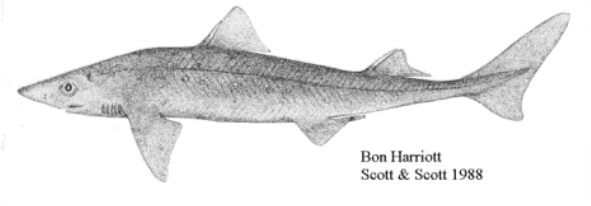
Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat
Maritimes Region **Science Advisory Report 2020/001**

ASSESSMENT OF SPINY DOGFISH IN THE NORTHWEST ATLANTIC



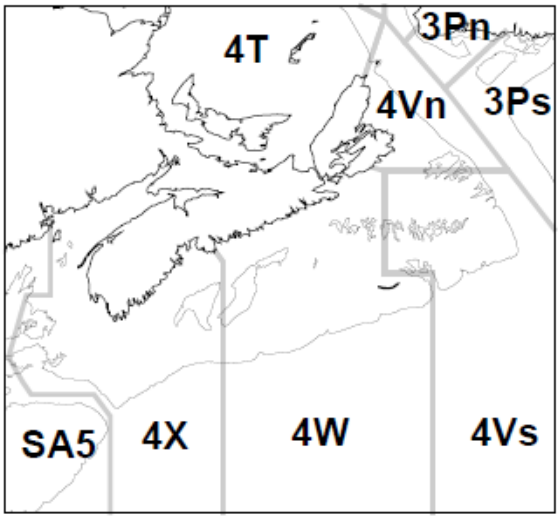


Figure 1. Spiny Dogfish assessment area in Canada.

Context:

Northwest Atlantic Spiny Dogfish (Squalus acanthias) is a small, temperate shark found in waters throughout the Northwest Atlantic, with large numbers occurring between North Carolina and southern Newfoundland. Spiny Dogfish is a transboundary resource, with the majority of catches being taken in the United States of America (US). Most Atlantic Canadian landings of Spiny Dogfish have historically been taken in longline and gillnet fisheries.

Canadian catches of Spiny Dogfish in 4VWX5YZ (Figure 1) were unrestricted prior to 2002. Since 2002, total allowable catch (TAC) limits have been in place for the Maritimes Region, but there has been no significant directed fishery since 2006. Since 2015, landed bycatch has been incorporated in the TAC. There are no restrictions on discarding at sea. Landings since 2009 from Canadian fleets have been less than 166 mt per year, making recent Canadian TACs non-restrictive.

A DFO framework review and assessment of Northwest Atlantic Spiny Dogfish occurred in January and May 2014 using data up to 2010. Efforts to incorporate more recent data into the framework model were not successful. A second framework assessment that considered data to 2015 was held in September 2017 and June 2018. The second part of the framework, a review of the modelling, rejected the model approach in favour of using an index-based assessment directly to inform stock status.

This Science Advisory Report is from the December 11, 2018, and February 13, 2019, Stock Assessment of Northwest Atlantic Spiny Dogfish. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- In Canadian waters, discards from otter trawl, gillnet and longline fisheries for groundfish are the primary source of fishing mortality of Northwest Atlantic Spiny Dogfish. Total discard estimates have been declining since the 1990s. In 2017, reported landings were 53 mt and dead discards were estimated as 606 mt.
- Since 2012, US landings of Spiny Dogfish have increased to approximately 10,000 mt annually, with dead discard estimates ranging from 3,200-5,800 mt per year.
- Two Research Vessel (RV) surveys provide estimates of Spiny Dogfish abundance. The National Marine Fisheries Service (NMFS) Spring survey in US waters serves as the primary index of population abundance. The Fisheries and Oceans Canada (DFO) Summer survey is thought to primarily index changes in distribution as the population moves northward in the summer months.
- The majority of survey catches in Canada are adult males, with lower but similar numbers of female and male juveniles. Female adults form the smallest component of the survey catches throughout the time series.
- The assessment model developed for the Northwest Atlantic Spiny Dogfish Framework Part 2: Review of Modelling Approaches and Assessment (June 27-28, 2018) was not accepted for a number of reasons, including: the predicted abundance trajectory was very sensitive to survey catchability estimates on upper bounds, residual patterns on maturation and pupping rate estimates, and a retrospective pattern for adult female abundance estimates in recent years.
- The US regularly undertakes assessments of the Northwest Atlantic Spiny Dogfish population to provide advice for their directed fishery. Participants at the December 2018 Canadian stock assessment meeting felt that relying on the US update to assess status and provide advice had several advantages over developing a new empirical approach based on US data. There was agreement that, until a joint or Canadian modeled approach could be developed, relying on the US assessment would be more informative than reviewing the survey index of adult female abundance without the context of a population model.
- Adopting the US reference points was considered to be appropriate under the Canadian Precautionary Approach Framework. The target Spawning Stock Biomass (SSB_{target}) was used as the Upper Stock Reference (USR) given that SSB_{target} represents a proxy for adult female biomass at Maximum Sustainable Yield (MSY) under the US assessment model. The USR becomes 159,288 mt. The Lower Reference Point (LRP) would be the threshold Spawning Stock Biomass ($SSB_{threshold}$) value, calculated as 50% of the USR, with a value of 79,644 mt. This would put the biomass estimates in the Cautious Zone since 2015.
- The US model that was used as the basis for advice included 2017 survey data but did not apply the Kalman filter when calculating swept-area biomass. Results suggest that biomass of mature females has been declining since 2012 and is estimated as 106,753 mt in 2018.
- The US assessment update concluded that the stock is not overfished and that overfishing is not occurring. The Allowable Biological Catch (acceptable level of removals) for 2017 was 23,045 mt and actual removals from all sources (other than Canadian discards) were estimated at 14,326 mt. For comparison, estimated Canadian removals (including discards) in 2017 were 659 mt.

- The 2018/19 Canadian total allowable catch (TAC; 4000 mt for directed fishery, 4000 mt for retained bycatch) is very unlikely to be reached in 2019/2020. There is currently no directed fishery, and any Canadian landings are from bycatch in other fisheries.
- As the stock is in the Cautious Zone, a significant increase in removals (landings or discards) beyond levels seen in the last 10 years could warrant a reevaluation of fishery impacts. However, at this time, removals from bycatch in Canadian waters are not expected to be at a level that would hinder stock rebuilding, particularly given the US assessment that total stock removals are at an acceptable level.
- While current removals in Canadian waters are very low, the determination that the stock is in the Cautious Zone and the decline in recent adult female biomass estimates warrants consideration of reducing the TAC to a more precautionary level.
- Full assessment of the Northwest Spiny Dogfish stock requires information from both the Canadian and US surveys and fisheries. Participants agreed that a modelled approach to determining stock status would be valuable, ideally jointly with US colleagues. It was also noted that the Mid Atlantic Fishery Management Council is planning a review of their data inputs and assessment approach (a “Benchmark”) in 2022.
- In the interim, science advice to management on Spiny Dogfish will be provided by reviewing the US stock assessment along with recent Canadian landings, as well as information about Spiny Dogfish from the DFO Summer survey.

BACKGROUND

Biology

Spiny Dogfish (*Squalus acanthias*) are small squaloid sharks found throughout coastal temperate oceans. The population in the Northwest Atlantic typically ranges from Newfoundland to Georgia and is most abundant along the continental shelf from Nova Scotia to Cape Hatteras. The population migrates seasonally, concentrating in mid-Atlantic waters to southern Georges Bank in the winter and spring, moving northward in the summer, and returning to Southern New England, Georges Bank and the Gulf of Maine in autumn. Throughout their distribution, Dogfish tend to school by size and by sex as they approach maturity. Adult female Dogfish form a small component of the population, typically less than 5%. The species exhibits sex-specific growth and maturity, with females growing larger and maturing later than males. In the Northwest Atlantic, Spiny Dogfish occur in water temperatures from 0-12°C (6-11°C preferred) and depths of 0-350 m (50-200 m preferred). Reproductive potential for the population is low due to slow growth rates, late age-at-maturity, and a 22-24 month gestation period for females, making them vulnerable to exploitation. In Canada, Spiny Dogfish were designated ‘Special Concern’ by the Committee on the Status of Endangered Wildlife in Canada in 2010, and a listing decision under the *Species at Risk Act* is pending.

Fishery

Landings of Spiny Dogfish were low prior to 1955 but increased with expanded fishing during the late 1950s and early 1960s. Landings increased again with the arrival of foreign fishing fleets in the Northwest Atlantic, peaking at about 25,000 mt in 1975. Since 1977, United States (US) commercial landings have accounted for most of the reported catch. A sharp intensification of the US commercial fishery began in 1990, peaking at more than 28,000 mt in 1996. Canadian landings were a relatively small proportion of the total catch until 2000, at which point the introduction of restrictive quotas in the US made Canadian landings a more significant portion of

the total. Since 2006, Canadian landings have been very low, and directed commercial fishing for Spiny Dogfish has occurred exclusively in the US since 2012 (Table 1).

Table 1. Landed catch and dead discards (mt) by Canada and US since 1991.

		1991-2000 (Mean)	2001-2010 (Mean)	2011	2012	2013	2014	2015	2016	2017
Canada	Landings	861	1946	124	65	5	54	1	33	53
	Dead Discards	3340	1725	1384	1493	988	294	51	817	606
	Total	4201	3671	1508	1558	993	348	52	850	659
US	Landings	19766	5202	9779	10881	7410	10767	8726	12231	11079
	Dead Discards	8504	5334	4787	4848	5010	5785	3322	3856	3247
	Total	28270	10536	14566	15729	12420	16552	12048	16087	14326

Canadian Landings and Discards

Foreign fleets fishing in Canadian waters landed substantial amounts of dogfish during the 1970s, peaking just less than 10,000 mt in 1974. During 1998-2008, landings by Canadian fleets increased by an order of magnitude, peaking at 3,578 mt in 2001 and averaging 2,300 mt. Most of these were taken in the directed longline fishery for Spiny Dogfish, with lesser amounts from gillnets and otter trawl. Since 2009, landings from all Canadian fisheries have been very low (Table 1).

In Canadian waters, discards from otter trawl, gillnet and longline fisheries for groundfish are the primary source of fishing mortality, with the exceptions of the foreign directed fishery in the 1970s and the Canadian directed fishery in the early 2000s. Total discard estimates have been declining since the 1990s, presumably due to more stringent management measures and lower total allowable catches (TACs) being implemented in groundfish fisheries. After accounting for gear-specific discard mortality (Table 2), dead discards by individual Canadian fleets have not exceeded 2000 mt in any year. In 2017, dead discards were estimated as 606 mt (Table 1).

Table 2. Mortality rates applied to Canadian and US discards.*

	Longline	Otter Trawl	Gillnet	Recreational Landings	Foreign Otter Trawl	Other Gear**	Scallop Dredge
Canada	0.1	0.25	0.55	0	0.25	0.1	NA
US	0.1	0.5	0.3	0.25	0.5	0.5	0.75

*Values from TRAC (2010) meeting for Spiny Dogfish.
**Other Gear represents bottom longline for Canada.

US Landings and Discards

During 1962-1979, US landings averaged about 400 mt annually, while landings by foreign fleets operating in US waters increased to upwards of 25,000 mt by the early 1970s. With the advent of the US directed fishery in 1990, landings averaged 17,900 mt from 1990-2000, but dropped to an average of 2,200 mt during 2001-2008 due to quota restrictions. Since 2012, US landings of Spiny Dogfish have increased to approximately 10,000 mt annually. Recreational landings have always been very low (averaging 200 mt from 1981-2008), although recreational

discards have been much higher (averaging 1,500 mt from 1981-2008). Estimated discards have been much lower than before the mid-1990s (Table 1).

Total Fishery Removals

During the years in which both commercial landings data and discard estimates are available, total fishery removals have been an order of magnitude higher in the US than in Canada (Figure 2). In the US, total removals remained high throughout the 1960s to late 1990s, dropping substantially in the early 2000s and increasing slightly to 2015.

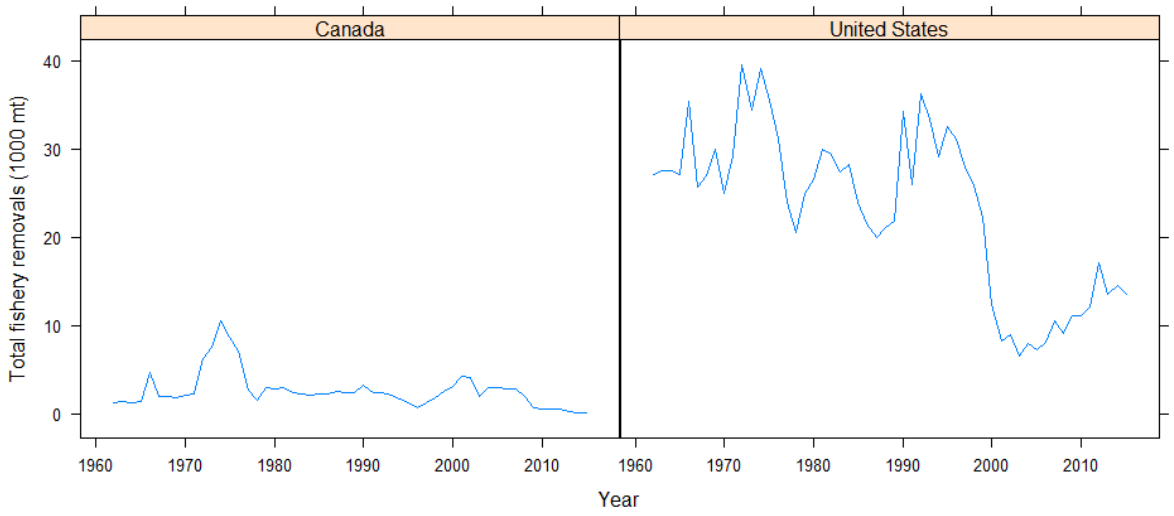


Figure 2. Total fishery removals (landings plus dead discards) for Canada and the US (1963-2015).

ASSESSMENT

Research Surveys

Two Research Vessel (RV) surveys provide estimates of Spiny Dogfish abundance. The National Marine Fisheries Service (NMFS) Spring survey in US waters serves as the primary index of population abundance, as most of the population is considered to be available to this survey. The Fisheries and Oceans Canada (DFO) Summer survey is thought to primarily index changes in distribution as the population moves northward in the summer months.

Canadian (DFO) Summer Survey

Stratified abundance estimates for all sex/stage groups of Spiny Dogfish were low at the beginning of the survey time series, increasing during the 1980s to the late 1990s, before gradually declining until 2010. In the most recent years, there was an extremely large peak in 2012-2013, which has since declined (Figure 3). The majority of survey catches in Canada are adult males, with lower but similar numbers of female and male juveniles. Female adults form the smallest component of the survey catches throughout the time series.

US Spring Survey

Abundance trends for Spiny Dogfish from the US Spring survey increased throughout the 1980s, gradually declined from the early 1990s until the early 2000s, increased rapidly from the mid-2000s through 2013, and then declined rapidly (Figure 3). A new survey vessel, the *Henry B. Bigelow*, employing a new type of trawl, replaced the *Albatross IV* beginning in 2009. The

Northwest Atlantic Spiny Dogfish Framework Part I: Review of Data Inputs (September 19-20, 2017) evaluated multiple ways in which data from a paired-tow calibration study could be used to standardize RV *Bigelow* catches relative to the RV *Albatross*. The methodology chosen was specific for each sex and stage of Dogfish, and reduced stratified abundance estimates considerably from 2009 onwards (Figure 4). Since the late 1990s, adult males have been the dominant component of survey catches.

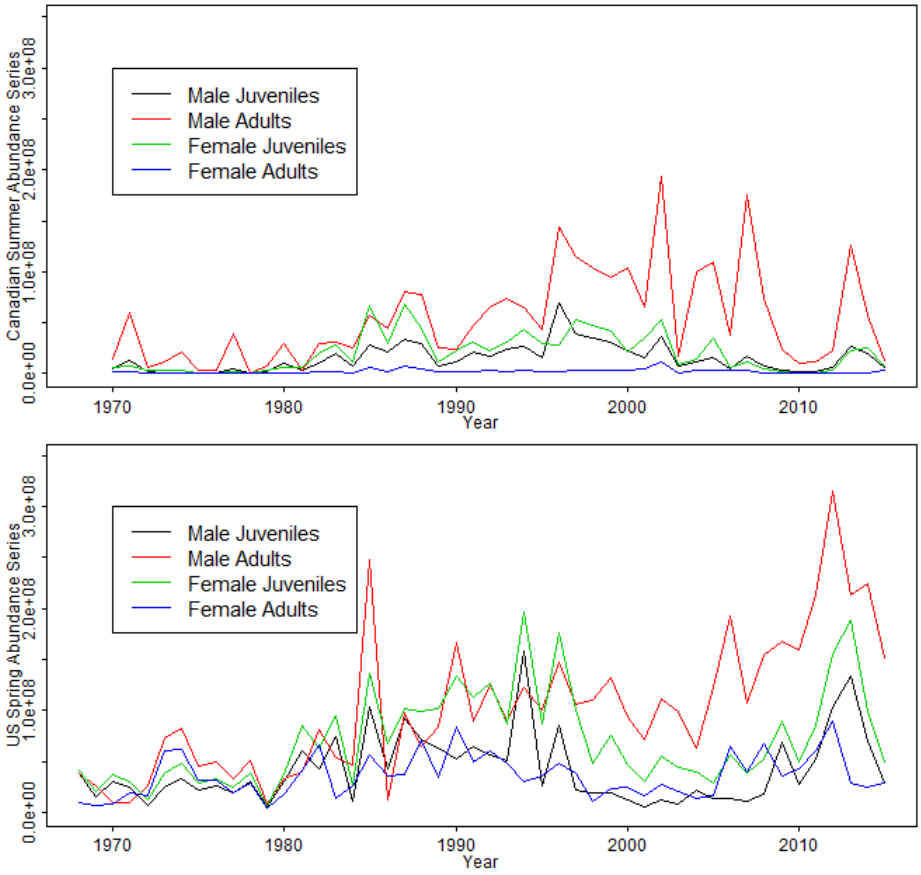


Figure 3. Stratified abundance estimates from the DFO Summer survey for 1970-2015 (top panel) and standardized US Spring survey for 1968-2015 (bottom panel).

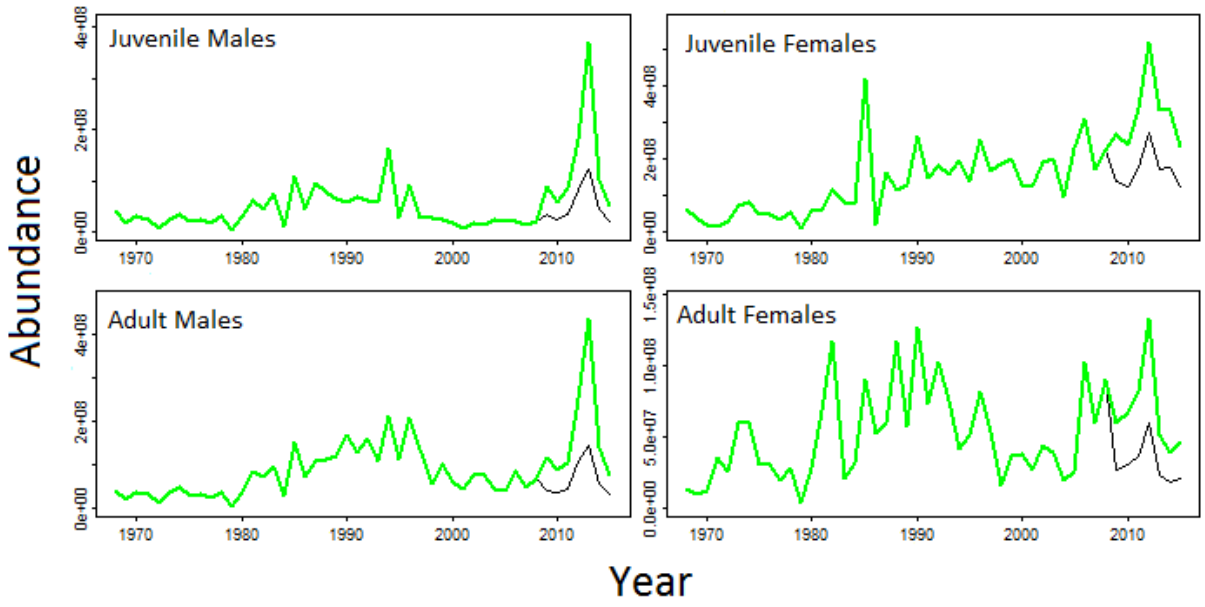


Figure 4. Stratified abundance estimates from the US Spring survey, showing the unstandardized (green) and standardized (black) survey years (1968-2015).

Modeling Framework

The assessment model developed for the Northwest Atlantic Spiny Dogfish Framework Part 2: Review of Modelling Approaches and Assessment (June 27-28, 2018) was a forward-projecting, stage-based, spatially-explicit population dynamics model with two time steps (November-April and May-October) in each year. Individuals belong to four possible stages: adult or juvenile males and females, and have two invariant characteristics: their sex and home region (Canada, US). The model predicted the population components via recruitment, maturity transitions between juvenile and adult stages, migrations between US and Canadian waters, natural mortality, and fishing mortality. Fishing mortality was incorporated as total removals (landings + dead discards) and the US Spring survey and DFO Summer survey were used to index abundance.

The model was not accepted for a number of reasons, including:

- The predicted abundance trajectory was very sensitive to the upper bounds on the US Spring survey catchability (where *q* was bounded between 0 and 1). When these bounds were removed, abundance was scaled downwards and recent trends in abundance of adult females were reversed.
- There were strong residual patterns for pupping and maturation rates.
- The lack of density-dependence in the projection model.
- A strong retrospective pattern in predicted abundance for adult females in recent years.

Other Assessment Approaches

During the framework review, non-model based approaches were discussed as a means to provide interim advice until a new assessment model could be developed. The adult female biomass index from the US Spring survey was proposed as the key indicator of stock status as this is considered to be the best index of the spawning stock biomass (Fowler and Campana

2015). Demersal female abundance was also evaluated in case it differed from adults with respect to trends. The two indices were essentially mirror images, so adult female abundance was retained as the primary index.

The proposed reference points to assess status relative to the abundance index were the mean of the five years encompassing the observed abundance peak (1988-1992) as an Upper Stock Reference (USR) and 50% of the USR as the Limit Reference Point (LRP). To reduce the impact of extreme values or annual variability in the abundance index, the bootstrapped median of the last three years in the time series was assessed relative to the USR and LRP. This empirical approach was reviewed at the Stock Assessment of Northwest Atlantic Spiny Dogfish (December 11, 2018), but it was not accepted as a basis for advice.

US Stock Assessment

The US regularly undertakes assessments of Northwest Atlantic Spiny Dogfish to provide advice for their directed fishery, and the latest update (Sosebee and Rago 2018) was circulated as a background document for the meeting. Participants at the December 2018 assessment meeting felt that relying on the US update to assess status and provide advice had several advantages over using an empirical approach based on US data:

- The information needed to interpret US survey indices on an annual basis may be more available to US stock assessors.
- The majority of commercial catch is from the US directed fishery and up-to-date catch composition information has not been available for Canadian stock assessments.
- Although index-based, the US assessment accounts for various sources of uncertainty and includes a projection component to assess status relative to reference points.

There was agreement that, until a joint or Canadian modeled approach could be developed, relying on the US assessment would be more informative than reviewing the survey index of adult female abundance without the context of a population model.

The US assessment uses estimates of swept-area biomass adjusted by fishery selectivity to calculate relative fishing mortality. Mean numbers per tow by sex and 1-cm length class are converted to average weights using sex-specific length-weight regressions. The average weights are then multiplied by total survey area and divided by the mean area swept by a standardized trawl haul. The resulting biomass estimates are partitioned into three size groups: < 36 cm, 36-79 cm and > 80 cm. For females, these categories correspond to young-of-the-year, immature animals and mature adults. For input into projections and to analyze trends, the biomass time series (in kg/tow) of mature females is smoothed using a Kalman filter applied to a three-year moving average. To determine the proportion of the population vulnerable to the fishery, selectivity is calculated as a sex-specific logistic function based on the size-frequency distribution of the survey catches. Relative fishing mortality becomes the ratio of catch to these selectivity-adjusted estimates of swept-area biomass.

Biological reference points were based on a Ricker stock-recruitment model, where the target Spawning Stock Biomass (SSB_{target})(159,288 mt) was a proxy for adult female B_{msy} (the biomass that results in the maximum projected recruitment) and $SSB_{threshold}$ was 50% of the target (79,644 mt). The reference fishing mortality at SSB_{target} (F_{msy}) is 0.2439. Status relative to reference points and the effects of various future harvest levels are estimated with a stochastic model that incorporates uncertainty in survey sampling and variation in the trawl footprint when calculating swept-area biomass (Rago and Sosebee 2010).

The population is considered to be overfished if $SSB < SSB_{threshold}$ and overfishing is occurring if $F > F_{msy}$. The level of removals at which overfishing might start to occur is calculated from

stochastic projections and called the Over-Fishing Limit (OFL). Starting from current biomass, expected removals in 2018 (estimated relative to 2017 values) were accounted for, and the OFL for 2019 becomes the catch where the probability of exceeding the target F (0.2439) is 0.4. For 2019, the OFL is 21,549 mt (total landings plus discards). Under the US fisheries management system, the OFL is used to calculate a lower value, the Allowable Biological Catch (ABC), which accounts for uncertainty in the estimation of the OFL as well as the condition of the stock. The ABC is derived from the OFL times the ratio of current SSB to target SSB (called the Pstar method). For 2019, the ABC for Spiny Dogfish is 12,914 mt.

Key differences between the data inputs used by the US assessment and those reviewed in the accepted component of the Framework for Spiny Dogfish (September 2017) relate to the method used to standardize survey catches since 2009 (to equate Bigelow catches to the Albatross) and the methods used to categorize life-history stages. Key assumptions of the US methodology are that selectivity, recruitment potential, and the proportion of total catch discarded remain constant over time. In the 2018 update, sensitivity of the assessment to the 2017 swept-area biomass estimates as well as to the Kalman filter were evaluated.

Stock Status

The stochastic model that was used as the basis for advice included 2017 survey data but did not apply the Kalman filter when calculating swept-area biomass. Results suggest that biomass of mature females has been declining since 2012 and is estimated as 106,753 mt in 2018 (Sosebee and Rago 2018).

Adopting the US reference points was considered to be appropriate under the Canadian Precautionary Approach Framework. The SSBtarget was used as the USR given that SSBtarget represents a proxy for adult female biomass at MSY under the US assessment model. The USR becomes 159,288 mt. The LRP would be the SSBthreshold value, calculated as 50% of the USR, with a value of 79,644 mt. This would put the biomass estimates in the Cautious Zone since 2015 (Figure 5).

If the RV Bigelow calibration methods developed at Northwest Atlantic Spiny Dogfish Framework Part I: Review of Data Inputs (September 19-20, 2017) are used, the stock is considered to have been in the Critical Zone since 2015 (Figure 6).

Since it was decided that US assessment would be used as the basis for advice from this point forwards, it was agreed that the stock should be considered in the Cautious Zone, based on the biomass estimates from the 2018 US stock assessment.

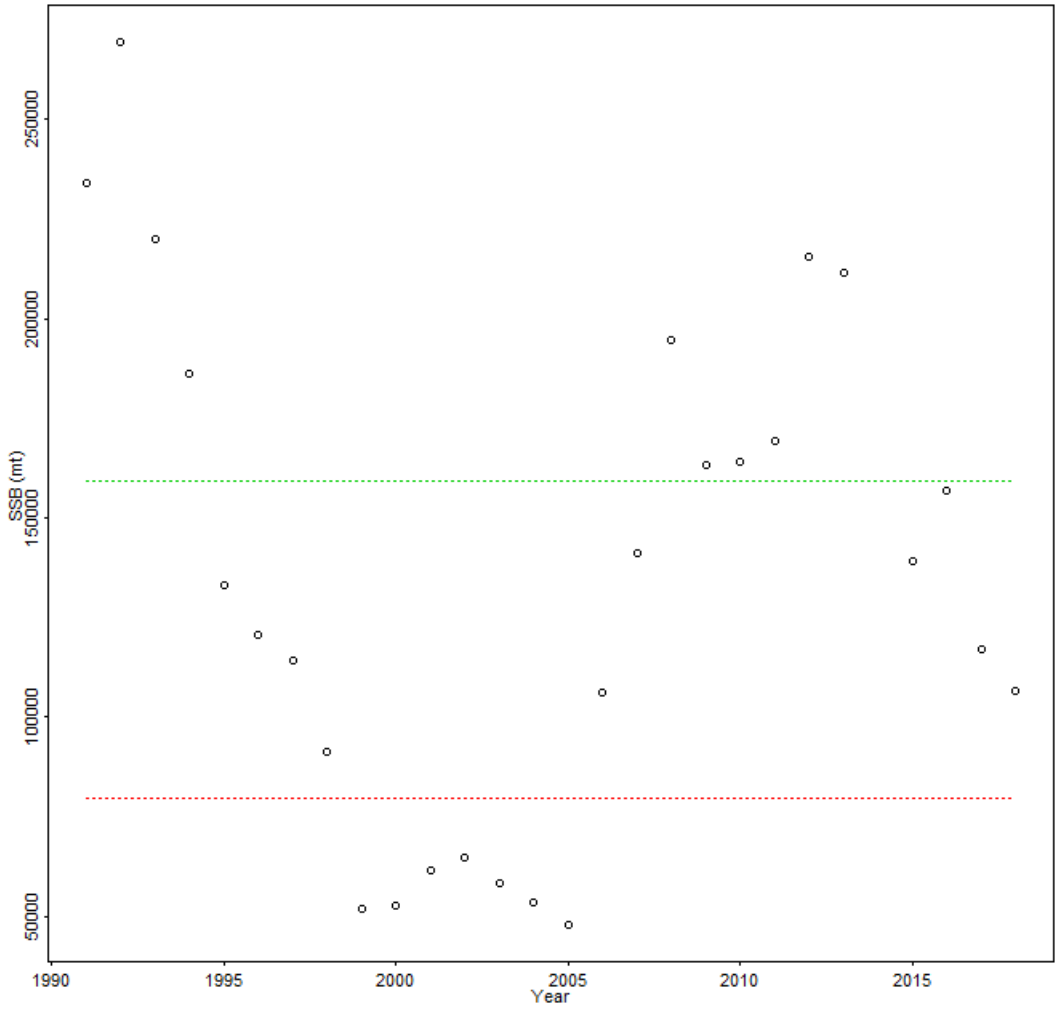


Figure 5. Harvest Control Rule using US estimates of adult female biomass (Sosebee and Rago 2018). The Upper Stock Reference (green line) is SSB_{msy} and the Limit Reference Point (red line) is 50% of SSB_{msy}.

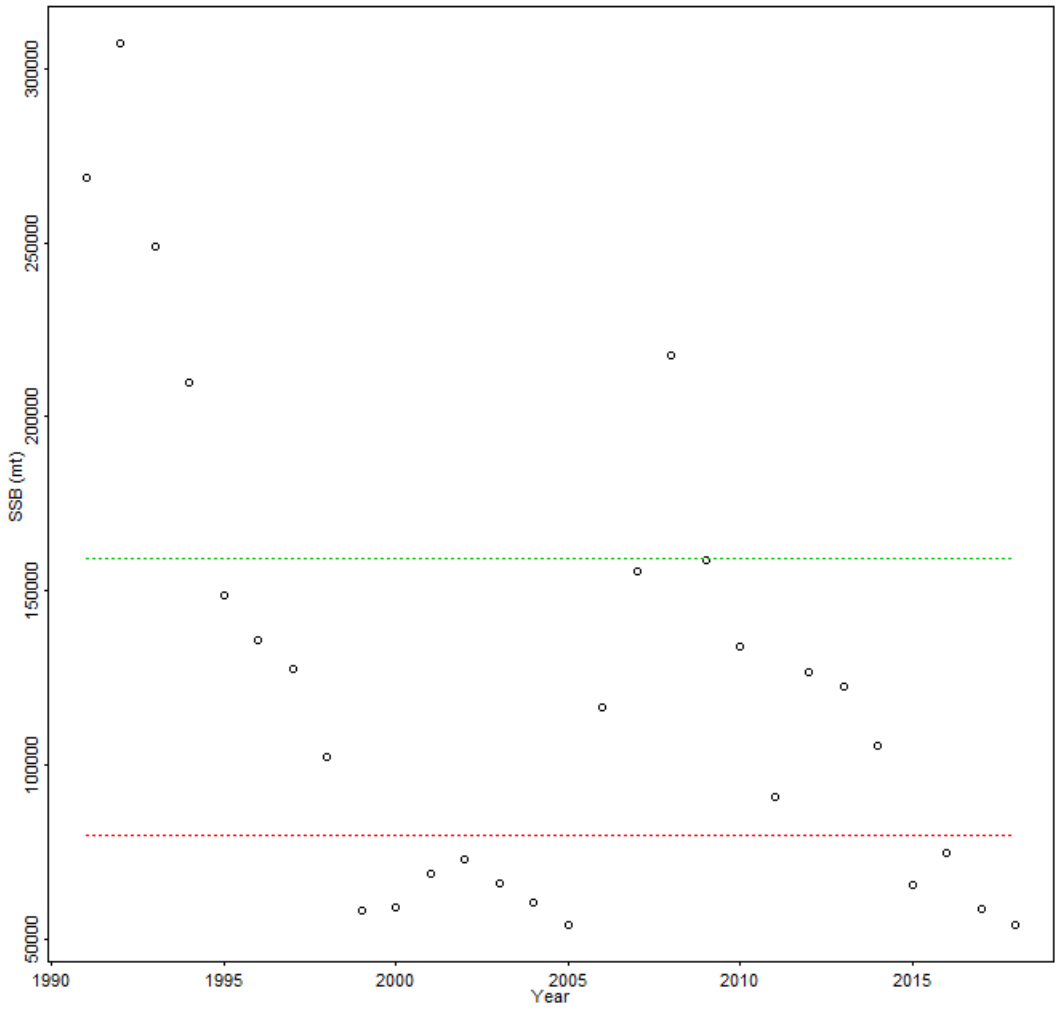


Figure 6. Harvest Control Rule using estimates of adult female abundance converted to biomass using methods as applied in TRAC (2010) and standardized as in Figure 4. The Upper Stock Reference (green line) is SSB_{msy} and the Limit Reference Point (red line) is 50% of SSB_{msy}.

Catch Advice

The US assessment update accepted by the Mid Atlantic Fishery Management Council (Sosebee and Rago 2018) concluded that the stock is not overfished and that overfishing is not occurring. The ABC (acceptable level of removals) for 2017 set by the Mid Atlantic Fishery Management Council was 23,045 mt and actual removals from all sources (other than Canadian discards) were estimated at 14,326 mt. For comparison, estimated Canadian removals (including discards) in 2017 were 659 mt.

It was noted that adult females comprise a small part of the total population (typically about 4%; Fowler and Campana 2015) but are the critical population component for stock productivity. Based on the DFO Summer survey, a small proportion of adult females migrate into Canadian waters, suggesting minimal impact of removals on the SSB from Canadian fisheries (see Figure 3).

The 2018/19 Canadian TAC (4000 mt for directed fishery, 4000 mt for bycatch) is very unlikely to be reached in 2019/2020. There is currently no directed fishery, and any Canadian landings

are from bycatch in other fisheries. As the stock is in the Cautious Zone, a significant increase in removals (landings or discards) beyond levels seen in the last 10 years could warrant a reevaluation of fishery impacts. However, at this time, removals from bycatch in Canadian waters (landings and discards) are not expected to be at a level that would hinder stock rebuilding, particularly given the US assessment that total stock removals are at an acceptable level.

While current removals in Canadian waters are very low, the determination that the stock is in the Cautious Zone and the decline in recent adult female biomass estimates warrants consideration of reducing the TAC to a more precautionary level.

If combined removals by Canada and the US exceeded the OFL defined for the stock, overfishing would be occurring. For 2019, the OFL would be harvests of 21,549 mt from all sources. Keeping total removals within the ABC would be a more precautionary approach and would be more consistent with stock status. The US ABC for 2019 is 12,914 mt.

Assessment frequency, triggers, and content of interim updates

Full assessment of the Northwest Spiny Dogfish stock requires information from both the Canadian and US surveys and fisheries. Participants agreed that a modelled approach to determining stock status should be pursued, ideally jointly with US colleagues. At a minimum, a data sharing arrangement would be required. It was also noted that the Mid Atlantic Fishery Management Council is planning a review of their data inputs and assessment approach (a “Benchmark”) in 2022.

In the interim, science advice to management on Spiny Dogfish will be provided by reviewing the US stock assessment along with recent Canadian landings, as well as information about Spiny Dogfish from the DFO Summer survey.

If total removals substantially increased in Canadian waters (above approximately 600 mt), it would be useful to monitor the catch composition to determine exploitation pressure on adult females. In this case, reinstating the monitoring done by port samplers and adding monitoring by at-sea observers to determine Spiny Dogfish catch composition would allow evaluation of the impact on adult females. Additionally, if the stock was determined to be in or approaching the Critical Zone, Canada would need to develop a rebuilding plan and revisit the assessment approach.

Sources of Uncertainty

One source of variability related to US Spring survey timing may need to be addressed when developing future assessment approaches. During 1988-2008, the US Spring survey was typically completed by the first week of May. During 1968-1987 and from 2009 onward, the survey could still be underway as late as June. Years in which the survey continued into June tended to be characterized by lower annual stratified abundance estimates for adult females, suggesting availability may be a concern for surveys that sampled too late. If prolonging the survey misses Dogfish that have left the survey area, these years would represent underestimates of abundance (Figure 6).

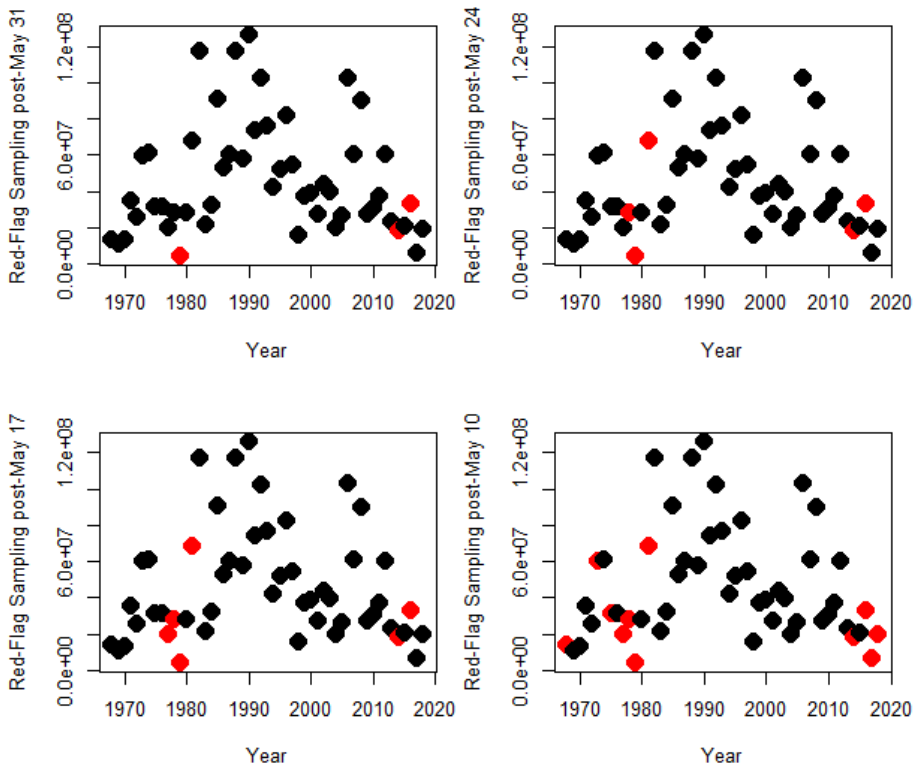


Figure 7. Annual US Spring survey estimates of adult female abundance (black points) and years where the survey ended after the date noted on the y-axis (red points).

Adult females comprise a very small proportion of the DFO Summer RV Survey catch, and it is assumed they are similarly unavailable to fisheries, but that may not be true. Adult females might move into Canadian waters in larger numbers in the spring and fall.

Discard mortality is more uncertain and higher than landings in both the US and Canada. Sex or size composition information is not collected for discards, and there is uncertainty around post-release mortality. To characterize the composition of discards from Canadian fleets, it would be necessary to re-instate monitoring by the at-sea observer program. The manner in which discards are calculated from US fisheries is not clear in the most recent assessment.

CONCLUSIONS AND ADVICE

Currently, there is no directed fishery for Spiny Dogfish in Atlantic Canadian waters, and landed bycatch levels are low. Total landings and estimated dead discards have not exceeded 1,000 mt per year since 2012.

At the Regional Advisory Process held to review the framework model (June 2018), the model was not accepted for a number of reasons, and non-model based approaches were discussed as a means to provide interim advice until a new assessment model could be developed. However, the US regularly undertakes assessments of Northwest Atlantic Spiny Dogfish to provide advice for their directed fishery. There was agreement that, until a joint or Canadian modeled approach could be developed, relying on the US assessment would be more informative than reviewing the survey index of adult female abundance without the context of a population model.

Adopting the US reference points was considered to be appropriate under the Canadian Precautionary Approach Framework. The SSB_{target} was used as the USR, 159,288 mt. The LRP would be the $SSB_{threshold}$ value, 79,644 mt. This would put the stock in the Cautious Zone, including the 2018 biomass estimate (106,753 mt).

At this time, removals from bycatch in Canadian waters (landings and discards) are not expected to be at a level that would hinder stock rebuilding, particularly given the US assessment that total stock removals are at an acceptable level. However, it was noted that if total Canadian landings exceed 600 mt, monitoring to determine catch composition (especially the contribution of adult females) should be pursued.

Opportunities to get a better understanding of discard composition in the fisheries with the most interactions (i.e. otter trawl and longline - from data inputs) should be investigated, for example, by having at-sea observers sample the discards. Additionally, ongoing monitoring of Spiny Dogfish bycatch by the at-sea observer program is recommended.

LIST OF MEETING PARTICIPANTS

Name	Affiliation
Barrett, Melanie	DFO Science / Population Ecology Division
Bowlby, Heather	DFO Science / Population Ecology Division
Clark, Kirsten	DFO Science / Population Ecology Division
Couture, John	Unama'ki Institute of Natural Resources (UINR)
Doherty, Penny	DFO Resource Management
Ford, Jennifer	DFO Science / Centre for Science Advice
Fowler, Mark	DFO Science / Population Ecology Division
Gillett, Roxanne	DFO Species at Risk Program
Hart, Dvora	NOAA / Northeast Fisheries Science Centre
Karbowski, Chelsey	Oceans North Canada
McNeely, Joshua	Maritime Aboriginal Peoples Council (MAPC) - IKANAWTIKET
Miller, Tim	NOAA / Northeast Fisheries Science Centre
Sark, Roger	Maliseet Nation Conservation Council
Sosebee, Katherine	NOAA / Northeast Fisheries Science Centre
Stone, Heath	DFO Science / Population Ecology Division
Vascotto, Kris	Atlantic Groundfish Council / Groundfish Individual Transferable Quota Association

SOURCES OF INFORMATION

This Science Advisory Report is from the December 11, 2018, and February 13, 2019, Assessment of Spiny Dogfish in the Northwest Atlantic. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Fowler, G.M. and Campana, S.E. 2015. Framework Assessment and 2013 Update using a Stage-based Population Model for Spiny Dogfish (*Squalus acanthias*) in the Northwest Atlantic. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/065. v + 134 p.

Rago, P.J. and Sosebee, K.A. 2010. Biological Reference Points for Spiny Dogfish . Northeast Fish Sci Cent Ref Doc. 10-06; 52 p.

Sosebee, K.A. and Rago, P.J. 2018. Update on the Status of Spiny Dogfish in 2018 and

Projected Harvests at the F_{msy} Proxy and P_{star} of 40%. Report to Mid-Atlantic Fisheries Management Council Scientific and Statistical Committee, September 11, 2018. 82 p.

Transboundary Resources Advisory Committee. 2010. Proceedings of the Transboundary Resources Advisory Committee (TRAC) Spiny Dogfish Review. Benchmark Data Meeting, 30 March – 2 April 2009. TRAC Proceedings 2010/01.

THIS REPORT IS AVAILABLE FROM THE:

Center for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
Bedford Institute of Oceanography
1 Challenger Drive, PO Box 1006
Dartmouth, Nova Scotia B2Y 4A2

Telephone: 902-426-7070
E-Mail: MaritimesRAP.XMAR@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087

Correct Citation for this Publication:

DFO. 2020. Assessment of Spiny Dogfish in the Northwest Atlantic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/001.

Aussi disponible en français :

MPO. 2020. Évaluation de l'aiguillat commun dans l'Atlantique Nord-Ouest. Secr. can. de consult. sci. du MPO, Avis sci. 2020/001.