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Proceedings of the Maritimes Region Science Advisory Process on the Assessment of Spiny Dogfish (*Squalus acanthias*)

14-15 November 2007

Bedford Institute of Oceanography
Dartmouth, Nova Scotia

Tana Worcester
Meeting Chair

Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
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Compte rendu de la réunion du Processus consultatif scientifique de la Région des Maritimes au sujet de l'évaluation de l'aiguillat commun (*Squalus acanthias*)

Les 14 et 15 novembre 2007

Institut océanographique de Bedford
Dartmouth (Nouvelle-Écosse)

Tana Worcester
Présidente de la réunion

Institut océanographique de Bedford
1 Challenger Drive, C. P. 1006
Dartmouth (Nouvelle-Écosse)
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June 2008 | **juin 2008**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

A Maritimes Region Science Advisory Process (SAP) was held 14-15 November 2007, at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, to assess the status of the spiny dogfish (*Squalus acanthias*) in Canadian waters. Participation in this meeting included Fisheries and Oceans Canada (DFO), non-DFO scientists, Nova Scotia Department of Fisheries and Aquaculture, Aboriginal communities, fisheries representatives, and non-governmental organizations. The results of this meeting are expected to inform decisions related to the management of the spiny dogfish fishery in Canada, and to assist in future discussions about the possibility of transboundary assessment with the United States of America.

SOMMAIRE

Une réunion s'est tenue les 14 et 15 novembre 2007, dans le cadre du Processus consultatif scientifique de la Région des Maritimes, à l'Institut océanographique de Bedford. Elle avait pour but d'évaluer l'état du stock d'aiguillat commun (*Squalus acanthias*) des eaux canadiennes. Participaient à cette réunion des représentants de Pêches et Océans Canada, des scientifiques de l'extérieur du MPO, ainsi que des représentants du ministère des Pêches et de l'Aquaculture de la Nouvelle-Écosse, des communautés autochtones, de l'industrie de la pêche et d'organisations non gouvernementales. Les résultats de la réunion devraient pouvoir éclairer les décisions au sujet de la gestion de la pêche de l'aiguillat commun au Canada et contribuer aux futures discussions sur la possibilité d'une évaluation transfrontalière de la ressource avec les États-Unis d'Amérique.

INTRODUCTION

After welcoming participants (Appendix 3) and doing a round of introductions, the Chair of the meeting, T. Worcester, provided a brief introduction to the meeting. She noted that this was first and foremost a science peer-review meeting, which means that the first responsibility of participants was to provide an objective review of the information that would be presented by S. Campana and J. Gibson. To assist in this review, two external reviewers had been invited to attend this meeting: K. Sosebee from the U.S. National Marine Fisheries Service (NMFS) and R. Rulifson from East Carolina University. In addition, the Chair encouraged other DFO Science staff to provide a critical review of the information presented. The Chair noted that there were a number of other participants with expertise and knowledge about spiny dogfish and the dogfish fishery, and she encouraged active participation in the discussion. Secondly, the Chair noted that this was a DFO science advisory meeting, and the final product would be a Science Advisory Report (SAR). While we would work toward majority agreement on the main conclusions of this report, the final product would represent DFO Science advice to Fisheries and Aquaculture Management (FAM). In addition, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) intends to conduct its own assessment of the status of spiny dogfish in the near future. This assessment was deferred, however, until DFO had completed the consolidation and review of a 5-year research program on spiny dogfish (Canadian data). Spiny dogfish is also being considered for listing under the Convention on International Trades in Endangered Species (CITES).

The Terms of Reference for the meeting were reviewed (Appendix 1), including the objectives of this meeting, which were to:

1. Evaluate the degree of association of dogfish in Canadian and US waters:
    - relative proportions in each country, and
    - seasonal migrations.
2. Evaluate human impacts on spiny dogfish in Canadian waters:
    - catch at age by fleet, area, and season,
    - discards and size composition by fleet, area, and season, and
    - mortality and size composition of discarded dogfish.
3. Evaluate abundance and productivity in Canadian waters, including:
    - stock trends and current status (whole population plus mature females),
    - productivity, growth, and longevity,
    - mortality, and
    - preliminary population model.

In order to address these objectives, 3 working papers were prepared. Once accepted, these will be compiled into research documents. This proceedings report is the record of the discussion. A Science Advisory Report (SAR) was also produced out of this meeting (DFO 2007).

The Agenda (Appendix 2) was reviewed, and nothing further was added.

14 November 2007: Day One

REVIEW OF THE STATUS OF SPINY DOGFISH

Review of Stock Structure

Working Paper: Stock structure, migration, and life history of spiny dogfish in Atlantic Canada. RAP Working Paper 2007/28.
Presenter : S. Campana
Rapporteurs: W. Joyce and T. Worcester

Presentation Highlights:

Life-history characteristics and habitat preferences of spiny dogfish were described, including preferred temperature range (6-10ºC), long gestation period (22-24 months), fork length of 50% maturity (55.5 cm at 10 years for males and 72.5 cm at 16 years for females), presence of mature and pregnant females throughout southwest Nova Scotia in summer/fall and movement offshore in winter, presence of mature females in Gulf and Newfoundland (NFLD) waters, number of free embryos (1-14, mode at 5 with large females having more), birth size (22-25 cm), and growth rates (males and females grow at similar rate until males mature). In general, Atlantic spiny dogfish grow faster, but do not live as long as in the Pacific (oldest at 31 years). The Atlantic population is considered to be more productive than the Pacific population.

Information on migration and distribution was also presented. At present, pupping grounds are unknown, but may be located in deep waters off the shelf, in deep basins in the central Scotian Shelf and Georges Bank (juveniles have been collected there), or in United States (U.S.) waters. Spiny dogfish in Canadian waters may include a mix of migratory and non-migratory populations. According to McFarlane and King (2003), 85% stay put, but some migrate long distances. According to Vince (1991), this pattern is not as clear and significant movements have been observed throughout Europe. Analysis of DFO's bottom trawl research vessel (RV) survey, spiny dogfish are coastal in summer but move deeper in spring. Abundance and biomass appear to be greater in spring than in summer, though this may be related to different catchabilities (behaviours) at these times. There also appears to be seasonal changes in size composition, with larger males and females in spring aggregations. This may indicate offshore mating aggregations in spring. Juveniles are caught in greater numbers in summer (high abundance years), which may either mean that their catchability is reduced in spring or they may go into U.S. waters. The summer RV survey catches very few mature females. Dogfish seem to migrate to maintain temperature.

At present, there is no genetic evidence of population structuring from Canadian samples. In addition, most spiny dogfish tagged in Canadian waters are recaptured in Canadian waters (94%), and most spiny dogfish tagged in U.S. waters were recaptured in U.S. waters (90%). However, there is some mixing of tags within the Gulf of Maine (13-20%). There is limited evidence that migration is conducted primarily by large, mature females, but this hypothesis will continue to be explored. In conclusion, it is felt that there is not one well-mixed population with the U.S., but spawning may occur in U.S. waters.

Implications for management are that dogfish in Canadian waters cannot be viewed in isolation, though management measures that treat spiny dogfish in this area as if they were a single, well-mixed group would also be inappropriate. Low levels of mature females should be concern for Canadian managers, even if fishing of this component of the population occurs primarily in U.S. waters.

Questions and Comments:

Industry Comment: Can get a big catch of females one day and then catch only males the next day, so they are separated by sex in schools, but are not far from each other.
Response: Dogfish are likely following feed.

Question: NFLD catch nothing less than 60 cm in winter. Are they moving inshore or up in water column?
Response: In U.S. waters, see large females inshore. Spiny dogfish seem to migrate inshore/offshore very quickly (hours, not weeks).

Industry Comment: All fish that were studied from fish plants were provided by Ocean Pride.

Question: What is the mortality of discards?
Response: Some areas in the offshore seem to have high rates of predation on longlines. This may not be a good pupping area.

Suggestion: Could you investigate spines to look for shifts in the environment of 4T dogfish, which could help to explain movement?

Comment: One fisherman did not agree with the disappearance of dogfish in 4VW, but agreed with most of the other statements that were made.

Question: Would dogfish have been recorded in the Gulf survey?
Response: Yes, but none were recorded.

Question: What extent would you expect to see smaller dogfish in commercial gear?
Response: This issue will be addressed in the next paper.

Review of Fisheries Information

Working Paper: Fishery and abundance information for spiny dogfish in Atlantic Canada. RAP Working Paper 2007/29.
Presenter: S. Campana
Rapporteurs: L. Marks and T. Worcester

Presentation Highlights:

Landings prior to 1977 were dominated by Russia (25,000 mt). From 1977-2000, landings were dominated by U.S. (peak of 27,000 mt). From 2000-2007, Canadian landings dominated (now approximately 2,500 mt).

Large amounts of spiny dogfish have been caught in groundfish trawls, longlines, and gillnet. Large amounts have also been caught in redfish trawls in 4X and 5Y. Average bycatch of spiny dogfish is approximately 2,000-3,000 mt per year recently, but it was up to 10,000 mt in the 1990s. Discard mortality is unknown, but it is estimated to be approximately 850 mt per year since 1986 (i.e., using 25% for otter trawls greater than 200 kg; 0% for otter trawls less than 200 kg; 55% for gillnets; 10% for longlines; and 25% for purse seines). The U.S. uses 50% for otter trawl and 30% for gillnets.

For fisheries catches recorded in 4X from 2002-2006, female total lengths ranged from 46-112 cm with an average of 81 cm, and male total lengths ranges from 36-94 cm with an average of 74 cm. Catch was 66% females, with 26% mature females. Mean age was 18 years for females and 16 years for males.

The Georges Bank RV survey indicates that the abundance of spiny dogfish peaked in 1993 and then declined to low levels. On the Scotian Shelf, the summer RV survey indicated no change in distribution or size composition between 1970-2006, but an increase in abundance since 1984; the spring RV survey indicated no change in distribution, size composition, or abundance from 1979-1984; and the fall RV survey indicated no trend in distribution or size composition from 1978-1984, but an increase in abundance. Based on the halibut longline surveys, there has been a relative increase in abundance since 1998. The redfish surveys conducted on the offshore slope were conducted in October-November, but rarely caught sub-adults. Based on the 4VW cod survey, abundance of spiny dogfish dropped after 1992 to 15% of its previous level. From the 4VsW sentinel survey, which is conducted September-October, relative abundance declined between 1995 and 2005. Based on the 4Vn sentinel survey (conducted in September), relative abundance declined from 1994-2001. Spiny dogfish appeared in the Gulf of St. Lawrence RV survey (conducted in September) in 1984, peaked in 1990s, and have been declining since. There is no trend in spiny dogfish abundance from the NFLD RV survey (conducted in spring) between 1972 and 2005.

Overall, it appears as though spiny dogfish abundance in Canadian waters increased from the 1980s to the 1990s (500,000 mt), and then it declined to present (300,000 mt). Overall, mature female abundance appears to have been about 25,000 mt in the 1980s, with a decline to present. Abundance in the U.S. appears to be about 4 times greater, and a recent upturn in U.S. waters has not been seen in Canadian waters. Overall, biomass of spiny dogfish is very high, but there has been a drop off in mature females.

Questions and Comments:

Someone asked why hook and line and gillnet were more prevalent than other forms of fishing? The response was perhaps these produced better quality fish (better size and freshness), it was part of a tradition, and possibly more sustainable.

Clarification was requested on the source of catches before 1982, e.g., from handline or trawling. S. Campana was not sure. These may have been gillnet catches that were processed on Grand Manan. Some processing was done on Prince Edward Island.

Table 3 was clarified, i.e., a “0” means that only a fraction of landings was caught while a blank means that nothing was caught or reported.

Reviewers appreciated the approach taken to determine discard mortality.

Someone asked whether there are size limits on spiny dogfish in U.S. The response was “no”, but discards are included in the assessment.

Clarification was requested on what was meant by the “relatively high” abundance currently in the summer RV survey. S. Campana noted that this would be relative to the time series; so since 1970.

One participant was surprised by the high variability in the DFO RV survey and felt that this may be representative of local abundance but not of the big picture. It was noted that the DFO RV

survey index is less noisy than the U.S. survey index. This variability is typical of a schooling species.

It was noted that there was a vessel change in the DFO RV survey in 1982. While there is no analysis of possible changes in fishing power between the 2 vessels for dogfish, there is not a big change in the abundance index at that point; though an increase is observed a few years later.

The rationale for the decline on Georges Bank was discussed but not resolved.

It was suggested that the decline in the spring RV survey could be a reflection of bottom temperature changes. However, these two things do not quite match.

It was unclear why there would be points on land, so it was suggested that S. Campana check to make sure the commercial index (halibut) was not included in with survey index. This could also be a result of data aggregation.

In the early years of the Gulf fall survey (using the RV *E.E. Prince*), they may have only fished during the day (1971-1984). This should be checked and adjusted if there are day/night changes in catchability (see Benoît and Swain, 2003).

S. Campana noted that he did not adjust the RV survey results for changes in gear catchability, though there have been difference in the timing and the type of gear used. He felt that these indices provide a ballpark estimate of abundance and are not meant to provide a completely accurate picture.

It was noted that the Scotian Shelf seems to be increasing while 4X and Georges Bank declined. It was also noted that for the 1970s, we only have the summer RV survey as an index of abundance.

It was unclear to participants why there appeared to be a different trend in spring and summer. At first look, the spring survey seemed to be a better index, though the summer RV index may be more of a reflection of juveniles.

Someone asked if one could compare temperature with abundance across regions. The response was that while Gulf and NFLD are included in these abundance estimates, they were only a very small part. S. Campana noted that he had not attempted to relate abundance to environmental parameters. He suggested that this might affect distribution more than abundance determinations.

It was noted that the U.S. summer and fall surveys were only included from 1975, but they go back as far as 1967.

It was noted that a corresponding increase in 4X was not observed during the decline in 4VW.

It was suggested that the Russian landings should be treated with caution. It was also noted that observers in the U.S. reported some “hiding” of catch as dogfish, i.e., fishermen may record non-dogfish catch as dogfish. This could affect the model, and it might impact on early abundance index. These values could be removed from the analysis to see what impact they may have.

Someone asked whether it was possible that spiny dogfish were being under-reported. The response was that this was not likely. This was supported by Ralph Halliday [pers. comm.], who thought the Russian landing statistics were probably as reliable as any for the time period in question.

Clarification was requested on the determination of sex ratio.

Review of Population Model

Working Paper: Population models for spiny dogfish in Atlantic Canada. RAP Working Paper 2007/30.
Presenter: J. Gibson
Rapporteur: T. Worcester

Presentation Highlights:

For the purposes of population modeling, the Canadian population of spiny dogfish is treated as a discreet unit. It is problematic when indices go in different directions. Selecting a starting point for the model can also be problematic. The model used for this assessment adds recruits and subtracts catches. Natural mortality is modeled using exponential decay. Initially, the model was fit to the summer RV survey data, and then data was added from the other RV surveys and longline sentinel surveys. Weighting was not a key issue. Other data source included foreign landings and Canadian landings. Three different productivity regimes were evaluated. The model seems to be very sensitive to the initial population size, and it has a tendency to converge at unrealistically high abundance. It also tends to estimate a value of alpha higher than the fecundity. Effect of migration would depend on whether there was a net migration in some direction and also on the ages that are migrating out of the system. At present, a spawner-recruit relationship is not evident. There are also unrealistic selectivity patterns (may need to separate sexes). The model is not good at predicting many of the survey indices. There are aspects of dogfish biology and the fishery that are not fully captured. However, some patterns do emerge. There is a shift towards exploitation of older age fish more recently. With alpha's less than or equal to 2, the model indicates high exploitation. Young fish are not being targeted. Spawner abundance ranges from 3.5 to 35 million.

Next steps are to: compile commercial catch and RV data on the same spatial scale so that spatial structuring can be examined, model the two sexes separately, use actual sample sizes as weights for the proportions at length, incorporate immigration and emigration, and look at standard deviation.

Questions and Comments:

Someone asked whether prior to 1978, there had been a change in regulation that changed things. It was noted that the Exclusive Economic Zone (EEZ) came into effect. This did not exclude foreign landings entirely, but they were more regulated. It is not known where the foreign landings came from, as they are only reported broadly within the Northwest Atlantic Fisheries Organization (NAFO) fishing areas.

It was unclear to some how small dogfish could be caught in gillnets when the mesh size is larger than the fish. It was noted that you would expect to see some small fish but not many. This could represent a small sample size, which could affect the selectivity curve.

Modeling does show a pulse of recruits, which is consistent with results from this morning. It also shows that the selectivity of the old summer RV survey series was much lower than the new survey.

Clarification was requested on the decision not to include density dependence.

It was suggested that the actual alpha could be determined rather than estimating alpha. However, age data for spiny dogfish is not available to fit a virtual population analysis.

It was suggested that the fecundity length relationship could be fit within the model, which may make it easier to interpret. J. Gibson responded that we do not have any data to show fecundity has changed with size, and there are larger issues to address.

Someone asked whether the same approach is being used for dogfish as for cod. J. Gibson responded that he was, but it is easier for dogfish because we have a better estimate for fecundity.

Additional questions included whether the seasonal selectivity of commercial catch had been determined (not yet); whether you would get a better fit if you started at 1980; whether the model had been fit to combined indices (no, might lose information); whether you would get the same trends if you broke the summer RV survey into component parts (would just become more variable); and whether an immigration or emigration parameter could be introduced into the model (could be estimated as part of the model).

J. Gibson suggested that the next iteration of the model could include movements that were discussed earlier today. He also suggested that one had to be careful not to force an assumption, as the model would go there if you gave it the option. It was suggested that a small component of data could be investigated for tomorrow, if we picked a time before or after an immigration/emigration event.

Someone asked why spiny dogfish seem to have moved away from some areas. J. Gibson suggested that they might have shifted habitat. If this is true, fishermen might be correct in believing that fish move rather than disappear.

Does the model allow for determination of maximum sustainable yield? J. Gibson indicated that the model can do that, but it requires density dependent behaviour in the population.

It was suggested that an improved process for capturing the experience of fishermen was required, and it was agreed that there would be further discussion of this at lunch. Fishermen felt that DFO could be doing better management, including more community-based management of the resource. DFO Science's role in this process was unclear.

15 November 2007: Day Two

SUMMARY OF DAY ONE

T. Worcester

Yesterday, presentations were made on life-history characteristics, stock structure, seasonal migrations, fishery statistics and catch composition, abundance indices, and a preliminary population model, including some of the outstanding issues with the model. We seemed to have general agreement on results related to habitat preferences (temperature/depth), growth, and some life-history characteristics, such as fecundity, longevity. We seem to know a lot about what large females are up to (distribution, seasonal movements from tagging), including northern/inshore movement in summer and southern/offshore movement in spring. The biggest gap in knowledge appears to be where pupping occurs and the subsequent movement of small juveniles. We might want to explore this a bit more. There seems to be some information from DFO's RV surveys as to where juveniles are being caught. The role of inshore versus offshore grounds is still uncertain. In terms of stock structure, there seemed to some difference in opinion on the significance of the genetic results, which showed no genetic differentiation. There may be some structure within the resident populations, but it is still unclear on how independent these are and what management implications might be.

There are numerous abundance indices to choose from (each modeled separately), but an aggregated index has been proposed (going to look at this in more detail today). Trends in abundance seem to be different in the summer and spring RV surveys. This will need to be resolved for assessment purposes. We have a general sense that the trends in abundance in Canadian and U.S. waters may be more similar than previously thought, but the Canadian population is generally smaller. We have a pretty good handle on fishing removals in terms of total catch by landings, plus a very good estimate of discards which improves the estimate of fishing mortality. There was some concern expressed about Russian landings, but we will continue to include these unless there is strong evidence to disregard this data. Catch by gear type, by area, aggregated by month for 2002-2006 gives the big picture on the seasonal distribution of fishing effort. Catch composition was provided, including length and sex composition in 4X (2002-2006) and age composition for 4VW (2003-2006), and there were some important differences from the U.S. J. Gibson gave a good introduction to his modeling, including what parameters and assumptions he is using, some of the issues that he is facing, and some preliminary results, which are to be used with great caution. It would be useful to revisit the modeling and determine if we can come up with any additional suggestions on next steps.

In addition to the formal presentations, we also heard concerns from several fishermen about the differentiation of gear impacts (e.g., differences between draggers, handline/longline, and gillnets), we heard some desire to talk about sustainable fishing practices, and there was also some discussion about the management implications of stock structure and seasonal migrations, i.e., what are the implications of seasonal movement for management between fleets within Canada? Concerns were expressed over the potential for joint management with the U.S. It was suggested that fisheries knowledge could be better incorporated into the assessment process, and there were outstanding questions related to the relationship between spiny dogfish and their prey, inshore movements in areas not being surveyed, and fishing behaviour. There were also some concerns about the implications of abundance estimates to CITES, COSEWIC, and the potential for listing of spiny dogfish under the *Species at Risk Act*.

DISCUSSION

Location of Pupping

S. Campana attempted to resolve confusion about possible pupping locations. He indicated that spiny dogfish give birth in winter and early spring. Based on timing, pupping must occur off continental shelf and deep basins. There is no one area where we find pups. They tend not to be caught until they are about 40 cm, so do not see them for the first few years. They are pelagic and so we only catch them when the trawl is coming up or going down. There is unlikely to be a single pupping ground; and they are likely to be pupping along the shelf break. There is nothing to stop them from shifting back and forth across international boundaries. He then showed a map of less than 40 cm dogfish against a backdrop of bottom temperature.

It was noted that the Americans also survey into 4X, and this biomass is probably included in the abundance index. It does not change things much, but it will be harder to separate out. L. Van Eeckhaute and S. Gavaris might have excluded U.S. strata in their assessments, and J. Neilson might have done it for pollock as well.

Fishermen think that the dogfish are pupping in the Bay of Fundy. In November, they see lots of pups on their decks and next month they do not see them. Some had yolk sacks attached (likely aborted foetuses), but some did not.

S. Campana's description of possible pupping locations is consistent with American data and experience. This would explain why we do not see pupping in U.S. inshore waters anymore. Not fishing deeper.

It was noted that the map showed bottom temperature, but if juveniles are pelagic, then they would be exposed to a different temperature regime.

To explain observations by fishermen, perhaps females that are ready to pup move out of the area and those that are left are those that are in first year of gestation.

K. Sosebee showed maps of U.S. dogfish less than 36 cm in water deeper than where commercial fishing is taking place.

It was agreed that juvenile migration is essentially unknown. It was suggested that this gap might be addressed to some extent by using the proposed Brown's Bank survey to investigate small dogfish.

It was noted that the juvenile silver hake surveys in October did not catch a single juvenile dogfish, and it was asked how deep the pelagic trawls went. The response was that the protocol was a three step oblique tow, with bottom trawl, mid-water trawl, and surface segments, which sampled the central portion of the Scotian Shelf. It was noted that the IYGPT (International Young Gadoid Pelagic Trawl) used for this survey has been returned to service, and DFO could do something with this.

Someone asked whether juveniles have been caught in mid-water trawls in the U.S. They have been caught in squid trawls, but catch in herring mid-water trawl have not been looked at explicitly.

It was noted that dogfish do show up on sounder. You can tell that they are dogfish by their distributional characteristics. You could potentially use sonar to identify schools of dogfish and then run an IGYPT trawl to catch them. The fat in the liver generates the acoustic signal.

It was noted that the U.S. recruitment index includes both Canadian and American waters.

Disappointment was expressed by one fisherman in response to the description of likely pupping locations. Migration is believed to occur within the Bay of Fundy, and it is hard to believe that pregnant females are not pupping there as fishermen report small dogfish swimming in the water both inshore (Bay of Fundy) and offshore. It was suggested that a project could be initiated to give fishermen the tools to identify the various ages and stages of dogfish. Information could then be collected from fishermen. If there are deep water pockets in the Bay of Fundy, then there may be pupping there depending on the water temperature.

Someone asked whether juvenile dogfish were caught in herring weirs. The response was that adults are caught but not juveniles. Shad fishermen catch dogfish with small mesh gear, but they are not allowed to keep them. This might be a source of data. It was suggested that Conner Brothers might separate dogfish from herring during processing; they should be asked. Also, DFO could ask mobile gear fishermen if they see dogfish in the winter. It was suggested that no dogfish are caught in January on Georges Bank. It is all caught in the northeast.

Abundance Indices

It was noted that the Georges RV survey index was not calculated correctly. Both Canadian and U.S. components were included together in the Canadian biomass index. However, correcting this may not change the abundance trend significantly.

When asked how far U.S. spring surveys go into 4X, the response was that they approach the entrance to the Bay of Fundy but do not go into the Bay of Fundy. There used to be good coverage on Browns Bank, but they stopped covering this area in 1987. Sampling further into the Bay of Fundy stopped in the 1970s. It was suggested that it might be worthwhile trying to look at areas of survey overlap to determine differences in survey catchability.

When doing estimate of minimum trawlable biomass, it should be recognized that there may be differences in catchability between Canadian and American surveys.

There is not enough confidence in the model yet to quote the results.

Is there an ability to track year classes and recruitment from RV surveys?

The model shows size classes rather than year classes. Where we are not seeing juveniles, it makes it difficult to do recruitment analysis. There will not be a reliable recruitment index for Canadian waters.

DFO surveys do not sample inshore areas. As females are thought to migrate inshore during the summer, the spring survey may therefore be more representative. There could be mass migrations.

Do we have a reliable index of abundance?

At present, we can see local changes in abundance, but we do not have big picture of total biomass unless we treat it as a fully mixed population.

See more variability in spring due to “bunching”. It might be possible to post stratify the data using temperature, though this would be easier to do using GIS. This could be used as a way to address the noise in the spring survey.

It appears as though the area occupied by dogfish has not changed over the time series. For example, the western part of 4X is pretty constant. Eastern 4X is a bit more variable. 4VW has declined. When there were lots of spiny dogfish in 4VW, they made a strong contribution to the total biomass. Does area occupied have an influence on biomass? There could be a difference in the way the data is skewed based on temperature, i.e., it could make a difference whether they are spread out or only caught in a few big tows. Some temperature effects have been shown here.

It was suggested that temperature could be used in the model as a predictor.

It was noted that survey stratification is based on depth rather than temperature, but spiny dogfish are temperature seekers rather than depth seekers. There may be a way of seeing where the variation is coming from.

It was asked whether other species have been looked at in this way. For example, striped bass in the U.S. will move up and down the coast. They move according to food or temperature. Regardless, the relative abundance is the same no matter where they are. Perhaps dogfish are doing same thing. Regional abundance will stay the same. 4X has not had large swings of temperature over time.

Using the ITQ survey might be a better way to look at this since it has a higher density of sets and samples inshore areas. However, the ITQ tries to avoid dogfish.

The peak of dogfish in the DFO RV survey is consistent with catch records and fishermen’s knowledge.

There is pressure from Americans to do a joint assessment and possibly joint management. DFO Science was given five years to come up with an answer. Next steps would be a joint assessment.

We should err on the side of caution, i.e., underestimate the biomass, if we are giving management a total biomass from which to calculate a Total Allowable Catch (TAC).

It was noted that the U.S. uses 80 cm for mature females and Canada used 82 cm.

There seemed to be more confidence in statements about the trends in mature female biomass as compared to total biomass.

It was suggested that the reason there were no females in the graph may be because the summer survey did not catch mature females in 4X after 1990.

Figure 29 will be a serious underestimate of mature female biomass. It was suggested that this figure should be deleted or this source of uncertainty should be acknowledged in the text. The 2 trends could also be shown separately.

Could look at U.S. spring stations in 4X and calibrate against Canadian data.

It would be fine to remove the figure because of concerns about Canadian data, but there were no concerns about the American trend. It is clear that there has been a decline in the U.S. stock due to fishing removals. The increase in the past few years was predicted. These are from 15 year old animals, so it is not expected to continue. Low recruitment years are expected to kick in.

Would it help for fishermen to do a survey once a week? They could report on the percentage of females in the catch. Other fishermen might be interested in collecting inshore data. Information gathered could support the theory (conceptual model) of where mature females are located.

Counts of aborted pups with no yolk sacs would be very useful. However, it would be hard for fishermen to contribute to an abundance index. Different gear types might give a different answer.

S. Campana committed to presenting all the information that had been gathered as a part of the Joint Project Agreement (JPA) to groups that had contributed.

The use of archival pop-up satellite tags was raised. These are very expensive ($5000 per tag) and are usually used on bigger fish.

What is really needed is the trend in abundance and whether fishing removals are having an impact on the population.

It was unclear as to whether another JPA would be possible; however, it is clear that more research is needed. We may have to be more creative. There has been some success with the lobster recruitment project.

For the advisory report, we cannot use the model for advice, but we can use trends shown in Figure 28. This shows a decline; but we can say with confidence that this is not exclusively a result of the fishery since landings are not high enough to explain the decline. Surveys catch a different length composition than the fishery. Thus, the decline observed in the survey is even less likely to be a result of the fishery. We need to have more discussion, and description in the advisory report, on the difference in trend between the spring and summer RV surveys. Overall, abundance looks like it is increasing unless there are catchability issues, in which case the population is stable. Overall, spiny dogfish biomass is high.

Modeling

Assumptions in the modeling include that the Canada population of spiny dogfish represents a single unit. The model starts with the summer survey index. It also uses 1960 as the starting time, though there was a suggestion that it should start later. It is unclear how migration should be addressed. Sexes are not yet separated. There are questions about gillnet selectivity and RV survey selectivity. There are also questions about spawner/recruit relationship.

Robustness of the model estimates with respect to length of the time series incorporated in the model should be examined, and trial results should not be included in the Research Document.

In response to a question on how to develop a better way of getting at selectivity of removals, J. Gibson noted that the population has seasonal spatial structure, which affects availability and gear selectivity. It is possible to fix selectivity curves, and we do have a lot of length frequencies from longlines and gillnets, though trawls differ quite a bit. However, given that there are so

many other issues to address, it may be better to apply a single selectivity curve. He also agreed that it is reasonable to suggest that there has been a shift from small fish to older fish.

The spawner/recruit relationship is a result of the model. An assumption was made that generates density dependence. If you remove that assumption, it disappears. This might not be unique. For many fisheries, we do not see compensatory response to reductions in fishing effort. However, we might also be missing something.

Developing a matrix of movement probability (distribution of fish through space and time) would not be an easy thing to do. There may be differences in behaviour through time (calendar time). However, it is not without precedent, e.g., tuna models in the Pacific. As we increase complexity, we will likely get convergence estimates. We will need to look at robustness. It may be possible to look at five big areas.

Extrapolation back in time is tricky, but is there a reason not to extrapolate back with the proportions of fisheries in the 1980s? Would it all have been otter trawl?

We could check whether NAFO displayed landings by gear type. Where there are significant Canadian landings, these are probably experimental fisheries. We could find out what these were.

REVIEW OF SCIENCE ADVISORY REPORT

Minimum trawlable biomass needs to be defined, and some caveats need to be stated about what it does or does not represent (e.g., surveys do not cover the full range of dogfish).

Differences in gear catchability may scale the total biomass differently between surveys.

The evidence that the Gulf of St. Lawrence population is a sink population should be referenced in the Research Document. For example, show the modal length across years, or a bubble plot.

Dogfish are observed along the Laurentian Channel at all times of the year.

Someone asked whether the Newfoundland spiny dogfish biomass is comparable to rest of Scotian Shelf, and the response was that it was comparable.

Labeling of figures should be improved during the editorial meeting, e.g., Figure 15.

It was suggested that the Canadian index could be prepared as a stacked plot. This should be tried but abandoned if too messy.

Commercial catch over total biomass was questioned. It can only be interpreted in terms of a trend. It was considered useful to have a plot of relative fishing mortality (F), but the survey catches a different size composition than the fishery.

Next steps for exploitation rate should be mentioned within the modeling section.

Emigration and natural mortality could account for the remainder, among other factors.

Not all areas are covered by surveys, so it is hard to track movement of spiny dogfish. There is the potential for emigration to unsurveyed areas. It is unknown if this represents an actual loss to the population, and, if it is a loss, whether it is temporary or permanent.

Without knowing the extent that Canadian spawners contribute to the health of the northwest Atlantic dogfish metapopulation, it may not be wise to increase the exploitation rate on mature females.

DFO summer RV surveys include 4VWX and 4T, not 5Z.

Use the statement, the “U.S. minimum trawlable biomass estimate has been slightly greater than the Canadian minimum trawlable biomass estimate.”

CONCLUSIONS AND NEXT STEPS

Presenters were thanked for their excellent presentations and for all the hard work that went into this assessment. Reviewers were thanked for the helpful comments and suggestions. Participants were thanked for their willingness to engage in the discussion.

An editorial meeting to review and finalize the Science Advisory Report will be held shortly, and the proceedings of this meeting will be distributed to participants once it approaches a final draft.

REFERENCES

Benoît, H.P., and D.P. Swain. 2003. Standardizing the Gulf of St. Lawrence bottom trawl survey time series: Adjusting for changes in research vessel, gear, and survey protocol. Can. Tech. Rep. Fish. Aquat. Sci. 2505.

DFO, 2007. Assessment of spiny dogfish in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/046.

McFarlane, G.A., and J.R. King. 2003. Migration patterns of spiny dogfish (*Squalus acanthias*) in the north Pacific Ocean. Fish. Bull. 10: 358-367.

Vince, M.R. 1991. Stock identity in spurdog (*Squalus acanthias* L.) around British Isles. Fish. Res. 12: 341-354.

Appendix 1. Terms of Reference

Assessment of the Status of NAFO Subareas 2 – 6 Spiny Dogfish
Science Advisory Process

Hayes Boardroom, Bedford Institute of Oceanography
Dartmouth, Nova Scotia

14 – 16 November 2007[1]

TERMS OF REFERENCE

Context

The Committee of the Status of Endangered Wildlife in Canada (COSEWIC) will be undertaking an assessment of the status of spiny dogfish in NAFO subareas 2 – 6. This assessment will inform the Department of Fisheries & Oceans' (DFO) determination of listing this species under the Canadian Species at Risk Act (SARA). COSEWIC has deferred its assessment until DFO has reviewed Canadian data which has been collected and processed as part of a five-year project to be completed in 2007. The focus of the meeting is an evaluation of stock structure and the newly collected Canadian data.

Objectives

The following issues will be addressed in order to develop scientific consensus through peer review:

- Evaluate degree of association of dogfish in Canadian and USA waters including:
  - Relative proportions of species in Canada and USA
  - Seasonal migrations, including pupping season and sites in Canada and USA, distribution of mature females and other seasonal movements
- Evaluation of human impacts on spiny dogfish in Canadian waters, including estimation of:
  - Canadian fishery catch-at-age by fleet, area, and season
  - Discards and size composition by fleet, area, and season
  - Mortality of discarded dogfish
  - Size composition of discards
- Evaluation of abundance and productivity in Canadian waters including estimation of:
  - Stock trends and current status of total resource and mature females by themselves
  - Productivity (recruitment and growth)
  - Growth and longevity, fecundity, sexual maturation, and other life history traits (e.g. sex ratios)
  - Mortality (natural and fishing)
  - Preliminary population model

Outputs

Canadian Science Advisory Secretariat (CSAS) Science Advisory Report
CSAS Proceedings summarizing the discussion
CSAS Research Document

[1] Actual dates: 14-15 November 2007

Participation

- DFO Science and Fisheries & Aquaculture Management branches in Maritimes, Gulf and Newfoundland
- Aboriginal communities / organizations
- Northeast Fisheries Science Center (NEFSC) National Marime Fisheries Service (NMFS)
- Fishing industry
- Nova Scotia and New Brunswick provincial representatives
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

Appendix 2. Agenda

Assessment of the Status of NAFO Subareas 2 – 6 Spiny Dogfish
Science Advisory Process

Hayes Boardroom, Bedford Institute of Oceanography
Dartmouth, Nova Scotia

14 – 16 November 2007[1]

DRAFT AGENDA

14 November 2007 – Wednesday

09:00 – 09:30	Welcome and Introduction (Chair)
09:30 – 10:00	Subareas 2–6 Dogfish review
10:00 – 10:15	*Break*
10:15 – 12:00	Subareas 2–6 Dogfish review
12:00 – 13:00	*Lunch*
13:00 – 15:00	Subareas 2–6 Dogfish review
15:00 – 15:15	*Break*
15:15 – 17:00	Subareas 2–6 Dogfish review

15 November 2007 – Thursday

09:00 – 10:00	Analyses identified from first day
10:00 – 10:15	*Break*
10:15 – 12:00	Analyses identified from first day
12:00 – 13:00	*Lunch*
13:00 – 15:00	Review of Draft of Science Advisory Report
15:00 – 15:15	*Break*
15:15 – 17:00	Review of Draft of Science Advisory Report

16 November 2007 – Friday

09:00 – 12:00	Completion of Review of Science Advisory Report
12:00	Adjournment

[1] Meeting concluded earlier than expected and, therefore, was adjourned at the end of 15 November 2007.

Appendix 3. List of Participants

Assessment of the Status of NAFO Subareas 2 – 6 Spiny Dogfish
Science Advisory Process

Main Auditorium, Bedford Institute of Oceanography
Dartmouth, Nova Scotia

14 – 15 November 2007

ATTENDEES

NAME	AFFILIATION
Bentzen, Paul	Dalhousie University, Dept. of Biology
Boudreau, Cyril	NS Fisheries and Aquaculture
Brooks, Cecelia	Maliseet Nation Conservation Council
Campana, Steve	DFO Maritimes / PED
Clark, Don	DFO Maritimes / SABS
Cronk, Ron	NB Dept. of Fisheries
Emberley, Jamie	DFO Maritimes / SABS
Facey, Amanda	Maritimes Aboriginal Peoples Council / NCNS
Farnsworth, Terry	Fundy Fixed Gear Council (FFGC)
Ford, Jennifer	Ecology Action Centre
Fowler, Mark	DFO Maritimes / PED
Gibson, Jamie	DFO Maritimes / PED
Hansen, Jorgen	DFO Maritimes / FAM
Hurley, Peter	DFO Maritimes / PED
Jayawardane, Aruna	Maliseet Nation Conservation Council
Joyce, Warren	DFO Maritimes / PED
Kulka, Dave	DFO Newfoundland / O&E
LeBlanc, Joshua	Ocean Pride Fisheries Ltd.
LeBlanc, Milton	Ocean Pride Fisheries Ltd.
Marks, Linda	DFO Maritimes / PED
Maxwell, Judith	Scotia-Fundy Inshore Fishermen's Assn. (SFIFA)
McNeeley, Joshua	Maritimes Aboriginal Peoples Council / NCNS
Peters, Gerard	DFO Maritimes / CDD
Rowe, Sherrylynn	DFO Maritimes / PED
Rulifson, Roger	East Carolina University
Showell, Mark	DFO Maritimes / PED
Sosebee, Katherine	NOAA, NMFS
Spence, Koren	DFO Maritimes / SARA
Waters, Christa	DFO Maritimes / SABS
White, Carolea	Fundy Fixed Gear Council (FFGC)
Whitman, William	NS Fisheries and Aquaculture
Worcester, Tana (Chair)	DFO Maritimes / CSA
Zinck, George	Prospect Area Fulltime Fishermen's Assn. (PAFFA)