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Proceedings of a Maritimes Regional Advisory Process Meeting on NAFO Subarea 3 – 6 Porbeagle Shark

11 – 12 April 2001
Ron Trites Boardroom
Bedford Institute of Oceanography

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FOREWORD

These Proceedings are a record of the RAP meeting which was held during 11 - 12 April 2001. The report records as faithfully as possible the contributions and discussion that transpired at the meeting. However, the individual interpretations and opinions expressed at the meeting are not necessarily or in all cases scientifically sustainable or supported by other participants. The discussion summaries document the deliberations, which led to the tabled proposals. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement has been reached.

AVANT – PROPOS

Le présent compte rendu relate les travaux de la réunion du PCR tenue du 11 au 12 avril 2001. Il reflète aussi fidèlement que possible les contributions et discussions des participants à la réunion. Toutefois, les opinions et interprétations individuelles qui y sont présentées ne sont pas nécessairement ou toujours soutenables sur le plan scientifique, ou appuyées par les autres participants. Le résumé des discussions documente les délibérations ayant abouti aux propositions déposées. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

TABLE OF CONTENTS

ABSTRACT

A RAP meeting to review the status of NAFO Subarea 3 – 6 porbeagle shark was held during 11 – 12 April 2001 at the Bedford Institute of Oceanography. The discussion a produced Stock Status Report for use in management for the 2001 fishing year. Recommendations were also made to improve future assessments.

RÉSUMÉ

Une réunion du PCR a eu lieu à l'Institut océanographique de Bedford les 11 et 12 avril 2001 pour examiner l'état des stocks de requin des sous-zones 3 à 6 de l'OPANO. Les discussions ont abouti à la production d'un Rapport sur l'état des stocks, qui servira à la gestion de l'année de pêche 2001. Des recommandations visant à améliorer les évaluations futures ont également été présentées.

INTRODUCTION

The chair, R. O'Boyle, opened the meeting by greeting the participants (Appendix 1) and inviting them to introduce themselves. The meeting letter of invitation is presented in Appendix 2.

The last assessment of the porbeagle resource was in November 1999. The current assessment is a significant upgrade of that assessment, with much new information added to the analysis. The remit of the meeting is given in Appendix 3. It was expected that the meeting would last the full two days scheduled.

It was asked of the fishery manager present when the Stock Status Report was required, to which it was replied as soon as possible. Participants were informed that until the Stock Status Report had been made public, they were to consider the discussion of the meeting confidential.

R. O'Boyle outlined how the meeting would be conducted. For the Proceedings, a rapporteur was assigned for each section of the SSR (i.e. biology, the fishery, resource status and outlook). The senior author would present the results of the analysis, during which questions of clarification only would be addressed. Following this, the external reviewers would be asked to provide comment, after which the floor would be opened to general discussion. These reviewers had been sent the working paper prior to the meeting. The external reviewers were R. Claytor and C. Fu. Comments of the latter are provided in Appendix 4.

After points of clarification, the meeting commenced.

REVIEW OF NAFO SUBAREA 3 – 6 PORBEAGLE SHARK ASSESSMENT

Working Paper: Campana, S., L. Marks, W. Joyce, and S. Harley. 2001. Analytical Assessment of the Porbeagle Shark (Lamna nasus) Population in the Northwest Atlantic, with Estimates of Long-term Sustainable Yield. RAP Working Paper 2001/33.

Biology

Rapporteur: W. Joyce

For Fig. 1, it was suggested to try alternate growth curves (i.e. young sharks both sexes combined) due to uncertainty of ageing above 15-17 years.

In regards to Fig. 2 of the working paper, the question was raised of how good the raw data fit the model. The information was very good and reliable and based on > 700 observations and 2 reports submitted by colleagues in the U. S.

A number of questions were raised about the reproductive biology of the porbeagle (Fig. 3), with the responses being:

- there is no evidence of sperm storage occurring
- the pupping grounds remain unknown at this point
- mating grounds appear to be off southern Newfoundland
- evidence of mating scars were seen on large females in early fall, supporting the early fall mating period
- porbeagles pup every year and have on average 3-4 pups
- the data suggests they would have to reproduce every year to sustain the population.

These points were supported by data presented in the working paper.

It was questioned if available tagging information supported latency of females. The tagging studies showed no signs of latency, and thus porbeagle doesn't appear to show signs of a latency period.

The question remains as to where the large females go after mating. They may move offshore and appear to go back to Georges Bank (no signs of large females caught in the Japanese tuna fishery). It may be that very large females are unavailable to the gear (unable to be caught by the gear) and were not included in the sample size because of this.

A reconstructed diet by size composition was discussed and proposed (Fig. 5). Science and Industry would like to see if daily consumption of the porbeagle could be determined.

The point was made that there was more sampling coverage of the offshore fleet, mostly due to the length of time the offshore vessels are at sea compared to smaller inshore vessels.

The depth and temperature that porbeagle prefer was discussed. Study of this is in progress. As well, it was questioned what the relationship between surface temperature and catch was. This is also under study.

The Fishery

Rapporteur: P. Hurley

There were questions on the effort trends provided in Table 8, particularly the increases in inshore effort in 1996 and again in 1999, and the decrease in 2000. The increase in 1996 was a result of exploratory licenses issued in the inshore sector in 1996. It was suggested that the increase in 1999 was a result of the Joint Project Agreement (JPA), but no other explanation was proposed. The decrease in 2000 was a result of the largest boat in the sector directing for other species in that year.

There was some discussion of landings reported in Table 2, particularly of the 2t of porbeagle by-catch landed from the swordfish fishery in 2000. Troy Atkinson was to confirm that landings from that fishery had been higher and provide numbers and CFVs if possible. There was also a comment that the porbeagle landings for the Gulf by inshore vessels seemed to be low in some years.

There was some discussion of by-catch levels reported in Table 4a and how and where the gear was fished and in particular that groundfish by-catch levels were so low. It was stated that there was no by-catch of sea turtles.

During discussion of Figure 6, it was pointed out that panels A and B were bottom depth, not gear depth, and reflected differences in the distribution of the fishery in spring and fall. The temperatures in panel C are mid-gear depths, not bottom temperatures and were obtained from direct observation using temperature recorders. Mid-gear temperatures used in Figure 7 were obtained from the MEDS database. There was a question with regard to zero values in Figure 7. It was noted that a zero value indicated that there was a temperature observation but no associated catch data.

There was the observation that the length frequencies in all panels in Figure 10 were bimodal. While Figure 10 presents data from two years combined, the bimodality can be seen clearly in Figure 11. It was suggested that the reduced numbers at 120cm in all panels in Figure 11 may be an artifact of the interdorsal length to fork length conversion. There were comments that the March 2000 inshore size composition was not the usual case. The large inshore vessel that did not participate in the 2000 fishery would usually catch large fish. There was some discussion of the implications of the trends in percent females >175cm in Figure 12. It was suggested that some further insight into differences in life history and migration dynamics could be gained by plotting the sexes separately in Figure 10, 11 and 13. It was also suggested that size composition data from the limited U.S. directed porbeagle fishery might provide some insight.

There was no discussion of management history.

Resource Status and Outlook

Rapporteur: M. Showell

Trends in Length Composition

Decreases in median fork length for fish from the NF-Gulf area were seen over time, indicating an increased exploitation rate for recent years. However, it was noted that the length did not change substantially from 1960 to 1980, suggesting little or no recovery in spite of a greatly reduced fishery. This may be due to small sample sizes for these years or differences in gear between the two periods. The suggestion was made that error bars would be useful to depict uncertainty associated with each years estimate. The group noted that a decreasing trend was still evident even if the 1960's and 1980 point were excluded.

Commercial Catch Rates

An increase in catch rate for the inshore fleet relative to the offshore was noted for recent years. This is probably related to the proportion of immature fish in the catches, as the trends were similar for mature sharks between the two fleets. It was noted that several vessels from the inshore fleet had fished in the same area (termed 'midshore' fleet) as the offshore fleet, and that a breakdown of catch rates to compare large and small vessels fishing in the same area might be useful. It was subsequently shown that catch rate trends for this 'midshore fleet' showed the same trend as for the offshore fleet.

A standardized catch rate for mature and immature porbeagles was developed using a GLM with subarea, month, vessel license, and year as factors. While not presented, standard regression diagnostics were reviewed and supported the assumptions underlying the methodology. Some interaction terms were noted, but did not affect the results. It was noted that a table of reference factors would be useful for the presentation and to allow the analysis to be repeated.

The standardized catch rate for mature fish increased from 1989 to 1992, with this increase was attributed to leaning by the industry over this period. Catch rates for mature fish have dropped subsequently, and recent estimates are amongst the lowest in the time series. The standardized catch rate for immature fish is also low, but has remained roughly stable since 1996.

The observation was made that the R^2 from the analysis was relatively low at 0.32 and 0.17 for the mature and immature sharks respectively, suggesting other factors not included in the analysis might be important.

Natural and Total Mortality from Catch Curves

Catch curves (ln-transformed numbers at age) were used to calculate total mortality rate, with a growth model applied to the length composition by sex along with an age length probability distribution generated from vertebral data.

Total mortality rates for the most recent years are considerably higher than those seen in 1961, and may represent an underestimate due to the reduced abundance of young sharks in recent years. Assuming Z = M for a lightly fished population, M was estimated to be 0.15 and 0.2 for mature males and females respectively, based on the 1961 catch curves.

It was pointed out that biases might be present in the results, as the standing stock was much different in the 1960's compared to the present. However, in contrast to groundfish, pulses of recruitment are not seen for this species, so this is possibly less of a problem. Nevertheless, the results should be interpreted with caution, especially for the earlier period.

Paloheimo Z's

Total mortality rate for recent years was estimated using Paloheimo Z methodology. Mortality estimates ranged between 0.27 and 0.37, with a mean of 0.32. A negative value for the Z estimate between 1998 and 1999 was judged to be an artifact resulting from a lack of sampling early in 1998 and was not considered reliable. It was noted that the data used in this method was the same as that used in the catch curve analysis, and for consistency and comparison ranges in ages used for the calculations should be the same between the two methods.

Petersen Tag

The exploitation rate for the porbeagle population for recent years was estimated from tag recapture information using the Petersen method. Exploitation estimated ranged from 4 to 12%, with a mean of 8%, with no trend across years. However, concern was expressed that tag-reporting rates by the Canadian industry may have decreased in recent years. If true, exploitation rate would be an underestimate of the true situation. It was suggested that a sensitivity analysis estimating exploitation levels for a range of tag reporting rates would be helpful. This was done and while the results were sensitive to tag return rates, as expected, the overall conclusions were the same. Further, the relatively small numbers of recaptures was questioned as possibly inadequate to draw conclusions. It was noted that this was only one piece of information, to be considered in the context of other estimates. A suggestion was made that a table of tag releases/returns would provide appreciation of amount of data on which conclusions are based, and should be included in the research document.

Yield per Recruit

Yield per recruit was calculated from length-weight, growth, natural mortality estimates, and area specific selectivity curves from the fitted population model. From this analysis, $F_{0.1}$ was estimated to be 0.18. Long term changes in median fork length for catches in the commercial

fishery were presented as a proxy for exploitation. Based on this, fishing mortality appeared to be less than $F_{0.1}$ during the 1980's, but increased subsequently to about the $F_{0.1}$ value. It was noted that this method assumes a steady state in the population numbers, in which case recent estimates of fishing mortality may be an underestimate. Further, average size of fish in the catch may also be a function of market conditions or fishery restrictions. For these reasons mean observed weight in the catch was not considered to be a useful indicator of exploitation rate.

Age & Sex Structured Population Model

An age and sex-structured population dynamics model was developed to estimate current population status relative to earlier years, using available catch at length, CPUE, growth and reproductive characteristics. Several formulations of the model were investigated, with variations in natural mortality, recruitment, and selectivity. Two model formulations (Base and Run 5) were judged to represent reasonable reconstructions of the population, with each estimating current fishing mortality to be at about 0.26, with a biomass 10-20% that of a virgin population.

It was felt that there could be more confidence in the model results for this species, compared to those that might be derived for bony fishes, due to the known rate of reproduction and relatively high survival rate. The model fit was best in the most recent years, as there are no catch data between the 1960's and 1980.

Discussion centred on selectivity options used in the model, and the possibility of large females being present in the population but unavailable to the fishery. The feeding habits of older fish were raised as a possible explanation – if they stopped feeding could this explain absence in the catch? However, there is no evidence to support this from analysis of stomach content data.

It was noted that the selectivity pattern fixed in the base case run was different between males and females for the NF/Gulf area when they should be the same. The suggestion was made that data points be added to the plots showing biomass results from the model, to aid in assessing the degree of fit. The plateau present in the stock/recruitment curve was questioned, given the assumption that each female produces 3.9 pups on an annual basis irrespective of size. In this case, an assumption is made that production will be reduced at very high population levels.

It was noted that the model presented is a work in progress, and that further improvements are likely. The overall results are nevertheless still valid.

Life Table Analysis

Age structured estimates of survival rates, sexual maturation, and fecundity were used in a life table analysis to provide estimates of population productivity. Based on this analysis, an exploitation rate where $F = 0.053$ would not result in a population decline. The intrinsic rate of population growth (r) for this species is about 7%, which is very low compared to

groundfish. It was noted that the F = 0.053 value was close to the Fmsy value of 0.038 from the population model. However, because a selectivity of 1.0 was used, numbers are biased downward – F might be slightly higher at 0.07 rather than 0.053 if the selectivity pattern for all areas is used. The life table analysis was re-run with a combined PR and produced similar results.

Bottom Line

A reasonable estimate of sustainable fishing mortality is 0.05, while estimates of current F around are around 0.2. A sustainable catch level is therefore about ¼ of that currently being harvested. Depending on which model results are selected, total biomass is 3-6 times below MSY.

APPENDICES

Appendix 1. List of Participants

Participants	Affiliation/Address	Telephone	Fax	E-mail
Troy Atkinson	Nova Scotia Swordfishermen Assoc.	(902) 457-4968	(902) 457-4990	Hiliner@ns.sympatico.ca
Ross Claytor	Invertebrates, DFO, BIO	(902) 426-4721	(902) 426-1682	Claytorr@mar.dfo-mpo.gc.ca
Mark Fowler	MFD, DFO, BIO	(902) 426-3529	(902) 426-1506	Fowlerm@mar.dfo-mpo.gc.ca
Caihong Fu	MFD, DFO, BIO	(902) 426-7814	(902) 426-1506	Fuc@mar.dfo-mpo.gc.ca
Patrick Gray	Atlantic Shark Association	(902) 475-1111	(902) 477-0563	
Shelton Harley	Dalhousie University, Halifax	(902) 494-3910		Harley@mathstat.dal.ca
Donny Hart	Atlantic Shark Association	(902) 868-2140	(902) 868-1126	Samfish@netcom.ca
Alain Hébert	DFO, GFC	(506) 851-7792		Hebertal@dof-mpo.gc.ca
Peter Hurley	MDF, DFO, BIO	(902) 426-3520	(902) 426-1506	Hurleyp@mar.dfo-mpo.gc.ca
Brian Johnson	DFA, Newfoundland	(709) 729-3766	(709) 729-1881	Bjohnson@mail.gov.nf.ca
Marc Johnston	NB Agric. Fish. & Aquaculture	(506) 755-4000	(506) 755-4001	Marc.johnston@gov.nb.ca
Warren Joyce	MDF, DFO, BIO	(902) 426-6387	(902) 426-1506	Joycew@mar.dfo-mpo.gc.ca
Martin Karlsen	Karlsen Shipping	(902) 423-7389	(902) 420-9222	Karlsen@ns.sympatico.ca
Wayne LeBlanc	Industry Gulf Nova	(902) 235-2597		Wlolsl@aura.com
Linda Marks	MFD, DFO, BIO	(902) 426-4435	(902) 426-1506	Marksl@mar.dfo-mpo.gc.ca
Bob Mohn	MFD, DFO, BIO	(902) 426-4592	(902) 426-1506	Mohnr@mar.dfo-mpo.gc.ca
Odette Murphy	Res. Mgt., DFO, Dartmouth	(902) 426-9609	(902) 426-9683	Murphyo@mar.dfo-mpo.gc.ca
Robert O'Boyle	RAP, DFO, BIO	(902) 426-3526	(902) 426-5435	Oboyle@mar.dfo-mpo.gc.ca
Bruce Osbourne	NSDF	(902) 424-0352	(902) 424-1766	Osbornbd@gov.ns.ca
Frank Reyno	Atlantic Shark Association	(902) 868-2256		
Eric Roe	Clearwater	(902) 443-0550	(902) 443-8443	Eroe@cffi.com
Mark Showell	MFD, DFO, BIO	(902) 426-3501	(902) 426-1506	Showellm@mar.dfo-mpo.gc.ca
Sean C. Smith	DFO, Science, BIO	(902) 424-6494		Sean_c_smith@yahoo.com
Sid Strowbridge	Deep Sea Trawlers	(902) 634-8049	(902) 634-8463	Sstrowbridge@cffi.com

Appendix 2. Letter of Invitation

Office of the Regional Advisory Process
Bedford Institute of Oceanography
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1-902-426-3526
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30 March 2001

Distribution

Subject: Peer review of Subarea 3 – 6 Porbeagle Shark Assessment

The assessment of the Subarea 3 – 6 porbeagle shark stock will be reviewed in the Ron Trites Boardroom, 4th floor, Van Steenburg Building, BIO during 11 – 12 April 2001. The meeting will start at 09:00 on the 11th and is planned to adjourn at 12:00 on the 12th. I invite you to attend this meeting.

The objectives of the peer review are to examine the scientific approach of the stock assessment, to identify any weaknesses in methodology, to help improve the clarity of the assessment, to identify important questions that may have been neglected, and to make research recommendations. The meeting's terms of reference is attached.

The peer review includes detailed review of the working paper on the stock assessment and draft Stock Status Report. Copies of the working paper will be sent to the scientific reviewers before the meeting to allow them time to become familiar with the material. At the meeting, science staff will provide a brief overview of their assessment, which will include the main conclusions, the supporting evidence, any new methods, and major limitations. The presentation will be followed by comments from the scientific reviewers and then from the participants. A finalised Stock Status Report will be prepared at the meeting. The minutes of the meeting will be published as a proceedings in the CSAS series.

Could you please let me know at your earliest convenience if you will be attending (902 426-7070 or myrav@mar.dfo-mpo.gc.ca).

We greatly appreciate your contribution to this valuable exercise.

Sincerely,

Original Signed by:

Robert O'Boyle

Appendix 3. Meeting Remit

In support of development of the 2002 and beyond Atlantic Pelagic Shark Management Plan, review information on porbeagle shark in NAFO Subareas 3 to 6, including the following:

Biology

- Determine productivity using an age-growth relationship and the latest information on reproductive potential

The Fishery

- Document trends in landings, catch composition and catch rate for as long a time series as possible.

- Provide a description of the temporal and spatial patterns in the fishery, with emphasis of the observed size / sex trends

Resource Status

- Estimate annual trends in productivity and mortality for as long a time series as possible.

- Provide estimates of the variability in the 2000 population size.

Outlook

- Provide biological reference points that can be used to guide the management of the fishery

- For 2002 and beyond, provide annual estimates of allowable yield.

Appendix 4. Comments of C. Fu on Working Paper

The researchers have explored with a great depth the biological aspects of the porbeagle shark, such as stock structure, age, growth, maturation and reproduction, that are critical in order to improve the understanding of the shark stock dynamics. As it is indicated in the paper that the intrinsic rate of population growth for shark is very low compared to most fishes, thus management would have to be very cautious. On the other hand, one prominent feature of the fishery is that selectivity for immature shark (ages 1 to 7) is very high, which makes the population to be more vulnerable to high exploitation rate.

The forward-projection model is helpful in obtaining the estimated index of biomass and female spawners. The estimated low selectivity for mature shark deserves caution, because it induces more optimistic view about the stock status by assuming more mature shark are not captured yet still in the ocean. Now that there is only one stock distributing in two areas, an analysis based on a set of data pooled over two regions is recommended for a comparison. With the pooled data, more reasonable estimation of selectivity curve could be expected. In any case, model estimation with selectivity value of 1.0 for all ages should be investigated, assuming there is not much difference in vulnerability to hooks among all ages. To me this is a more likely case except for the fact that fishers are avoiding large sharks.

As far as I can tell, catchability is not incorporated in this model. Although it can be accounted partially by the selectivity curve for ages not fully recruited, the model implicitly assumes that catchability for fully recruited sharks is 1.0. Consequently, the estimates of biomass from the model are perceived to be an absolute measure of those in the ocean. This may not be true. In addition, the estimation of fishing mortality is related to the assumption on catchability. Thus the uncertainty about this parameter needs to be addressed. I spoke to Bob Mohn, and he agreed with me.

Minor point: Last column of Table 15: Likelihood → - ln(likelihood)

Caihong Fu
MFD, BIO