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Assessment of Thorny Skate (*Amblyraja radiata* Donovan, 1808) in NAFO Divisions 3LNO and Subdivision 3Ps

by

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Abstract

Available information on the fishery, management, biology, and assessment of Thorny Skate in NAFO Divisions 3LNO and Subdivision 3Ps was reviewed to determine the status of this stock. Based on the continuous distribution and lack of physical barriers between Div. 3LNO and Subdiv. 3Ps, Thorny Skate in Div. 3LNOPs is considered to constitute a single stock. In 2007-2012, an average of 5 701 tons of Thorny Skate from Div. 3LNO was commercially landed. STACFIS-agreed total landings from Div. 3LNO was 4 353 t in 2013. Canadian reported landings in Subdiv. 3Ps averaged 851 t in 2007-2012, and was 285 t in 2013. Sampling of Canadian commercial catches for skate lengths by at-sea Canadian Fisheries Observers indicated that Canadian gillnetters directing for Monkfish in NAFO Div. 3O caught 62-87 cm TL skates in 2012, with a mode of 73-74 cm; Canadian trawlers directing for skates in Subdiv. 3Ps caught 34-97 cm TL skates, with a mode of 60-67 cm (1999-2007); and skates trawled in the Subdiv. 3Ps redfish fishery were 36-96 cm TL, with a mode of 75-79 cm (2005-2010). An Index of Fishing Mortality for Div. 3LNO increased from the late 1980s to a peak of 30% in 1997; then stabilized at approximately 17% during 1998-2004. In 2005, this Index declined to 4%, and remained around 5% since then. Since 1985, fishing mortality in Subdiv. 3Ps was relatively constant; remaining below 5% in most years. After observing a drastically declining trend over 1985-1995, Canadian spring research surveys indicated that biomass and abundance of Thorny Skate in Div. 3LNO were relatively stable at low levels since then. Most notable in 2011 was the reduced biomass estimate in Div. 3N (21 239 t); relative to the previous 41 373-ton average in 2006-2010. Thorny Skate distribution in Div. 3LNOPs for 2007-2013 continued to be concentrated on the southwest Grand Banks, in Subdiv. 3Ps, and northward along the edge of the Bank.

Introduction

Thorny Skates (*Amblyraja radiata* Donovan, 1808) are widely distributed in temperate and arctic waters of the North Atlantic. In the western Atlantic, Thorny Skate are distributed from Greenland to South Carolina, with the center of distribution on the Grand Banks (Fig. 1) in NAFO Divisions 3LNO. Commercial catches of skates consist of several skate species; although Thorny Skate dominates the catch composition. In Canadian commercial catches, about 95% of the skate catch are Thorny Skates (Kulka and Miri 2007; Kulka and Mowbray 1999); similar to the proportion of Thorny Skate in EU-Spain research survey catches in Div. 3NO (González-Troncoso *et al*. 2013). Thus, the skate fishery on the Grand Banks can be considered a directed fishery for Thorny Skate.

Fishery and Management

TAC Regulation

Thorny Skate came under quota regulation in 1995, after a directed skate fishery was established in 1994 by Canada in its Exclusive Economic Zone (EEZ). A Total Allowable Catch (TAC) of 5 000 tons for Divisions 3LNO and 1 000 t for Subdivision 3Ps were adopted by Canada in 1995; with gear and bycatch policies. In 1996, the TAC was raised to 6 000 t for Div. 3LNO and 2 000 t for Subdiv. 3Ps. In 1997, the TAC was reduced to 1 950 t for Div. 3LNO and 1 050 t for Subdiv. 3Ps.

Outside Canada's EEZ, catch was unregulated until September 2004, when the Northwest Atlantic Fisheries Organization (NAFO) Fisheries Commission set a TAC of 13 500 t for 2005-2009 in Div. 3LNO. This TAC was lowered by NAFO to 12 000 t for 2010-2011, and to 8 500 t for 2012. The TAC was further reduced to 7 000 t for 2013 and 2014. The TAC for Subdiv. 3Ps has been maintained at 1 050 t by Canada.

Landings Trends

On the Grand Banks, Kulka and Mowbray (1998) reported that significant bycatch of skates have been taken since commencement of offshore fishing in the late 1940s; initially by non-Canadian fleets and later by Canadian vessels. Prior to the mid-1980s, non-Canadian fleets comprised the largest component of offshore fisheries on the Grand Banks, and took several thousand tons of skate as bycatch each year. The bycatch derived primarily from the Greenland Halibut fishery and from the Canadian mixed fishery for Thorny Skate, White Hake, and Monkfish (Kulka and Mowbray 1999). Kulka and Mowbray (1998) estimated that approximately 5 000 t, on average, were discarded annually by Canadian fleets during the 1980s and early 1990s, although only a few hundred tons were recorded in Canada's annual landings statistics during that period.

Catches for NAFO Div. 3LNO (Table 1; Fig. 2) increased in the mid-to-late 1980s with the commencement of a directed fishery for Thorny Skate. In 1985, Spain began targeting skate in a non-regulated fishery in the NAFO Regulatory Area (NRA) (Junquera and Paz 1998; del Río and Junquera 2001). During the period from 1985-1991, landings averaged 17 000 t and peaked at approximately 28 400 t in 1991 (STATLANT 21A). This fishery was mainly prosecuted by Spain, Portugal, USSR, and the Republic of Korea. Non-Canadian landings significantly declined to only 5 059 t in 1992 (Table 1). In 2000, Russia joined the directed fishery for Thorny Skate. Due to a new Canadian directed fishery that began in 1994, Canadian landings increased during 1994-1999 to an average of 1 590 t (Table 1; Simpson and Miri 2012). Since 2000, total reported landings of skate by all countries in Div. 3LNO declined (Table 1; Fig. 4). In 2010-2012, an average of 5 033 t of Thorny Skate was landed from Div. 3LNO. STATLANT 21A-reported landings from Div. 3LNO for 2013 totaled 4 353 t.

In NAFO Subdiv. 3Ps, NAFO STATLANT 21A data indicated that Canadian fleets reported the majority of Thorny Skate landings in recent years, while St. Pierre and Miquelon (EU-France) annually reported small landings of this species (Table 2; Figs. 3,4). Prior to 1994, Canadian landings of Thorny Skate in Subdiv. 3Ps rarely exceeded a few hundred tons. Canadian reported landings averaged 1 327 t from 1994-2008, and 415 t in 2010-2012. In Subdiv. 3Ps, Canadian total landings reported for 2013 was 285 t (STATLANT 21A).

Fisheries Interactions

Thorny Skate are captured by a number of gear types, in directed fisheries and as bycatch in fisheries directing for other species (Table 3a,b). Thorny Skate are caught in fisheries that are directing for many other species (Table 5c,d), but mainly in those fisheries that are directing for Atlantic Cod, Atlantic Halibut, Monkfish, White Hake, and Lumpfish (*Cyclopterus lumpus*). Similarly, in Thorny Skate-directed fisheries conducted in Div. 3LNOPs, bycatch of other commercially important species occurs, including Atlantic Cod (*Gadus morhua*), Haddock (*Melanogrammus aeglefinus*), American Plaice (*Hippoglossoides platessoides*), White Hake (*Urophycis tenuis*), Atlantic Halibut (*Hippoglossus hippoglossus*), and Monkfish (*Lophius americanus*; Table 5).

Commercial Size

Sampling of Canadian commercial catches by at-sea Canadian Fisheries Observers indicated that skates caught by Canadian gillnetters directing for Monkfish in NAFO Div. 3O in 2008 were of a size range similar to that of previous years: 51-110 cm Total Length (TL), with a mode of 72-77 cm (Fig. 5a; Kulka *et al.* 2006). However, the size range of skates (62-87 cm; mode of 73-74 cm) from that same fishery in 2012 indicated that large adults were missing. The skate-directed Div. 3O longline fishery in 2000 caught 56-101 cm fish, with a dominant mode at 80 cm. In 1999-2007, Canadian trawlers directing for skates in Subdiv. 3Ps caught 34-97 cm TL skates, with a mode of 60-67 cm (Fig. 5b; right column). One exception was in 1999, when smaller skates of 18-26 cm TL were also trawled in that fishery, and a dominant mode was seen at 80 cm. Skates trawled in the Subdiv. 3Ps redfish fishery in 2005-2010 were 36-96 cm in length, with a mode of 75-79 cm, although smaller skates of 21+ cm were also caught in 2005, with a mode of 67-68 cm (Fig. 5b; left column). The Canadian skate-directed gillnet fishery in 2000-2002 caught fish of 49-107 cm TL, with a mode of 76-80 cm (Fig. 5c; left column). In 2008, Canadian longliners directing for skates in Subdiv. 3Ps caught a similar range of sizes: 52-90 cm TL with a mode of 77-79 cm (Fig. 5c; right column). Thorny Skates caught in various Canadian fisheries in Div. 3LNOPs were not sampled in 2011, and skate length frequencies from 2013 are not yet available.

In 2007-2013, commercial length distributions from EU-Portugal, EU-Spain, and Russia in skate-directed trawl fisheries (280 mm mesh) of Div. 3LNO in the NRA indicated that the range of sizes caught did not vary between EU-Spain and Russia, and were similar to those reported in previous years (Fig. 5d; Kulka *et al.* 2006). One exception was the distribution of skates caught by EU-Portugal in Div. 3NO: a 25-45 cm TL range with a mode of 38 cm (2007) and 42 cm TL (2009) was significantly smaller than those of EU-Spain and Russia (27-95 cm; with a mode of 66 cm). Although these countries used 280 mm mesh in their commercial trawls, this comparison shows that EU-Portugal consistently caught an abbreviated range of smaller skates. Another noteworthy result was reported by EU-Spain in 2008; whereby its trawlers also caught a significant mode of 46–49 cm TL skates (Fig. 5d). In 2011, EU-Portugal directed for skates with a smaller mesh size (200 mm), and a 32-82 cm TL range with a mode of 60 cm skates was observed in a small sample taken at sea. In 2013 using 280 mm mesh, EU-Portugal caught 26-85 cm TL skates (mode of 49-50 cm) in Div. 3N.

In other directed trawl fisheries (130-135 mm mesh) of Div. 3LNO (NRA) during 2007-2009, length distributions of skate bycatch also did not vary between EU-Spain and Russia (Fig. 5e). However, EU-Portugal caught an abbreviated range of smaller skates in 2007, 2009, and 2010: a 24–84 cm TL range with a mode of 38 cm (2007), 46 cm (2009), two modes of 54 and 60 cm (2010), and another two modes of 60 and 76 cm TL (2011); while EU-Spain caught 26-86 cm skates with a 67-cm mode (2009). In 2008-2013, the size range of skate bycatch reported by EU-Portugal was similar to that of Russian trawlers (24-84 cm); although Russia also reported a small catch of 12-18 cm young-of-the-year skates in 2008 (Fig. 5e). EU-Portugal also reported two modes of 49 cm and 70 cm in 2013, and Russia reported skate modes of 57 cm and 69 cm in 2012. EU-Spain did not sample Div. 3LNO skate bycatch after 2009.

Russia sampled only 59 specimens during the NAFO Div. 3L Greenland Halibut fishery in 2009, and sampled 38 skates in 2011 (unsampled bycatch in 2010, 2013). Thorny Skates varied between 43-103 cm in length; with a mode of 61 cm. Three specimens of 115, 148, and 166 cm TL in 2011 are highly suspect, and were probably misidentified Spinytail Skates (*Bathyraja spinicauda*). In 2012, 64 sampled Thorny Skates ranged in size from 33-78 cm TL (mean length=66.7 cm) in the Div. 3L Greenland Halibut fishery, and 15 skates in Div. 3N varied between 24-66 cm TL (mean=47.9 cm). In the Div. 3L redfish fishery in 2013, 10 sampled Thorny Skates varied from 60 cm 84 cm TL (mean=71.5 cm).

Research Survey Data

Canadian Spring Surveys

Stratified-random surveys have been conducted by Canadian research vessels in the spring (April-June) of each year from 1971 to 2013. A summary of the stratified-random survey design adopted by the DFO - NL Region can be found in Doubleday (1981). While survey design has remained constant, additional strata have been included in recent years, along with modifications to some of the original strata (Bishop 1994). A significant change in the

surveys is the addition of shallower and deeper strata after 1993. Additional causes of variation in spring survey coverage are discussed in detail by Brodie and Stansbury (2007), and Healey and Brodie (2009). The spring survey can be split into three time series, based on the trawl used in each period: 1971-1982 (Yankee), 1983-1995 (Engel), and 1996-2013 (Campelen; see McCallum and Walsh 1996). Conversion factors exist for the Engel to Campelen gear change (Simpson and Kulka 2005), but not for the Yankee to Engel gear change.

Historical abundance and biomass indices from Canadian spring surveys in NAFO Div. 3LNOPs are provided in Table 6and Figure 6a. Since the mid-1990s, spring biomass indices for Thorny Skate in Div. 3LNOPs have been generally increasing. Abundance indices, while generally increasing, have not increased at a similar rate. Similar results were reflected by mean number and mean weight of skates per tow for Canadian spring surveys in 1996-2009 (Fig. 7), after a drastically declining trend over 1985-1995. In 2012, biomass estimates for Thorny Skate in Div. 3L, 3N, and 3O were 14 828 t, 38 621 t, and 53 443 t tons, respectively); in 2013, the biomass estimates for these same Divisions were 11 713 t, 43 547 t, and 76 358 t, respectively. Most notable in 2013 was the increased biomass in Div. 3N, relative to the previous 31 167-ton average in 2008-2012. A similar notable increase in biomass in Div. 3O to 76 358 t was observed relative to the previous 5-year average (2008-2012) of 54 747 t. Overall, the current biomass estimate for the Div. 3LNO area in 2013 was 131 618 t, which is well above the recent five-year (2008-2012) average biomass estimate of 100 101 t. In Subdiv. 3Ps, the biomass index was estimated at 34 455 t in 2013, which is slightly below the recent five-year (2008-2012) average biomass of 36 855 t.

Canadian Autumn Surveys

Annual stratified-random autumn surveys have been conducted by Canada in NAFO Div. 3L from 1981 to 2013. In 1990-2013, autumn surveys also extended onto the southern Grand Banks in Div. 3NO. Canadian surveys from 1983-1994 were conducted with an Engel trawl, and from 1995-2013 with a Campelen trawl. It must be noted that Canada does not survey Subdiv. 3Ps in autumn, and did not survey Div. 3NO before 1990. Therefore, autumn survey data are not directly comparable to spring indices (which extend over the entire stock area and time period; except for certain Divisions and years). Furthermore, autumn surveys reach deeper maximum depths (~1 400 m in recent years) than those in spring (~750 m). Because the autumn series is not spatially complete over the designated stock area, spring surveys are used as the primary estimator of biomass and abundance trends for this stock. However, autumn indices are still considered in assessments of this stock, because this survey is conducted when a greater proportion of Thorny Skate is available to survey trawl gear. During autumn, Thorny Skates are concentrated on the shelf; whereas in spring, part of this population has moved to the shelf edge, and a proportion apparently moves outside of the survey area (Kulka *et al.* 2004). While using spring estimates of biomass and abundance to examine trends in this stock, it is assumed that the proportion of skate that moves outside of the surveyed area remains consistent between years. Additional causes of variation in survey coverage are discussed in detail by Brodie (2005), and Kulka and Miri (2007).

Historical abundance and biomass indices from Canadian autumn surveys in NAFO Div. 3LNO are provided in Table 7 and Figure 6b. Autumn abundance indices of Thorny Skate remained stable at a low level since 1995; except for a slight increase in biomass estimates over 2007-2008. In 2012, biomass estimates for Thorny Skate in Div. 3L, 3N, and 3O were 19 124 t, 43 739 t, and 107 777 t, respectively. In 2013, the biomass estimates in these areas were 20 752 t, 44 160 t, and 92 042 t, respectively. In Div. 3L and 3N the recent biomass estimates are below the recent five year average of 21 271 t and 49 524 t, respectively. The index in Div. 3O is above the recent five year average of 74 156 t. The current overall biomass estimate of 156 954 t for Div. 3LNO is above the recent five-year (2008-2012) average biomass of 144 952 t.

EU-Spain 3NO Survey

Spain initiated a survey of the NAFO Regulatory Area of Div. 3NO in 1995. Initially, the survey was carried out in spring with the C/V *Playa de Menduiña* using a Pedreira bottom trawl. Since 2001, the R/V *Vizconde de Eza* replaced the C/V *Playa de Menduíña* and a Campelen net replaced Pedreira gear (González-Troncoso *et al.* 2011).

Abundance and biomass of Thorny Skate were calculated from EU-Spain surveys in the NRA of Div. 3NO from 1997-2011. The survey biomass index showed a consistent increase from 5 000 tons in 1995 to a peak of 50 000 t in

2000. Since 2001, this index fluctuated on an annual basis; averaging 36 307 t in 2001-2006. In 2007-2010, the biomass index averaged 21 504 t. This index declined from 19 959 t in 2009 to 17 887 t in 2010, and to 10 365 t in 2011: the lowest in the surveys since 1997. This index increased to 28 867 t in 2012, but declined in 2013 to 19 640 t,

A comparison of the Canadian Campelen spring biomass indices to those of the Spanish Div. 3NO surveys in 1997-2013 indicated that, since 2007, the trends have diverged: the EU-Spain index declined until 2011, while the Canadian 3NO index has been generally increasing (Fig. 8). A correlation analysis of biomass estimates in strata that are sampled by both surveys was conducted in 2012. While overall indices diverged, the average correlation of stratified catch in strata common to both surveys over 1997-2010 has increased relative to 1997-2007. Differences in the indices appear to result from poor catch rates in the EU-Spain survey since 2007 in deeper strata 752-759, which are not sampled in the Canadian survey. In 2012 both indices increased, however while the EU-Spain index declined in 2013 the Canadian index continued to increase. It should be noted that the Canadian survey covers the entire area of Div. 3NO; whereas the Spanish survey is limited to the NRA of Div. 3NO.

EU-Spain 3L Survey

Spain initiated a stratified random summer bottom trawl survey of the NAFO Regulatory Area of Div. 3L in 2003. This survey was conducted with the R/V *Vizconde de Eza* using a Campelen trawl. Due to the vessel's mechanical difficulties, the survey was not conducted in 2005, and some strata were missed during 2003 and 2004.

Abundance and biomass estimates of Thorny Skate were available from EU-Spain surveys in the NRA of Div. 3L from 2003-2013 (excluding 2005). The survey provided a 7 000 t biomass estimate in 2003-2004 during which some strata were missed. In 2006, the biomass was 11 531 t, which increased to 14 486 t in 2007. Since 2007, this index has declined to an estimate of 4 448 t in 2011, the lowest in the time series. In 2012 the index increased, followed by a slight decline in 2013.

A comparison of the Canadian Campelen autumn 3L biomass indices and the Canadian Campelen spring Div. 3L biomass index to those of the Spanish Div. 3L surveys in 2003-2013 indicated that, since 2009, trends in all three time series while variable are relatively stable (Fig. 9). It should be noted that the Canadian survey covers the entire area of Div. 3L; whereas the Spanish survey is limited to the NAFO Regulatory Area of Div. 3L. In recent years, the Canadian fall index has increased slightly, while both the Canadian spring and EU-Spain indices declined in 2013.

Index of Fishing Mortality

A relative Index of Fishing Mortality (Relative F = STACFIS agreed commercial landings/Canadian spring survey biomass index) was calculated for Thorny Skate in Div. 3LNO and Subdiv. 3Ps for 1996-2013. The Fishing Mortality Index for Div. 3LNO increased from the late 1980s to a peak of 29% in 1997; then stabilized at approximately 17% during 1998-2004 (Fig. 10). In 2005, this Index declined to 4%, and has remained around 5% since then. Since 1985, fishing mortality in Subdiv. 3Ps was relatively constant; remaining below 5% in most years (except for 7% in 2001-2002).

Survey Size Structure

Lengths of Thorny Skates captured in the Canadian Campelen spring surveys of Div. 3LNO and Subdiv. 3Ps from 1997-2013 ranged from 5-105 cm TL (Fig. 11). For most areas and years, a peak of young-of-the-year skates (YOY: 5-20 cm TL) was observed, and averaged 15 cm TL. A dominant peak of skates can be seen in spring survey data, with the following modes: 55 cm in 2004 and 2005; 62 cm in 2006; 66 cm in 2007; 69 cm in 2008; 71 cm in 2009 and 2010, 72 cm in 2011; 74 cm in 2012; and 77 cm in 2013.

Life Stages

Numbers of Thorny Skate at length caught by Canadian Campelen spring surveys in Div. 3LNOPs during 1996-

2013 were partitioned into young-of-the-year (YOY), immature, and mature components (Fig. 12). Various life stages of Thorny Skate underwent similar trends, particularly in recent years. In 1996-2009, Thorny Skate YOY abundance appeared to be relatively stable. During 2010-2012 this index increased, but subsequently declined in 2013. Abundance estimates of immature and mature skates (both sexes) have fluctuated, but generally increased from 2009-2012, and declined in 2013.

The ratio of males to females in the sampled population remained relatively constant during 1996-2013, with some fluctuations in these three components (Fig. 13): YOY averaged 1:1 males to females; ratio of immature males to females was always smaller than 0.94 (average of 0.73); while the mature abundance ratio was always greater than 1 (average of 1.5). This pattern suggests some difference in the catchability of male and female Thorny Skates at different life stages; potentially due to differential migration into and out of the sampled area.

Thorny Skate standardized recruitment, based on the number of skate less than 21cm is illustrated in Figure 14. This recruitment index declined to below parity from 1.3 in 1996, with the lowest value of 0.3 occurring in 1999. A recent peak of 2.6 in 2012 was followed by a decline to 1.7 in 2013. Overall, recruitment over the period 2010-2013 has been above parity. Note that the 2006 values are not presented, because survey coverage was incomplete due to mechanical difficulties on Canadian research vessels.

Distribution

In Div. 3LNO and Subdiv. 3Ps, the distribution of Thorny Skate has changed significantly since the 1980s. In the early 1980s, Thorny Skates were widely distributed over the entire Grand Banks in moderate to high concentrations (Kulka and Miri 2007). By the late 1990s, much of the biomass was concentrated in the southwest. In 2001-2005, the area of high concentration expanded northward and along the Bank edge. It is important to note that part of this population moves to the shelf edge in spring; thereby moving outside of the Canadian spring survey area (Kulka *et al.* 2004). However, Thorny Skates are concentrated on the shelf during autumn. In 2004-2013, Thorny Skate distribution in Div. 3LNOPs continued to be concentrated on the southwest Grand Banks, in Subdiv. 3Ps, and northward along the edge of the Bank (Fig. 15a,b).

Feeding

Thorny Skate diets were studied previously by González et al. (2006) and others (Templeman 1982; Román et al. 2004). González et al. (2006) found that Thorny Skates feed on a wide variety of prey species, and that the main prey groups were Pisces and Crustacea. They also found that predation on fish increased with skate body size, while predation on crustacean species declined with skate size. Based upon percent occurrence, Simpson et al. (unpubl.) recently found that polychaetes and shrimp dominated the diet of Thorny Skates in 570 stomachs sampled from NL waters, while hyperiids, Snow Crabs, Sand Lance, and euphausiids were also important prey items (Table 8).

Summary

Thorny Skate underwent a decline in Div. 3LNO over the late 1980s, suddenly increased in 1990-1991, declined again over 1992-1996, then stabilized at a low level (except for a slight increase in 2007-2008). Thorny Skate distribution in Div. 3LNOPs for 2007-2013 continued to be concentrated on the southwest Grand Banks, in Subdiv. 3Ps, and northward along the edge of the Bank. An Index of Fishing Mortality for Div. 3LNO increased from the late 1980s to a peak of 30% in 1997, and stabilized at approximately 17% during 1998-2004. In 2005, this Index declined to 4%, and remained around 5% since then. From a peak of 18 277 tons in 2000, total reported landings of skate by all countries in Div. 3LNO declined to an average of 5 317 t in 2005-2009. In 2010-2012, average reported landings from Div. 3LNO further declined to 4 953 t. The 2013 TAC of 7 000 t for skates in Div. 3LNO continues to greatly exceed the average commercial catch during a period when minimal or no rebuilding of this stock has occurred.

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Table 1. NAFO-reported landings (tons) of skates in Div. 3LNO, 1960-2013 (STATLANT-21A).

Year	Canada	Other	Total
1960	0	73	73
1961	0	119	119
1962	0	99	99
1963	0	65	65
1964	0	145	145
1965	17	199	216
1966	75	347	422
1967	212	188	400
1968	128	31	159
1969	68	1,123	1,191
1970	99	539	638
1971	125	77	202
1972	64	487	551
1973	10	413	423
1974	638	1,690	2,328
1975	180	2,535	2,715
1976	260	1,006	1,266
1977	551	1,266	1,817
1978	816	1,015	1,831
1979	382	657	1,039
1980	351	1,027	1,378
1981	244	1,467	1,711
1982	52	756	808
1983	4	1,277	1,281
1984	0	2,013	2,013
1985	9	10,390	10,399
1986	52	14,277	14,329
1987	195	18,301	18,496
1988	91	18,675	18,766
1989	15	14,222	14,237

Year	Canada	Other	Total
1990	44	14,726	14,770
1991	18	28,390	28,408
1992	78	5,059	5,137
1993	78	5,992	6,070
1994	1,554	6,601	8,155
1995	2,412	4,912	7,324
1996	1,314	4,804	6,118
1997	2,165	9,903	12,068
1998	1,013	8,501	9,514
1999	1,081	10,864	11,945
2000	498	17,779	18,277
2001	354	14,507	14,861
2002	1,107	10,648	11,755
2003	671	13,592	14,263
2004	352	11,476	11,828
2005	685	2,853	3,538
2006	249	5,255	5,504
2007	101	6,110	6,211
2008	243	6,867	7,110
2009	435	5,286	5,721
2010	50	5,314	5,364
2011	69	5,479	5,548
2012	185	4,066	4251
2013	22	4331	4353

Table 2. NAFO-reported landings (tons) of Thorny Skate in Subdiv. 3Ps, 1960-2013 (STATLANT-21A).

Year	Canada	Other	Total
1960	0	11	11
1961	0	17	17
1962	0	11	11
1963	0	58	58
1964	0	145	145
1965	0	85	85
1966	0	126	126
1967	0	162	162
1968	86	67	153
1969	0	353	353
1970	35	229	264
1971	303	213	516
1972	8	184	192
1973	7	231	238
1974	122	641	763
1975	9	490	499
1976	91	230	321
1977	521	360	881
1978	454	256	710
1979	545	121	666
1980	554	609	1,163
1981	558	520	1,078
1982	117	395	512
1983	0	516	516
1984	21	602	623
1985	21	944	965
1986	7	1,576	1,583
1987	52	787	839
1988	2	781	783
1989	0	1,685	1,685
1990	5	549	554
1991	1	639	640
1992	13	46	59
1993	22	11	33
1994	1,566	3	1,569
1995	1,866	4	1,870
1996	603	2	605
1997	829	3	832
1998	1,251	6	1,257
1999	1,102	4	1,106
2000	935	21	956
2001	1,769	39	1,808
2002	1,413	238	1,651
2003	1,705	82	1,787
2004	1,190	87	1,277
2005	967	15	982
2006	910	78	988
2007	1,347	491	1,838
2008	763	632	1,395
2009	645	_	645
2010	342	_	342
2011	513	_	513
2012	371	_	371
2013	285	_	285

Table 3a. Canadian reported landings (tons) of Thorny Skate (ZIFF data) in Div. 3LNO directed versus bycatch fisheries by gear type, 2000-2013.

Year	Bycatch			Bycatch Total	Directed			Directed Total
year	Gillnet	Lines	Trawl		Gillnet	Lines	Trawl	
2000	61	111	6	178	269	47	3	319
2001	92	3	14	109	50	195		246
2002	515	9	21	545	171	281	109	561
2003	241	49	12	302	63	201	53	317
2004	208	12	8	228	59	64		123
2005	161	10	4	176	24	489		513
2006	98	16	18	132	64	36		100
2007	29	7	2	38	1	34		35
2008	48	183	0	231	0	6		7
2009	37	77	0	113		319	2	321
2010	33	8	1	41	10			10
2011	58	11		69				
2012	154		0	154	32			32
2013	11	1	0	12	10			10

Table 3b. Canadian reported landings (tons) of Thorny Skate (ZIFF data) in Subdiv. 3Ps directed versus bycatch fisheries by gear type, 2000-2013.

Year	Bycatch			Bycatch Total	Directed			Directed Total
	Gillnet	Lines	Trawl		Gillnet	Lines	Trawl	
2000	61	111	6	178	269	47	3	319
2001	92	3	14	109	50	195		246
2002	515	9	21	545	171	281	109	561
2003	241	49	12	302	63	201	53	317
2004	208	12	8	228	59	64		123
2005	161	10	4	176	24	489		513
2006	98	16	18	132	64	36		100
2007	29	7	2	38	1	34		35
2008	48	183	0	231	0	6		7
2009	37	77	0	113		319	2	321
2010	33	8	1	41	10			10
2011	58	11		69				
2012	154		0	154	32			32
2013	11	1	0	12	10			10

Table 4a. Canadian reported landings (tons) of Thorny Skate in Div. 3LNO by main species targeted (ZIFF data), 2000-2013.

Directed Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Atlantic Cod	90	1	1	1	0	4	0	0	0	0				
Atlantic Halibut	16	12	36	39	29	14	11	6	20	30	8			1
Lobster	0	0	0											
Lumpfish	3	7	3	13	13	17	7	9	3	4	2	1	1	
Monkfish	17	65	472	184	175	129	83	15	39	29	22	55	66	8
Redfish	1	14	21	5	1	3	10	1		0	1		0	0
Skate	319	246	561	317	123	513	100	35	7	321	10		32	10
Greenland Halibut	9	2	3	11	3	7	3	1	1	0	3	0	1	2
White Hake	20	3	4	32	4	0	16	2	166	49	1	12	85	
Winter Flounder	16	5	2	3	1	1	2	3	2	2	4	1	1	1
Yellowtail Flounder	5	0	0	15	2	1	0	0	0	0	0			0

Table 4b. Canadian reported landings (tons) of Thorny Skate in Div. 3Ps by main species targeted (ZIFF data), 2000-2013.

Directed species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Atlantic Cod	90	1	1	1	0	4	0	0	0	0				
Atlantic Halibut	16	12	36	39	29	14	11	6	20	30	8			1
Lobster	0	0	0											
Lumpfish	3	7	3	13	13	17	7	9	3	4	2	1	1	
Monkfish	17	65	472	184	175	129	83	15	39	29	22	55	66	8
Redfish	1	14	21	5	1	3	10	1		0	1		0	0
Skate	319	246	561	317	123	513	100	35	7	321	10		32	10
Greenland Halibut	9	2	3	11	3	7	3	1	1	0	3	0	1	2
White Hake	20	3	4	32	4	0	16	2	166	49	1	12	85	
Winter Flounder	16	5	2	3	1	1	2	3	2	2	4	1	1	1
Yellowtail Flounder	5	0	0	15	2	1	0	0	0	0	0			0

Table 5. Canadian reported landings (tons) of various species in Thorny Skate-directed fisheries in NAFO Div. 3LNOPs (ZIFF data), 2004-2013.

Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Atlantic Cod	13.0	43.7	30.8	111.1	42.1	34.0	3.7	0.6	2.3	0.4
Cusk	0.1			0.0		0.2				
Haddock	2.8	33.6	2.6	5.7	1.3	60.5	0.2	0.0	1.2	0.0
Atlantic Halibut	5.5	15.0	10.4	6.9	3.7	20.6	2.3	1.3	4.5	1.6
Lumpfish		0.2		0.0						
Monkfish	68.6	31.1	57.8	11.3	4.6	1.9	5.3	5.0	5.5	2.2
American Plaice	26.1	27.3	30.9	43.8	34.7	14.3	4.3	31.6	1.6	4.7
Pollock	0.7	0.6	11.0	3.0	0.6	3.2	17.4	2.2	0.0	0.0
Redfish	0.1	0.1	0.1	0.0	0.1	0.1	0.0		0.0	
Shortfin Mako Shark			0.0		0.0	0.0				
Greenland Halibut	0.0	0.4	0.2	0.0	1.5	1.0		0.1	0.0	0.0
Whelks		53.1								
White Hake	5.2	13.9	9.6	53.5	1.8	48.5	8.9	0.9	3.1	0.1
Winter Flounder	0.1	0.0	0.0	0.1				0.5		0.1
Witch Flounder	0.1	1.7	1.1	1.5	0.3	0.8		0.0	0.0	
Wolffish	0.0	0.0	0.1	0.4	0.3	0.0		0.0		
Yellowtail Flounder	0.1	0.6	0.4	2.0	0.2	0.5		0.1	0.1	

Table 6a. Abundance of Thorny Skate from Canadian spring research surveys in Div. 3LNOPs, 1971-2013. Surveys were conducted with a Yankee trawl (1971-1983; data unconverted), an Engel trawl (1983-spring 1995; data converted to Campelen-equivalents), and a Campelen trawl (spring 1996--2013). Subdiv. 3Ps was not surveyed in 1971, 2006; Div. 3O was not surveyed in 1972, 1974, 1983; and Div. 3N was not surveyed in 1983. Deep strata in Div. 3NO were not surveyed in 2006.

Year	3L	3N	3O	3Ps	3LNOPs
Yankee Series - Unconverted					
1971	11,533	3,921			15,454
1972	11,037	15,634		5,615	32,285
1973	12,114	11,033	12,830	6,822	42,800
1974	26,621	11,627		11,136	49,383
1975	24,762	8,273	12,183	1,654	46,871
1976	28,294	21,419	28,595	19,118	97,427
1977	25,240	16,375	7,518	8,840	57,973
1978	21,879	10,117	7,578	11,911	51,485
1979	23,370	13,859	7,496	8,310	53,034
1980	19,206	15,847	16,788	12,200	64,041
1981	33,223	9,694	5,912	12,195	61,024
1982	21,391	23,623	11,055	3,562	59,632
1983				12,249	12,249
Engel series - Campelen Equivalents					
1984	7,574	25,226	24,615	9,417	66,832
1985	63,081	45,278	50,123	55,214	213,697
1986	51,231	53,394	21,134	36,153	161,911
1987	39,151	33,538	34,041	28,113	134,844
1988	35,030	26,474	42,991	19,043	123,538
1989	40,350	30,030	17,678	25,863	113,921
1990	43,938	71,656	40,118	21,344	177,055
1991	34,779	44,549	35,195	50,254	164,777
1992	37,475	20,645	35,567	21,510	115,198
1993	27,765	17,068	15,025	21,580	81,437
1994	15,999	17,565	19,105	19,221	71,891
1995	9,320	7,017	26,781	19,493	62,611
Campelen Series					
1996	10,418	10,636	22,731	25,591	69,376
1997	6,804	13,554	25,635	18,379	64,372
1998	7,764	10,140	34,130	22,781	74,815
1999	8,263	15,967	36,042	20,212	80,484
2000	12,512	16,027	28,525	18,574	75,638
2001	8,521	16,276	33,321	17,606	75,724
2002	5,920	8,469	32,902	17,560	64,851
2003	6,737	9,645	34,734	24,615	75,732
2004	4,762	8,925	21,153	24,256	59,095
2005	11,011	15,986	26,621	26,399	80,016
2006	8,450	23,618	17,778		49,846
2007	11,357	24,065	23,317	11,440	70,180
2008	10,572	14,477	22,738	31,239	79,027
2009	5,810	15,560	18,132	19,128	58,629
2010	10,964	20,714	32,747	26,447	90,872
2011	7,226	12,731	31,576	23,409	74,942
2012	13,342	15,866	24,268	21,848	75,324
2013	10,681	20,682	35,416	35,067	101,846

Table 6b. Biomass of Thorny Skate from Canadian spring research surveys in Div. 3LNOPs, 1971-2013. Surveys were conducted with a Yankee trawl (1971-1983; data unconverted), an Engel trawl (1983-1995; data converted to Campelen-equivalents), and a Campelen trawl (1996-2013). Subdiv. 3Ps was not surveyed in 1971, 2006; Div. 3O was not surveyed in 1972, 1974, 1983; Div. 3N was not surveyed in 1983. Deep strata in Div. 3NO were not surveyed in 2006.

Year	3L	3N	3O	3Ps	3LNOPs
Yankee Series - Unconverted					
1971	35,100	11,307			46,408
1972	23,391	36,084		16,422	75,897
1973	17,993	27,241	23,288	13,417	81,940
1974	40,252	21,823		22,428	84,503
1975	31,191	21,579	25,328	5,719	83,817
1976	40,242	39,416	80,235	29,506	189,399
1977	63,601	44,092	19,632	12,326	139,651
1978	37,944	16,394	17,803	10,266	82,407
1979	44,377	23,877	19,820	10,094	98,168
1980	41,247	26,141	21,488	21,149	110,025
1981	55,274	17,293	12,311	11,450	96,329
1982	37,768	30,161	22,868	7,363	98,161
1983				13,704	13,704
Engel series - Campelen Equivalents					
1984	17,269	57,720	61,026	20,318	156,333
1985	102,351	86,438	110,322	36,954	336,065
1986	69,864	110,325	46,634	47,728	274,551
1987	82,037	60,535	51,007	40,697	234,276
1988	70,143	49,686	87,375	29,993	237,197
1989	73,291	49,142	40,172	44,271	206,875
1990	45,312	47,479	61,946	24,264	179,002
1991	22,197	28,925	99,003	61,534	211,659
1992	11,945	23,047	57,929	38,693	131,615
1993	8,546	18,550	35,113	16,256	78,465
1994	3,920	10,193	28,874	16,539	59,526
1995	2,798	2,824	32,323	24,924	62,869
Campelen Series					
1996	4,993	11,010	35,529	21,851	73,382
1997	3,969	9,703	28,293	20,705	62,669
1998	5,807	13,186	42,351	28,629	89,972
1999	7,266	26,254	54,045	32,062	119,626
2000	14,011	27,861	40,917	22,528	105,317
2001	10,383	29,197	59,078	24,566	123,223
2002	8,580	13,986	38,025	22,127	82,718
2003	8,411	18,216	49,707	37,072	113,406
2004	7,806	20,425	39,740	38,354	106,325
2005	19,266	33,757	46,515	32,702	132,240
2006	16,193	56,698	25,252		98,143
2007	25,044	54,188	48,369	21,080	148,682
2008	23,344	32,196	42,220	38,509	136,270
2009	7,765	29,478	52,619	27,788	117,651
2010	14,944	34,303	68,435	39,968	157,650
2011	10,046	21,239	57,020	44,310	132,615
2012	14,828	38,621	53,443	33,699	140,592
2013	11,713	43,547	76,358	34,455	166,072

Table 7a. Abundance of Thorny Skate from Canadian autumn research surveys in Div. 3LNO, 1981-2013. Surveys were conducted with an Engel trawl (1978-1994), and a Campelen trawl (1995-2013). Due to vessels' mechanical difficulties, deep strata of Div. 3NO were not surveyed in 2003, 2004, 2006, 2008.

Year	Div. 3L	Div. 3N	Div. 3O	3LNO
Engel Series				
1981	33,523			
1982	36,223			
1983	103,303			103,303
1984	70,979			70,979
1985	86,070			86,070
1986	75,424			75,424
1987	80,879			80,879
1988	86,633			86,633
1989	76,793			76,793
1990	116,758	43,855	53,191	213,803
1991	73,576	61,128	29,680	164,384
1992	94,058	33,854	24,675	152,587
1993	61,501	31,073	41,382	133,957
1994	44,205	50,141	30,748	125,094
Campelen Series				
1995	23,299	37,322	30,582	91,203
1996	23,483	22,694	45,145	91,321
1997	13,448	30,540	50,047	94,035
1998	8,917	21,132	29,785	59,834
1999	10,448	25,116	31,847	67,411
2000	12,536	31,419	39,918	83,873
2001	12,655	21,352	42,095	76,103
2002	7,541	30,925	24,488	62,954
2003	9,363	19,203	34,556	63,121
2004	6,369	21,068	32,343	59,780
2005	11,346	20,027	30,553	61,927
2006	8,888	23,211	27,688	59,787
2007	13,372	36,453	29,768	79,594
2008	15,856	48,011	40,944	104,811
2009	17,145	28,813	42,965	88,922
2010	18,429	30,859	28,137	77,426
2011	16,841	26,907	36,711	80,459
2012	21,202	30,226	51,813	103,240
2013	15,693	25,196	35,785	76,674

Table 7b. Biomass of Thorny Skate from Canadian autumn research surveys in Div. 3LNO, 1981-2010. Surveys were conducted with an Engel trawl (1978-1994), and a Campelen trawl (1995-2013). Some deep strata were not sampled in NAFO Div. 3L during the 2004 autumn survey.

Year	Div. 3L	Div. 3N	Div. 3O	3LNO
Engel Series				
1981	36,467			
1982	65,293			
1983	165,500			165,500
1984	149,061			149,061
1985	141,054			141,054
1986	113,170			113,170
1987	87,843			87,843
1988	107,910			107,910
1989	67,877			67,877
1990	95,586	67,459	97,496	260,540
1991	52,655	103,959	75,526	232,141
1992	40,289	52,980	42,383	135,652
1993	24,096	35,528	64,294	123,918
1994	16,212	50,950	31,929	99,090
Campelen Series				
1995	11,306	40,775	44,653	96,734
1996	14,459	28,629	36,969	80,057
1997	7,534	43,075	58,160	108,770
1998	9,205	34,279	39,280	82,764
1999	13,614	32,609	42,608	88,831
2000	17,722	61,202	40,861	119,786
2001	16,420	34,311	62,156	112,886
2002	11,068	52,855	40,593	104,517
2003	14,463	36,829	46,123	97,416
2004	11,327	45,678	26,361	83,366
2005	20,107	37,442	61,595	119,143
2006	18,610	54,372	50,605	123,587
2007	30,089	70,198	56,976	157,263
2008	27,182	83,861	75,892	186,935
2009	22,848	40,801	63,200	126,849
2010	21,051	27,270	54,857	103,178
2011	16,150	51,955	69,053	137,158
2012	19,124	43,739	107,777	170,640
2013	20,752	44,160	92,042	156,954

Table 8. Percent occurrence and percent by weight of all prey groups found in the diet of 570 Thorny Skates from Newfoundland and Labrador waters.

PREY GROUP	(%) OCCURENCE	(%) BY WT.
UNIDENTIFIED MATERIAL	54.74	21.97
POLYCHAETES	22.28	2.93
SHRIMP, *NATA.* (ns)	21.4	12.69
HYPERIIDS (Family)	13.16	1.90
CRAB,SNOW/QUEEN	6.49	19.99
SAND LANCE, OFFSHORE	5.79	10.72
EUPHAUSIIDS	5.79	0.42
UNIDENTIFIED FISH	5.09	4.59
CRUSTACEANS	4.56	0.66
SHRIMP, *PAND.BOR.*	3.51	4.54
MALACOSTRACAN REP. (ns)	2.63	3.00
CRAB, TOAD *HYAS* sp.	2.11	2.76
CEPHALOPODS (ns)	1.93	2.52
SHRIMP, *PANDALUS* sp.	1.93	2.01
SHRIMP, *PAND.MON.*	1.75	2.94
GAMMARIDS (SubOrder)	1.58	0.15
MYSIDS	1.58	0.15
SCULPINS (ns)	0.7	0.31
SHRIMP, *PASIP.MUL.*	0.53	0.12
SHRIMP, *PAND.PRO.*	0.35	0.32
SHRIMP, *ARG.DEN.*	0.35	0.24
EELPOUT (ns)	0.18	1.90
SEA ROBIN, SHORTWING	0.18	0.00
MAILED SCULPIN (ns)	0.18	0.04
ALLIGATORFISH, NORTHERN	0.18	0.33
SEASNAIL, GELATINOUS	0.18	0.06
RIGHTEYE FLOUNDER (ns)	0.18	1.22
AMERICAN PLAICE	0.18	0.11
YELLOWTAIL FLOUNDER	0.18	0.98
SEA DEVIL (ns)	0.18	0.04
TANAID	0.18	0.02
ISOPOD	0.18	0.00
SHRIMP, *SPIRO.SP.*	0.18	0.03
SHRIMP, *SPIRO.LIL.*	0.18	0.03
SHRIMP, *LEB.POL.*	0.18	0.01
SHRIMP, *CRANG.SEP.*	0.18	0.17
HERMIT CRAB, *PAG.* sp.	0.18	0.02
CRAB, *CANC.* sp.	0.18	0.10
STONES	0.18	0.01
SHELLS	0.18	0.00

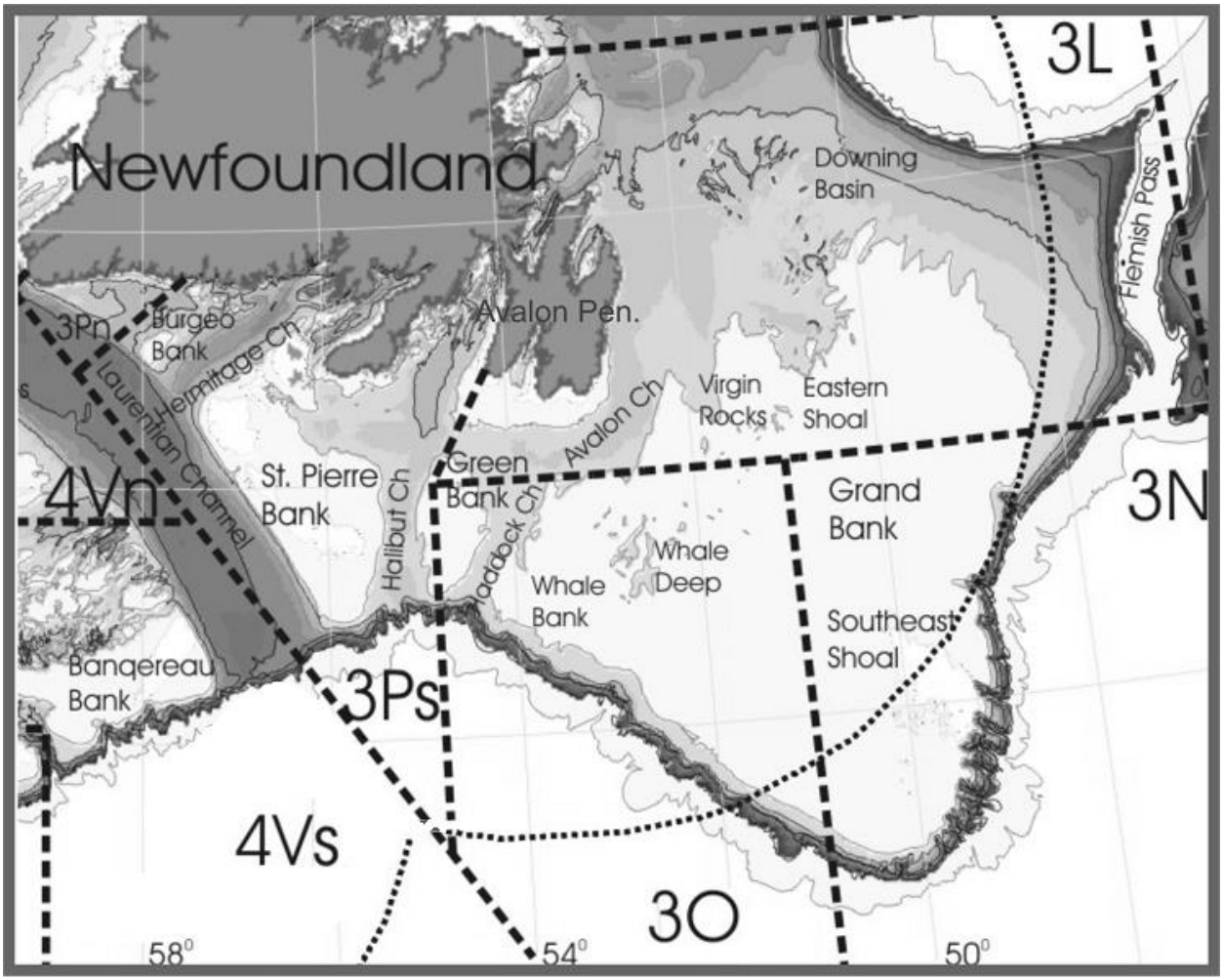

Figure 1. Map of NAFO Divisions 3LNO and Subdivision 3Ps in relation to Canada's 200-mile limit (small black dotted line).

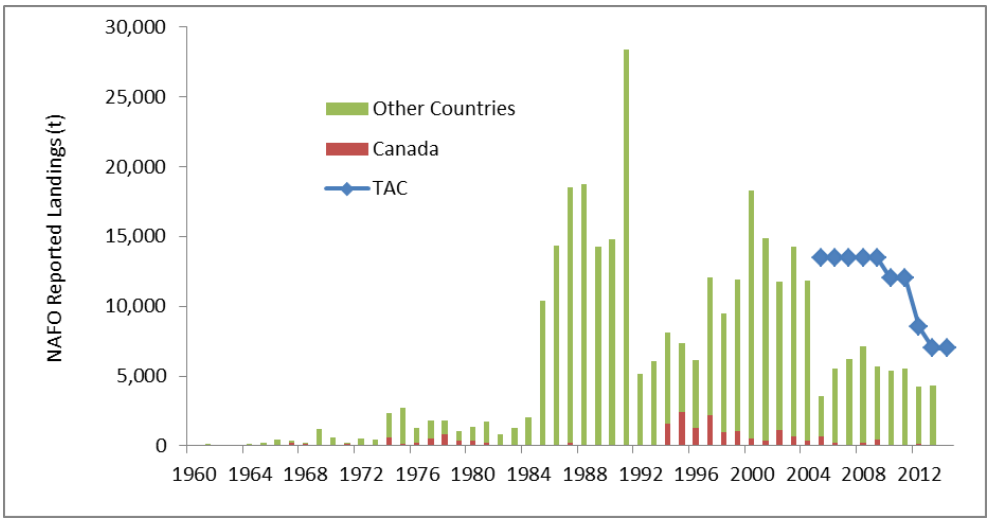

Figure 2. Reported landings (tons) of Thorny Skate by Canada and other countries in NAFO Div. 3LNO in 1960-2013 (STATLANT-21A).

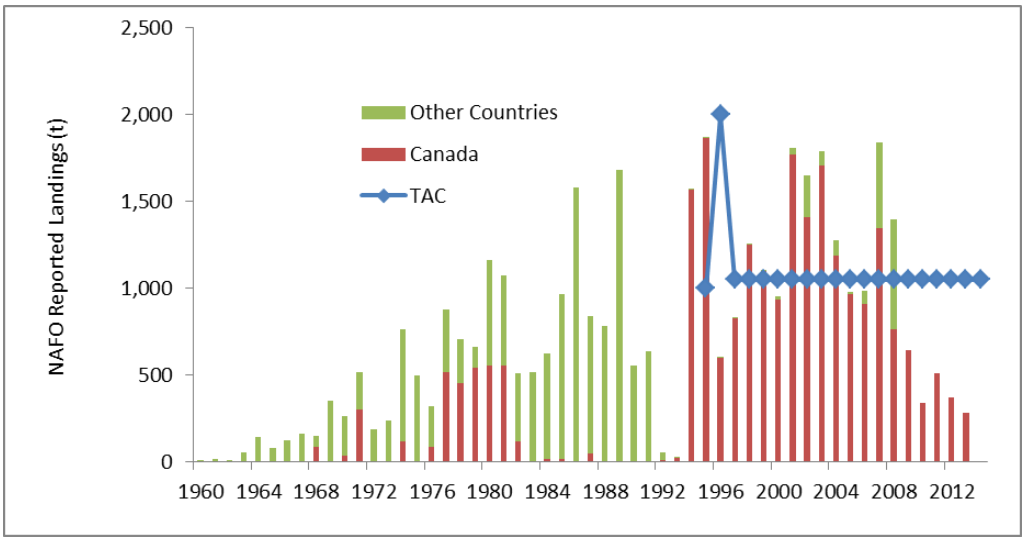

Figure 3. Reported landings (tons) of Thorny Skate by Canada and other countries in NAFO Subdiv. 3Ps, 1960-2013 (STATLANT-21A).

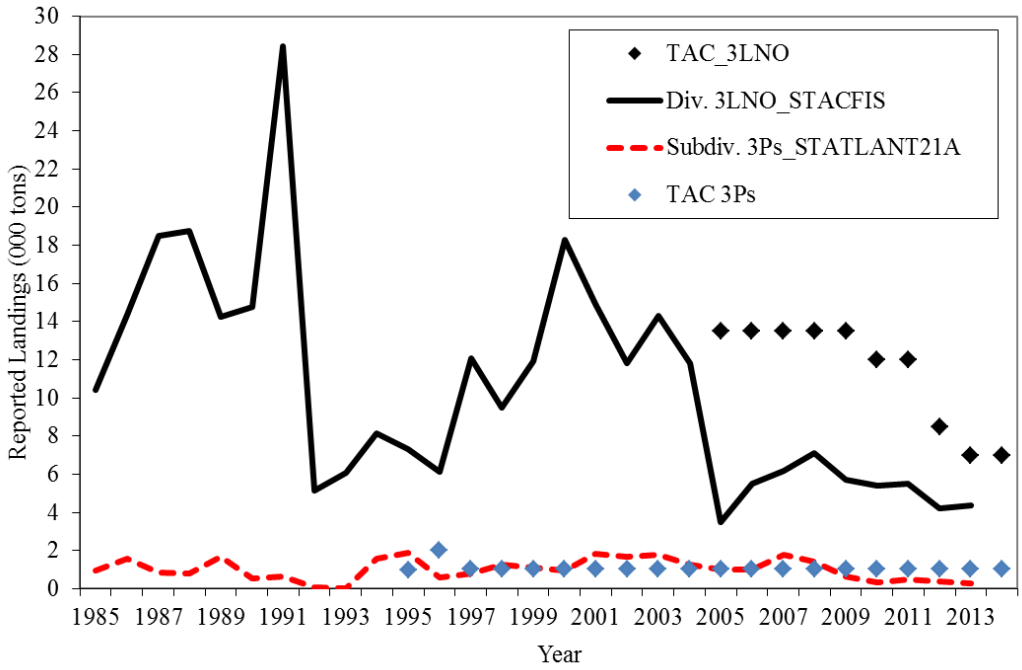

Figure 4. Total reported landings and Total Allowable Catch (TAC) of Thorny Skate in Div. 3LNO (STACFIS) and Subdiv. 3Ps (STATLANT-21A), 1985-2013.

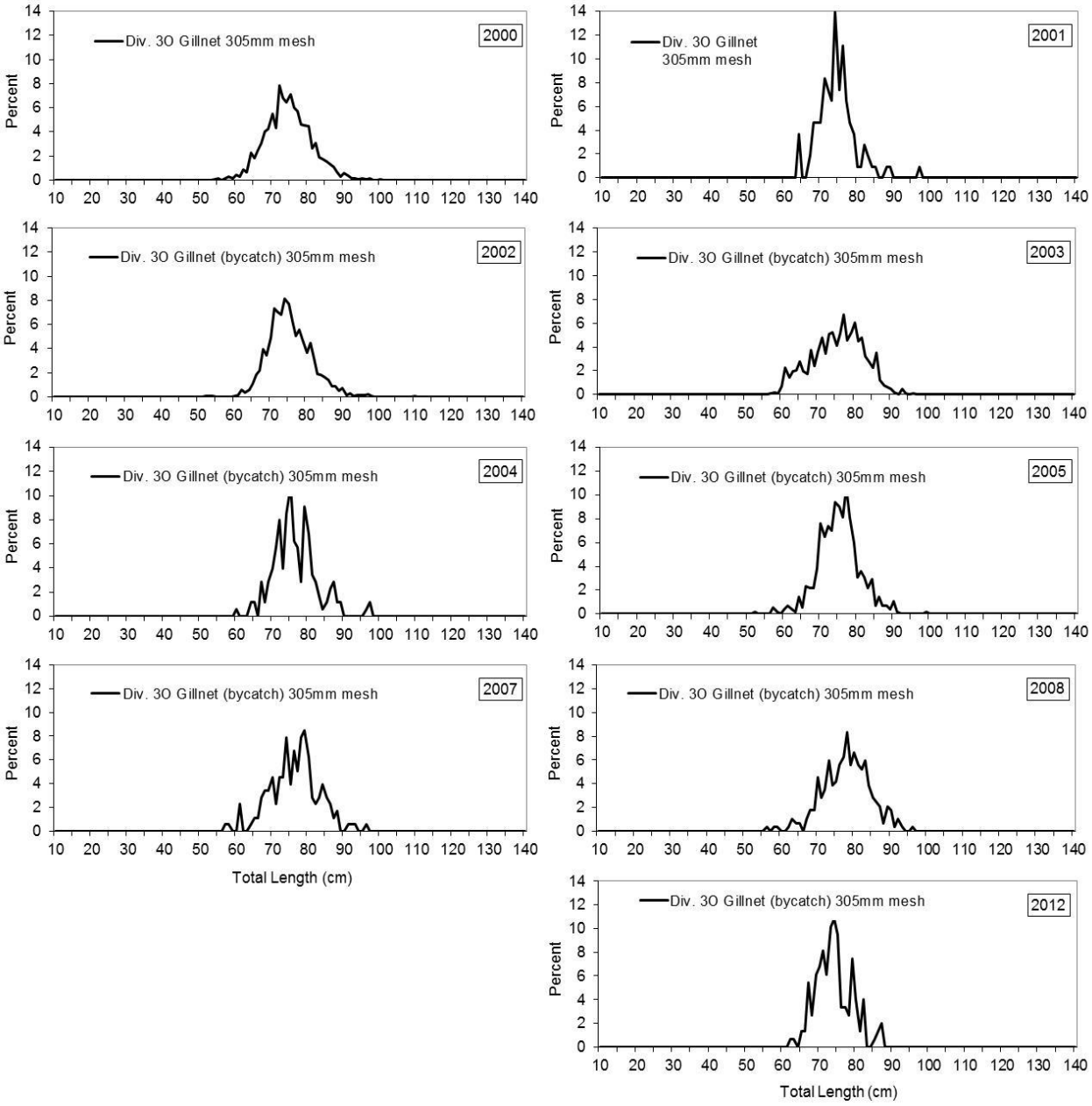

Figure 5a. Length distributions of Canadian commercial catches (sexes combined) in NAFO Div. 3O for directed skate and bycatch gillnet fisheries, 2000-2012. Data are from Canadian Fisheries Observers. Note that Div. 3O skates from this gear were not sampled in 2009-2011.

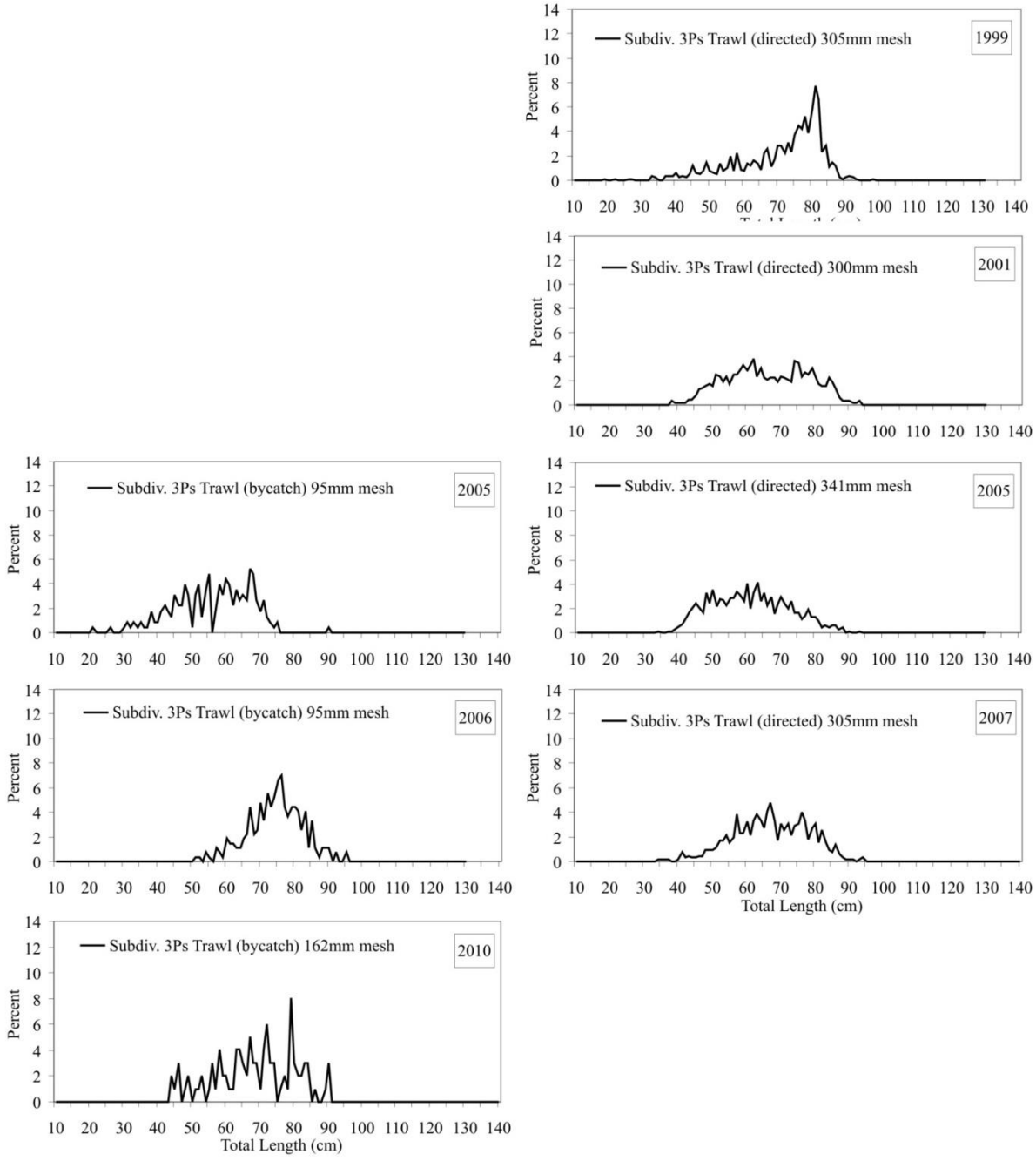

Figure 5b. Length distributions of Canadian commercial catches (sexes combined) in NAFO Subdiv. 3Ps for directed (right column) skate and bycatch (left column) bottom trawl fisheries, 1999-2010. Data are from Canadian Fisheries Observers. Note that Subdiv. 3Ps trawled skates were not sampled in 2011-2012.

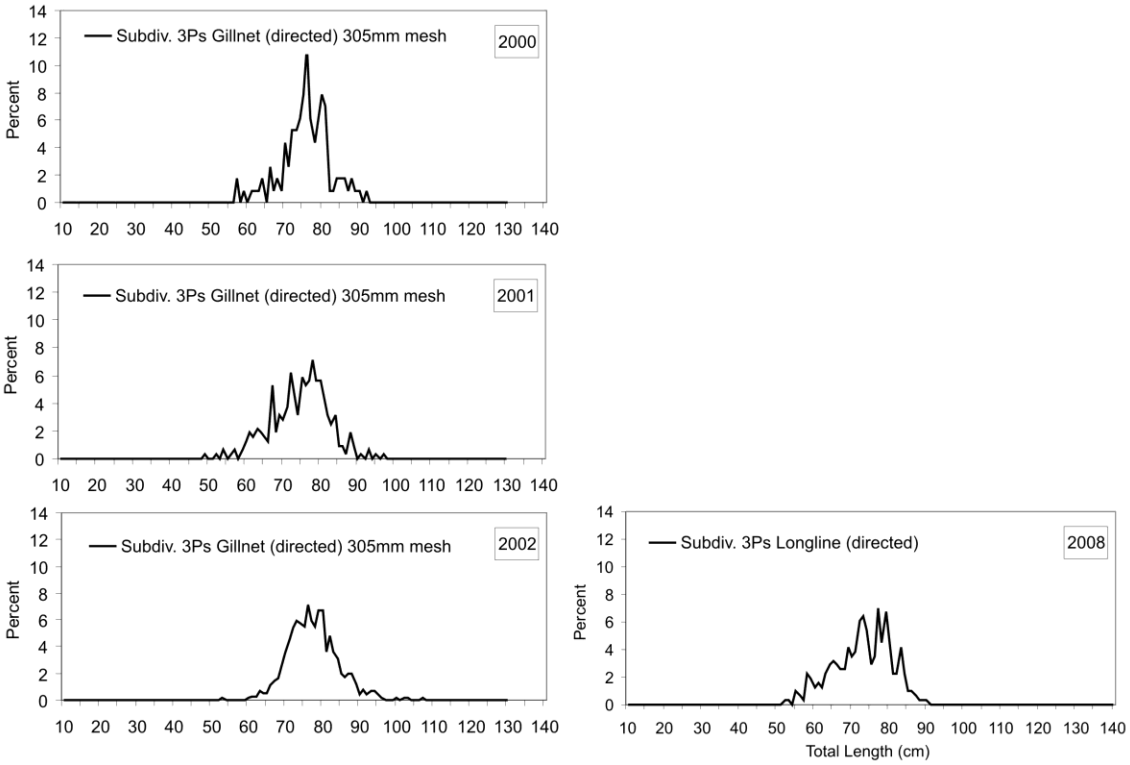

Figure 5c. Length distributions of Canadian commercial catches (sexes combined) in NAFO Subdiv. 3Ps for directed skate gillnet (left column) and longline (right column) fisheries, 2000-2008. Data are from Canadian Fisheries Observers. Note that Subdiv. 3Ps skates from these gears were not sampled in 2009-2012.

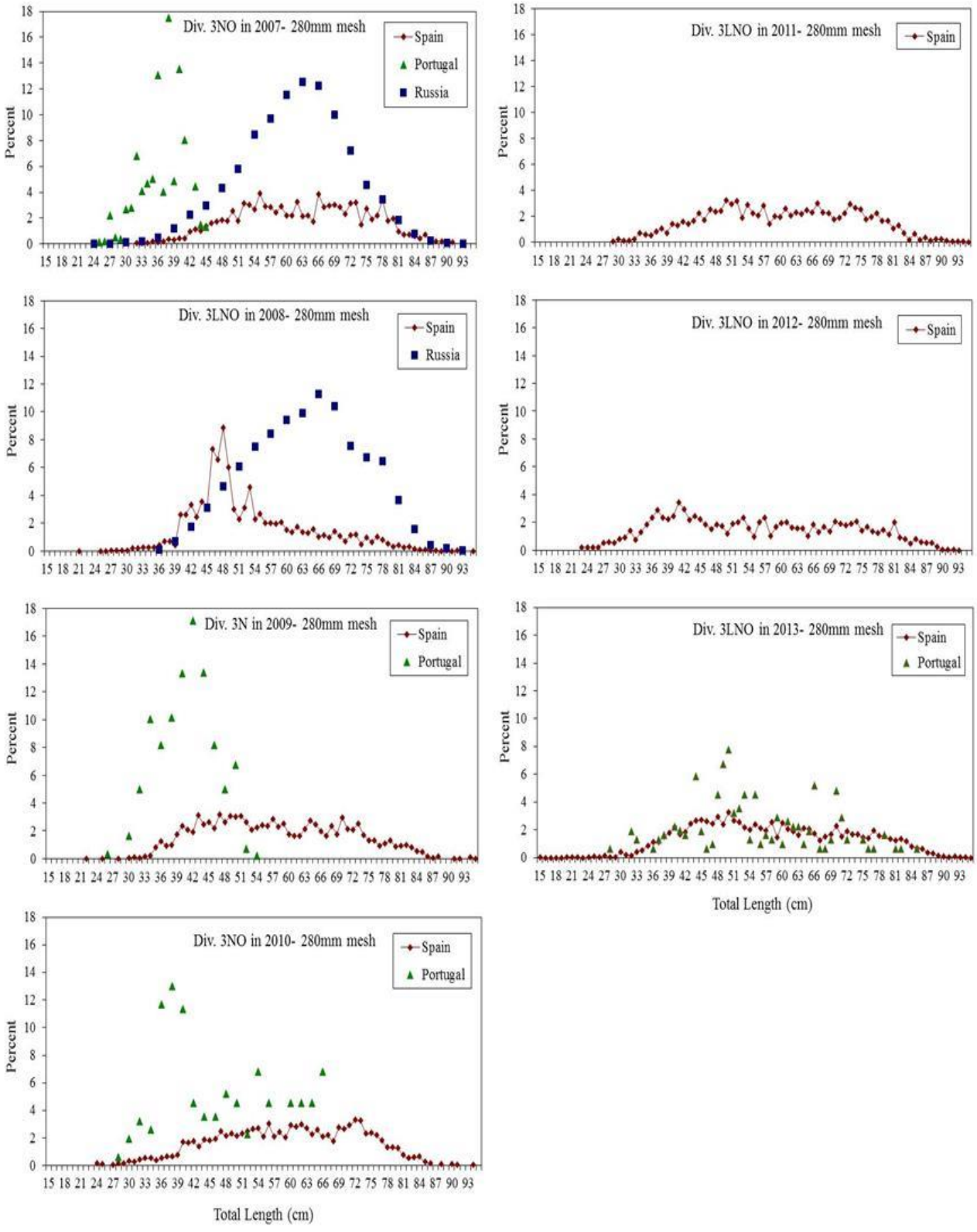

Figure 5d. Length distributions of commercial catches (sexes combined) in NAFO Div. 3LNO by country for the directed skate (280 mm) trawl fishery, 2007-2013.

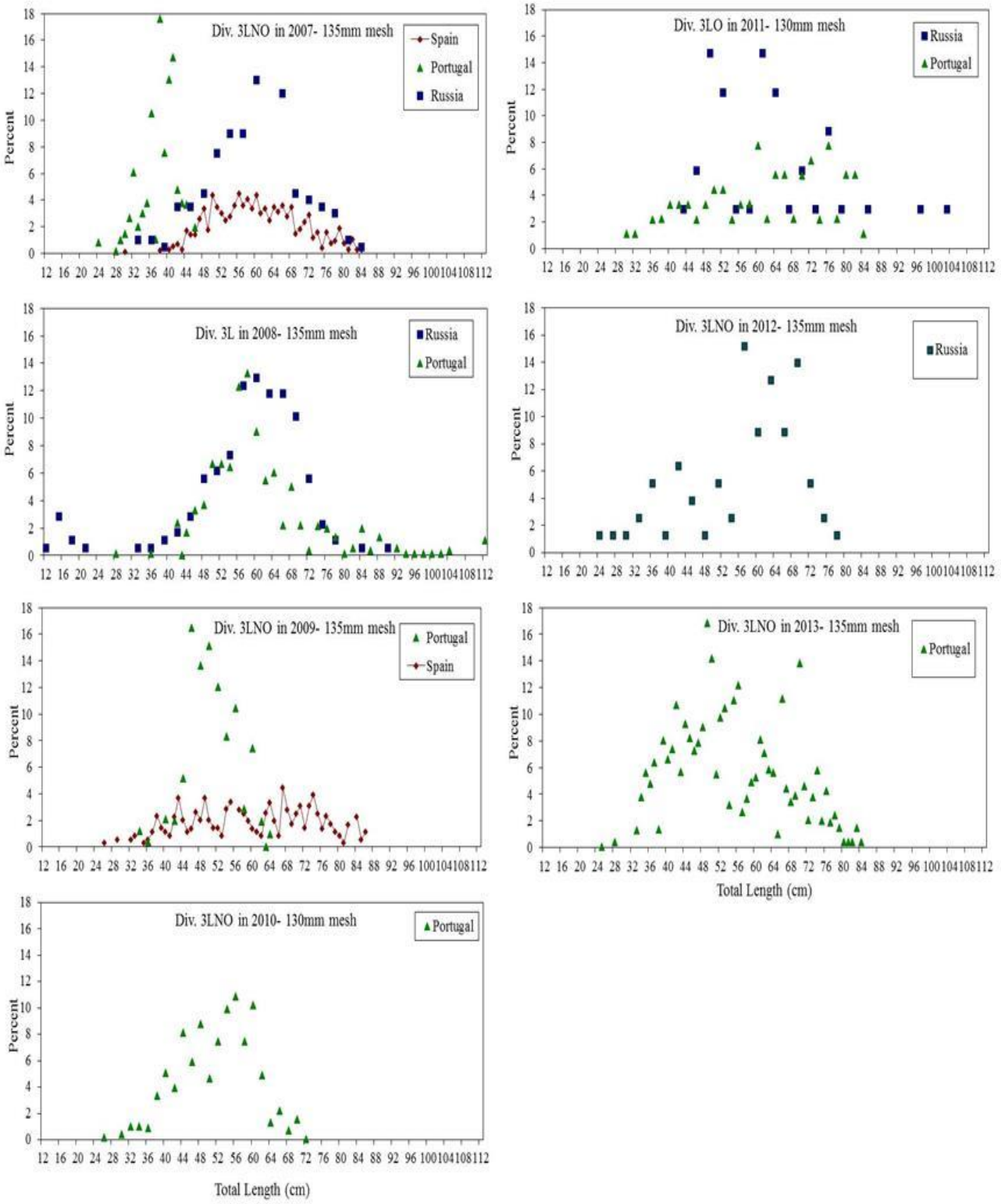

Figure 5e. Length distributions of commercial catches (sexes combined) in NAFO Div. 3LNO by country for the skate bycatch (135 mm) trawl fisheries, 2007-2013.

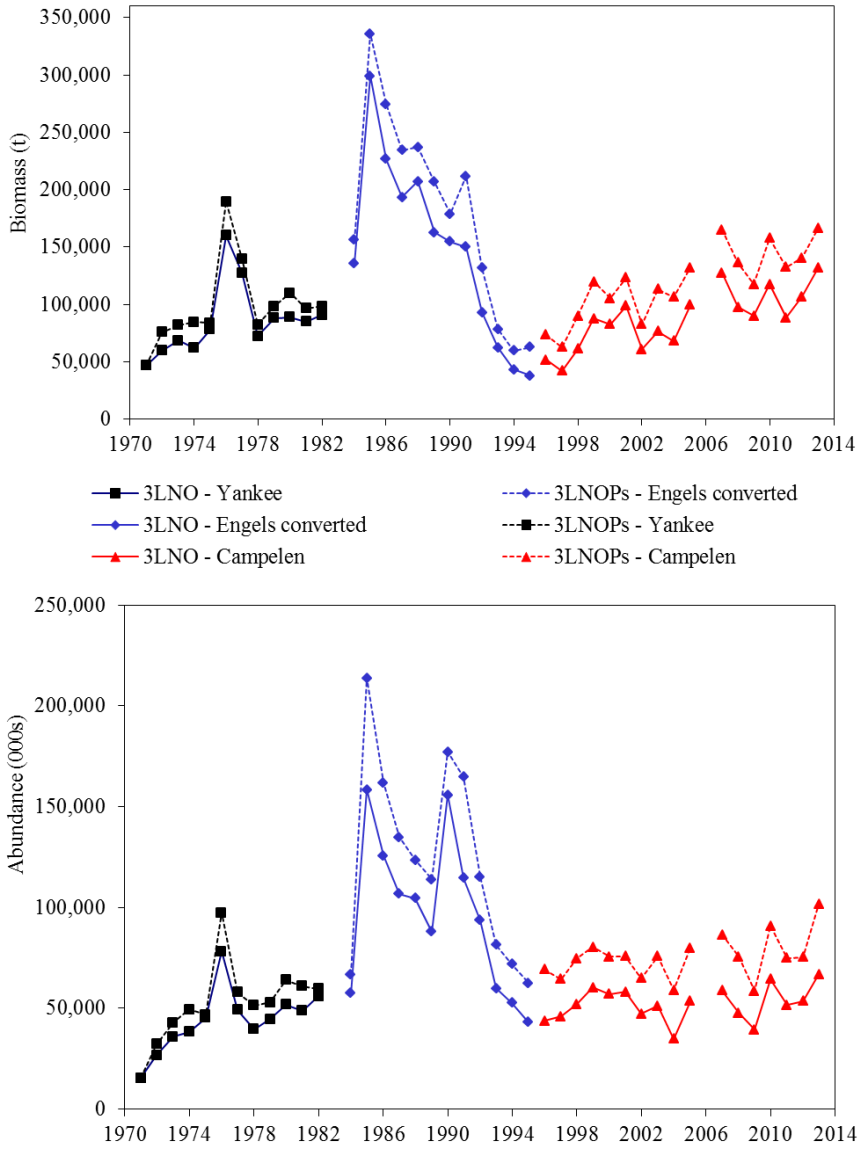

Figure 6a. Relative biomass and abundance indices for Thorny Skate from Canadian spring research surveys in NAFO Div. 3LNO and 3LNOPs, 1971-2013. Note that, due to mechanical difficulties on research vessels, Div. 3LNO were not surveyed in 1983, and the deeper (>103 m) portion of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006.

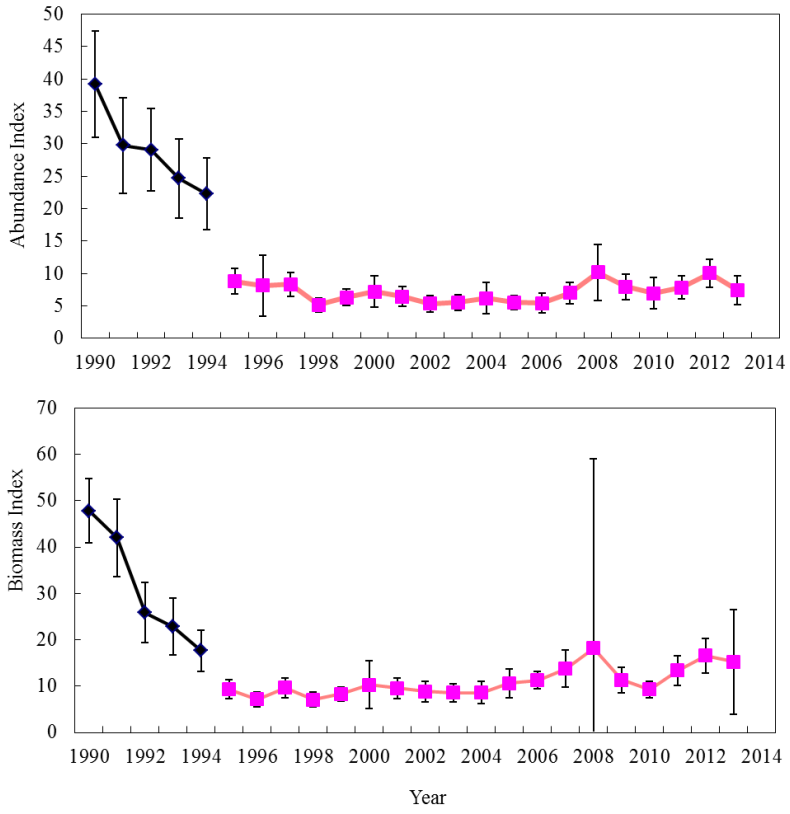

Figure 6b. Canadian autumn research survey biomass and abundance indices for Thorny Skate in NAFO Div. 3LNO, 1990-2013. Due to research vessels' mechanical difficulties, deep strata of Div. 3NO were not surveyed in 2003, 2004, 2006, 2008.

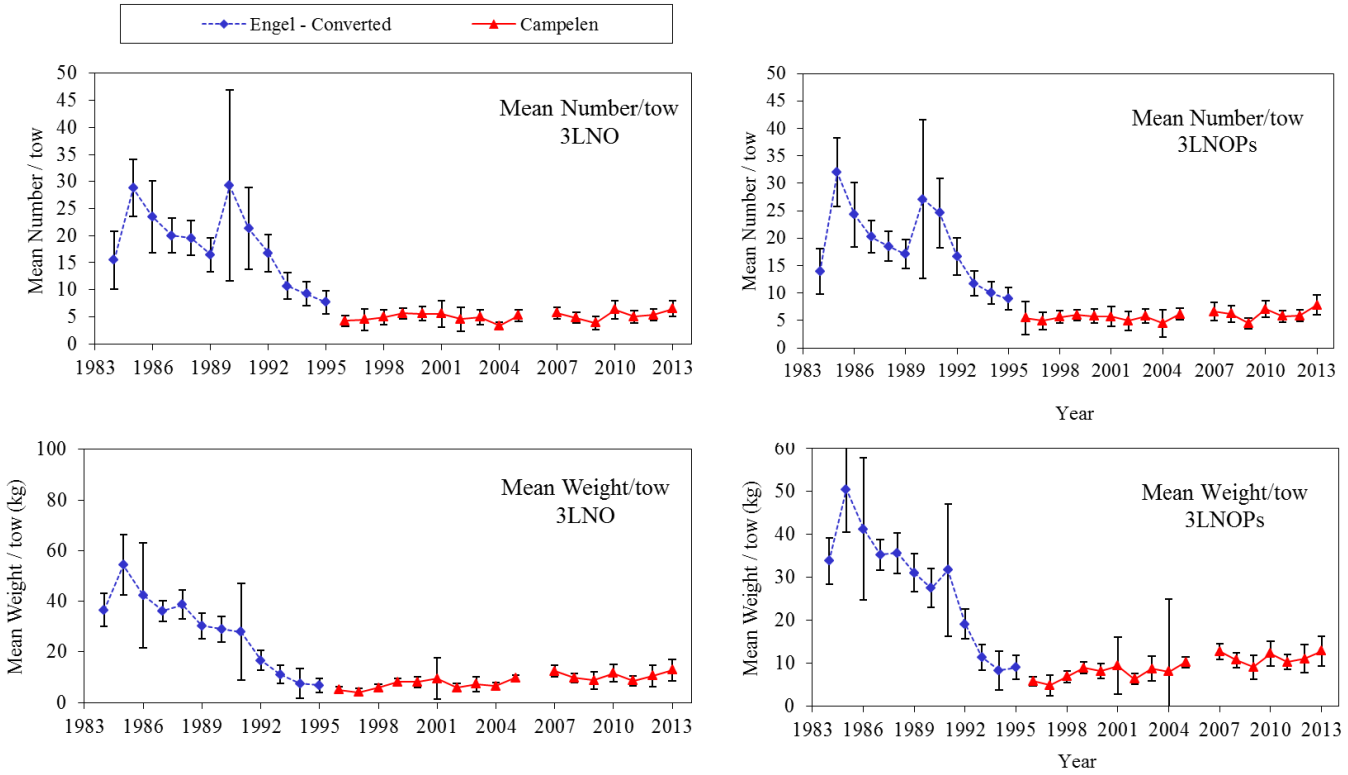

Figure 7. Mean numbers and weights (kg) per tow (+/- 95% CI) of Thorny Skate from Canadian spring surveys in NAFO Div. 3LNO and 3LNOPs, 1971-2013. Note that, due to mechanical difficulties on research vessels, Div. 3LNO were not surveyed in 1983; and the deeper (>103 m) portion of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006. Where lower confidence limits were negative, error bars were omitted (hollow symbols).

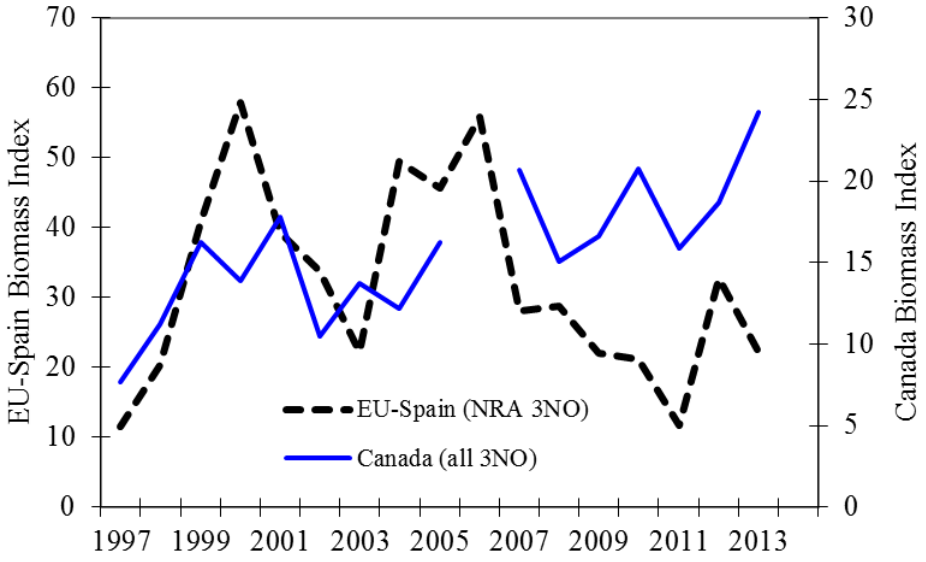

Figure 8. Comparison of Thorny Skate biomass indices from the Canadian Campelen spring survey and the Spanish spring survey in Div. 3NO, 1997-2013. Note that Spanish surveys occur only in the NAFO Regulatory Area (NRA) of Div. 3NO.

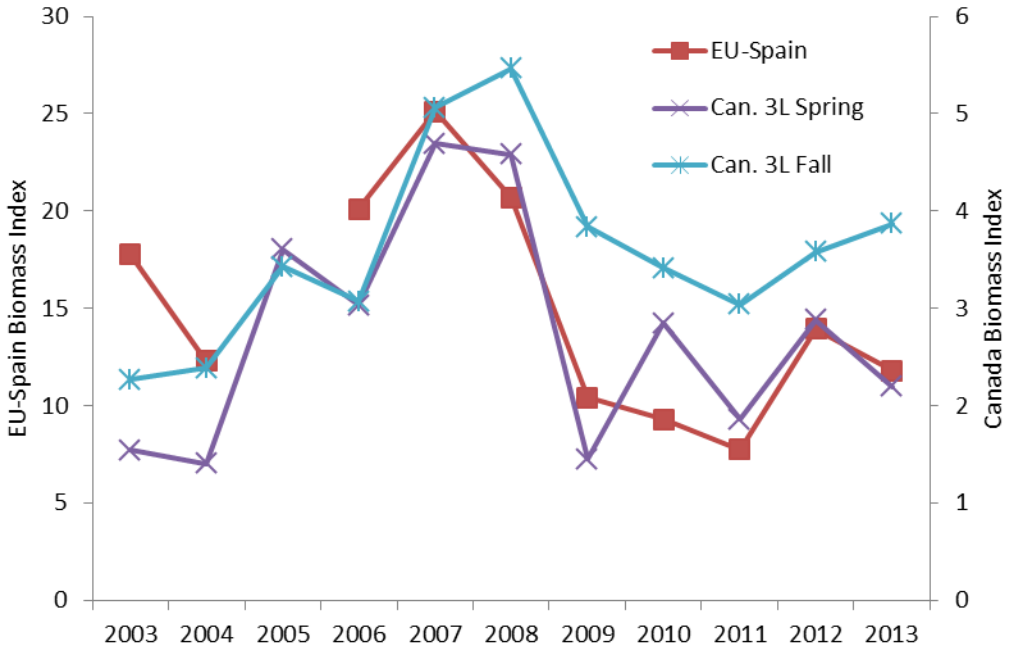

Figure 9. Comparison of Thorny Skate biomass indices from the Canadian Campelen surveys and the Spanish summer survey in Div. 3L, 2003-2013. Note that Spanish surveys occur only in the NAFO Regulatory Area (NRA) of Div. 3L.

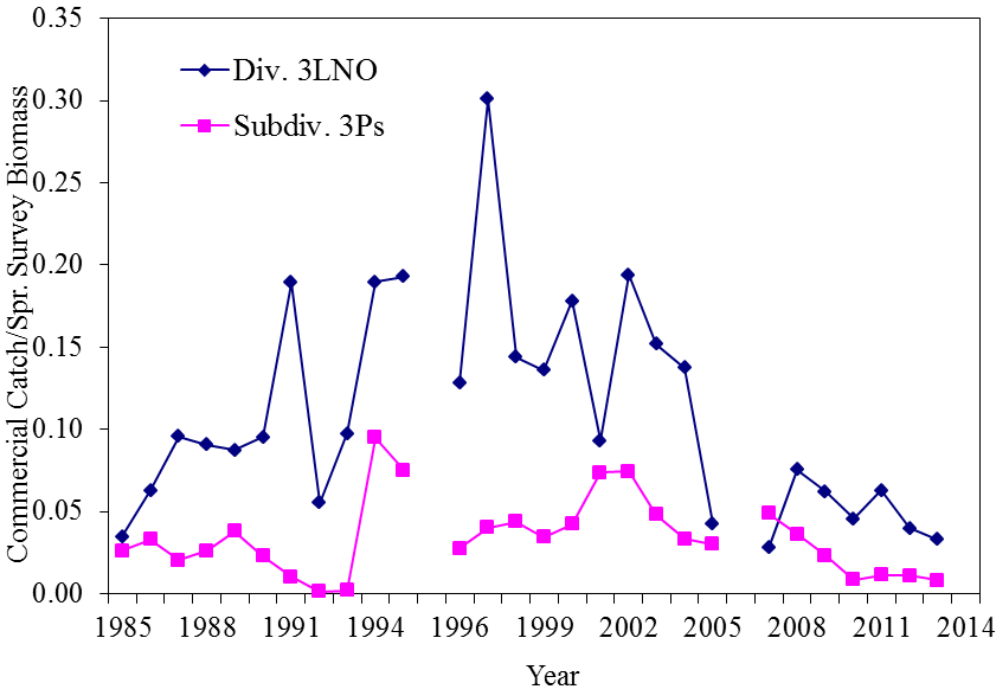

Figure 10. Fishing Mortality Index (reported landings/spring survey biomass) for Div. 3LNO and Subdiv. 3Ps, 1985-2013. Commercial landings are STACFIS-agreed numbers; biomass indices are from Canadian spring research surveys. Note that, due to mechanical difficulties on research vessels, the deeper (>103 m) portion of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006.

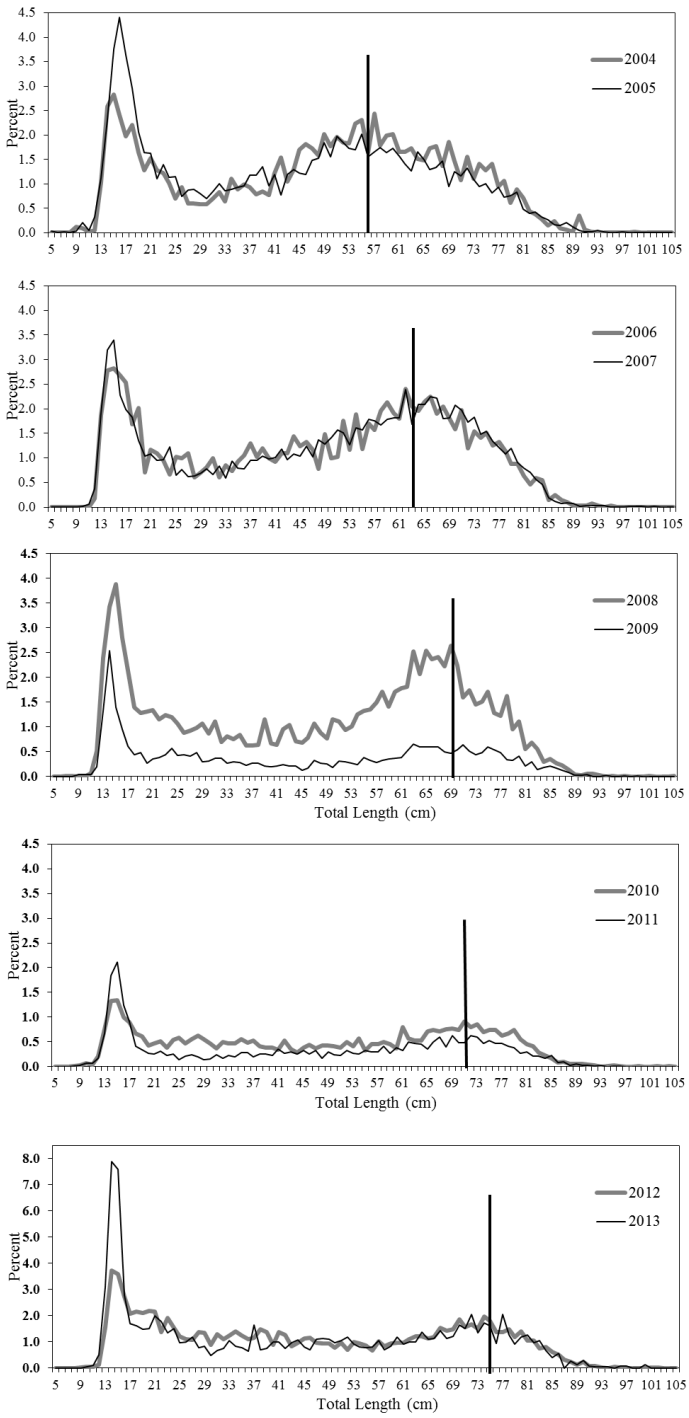

Figure 11. Length distributions of Thorny Skate from Canadian Campelen spring surveys in NAFO Div. 3LNO and Subdiv. 3Ps, 2004-2013. Vertical bars represent dominant modes of skates (excluding YOY). Note different values for the Y-axis in 2012-2013. The deeper (>103 m) portion of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006, due to mechanical difficulties on research vessels.

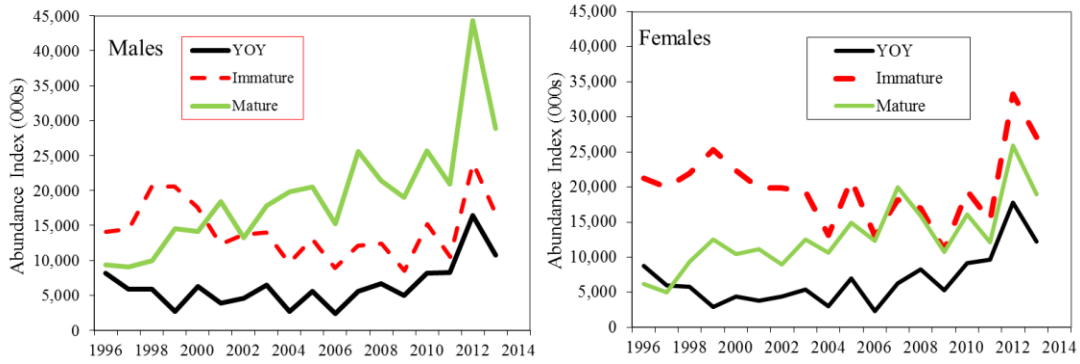

Figure 12. Estimated abundances of male and female Thorny Skates by life stage in NAFO Div. 3LNO and Subdiv. 3Ps from Canadian Campelen spring surveys, 1996-2013. Note that the deeper portion (>103 m) of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006, due to mechanical difficulties on research vessels.

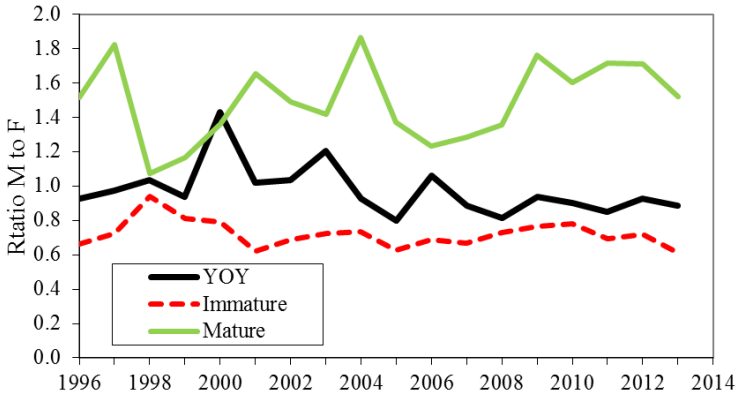

Figure 13. Ratio of staged male *versus* female Thorny Skates in NAFO Div. 3LNO and Subdiv. 3Ps from Canadian Campelen spring surveys, 1996-2013. Note that the deeper portion (>103 m) of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006, due to mechanical difficulties on research vessels.

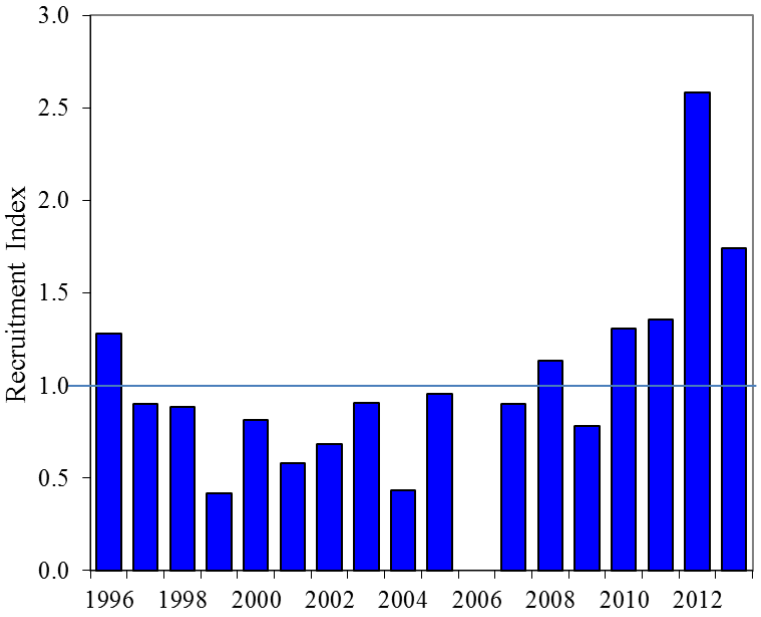

Figure 14. Standardized recruitment index (Thorny Skate>21cm) from Canadian spring surveys in Div. 3LNOPs, 1996-2013. Note that the deeper portion (>103 m) of Div. 3NO, as well as,Subdiv. 3Ps, were not surveyed in 2006, due to mechanical difficulties on research vessels.

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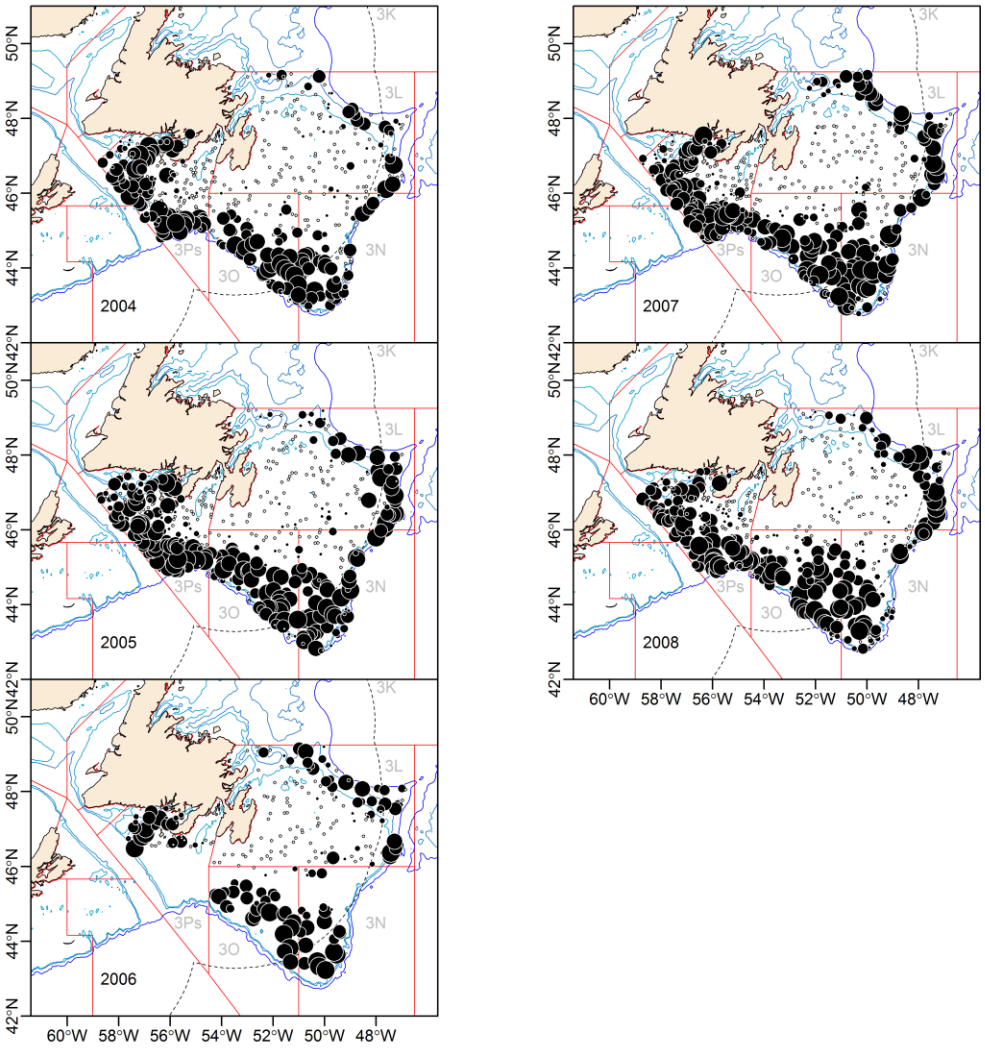

Figure 15a. Distribution of Thorny Skate on the Grand Banks (NAFO Div. 3LNOPs), based on Canadian spring surveys in 2004-2008. Note that the deeper portion (>103 m) of Div. 3NO, as well as Subdiv. 3Ps, were not surveyed in 2006, due to mechanical difficulties on research vessels.

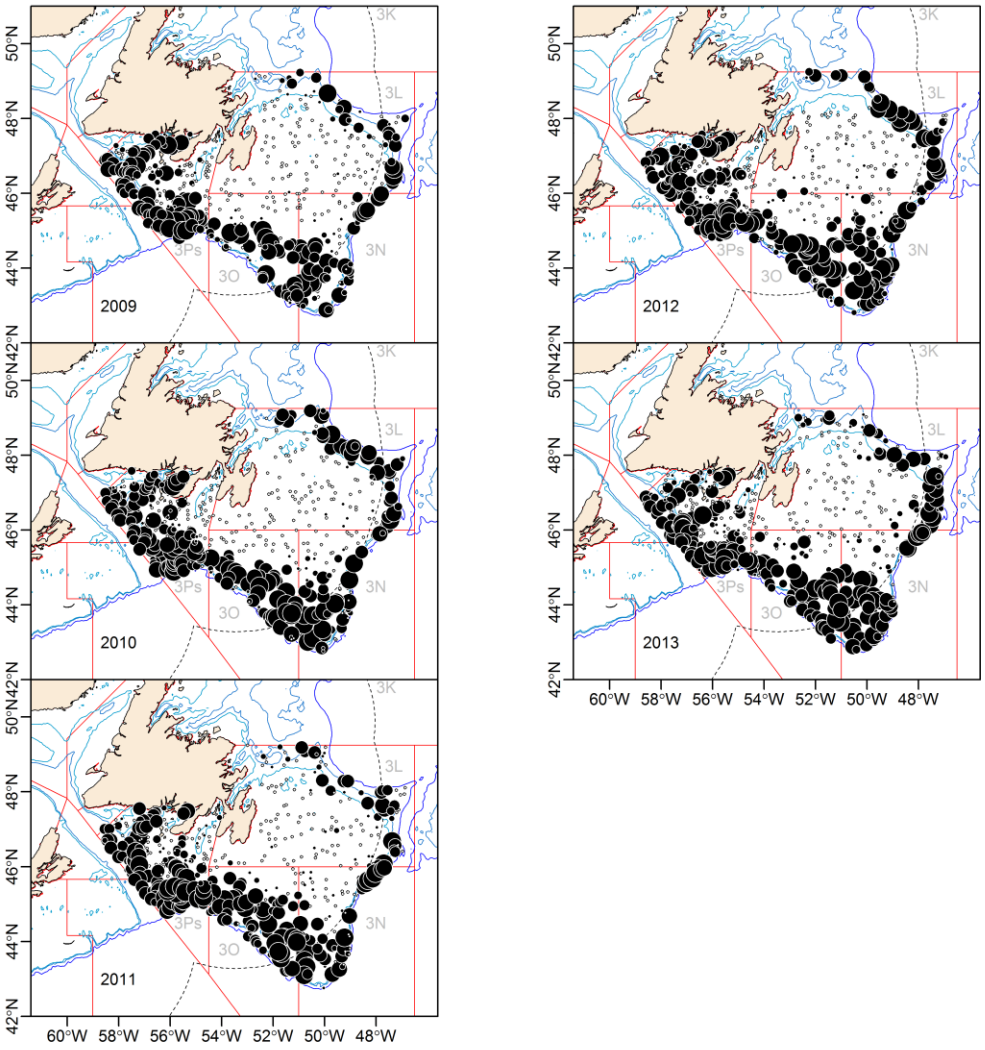

Figure 15b. Distribution of Thorny Skate on the Grand Banks (NAFO Div. 3LNOPs), based on Canadian spring surveys in 2009-2013.