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Harp Seal Review Meeting

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Jake Rice, Chairperson

Canadian Stock Assessment Secretariat
200 Kent, Ottawa
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ABSTRACT

A meeting of the National Marine Mammal Review Committee was held 11-12 April 2000 in Ottawa and included representatives from the industry, federal government scientists and fisheries managers, academics, and invited experts from the international science community. The purpose of the meeting was to provide peer review of the 1999 harp seal survey, recent hunt statistics, information on unreported sources of seal mortality, some new developments in analytical methods, and estimates of total population, in order to assess status of the Northwest Atlantic harp seal population.

RÉSUMÉ

Le comité national de revue des mammifères marins s'est réuni à Ottawa les 11 et 12 avril 2000 et a accueilli des représentants de l'industrie, des scientifiques et gestionnaires du gouvernement fédéral, des chercheurs universitaires ainsi que des experts de la communauté scientifique internationale. L'objectif de cette réunion était de procéder à une revue par des pairs des résultats de relevés du phoque du Groenland de 1999, des statistiques récentes sur la chasse, de l'information sur les prises non-déclarées sur la mortalité des phoques, de développement en méthodes analytiques, des estimés de la population totale, dans le but d'évaluer l'état de la population de phoque du Groenland de l'Atlantique Nord-ouest.

OPENING REMARKS

The chairman welcomed participants (Annex 1). The meeting terms of reference (Annex 2) and agenda (Annex 3) were reviewed and adopted. Participants established the order in which the working papers would be presented. The list of documents reviewed at the meeting is provided in Annex 4.

REVIEW OF WORKING PAPERS

Day 1 Discussions

1. Preliminary estimates of Harp seal by-catch in the Newfoundland lumpfish fishery. By D. Walsh, B. Sjare and G.B. Stenson. NMMRC WP 1.

Presenter: Becky Sjare
Rapporteur: Mike Hammill

Summary:

The incidental by-catch of marine mammal species in fishing gear is a worldwide phenomenon of major conservation concern. The waters of Newfoundland have been intensively fished and the by-catch of marine mammals is thought to be substantial; however, little effort has gone into quantifying the magnitude of the take. What information is available focuses primarily on entrapments of large cetaceans and seals are under-reported or not reported at all. This working paper presents preliminary estimates of the number of harp seals taken as by-catch in the Newfoundland lumpfish gill net fishery from 1979-1998. Estimates are based on reported landings of lumpfish roe obtained from DFO Statistic Branch and on data from 1989-1998 obtained through a marine mammal by-catch logbook program. From the start of the commercial fishery in 1968 until 1984 the by-catch of harp seals remained below 10,000 animals. During the next three years it increased dramatically to a high of approximately 30,000 seals in 1987 and then dropped sharply to just below 3,000 by 1990. It then increased again to a high of approximately 36,000 seals in 1994 and then dropped to 17,000 in 1995 where it has remained. Estimates of the number of harp seals taken during the lumpfish gill net fishery provide a long term view of by-catch as a source of mortality for harp seals; previously our knowledge for this species was extremely limited both from a temporal and geographical perspective. These new estimates also provide the basis for future by-catch work and population modelling initiatives.

Discussions:

There was a general discussion on general lumpfish biology and it pertains to the fishery (i.e. only females taken for roe); the length of the fishing season (approximately April - early June); and some general details on how gillnets are set and hauled.

A number of possible biases and limitations in the data obtained from the logbook program were reviewed and discussed.

Questions were raised about the commitment of participating fishermen to the program and data quality they provided. Fishermen participated on a voluntary basis, although they did receive an honorarium. Given the amount of work involved in keeping the logbook, it was evident participants had a genuine interest in the project and several remained in the program for several years. Until recently (limited resources) each fisherman was visited in part to ensure that information was being taken consistently. Given DFO personnel do not monitor the fisherman's activities on the water, the over-all success of the program is dependent on the ethics of the participants. However, there have been no major problems to date in this regard. There was a question regarding whether captures by fishermen that have participated in the program over a long period differed from catches of newer participants. This information is available and will be looked at in the future. Based on the above discussion it was suggested that the objectives of the logbook program be re-examined. If the primary goal is to produce unbiased estimates of by-catch for the harp seal model, then perhaps fishermen should be rotated through the program. However, if it were more important to address specific concerns related to the seal by-catch then keeping fishermen involved in the program for longer periods of time would be more important.

Also, data on drop out rates by fishermen were not available. There was a suggestion that a drop off in catch rates coincided with the appearance of seals in the area, possibly beaters pursuing lumpfish.

Other types of data gaps and data limitations in both the historical roe landings and the logbook data were also noted.

The consequences of the lack of any province-wide estimate of fishing effort in the industry were discussed. This limitation necessitated the use of roe landing as an indicator of fishing effort; although this approach is not the preferred one, in the case of the lumpfish fishery, it is the only option.

Discussion noted the limited knowledge concerning the current and historical stock status of lumpfish. Biomass estimates for the fishery are poorly documented so it is difficult to assess roe landings in an ecological context.

Potential problems associated with the low number of fishermen in the program on an annual basis were considered. The number of participants depended on the human and financial resources available. Effort has been made to ensure that there is adequate coverage of major lump fishing areas. Overall, the coverage is good along the south coast, variable on the West Coast, and poor on the North East Coast. Only small boat fisherman were included in analyses presented here; sampling does not cover the sector using boats >35 feet which account for 10-20% of the fishery. Roe landings for these larger vessels are available and it may be possible to estimate by-catch in the future.

Given that the lumpfish gillnet fishery is only one source of by-catch there were questions addressing the relevance of focusing only this species. Since 1990, catches of lumpfish from other in-shore gear sectors have been insignificant due to fishery closures and the cod moratorium in 1992. By-catch of seals in the off-shore by the various trawl fisheries is not well documented and should be examined in the future; however, it is likely catches in this gear sector also declined during the 1990s.

Several points of clarification regarding how missing data and gaps in the historical records of roe landings and seal by-catch were estimated and/or addressed were made. During years from 1989-1998 when there were no data on the numbers of seals taken as by-catch for a region, it was assumed that the catch would be best represented by the mean of catches from the other two regions (i.e. South Coast, West Coast and Northeast Coast). For years prior to logbook program the number of seals caught/tonne of landed roe in each region was assumed to be the median value for the period 1989-1998. In the future these data should be re-examined to decide what is the most appropriate index to use such as the annual median, 3 or 5 year medians.

It was suggested that some of the between fisherman variability be examined, in terms of seals per ton of roe caught. It was recognized that there are many factors that can influence captures including ice conditions, which will affect net placement and also inshore movements of seals.

2. Estimating struck and loss rates for harp seals in the Northwest Atlantic. By B. Sjare and G.B. Stenson. NMMRC WP 2.

Presenter: Becky Sjare
Rapporteur: Mike Hammill

Summary:

One of the major sources of unreported mortality during the commercial harp seal hunt in the Northwest Atlantic is the number of animals killed or fatally wounded and not recovered by hunters (i.e. seals that are struck and lost). With the significant expansion of the hunt both in Canada and in Greenland during the mid 1990s, there is a concern that unreported mortalities of harp seals struck and lost may have reached a level that, when added to reported catches, is not sustainable from a long-term management perspective. To address this problem a study on the number of seals struck and lost during the annual Canadian hunt was initiated. The results summarized in this working paper are based on observations collected by the Marine Mammal Section, DFO and the Sea Watch Observer Program in 1998 and 1999. In general, overall loss rates for "ragged jackets" and beaters taken on the ice varied from 0-2.0% and from 3.2-10.0% when taken in the water. Older seals aged 1+ had loss rates of approximately 1.3-11.1% when taken on ice and rates of 13.8-50.0% when taken in the water. Sample sizes were limited (especially for seals taken in the water) and there was only partial coverage of the hunt. However, these data provide current estimates of struck and loss rates and has been incorporated into the current harp seal population model.

Discussions:

Good data on the number of seals struck and lost in the Northwest Atlantic are limited. Loss rates are influenced by habitat conditions (shot in the water vs. on ice), season, hunter skill and local weather conditions. All of these factors contribute to the highly variable loss rates documented in literature.

The blubber layer of a harp seal varies significantly on a seasonal basis – the fatter the seal the better it will float when killed. The issue of using an index of fatness to estimate sinking rates was raised and it was noted that Winters examined this in 1999 at the NMMPRC meeting. The results were reviewed there and it was concluded the analysis is difficult to apply to actual estimates of sinking rates. However, the rates estimated by Winters were not inconsistent with the rates used currently in the population model.

Hunting of beaters at the Front is directed towards animals on the ice and therefore, over all loss rates are very low. When animals are shot in the water, often a small boat accompanies the larger boat to retrieve animals; animals are recovered using gaffs.

Looking at fatness, it was suggested to apply a logistic model to model floating versus sinking. It was suggested that putting the data into a larger table separating out season, habitat and age would aid in following the different struck and loss rates applied. Given the type of variability involved, it is difficult to simply apply a mean for struck and lost rate under all conditions. It may be more advisable to stratify more, taking into account age, location and habitat.

Given that seal hunting techniques vary from one geographic region another, its not surprising that estimates of struck and loss vary significantly as well. In Greenland, the loss rates of full time hunters are thought to be low, but the loss rates of part-time hunters are unknown. The Greenland hunt is directed towards animals in the water, not on the ice.

There was considerable discussion on the potential influence fisheries observers may have had on the hunting practices of the sealing crew. This is always a concern particularly when trying to

collect information on a sensitive issue. It was reported that the observers in this program interacted with the crew as much as possible, collected biological samples and did not over-emphasize that they were also noting struck and loss. In general, all sealers were co-operative and understood the importance of documenting the number of seals struck and lost. In addition, the results obtained by the fisheries observers were consistent with information collected by DFO personnel over the years. The group accepted that direct observation of hunting activities is still the best practical way to collect information on loss rates, and agreed that there is no evidence that the presence of observers had a major influence on the quality and accuracy of struck and loss data collected.

In the model, 5% has been used for young of the year during the Canadian hunt and 50% has been used for seals one year of age and older during the southern Canadian hunt and for all seals in the Canadian Arctic and Greenland. The meeting concluded these values were suitable for use in the population model.

3. Catch-at-age of Northwest Atlantic Harp Seals, 1952-1999. By G.B. Stenson, B.P. Healey, B. Sjare and D. Wakeham. NMMRC WP 3.

Presenter: Garry Stenson
Rapporteur: Mike Hammill

Summary:

Information on catch levels and the age structure of the catch (catch-at-age) is necessary for accurate population estimation and responsible management of the harp seal (*Phoca groenlandica*) in the Northwest Atlantic. Harp seals are hunted off southern Labrador and the northeast coast of Newfoundland ('the Front'), in the Gulf of St. Lawrence ('the Gulf'), along west and southeast Greenland, and the eastern Canadian Arctic. This report summarizes available harp seal catch and catch-at-age statistics from 1952 to 1999 for each of these areas. Between 1952 and 1971, catches taken at the Front and Gulf averaged in excess of 288,000 seals. Between the introduction of quotas in 1972 and the demise of the large vessel hunt in 1982, an average of 165,000 seals were taken annually. Catches decreased after 1982 and remained low, averaging approximately 52,000, until 1995. Annual catches again increased to over 240,000 between 1996 and 1999. Prior to 1980, catches in Greenland were consistently less than 20,000 animals. Data collected since 1980 suggest that Greenland catch increased steadily until 1996, declined slightly in 1997 but increased again in 1998 to approximately 89,000. Based on the first nine months of 1999, catches have continued to increase to over 100,000 harp seals. Limited data are available from the Canadian Arctic; however, current catch levels are assumed to be relatively small (<5,000). The age composition of catches at the Front and in the Gulf were estimated based on reported numbers of pups taken and biological sampling of seals one year of age and older (1+) taken from the commercial harvest and research samples. Estimates of the age composition of seals harvested in Greenland were obtained from biological samples collected in West Greenland between 1970 and 1993. The use of this age structure to represent the ages of seals taken in the current Greenland harvest is consistent with lengths obtained during recent sampling in Greenland.

Discussion:

The discussion reviewed a number of points about the record of catches. Catches were very high during the 1950's. The introduction of catch quotas in 1970 reduced catch levels. Changes in reporting methods have led to revisions to estimates of Greenland catches. Because these catches are based on a logbook collection program, there may be as much as a 1-2 year delay until the catch data are updated. The current estimates for 1999 are based on catches up to September 1999. The age structure of the Greenland hunt consists of a higher proportion of older animals. Kapel provided some age structure data. These data suggest a change in the age structure of the harvest towards older animals since the early 1980s. It was noted that this change in age composition is consistent with an increase in the proportion of older animals reported by the

hunters. The age structure in the length frequency data as a metric of age obtained from recent sampling is consistent with the age structure used in recent years.

It was reported that there are limited data on catches from the Arctic. The Nunavut Wildlife Board is conducting a harvest study that should provide estimates of recent catches. A request has been made for these data but they are not available yet. Also, technical reports by Smith and Taylor, and work by Haller may provide more insight into historical harvest statistics.

It was also confirmed that reported catches in the Front and Gulf are cross-checked against reports by Fisheries Officers and sales receipts. The author stated that catches obtained during the large vessel hunt are probably quite accurate, whereas catch reports obtained from the small boats may be less accurate. However, in recent years there have been increased efforts to confirm the catch reports.

It was not clear how the adult struck and loss rate estimates were applied in these catch estimates. It was argued that using the reciprocal of these rates may underestimate the correction factor that needs to be applied bump up the catches to total kill from the hunt.

4. Recent estimates of reproductive rates for harp seals in the Northwest Atlantic. By B. Sjare and G.B. Stenson. NMMRC WP 4.

Presenter: Becky Sjare
Rapporteur: Bob Mohn

Summary:

The pregnancy rate and mean age of sexual maturity of harp seals (*Phoca groenlandicus*) are two important reproductive parameters with respect to the management of this species in the Northwest Atlantic. They may be useful indices of population change, and in addition, pregnancy rate data are incorporated into the current harp seal population model. This working paper provides new data on these parameters and describes our general reproductive sampling protocol. Estimates of the total number of harp seals in the Northwest Atlantic declined from approximately 3.0 million in the 1950s to 1.8 million in the early 1970s and then increased to 5.2 million in 1998. During this period, pregnancy rates increased from 85.5% in the 1950s to a high of 95.2% in the mid 1960s and declined to approximately 70.9% by in the early and mid 1990s. The mean age of sexual maturity decreased from 5.8 years in the mid 1950s to 4.6 in the early 1980s and then increased to 5.6 years by the late 1990s. Given the population dynamics of the harp seals, these changes in pregnancy rates and mean age of sexual maturity are consistent with a density dependent response. However, coinciding with the increase in seal abundance in recent years, there have also been significant changes in oceanographic conditions in the Northwest Atlantic that may have influenced the availability of prey species.

Discussion:

It was noted that analyses distinguished between maturity (having ovulated) and pregnancy (carrying a late fetus) rates.

With regard to a question about CV's (Coefficient of Variation) for pregnancy rate's, it was reported that earlier work by Warren (Warren et al 1997) calculated them.

A question was posed about potential changes in sampling of pregnancy rates over time, specifically, distribution of samples between Fall and winter and on-ice versus in the water from small boat hunt. Checks on area differences found that the estimates were consistent. It was agreed that many sorts of bias could enter from seasonal and annual differences. However, when

possible, the same collectors have been used for long periods, and they have used the same collecting methods through their participation.

It was asked if it was possible to estimate miscarriage and inter-uterine mortality rates? These rates may be inferred from ovulation rates, which did vary slightly over time:

1981-84 - ~95%
1985-90 - ~80%
1992-95 - 90%

It was suggested that the mean age of first reproduction may be calculated using primiparous animals.

It is also possible to look at the age of primiparous females, and these data were reviewed earlier.

5. Predicting pregnancy rates for Northwest Atlantic harp seals (*Phoca groenlandica*). By B.P. Healey, N.G. Cadigan and G.B. Stenson. NMMRC WP 5.

Presenter: Brian Healey
Rapporteur: Bob Mohn

Summary:

Reliable estimates of annual-at-age pregnancy rates are required to estimate the population size of Northwest Atlantic harp seals (*Phoca groenlandica*). Reproductive data has been collected in 25 years between 1954 and 1997. However, the data are highly variable, and significant gaps in sampling occur. To remove some of this variability, we use a non-parametric regression estimator (with Gaussian weight function) to predict expected pregnancy rates from the sample data. In order to predict the annual-at-age pregnancy rates for seals over the entire period, and to extrapolate the pregnancy rates to 1998 and 1999, we smooth the observed rates and bridge the sampling gaps for years with no sampling by applying kernel smoothing, selecting the bandwidths for smoothing using the generalized cross-validation statistic.

Discussion:

There were several concerns expressed about the results presented in the working paper. The working paper describes a method to obtain a smooth set of rates that responds better to variation in sample sizes than the chi-square analysis used previously (Warren et al. 1997) to fill in data gaps. However, the non-parametric approach seems to fit peaks earlier than chi-square method and earlier than the peaks seem to appear in the raw data.

It was noted that the chi-square method resulted in similar groupings when used backward in time. The non-parametric method is independent of direction.

There was concern that the fit of the non-parametric method for age 5 does not pass through the data; changes in rates occur before the data suggest; nor are the estimates for the youngest age responding as expected in Figure 2. In general it would be expected that interpolator would smooth over data gaps but because the pregnancy rates for 5 year olds increased after the gap, the shift in timing resulted in a peak occurring during the sampling gaps.

In response to a question about the use of bootstrapping, it was confirmed that the smoothed rates had been bootstrapped.

In response to question regarding availability of condition data to explain the low rates in the 70s, it was reported that few data are available to allow that point to be investigated. With regard to a questions about aging errors biasing the estimates of pregnancy rates at age, it was reported that

the same ager has been used since the 80s and that studies done in the early 1980s suggest that aging is pretty good up to age 7.

It was suggested that the smoothing method be re-examined to determine if there was an explanation for the disparity between the changes observed in the data vs. the smoothed rates. Additional suggestions as to possible treatments of the gaps in the pregnancy rate data included:

- Putting the overall mean into the data gaps.
- Fit the data in two pieces and then arbitrarily fill the gap with either a linear trend or the midpoint between the end of the early series and the beginning of the later series.

6. 1999 pup production of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. By G.B. Stenson, M.O. Hammill, J.F. Gosselin and B. Sjare. NMMRC WP 6.

Presenter: Mike Hammill
Rapporteur: Bob Mohn

Summary:

To determine current pup production of Northwest Atlantic harp seals, aerial surveys of the whelping (pupping) concentrations off southern Labrador and/or eastern Newfoundland ("Front") and in the northern and southern Gulf of St. Lawrence ("Gulf") were conducted during March 1999. A total of 5 concentrations were located, 2 at the Front, one in the northern Gulf and 2 closely spaced groups in the southern Gulf. The northern concentrations were located near traditional areas while the southern Gulf group formed up on suitable ice in the traditional areas but drifted southward towards Prince Edward Island where they coalesced prior to the survey. Photographic surveys were conducted on all concentrations between 14 and 24 March while a visual survey was made of the southern Gulf concentrations on 14 March. Photographic counts were corrected for misidentified pups by comparing multiple readings of photographs made by two or more readers. Survey estimates were also corrected for pups absent from the ice at the time of the survey using the occurrence of distinct age-related developmental stages. Multiple estimates were available for two of the whelping concentrations. Pup production was estimated to be 739,100 (SE=96,300) at the Front, 82,600 (SE=22,500) in the northern Gulf and 176,200 (SE=25,400) in the southern Gulf (Magdalen Island) for a total of 997,900 (SE=102,100).

Discussion:

In response to several questions about details of survey method, a number of points were made. The combinations of visual and photographic surveys were both based on systematic sampling designs. Multiple planes and helicopters were used to try and cover entire patch in a single day. Multiple readings of individual photos were compared and any differences were resolved by consensus. It was easy to discriminate between pups and adults. This led to correction factors for each reader/patch. For 5 of 6 readers, the intercept of the regression for the correction factor was not significantly different from zero and so the regression was fit through the origin; for the 6th reader the intercept was significantly different from zero and so a standard linear regression was used.

In response to a question about the possibility of seals being hidden by ice clumps, it was reported that usually surveyors walk the ice and get a feeling for it but this year there was not any opportunity to see what might be under the ice. However, in normal years relatively few pups are hidden. Also, in Newfoundland, the ice was fairly flat (not rafted) in 1999. No correction was used for unseen animals.

In explaining the correction process for animals not yet born, it was noted that the estimation procedure uses 7 stages and models transitions. Often the proportion of pups in each stage is obtained by walking on the ice. However, due to poor ice conditions most of the staging was

carried out from low flying helicopters in 1999. Generally, pupping seemed to have been completed in all concentrations prior to the surveys and no correction was added. It was reported that corrections for pups not born at the time of the survey were estimated using the model developed by Myers and used during the 1990 and 1994 surveys. This model indicated that a very small correction should be applied to the estimates from the Front and Northern Gulf. The larger correction should be applied to the southern Gulf estimates. However, the southern Gulf data did not fit the model well, perhaps because of aggregation of pups of similar age or changes in the stage duration. It was also suggested that pulses of pupping in southern Gulf could explain the problem of lack of fit of the Myers' correction method. The lack of fit observed with the southern gulf data may also have been the result of the mixing of two groups with different timings. This would confound the stage transitions.

With regard to question of how these compare to previous estimates, it was reported that pupping appeared to have been similar in terms of timing. However, the surveys were carried out slightly later in 1999 than previously, at a time when pupping was expected to have been completed.
With regard to a question about the impact of melding of separate patches, it was noted that this would confound the stage transitions, and the southern Gulf patches did merge between the 4th and 20th of March.

Following discussion of use of the Myers' model corrections for pups not yet born, it was agreed that the meeting did not have sufficient information to determine if the corrections were justified. Also, the necessary data and programs to rerun the analyses were not available, and the fits of the existing analyses were poor. It was also noted that the corrections would increase the estimate by only 1.5%, with main effect in southern Gulf.

Among the alternatives of:

Option 1 - Use corrections from the Myers' model and weight them with their CVs.

Option 2 - Use the uncorrected pup production and add text for probable effect and direction.

The meeting preferred the 2nd option.

Photographs for this survey were of suitable quality (but there were UV camera problems) and the same quality as 1994 but there were no ground verifications

Day 1 adjourned at 16h00. The chairman asked that Mohn, Stenson, and Healey spend additional time, throughout the rest of the afternoon and evening, working on the prediction of pregnancy rates model e.g. smoothing. Also, Sjare was asked to start drafting a list of items to be presented to the press.

Day 2 Discussions

7. Estimating pup production and population size of the Northwest Atlantic harp seal (*Phoca groenlandica*). By B.P. Healey and G.B. Stenson. NMMRC WP 7.

Presenter: G. Stenson
Rapporteur: S. Innes

Summary:

Pup production and population size of the Northwest Atlantic harp seal (*Phoca groenlandica*) for the period 1960 to 2000 were estimated using independent survey estimates of pup production, annual estimates of pregnancy rates, and age-structured removals. Removals included reported catch, estimated by-catch and assumed levels of seals killed but not landed (struck and lost). These data were fit to a two-parameter age structured population model that allows for different assumptions of pup mortality. The parameters estimated in the model are the pup selection parameter (*s*) and unaccounted mortality (*m*). The impact of assuming that the mortality of young seals (age class 0) was greater than that of seals one year of age and older (1+) was illustrated by using a fixed multiple (γ) to increase age class 0 mortality of *m* for older (1+) seals. Replacement and sustainable yields were estimated under differing assumptions of the age structure of the harvest. The uncertainty associated with the estimates was determined by randomly re-sampling from within the sampling error of the available pup production estimates and reproductive rates.

Assuming that the unreported mortality of age class 0 seals is 3 times that of 1+ animals, and including uncertainty in the pup production and reproductive data, the total population was estimated to be approximately 5.44 million, with a 95% confidence interval of 4.31 to 6.57 million seals in 2000. Assuming different levels of gamma changes the estimates slightly, but the differences were not significant. The population was estimated to have increased from the early 1970s until 1996. Since then the population has been relatively stable, growing at a rate of less than 1% per year. Using the current age structure of the removals (~70% young of the year), the 2000 replacement harvest was estimated to be approximately 557,000 with 95% confidence interval (C.I.) 383,000, to 732,000. Assuming that the levels of by-catch and the Greenland harvest remain at the 1999 level used in the model, and accounting for struck and loss, the corresponding replacement level of seals that can be landed in southern Canada is 281,000; (95% C.I.: 151,000, to 412,000). This level would be reduced slightly if the proportion of young in the harvest decreases.

Discussion:

The second author provided an overview of the paper, highlighting the points which follow. Assessments are projections of a model that summarizes information about the number of pups from surveys, reproduction and catches. Based upon the pup production survey estimate from 1994, the total population was estimated to be approximately 4.8 million under the assumption of constant mortality for all age groups and 4.5 million if mortality of seals during the first year is assumed to be 3 times that of older seals. Replacement yields were estimated to be in the order of 280,000 – 300,000 under the constant mortality assumption. Since the assessment was completed in 1995, historical estimates of catches in Greenland were revised and both the Canadian and Greenland catches increased. The model was updated last year based on the new catch data and information about struck and lost seals. The researchers examined the impact of various assumptions on the relative mortality rate of pup harp seals relative to harp seals which are 1 year or older. Pup production estimates were reviewed and only seven were deemed comparable. Two levels of population productivity were investigated. Replacement yield represents the catch that holds the population constant between 2000 and 2001, and sustainable yield, which represents the catch for which the projected populations in 2010 and 2020 are equal. However, this model had made assumptions about the size of the Greenland catch and

incorporated a summary of fertilities that have been discussed previously and to which some alternatives were presented.

Revised estimates of recent Greenland catches were provided during the meeting and it was **agreed** that they should be included into the model. These were 1997 – 76,736, 1998- 89,147, and 1999- 103,707 seals. The 1999 catch is an estimate based upon reported catches during the first 9 months of the year. Catches since 1996 have been adjusted for unreported catches based on earlier estimates. Catches in Greenland appear to have been affected by changes in the ecosystem; harp seal catches have increased in the southwestern area which used to have a cod fishery. In recent years this fishery has declined while capelin and seals have increased in the area. The seals are used for local meat and the pelts are sold under subsidy.

Discussion then moved on to the relative mortality rate of 0 aged harp seals in comparison to seals that are 1 or older. The working paper used three possible factors – mortality was equal across all age classes, and mortality of the 0 age class was 3 times or 5 times the other seals mortality rate. It was noted that the three times factor has a slightly better fit to the data, but differences in fit among the three options were not large. Discussion also occurred about the assumption that mortality was constant across all years covered by the model. Other forms of information that might be correlated with mortality were advanced (condition factors, ice conditions). This portion of the discussion lead to a research recommendation. Unfortunately, the model does not have a sufficient number of surveys (degrees of freedom) to estimate more than one mortality rate (i.e. M_{adult}). It was **agreed** that a mortality rate for 0 aged seals which is three times that of adults should be used in the present assessment. The decision was based on mammalian life histories, but that there is little information to support this for this stock of harp seals.

Adjustments to the 1999 aerial survey estimates for the number of pups not yet born were reviewed and it was confirmed that no adjustment should be used until there is further support provided. This also lead to a research recommendation. It was also agreed that any adjustment would be small in relation to other areas of uncertainty.

Summary Discussions of Model Formulation:

The group was then tasked to come to agreement on three areas necessary to selecting the parameters used in the model. These were:

1. the smoothing method to provide as summary of the reproductive rates of female seals
2. the magnitude of the struck and loss adjustment , and
3. the surveys which are used in the model.

Smoothing

The three alternative methods of smoothing the reproductive data were discussed. These included the non-parametric smoothing method outlined in WP-05, the ci-square method described in Warren *et al*. 1997, and a LOESS method provided by B. Mohn. It was **agreed** that the method in WP-05 was less preferable to the other two, but that it had provided the basis for fruitful discussion. Discussion then centered on the characteristics of LOESS soothing and particularly in the region near the ends of the data set, and what assumptions were necessary to project it forward into 1997 through 1999.

The Warren *et al*. (1997) method was then discussed in relation to the LOWESS and its own merits. There is a need to review the subjectivity clauses used in this method and the outcome of their use. The estimates used assume a ‘step’ in the reproductive rates in cases where there is a change in fertility rates on either side of a gap in the data. It was confirmed that the steps within the data were robust, but that the use of a ‘step’ was arbitrarily chosen to move from the lower fertility rate to higher rate observed in the data.

It was **concluded** that the assessment model using the Warren *et al*. (1997) summary of fertility data was preferred by most participants, but that the subjectivity clauses should be reviewed.

Struck and Loss

A summary of two years of new struck and loss data from portion of the hunt were presented in WP-02. It was discussed whether these were sufficient to alter the summary agreed to in 1999 (NMMRC 1999). It was **agreed** that these new data did not change the conclusions agreed to at the previous meeting and therefore the levels of struck and loss recommended in 1999 should be retained. These levels are:

- The loss rate for young of the year seals killed in southern Canadian waters prior to the end of the large vessel hunt in 1993 is assumed to be 1%.
- The loss rate for young of the year seals killed in southern Canadian waters since 1982 is assumed to be 5%.
- The loss rate for seals one year of age and older taken in southern Canadian waters and all seals taken in Greenland or The Canadian Arctic is assumed to be 50%.

Surveys used in analysis

The available data on surveys and other estimates were reviewed and the reasons for the selection of the seven pup production estimates used in the model runs discussed. These were the only available estimates that were complete (with confidence intervals) for all areas that could be attributed to a single year and the group agreed they should be the ones used for population estimations.

Finally, it was re-confirmed that the Warren et al (1997) method would be used for estimated.
Age specific pregnancy rates; the revised Greenland catch data would be used, and the bycatch estimates from the first working paper would be included explicitly in the removals.

General discussion, review and approval of conclusions & advice

Rapporteur: B. Sjare

Research Recommendations

Catch statistics from Arctic are needed.

Further work on the model for fitting birthing distributions, including good diagnostics, user friendly interfaces and, ability to make comparison with existing models are required.

Better ways of counting pups on photos – image analysis; using UV in tandem are needed.
- some discussion of overall survey costs; use of CCG ships;
- new digital and/or video methodology would ensure that results would be done faster and could allow more surveys, and these should be explored.

Development of these new techniques will require some time, so work should start right now, even if a survey is not planned for next year.

Better information on reproductive statistics is also needed. Part of the concern is based on the fact that different trends are appearing in Canada and Greenland. Some participants flet strongly that there may geographic and temporal trends in that need to be address. It was agreed that more samples, and stressed that it is necessary to make sure that sampling occurs at the right time of the year; late term pregnancy rates are needed.

There was agreement that frequency of sampling needs to be reviewed. There were differences of opinion on whether it is better to sample heavily in one year and let the rest go or continue to take annual samples. Among the viewpoints expressed were those:
- Annual rates are net needed; better estimates spaced a few years apart would be more useful.
- If we had better data we wouldn't need to smooth.
- Well spaced sampling is important if we want unbiased estimates of pregnancy rates.
- We do have a sampling target but we can't always do it, and that creates problems.
- Annual estimates are particularly important for years of the survey.
- Representative geographic coverage is essential for any sampling program.

Struck and lost rates very important, particularly new estimates in Greenland. This area needs more work.

There was a discussion of whether more information on by-catches was a priority. It was noted that we have a commitment as a Department to get better information on by-catch.
It was noted that we need something to put the data back to the historic time series, and not much effort information is available for inshore fisheries. Better bycatch are not essential from seal population dynamics perspective but may need such data to address other concerns.
It was suggested that improving bycatch information could be approached through an inshore monitoring program. Most participants agreed this is a good idea to follow up on.

Discussion on Media Bullets

Most points were **agreed** to quickly and are reflected in the revised bullets.

There was some discussion on what is the best in terms of a definition – killed or struck. The group **agreed** to go with struck because it is 'universally' known.

There was some discussion on the fact that the total removals should not just be reported without giving the breakdown of Canadian catch. The public is familiar with seeing "catch" data not include some of the factors we have included in "removals" (struck-an-lost, by-catches, catches in the North), and may misinterpret the current numbers relative to numbers reported in the past.

It was agreed that we would not discuss explicitly hypotheses for why the pregnancy rates are low. Rather, we would deal with questions on a case by case basis

Presentation of New Model Runs

The group requested plots or tables matching results in the new handouts with the original base run.

It was agreed that the overall pattern was the same as concluded last year: the seal population reached a minimum in 1970s, increased steadily to 1995 and then leveled off. The main comment for a media bullet should describe the general population trend.

With regard to what to say something about pup production three questions should be discussed –

- a statement about the comparison between the survey pup estimate and the model estimate,
- a statement about the current pup estimates and past estimates
- a statement about the increasing pup production but a stable total population

With regard to commenting on the match between the model estimate in 1999 and the survey estimate, it was agreed that we need to report the 1999 pup production from the survey.

There was substantial discussion on whether or not the 1994 and 1999 estimates should be compared. The problem for public understanding is that pup production has increased but we don't see an increase in the population. Do we need to provide some explanation?

It was agreed that the explanation for the apparent contradiction was implicit in the three questions above, and that wording clarifying the point would be added into bullets.

With regard to how to address replacement yield, it was quickly agreed to break it down in the same way as in past assessments.

It was agreed that all working papers except the smoothing paper (WP #5) be submitted as CSAS Research Documents.

CLOSING REMARKS

The chairman thanked all participants for their contribution to the meeting. It was noted that participants would receive copies of the papers presented at the meeting after they are published in the Canadian Stock Assessment Secretariat Research Document Series. The meeting adjourned at 16h00 on 12 April 2000.

Annex 1. Participants List

Participant	Region / Sector	E-mail
BOWEN, Don	DFO Maritimes / Science	bowend@dfo-mpo.gc.ca
CAMPBELL, Scott	DFO Newfoundland / Science	campbells@ dfo-mpo.gc.ca
GOSSELIN, Jean-François	DFO Laurentian / Science	gosselinj@ dfo-mpo.gc.ca
COISH, Ches	Sealer - Hillgrade, Newfoundland	
HAMEL, Joanne	DFO NCR / Science	hamelj@ dfo-mpo.gc.ca
HAMMILL, Mike	DFO Laurentian / Science	hammillm@ dfo-mpo.gc.ca
HEALEY, Brian	DFO Newfoundland / Science	healeybp@ dfo-mpo.gc.ca
INNES, Stu	DFO Central & Arctic / Science	inness@ dfo-mpo.gc.ca
JONES, Ken	DFO NCR / Fisheries Management	jonesk@ dfo-mpo.gc.ca
KINGSLEY, Michael	Greenland Institute of Natural Resources	mcsk@natur.gl
LAVIGNE, David	International Marine Mammal Association	Dlavigne@imma.org
MACLAREN, Ian	Dalhousie University, Halifax, NS	Iamclar@is.dal.ca
MELLANO, Grace	DFO NCR / Fisheries Management	mellanog@ dfo-mpo.gc.ca
MOHN, Robert	DFO Maritimes / Science	mohnr@ dfo-mpo.gc.ca
PENTON, Aiden	Sealer – Joe Batt's Arm, Newfoundland	
POWLES, Howard	DFO NCR / Science	powlesh@ dfo-mpo.gc.ca
RICE, Jake	DFO NCR / Science	ricej@ dfo-mpo.gc.ca
ROSING-ASVID, Aqqalu	Greenland National Marine Mammal Laboratory	Arosing-asvid@zi.ku.dk
SJARE, Becky	DFO Newfoundland / Science	sjareb@ dfo-mpo.gc.ca
STENSON, Garry	DFO Newfoundland / Science	stensong@ dfo-mpo.gc.ca
WARING, Gordon	Northeast Fisheries Science Center, Woods Hole, MA, USA	gwaring@whsun1.wh.whoi.edu
WOODMAN, Fred	Fisheries Resource Conservation Council (FRCC)	woodmanf@ dfo-mpo.gc.ca
YORK, Anne	National Marine Mammal Laboratory, Seattle, USA	anne.york@noaa.gov

Annex 2. Terms of reference

TERMS OF REFERENCE
HARP SEAL PEER REVIEW MEETING
April 11-12, 2000 – Ottawa

1. Review results of harp seal surveys conducted in 1999, and provide from the survey data, as fully as they allow, estimates of population size and demographic parameters, including associated uncertainties

2. Review information on the 1999 harp seal hunt, including any new information on quota compliance, struck-and-lost, Greenland and Arctic harvest, etc.

3. Review any new developments in modeling or analysis of harp seal population status or dynamics in the Northwest Atlantic

4. Using results of 1-3, provide estimates (including, to the fullest extent possible, associated uncertainties) for:

    a) Current status of harp seals in the Northwest Atlantic;
    b) Recent harp seal pup production in the Northwest Atlantic;
    c) Updated trajectories for harp seal populations in the Northwest Atlantic over the past 20 years
    d) Updated estimates of replacement yield, including, if appropriate, yield options for different age compositions of the harvest.

5. Provide the basis for a Stock Status Report on Harp Seals in the Northwest Atlantic.

Annex 3. Proposed agenda

National Marine Mammal Review Committee Harp Seal Assessment Meeting
11-12 April 2000, 200 Kent Street, room 4E001, Ottawa, ON

DAY 1 - 11 April
09:00 - Opening remarks and introductions
09:10 - Review and adoption of agenda
09:15 - Review of working papers
10:15 - Break
10:30 - Review of working papers (continued)
12:00 - Lunch
13:00 - Review of working papers (continued)
15:00 - Break
15:15 - Review of working papers (continued)
17:00 - Adjourn

DAY 2 - 12 April
09:00 - Review of working papers (concluded)
10:15 - Break
10:30 - General discussion of conclusions & advice
12:00 - Lunch
13:00 - Review & approval of conclusions and advice
15:00 - Break
15:15 - Next steps – research recommendations, etc.
16:30 - Adjourn

Annex 4. List of Working Papers

Working papers presented at the National Marine Mammal Review Committee Harp Seal Review Meeting, 11-12 April 2000, Ottawa, ON.

Healey, B.P., N.G. Cadigan and G.B. Stenson. Predicting pregnancy rates for Northwest Atlantic harp seals (*Phoca groenlandica).* NMMRC WP 5.

Healey, B.P. and G.B. Stenson. Estimating pup production and population size of the Northwest Atlantic harp seal (*Phoca groenlandica*). NMMRC WP 7.

Sjare, B. and G.B. Stenson. Estimating struck and loss rates for harp seals in the Northwest Atlantic. NMMRC WP 2.

Sjare, B. and G.B. Stenson. Recent estimates of reproductive rates for harp seals in the Northwest Atlantic, NMMRC WP 4.

Stenson, G.B., B.P. Healey, B. Sjare and D. Wakeham. Catch-at-age of Northwest Atlantic Harp Seals, 1952-1999. NMMRC WP 3.

Stenson, G.B., M.O. Hammill, J.F. Gosselin and B. Sjare. 1999 pup production of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. NMMRC WP 6.

Walsh, D., B. Sjare and G.B. Stenson. Preliminary estimates of Harp seal by-catch in the Newfoundland lumpfish fishery. NMMRC WP 1.