



## ASSESSMENT OF NAFO SUBDIVISION 3PS THORNY SKATE (*AMBLYRAJA RADIATA*)



Photo: Thorny Skate, *Amblyraja radiata*.  
(Carolyn Miri, DFO-NL Region)



Figure 1. Subdivision 3Ps management area and economic zone around the French islands of St. Pierre et Miquelon (SPM, dashed line).

### Context:

Thorny Skate (*Amblyraja radiata*) is widely distributed in depths ranging from 18 m to over 1,500 m, in temperatures from  $-1.4^{\circ}$  to about  $6^{\circ}\text{C}$ , and on both hard and soft bottoms. Previous studies indicated that Thorny Skate undergo seasonal movements toward the shelf edge in the winter/spring, returning onto the bank in mid-summer and fall; probably to spawn. Thorny Skate in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps (Fig. 1) and adjacent Divisions 3LNO are considered to constitute a single stock.

Until the mid-1990s, there was limited interest by the Canadian fleet to fish for skates in waters around the island of Newfoundland. Previously, they were usually discarded despite being the most common non-commercial bycatch in offshore trawler catches. This bycatch was not reported in Canadian landings statistics. Most of the reported landings before 1994 were attributable to non-Canadian fleets. With the decline of other groundfish resources, Canadian interest in skate increased and a Total Allowable Catch (TAC) of 1,000 t was introduced in 1995 for NAFO Subdiv. 3Ps (inside Canada's Exclusive Economic Zone or EEZ), raised to 2,000 t for 1996; then lowered and maintained by Canada at 1,050 t from 1997 to present.

Catch was unregulated in 3LNO until 2005 when the NAFO Fisheries Commission set an annual TAC of 13,500 t. This TAC was maintained until 2009, reduced to 12,000 t annually for 2010-11, and to 8,500 t for 2012. The TAC was further reduced to 7,000 t for 2013 and has remained unchanged.

This Science Advisory Report is from the November 2-6, 2020 regional advisory meeting on Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Thorny skate. Additional

publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

## SUMMARY

- Bottom temperatures in NAFO Subdiv. 3Ps remained above normal between 2009 and 2019, but no data are available for 2020. Zooplankton data were also unavailable for 2019 and 2020. Satellite imagery indicated that the timing and magnitude of the spring phytoplankton bloom were normal in 2020, after two consecutive years of early onset and above-normal production.
- Ongoing warming trends, together with an increased dominance of warm water fishes, indicate that this ecosystem continues to experience structural changes.
- Thorny Skate in Subdiv. 3Ps and adjacent Div. 3LNO are considered to constitute a single stock, which is managed by Canada in Subdiv. 3Ps and by NAFO in Div. 3LNO.
- Life history characteristics of Thorny Skate result in low intrinsic rates of population growth; thereby leading to low resilience to fishing mortality.
- In Subdiv. 3Ps, reported landings by Canada and France totaled 1,059 t in 2018, and 969 t in 2019, approximately double the previous six year average catch (497 t over 2012–2017).
- The Canadian DFO research survey abundance index for Subdiv. 3Ps was relatively stable from 1993–2019, while the survey biomass index indicated a gradually increasing trend. Similar trends were observed in Div. 3LNO. There was no spring survey in 2020.
- The relative estimate of fishing mortality for Thorny Skate in Subdiv. 3Ps has been below the long-term average (1996–2019) since 2010. Relative fishing mortality in Div. 3LNO also remains low.
- In Subdiv. 3Ps, the abundance of Thorny Skates  $\leq 21$  cm in total length has been below average during 2018–2019. Overall, the stock recruitment index for the entire stock area in Subdiv. 3Ps and Div. 3LNO has also fluctuated without trend, but has been below the long-term average over 2018–2019.
- The Thorny Skate stock in Subdiv. 3Ps and Div. 3LNO is currently above  $B_{lim}$ . The probability that the current biomass is above  $B_{lim}$  is  $>95\%$ .
- The stock biomass has been generally increasing since the mid-1990s, indicating that the stock has been able to sustain the range of catches over this period.

## INTRODUCTION

Thorny Skates (*Amblyraja radiata* Donovan, 1808) are widely distributed in temperate and Arctic waters of the North Atlantic. In the western North Atlantic, Thorny Skate is distributed from Greenland to South Carolina, with the center of distribution on the Grand Banks in NAFO Div. 3LNO (Fig. 1). The Grand Banks stock extends into Subdiv. 3Ps. Canadian commercial skate catches consist mainly of Thorny Skate (~95%, Kulka and Miri 2007); which is similar to the proportion (97–99%) of Thorny Skates caught in the Canadian DFO annual spring research survey (see **Survey Catch Composition – Other Skates**, in Simpson and Miri 2020). In the European Union (UN)-Spain research survey of Div. 3NO over 2014–16, Thorny Skate comprised approximately 90% of the skates caught (González-Costas et al. 2020). Thus, the skate fishery on the Grand Banks can be considered a directed fishery for Thorny Skate.

## Species Biology

### Stock Structure

Based on a continuous distribution and lack of physical barriers between the south coast of the island of Newfoundland (NAFO Subdiv. 3Ps) and the Grand Banks (NAFO Div. 3LNO), Thorny Skate in Subdiv. 3Ps and adjacent Div. 3LNO are considered to constitute a single stock, which is managed by Canada in Subdiv. 3Ps and by NAFO in Div. 3LNO.

### Spawning

Life history characteristics of Thorny Skate result in low intrinsic rates of population growth; thereby leading to low resilience to fishing mortality. The life span of Thorny Skate in Newfoundland and Labrador waters is unknown. The time between tagging and recapture of some individuals suggests that they can live at least twenty years. They deposit 6–40 egg cases per year, each of which contain a single embryo. Limited data suggest that reproduction occurs during the summer/fall period.

### Maturation

Males mature at smaller sizes than females, and size at maturity increases from northern to southern latitudes.

### Distribution

Thorny Skate is widely distributed in depths ranging from 18 m to over 1,500 m, in temperatures from -1.4°C to about 6°C, and on both hard and soft bottoms (Fig. 2). Previous studies indicated that Thorny Skate undergo seasonal movements toward the shelf edge in the winter/spring, returning onto the Bank in midsummer and fall; probably to spawn. In Subdiv. 3Ps, Thorny Skates are distributed on Burgeo, St. Pierre, and Green Banks, and also in the deeper waters of the Laurentian, Hermitage, and Halibut Channels. Prior to the stock decline and a concomitant period of spatial contraction, Thorny Skates were distributed throughout Subdiv. 3Ps and Div. 3LNO; including the shallower areas of the Grand Banks.

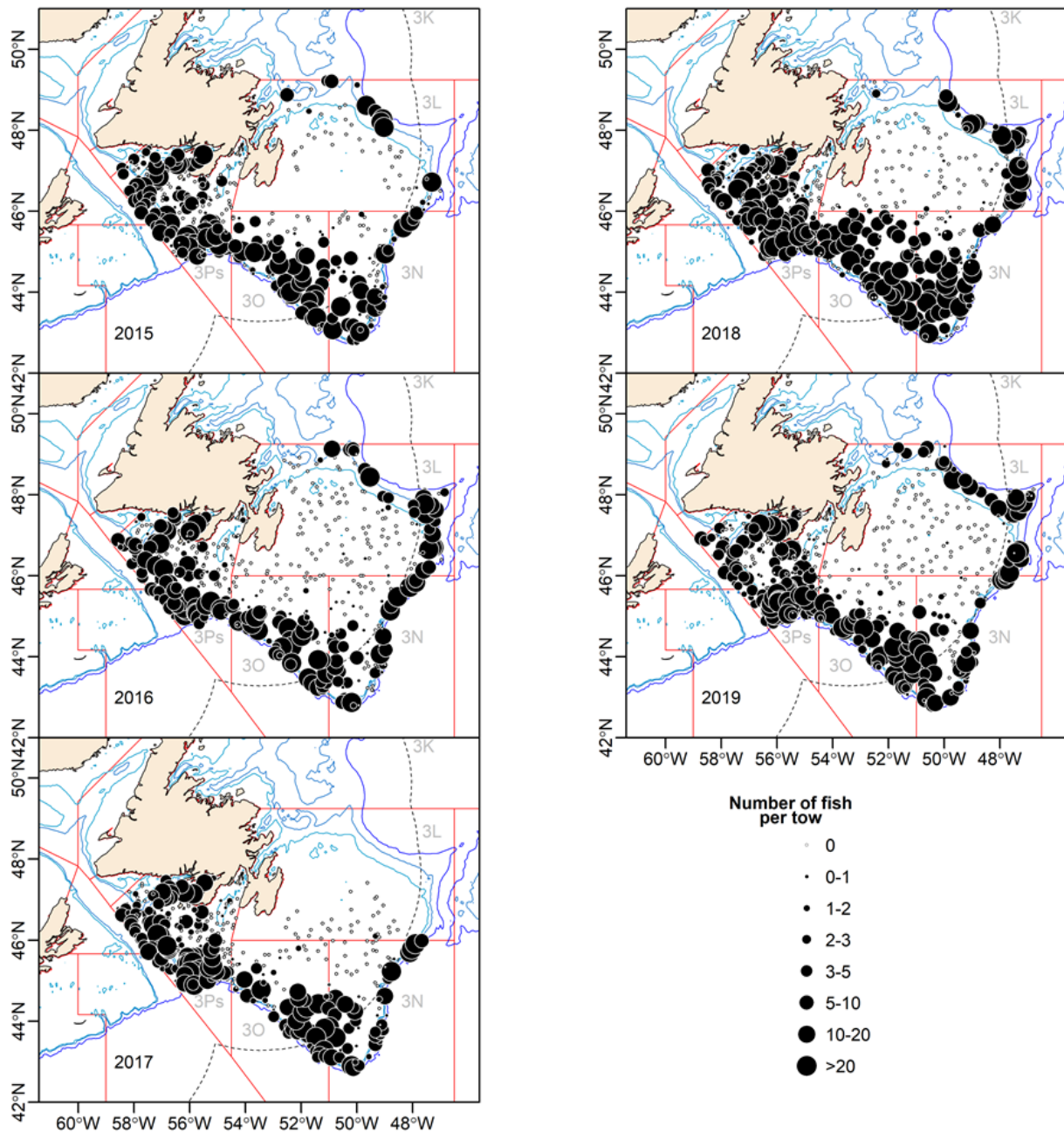


Figure 2. Distribution of Thorny Skate on the Grand Banks (NAFO Subdiv. 3Ps and Div. 3LNO), based on Canadian spring research surveys in 2015-19.

### Oceanography and Ecosystem Overview

Oceanographic and ecosystem conditions in Subdiv. 3Ps are influenced by warm Gulf Stream waters from the south, the Labrador Current from the north, as well as complex bottom topography in the region and local atmospheric climate conditions. Bottom temperatures in Subdiv. 3Ps remained above normal between 2009 and 2019, but no data were available for 2020. Zooplankton data were also unavailable for 2019 and 2020. Satellite imagery indicated

that the timing and magnitude of the spring phytoplankton bloom were normal in 2020; after two consecutive years of early-onset and above-normal production. The overall biomass of the fish community in 3Ps has been relatively stable since the mid-1990s, whereas the overall abundance has increased due mainly to an increase in small plankton-eating fishes (e.g., sand lance [*Ammodytes americanus*]). There has been an increased dominance of warm water species such as Silver Hake (*Merluccius bilinearis*) since 2010, linked to an ongoing warming trend, indicating that this ecosystem continues to experience structural changes.

## The Fishery

### TAC Regulation

Thorny Skate came under quota regulation in 1995, after a directed skate fishery was established by Canada in EEZ in 1994. A TAC of 1,000 t for NAFO Subdiv. 3Ps was adopted by Canada in 1995; with gear and bycatch restrictions. In 1996, the TAC was raised to 2,000 t for Subdiv. 3Ps, and then reduced and maintained at 1,050 t from 1997 onward.

Catch was unregulated in 3LNO until 2005, when the NAFO Fisheries Commission set an annual TAC of 13,500 t (Fig. 2). This TAC was maintained until 2009, was reduced to 12,000 t annually for 2010–11, and to 8,500 t for 2012. The TAC was further reduced to 7,000 t for 2013 and has remained unchanged. The NAFO Commission agreed to maintain this TAC at 7,000 t for 2021–22.

### Catch Trends

In Subdiv. 3Ps, NAFO STATLANT-21A data indicated that Canadian fleets reported the majority of Thorny Skate landings, while St. Pierre and Miquelon (EU-France) reported smaller landings (Table 1; Fig. 3). Prior to 1994, Canadian landings of Thorny Skate in Subdiv. 3Ps rarely exceeded a few hundred tons. Total reported landings in Subdiv. 3Ps averaged 1,300 t from 1994–2008, 500 t from 2009–11, and 300 t over 2012–17. In Subdiv. 3Ps, reported landings by Canada and France totaled 1,059 t in 2018, and 969 t in 2019, approximately double the previous six-year average total landings (497 t over 2012–17). Canadian catch has been within the TAC, however when combined with French catch in 3Ps, the TAC was exceeded in 1998–2010, and 2018–19.

Table 1. Reported Thorny Skate landings from NAFO Subdiv. 3Ps (in tons).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>TAC</b>	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
<b>Canada</b>	645	342	513	354	286	201	168	404	413	944	890
<b>Other</b>	354	529	228	224	271	145	75	250	192	115	79
<b>Total</b>	999	871	741	578	557	346	243	654	605	1,059	969

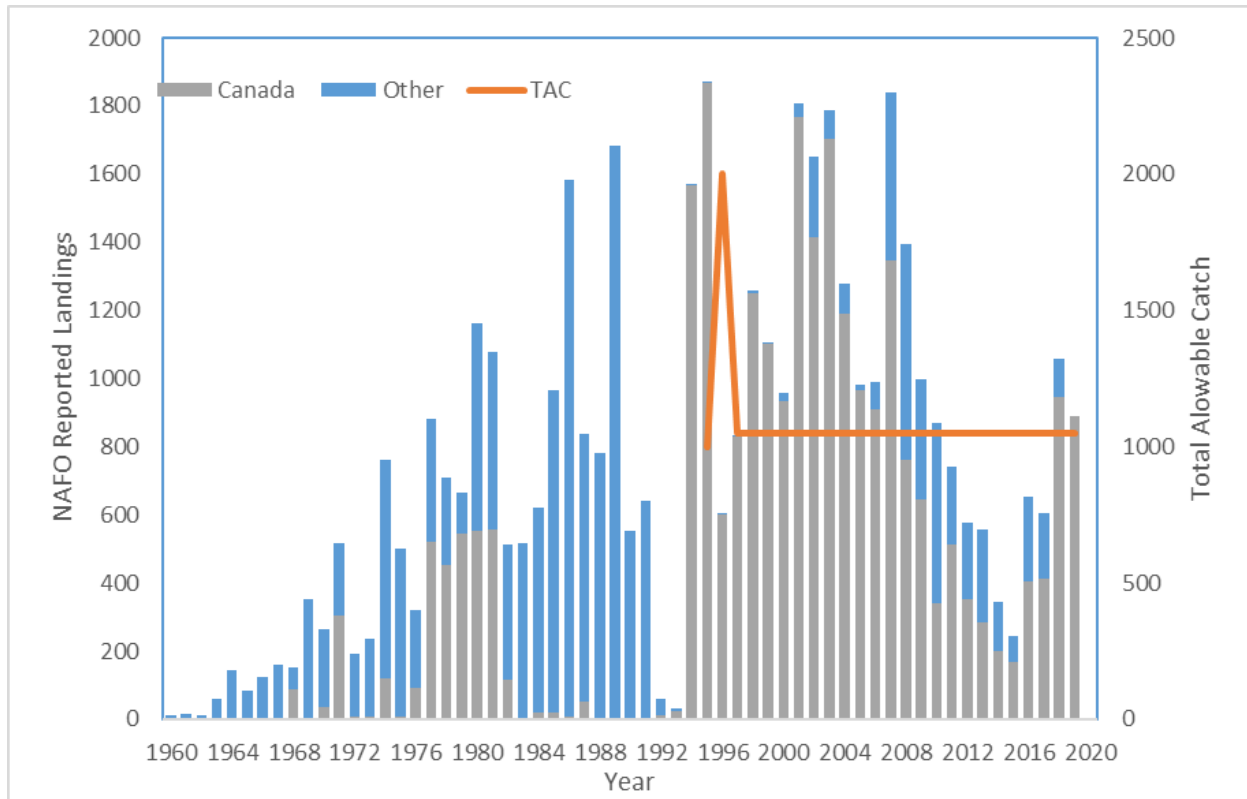


Figure 3. NAFO-reported landings (tons) of Thorny Skate by Canada and other countries in NAFO Subdiv. 3Ps in 1960–2019 (STATLANT-21A). Data do not include discards at sea. TAC in Subdiv. 3Ps is set by DFO.

The level of total commercial removals of Thorny Skate is uncertain. It is highly probable that historical landing records have been biased both upwards (e.g., due to misreporting of landings by location and/or species) and downwards (e.g., due to unreported discards at sea). In assessing stock status, it is crucial that commercial skate landings data be reported by species, and that commercial discards of Thorny Skate at sea be reported in order to reliably estimate total commercial removals from the population.

## ASSESSMENT

### Resource Status

#### Sources of Information

Stock status was updated using commercial landings reported by Canadian fishers operating in Canada’s EEZ (1985–2019), commercial landings reported by NAFO-member countries in the NAFO Regulatory Area (NRA) of Div. 3LNO and Subdiv. 3Ps (1960–2019), length distributions of commercial catches sampled at sea by Canadian Fisheries Observers, and relative biomass and abundance indices from Canadian research trawl surveys conducted in spring (Div. 3LNOPs in 1972–2019; except in 2006) and fall (Div. 3L in 1981–2019; Div. 3NO in 1990–2019). Canadian Research surveys

Canadian spring research surveys are considered to reflect trends in the Thorny Skate population in Subdiv. 3Ps and Div. 3LNO. However, there have been changes in the timing and

extent of survey coverage over time, which could affect estimates of population abundance and biomass (see Rideout 2020, and Rideout and Ings 2020 for details).

In Subdiv. 3Ps, the Canadian stratified-random bottom trawl surveys have been conducted by DFO since 1972. These surveys over 1972–82 entailed relatively low coverage, with fewer sets per year on average. The DFO spring survey in 2006 was not completed, due to mechanical issues with the research vessel; therefore, 2006 survey estimates are not provided. There was no 2020 spring survey in Subdiv. 3Ps and Div. 3LNO, thereby precluding any estimate of abundance and biomass in Subdiv. 3Ps for that year.

Historical abundance and biomass indices from Canadian spring surveys in Subdiv. 3Ps Div. 3LNO and are provided in Figure 4. Since the mid-1990s, spring biomass indices for Thorny Skate in the entire stock area were generally increasing, following a declining trend over 1985–95.

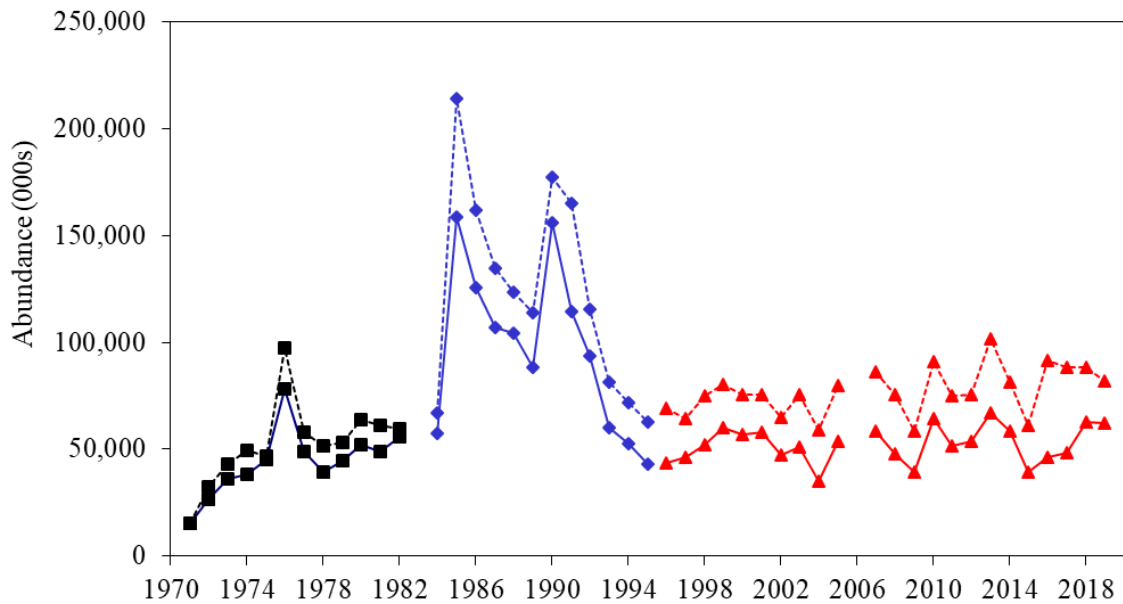
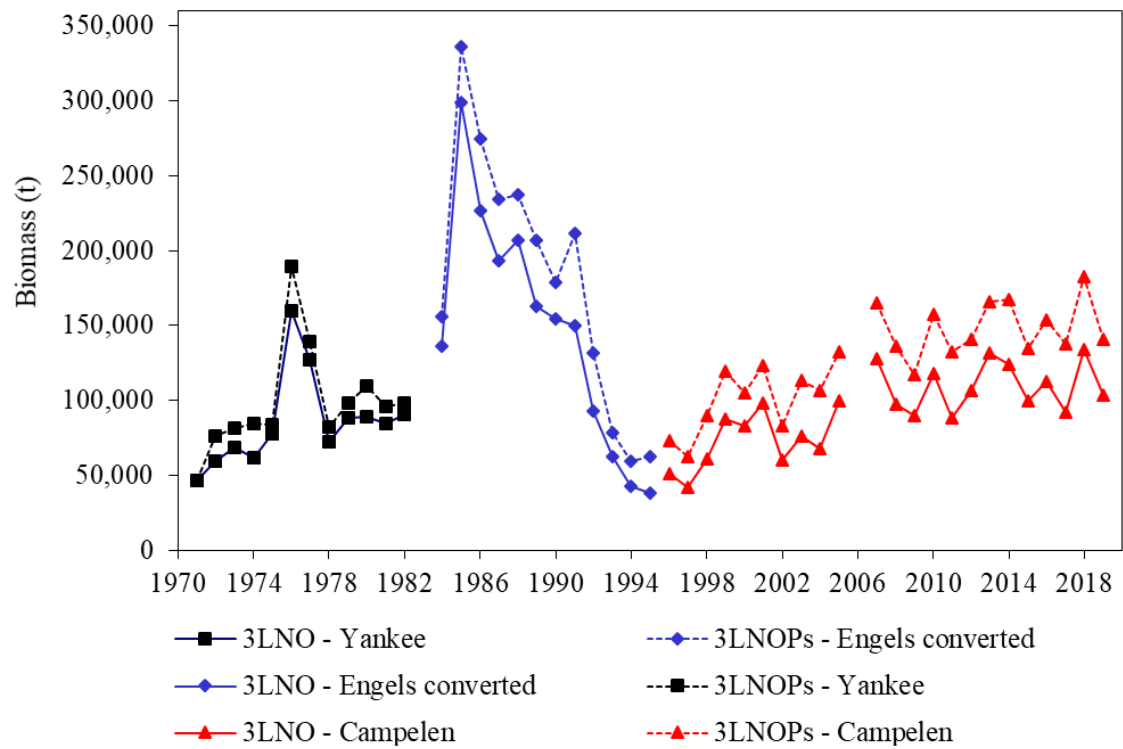


Figure 4. Relative biomass and abundance indices for Thorny Skate from Canadian spring research surveys in NAFO Subdiv. 3Ps+Div. 3LNO and in NAFO Div. 3LNOPs, 1971–2019.

In Subdiv. 3Ps, the biomass index was 48,339 t and 37,211 t in 2018 and 2019 respectively. The 2019 biomass estimate was below the 2014–18 average of 39,903 t (Fig. 5). Previously, the spring biomass index averaged 33,500 t during Engel survey years (using Campelen-equivalents). The Subdiv. 3Ps spring abundance index fluctuated around 25 million skates in



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1996–2017, with a peak of 45 million fish in 2016, and averaged 29 million fish in the Engel years (Campelen-equivalents; Fig. 5). Overall, the Canadian DFO research survey abundance index for Subdiv. 3Ps was relatively stable from 1993–2019, while the survey biomass index indicated a gradually increasing trend. Similar trends were observed in Div. 3LNO.

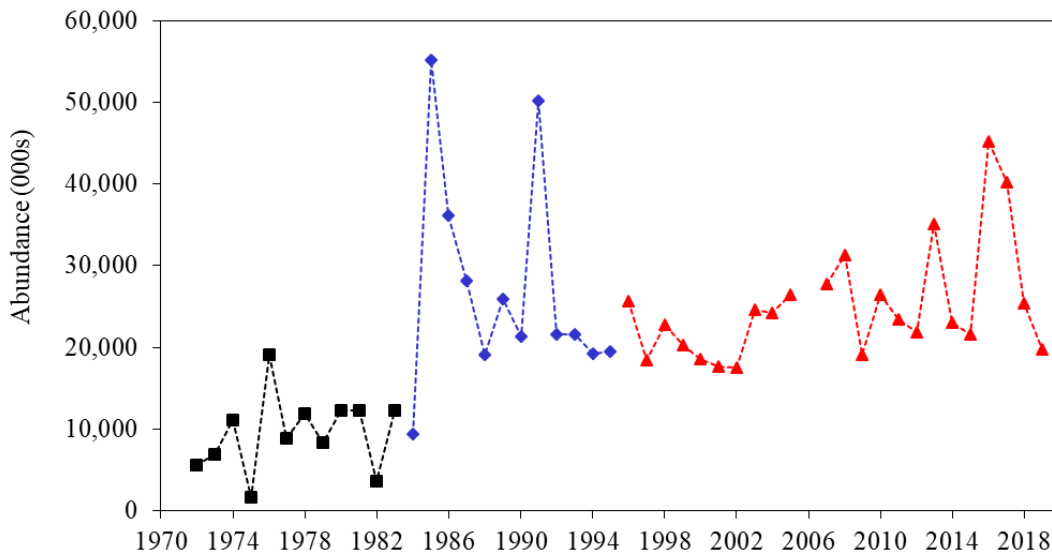
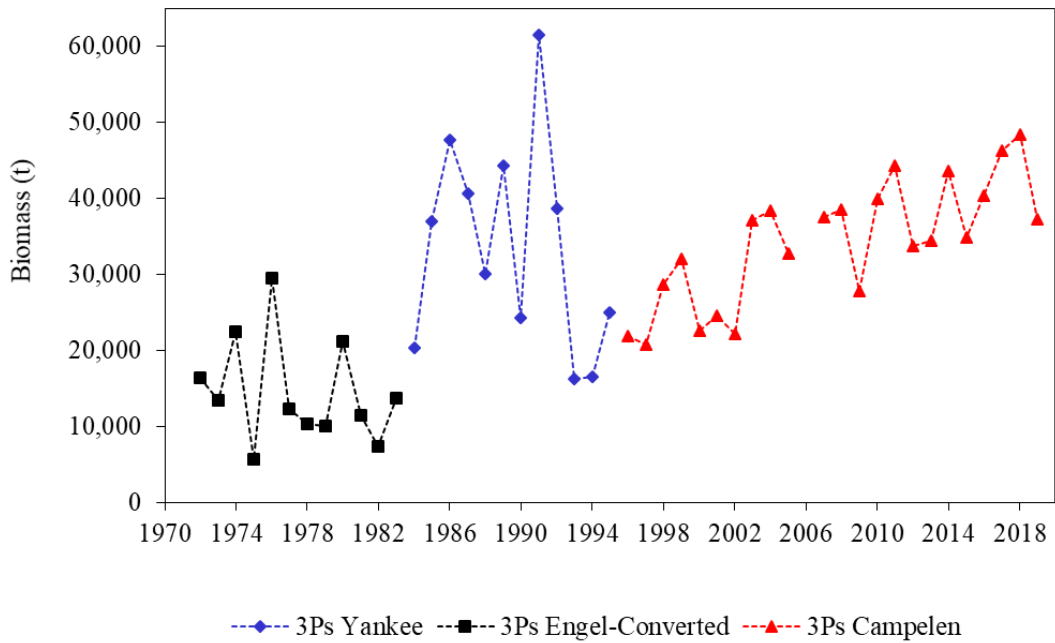


Figure 5. Relative biomass and abundance indices for Thorny Skate from Canadian spring research surveys in NAFO Subdiv. 3Ps, 1972–2019.

## Recruitment

A standardized index of Thorny Skate recruitment in Subdiv. 3Ps + Div. 3LNO, based on the number of skates  $\leq 21$  cm total length, is illustrated in Figure 6. In 2019, the recruitment index was comparable to the long-term average. The 2006 and 2020 indices are not presented; due to incomplete Canadian spring survey coverage, and the Div. 3L survey was incomplete in 2015 and 2017. In Subdiv. 3Ps, the abundance of Thorny Skates  $\leq 21$  cm has also been below average in 2018–19. Overall, the recruitment index for the entire stock area (Subdiv. 3Ps and Div. 3LNO) has fluctuated without trend, but was below the long-term average over 2018–19.

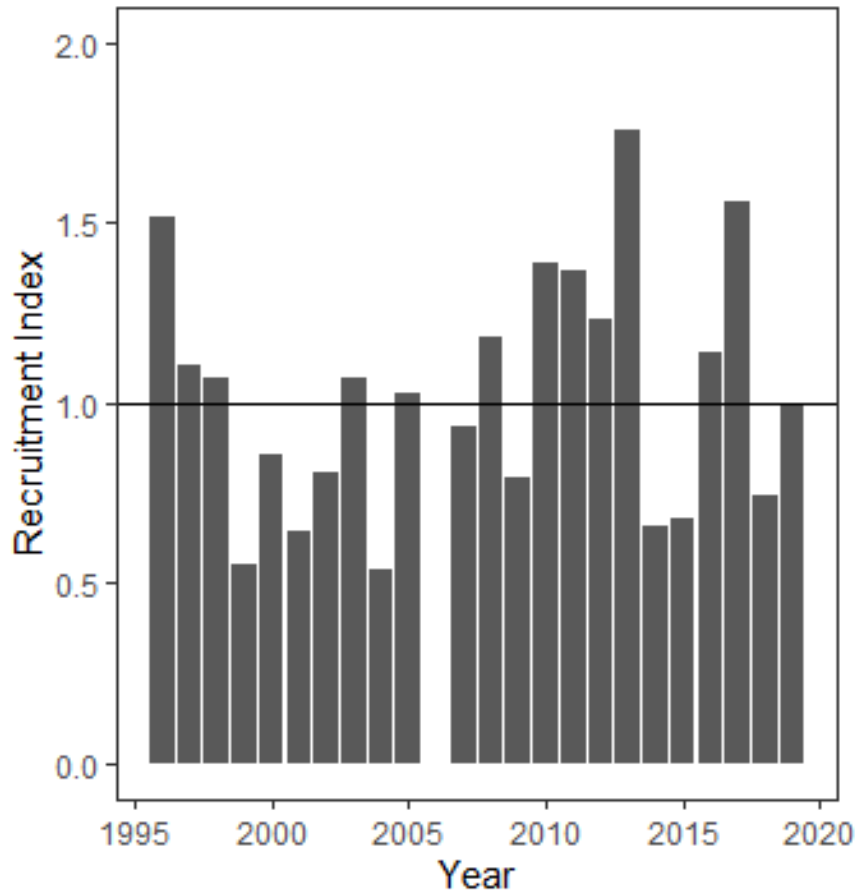


Figure 6. Standardized recruitment index (Thorny Skate  $\leq 21$  cm Total length) from Canadian spring surveys in Div. 3LNOPs, 1996–2019. The deeper portion ( $>103$  m) of Div. 3NO, as well as all of Subdiv. 3Ps, were not surveyed in 2006. The horizontal line depicts the standardized average recruitment for 1996–2019.

## Index of Fishing Mortality

A relative Fishing Mortality Index (Relative  $F = (\text{NAFO STATLANT-21A landings} / \text{Canadian spring survey biomass estimate})$ ) was calculated for Thorny Skate in Subdiv. 3Ps for 1996–2019 (Fig. 7). This relative index was below the long-term average (1996–2019) in Subdiv. 3Ps since 2010; while that in NAFO Div. 3LNO also remained low since 2012.

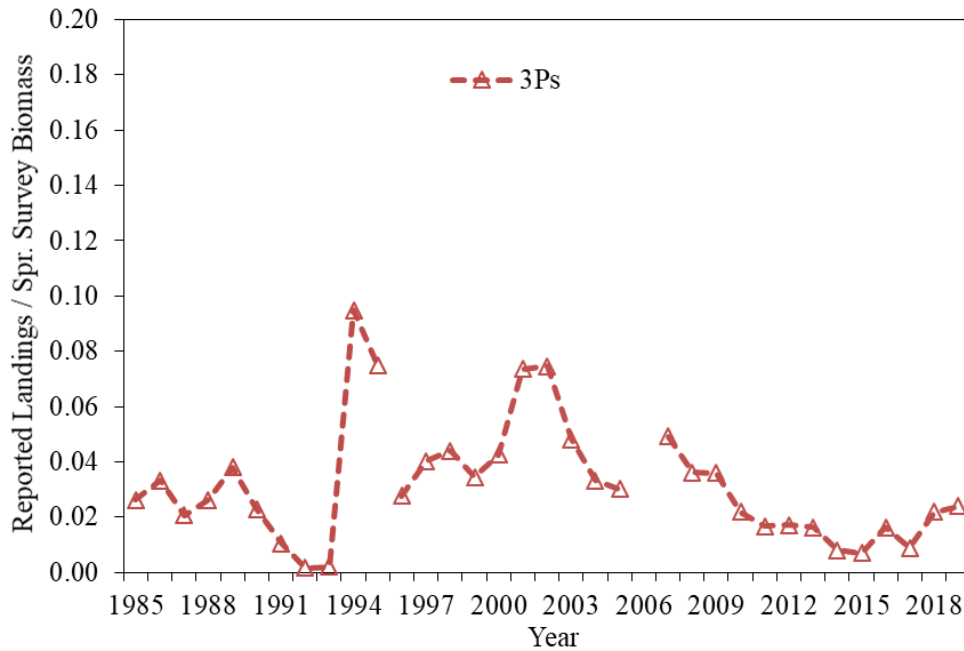


Figure 7. Fishing Mortality Index (reported landings/spring survey biomass) for Subdiv. 3Ps, 1985–2019. Commercial landings are NAFO STATLANT-21A; biomass indices are from Canadian spring research surveys.

### Stock Status

Based upon a qualitative evaluation of Thorny Skate stock biomass trends and recruitment indices, the assessment is considered data-limited and, as such, is associated with a relatively high level of uncertainty. The next full assessment of this Div. 3LNOPs stock by NAFO Scientific Council will be in 2022.

This Div. 3LNOPs Thorny Skate stock is currently above the limit reference point ( $B_{lim}$ ), as defined from survey indices as  $B_{loss}$  (Simpson et al. 2015, Fig. 8). The probability that its current biomass is above  $B_{lim}$  is >95%. Total survey biomass estimates in Div. 3LNOPs have remained stable since 2007. Recruitment in 2017 was above average, but then declined to below average in 2018–19. Relative fishing mortality remained low. Overall, Thorny Skate stock biomass was generally increasing since the mid-1990s; indicating that this stock has been able to sustain the range of catches over this period.

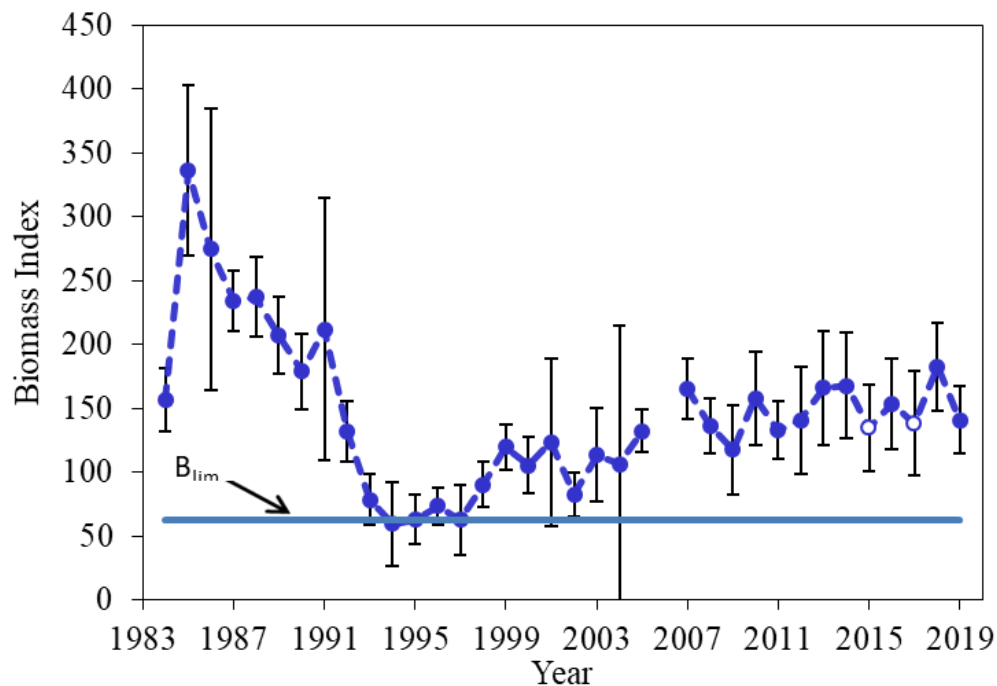


Figure 8. Biomass Index for Thorny Skate, from Canadian spring research surveys in Div. 3LNOPs, 1984–2019. Horizontal line represents  $B_{lim}$ . Surveys in 2015 and 2017 (open circles) were incomplete.

### Sources of Uncertainty

The assessment of the status of Thorny Skate is limited by a paucity of information on the life history of this species, as well as uncertainties regarding its commercial catch history. Key biological information, such as growth rates, age of maturity, and population/age structure of the Div. 3LNOPs stock is lacking. Thus, it is not possible to undertake age-based analyses or estimate spawning stock biomass with any certainty. This lack of data is accentuated in the attempts to develop Thorny Skate stock-recruit relationships and model stock dynamics.

Lack of speciated commercial skate landings, misreporting of fishing locations and/or species caught, and unreported discards at sea, place substantial restrictions on the evaluation of fishing mortality of Thorny Skates; as does the reliance on a single annual Canadian research survey in Subdiv. 3Ps.

Thorny Skate has undergone substantial changes in its distribution since the 1980s. The Div. 3LNOPs stock has become increasingly aggregated in Subdiv. 3Ps, and on the southern part of the Grand Banks. The result is a decreasing area of occupancy, and increasing catch rates in commercial fisheries occurring where these skates are aggregated. Despite a number of years of reduced commercial landings, there has been little recovery of Thorny Skate in Div. 3LNOPs, although abundance estimates appeared stable in the Subdiv. 3Ps portion of the stock area.

### CONCLUSIONS AND ADVICE

Reported commercial landings of Thorny Skate in Subdiv. 3Ps have increased considerably in 2018–19. Discarding of skate bycatch at sea remains unreported by Canadian and other fishers, resulting in higher mortalities than available fisheries statistics indicate. Commercial skate landings remain unspciated when reported by Canadian and other fishers. Reporting skate

**Newfoundland and Labrador Region**

landings and discards by species should be made mandatory for commercial harvesters operating in Canada's EEZ; thereby improving fisheries statistics for stock assessment purposes. In addition, given that Canadian at-sea fisheries observers constitute the sole source of data on total catch (= landings + discards) by species, annual observer coverage of Canadian Thorny Skate directed, and bycatch fisheries should be increased to greatly improve the reliability and representativeness of fishing mortality estimates, and allow at-sea collections of important biological data on this species (e.g., length, weight, sex, maturity, stomach contents).

Distribution and abundance indices of Thorny Skate in Subdiv. 3Ps were stable over the near-term; whereas biomass estimates have been gradually increasing. The relative Fishing Mortality Index for Thorny Skate in Subdiv. 3Ps has remained low. A six-year assessment schedule is recommended for Subdiv. 3Ps Thorny Skate. This subcomponent is included in the biennial Div. 3LNOPs Thorny Skate stock assessments (with interim monitoring reports in non-assessment years) conducted by NAFO Scientific Council. Furthermore, a full assessment should be triggered if the major population indicator for this species (i.e., the DFO spring survey biomass index) increases or decreases by more than two standard deviations, as reviewed by NAFO Scientific Council. This re-assessment may result in revised landings advice to DFO Resource Management for Thorny Skate-directed and bycatch fisheries in Div. 3P.

**LIST OF MEETING PARTICIPANTS**

<b>Name</b>	<b>Affiliation</b>	<b>3-Nov</b>	<b>4-Nov</b>	<b>5-Nov</b>
Krista Baker	DFO Science, NL Region	X	X	X
Roanne Collins	DFO Science, NL Region	X	X	X
Nick Gullage	DFO Science, NL Region	X	X	X
Eugene Lee	DFO CSAS, NL Region	X	X	X
Karen Dwyer	DFO Science, NL Region	X	X	X
Laura Wheeland	DFO Science, NL Region	X	X	X
Paul Regular	DFO Science, NL Region	X	-	X
Danny Ings	DFO Science, NL Region	X	X	X
Keith Lewis	DFO Science, NL Region	X	X	X
Fred Cyr	DFO Science, NL Region	X	X	X
Shelley Dwyer	DFO RM, NL Region	X	X	X
Hannah Munro	DFO Science, NL Region	X	X	-
Divya Varkey	DFO Science, NL Region	X	X	X
Mark Simpson	DFO Science, NL Region	X	X	X

**Assessment of NAFO Subdiv. 3Ps  
Thorny Skate**

**Newfoundland and Labrador Region**

<b>Name</b>	<b>Affiliation</b>	<b>3-Nov</b>	<b>4-Nov</b>	<b>5-Nov</b>
Deborah Austin	DFO Science, NCR Region	X	X	X
Carolyn Miri	DFO Science, NL Region	X	X	X
Nicolas Le Corre	DFO Science, NL Region	X	X	-
Luiz Mello	DFO Science, NL Region	X	X	-
Andrew Cuff	DFO Science, NL Region	X	-	-
Rajeev Kumar	DFO Science, NL Region	X	X	X
Emilie Novaczek	DFO Science, NL Region	X	X	-
Garry Stenson	DFO Science, NL Region	X	-	-
Nicole Rowsell	NL Government	X	X	X
Anna Tilley	NL Government	X	X	X
Greg Robertson	ECCC	X	X	X
Joel Vigneau	IFREMER	X	X	X
Jonathan Deroba	NOAA	X	X	X
Erin Carruthers	FFAW	X	X	X
Brian Careen	Harvester	X	X	-
Kris Vascotto	Atlantic Groundfish Council	X	X	X
Noel Cadigan	Marine Institute	X	X	X
Chelsey Karbowski	Oceans North	X	X	X
Devan Archibald	Oceana	X	X	X

## SOURCES OF INFORMATION

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**THIS REPORT IS AVAILABLE FROM THE:**

Centre for Science Advice (CSA)  
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Fisheries and Oceans Canada  
Northwest Atlantic Fisheries Centre  
P.O. Box 5667  
St. John's NL Canada  
A1C 5X1

E-Mail: [DFONLCentreforScienceAdvice@dfo-mpo.gc.ca](mailto:DFONLCentreforScienceAdvice@dfo-mpo.gc.ca)  
Internet address: [www.dfo-mpo.gc.ca/csas-sccs](http://www.dfo-mpo.gc.ca/csas-sccs)

ISSN 1919-5087

ISBN 978-0-660-43015-7 N° cat. Fs70-6/2022-009E-PDF

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Correct Citation for this Publication:

DFO. 2022. Assessment of NAFO Subdivision 3Ps Thorny Skate (*Amblyraja radiata*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2022/009.

*Aussi disponible en français :*

MPO. 2022. Évaluation de la raie épineuse (*Amblyraja radiata*) de la sous-division 3Ps de l'OPANO. Secr. can. des avis sci. du MPO. Avis sci. 2022/009.