may be closer to a threshold such that a catastrophic event which removes a significant fraction of the population could reduce the population to a point where other risks, such as inbreeding depression or an Allee effect, are significant. Few data are available relating current risks to the likely

fraction of the population lost, to estimate the increased risk directly. In the event that the difference between the population size and the suggested thresholds for the small population risks decline, vulnerability to small scale perturbations increases at an unknown rate. A modeling exercise on a typical large whale by Breiwick and DeMaster (1999) which incorporated demographic stochasticity and also incorporated an additional source of variability in the survival rate (a reduction by 10 percent or 20 percent every 10 years) that was termed a "simple form of environmental stochasticity" concluded that 1) the most important pieces of information that determine the fate of populations at low levels are the initial population level and the intrinsic rate of increase, 2) environmental stochasticity is likely to be a more important factor in population growth for whales at reduced levels than demographic stochasiticity, and 3) it is not possible to set a population level below which additional aboriginal hunting should not be allowed, without quantitative information on the magnitude and frequency at which environmental stochasticity is causing survival rates (and/or reproductive rates) to decrease. These results were for a harvest rate 8 to 12 times higher than the level NMFS is proposing and reviewed every 100 years rather than every five years. This suggests that although any harvest results in an increased risk, it is incremental and fairly small at the levels NMFS is considering. However, because the risk is unknown and has the potential to force the population below 200 animals, this bears continued scrutiny and should be reviewed during the five year harvest reviews.

6) <u>vulnerability to demographic stochasticity due to reduced population size</u>: It is unlikely that this is a significant issue for populations larger than 200 whales. See statements under 5) from Breiwick and DeMaster (1999).

Literature Cited

Breiwick, J.M. and D.P. DeMaster. 1999. Exploratory type 3 fishery simulations. Unpublished Manuscript, document of the Scientific Committee, International Whaling Commission. SC/51/AWMP8.

Hobbs, R.C., K. L. Laidre, B. A. Mahoney, D. J. Vos, M. Eagleton. *In Review*. Movements and area use of beluga, *Delphinapterus leucas*, in Cook Inlet, Alaska

Lande, R. 1991. Applications of genetics to management and conservation of cetaceans. Pp. 301-311, (ed. A.R. Hoelzel), in Genetic Ecology of Whales and Dolphins. Report of the International Whaling Commission, Special Issue 13.

Meffe, G.K., Carroll, C.R., and Contributors. 1997. Principles of conservation biology. 2nd Ed. Sunderland, MA. Sinauer Associates. 729p.

Ralls, K., J. Ballou and R. L. Brownell, Jr. 1983. Genetic diversity in California sea otters: Theoretical considerations and management implications. Biol. Conserv. 25:209-232.

Rugh, D.J., K.E.W. Shelden, and B.A. Mahoney. 2000. Distribution of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska, during June/July 1993-2000. Mar. Fish. Rev. 63(3):6-21.

Rugh, D.J., B.A. Mahoney, and B. K. Smith. *In Review*. Aerial surveys of belugas in Cook Inlet, Alaska between June 2001 and June 2002.

Technical Notes for NMFS Harvest Plan April 26, 2004

Within the harvest plan there are several statements that are based on population modeling and analysis. The intent here is to describe these analyses in sufficient detail that a person knowledgeable in population modeling and computer programming could repeat the results or determine if the methods were indeed valid. Note that several of the definitions below are not original to this document, but were developed by the Technical Committee or earlier. I have included them here for completeness.

<u>Population Projection Model</u>

Except where noted otherwise, all population modeling was done using a population projection model written algebraically as:

$$N_{y+1} = (N_y\text{-}H_y)[1\text{+}(R_{max})(1\text{-}[(N_y\text{-}H_y)/K]^z)]$$

With:

Abundance (N_y) is the number of beluga in the population at the beginning of year y and N_0 is the population size at the beginning of the initial year of a harvest policy.
Harvest (H_y) is the number of whales harvested in year y as determined from a harvest rule;
Maximum Growth rate (R_{max}) is the rate at which the population grows when N is small;
and fixed values for other parameters (K =1,300 and Z =2.39).

<u>Definitions</u>

Year of Recovery: For a depleted population the year of recovery for harvest policy P, Y_{rP} , is the first year that the size of the population N is greater than or equal to 780.

Time to Recovery: The time to recovery in years for a population under harvest policy P is: $T_{rP} = (Y_{rP} -1)+ [780\text{-}N(Y_{rP} -1)]/[N(Y_{rP})\text{-}N(Y_{rP} -1)]$

Delay in Recovery: The percent delay in recovery attributed to harvest policy P, D_P for a population is calculated as: $D_P = [(T_{rP} - T_{r0})/ T_{r0}] \text{ X } 100$, where P = 0 is defined as the zero harvest policy for the same population.

25/95 Criterion: A harvest rule meets the 25/95 criterion for a range of initial population sizes (N_{0Min} , N_{0Max}) if for any initial population size (N_0) drawn from a uniform random distribution covering the range, U(N_{0Min} , N_{0Max}), and Rmax drawn from a uniform random distribution between 0.02 and 0.06, U(0.02, 0.06), and constant during the period of recovery, delay in recovery will be less than or equal to 25% with probability not less than 95%.

Increasing Population: has an R_{max} greater than or equal to 0.02, with the archetype increasing $R_{max} = 0.04$

Stable Population: has an R_{max} greater than –0.02 and less than 0.02, with the archetype increasing $R_{max} = 0.0$

Declining Population: has an R_{max} less than or equal to -0.02, with the archetype declining $R_{max} = -0.04$

<u>Statements in Harvest Plan</u>

Lower Limit for harvest, N = 260

The determination of harvest level for a 5 year period is based on an arithmetic average of abundance estimates for the previous 5 year period. NMFS has determined that a population size of 200 represents a point at which the removal of even one animal would represent an irreplaceable loss to the population. Consequently a limit for the 5 year average abundance somewhat greater than 200 was required to insure that there is a less than 5% likelihood that a harvest is taken from a population of 200 or fewer beluga whales.

The value of 260 was determined from the 95th percentile (257, rounded up to the next largest multiple of 10) of the distribution of 10,000 draws of five year average abundance estimates. Each of these were the average of 5 annual abundance estimates drawn from a normal distribution with the mean, an abundance projected backwards from 200 as $N_y = 200\,(1+R_{max})^y$ for y = -5, -4, -3, -2, -1, and CV chosen at random from the CV's of the CIB abundance estimates from 1996 to 2003 (0.28, 0.14, 0.29, 0.14, 0.23, 0.087, 0.12, 0.107). Each population projection was based on an R_{max} chosen from a uniform random distribution between 0.00 and -0.06. The calculations were done in an EXCEL[1] spreadsheet.

The trend is determined as the growth rate multiplier in a log-linear regression of the abundance estimates for the previous 10 years. If the growth rate multiplier is significantly greater than 1 at the 95 % level the trend is considered to be increasing, if the growth rate multiplier is significantly less than 1 at the 95 % level the trend is considered to be decreasing, and otherwise the population is considered to have no trend.

To determine the time frame necessary to distinguishing among the three types of trends, simulations were run using the population projection model above with zero harvest and N_0 set to 350 for the two archetypes, $R_{max} = 0.04$ for an increasing population and $R_{max} = -0.04$ for a declining population. A time series of abundance estimates was generated by drawing the estimate at random from a normal distribution with mean as the abundance from the model at that time step and a CV for each year drawn at random from the CV's of the CIB abundance estimates from 1996 to 2003 (0.28, 0.14, 0.29, 0.14, 0.23, 0.087,

---

[1] Use of trademarks or product names does not imply endorsement by the US Government

0.12, 0.107). The population was projected forward 10 years creating time series of 11 years total. Log-linear regression was applied to sub sets of these times series for lengths ranging from 2 to 11 years for each simulation to estimate the observed growth rate by length of series. This process was repeated 10000 times for each archetype and the resulting sets of growth rates by series length were examined to determine at which time series length, 95% of the growth rates were greater than zero in the case of $R_{max} = 0.04$ and less than zero in the case of $R_{max} = -0.04$. In both cases the 95th percentile fell closest to 10 years, consequently 10 years was adopted as the time period for estimating trend. The calculations were done in an EXCEL spreadsheet.

Table of five year strike limits by population size and observed trend

The strike limits were determined using a computer program which simulated populations starting in each range with the prescribed trend and different trial harvest values until a suite of values were found which met the 25/95 criterion for each range. Harvest for five year periods with $N_{average} < 260$ was set to zero and $260 < N_{average} < 300$ limited to a maximum of 5 in 5 years. Trial harvest values were constrained to be nonincreasing from the highest to lowest population size class and from increasing growth trend to declining growth trend. Harvest levels were fit starting with the box for increasing trend and N_0 between 700 and 780 and proceeded down through the population sizes in the increasing trend column then completing the no trend column and finally the declining trend column. The harvest level currently in each box was tested as follows:

1) The current harvest level was checked to determine if it met the nonincreasing criterion and that the harvest levels for smaller population sizes and lower trends met the criterion. Any harvest level that didn't meet the criterion was reset lower to meet the criterion.
2) The harvest level, after any nonincreasing criterion adjustment, was tested using 10000 simulations with N_0 drawn from a uniform distribution spanning the population size range and an R_{max} drawn from a range determined by the trend.
3) The harvest limit was changed downward by one whale in 5 years if it failed to meet the 25/95 criterion. If it met the 25/95 criterion then one whale in 5 years was added and the new harvest level was tested and retained if it met the 25/95 criterion and the nonincreasing criterion.
4) The fitting routine then moved to the next box in the testing sequence.

Each of the test simulations proceeded through the following steps:

1) A value for N_0 was chosen at random from a uniform distribution spanning the range for the box being tested. An R_{max} for the period prior to year zero was drawn from a uniform random distribution between 0.02 and 0.06, 0.02 and -0.02, and -0.02 and -0.10 for the increasing, stable and declining trends respectively. An R_{max} for the period after the initial year was drawn at random from a uniform distribution between 0.02 and 0.06.
2) The population was then projected forward 100 years with no harvest using the posterior Rmax to determine the time to recovery with no harvest using year = 0 as the starting point.

3) A value for N_{-10} for the harvested population was determined using a bisecting routine with an initial range of 0 to $2N_0$, harvest in this range was set to the value for N_{-5} with the appropriate trend after the initial trial. A value for N_{-10} was accepted if the resulting projected N_0 was less than 0.1 different from the randomly chosen N_0.
4) The projection of the population with harvest began with year = -10 and projected forward to year = 100. An abundance estimate was drawn for each year from a normal distribution with mean N_y and a CV drawn at random from the CV's of the CIB abundance estimates from 1996 to 2003 (0.28, 0.14, 0.29, 0.14, 0.23, 0.087, 0.12, 0.107). Every 5th year starting with year = 1 the arithmetic average of the abundance estimates was computed from the previous 5 years (year-5 to year-1), and a log-linear regression of the abundance vs. year over the previous 10 years (year-10 to year-1). The growth rate estimated by the regression was compared to 0 and an F-statistic computed to determine if it was significant. If the growth rate was significant and greater than zero the population was considered to be increasing if significant and less than zero, declining, other wise stable. Using the trend and average abundance the harvest for that year and the following 4 years (year to year +4) was found in the table and the annual harvest was set to the value divided by 5.
5) The year of recovery was determined and the delay in recovery computed as above.

This process was repeated 10000 times to test each harvest value. If more than 500 of the simulations had delays longer than 25% then the harvest was considered to have failed to meet the criterion. Each test used a new random seed drawn from the computer clock, so the same value that passed the test with one seed might fail on the next. The test is essentially a bionomial process with standard error of 0.002 so even a harvest level with a true failure probability of 0.048 for individual trials has a 1 in 6 chance of failing to meet the 25/95 criterion for a particular test.

Each box was affected by the boxes above and below it so it was necessary to iterate several passes through the table before the harvest levels would converge to consistent levels. These levels would continue to change from one iteration of the table to the next. The total changes between iterations were summed and when a table had 9 or fewer changes from the previous iteration it was saved to the output with the estimated probability for each box. After 100 of these potential harvest lists were collected they were examined and the one with the high average failure rates for individual trials and no failure rate greater than 0.05 was used for the table.

The potential harvest tables were generated by a FORTRAN 90 program, the comparison among the potential harvest tables was done in an EXCEL spreadsheet.

Excess Mortality Level

The derivation of the excess mortality level is adequately explained in the harvest plan. It is included here to note that excess mortalities were not considered in setting the harvest tables.