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CERT

Comité d'évaluation des ressources transfrontalières

TRAC

Transboundary Resources Assessment Committee

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Proceedings of the Transboundary Resources Assessment Committee (TRAC) Spiny Dogfish Review

Benchmark Data Meeting
30 March – 2 April 2009

Benchmark Model and Assessment Meeting
25-29 January 2010

Stephen H. Clark Conference Room
Woods Hole Laboratory
Woods Hole, Massachusetts, USA

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FOREWORD

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or misleading, but are included to record as faithfully as possible what transpired at the meeting. 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 had been reached.

AVANT-PROPOS

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s’est dit à la réunion. 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.

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ABSTRACT

The Transboundary Resources Assessment Committee (TRAC) met during 30 March – 2 April 2009 in Woods Hole, Massachusetts, USA, for a benchmark data review for spiny dogfish and a benchmark model review for Eastern Georges Bank cod. Results of the data review for dogfish will be applied in the upcoming benchmark model review and assessment and results of the cod model review will be applied in the next assessment. Proceedings for the cod review can be found on the TRAC webpage: http://www.mar.dfo-mpo.gc.ca/science/trac/rd.html. The remainder of the document will only refer to the spiny dogfish proceedings.

The TRAC met again during 25-29 January 2010 for a benchmark review of spiny dogfish assessment models. A consensus was not reached on a benchmark model; therefore, for USA management purposes, the previous USA assessment was updated and stock status was determined from that assessment.

RÉSUMÉ

Le Comité d'évaluation des ressources transfrontalières (CERT) s'est réuni du 30 mars au 2 avril 2009 à Woods Hole (Massachusetts), aux États Unis, pour procéder à un examen des données sur les points de référence visant l'aiguillat commun et à un examen du modèle de référence applicable à la morue de l'est du banc Georges. Les résultats de l'examen des données sur l'aiguillat commun seront utilisés dans le prochain examen du modèle de référence portant sur ce stock, tandis que les résultats de l'examen du modèle de référence concernant la morue serviront à la prochaine évaluation de cette ressource. Le compte rendu de l'examen sur la morue peut-être consulté dans la page Web du CERT, à l'adresse suivante : http://www.mar.dfo-mpo.gc.ca/science/trac/rd.html (version anglaise seulement). Il ne sera question ici que du compte rendu des discussions concernant l'aiguillat commun.

Le CERT s'est réuni de nouveau du 25 au 29 janvier 2010 pour procéder à un examen des points de référence des modèles d'évaluation de l'aiguillat commun. Faute de consensus au sujet d'un modèle de référence, l'évaluation précédente réalisée par les États-Unis a été actualisée et a servi à déterminer l'état du stock aux fins de gestion de la ressource par les États-Unis.

A. DATA MEETING

A. Introduction

The Transboundary Resources Assessment Committee (TRAC) co-chairs, L. O'Brien, and T. Worcester welcomed participants (Appendix 1) to the 2009 TRAC benchmark data review for spiny dogfish (herafter referred to as either spiny dogfish or dogfish) and benchmark model review for Eastern Georges Bank cod. The TRAC was established in 1998 to undertake joint USA / Canada assessments of resources in the Georges Bank transboundary region. Eastern Georges Bank cod and haddock and Georges Bank yellowtail flounder were the first stocks to be assessed by TRAC, followed by Atlantic herring. TRAC assessments of spiny dogfish and Atlantic mackerel are being conducted for the first time in 2009. The TRAC received approval for all Terms of Reference (ToR) to be addressed from the USA/Canada Steering Committee for both spiny dogfish and cod, as well as from the Transboundary Management Guidance Committee (TMGC) for the ToR related to cod only.

The TRAC review process is two tiered, with assessment updates typically undertaken between more intensive benchmark reviews. This is the first benchmark review of spiny dogfish in the TRAC. The previous model benchmark review for Eastern Georges Bank cod was held in 2002.

The ToR and agenda for the meeting are provided in Appendices 2 and 3, respectively. During the meeting, each working paper was presented by one of the authors and then followed by a plenary discussion of that paper. Rapporteurs documented these presentations and discussions for the Proceedings. The remainder of the document pertains strictly to the spiny dogfish proceedings.

A. Commercial and Recreational Fisheries

TRAC Presentation:	USA Commercial Landings, Discard Estimates, and Recreational Fishery
Presenter:	K. Sosebee
Rapporteur:	C. Millar

Presentation Highlights

Data from the previous United States assessment completed in 2006 (NEFSC 2006) were updated. Historical records dating back to 1931 indicate levels of USA commercial landings of dogfish in Subareas 5 and 6 (Figure 1) of less than 100 mt in most years prior to 1960 (NEFC 1990). USA commercial landings of dogfish from Northwest Atlantic Fisheries Organization (NAFO) Subareas 2-6 were around 500 metric tons (mt) in the early 1960s, dropped as low as 70 mt during 1963-1975 while averaging about 90 mt, and remained below 1,000 mt until the late 1970s. Landings increased to about 4,800 mt in 1979 and remained fairly steady for the next ten years at an annual average of about 4,500 mt. Landings increased sharply to 14,900 mt in 1990, dropped slightly in 1991, but continued a rapid expansion from 18,987 mt in 1992 to over 28,000 mt in 1996. Landings in 1996 were the highest recorded. Landings declined in 1997 and 1998 to around 20,000 mt. In 1999, the last full year unaffected by regulations, the landings declined to 14,860 mt. USA landings dropped to about 2,200 mt in 2001 and 2002 in response to quota restrictions.

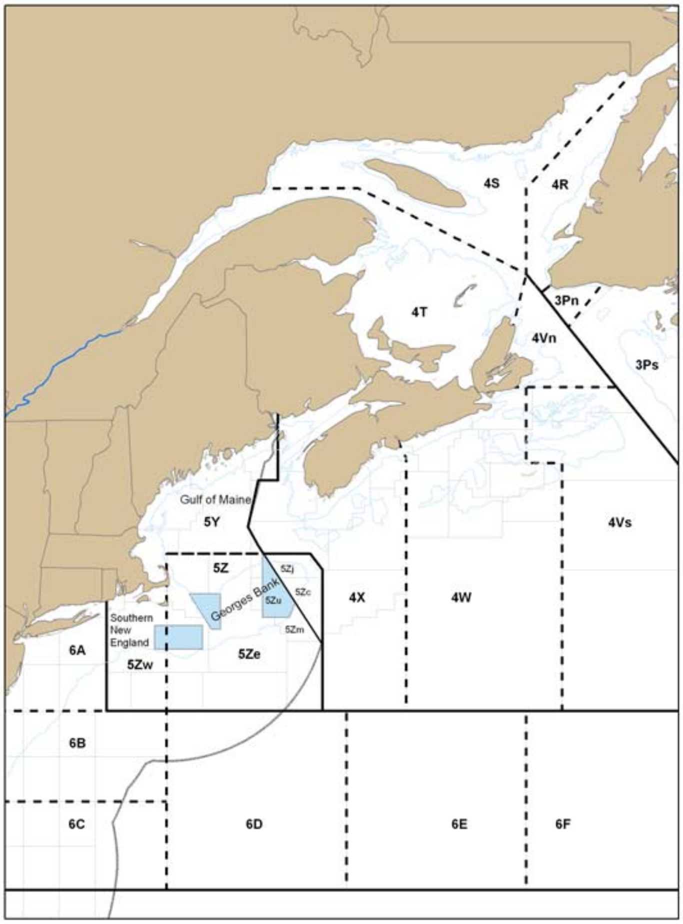


Figure 1. NAFO Subareas and Divisions.

The primary gear used by USA fishermen to catch spiny dogfish has been otter trawls and sink gill nets. The latter accounted for over 50% of the total USA landings during the 1960s, while the former was the predominant gear through the 1970s and into the early 1980s. During the peak period of exploitation in the 1990s, sink gill nets were the dominant gear. Data were also presented by combined gear type, month, and region (Gulf of Maine (GOM), Georges Bank (GBK), Southern New England (SNE), and Mid-Atlantic (MDA)).

The temporal and spatial pattern of dogfish landings are closely tied to the north-south migration patterns of the stock. Peak landings from May through October coincide with residency of dogfish along the southern flank of GBK, the GOM and the near shore waters around Massachusetts. As the population migrates to the south in late fall and early winter, landings increase in the southern states, especially North Carolina. USA dogfish landings have been reported in all months of the year, but most have traditionally occurred from June through September. During the peak years of the domestic fishery, substantial quantities were also taken during autumn and winter months.

In most years since 1979, the bulk of the landings occurred in Massachusetts. Other states with significant landings include New Jersey, Maryland, and Virginia. Landings in North Carolina peaked in 1996 at 6,200 mt, about half of the Massachusetts landings, but dropped sharply to about 1,300 mt between 1997 and 2000. North Carolina landings in 2001-02 were negligible. In 2001 and 2002, virtually all of the landings were taken north of Rhode Island.

Discard estimates from SAW/SARC (Northeast Regional Stock Assessment Workshop/Stock Assessment Review Committee) 43 have been re-estimated in this assessment (Table 1). The ratio-estimator used in this assessment is based on the methodology described in Rago et al. (2005) and updated in Wigley et al. 2007. It relies on a discard/kept (d/k) ratio where the kept component is defined as the total landings of all species within a “fishery”. A fishery is defined as a homogeneous group of vessels with respect to gear type (longline, otter trawl, shrimp trawl, sink gill net, and scallop dredge), quarter (to be determined, TBD), and area fished (TBD). Mesh size was not used to split out otter trawl trips or sink gill net trips. All trips were included if they occurred within this stratification regardless of whether or not they caught dogfish.

Table 1. Discard rate of spiny dogfish by gear, by country.

Gear	Canada	US
Gill Net	0.55	0.30
Line Trawl	-	0.10
Longline	0.10	0.25
Midwater Trawl	-	0.50
Otter Trawl	0.25 > 200 kg, 0 < 200 kg	0.50
Pair Trawl	-	0.50
Purse Seine	0.25	0.50
Scallop Dredge	-	0.75
Scallop Trawl	-	0.50
Shrimp Trawl	-	0.50

The discard ratio for dogfish in stratum h is the sum of discard weight over all trips divided by sum of kept weights over all trips:

$$\hat{R}_h = \frac{\sum_{i=1}^{n_h} d_{ih}}{\sum_{i=1}^{n_h} k_{ih}} \qquad (1)$$

where d_{ih} is the discards for dogfish within trip i in stratum h and k_{ih} is the kept component of the catch for all species. R_h is the discard rate in stratum h. The total discard within a strata is simply the product of the estimate discard ratio R_h and the total landings for the fishery defined as stratum h, i.e., $D_h=R_hK_h$.

Missing cells are imputed using averages of existing cells. The number of trips samples by gear type, month, and region (GOM, GBK, SNE, and MDA) were presented to the TRAC to determine what grouping to use for modeling purposes.

Estimates of recreational catch of dogfish were obtained from the National Marine Fisheries Service (NMFS) Marine Recreational Fishery Statistics Survey (MRFSS, see Van Voorhees et al. 1992 for details). Recreational catch data have been collected consistently since 1979 but sex is not recorded. The MFRSS estimates are partitioned into three categories of numbers caught and landed: A, B1, and B2. Type A catches represent landed fish enumerated by the interviewer, while B1 are landed catches reported by the angler. Type B2 catches are those fish caught and returned to the water. Biological information on dogfish is generally scanty, resulting in wide annual fluctuations in mean weights. In past assessments, an average weight of 2.5 kg per fish was assumed for all years to compute total catch in metric tonnes (mt). Data were presented with numbers of fish measured for the landed and discarded fish by wave (2-month time period) and state. These will be used to compute total catch.

The seasonal distribution of biological sampling of the landings generally coincided with the seasonal pattern of landings. Most samples were taken in June through November with much lower effort from January to May. Observer trips sampled for landed and discarded fish by gear type, month, and region (GOM, GBK, SNE, and MDA) were presented for the TRAC to decide what grouping to use for modeling purposes.

TRAC Presentation: Stock Structure, Life History, Fishery and Abundance Indices for Spiny Dogfish (*Squalus acanthias*) in Atlantic Canada. TRAC Working Paper 2009/05.
Presenter: S. Campana
Rapporteur: C. Millar

Presentation Highlights

In 2003, an intensive 5-year research program on Canadian dogfish was initiated by Fisheries and Oceans Canada (DFO), conducted in cooperation with the dogfish fishing industry. The program provided for the collection of large numbers of at-sea and landed samples of dogfish catches that were used in analyses of commercial catches and dogfish biology. Campana et al. (2007) presented an overview of all work done to date to better understand the stock structure, migration patterns, abundance trends and current state of the Canadian portion of the Atlantic spiny dogfish population. This information was updated to 2008 in the current report, as a prelude to a joint Canadian-USA stock assessment.

Canadian landings were low between 1962 and 1986, but have averaged about 2,500 mt annually since 2000, with the majority of that being directed catch by handline and longline, followed by gillnets. Landings in 2008 were lower due to reduced markets. The vast majority of landings were reported from Nova Scotia during the summer. The quota since 2004 has been set at 2,500 mt, but this quota was not based on scientific advice.

To quantify dogfish bycatch, observer records of dogfish catch relative to target catch were calculated by fishery, NAFO area, season and year. The proportion of dogfish in each observer cell was then multiplied by the total reported landings of the target catch in each cell to obtain the estimated dogfish catch in each cell. The largest bycatch was associated with the groundfish (bottom otter trawl (OTB), longline (LL), gillnet) and OTB redfish fleets in NAFO Divisions 4X5Y, although all areas and most fleets reported large dogfish bycatches at some times. Total discards have averaged 2,000-3,000 mt annually in recent years, although discards of up to 10,000 mt were estimated for some years in the 1990s. Dogfish discard mortality in Canadian waters was calculated as per the following: 25% for OTB catches > 200 kg, 0% for OTB catches < 200 kg, 55% for gillnet catches, 10% for longline catches, and 25% for purse seine catches (Table 1). Estimated dogfish discard mortality has averaged about 850 mt annually since 1986. Discard mortality often exceeded reported catch prior to 1999, but recent landings have greatly exceeded discard mortality.

The length composition of the commercial catch over the years 2002-2006 in 4X indicated that females ranged in length from 46-112 cm total length (TL), while males ranged from 36-94 cm. Most of the catch was of sub-adult and adult size. Median size of females in the catch was 81 cm TL, while that of males was 74 cm. In terms of catch numbers, 66% consisted of females, and 26% of the catch consisted of mature females. The proportion of females in the catch was much lower than that present in the USA commercial catch. Comparisons of at-sea versus landed size compositions indicated that there was no appreciable highgrading of the catch. Dogfish in the commercial catch tended to be fairly old, with a mean age of 16 yr for males and 18 yr for females.

Discussion

United States Data

Stratification Schemes:

Stratification is by gear type and area and independent of species composition. The main issue is with the number of possible strata. The finer the strata, the sparser the data. It was suggested that various strata could be collapsed and the resulting estimates and coefficients of variation (CVs) be inspected. It was also suggested that regression trees could be used to inform which strata are similar and so could be collapsed.

Discard Rates Prior to 1988:

There is no discard sampling prior to 1989. Fishing for dogfish was eliminated in the late 1990s as the stock was considered to be overfished; prior to this, fishing was encouraged. Estimates of dead discards since 1989 are around the level of the landings, which would be around 18,000 mt in the early 1990s and then declining to 3,000 mt by the 2000s. The feasibility of estimating or hind casting discards prior to 1989 was raised. It is considered that the fishery prior to 1989 is not comparable to that after; however, it was commented that the current fishery may be most applicable (with respect to discard rates) to the period prior to 1989.

Recreational Fishery:

Samples of individual weights from recreational fishery show that the average weight of dogfish in the recreational catch seems to have declined. A value of 2.5 kg was previously used and new data suggest that using the existing biological data, grouped by years, may be a better way of estimating catch. It is not clear if this is a biological effect, but it is known that, in the 1990s, there were more big females closer to shore where the recreational fishery takes place and this could explain the change. It was agreed that these new data be used to update the estimate of mean weight in the recreational catch.

Gear Specific Discard Mortalities:

Discard mortality is thought to vary by gear. The fact that long-line hook and line discard mortalities were different was queried; long-line (principally commercial) discard mortality is set to 10%, whereas hook and line (principally recreational) discard mortality is 25%. The reason for this difference is that hook and line fishers are thought to be less “happy” to catch dogfish than long-liners and so are presumably more rough with the fish, resulting in an increased mortality rate. It was also commented that these mortalities were assigned by scientists and stakeholders jointly and may be subjectively influenced.

It was put forward that trawl discard mortalities, currently set at 50%, should be increased. Based on long tows resulting in 100% mortality and short tows resulting in 0%, and lack of information on the distribution of tow duration for trawl gears, it was argued that 50% is a fair compromise.

Canadian Data

Discard Raising Variables:

Canadian discards are estimated using targeted species landings as the auxiliary variable, e.g. redfish is one target species. This differs from the USA as the USA uses total landings as the auxiliary variable. The USA method is likely to be less precise than the Canadian method; however, it is likely to be more robust (or less biased). The USA tried estimating discards using target species as the auxiliary variable and found that discards tended to be underestimated. Due to the Canadian sampling scheme, it is not possible to use total landings as the auxiliary variable. The TRAC attendees did not consider this a major issue.

Ageing of Spiny Dogfish:

Spines were aged and validated using a carbon dating method. The age distribution from these data applied to the commercial landings data did not show any cohort signals. This indicates a size selective fishery. It was also pointed out that, for slow growing, long lived species such as spiny dogfish, it is common for cohort signals not to be evident.

General Data Comments

USA data as a whole is good from 1990, with landings reliable from 1980. Prior to 1979 there are survey data. Canada has discard data back to 1986, and the USA has discard data back to 1989. There was concern over truncating the data series from 1990; the main reason being that spiny dogfish are so slow growing and long lived that truncating the data would remove a large amount of information on older cohorts thus removing the amount of full cohorts in the data set. It was suggested that models based on a truncated data set and a full data set could be compared as a sensitivity analysis.

Harmony of the USA and Canadian Data

Discard Auxiliary Variable:

It was suggested that it would be useful to compare overlapping USA and Canadian fishing areas to see if there are differences in the estimated discard rates. However, no real overlap exists and the group agreed that this issue was of minor importance.

Discard Mortalities:

Further study into gear specific mortality rates is a difficult proposition. The group agreed that it would be better to come to a consensus than to recommend a study.

Years included in the models will be determined after the presentation of survey data

Growth Model:

It was noted that the parameters of the growth curves presented by Canada differ from that used by the USA. The USA applies the growth model from a previous study by Nammack (1985), and the Canadian growth model is based on recent data with validated ages. The Canadian data is considered to be more accurate; however, only large fish were available at the time of the study. The data used in the Nammack paper include smaller fish. It is preferable to use the same growth model for the USA and Canada unless is can be demonstrated that growth is different. To investigate this, it was noted that the USA has 100s and Canada has 1,000s of unread spines that could contribute more information. This could be a potential area of future work, but it was noted that it would be a considerable undertaking.

TRAC Presentation:	Are Spiny Dogfish Longline Catches Predictable Using Traditional Ecological Knowledge?
Presenter:	R. Rulifson
Rapporteur:	C. Millar

Presentation Highlights

Highliner commercial fishers in New England claimed they could predict spiny dogfish catches in nearshore coastal Atlantic waters with regard to fish size and sex based on time of day at which longline gear was set. Specifically, their observations suggested that 1) the sex ratio would change from a 1:1 male-to-female ratio to nearly all female, and 2) fish size would increase through the day. These hypotheses were tested by setting longlines in the same area of Cape Cod Bay, Massachusetts, over a one-day period at various times in a manner consistent with commercial fishing methods (Tables 2-3). A total of 762 females and 157 males were collected. All 919 fish were tagged and released; only one fish was recaptured by longline during the study suggesting that 1) these fish were hook-averse (at least temporarily), 2) the aggregation of spiny dogfish was quite large, 3) the aggregation was transient allowing new fish to be exposed to fishing gear, or a combination of these factors. The sex ratio of spiny dogfish caught after sunrise was 1:1.65 males to females. By the end of the day, the ratio was 1:30. Male dogfish caught later in the day averaged a greater average total length (Haul 5, Time 15:20, 782 ± 32 mm TL) compared to early morning catches (Haul 1, Time 08:00, 740 ± 33 mm TL). Average lengths of females throughout the day were not statistically different (Table 4). Results of this study suggest that time of day at which sampling for population demographics by federal and state agencies may influence results of sex ratio and fish size, at least in coastal waters north of Cape Cod, Massachusetts.

Results indicate that New England “highliners” (successful, highly respected, full-time commercial fishermen) have identified temporal behavioral patterns not previously reported by researchers of northwest Atlantic spiny dogfish populations. The Atlantic States Marine Fisheries Commission (ASMFC), the Mid-Atlantic Fisheries Management Council (MAFMC), and the New England Fisheries Management Council (NEFMC) have considered the feasibility of a male spiny dogfish fishery. An all-male fishery could alleviate some of the fishing pressure on reproductive females and provide a viable economic alternative for commercial fishermen. Further research using the methods employed in this work could support the development of an all-male spiny dogfish fishery, in which males could be more efficiently targeted early in the day. The ASMFC Spiny Dogfish Technical Committee noted that, while a male-only fishery would not harm stocks, it would increase the discard of females and affect model assumptions for stock assessments (ASMFC 2008).

Recommendations for future research include an evaluation of existing datasets to identify potential time biases in sex ratio estimation for survey areas. Also, this experiment should be repeated by longline fishers and in alternative gear-based fisheries (e.g., gillnets, trawls) under different weather conditions, in separate seasons, and across depth strata.

Table 2. Locations of longline gear deployed off Green Harbor, Massachusetts.

Haul number	Time	Latitude	Longitude	Depth (m)
1	8:00	42º 05.30'	70º 33.48'	26.5
2	11:15	42º 04.50'	70º 35.11'	22.9
3	13:29	42º 04.50'	70º 35.11'	20.7
4	14:30	42º 04.50'	70º 35.11'	21.3
5	15:20	42º 03.91'	70º 35.30'	22.7

Table 3. Environmental data associated with gear deployments off Green Harbor, Massachusetts.

Haul number	Water temp (ºC)	DO (mg/L)	% Oxygen	Salinity
1	15.5	7.91	93.0	27.5
2	15.6	7.77	94.4	29.4
3	15.8	8.02	95.7	29.3
4	16.0	8.08	98.1	29.3
5	15.8	8.49	102.3	29.3

Table 4. Average fish length (TL, mm ± SD), sex ratio, number of sex caught, and average TL (mm ± SD) by haul.

Haul	Total Catch (n)	TL (mm)	Sex ratio (F:M)	Female TL	Male TL
1	350	812 ± 72	1.65	855 ± 51	740 ± 33
2	236	841 ± 43	18.67	846 ± 38	743 ± 27
3	114	849 ± 44	18.00	850 ± 41	811 ± 71
4	125	846 ± 58	30.25	848 ± 57	756 ± 33
5	94	849 ± 46	30.33	851 ± 45	782 ± 32

A. Research Bottom Trawl Surveys

TRAC Presentation: Canadian Research Bottom Trawl Surveys
Presenter: S. Campana
Rapporteur: C. Legault

Presentation Highlights

There were a total of 11 research vessel (RV) and industry survey abundance indices for dogfish in Canadian waters, as summarized below.

Survey	NAFO Divisions	Month	Time Series	Trends	Comments
Summer RV	4VWX5Z	July	1970-2008	High but variable since 1984	Good index for all but mature females
Spring RV	4VWX	March	1979-1984	No trend	
Fall RV	4VWX	Oct	1978-1984	No trend	
March RV	4VW	March	1986-2007	Sudden decline in 1993 which has persisted to present	
Georges RV	5Ze	Feb	1986-2008	Sudden decline in 1994 which persisted to 2007	
Redfish RV	4VWX	Oct	1982-1988	Few dogfish caught	
4VsW cod sentinel LL	4VsW	Oct	1995-2005	Decline	
Halibut LL	3LNO4VWX	June	1998-2008	No trend	
4Vn cod sentinel LL	4Vn	Sept	1994-2001	Low after first year	
Gulf RV	4T	Sept	1971-2008	Zero from 1971-1984; high values in 1985 which have gradually declined since with no recruitment	Sink population
Newfoundland Spring RV	3P	Apr	1972-2005	No trend	

The comparison of the various summer/fall RV surveys (summer 4VWX5Z, fall 4VWX and 4T) indicates that the fall and summer trawlable biomasses are roughly comparable, and show similar trends. However, the trawlable biomass in the southern Gulf of St Lawrence (4T) is roughly 10% of that on the Scotian Shelf (4VWX), and thus is small by comparison. A comparison of the relative abundance indices among the various industry surveys (included both longline and mobile gear surveys) provides no strong insights into abundance trends.

A comparison of the spring RV surveys shows that the spring 4VWX, spring 4VW and the February 5Ze Georges Bank trawlable biomasses are all comparable, although the spring 4VWX survey does not overlap in time with any other spring survey. The trawlable biomass in Newfoundland waters was negligible compared to the other regions prior to 1997, but the biomass in the other regions subsequently declined so that the Newfoundland biomass is now comparable.

In light of the differing seasons for RV surveys across regions in Atlantic Canada, it is difficult to prepare a single within-season index that covers all regions and time periods. Only the spring surveys caught mature females; mature females were inshore of the RV gear in the summer and fall. A spring estimate of minimum trawlable biomass was calculated by summing the biomasses from the February 5Ze (1986 onwards), spring 4VWX (1979-1984 only), March 4VW (1986 onwards), spring Newfoundland, and summer 4X (1985 onwards) surveys. This index does not include estimates from 4T, and is probably a gross underestimate for years prior to 1979. It also assumes that spring 4X is at least as large as summer 4X (which is probably true). It probably provides a reasonable approximation of the minimum trawlable adult biomass summed across areas.

The estimate of summer minimum trawlable biomass in Canadian waters was calculated as the sum of the summer 4VWX and 4T surveys. Therefore, the index does not include an estimate for Newfoundland waters. Since the summer RV surveys do not adequately represent the abundance of mature females, the summer index is probably a better representation of sub-adult biomass than adult biomass.

A comparison of the spring minimum trawlable biomass between Canadian and USA waters shows comparable trends, increasing from the early 1980s to the early 1990s, then declining somewhat to the present. Mean values for both indices were around 500,000 mt in the early 1990s, declining to about 200,000 mt in 2008 for the Canadian index. Across the time series as a whole, the USA minimum trawlable biomass estimate (NEFSC 2006b) has been slightly greater than the Canadian minimum trawlable biomass estimate.

The summer/fall minimum trawlable biomass trends for both countries are more variable than are those from the spring. Both indices show a consistent upward or stable trend from about 1985 to the present. Once again, the USA minimum trawlable biomass estimate slightly exceeds the Canadian estimate. The most recent Canadian biomass values are about 200,000 mt, corresponding to about 120 million fish.

In the absence of a recent spring RV survey in 4X, it is not currently possible to estimate trends in mature female biomass for spiny dogfish in Atlantic Canada. Nor was it possible to estimate the exploitation rate for spiny dogfish in Atlantic Canada. However, biological studies indicate that the Atlantic population of spiny dogfish is more productive than is the northwest Pacific population.

Discussion

All the Canadian research trawl and industry based surveys available for dogfish were described. Based on all surveys, the vast majority of dogfish are located around southern Nova Scotia. The summer and spring surveys are most comprehensive in terms of areal coverage. The summer survey is not a good indicator of mature female dogfish abundance because these animals are thought to be inshore of the survey strata at this time of year. This hypothesis is supported by the presence of mature female dogfish in the spring survey and overall catches in the spring which are 2-10 times higher than catches in the summer. Additionally, comparison of length frequency distributions from the summer survey and commercial catches during this season indicates that the large females are located in waters inshore of the survey strata. It is hypothesized that, in the winter and spring, both sexes of dogfish aggregate in deeper water for mating and pupping and then separate in the summer and fall with the females moving to inshore waters.

Young dogfish (<5 years old) are rarely encountered in the bottom trawl surveys. It is thought that they are pelagic at this age and not available to the gear. However, they are seen more frequently in the summer survey than the spring survey, so there is a seasonal component as well.

The 4Vn sentinel longline survey is still ongoing, so indices for 2007 and 2008 should be available. In the working paper, Figure 43 for this survey does not include data for 1996 or 1997. This survey time series will be updated to include all available data.

It was noted that in some years there was not full coverage of Georges Bank by the survey. This aspect was ignored when the dogfish index was created for this survey. It was recommended that notation should be added to survey tables indicating years of incomplete coverage. However, the CVs for dogfish surveys are quite high relative to other fish such as cod, so the impact of incomplete coverage would probably not be easily detected.

The spring survey in 4X has not been conducted in recent years. This is considered the largest data gap for dogfish in Canadian waters because this survey does capture large females. However, lack of length frequency information prevents a mature female index from being created for this survey. The spring survey is more consistent with the USA survey than the summer survey, and the spring survey is less variable than the summer survey. Even though there may be USA fish in Canadian waters in summer, the minimum swept area biomass estimates are lower than the corresponding estimates from the spring, due to the lack of large female dogfish in the summer survey.

It was noted that there is a possibility of adding another sampler to the Individual Transferable Quota (ITQ) survey for lobster data collection. This additional sampler may allow more length frequency data for dogfish to be collected.

Given the slow growth rates of dogfish, it is not surprising that modes cannot be tracked well in length distributions from any surveys.

It was suggested that including bottom temperature as a covariate when developing the survey indices might be helpful given the temperature preferences of dogfish. This could be informative in Canadian surveys because 5ºC appears to be a lower limit for dogfish. The importance of environmental factors was noted by the report. For example, in 2007, industry encountered dogfish in early June on Eastern Georges Bank. This was unprecedented; raising the question of what was different in that year.

Given the different spatial and temporal coverage of the many surveys in Canadian waters, there is a need for a movement model to allow joining them all together. There have been some strong declines in some areas in Canada, as well as a “sink” in Gulf of St. Lawrence, indicating large scale movements or colonizations (perhaps also changes in migration timing). Also, the Scotian Shelf lost 90% of the abundance of its dogfish in one year, and dogfish have been absent since. There was no fishery event that could account for this drop.

TRAC Presentation: USA Research Bottom Trawl Surveys
Presenter: K. Sosebee
Rapporteur: C. Legault

Presentation Highlights

The Northeast Fisheries Science Center (NEFSC) has conducted both spring and autumn trawl surveys of the USA continental shelf annually since 1963. The surveys extend from the Gulf of Maine to Cape Hatteras. Details on the stratified random survey design and biological sampling methodology may be found in Grosslein (1969) and Azarovitz (1981). Sex of spiny dogfish was not routinely examined until 1980. There are some data by sex for 1968-1972.

Potential sets of indices of relative stock biomass and abundance for spiny dogfish were presented from NEFSC spring and autumn bottom trawl survey data. These ranged from splitting out the four regions (GOM, GBK, SNE, and MDA), combining some together, including inshore strata, and some sets excluding the Canadian side of the Gulf of Maine and Georges Bank. The survey index that has been used for previous stock assessments was split out into size and sex groups. The female spawning stock increased from 1980 through 1989 and subsequently declined through 2002. Spawning stock biomass (SSB) has since increased. The trend in juvenile female biomass increased through 1992 and has since slowly declined. The male biomass has generally increased over time, although the small amount greater than 80 cm shows a similar pattern to mature females. Biomass of spiny dogfish <= 35 cm (1-2 years old) shows strong recruitment through the 1980s and early 1990s with a recruitment failure from 1997-2003. Recent recruitments have been moderate.

Abundance indices for spiny dogfish from Massachusetts spring and autumn inshore bottom trawl surveys are available from 1978-2008 and can be split into north and south of Cape Cod.

There are some additional surveys available for future use. All the surveys are listed below.

Survey	Month	Years	Region
NEFSC Autumn	November/December	1963-1967	GOM-SNE
NEFSC Autumn	September/October	1968-1974	GOM-MDA Offshore Only
NEFSC Autumn	September/October	1975-1978	GOM-MDA Offshore plus Inshore from Cape Cod South
NEFSC Autumn	September/October	1979-2008	GOM-MDA Offshore plus Inshore from Massachusetts Bay South
NEFSC Spring	March/April	1968-1975	GOM-MDA Offshore Only
NEFSC Spring	March/April	1976-1978	GOM-MDA Offshore plus Inshore from Cape Cod South
NEFSC Spring	March/April	1979-2008	GOM-MDA Offshore plus Inshore from Massachusetts Bay South
NEFSC Winter	February	1992-2007	GBK-MDA (mostly SNE-MDA, offshore only)
MADMF[1] Autumn	September	1978-2008	Massachusetts Bay around Cape Cod to Nantucket Sound
MADMF Spring	May	1978-2008	Massachusetts Bay around Cape Cod to Nantucket Sound
ME/NH Autumn	October	2000-2008	Coastline of Maine (ME) and New Hampshire (NH)
ME/NH Spring	May	2001-2008	Coastline of Maine and New Hampshire
NEAMAP[2] Autumn	September/October	2007-2008	State waters from Rhode Island to North Carolina
NEAMAP Spring	April/May	2007-2008	State waters from Rhode Island to North Carolina
New Jersey Bi-Monthly		1988-2005	
ASMFC Summer Shrimp	July-August	1985-2008	Inshore Gulf of Maine

[1] Massachusetts Division of Marine Fisheries
[2] Northeast Area Monitoring and Assessment Program

Discussion

The sudden jump in abundance of large females at the end of the spring survey is thought to be due to a combination of underestimation of the low values and overestimation of the high values. This large increase in abundance cannot be explained by the growth rates of dogfish and is probably just a reflection of the uncertainty present in the surveys.

There was "recruitment failure" during years 1997-2003 when very few dogfish <35 cm were encountered in USA surveys. A number of hypotheses were presented as to why this happened, mostly based on the low abundance of females combined with low average size of females during this period. An increase in the male to female sex ratio also occurred at this time.

It was noted that there is a lack of dogfish <60 cm in recent years. These animals have low catchability in the surveys and there was poor recruitment during the years 1997-2003. Progressive loss over time of smaller sizes in the survey size distributions for female dogfish is consistent with observed growth patterns and low recruitment. The same truncation is seen for smaller sizes in the size distribution for males. Using the Nammack (1985) growth curve, a 10 cm increase in 3 years is feasible, so fish could be growing into the observed length distribution.

The expected proportion at equilibrium of mature males to mature females should be around 2:1 if natural mortality (M) is the same because males mature younger but survive as long. Multiple paternity has been demonstrated in other sharks, which could explain the expected 2:1 male to female ratio. The current ratio of males to females is around 7, indicating a lack of females. It was asked how this information should be used in modeling. It is indicative of exploitation using a simple life history model. It has been used to demonstrate that a males only fishery would be a way to bring this ratio back in line. It is possible to invert this ratio and estimate a fishing mortality (F), and it may be interesting to do this. The last three years appear to be indicating a correction in the ratio, perhaps due to reduction in directed fishery for large females. The early 1980s is consistent with a lightly exploited population based on the observed sex ratio. Length distribution also concurs with this hypothesis. There are implications for starting conditions for a model, with the caveat that bycatch has been occurring throughout the time period.

It was noted that there is a remarkable increase in the fall survey in the Gulf of Maine region. There is a similar increase in the spring survey in the Mid-Atlantic region. The population appears to be "sloshing" from MDA in spring to GOM in the fall. The increase in the GOM is coincident with rebuilding of herring population and increase in lobster population. One hypothesis is that herring are tighter on the bottom and attract dogfish to bottom thereby increasing catchability of dogfish. Herring catchability has changed dramatically in some areas, possibly indicative of how tight the herring were staying to the bottom. The same thing could be happening with dogfish.

Although the CVs of the surveys are 20-30% annually, which is not bad, the time series of abundance does not track well for slow growing dogfish. The variance from year to year is much higher than would be expected from an exact measure of population abundance with a 20-30% CV of measurement error.

The catch rates of dogfish can be high in the inshore strata. However, due to the small size of these inshore strata, it does not translate to large amounts of biomass.

The difference in magnitude between the winter survey and the spring and fall surveys is due to the longer ground cables in the winter survey resulting in herding. This results in a relative catchability difference.

Observer data is consistent with survey data regarding female proportion in catch as a function of distance from shore.

The USA inshore strata are much shallower than Canadian inshore strata. This is a reason the USA surveys can find dogfish in both seasons. The new USA survey vessel (Henry B. Bigelow) will only be able to survey strata about equivalent to the DFO shallowest strata. The USA inshore strata will be covered by the NEAMAP and state surveys instead.

Male dogfish have moved further inshore in the fall survey over time. Female dogfish have also moved inshore some, but they are now are coincident in inshore waters, causing lots of headaches for inshore fishermen. The same pattern is observed in the spring survey but not as strong.

The overall migration pattern of dogfish based on the USA survey information was described. In spring, females are pupping in SNE-MA region. After they pup, the females and males are distributed offshore to mate for the next year. They move north in the summer and fall to feed. Some females stay north during an intermediate year (2 year gestation). Fish move south to the GB area and however far they get before pupping again. It was recommended that a plot summarizing all the information regarding migration, mating, and pupping be put together by the dogfish experts at the meeting.

TRAC Presentation:	Maine/New Hampshire (ME/NH) Inshore Research Bottom Trawl Surveys
Presenter:	M. Cieri
Rapporteur:	C. Legault

Presentation Highlights

Data on spiny dogfish catch per unit effort was examined for the ME/NH inshore bottom trawl survey, 2000-2008. In general the survey was without trend over the time series, with a notable exception of an increase in dogfish catch during the 2004 and 2005 fall surveys. Previous to, and since those years, catch has remained low. There has been a general trend of increasing adult male to female ratio in this survey (ranging from 2 to 16), but it was noted to be the result of increasing male abundance rather than a pronounced decrease in female abundance.

Discussion

The survey doesn’t lend itself well to inclusion in any quantified assessment structure. It was noted that this survey catches a relatively narrow size range of dogfish (the 70-79 cm length bin), which are almost entirely males. Most catches of dogfish occur in New Hampshire and southern Maine at the time when herring are spawning in the same area during the fall. The minimum swept area biomass estimates are quite small for this survey (ranging from 3,000 to 20,000 mt), are quite variable, and are mostly without trend. This may indicate that the survey is sampling a small proportion of the total abundance of the available population or the abundance seen in the survey is strongly related to survey timing. Based on the results of the Massachusetts (MA) state survey, it was suggested that the ME/NH survey does not catch many mature female dogfish because these fish are in Cape Cod Bay during this time of year.

A. Data Availability for Spatial Models

TRAC Presentation: Tagging Spiny Dogfish Overwintering in North Carolina, and Summering in Bay of Fundy, Canada
Presenter: R. Rulifson
Rapporteur: L. Brooks

Presentation Highlights

From 1996 through 2007, East Carolina University (ECU, Rulifson laboratory) tagged and released spiny dogfish collected by trawl and gillnet during winter in near-shore waters of North Carolina and collected by longline during summer from the inner Bay of Fundy, Canada. Each fish was tagged with a Floy single barb dart tag with twisted stainless steel insert (SS-94). Each tag was printed with the return address, website (www.spinydogfish.org) and reward information. Over the years, rewards were $5 and $20 USD, and $10 and $50 USD. High dollar rewards were released at a ratio of 1 high-dollar tag to 10 low-dollar tags.

Over the 12 years of the study, a total of 38,268 tagged spiny dogfish were released: 84.5% (32,341) females and 13.1% (5,029) males; sex was not documented for the remainder (898). Release sites in North Carolina had similar sex ratios regardless of latitude. South of Cape Hatteras (30° to 33° N), a total of 920 fish were released: 807 females (87.7%) and 112 males (12.2%). From 35° to 37° N latitude, 30,084 females (84.5%) and 4,895 males (13.7%) were released; sex was unknown for 628 releases. In the Bay of Fundy, Canada, 1,734 tagged spiny dogfish were released: 1,443 females (83.2%), 22 males (1.3%), and 269 not recorded though most likely they were females.

The most important result from this study to date is that over 90% of the recaptured fish were caught in the country of release. As of the TRAC presentation, 397 tags (1.04%) had been returned: 335 females (84.4%) and 18 males (4.5%), with sex of 44 not documented. Of the fish released in Canada, 90.2 % (46 fish) were recovered in Canadian waters, and 9.5% (5 fish) were recovered in USA waters. Of the fish released in North Carolina waters, 93.6% (322 fish) were recovered in USA waters and only 6.1% (21 fish) were recovered in Canadian waters (0.3% of the recaptures had no recapture location).

There was no significant difference between recaptures from trawl-released and gillnet-released spiny dogfish; handline and longline releases had the highest rate of return. A total of 71.95% of all tagged dogfish were released from trawls, 24.16% were released from gillnets, and 3.89% were released from handlines and longlines. Trawl recaptures (0.885%) and gillnet recaptures (0.896%) were statistically equal; handline/longline tags were returned at a rate of 2.36%, likely the result of the same fishery returning the tags within one year of release.

Locations of tag returns confirm a northward migration from overwintering North Carolina waters during the spring, a summer period in New England, and a southward progression during the fall for overwintering off North Carolina (Figure 2). Fish tagged and released in Canada did not exhibit this behavior. Based on the results of this long-term study, and results from similar tagging studies by Dr. Steven Campana of DFO, a new paradigm for spiny dogfish migration patterns in the northwest Atlantic Ocean was presented. After considerable discussion among TRAC participants, the paradigm was revised to show five separate migration patterns (Figure 3). Component #1 encompasses the coastwide north-south seasonal migration. Component #2 suggests a counter-clockwise migration in the Bay of Fundy, Gulf of Maine and Georges Bank, with some mixing between USA and Canadian stocks. Component #3 depicts the seasonal onshore-offshore migration pattern of spiny dogfish on the Scotian Shelf. Component #4 depicts movements of a vestigial population of dogfish likely caused by a large introgression of dogfish into the Gulf of St. Lawrence, with no recruitment. Component #5 is another small dogfish population off Newfoundland making seasonal onshore-offshore movements.

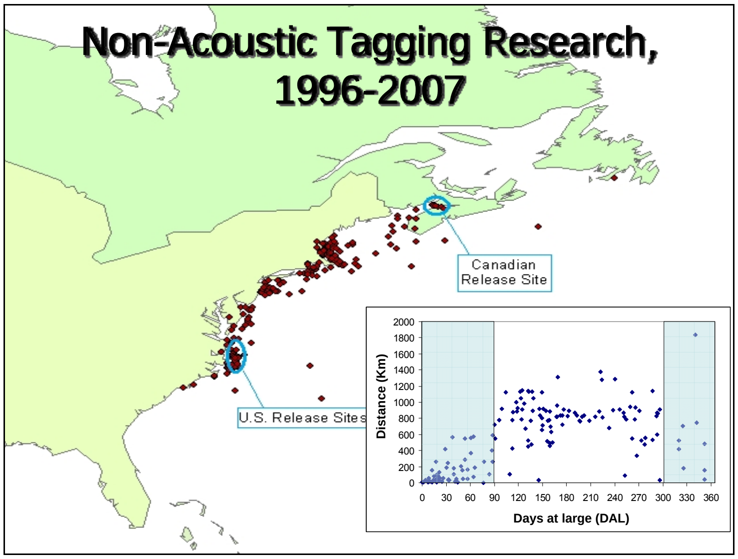


Figure 2. Eastern seaboard of North America showing the release locations of tagged spiny dogfish (blue circles) by East Carolina University, recapture locations (red diamonds), and distance from the release sites as a function of the number of days at large before recapture (Rulifson, unpublished data).

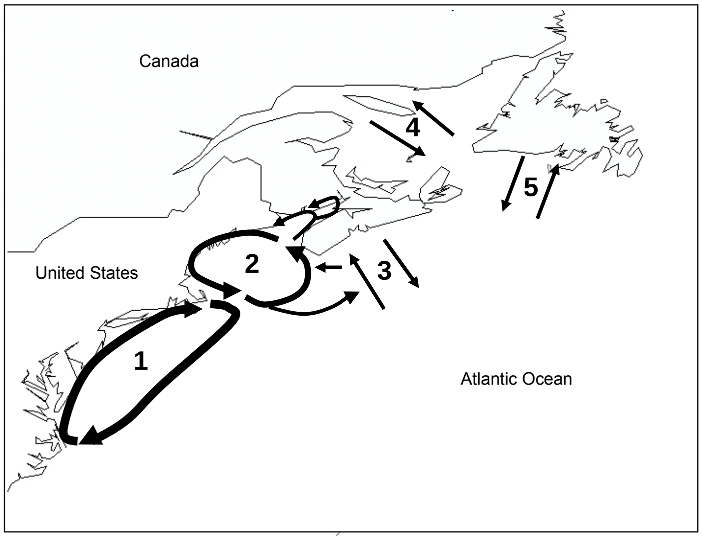


Figure 3. Proposed new paradigm for spiny dogfish migration in the Northwest Atlantic Ocean. Components #1-5 explained in the text (Cudney-Burch, Rulifson, Campana, Beamish, Sosebee, and Moore, unpublished data).

Discussion

The Floy external tags were identical for the two release sites (USA and CAN). The reward tags were $10 and $50, and released at a 10:1 ratio, respectively. Both tags were yellow and looked the same, so until a fisherman read the tag, he wouldn't know where it had been tagged.

The release dates were different for the two release sites. In the USA, it was 1996-2007 (i.e., there were releases in all years), but in Canada, release dates were 1996 and 2005. The data are available for recaptures by release period to help determine if releases and recaptures were proportional to fishery effort, given the reduction in the USA fishery after 2001 (in the Gulf of Maine). Alternatively, data could be summarized by the 2 boxes and 2 time periods. In addition, it was mentioned that Dr. Campana also summarized the recaptures by total landings and found the same pattern of recaptures, suggesting that recapture rate is not completely confounded with fishery effort.

One of the scientists identified the fact that, despite all of the various tagging studies, there are no fish tagged off of MA in the spring, which would help elucidate where those fish went. On the other hand, a lot of fish that are tagged elsewhere are recaptured in MA. Dr. Rulifson conducted a tagging study this past fall off of MA, where 900 fish were tagged, but it is too soon to have much data for analysis. He also stated that it would be interesting to do more tagging at that location with different gear types. For the current 900 fish tagged, longline gear was used, but the hook was ripped out of the dogfish mouths, and Dr. Rulifson was not sure whether that might affect survival rate.

Regarding tag recaptures in Newfoundland, it was asked whether those fish were east of Halifax. Dr. Campana responded that Figure 15 of his TRAC working paper summarizes this information, and that it shows limited mixing. Furthermore, for dogfish tagged further east, they remained there, thus supporting the proposed stock boundary at Halifax.

Regarding a figure that summarized movement of dogfish with arrows (from a white paper developed from a Spiny Dogfish Workshop at East Carolina University)), the 2 box approach seems supported. However, arrow number 2 suggested strong circular movement, but the data do not seem to support that. Revisions were made and are presented in Figure 3, reflecting migration patterns discussed at the meeting.

A comment was made that the graph of distance versus days at large was interesting and suggests that dogfish are capable of moving outside of the defined boxes. It was clarified that, while dogfish can travel large distances, they appear to remain in the defined 2 boxes.

TRAC Presentation: Tagging Studies
Presenter: S. Campana
Rapporteur: L. Brooks

Presentation Highlights

Spiny dogfish in the northwest Atlantic can be characterized as a heterogeneous and complex stock complex with both resident and migratory stock components. Available evidence suggests that dogfish in USA and Canadian waters are not distinct stocks, but that the linkage between the areas is only partial. The conceptual model appears to be one of resident components in the northern part of the range, overlayed by a migratory, transboundary component. Seasonal migrations are pronounced throughout the range, although they are primarily north-south in USA waters and inshore-offshore in Canadian waters. The seasonal north-south migrations appear to move to some extent into Canadian waters each spring, and return each fall. The magnitude of the transboundary mixing is difficult to quantify. Low tag return rates, unknown reporting rates, and changes in survey design over time reduce the scope of inferences that can be drawn about quantitative migration rates. The bulk of the population biomass is found in USA waters. The following summarizes the current evidence in support of the above view of stock structure.

- Although genetic studies are incomplete, no genetic differences have yet been identified (based on microsatellite DNA) among stock components or regions.
- Over 46,000 dogfish have been tagged in 7 separate studies between 1942 and 2008, with 667 recaptures. Although unweighted by fishing effort, there appeared to be a clear seasonal pattern of migration between North Carolina in the winter and the northeastern USA and southwest Nova Scotia in the summer.
- For the most part, dogfish tagged in Canadian waters remained in Canadian waters, and those tagged in U.S. waters remained in USA waters. However, there was clearly some movement between countries, with the Gulf of Maine region being the primary mixing ground. Overall, 346 of 384 (=90%) of recaptures from USA tagging sites were recaptured in USA waters, and 267 of 283 (=94%) recaptures from Canadian tagging sites were recaptured in Canadian waters. Restricting the analysis to the Gulf of Maine, 75/86 (=87%) of USA tagged fish and 41/51 (=80%) of Canadian tagged fish were recovered in their respective country of release.
- Gravid females were broadly distributed throughout the population range in USA waters, and on the southern Scotian Shelf in Canadian waters. Late stage gravid females are restricted to areas south of Georges Bank Young-of-the-year pups have also been collected throughout the range, particularly near the shelf edge, although their abundance is much higher in USA waters. The absence of a spring survey in 4X has constrained collections of pups. It appears that mating and pupping occurs on or near the shelf edge in spring in both USA and Canadian waters, but is much more prevalent in USA waters.
- Seasonal RV surveys strongly suggest that dogfish engage in seasonal inshore-offshore movements in Canadian waters, and north-south movements in U.S. waters. Seasonal migrations may be linked to temperature preferenda of 5-12ºC.
- Assuming equal catchability of survey vessels, biomass estimates from spring surveys are about twice as high in spring surveys as in summer/fall surveys, suggesting greater dispersal in the summer/fall. In Canadian waters, spring biomass estimates do not suggest substantial loss of dogfish to USA waters.
- Major distributional shifts in 4VW and 5Z suggest large-scale emigrations may be persistent traits of spiny dogfish. Causes for these movements are unknown but may be related to forage or temperature requirements.
- Tagging and surveys indicate that dogfish in the southern Gulf of St Lawrence (4T) and around Newfoundland are more or less isolated from dogfish further south.

Discussion

It was noted that, in the tagging study by Jensen, recaptures are confounded by a lack of USA effort, and the presence of foreign fleets that may/may not have reported tags.

Returning to the figure with arrows for movement (Figure 3), it was clarified that, with hindsight, arrow 1 would go as far as arrow 2, and even partially moving over to arrow 3. Two separate movement patterns are seen. Arrow 1 is the north-south movement, but then there is the inshore-offshore movement for areas 3, 4, and 5. The referenced figure was a first cut, and the size of the arrows does not suggest movement strengths. It was noted that the strongest signal seen is arrow 1, and the question arose as to whether that movement would be subsumed in the USA box. In addition, the mixing between regions seems to have the smallest signal. To clarify, it was suggested that there would be a strong enough flux between areas on a seasonal basis because the northward movement (arrow 1) crosses the purported stock boundary. This discussion led to questions about the magnitude of landings in the Bay of Fundy and the Gulf of Maine, and the timing of those landings relative to the north-south movement. In response, most of the effort in the Bay of Fundy occurs when the migration has already left, although some North Carolina (NC) tagged fish were caught in July-Aug in Bay of Fundy (Hall's Harbour). Also, there may be some dogfish from MA in spring that move north into the Bay of Fundy, but as was already mentioned, there are no tag releases in MA to better define local movement.

It was asked what statistical areas in the Gulf of Maine comprise the catches. Statistical Areas 512 and 514 are the primary ones, with almost nothing reported in 511-512. It was suggested that this pattern of landings may in part be due to regulation, which splits the fishery into a MA component and an 'everybody else' component.

Again, returning to recaptures and the possible confounding with effort, it was asked if one were to weight the returns by landings, does that change the perception of movement. Dr. Campana responded that he attempted to do just that in Table 1, but that it was only possible in a couple of studies; where it was possible, the overall picture did not change.

It was asked whether there is any data that might represent female movements offshore to avoid males. In response, it was noted that most of the tagging and recaptures are on mature females, so no difference could be detected between males, nor between mature and immature females. Nevertheless, no obvious difference between males and females is apparent from the data that exists.

Regarding the proposed stock boundary, it was asked if the Canada/USA borders did not exist, biologically would you impose a boundary on the stock. In response, it was noted that the limiting factors are the data and reported landings. In the absence of national borders, one might desire more boxes, because the northern component seems primarily resident – perhaps because it is the northern boundary of the stock. However, given the tagging data, it seems like the current split is a reasonable starting point. Different modeling approaches were then discussed. It was noted that an assessment with 2 separate boxes without any overlap had already been attempted, but the model fit very poorly. It was noted that compartment models have been tried elsewhere, and with dogfish you won't see cohorts or annual growth signals, so it will be hard to tease this apart in terms of annual mixing. Therefore, one might want to give serious consideration to modeling the stocks separately. After some discussion, it was suggested that several reasonable variants were the proposed 2-box with movement, a USA-only assessment (and CAN-only assessment), and assessing the whole stock (USA and Canada) as one unit.

Regarding the model boxes (spatial and temporal), it was asked if the inshore-offshore movement is aliased by season. It was clarified that in Canada there is both inshore-offshore and north-south movement by season, whereas, in the USA, it is more of a north-south movement. So, both of the proposed model "boxes" are needed.

The suggestion for going forward with modeling was to lump and split as time permits.

A. Diet and Consumption

TRAC Presentation: Diet of Spiny Dogfish and Consumption Estimates
Presenter: J. Link
Rapporteur: B. Overholtz

Presentation Highlights

The NEFSC has collected food habits data on its bottom trawl surveys routinely since the early 1970s. These stomach samples are processed, the data then audited, and the audited data are archived into the NEFSC's Food Habits Database System (FHDBS). There are over 60,000 spiny dogfish stomachs in FHDBS. After secondary auditing, checking, accounting for other strata, seasons or groupings, etc., there are >55,000 stomachs in this analysis covering over 30 years, 2 main seasons, and a broad geography. For perspective, >500,000 stomachs are in the FHDBS.

The following strata sets were used, corresponding to the two main regions (Southern New England/Mid Atlantic and Gulf of Maine/Georges Bank) with inshore and offshore components:

01130-01300, 01360-01400	GOMGBK (Gulf of Maine-Georges Bank)
01010-011120, 01610-01760	SNEMDA (Southern New England-Mid Atlantic)
03560-03660 (inshore)	GOMI
03010-03550 (inshore)	SNEMDAI

Additionally, the following sex-size group cutoffs were established to capture major changes in the life history (and associated feeding) of spiny dogfish:

Length	Sex		
<=35	Both	Recruits	R
36-59	B	Juveniles	J
60-79	M	Mature Males	MM
60-79	F	Juvenile Females	JF
80+	M	Old Males	OM
80+	F	Mature Females	MF

Before parsing out into year, season, size-sex group, or region, the diet of spiny dogfish is characterized as feeding upon largely small pelagic fishes and mega-plankton (Figure 4).

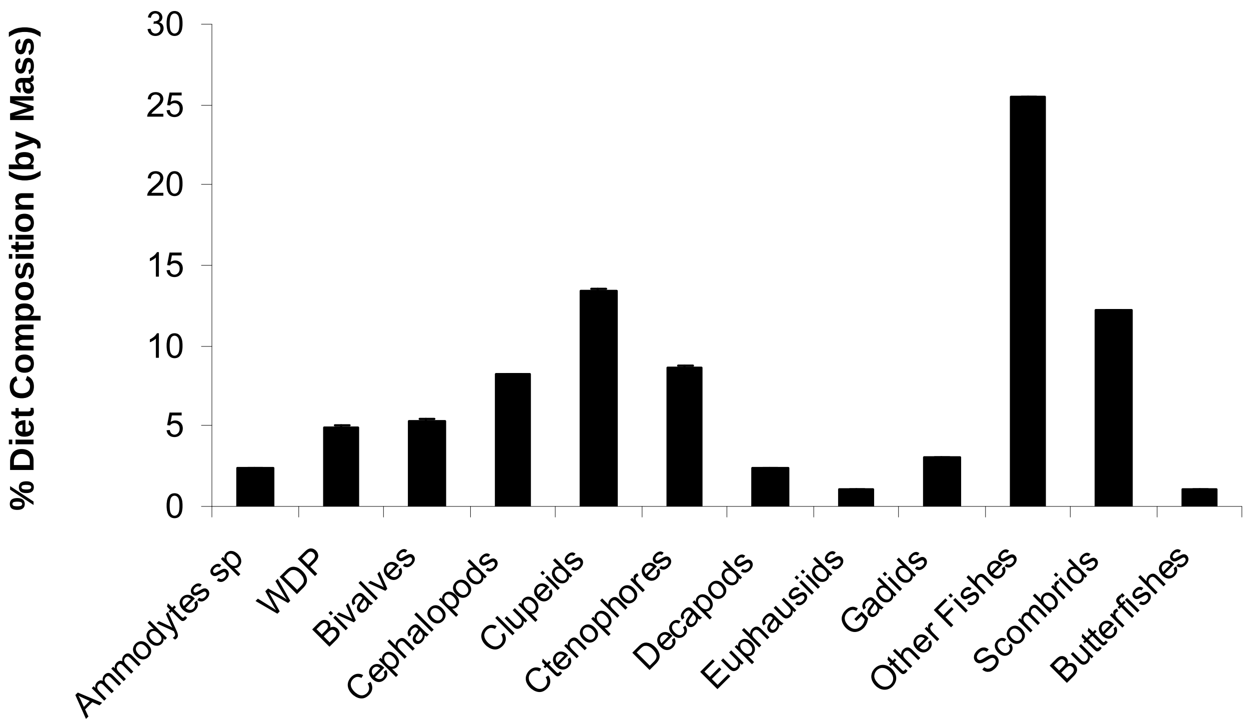


Figure 4. Mean diet composition of all spiny dogfish.

To estimate mean stomach contents (S_i), spiny dogfish had the total amount of food eaten (as observed from food habits sampling) calculated for each size class, temporal and/or spatial scheme. The denominator in the mean stomach contents (i.e., the number of stomachs sampled) was inclusive of empty stomachs. These means (grams) were weighted by the number of tows in a temporal and spatial scheme as part of a two-stage cluster design (Link and Almeida 2000).

Estimates were calculated on an annual basis for each spiny dogfish size class. These size classes corresponded to a combination of size-sex considerations (see Table above). The regions corresponded to GOMGBK, and SNEMDA, with both inshore and offshore components (for a total of 4 spatial regions, as defined above). Although the food habits data collections started quantitatively in 1973, collections for spiny dogfish weren't initiated until 1977. For more details on the food habits sampling protocols and approaches, see Link and Almeida (2000). Key diagnostics were the number of empty stomachs over time and mean length vs. mean stomach contents weight (with ± 95% CI), which were examined to identify any major outliers in the data and to ascertain any notable patterns in variance.

To estimate diet composition (D_{ij}), the amount of each prey item was summed across all spiny dogfish stomachs. These estimates were then divided by the total amount of food eaten in a size class, temporal and spatial scheme, totaling 100%. These estimates are proportions and were only presented for those major prey comprising >85% of the total for each size class, temporal and spatial scheme.

Using this information, a consumption model was developed for each season (spring and fall), size-sex group, region, and year for spiny dogfish. The method for estimating consumption employs an evacuation rate model, modulated by local temperatures, and keys off of mean stomach contents. There has been copious experience in this region using these models

(Durbin et al. 1983; Ursin et al. 1985; Pennington 1985; Overholtz et al. 1991, 1999, 2000, 2008; Tsou and Collie 2001a, 2001b; Link and Garrison 2002; Link et al. 2006, 2008; Methratta and Link 2006; Overholtz and Link 2007; NEFSC 2007a, 2007b; Link and Sosebee 2008; Tyrrell et al. 2008; Moustahfid et al. 2009a, 2009b). An example estimate is shown in Figure 5.

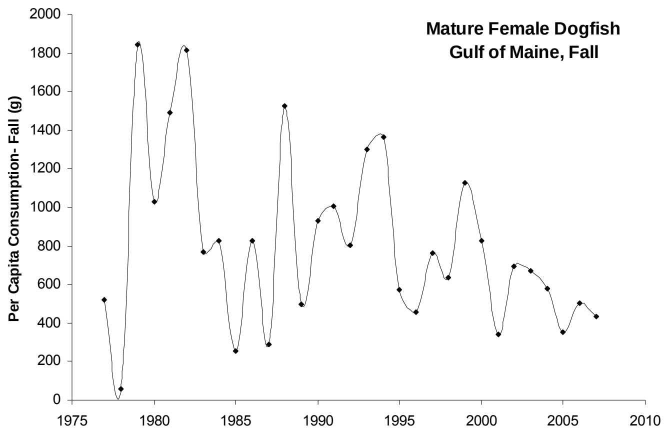


Figure 5. Per capita consumption estimates for mature female dogfish in the fall of the GOMGBK region.

Once per capita seasonal consumption is calculated, it can be scaled by diet composition for prey items of interest. Then those estimates are integrated into an annual estimate of consumption, and scaled by population level abundances for each size-sex group, region and year combination. A region-wide estimate can also be integrated across all of the factors just noted to obtain the total amount of removals by spiny dogfish.

Several areas of uncertainty and options for improvement have been noted, including the parameterizations for the consumption model and exploring the percentage empties of dogfish stomachs in the 1990s. Yet, given these caveats, this approach is feasible, straightforward, and mostly has sufficient data (with a few exceptions in the spring survey for smaller size classes of the inshore regions) to address future and related ToR for spiny dogfish consumptive removals.

Discussion

A question on the stomach content data was asked, and it was determined that the stomach content data used in the analysis is the mean stomach contents for the various size/sex categories. Another query asked if using bottom temperature is consistent with the dogfish predation. It appears to be a useful integrator of several factors and a better choice than surface temperature. Some analyses of survey data for co-occurrence with prey items have been completed, but much remains to be done.

Prey composition of the dogfish diet relative to changing growth rates has not been investigated. Dogfish are eaten by a few fishes; they show up rarely in the 500,000 stomach database, probably consumed occasionally by tuna, sharks, etc.

A comprehensive comparison of USA and Canadian dogfish stomach data has not been completed. There appear to be fewer Canadian data. Preliminary investigations of data suggest that diets are similar. It was noted that the equivalent percentage of body weight (BW) consumed per day implied from the current analysis is roughly 0.5-0.8%. This is consistent with studies from the lab and field that suggest that elasmobranchs have a slower metabolism than teleosts, and consume roughly 0.5-1% vs. 1-3% (BW) per day.

Dogfish diet appears to reflect prey abundance, as seen by consumption of sand lance in the late 1970s and early 1980s when herring and mackerel were scarce. Dogfish then switched back to herring when the stock recovered. Changes in condition with different prey have not been investigated. Someone asked if the diet composition of dogfish is possibly a good abundance index for various prey items, particularly for the prey that represent the largest components of the diet, such as ctenophores and herring.

There was some concern that the estimate of consumption may be lower than expected given the current understanding of spiny dogfish life history.

There is possibly a pattern in the percent of empty stomachs, but further investigation is needed. The percent increase in the 1990s was noted, but the cause hasn't been determined.

The analyst asked if he should proceed with the dogfish consumption calculations for the model meeting. The TRAC agreed that the approach was reasonable and at about the right level of temporal and spatial scale. It was noted that there is a difference between sexes. The available data could be aggregated, but any further disaggregation would probably not be feasible.

The consumption model is based on a 24 hour day. Evacuation rates are averages; also, an alpha that reflects an average over many prey types, mostly soft bodied, is being used. Cluster sampling design was being used to calculate input data for the consumption analysis. There is no evidence of cannibalism by spiny dogfish. In this ecosystem, only silver hake appear to be cannibalistic.

A. Reproductive Biology and Reference Points

TRAC Presentation: Reproductive Biology and Rebuilding (Biological Reference Points)
Presenter: P. Rago and K. Sosebee
Rapporteur: L. Brooks

Presentation Highlights

Information was presented on a study of spiny dogfish reproductive biology that was initiated in 1998 and is currently ongoing. Spiny dogfish females 65 cm or greater in total length (10 cm below the previously estimated size at first maturity) were examined during the bottom trawl surveys conducted by the NEFSC from 1998-2008.

Each female was examined for the presence of free embryos, fertilized uterine eggs (candled embryos), and ovarian eggs. Immature females were classified as those with small ovaries containing either no eggs or small, non-developing eggs. A female was determined to be mature if large, well-developed eggs were present in the ovaries or if embryos were present in the uterus. If free embryos were present and time permitted, the embryos were counted for fecundity analysis. Candled embryos and ovarian eggs were not used in the fecundity analyses because they were prone to rupture.

The relationships between pup weight and average pup weight with maternal length show a consistent increase with maternal length. A 100 cm female produces a pup that is 5 cm longer and about 50% heavier than an 80 cm female. The number of pups produced also increased with maternal length but females with more than 6 pups were uncommon for dogfish less than 95 cm. The number of fertilized eggs and free embryos did not appear to change with gestational month. Such changes might be expected if capture stress or other factors were decreasing the number of fertilized eggs within the females. Larger numbers of near-term free embryos also corresponded to larger average sizes. Thus larger females produce larger clutches of eggs and larger average-sized pups. Collectively, these factors suggest, but do not confirm, that larger females produce offspring of higher fitness and are potentially subject to a smaller spectrum of predators.

Discussion

The measure of reproductive potential for spiny dogfish should be based on pups. Having an improved understanding of the mechanisms, viability, etc., and expressing those as biological processes rather than steepness would be preferred. The reference points will be influenced by what measure is used. For background context, it was explained that the historical reference point used came from an exploratory investigation of the stock-recruit curve in 1996. That preliminary analysis suggested that a plot of pups vs. SSB was domed, with the peak of the dome occurring around 200,000. This pattern broke down when looking at data plotted from 1968-2006, hence the desire to build a new stock-recruit function from first principles. The previous F_{ref} was based on maintaining pups/recruit =1, given the age (length) at entry to the fishery. Given that there is now more information, it makes sense to rethink the basis of the reference point.

Clarification was asked regarding units of SSB used in the model mentioned above. The units were biomass of all females above 80 cm. Given that the number of pups produced looked linear with length, someone asked what the pattern using weight was, and should number of pups born be predicted from a function of pups at length rather than the total weight of mature females. The scientists reported that they thought the relationships were linear and would scale. Using pup production rather than SSB may be a more precise estimate of spawning potential.

Summarizing the Canadian reproductive information, Dr. Campana stated that the NEFSC data and conclusions were consistent with what was found from Canadian data. Also, with respect to spatial distribution, gravid females in Canadian waters are widely dispersed. Furthermore, there was no evidence of pupping grounds because there is no sampling of fish just prior to birth, primarily because of the absence of a spring survey.

A. Data Benchmark Consensus

Dogfish exhibit complex migration patterns. Existing tagging studies are informative but not sufficient to quantify migration rates outside of a more complex modeling approach. Analyses of raw recapture rates, suggests limited movements of dogfish out of the country of release. More detailed examination of time at large and the general patterns of fishing effort in the area of release are necessary before these indicators of general movement patterns can be used to quantify flux among release areas. In particular, potential influences of fishing effort, and reporting rates on recapture probabilities need to be addressed.

Sufficiency of Data

All assessment models reflect a compromise between sufficient realism of biological processes and availability of data to support candidate hypotheses. Compared to other shark species, assessments of spiny dogfish are supported by abundant fishery independent and dependent data. Nonetheless, major information gaps in landings and surveys are evident, and no routine age data are collected. Available landings information includes total landings by country and gear type. Biological sampling for length and sex is available in both Canada and the USA since 1982. Spatial resolution of the USA fishery is generally restricted to NAFO statistical area although state water fisheries in the USA are identified uniquely.

Discard information is not available prior to 1989 and must be imputed for earlier periods. Coverage for gill net and otter trawl fisheries occurs in most years, but data are sparser for other gears. Size and sex composition of the landings and discards are available for the more recent years. The survival rates of discarded dogfish in different gears are available from a limited number of studies.

Multiple fishery-independent surveys are available in each country. Details on the spatial coverage, duration, sampling domain, and sampling units are described earlier. Sex specific information in the USA surveys is available since 1982. It should be noted that the USA federal surveys changed in 2009 when a new vessel and net were first used to monitor the resource. Experiments that compared the performance of the *R/V Albatross IV* and *FSV Bigelow*, conducted in 2008, are expected to be useful in the development of constraints on catchability.

The USA and Canada surveys overlap in their spatial coverage, and some changes in sampling design have occurred. Industry-based surveys and cooperative studies are available for both countries and can be used to supplement the surveys and other fishery-dependent monitoring studies.

A number of tagging studies have been conducted and were summarized earlier. These data, when combined with other survey and catch information may be sufficient to quantify migration rates. However, overall low return rates and unknown reporting rates are major sources of uncertainty.

Accurate growth models are essential for modeling spiny dogfish. The assessment models are based on calibration to size information but the dynamics are controlled by the assumptions related to the size-specific growth rates that occur annually.

Diet composition data are useful for assessing the impact of spiny dogfish on prey species. Such information is also useful for identifying possible cues for migrations.

Basic Model Structure

A review of the available data and modeling approaches suggested that a forward-projecting, length-based model could be supported by the data. The group recognized the potential sensitivity of model results to region specific growth rates but agreed to use a common growth curve initially. Two spatial units, roughly defined at the Hague line boundary were considered as approximate operational stock areas between the USA and Canada. At the inception of the USA Fishery Management Plan, the fishing season was divided into two periods (May 1st, year t to October 31st, year t, and November 1st, year t to April 30th, year t+1). These time periods, within the year, alias changes in availability of fish to northern and southern states within the

USA. Data from 1986 to 2008 were judged to have the highest quality; earlier data varied in quality and required additional assumptions regarding discard rates, and size and sex composition. Longer term extrapolations to earlier periods may be difficult. Dogfish landings and discards occur primarily in gill nets, trawls, and longline/hook gear. It was considered desirable to include separate selectivity functions for these gears.

Spiny dogfish are recorded by sex in most research trawl surveys and in landings and discards. Capturing the dimorphic growth and maturation patterns was considered to be an essential feature of the model. Available life-history information on the effects of maternal size on the number and size of pups suggests that a process-oriented stock recruitment relationship can be developed for spiny dogfish. Moreover, the group considered the potential density dependent effects of sex ratio as important features to include in the model.

The proposed model complexity is beyond what may be feasible in this assessment. The group recommended consideration of full and reduced models as a way of improving understanding of stock dynamics. For example, USA only or Canada only models may prove helpful in explaining anomalies.

For surveys that do not cover the entire range of the species, it may be helpful to apply generalized statistical models to identify measures of trend. Spatial analyses of at-sea observer data are likely to help identify seasonal distributional patterns.

B. MODEL AND ASSESSMENT MEETING

B. Introduction

The Transboundary Resources Assessment Committee (TRAC) co-chairs, L. O'Brien and T. Worcester welcomed participants (Appendix 4) to the 2010 TRAC benchmark model review and assessment of spiny dogfish.

The Terms of Reference and Agenda for the meeting are provided in Appendices 2 and 5, respectively. During the meeting, each working paper was presented by one of the authors and then followed by a plenary discussion of that paper. Rapporteurs documented these presentations and discussions for the Proceedings.

B. Review of Data Meeting Consensus

TRAC Presentation: Review of Benchmark Data Consensus
Presenter: L. O'Brien
Rapporteur: J. Blaylock

Presentation Highlights

See Section A. Data Benchmark Consensus (p. 27).

Discussion

A question was raised about the ability of the data to support cohort-slicing, which would allow for a pre-selection of models. The TRAC was informed that cohort evidence is generally not expected for elasmobranchs.

The TRAC inquired whether any analysis was done in relation to the predictive ability of the data (what can year *n* say about year *n+1*?). An example of a very simple model will be presented in the overview of the current assessment.

Retrospective analysis was conducted for this meeting.

B. Current USA Dogfish Model

TRAC Presentation: Current USA Spiny Dogfish Assessment Model
Presenter: P. Rago
Rapporteur: J. Blaylock

Presentation Highlights

The current model to assess spiny dogfish for USA management purposes was summarized. This model is based on swept area biomass estimates derived from the NEFSC spring bottom trawl survey, landings in Areas 3-6, and discard estimates in USA fisheries. Uncertainty in all of these components is characterized using a stochastic model that estimates the joint effects of these sources of uncertainty on the estimated biomass and fishing mortality rates. A simple mass balance model provides evidence that the swept area estimates of abundance are close to the absolute biomass estimates. Major changes in abundance of mature female biomass were observed following commencement of the directed fishery in 1989. Changes in the size structure of the population and sex ratio were observed in the landings and multiple surveys.

A method was proposed to establish feasible ranges of abundance based on assumed survey catchability factors and plausible ranges of historical fishing mortality rates. These heuristic range can be used to establish independent bounds on estimates from more analytical models.

Discussion

Some clarifications were necessary regarding the extent of the surveys used in the assessment:

- Inshore strata are surveyed more intensely by state surveys than by NEFSC surveys.
- NEFSC spring survey is the primary survey used in the assessment.
- NEFSC spring survey starts after March 1st and lasts 8-10 weeks, moving from the south (Cape Hatteras) to the north (Gulf of Maine). NEFSC autumn survey starts in early September and last 8-10 weeks as well.
- An average of 48% of mature females are inshore in the fall.
- There does not appear to be a major influx to the inshore areas in the spring.

There was some discussion about the discard mortality rates currently used in the assessment and whether these rates are appropriate. There is ongoing work to address this issue (Campana, Rulifson), which should yield results soon that will help resolve these questions.

The stochastic model estimate of SSB indicates a threefold increase in biomass in the last five years, which may be biologically infeasible. Several hypotheses were discussed:

1. The dogfish moved close to the shelf in the very cold springs of 2004-2005, thus being less accessible to the survey, and causing an abrupt change in catchability (q).
2. Spiny dogfish might be more pelagic than what is presently accepted, and biomass estimates could be much higher.

This discussion also led to speculation of the possibility that the NEFSC survey is catching the same population in the Gulf of Maine in May that it was in the south in March (survey following population).

Concern was expressed about the assumed natural mortality rate (0.092) and the level of confidence in that value. The presenter confirmed that some sensitivity analyses have been conducted.

The envelope method is a non-model based approach of developing a range of scenarios. While ad-hoc, this method is valuable since it allows for identification of a range of stock sizes, within which the results of the chosen model should be.

Cannibalism is known to take place in spiny dogfish, which could be a factor causing spatial segregation between males and females in this species.

B. Overview of Proposed Benchmark Models

TRAC Presentation: Comparison of Proposed Benchmark Models
Presenter: P. Rago
Rapporteur: J. Blaylock

Presentation Highlights

Factor	Haist Model	Stock Synthesis
General	Forward Projecting	Forward Projecting
Software	AD Model Builder (ADMB), custom	ADMB, Stock Synthesis 3 (SS3)
Growth model	Campana 2009	Nammack 1985
Max Age (yr)		40
Maturity		Female 80 cm; Males 60 cm
Natural Mortality	0.1 Juveniles, 0.15 Adults	0.092
Spatial Structure and Migration	Yes	No
Sexes	Males and Females	Females only
Time period	1962-2008	1982-2008 “fishing year”
Time Step	6 month (Nov-Apr, May-Oct) (from 1970 onward)	12 months (May(t)-Apr(t+1)
Landings	Multiple fleets (4 CDN, 7 USA)	Aggregate fleet
Discards	Multiple fleets with varying selectivity	Aggregate fleet
Selectivity	Varies by fleet but not by year	Random walk by year with constraints
Constraints on Survey q	No	Yes
Tagging Data	No	No
Surveys	9 surveys (4 CDN, 5 USA)	USA Spring
Sequence of Events	1-Mortality, 2-Grow, 3- Recruit 4. Move	Simultaneous?
Stock Recruitment Model	Compensatory pup survival rate	Ricker Model
Likelihood Emphasis Factors	Weighted	Currently unweighted
Diagnostics/Retrospective	Not yet implemented	Available
Estimates of F	Max F on fully recruited	Max F on fully recruited
Biological Reference Points	Not yet implemented	Included

Discussion

Based on the model comparisons, the TRAC decided to create a similar table to tabulate and summarize the model input and formulations for both the Haist and SS3 models.

B. Data Input for Benchmark Models

TRAC Presentation:	Data Input for USA Stock Synthesis (SS3) Benchmark Model. TRAC Working Paper 2010/02
Presenter:	K. Sosebee
Rapporteur:	J. Blaylock

Presentation Highlights

Fishery-Dependent Information

Commercial landings were summarized in several different ways. Annual calendar landings were presented for USA and distant-water fleets. Estimates of recreational catch of dogfish were developed for landed and discarded dogfish using an average weight of 2.5 kg per fish to estimate weights. Discard estimates from SAW/SARC 43 were updated for the otter trawl and gill net fisheries. Discards from 1964-1980 were hindcast using the same rates that were used in the previous assessment. The size and sex composition of the total catch was taken directly from SARC/SAW 43.

The USA landings were also presented by two time periods, May 1-October 31 and November 30-April 30. To split the foreign landings between the USA and Canada, an assumption of 70/30 percent USA/Canada was used for Georges Bank since the data were not split out until 1985. The recreational numbers by time period were converted to metric tons using pooled average weights from the sampled fish. Discards were revised to reflect fishing year and included longline, otter trawl, shrimp trawl, sink gill net, scallop dredge, and mid-water trawl.

The commercial landings and discards by fishing year were split out by sex using the pooled fishing year port samples for the landed portion and the pooled fishing year observer samples for the discards. For most years, the sampling is adequate; however, there a few years with less than 10 samples. The Canadian landings and discards were assumed to have the same size and sex structure as the USA fishery for some models, but other model formulations used the Canadian length samples directly. This involved pooling across years as the Canadian sampling is more sporadic than the USA sampling, although when there is sampling it has been intense. The recreational landings and discards were also assumed to have the same size and sex structure as the USA commercial fishery given that the recreational length frequency data was not sampled by sex. The resulting landings by sex indicate that the majority of the landings of spiny dogfish have been female and that females also make up more than 50% of the discards by weight. For some of the modeling work, the length composition data by gear type and half year were used directly as is.

Fishery-Independent Information

The NEFSC has conducted both spring and autumn trawl surveys of the USA continental shelf annually since 1963. The surveys extend from the Gulf of Maine to Cape Hatteras. Sex of spiny dogfish was determined from 1968-1972 and then from 1980 to current. Indices of relative stock biomass and abundance for spiny dogfish were presented from NEFSC spring and autumn bottom trawl survey data. Overall indices were determined using only the offshore strata (1-30, 33-40, and 61-76) in order to obtain longer time series (i.e., 1967-2008 the autumn survey and 1968-2009 the spring survey). Two other strata sets were also used to calculate alternative indices. An index that includes the inshore strata from Cape Cod Bay to Cape Hatteras (inshore 1-66), was calculated; however, the Bay of Fundy strata were excluded because those strata may not be sampled in the future (offshore 33-35). An additional index was estimated that included the inshore strata but excluded any strata (offshore 16-18, 21-22, 29-30, 36) that straddle the Hague line (International Boundary) along with the Bay of Fundy strata.

The three strata sets generally agree with regard to trend, with the autumn survey showing the greatest difference because of the inclusion of the inshore strata, which are more important in the autumn. Both seasons indicate an overall increase in abundance and biomass from the early 1970s through the early 1990s. From the 1990s to the early 2000s, the total biomass index declined, with the greatest change occurring for females in the spring survey. A subsequent increase occurred through 2009. The rate of change in the autumn survey has generally been less than observed for spring but still indicates an increase in biomass at the end of the time series.

Estimates of minimum stock biomass were determined from the NEFSC spring survey catches. Mean numbers per tow by sex and 1-cm length class were converted to average weights using a length-weight regression (females: $W = \exp(-15.0251) * L^{3.606935}$; males: $W = \exp(-13.002) * L^{3.097787}$). These average weights were then multiplied by the total survey area (64,207 n mi^2) and divided by the average area swept by a 30-minute trawl haul (0.01 n mi^2). Three size categories were defined (<=35 cm, 36-79 cm, and >=80 cm), which approximately correspond to new recruits, males and immature females, and mature females, respectively.

Discussion

Some discrepancies between the text and the tables of the Working Paper were noted. These will be adjusted.

In the absence of age composition, a suggestion was made to consider the length composition data by cohort slicing to be able to follow cohorts through time.

Clarification was given on the rationale behind the use of two different time periods between the USA and Canadian models:

- USA (1982-2008): There is an absence of information on sex ratios prior to 1982, discards are less reliable, and there was a second period of high catch in the 1990s, similar to those in early 1970s.
- Canada (1962-2008): The time period starts earlier in an effort to incorporate large landings that occurred in the early 1970s.

The USA benchmark model is female-based only. Since males represent about a quarter of the catch in some years, there is some concern about leaving them out. The Canadian model will be treating both sexes, providing a base for comparison.

TRAC Presentation: Data Inputs for Canadian Benchmark Haist Model. TRAC Working Paper 2010/01
Presenter: S. Campana
Rapporteur: J. Blaylock

Presentation Highlights

The data inputs reviewed at the previous TRAC meeting were summarized. Landings data since 1960 increased markedly in the mid-1960s due to the presence of foreign vessels fishing near the Canada-USA border. Since 1986, Canadian landings have been dominated by directed longline/handline fisheries and, to a lesser extent, gillnets. Estimated dead discards exceeded landings prior to 1998, but they have been considerably less than landings since the emphasis on the directed fishery beginning in 1998. Landings from all sources in Canadian waters peaked at almost 4,000 mt in the early 2000s.

The summer RV survey has been conducted since 1970, and is the primary ongoing index of dogfish abundance in Canadian waters. Comparison with seasonal (spring and fall) surveys in the 1980s indicated that the summer survey does not capture mature females, due to their proximity to shore. As a result, the summer survey is a poor index of mature female abundance. Analysis of the seasonal surveys in the 1980s indicated that most of the summer biomass, plus the mature females, moved offshore to overwinter, rather than migrating into USA waters.

Dogfish abundance in the summer survey has increased to about five times that observed in the 1970s. The summer survey abundance index tends to parallel the USA fall survey abundance index. Minimum trawlable biomass in Canadian waters is about 40% of the total of the Canadian summer and USA fall minimum trawlable biomasses. A proxy for spring biomass in Canadian waters is relatively similar to that of the USA spring survey.

Discussion

The fishery in Canada is much more mixed (i.e., males and females) than in the USA. There are also differences in market, in that much of the Canadian fishery is directed to Europe where all sizes can be sold. Thus, there is little discarding in the Canadian fishery.

There is a difference in timing between the USA NEFSC spring survey and the Canadian spring survey.

Given the numerous surveys used, a request was expressed to see a figure that would help to get a sense of the trends of each survey and how they relate to each other.

Uncertainty in spiny dogfish movement patterns led to questioning about whether the Canadian surveys might be catching a different segment of the population. There is no evidence supporting this hypothesis, but it could be possible that the females are the only ones migrating, moving south to reproduce. Movement of this species could explain the large swings in survey indices that are observed.

Finally, there was some discussion about the necessity to have a spatially-explicit model. Migration is evident, but including this aspect in the model might be making it more complicated than is necessary. Consensus was reached that an additional run of the Haist model would be performed with the migration parameter turned off, essentially running it as one region for comparison.

B. Forward Projecting Models

TRAC Presentation: Canadian Length–Based, Spatial Model
Presenter: S. Campana and V. Haist
Rapporteur: T. Worcester and J. Blaylock

Presentation Highlights

The model was fit initially using all available research surveys in both Canada and the USA. However, surveys with short time series (e.g. spring and fall DFO, ITQ, and DFO February Georges Bank) and those with incomplete coverage of the stock areas (e.g. MADMF) were later excluded. Thus, the final model that was reviewed included the DFO summer RV survey, and the NEFSC spring, winter and autumn surveys.

In general, survey and fishery selectivities appeared to be well estimated by the model. The appearance of a dome at large sizes (>90 cm) in some surveys and fisheries suggested that flat-topped selectivity would not be an appropriate choice for those fisheries.

As is common with models incorporating both length composition and survey abundance data, the length compositions dominated the model fit. Therefore, the catch and survey length composition data were downweighted to 0.1 of their initial weights.

Initial model runs indicated that summer population biomass through the entire stock area had declined by about 50% since 1970. Mature female numbers peaked in the late 1970s, declined to a low around 1998, and has increased subsequently. The migration parameter suggested that a larger proportion of males migrated between regions than females, at least at lengths greater than 45 cm. Length compositions were relatively well fit in recent years, but markedly less so prior to 1996. Survey abundance trends were relatively well fit when disaggregated by sex and maturity, particularly for mature females.

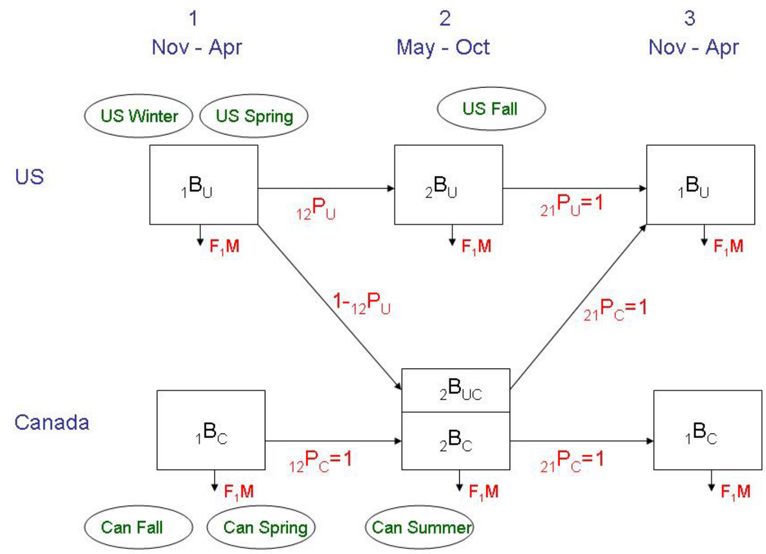
A number of model runs were made through the course of the meeting, evaluating the sensitivity of the model to:

- Length composition weighting: as the weighting increased, the goodness of fit to the length compositions increased, but that to the survey abundances decreased
- Estimation of M: juvenile and adult M were estimated at values relatively similar to those assumed (0.18 and 0.15 estimated for juvenile and adult, respectively)
- Penalty on CA:USA summer biomass proportion of 0.41 removed: small effect on model
- Assumed population size at model start relative to virgin: affected initial trajectory

A model run amalgamating the two regions into one was attempted but was not successful.

Discussion

The following graphic was created by TRAC to clarify the movement of fish in the Haist model.



TRAC Presentation: USA Length–Based Model: Stock Synthesis
Presenter: K.Sosebee
Rapporteur: P. Nitschke

Presentation Highlights

Using the Stock Synthesis modeling program (SS3), many variations of the data inputs and parameter setups were used to try and build a model that resembled the previous assessment. Initially, calendar year landings and discards with sexes combined were input as two separate fleets from 1982-2008, and the spring survey total biomass index was used as a calibration index. The length composition data for the landings was taken from the combined gear port samples and the discards from the combined gear observer samples. The growth used in most of the synthesis runs was taken from Nammack et al. (1985), as were the length-weight parameters.

Many of the runs did not match the survey data trend, so extra variance was allowed for the initial discards. This resulted in a slight improvement to the fit. Since most of the signal in the survey has been for mature females, an attempt was made to use the index of SSB from the survey as a separate index. The fit to the overall survey was still not very good but the fit to the SSB index was very good. Since this model seemed to improve some diagnostics, a decision was made to split the survey into male and female components so as to not use the same data twice. Before that was done, the move was made to fishing year catch. Some alternative runs were made with the Campana growth parameters, but the overall fit and the fit to the length compositions were not as good, so the Nammack growth parameters were used for the rest of the models. Once the survey data were split into male and females, an attempt was made to estimate the growth parameters one at a time to see if that improved the fits. Estimating Linf actually gave the lowest likelihood of this set of model runs; however, the estimates of SSB of 300,000,000 mt were highly infeasible and the estimates of Linf were very low. Estimating carrying capacity (K), on the other hand, improved the fit of the commercial length composition data and still gave feasible results with slightly low values of K.

After a great deal of discussion, it was decided to try a female only model. The final set of model formulations uses the female fishing year catch, a Ricker stock-recruitment curve with the steepness parameter free to move above one, estimating variance at size, with a strong prior on catchability based on some FSV Henry Bigelow assumptions, M = 0.092, Nammack growth parameters, and a random walk on L50 for both the landings and discard selectivity. The difference in runs is the lambda given to the survey trend. No model was acceptable.

Future runs include extending the time series back to 1962 by making an assumption of proportion female in the historical catch, a USA only model, another attempt at including males, and creating a recruitment index to try to match the survey length composition. Longer term plans include putting the discards in the discard portion of stock synthesis instead of a separate fleet, splitting the landings and discards into separate fleets to include the Canadian length data, two season model, and a two area model using the existing tagging data.

Discussion

Most of the discussion centered on model configuration differences between the Haist and SS3 models. It was difficult to distinguish how model configuration influenced the varying results between the two models. The base run from the Haist model was configured as a multi-fleet, two time block, two sex, two stock model with fixed migration rates based on tagging data. The two stock model assumes a resident USA and Canadian population with a proportion of USA fish migrating into the Canadian stock area during half of the year. The migratory USA proportion is assumed to move back to the USA stock area in the second time block if it survives the Canadian fisheries. The SS3 model assumes a single stock annual time block in which the DFO and NEFSC surveys are a measure of population abundance for the entire stock. A run with the Haist model as a single stock unit did not resolve the differences in the results between the two models.

There is also substantial difference in the approach for estimating selectivity between the two models. The Haist model was designed to estimate a single dome shaped selectivity pattern over the time series for each fishery separately whereas SS3 combined all fisheries into a landing and discard component by country and estimated a logistic selectively curve that was allowed to vary over time using a random walk function. Essentially, the Haist model was designed to estimate gear selectivity patterns with no temporal variation but more spatially stratified, while the SS3 modeled the temporal changes of the fisheries with the different fisheries and gears combined.

The Haist model modeled the sexes separately while the SS3 model was limited to female dogfish. However, the Haist model was fitted to the aggregate survey indices of both sexes. Very different dynamics are seen between the sexes in the surveys. The larger USA fishery was predominately comprised of the larger female fish while the smaller Canadian fishery had landings of both sexes. The development of the directed USA large female fishery does seem to correspond to a truncation of the larger fish in the survey during the mid 1990s. There was some discussion with regards to the management of males caught in the Canadian fishery if a female only model was accepted.

An updated Canadian growth study had lower growth rates for the smaller/younger dogfish relative to Nammack et al. (1985) study. The update growth study was used in the Haist model. The base run in the SS3 model used the Nammack et al. (1985) von Bertalanffy growth model. However, a run using the updated growth model did not substantially alter the SS3 model results. In the Haist model, growth was modeled as a growth transitional matrix.

Results in the female dogfish SS3 model was influenced by the input weight on the spring NEFSC index. The SS3 model did not fit the higher abundance seen in the spring index in the early 1980s. The model also had difficultly matching the smaller and larger fish observed in the length frequency distributions from the spring survey in the early 1980s.

Results for both models are influenced by their initial startup conditions and assumptions. The hindcasting of estimated discards with the assumed discard mortality rates and the existence of a substantial foreign fishery during the 1960s and 1970s seems to produce some fitting conflicts with the elasmobranch outburst seen in the surveys during early 1980s. The long lifespan and size selective targeting of the largest/oldest component from the fishery results in persistence of the initial model conditions and assumptions over a long time period within the model time series.

The SS3 model hits the upper bound on the q estimate for the spring NEFSC survey. Bounds on q were setup as priors in the SS3 model based on the feasible range from the area swept estimates in the survey. It appears the SS3 model favors lower biomass estimates so that the estimated F will have a greater influence on the population to match the observer dynamics in the data.

B. Reference Points and Projections

TRAC Presentation: Mechanisms for Reduced Recruitment
Presenter: P. Rago
Rapporteur: J. Nieland

Presentation Highlights

Spiny dogfish recruit biomass was reduced during 1997 – 2003. Four hypotheses were presented for why this reduction may have occurred:

1. Recruit availability to the NEFSC spring and autumn bottom trawl surveys may have changed.
2. The average size of females has decreased.
3. The average size at birth has decreased.
4. The ratio of mature male to mature female abundance has increased.

The first hypothesis addresses the possibility that the decrease in recruit biomass may have occurred because small dogfish moved off of the bottom and, therefore, were unavailable to the bottom trawl surveys. The second hypothesis addresses the possibility that a decline in the average size of mature females and the associated lower size-specific fecundities may have caused a decline in recruitment. The length of mature females sampled in the NEFSC spring bottom trawl survey declined in the 1990s, and females greater than 90 cm were no longer seen in the spring or fall surveys after that time. Spawning stock biomass and numbers of recruits were modeled with a Ricker stock-recruitment curve, and the data points from 1997 to 2003 were all in the lower left corner of the plot, indicating low spawning stock biomass and low numbers of recruits. The odds ratio test statistic of this analysis suggested that the odds of recruitment being less than the model prediction is 4.5 times greater when females are smaller than the median size of 87 cm. These results suggest female size is an important factor in observed recruitments. The third hypothesis addresses the possibility that a decrease in the average size at birth may have caused the decline in recruitment. Both the number of pups and the average pup weight increase with maternal length, so the decline in length of mature females in the NEFSC spring survey in the 1990s may have resulted in a decline in the number and average weight of pups. The fourth hypothesis addresses the possibility that the increase in the ratio of mature males to mature females may have caused the decrease in recruit biomass. The ratio of mature males to mature females in the NEFSC spring survey began increasing in the 1990s, and a higher level of mixed sex tows and overlap in size of mature males and mature females were recorded. Both the spring and autumn surveys suggest mature males have been showing up closer to shore since the 1990s, which could cause an overlap in mature males and mature females.

Discussion

The group discussed other possible reasons for the increase in the ratio of mature males to mature females and the decrease in the size and number of pups. A change in prey distribution could have caused male spiny dogfish to move inshore. An outbreak of winter skates and dogfish did occur on Georges Bank in the mid-1980s, but the distribution of other elasmobranchs did not change. A drop-off in pup length occurred in 1994-95. Female dogfish abundance dropped off in Canadian waters at that time. The migration of young mature females from Canadian waters to USA waters could explain the drop in size of pups. The relationship between size of females and numbers of pups has a large amount of variability around it. The number of pups could also be the result of paternal influence. The TRAC speculated that, for example, a large female could have mated with a young male and produced a low number of pups.

TRAC Presentation: Biological Reference Points and Projections
Presenter: P. Rago
Rapporteur: J. Nieland

Presentation Highlights

Estimates of biological reference points for fishing mortality are based on a length-based life history model. The overfishing threshold is defined as the fishing mortality rate at population replacement. Biomass reference points are estimated as the spawning stock biomass that produces maximum recruitment in a Ricker stock-recruitment model. The model uses survey based estimates of stock size and recruitment. Both the fishing mortality and biomass reference points rely on size selectivity function estimates derived by comparison of length frequency in the catch and NEFSC spring survey.

A stochastic size and sex-based projection model is used to compare alternative harvest scenarios. The intense size and sex selective fishery between 1989 and 2000, and reduced recruitment from 1997-2003, created an initial population structure that is expected to induce future oscillations in abundance. These have important implications for future management options.

Discussion

The group discussed using a stock-recruitment model that included pup size as a predictor variable. The average weight of pups and average weight of mature females is a highly correlated relationship. The average weight of pups is a better predictor variable than average weight of mature females and incorporates paternal effects as well. Including the average weight of pups as a predictor variable in the model is similar to what scientists on the west coast have done in states of nature models. This stock-recruitment relationship could be directly implemented in the SS3 model. The Haist model does not include a stock-recruitment relationship, but a scalar for good and bad recruitment years could be used instead. The question of whether or not to build uncertainty into the stock-recruitment parameters was also posed.

The group asked for more information about the NEFSC spring and autumn bottom trawl surveys, specifically how efficient the survey is at picking up recruits and how the calibration coefficient from the Albatross IV to the Henry Bigelow functions.

B. Ecosystem Considerations

TRAC Presentation: Population Consumption
Presenter: J. Link
Rapporteur: L. Col

Presentation Highlights

Food habits were evaluated for spiny dogfish as major a predator in the ecosystem. The total amount of food eaten and the type of food eaten were the primary food habits data examined. From these basic food habits data, diet composition, per capita consumption, total consumption, and the amount of prey removed by spiny dogfish were calculated. Contrasts to total energy flows in the ecosystem and fishery removals of commercially targeted skate prey were conducted to fully address the Term of Reference.

- Dogfish diet has been dynamic– across ontogeny, geography and time– yet is mainly focused on small pelagics and mega-plankton.
- Total dogfish consumption is driven by its abundance (Figure 6).
- Dogfish consumption (total, seasonal, by prey, etc.) is mostly driven by mature females.
- Most diagnostics within reasonable range, but a high percentage of empties was noted.
- Slightly higher (per capita) consumption in southern regions (details not shown) are reflective of differences in temperature- yet all at similar orders of magnitude (as scaled by abundance).

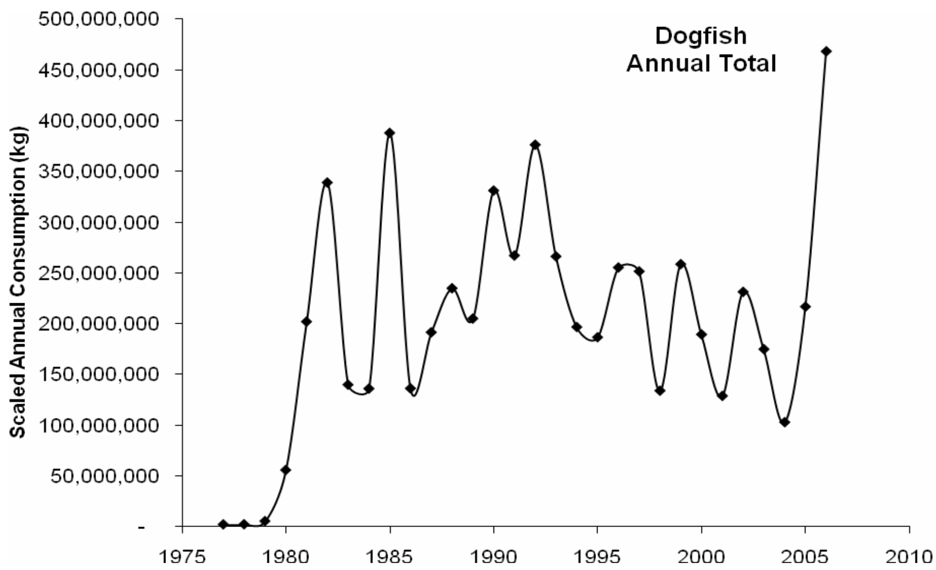


Figure 6. Total amount of food consumed by spiny dogfish.

Discussion

The TRAC noted trends in the total consumption by certain size-sex groups of spiny dogfish in the GOMGBK region, namely a decline in recent years. It was cautioned that trends in a specific size/sex group for a specific region may not be representative of the population. It was noted that, in general, there are some declining trends in consumption for larger (older) dogfish, which are somewhat compensated by increases in consumption by medium-sized (younger) dogfish. However, the mechanism for this apparent shift in consumption rates is unclear.

The concern was raised that the evacuation rate (alpha parameter) was constant for all prey types when in reality it varies. For simplicity, a constant value was used of α=0.002. It was noted that this is a typical value used for prey finfish, and is likely an underestimate for invertebrates (especially ctenophores) which are closer to α=0.02. Another concern was that the evacuation rate does not account for prey-specific caloric quantities. Some general trends in diet composition were seen, with squid consumption declining slightly, and ctenophore consumption increasing over time. Overall, it was concluded that when pelagic organisms including clupeids, ctenophores and cephalopods are combined, diet composition by dogfish was relatively constant. Therefore, these trade-offs due to prey availability could change caloric value of the prey. Generally, throughput was relatively low for dogfish consumption compared to the entire ecosystem, whereas energy flow for some specific prey may be high.

The TRAC discussed that the spring and fall NEFSC surveys may be missing the higher rates of consumption that could occur during the summer, due to increased metabolic rates during the warmer months. It has generally been accepted that the spring survey is used as a proxy for the winter months and the fall survey is used as a proxy for the summer months, and temperatures are assumed to be similar. The TRAC also commented that dogfish on the west coast tend to target benthos (especially bivalves) more than is apparent in the spiny dogfish diet composition. It was noted that smooth dogfish off the east coast generally are more benthivorous, and may be filling this niche, whereas spiny dogfish tend to target more pelagic prey.

Predators of dogfish were discussed, as well as the occurrence of cannibalism. However, little evidence to support this was noted from the sparse occurrences of recorded dogfish predation, other than to say that the lack of dogfish pups in stomachs indicates negligible cannibalism. This is not surprising considering the average pup length of about 30 cm is larger than typical prey sizes for most predators (including dogfish) due to gape width and swimming velocity considerations. The few instances of dogfish predation were seen from goosefish, and larger sharks that are not typically sampled during NEFSC bottom trawling surveys.

The total consumption for all sizes and sexes of dogfish was on the order of 50 mt to 500 mt, which the TRAC commented seemed low assuming previous findings that dogfish consume approximately 0.5% of their body weight in prey per day. These numbers were double checked and consumption should indeed be on the order of 10^{10}-10^{11} g yr^{-1} (Figure 6 now corrected,) but are subject to change given novel estimates of abundance from updates to the other assessment models thereof). The TRAC questioned whether data and model results supported observations from fishermen that dogfish seemed to be so abundant that they were either consuming or outcompeting more valuable fish species. This was backed by fishing industry representative comments that dogfish were negatively impacting fishing livelihoods of longliners and gillnetters. Overall, the estimated consumption rates of dogfish are generally lower than the consumption rates of 2-3% of body weight for other finfish, and data do not support that dogfish are exceptionally voracious predators. It was discussed that the vast majority of prey were herring, squid and ctenophores, whereas only about 10 dogfish stomachs contained cod out of more than 60,000 samples. It was, therefore, concluded that although there is potential for localized interference competition, it is not likely that this is significant at the population level. However, due to their population size, spiny dogfish are one of the major predators of prey fish and invertebrates in the region.

The TRAC also discussed whether empty stomachs relate to female reproductive status. It was noted that there may be a correlation since previous studies of other fish have shown that females tend to either feed heavily leading up to spawning or just following spawning. Other predators of clupeids were discussed, including monkfish. It was noted that monkfish are opportunistic feeders that have comparable percents of herring in their diets, although due to their smaller population size, they consume less herring than spiny dogfish. Previous studies of isotope analyses were discussed, including a Stellwagen Bank study that found dogfish to have average trophic levels around 3.5 to 4, indicating that they are somewhat piscivorous. It was noted that the size and scope of isotropic studies are much smaller than NEFSC stomach samples, but these trophic levels did correspond to survey findings. In general, the trophic level for dogfish is mid-ranged, with other fish such as goosefish being higher. Finally, it was discussed that although other consumption models were not used in this study, they have been used in the past to validate the evacuation rate method used here.

Further analyses suggested during discussion:

- Could integrate all regions, size-sex classes, seasons, etc. and contrast to recent energy budgets from this ecosystem to obtain scope of dogfish consumptive removals.
    - Preliminary contrasts (not shown) suggest current consumption not out of reasonable range for this stock; high fluxes via this species too!
- Could sum dogfish consumptive removals for particular prey of interest and contrast to landings.
    - C/L, C/B, etc. ratios have been informative in the past.
    - Inputs into M2 calculations for “forage” stocks.
- Could compare dogfish consumptive demands to other species in ecosystem.

- Preliminary comparisons (not shown) suggest that pound for pound, silver hake eat a lot, yet needs to be scaled by population level abundance and biomass.

- Could make additional projections based off of projected abundances.

B. Recommendations

Subsequent to the TRAC, it was determined that the next benchmark model meeting would convene in the summer of 2011 at the earliest, and an assessment meeting would occur at a later meeting.

Model Recommendations

For both models:

- Explore profiles of parameters (M, q, migration).
- Run simulation tests with common simulated data (high priority). Once established, simulations could be also used for Management Strategy Evaluation (MSE).
- For comparative purposes, agree to present similar model formulations (times series, M) and diagnostics (q parameters, SSB trends, retrospective).
- Provide measures of uncertainty (i.e. Biomass, F, biological reference points) for model comparison and for forecasting.
- Develop succinct summary output for the provision of advice for managers.
- Include 2009 catch and survey data.
- Compare Nammack and Campana growth models.
- For NEFSC spring survey, drop inshore strata to extend time series back to 1968.

SS3 model:

- Move to 2 area, 2 season, 2 sex formulation, including tagging data.
- Incorporate data for number of pups at maternal length for SSB estimation.

DFO/Haist model:

- Explore or compare with more traditional stock-recruitment relationships, and variance estimation of parameters; introduce uncertainty around stock-recruitment.
- incorporate projections, biological reference points.
- explore logistic selectivity.
- explore effects of constraints on von Bertalanffy parameters.
- explore effect of initial population size and initial Can:USA ratio.

Biological/Other

- Evaluate age determinations to determine possible changes in growth, both spatially and temporally, using archived spines and more recent collections (possibly start new program).
- Create reference collection of spines to determine quality control; agreement between readers.
- Compare dogfish consumption estimates for USA and Canadian waters; explore alternative estimation of consumption (i.e., including or not percentage empty, prorating animal remains, stable isotopes, differential digestion rate by prey type). In addition, include inshore estimates from NEAMAP surveys.
- Explore mechanisms (temperature, prey, reproduction) for migratory movement (north-south, inshore-offshore).

- Explore incorporation of additional survey data (e.g. cooperative research, industry-based surveys).

B. Benchmark Model Consensus

A consensus transboundary stock assessment model was not developed at this benchmark TRAC. The TRAC examined two different forward projecting benchmark models. The first model, referred to hereafter as the Haist model, considered the dogfish stock as composed of two (USA and Canada) spatially interacting components, structured by age, length, and sex. The model included a resident northern subpopulation, and a southern subpopulation having both resident and migratory components. The model included a constant migration rate between stock components for all years by half-year time steps (November$_{t-1}$-April$_{t}$ and May$_{t}$-October$_{t}$). Selectivity estimated for each fishing fleet was constant throughout the time series and multiple NMFS and DFO surveys were used to provide indices of abundance.

The second model, implemented in Stock Synthesis 3 (SS3), considered the population as a single unit stock of female dogfish without spatial structure and with an annual time step (fishing year: May$_{t}$ –April$_{t+1}$). Fishery selectivity of two fleets, defined as USA landings and USA discards aggregated over all gear types, was allowed to vary over time using a random walk. Fishery selectivity for each of the two Canadian fleets (landings and discards aggregated over all gears), was assumed to be constant over time.

The two models also differed in the parameters applied for growth and natural mortality. Algorithms for determining biological reference points and for conducting catch and stock projections were available within the SS3 model , but not within the Haist model.

While the two models represented progress from the approach used in the NEFSC (2006b) assessment, comparing the performance of the two models was difficult because of differences in the data used in model fitting and to the widely divergent assumptions in each model.

During the TRAC, analysts developed alternative formulations of both models to reduce the differences in the initial assumptions. For example, the Haist model was repeated using a formulation with only a single homogenous region. An SS3 model was presented that used the same research survey data as the Haist model as input. Although these efforts were informative, the diagnostics produced by each model remained so divergent that direct comparisons of model performance remained challenging.

Irrespective of the model formulations, neither model produced satisfactory fits to times series of relative abundance estimates from the research surveys. Model fits to survey length frequencies were generally better than for abundance, in part due to the large number of observations available for fitting. The results of both models appeared to be strongly influenced by initial starting conditions. Neither model was accepted by the TRAC due to unacceptable levels of uncertainty in the model outputs. Further model explorations were encouraged in both cases.

Given that USA management advice was required in 2010, it was agreed that the previous USA assessment approach (Rago and Sosebee 2010) would be used to provide the current status of spiny dogfish for USA management purposes. In this approach, estimates of biomass and fishing mortality are derived from a stochastic length-based, survey swept-area method using data from the NEFSC spring trawl survey and USA landings and discards from commercial and recreational fisheries, as well as Canadian landings. Current status of spiny dogfish for Canadian management purposes will be developed separately from the TRAC process.

B. Comments by Three of Four Invited Reviewers

A huge effort was put in by the scientists on developing methods for assessing the stock. These included a first attempt to use SS3, and a new approach by Haist et al. to include two spatial units. Though no consensus was reached, much was learned by the exploratory work conducted. This work will lead to further development and should allow for consensus to arise by the time of the next assessment. Meanwhile, an update of the 2006 assessment with data for 2007-2009 is a valid approach for USA.

The failure to reach consensus was to a large extent due to the limited time available at the meeting, and that model formulation and results arrived too late to be fully evaluated. In order to be successful, most of this work should have been done in advance. This is the first time spiny dogfish assessment was conducted in TRAC and difficulties in bringing it into the system are to be expected. In order to achieve success at the next TRAC assessment meeting for this stock, the reviewers put forward some suggestions.

It appears to the reviewers that the TRAC process required an additional meeting on the assessment models prior to this consensus review. For example, at this meeting we were asked to consider and review models with fundamentally different structures and assumptions on the fly. This is not an appropriate use of reviewers' time. It would be useful to have a formal deadline for uploading of model descriptions and base case model runs, including diagnostics that would allow time for fuller consideration by the reviewers. It would free up time at the meeting for discussion of key difficulties. The difficulties would ideally be outlined in advance, and the time at the meeting spent on their resolution.

Given that both approaches brought forward in the TRAC were being applied to spiny dogfish for the first time, it would have been advisable to have simulation studies conducted to understand the precision and accuracy of the models in reproducing known parameters.

An agreement on the diagnostics for each model could be agreed in advance. This would facilitate better comparisons during the meeting. Again, a formal deadline, perhaps one week before the meeting, would be a good idea.

There was much discussion about the spatial structure of the stock. Spatial considerations were discussed in relation to growth, meta-population structure and management area. These spatial considerations should be ironed out before the next meeting. In addition it would be good to arrive at an agreed set of terminology covering management unit, stock component, stock area, etc.

There may be differences between USA and Canada regarding peer review, and quality control for the adoption of assessment models. Mutual awareness of these differences is important because they can prevent consensus. This may be a wider TRAC procedural issue, but certainly should be addressed before the next meeting.

It is further worth noting that some discussion during the meeting could have been avoided if prior agreement had been reached on:

1. The specific growth model to be used in the stock assessment models. The uncertainty involved with the use of the Nammack and Campana models was unnecessary. In fact, both growth models should be tried in both stock assessment models to examine the sensitivity of the results to growth model selection.

2. The specific estimates of natural mortality that would be used in the models. It is recognized that upon discussion new estimates would be arrived at, but the first issue is model comparison, so the exact final estimates of M used are less important here.

3. The stock assessment scientists might also consider applying a more well-recognized model such as a Pella Tomlinson/ Beverton Holt model as one way to validate special (simplified) cases of the more general SS3/Haist models.

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APPENDICES

Appendix 1. Data Meeting List of Participants.

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Appendix 2. Terms of Reference.

Transboundary Resource Assessment Committee (TRAC)
Spiny Dogfish Benchmark and Assessment

March 30 – April 3, 2009 (DATA)
25-29 January 2010 (MODEL)
Woods Hole, MA.

TERMS OF REFERENCE

Context

The TRAC was established in 1998 to peer review assessments of transboundary resources in the Georges Bank area and thus to ensure that the management efforts of both Canada and USA, pursued either independently or cooperatively, are founded on a common understanding of resource status. In addition to annual assessment reviews, TRAC also periodically conducts “benchmark reviews”, which examine methodologies that may be most suited for assessment of a particular stock and establish an approach to be followed.

Spiny dogfish has not previously been assessed through the TRAC process. However, scientists from both countries have participated in the peer review of each other’s spiny dogfish assessments at various times in the past. The last Northeast Regional Stock Assessment Workshop (SAW) Review was conducted in June 2006. The last DFO assessment of spiny dogfish occurred in November 2007.

At the Canada / USA Scientific Discussions in April 2007 (at the request of the Transboundary Resource Management Steering Committee), it was agreed that a TRAC benchmark of spiny dogfish would be conducted in 2009. Subsequently, it was agreed that a data inputs meetings would be held in the spring of 2009 and the modeling review and assessment would be held in summer/fall 2009.

The purpose of these meetings is to review and incorporate any new information from survey indices and the fisheries, revisit any model formulation issues and recommend a suitable approach upon which to base management advice.

Objectives

Data Inputs Meetings (February 2009)

- Review progress made on the recommendations from the 43rd SAW meeting and the 2007 DFO assessment.
- Update results with the latest information from fisheries and research surveys.
  - Description of the USA and Canadian spiny dogfish fisheries, commercial and recreational.
    - Landings by year, gear, and area. Trends in size composition and sex.
  - Description of the indices of abundance.
- Review methods for discard estimation and imputation of historical estimates.
- Consider data requirements for spatially-structured population model and evaluate sufficiency of existing data to support multi-stock/area models of dynamics.
    - Summarize progress/results of ongoing/completed genetic identification studies.
    - Review existing tagging studies.

- Investigate reproductive biology of spiny dogfish.
    - Update measures of reproductive potential and their implications for rebuilding.
- Review factors influencing availability of spiny dogfish to survey gear including ontogenetic and environmental factors.
- Update various fishery-independent monitoring surveys and explore inter-relationships among surveys.
- Evaluate existing diet composition data and implications for population level consumption estimates.

Modeling Meeting and Assessment (Summer/Fall 2009)

- Review the assessment model formulation issues and recommend an approach for stock status determination.
    - Exploration of length-based forward projection models and other relevant approaches.
- Apply the agreed assessment approach to update the status of the Northwest spiny dogfish stock through 2008 and characterize the uncertainty of estimates.
- Identify candidate mechanisms for reduced recruitment since 1997.
- Investigate implications of skewed sex ratio on pup production.
- Review the biological reference points for F and spawning stock biomass to meet management requirements of both countries.
- Review forecasting approach and conduct projections to meet the management requirements of both countries.
- Identify potential future work (tagging and genetic studies, and other collaboration between both countries) that may improve the determination of stock status.
- Consider ecosystem implications of spiny dogfish consumption of prey species, and potential competition with other species.

Outputs

TRAC Proceedings, which will document the details of the review and summarize the consensus results.
TRAC Reference Documents

Participants

NEFSC and DFO Stock Assessment teams and other
Invited external reviewers
Representatives from USA and Canadian management
USA State and Canadian provincial representatives
USA and Canadian fishing industry participants

Appendix 3. Data Meeting Agenda

Transboundary Resources Assessment Committee
Eastern Georges Bank Cod and Spiny Dogfish
Benchmark Reviews

NEFSC Woods Hole Laboratory, Woods Hole, MA. USA
Clark Conference Room

March 30 – April 3, 2009

AGENDA

30 March 2009 – Monday -- Eastern Georges Bank Cod

9:00 – 9:15	Welcome and Introduction (Chairs)
9:15 – 10:30	Review of Data Meeting Current Eastern Georges Bank Cod Model Formulation
10:30 –10:45	Break
10:45 –12:00	Alternative Model Formulations
12:00 – 1:00	Lunch
1:00 – 3:00	Continue: Alternative Model Formulations
3:00 – 3:15	Break
3:15 – 5:30	Continue: Alternative Model Formulations Other Working Papers (e.g.: tagging)

31 March – Tuesday -- Spiny Dogfish

8:30 – 10:00	Commercial Landings, Discard Estimates, and Recreational Fishery
10:00 – 10:15	Break
10:15 – 12:00	Continue: Landings and Discards
12:00 – 1:00	Lunch
1:00 – 3:15	Research Bottom Trawl Surveys: - Inter-Relationships Among Surveys - Availability of Spiny Dogfish to Survey Gear
3:15 - 3:30	Break
3:30 - 5:00	Continue: Surveys
5:00 - 5:30	Review Progress Made on Previous Recommendations

1 April 2009 – Wednesday

08:30 – 10:00	Spiny Dogfish :Data Availability for Spatial Models (tagging, etc)
10:00 – 10:15	Break
10:15 – 12:00	Population Level Consumption Estimates Reproductive Biology; Rebuilding

12:00 - 1:00	Lunch
1:00 - 3:15	Revisit Cod Models
3:15 - 3:30	Break
3:30 - 5:30	Continue: Cod Models

2 April 2009 – Thursday

08:30 - 10:00	Eastern Georges Bank Cod: Reference Points and Projection Procedures
10:00 - 10:15	Break
10:15 - 12:00	Continue: Eastern Georges Bank Cod
12:00 - 1:00	Lunch
1:00 - 3:15	Any Follow-up; Start Report Writing
3:15 - 3:30	Break
3:30 - 5:30	Report Writing

3 April 2009 – Friday

08:30 - 10:00	Report Writing
10:00 - 10:15	Break
10:15 - 12:00	Continue: Report
12:00 - 1:00	Adjournment

Appendix 4. Model and Assessment Meeting List of Participants.

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Appendix 5. Model Meeting Agenda

Transboundary Resources Assessment Committee
Spiny Dogfish Benchmark Model Review

NEFSC Woods Hole Laboratory, Woods Hole, MA. USA
Clark Conference Room

January 25 – January 29, 2010

AGENDA

25 January 2010 – Monday -- Spiny Dogfish Models

1:00 – 1:15	Welcome and Introduction (Chairs)
1:15 – 3:00	Review Data Meeting Consensus
	Current Spiny Dogfish Model Formulation
	Brief Overview/Description of Benchmark Models to be Reviewed:
	SS3
	Haist
3:00 – 3:15	Break
3:15 – 5:30	Data Inputs for Both Models

26 January – Tuesday

8:30 – 10:00	SS3
	Model Formulations, Results, Diagnostics
10:00 – 10:15	Break
10:15 – 11:30	SS3: Continued
11:30 – 12:30	Lunch
12:30 – 2:00	Haist Model/Webex
	Model Formulations, Results, Diagnostics
2:00 – 3:15	Haist: Continued
3:15 - 3:30	Break
3:30 - 5:30	SS3/Haist Model: Continued

27 January – Wednesday

08:30 – 10:00	Review Additional Work: SS3 and Haist
10:00 – 10:15	Break
10:15 – 12:00	Review Additional Work: SS3 and Haist
12:00 - 1:00	Lunch
1:00 - 3:15	Model Selection
3:15 - 3:30	Break
3:30 - 4:30	Model Selection
4:30 - 5:30	Mechanisms for Reduced Recruitment

28 January – Thursday

08:30 - 10:00	Reference Points and Projections
10:00 - 10:15	Break
10:15 - 12:00	Population Level Consumption Estimates
	Review Previous and Future Recommendations
12:00 - 1:00	Lunch
1:00 - 3:15	Stock Status Report Writing
3:15 - 3:30	Break
3:30 - 5:30	Report Writing

29 January – Friday

08:30 - 10:00	Report Writing
10:00 - 10:15	Break
10:15 - 12:00	Continue: Report
12:00 - 1:00	Adjournment