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Status of Haddock (*Melanogrammus aeglefinus*) in NAFO Subdivision 3Ps

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Haddock (*Melanogrammus aeglefinus*) in the Northwest Atlantic Fisheries Organization (NAFO) Subdivision (Subdiv.) 3Ps was last fully assessed in 2001 (DFO 2001). Prior to the moratorium in 1993, with the exception of some high catches in 1954-56 (35,000 t), catches were less than 7,500 t. A high peak of 58,000 t was largely due to the 1949 year class and another peak (although lower) in 1985-86 was due to the 1981 year class. Since the moratorium, catches have been low, averaging 227 t (average catch since 1996 is 252 t). Bycatch of Haddock since the moratorium has been mostly the result of the directed cod fishery and a “mixed” white hake fishery. Mainly the gears used have been the otter trawl and gillnet fisheries. Depending on which gear is utilized, the length range of the bycatch is generally 40-70 cm. Biomass varied without trend at low levels with the exception of 1985-87, which averaged >20,000 t. Since the moratorium, biomass averaged ~2,800 t. Abundance showed a similar trend; however, with the exception of a high value in 2007 (which was the result of one large tow), there were some higher values in 1999 and 2000, which were the result of the 1998 year class. When numbers at length from the Research Vessel (RV) surveys are examined, strong year classes can be followed through for several years, especially the 1981 year class. In April, from the RV surveys, Haddock are distributed mainly at the bottom of the Halibut Channel. In the 1980s, when abundance and biomass were highest, the RV surveys occurred in February-March and Haddock were distributed over the St. Pierre Bank, Burgeo Bank and the Halibut Channel. There appears to be no trend in maturity at length over time. Current lack of conversion factors and episodic recruitment are impediments to determination of reference points.

État de l'aiglefin (*Melanogrammus Aeglefinus*) dans la sous-division 3Ps de l'Organisation des pêches de l'atlantique nord-ouest (OPANO)

RÉSUMÉ

La dernière évaluation complète de l'aiglefin (*Melanogrammus aeglefinus*) dans la sous-division 3Ps de l'OPANO remonte à 2001 (Pêches et Océans Canada, 2001). Avant le moratoire de 1993, et à l'exception des prises élevées durant la période 1954-1956 (35 000 t), les prises se montaient à moins de 7 500 t. Un sommet à 58 000 t avait été grandement dû à la classe d'âge de 1949, et un autre sommet (quoique moins élevé) en 1985-1986 avait été dû à la classe d'âge de 1981. Depuis le moratoire, les prises sont peu élevées, se montant en moyenne à 227 t (depuis 1996, la moyenne des prises est de 252 t). Les prises accessoires d'aiglefins ont été principalement attribuables à la pêche dirigée de la morue et à la pêche « mixte » de la merluche blanche. Les engins qui ont été surtout utilisés ont été les chaluts à panneaux et les filets maillants. Selon l'engin utilisé, la longueur des prises accessoires est comprise généralement entre 40 et 70 cm. La biomasse a varié à des niveaux peu élevés sans présenter de tendance, à l'exception de la période 1985-1987 où elle était supérieure à 20 000 t. Depuis le moratoire, la biomasse s'élève en moyenne à environ 2 800 t. L'abondance montre une tendance similaire, avec cependant une valeur élevée en 2007 (résultat d'un grand trait) et des valeurs plus élevées en 1999 et 2000, attribuables à la classe d'âge de 1998. Lorsque l'on examine les nombres selon la longueur provenant des relevés effectués par le navire de recherche (NR), on peut suivre les fortes classes d'âge durant plusieurs années, surtout la classe d'âge de 1981. Les relevés par NR nous apprennent qu'en avril, les aiglefins se rassemblent principalement sur le fond du chenal du Flétan. Dans les années 1980, lorsque l'abondance et la biomasse étaient à leurs plus hauts niveaux, les relevés par NR avaient lieu en février et en mars, et l'on avait constaté que l'aire de répartition de l'aiglefin s'étendait sur le banc de Saint-Pierre, le banc Burgeo et le chenal du Flétan. Il semble qu'il n'y ait pas de tendance pour la maturité à la longueur au fil du temps. L'absence actuelle de facteurs de conversion et le recrutement épisodique sont des entraves à la détermination des points de référence.

INTRODUCTION

Four stocks were assessed as part of a regional assessment of Groundfish stocks from the Newfoundland and Labrador (NL) Region. These were NAFO Subdiv. 3Ps Haddock, Pollock, Plaice and Divs. 3LNO Haddock. The purpose of this document is to assess the status of the Haddock stock in Subdiv. 3Ps and was last assessed in an update in 2005 (DFO 2005). The current assessments were requested by Fisheries and Aquaculture Management to provide the Minister with advice that will inform the management decisions for the 2014 fishing season.

Information for the assessment was considered from landings reported from NL and the Maritimes Regions as well as France (St. Pierre and Miquelon) (2009-13), and Canadian RV surveys (winter/spring 1972-2013). Information from RV surveys provide distributional data, indices of biomass and abundance, length frequencies, maturities at length, spawning stock biomass based on length data and a recruitment index (fish <20 cm).

ASSESSMENT

ENVIRONMENTAL OVERVIEW

There is a clear warming signal in Subdiv. 3Ps; since the early 1990s, bottom temperature during the spring survey has been increasing at an average rate of around 3% per year. Although trends of the fish community in the 1980s and early 1990s are potentially confounded with changes in the RV survey (e.g. timing of survey, sampling effort, gear change), it seems clear that the fish community declined during the mid-1980s and early 1990s. This decline was also accompanied by a decrease in the average fish size. Overall, the biomass and abundance of the fish community has increased since the mid-1990s. Increases in biomass have been moderate, while increases in abundance have been clearer and led by planktivore species like Sandlance, and to a lesser extent Herring. During this period, average fish size has shown ups and downs, without a consistent trend. Changes in biomass/abundance (BA) ratio at the fish community level can be explained by changes in community composition, like recent increases in planktivores. Among piscivores, Atlantic Cod is the dominant species in this functional group. Pollock has shown fluctuations over time, with 2010 and 2012 being relatively strong years compared to all others. During the early 2010s, dominance of Cod seems to be increasing among piscivores, but other gadoids (e.g. Silver Hake) also seem to be increasing within this functional group. Among large benthivores, American Plaice biomass levels have shown very few changes since the mid-1990s. This functional group has been dominated by Thorny Skate and American Plaice. Haddock has shown fluctuation but is not a dominant species among large benthivores. The observed warming of this system, together with recent increases of “warmer-water” species like Sandlance, Silver Hake, and Pollock suggests that this ecosystem could be undergoing structural changes.

There is limited diet information for Subdiv. 3Ps. The available data for American Plaice (spring 2013) indicates a diet dominated by Sandlance, brittle/basket stars and other echinoderms. This is different from Divisions 3LNO samples which show a diet with a higher proportion of Capelin and Sandlance.

Ocean Climate Conditions

A key indicator of ocean climate conditions on the NL Shelf, the North Atlantic Oscillation (NAO) index, returned to a negative phase in 2013 and as a result arctic air outflow to the Northwest Atlantic during the winter decreased over the previous year. This appears to have resulted in an increase in winter air temperatures over much of the Labrador Sea area causing a continuation of less sea-ice than normal on the NL Shelf. As a result of these and other factors, local water temperatures remained above normal in most areas in 2013 but show a decrease over 2011-12 values. In particular, average Subdiv. 3Ps bottom temperatures decreased from 3.3^{o}C to 2.9^{o}C, an approximate decrease of 1 standard deviation. In general, all environmental indices indicate a continuation of the warmer than normal trend throughout the area since the mid-1990s. During the past two years however temperatures have decreased compared to the record warm conditions of 2011.

COMMERCIAL LANDINGS AND TOTAL ALLOWABLE CATCHES

Landings of Haddock were highest in the 1950s, due mainly to the presence of the strong 1949 yearclass. This value peaked in 1955 with 58,000 t of catch (Figure 1). Yearclasses produced since then have not given rise to large catches. The relatively abundant 1981 year class recruited to the fishery in 1984 and catches peaked in 1985; however, at much lower levels than the 1950s. Catches have declined since then and been less than 600 t since 1992. The average catch over the last 5 years (2009-13) is 166 t. There has been no directed fishing on this stock since 1993.

In recent years, Haddock has been taken as bycatch in several fisheries in Subdiv. 3Ps. Mainly it is taken from cod and white hake fisheries, though in one of the most recent years up to 35% of the total bycatch of Haddock was taken in the witch flounder fishery. It is also taken in redfish, monkfish, skate, Atlantic halibut, and Greenland halibut fisheries (Table 1). Haddock is removed mainly by gillnet and otter trawl gears (Table 1).

Haddock landings comprised a small percentage of the directed fishery for cod (<2%), but a large percent of the directed catch of white hake (~55%) (Figure 2). The white hake fishery is considered a “mixed fishery”. Landings of Haddock by France (St. Pierre and Miquelon) ranged from 17-64 t annually between 2009 and 2013.

Observer and port samples length frequencies from 2002-12 were analyzed to determine the size structure of the catch (Figures 3-6). The catch was dominated by samples from 3Psh from 2005; and by otter trawl since 2008. In general, there were more fish measured from 2008 onward. Length frequencies were grouped by year, gear and type. An overall weighted frequency was computed for each bin by weighting individual length frequencies by the associated trip landings. This gives a proxy for catch at length. In general for 2002, the linetrawl (LT) and seine catch was dominated by fish ranging between 45-60 cm (slightly larger for LT). Length frequency plots from the commercial otter trawl indicate progression of year classes until 2010, in years where data is available. A peak at about 45 cm in 2010 indicates a stronger than average year class (possibly the 2006 year class) that can be followed in the catch until 2012. In recent years the catch from gillnet indicates a larger size range than otter trawl (Figures 3-6).

BIOLOGY

Haddock (*Melanogrammus aeglefinus*) is a benthic gadoid species, ranging from Greenland to Cape Hatteras. Several stocks exist in the Northwest Atlantic. In general, stocks are divided by the Fundian and Laurentian Channel (>180 m depth). In Newfoundland waters, two such stocks exist, the Grand Banks Haddock stock and the Saint Pierre Bank stock (Begg 1998). Haddock from Grand Bank and St. Pierre Bank are also thought not to mix extensively and are considered separate stocks based on differences in growth rate and year class compositions (Begg 1998; Scott and Scott 1981). Stocks off Newfoundland are thought to be near the northern limit of temperature preference but they do range further north to Greenland and off the Strait of Belle Isle (Blacker 1971).

The diet of Haddock consists of small worms and brittle stars, and fish such as sand eels and capelin. Haddock generally tend to have competitive interactions with cod and yellowtail flounder. Haddock prefer depths of 90 m to a maximum of 375 m and temperatures of 2-10^{o}C. They spawn off Newfoundland from January to July.

In general, Haddock on St. Pierre Bank are faster growing and a greater mean length-at-age and length at first-maturity than those on the Grand Bank (Divs. 3LNO) (Templeman et al. 1978ab, Templeman and Bishop 1979ab).

RESEARCH VESSEL SURVEYS

Biomass, abundance and distribution

Annual RV surveys have been conducted by Fisheries and Oceans Canada (DFO) in Subdiv. 3Ps since 1972 (Figure 7). From 1972-83 a Yankee 41.5 otter trawl was used in the surveys and towed at 3.5 knots for 30 minutes in order to derive index estimates. In 1984, in Subdiv. 3Ps, the research vessel was fitted with an Engel 145 otter trawl and this gear was used until 1996, when it was changed to a commercial shrimp trawl. This trawl, the Campelen 1800, was utilized in order to accommodate a multispecies survey and is towed at a speed of 3.0 knots for 15 minutes. All values are standardized to 15 minutes.

Although comparative fishing was carried out between these gears, no conversion factors have been developed for Haddock. It is expected that, in general, the Campelen catches more small fish (Warren et al. 1997). Therefore the time series from each gear cannot be compared directly.

The survey covered only a few strata deeper than 400 m before 1979; since then depths of up to 750 m are surveyed annually. Survey coverage was expanded in 1997 to cover additional strata in the inshore area. Survey timing has changed as well, with the time period prior to 1994 being carried out in some years in winter (February-March) but since 1994 being carried out in spring (April-June) (Table 2).

Haddock biomass in Subdiv. 3Ps was low from 1972-83 and increased and peaked in 1985 (due to the presence of the relatively strong 1981 year class), then declined to low levels (Figure 8). The biomass estimates from the Campelen time series are variable but low. The abundance followed similar trends with the exception of increases due to stronger incoming year classes (Figure 9). The 1981 year class supported moderate catches in the fishery until the late 1980s. Afterwards, there were no strong year classes until 1998 (Figures 10-12).

This 1998 year class progressed through to mature fish (Figure 12); however, there have been no above average year classes since that time (the large estimate in 2007, along with the large variance, is due to one large tow of small (<20 cm) Haddock) (Figure 9). Most of the biomass of Haddock is within the 90-300 m depth zone (Tables 3 and 4).

Size composition

Size distribution of Haddock is examined using numbers at length annually (Figures 10-12). These indicate that some year classes are strong and can be followed for several years, in particular 1981 and 1998. The 2006 year class, which appeared to be strong, can be seen in consecutive years but is considerably weaker. This was also largely due to one large tow. The most recent years indicate the presence of larger and presumably mature fish. L_{50} for Haddock in Subdiv. 3Ps is 50 cm for females and 40 cm for males (Templeman and Bishop 1979).

Recruitment

An index of recruitment is considered to be age 1 fish (proxy being fish less than 20.5 cm). A plot of these small recruits is shown in Figure 13 and there have been few strong pulses in the recruitment index over the survey. The 1972, 1981, 1988, 1998, 2006 and 2011 yearclasses are the strongest in the time. In the Campelen time series, 1999 age 1s (the 1998 year class) was above average and the 2007 was above average (but this was because of one very large tow).

Spawning Stock Biomass

The index of spawning stock biomass (calculated from numbers at length, converted to weights at length and then multiplied by proportion mature) was highest in the mid-1980s and variable during the Campelen period (Figure 14). Average length at 50% maturity over the entire time series is 50 cm for both sexes.

Distribution

Plots of mean weight (Figures 15-18) and mean number per tow (not shown) by year indicated that most Haddock catches in the survey are rarely found outside the 100-300 m depth contour. In the 1980s Haddock catches were distributed near the edge of Burgeo Bank and along the western edge of St. Pierre Bank. In recent years, catches are distributed mainly at the bottom of the Halibut Channel (Figures 17 and 18). This change may be due to the timing of the survey rather than an actual shift in distribution.

CFER Acoustic Survey

Surveys conducted by the Centre for Fisheries Ecosystems Research in Subdiv. 3Ps during 12-22 May 2012 and 16-18 May 2013 revealed aggregations of Haddock along the edges of Halibut Channel and the western shelf slope of St. Pierre Bank. In 2012, Haddock length ranged between18-78 cm (n=351) with modes at approximately 23 cm and 56 cm. In 2013, there was a large mode at 31 cm although fish up to 83 cm in length were also observed (n=1,403). Estimates of ages, based on otolith sections, revealed that fish ranged from 1 to 14 years of age with 2006 and 2011 cohorts featuring prominently in the survey catch. Examination of gross morphology of the gonads revealed many individuals to be approaching spawning or spent and that 50% of females had reached sexual maturity by 41 cm. Individual growth rates and length at maturity during 2012-13 appeared similar to those observed for this stock in the past.

Reference Points

Some reference points were considered (discussed) but not accepted at the meeting. This was because there is no analytical assessment and only RV indices and catch data are available. There are different gears at different time periods and there are no conversion factors in place for Haddock so there isn't a long time series from which to derive adequate reference points. Complicating this process is the fact that Haddock tends to have episodic recruitment – with large year classes supporting subsequent fisheries for some years after.

Two methods were attempted for obtaining potential limit reference points for Haddock. These were:

1. the 10th percentile of the cumulative biomass over the time series or;
2. 15% of the highest observed biomass.

The first method gave a very low LRP – only the 4th lowest biomass level in the time series (there are only 41 data points) and was thus considered unreasonable. The second method gave a number of 4,852 t, which is 15% of 32,349 t, the biomass from 1985, the highest observed level in the time series.

CONCLUSION AND ADVICE

The lack of conversion factors does not allow for comparisons between time periods (Yankee 1972-82; Engel 1983-95; Campelen 1996-2013). Two large recruitment events have been observed in this stock. One year class in each of the 1950s and 1980s supported larger than average catches. It appears that the stock has pulses of episodic recruitment but these are infrequent.

Catch ranged widely from 147 t to 58,000 t from 1953 to 1992, with a singular anomalously high observation of 58,000 t in 1955. The survey indices have varied without trend since 1996 while catch has ranged from 84 to 621 t (average 252 t). Catches above this range should be treated with caution until there is evidence of an increase in stock size.

Environmental conditions play a large role in survival of Haddock recruits. In years where survival is good, one strong year class can sustain fisheries for a number of years. However, studies have shown that, for example, Haddock in the North Sea show an earlier size at maturation at high temperatures (Baudron et al. 2011). Therefore, warming trends in oceanic temperatures could eventually cause a further decline in Haddock yields.

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FIGURES AND TABLES

Table 1. Bycatch (kg) of Haddock by gear and directed species for 2009-2013 in Newfoundland fisheries.

Year	Gear	Cod	Ghal	Hake	Halibut	Monkfish	Pollock	Redfish	Skate	Wolffish	Total by gear	Annual total
2009	**Danish**	-	-	-	-	-	-	-	-	103	103	-
2009	**Gillnet**	7,481	-	63,844	-	384	-	62	16	-	71,787	-
2009	**Handline**	131	-	-	-	-	-	-	-	-	131	-
2009	**Longline**	8,020	-	33	35	-	-	10	432	-	8,530	-
2009	**Otter**	19,522	-	-	-	-	-	3,421	-	55,650	78,593	-
Total by Fishery	**-**	35154	-	63877	35	384	-	3493	448	55753	-	159144
2010	**Gillnet**	4,460	-	23,451	-	148	66	38	-	-	28,163	-
2010	**Handline**	9	-	-	-	-	-	-	-	-	9	-
2010	**Longline**	1,619	-	501	401	-	-	-	3	-	2,524	-
2010	**Otter**	99,536	-	-	-	-	-	12	158	936	100,642	-
Total by Fishery	**-**	105,624	-	23,952	401	148	66	50	161	936	-	131,338
2011	**Gillnet**	12,223	-	35,339	-	4	4631	54	1	-	52,252	-
2011	**Handline**	6	-	-	-	-	-	-	-	-	6	-
2011	**Longline**	818	1	-	62	-	-	-	-	-	881	-
2011	**Otter**	34,144	-	-	-	-	-	112	-	508	34,764	-
Total by Fishery	**-**	47,191	1		62	4	4,631	166	1	508		87,903
2012	**Gillnet**	11,653	-	39,868	-	-	7,632	28	1,001	-	60,182	-
2012	**Handline**	418	-	7	88	-	-	-	-	-	513	-
2012	**Longline**	39,503	-	-	-	-	-	293	-	920	40,716	-
2012	**Otter**	19	-	-	-	-	-	-	-	-	19	-
Total by Fishery	**-**	51,593	-	39,875	880	-	7,632	321	1,001	920	-	101,430
2013	**Gillnet**	3,869	-	31,525	-	-	-	35	2	-	35,431	-
2013	**Handline**	3	-	-	-	-	-	-	-	-	3	-
2013	**Longline**	662	-	36	239	-	-	-	-	-	937	-
2013	**Otter**	32,326	-	-	-	-	-	-	-	8,715	41,041	-
Total by Fishery	**-**	-	-	-	-	-	-	-	-	-	-	77,412

Table 2. Summary of successful sets in the Canadian spring surveys of NAFO Subdiv. 3Ps from 1998-2013.

Year	Start Date	End Date	Number Days	Number Sets
1983	23-Apr-83	8-May-83	15	164
1984	10-Apr-84	17-Apr-84	7	93
1985	8-Mar-85	25-Mar-85	17	109
1986	6-Mar-86	23-Mar-86	17	136
1987	13-Feb-87	22-Mar-87	37	130
1988	27-Jan-88	14-Feb-88	18	146
1989	1-Feb-89	16-Feb-89	15	146
1990	1-Feb-90	19-Feb-90	18	108
1991	2-Feb-91	20-Feb-91	18	158
1992	6-Feb-92	24-Feb-92	18	137
1993a	6-Feb-93	23-Feb-93	17	136
1993b	2-Apr-93	20-Apr-93	18	130
1994	6-Apr-94	26-Apr-94	20	166
1995	4-Apr-95	28-Apr-95	24	161
1996	10-Apr-96	01-May-96	22	148
1997	2-Apr-97	23-Apr-97	22	158
1998	10-Apr-98	05-May-98	25	177
1999	13-Apr-99	06-May-99	23	175
2000	8-Apr-00	11-May-00	34	171
2001	7-Apr-01	29-Apr-01	23	173
2002	5-Apr-02	27-Apr-02	21	177
2003	5-Apr-03	02-May-03	23	176
2004	11-Apr-04	11-May-04	30	177
2005	17-Apr-05	09-May-05	22	178
2006	13-Apr-06	18-Apr-06	5.1	48
2007	4-Apr-07	02-May-07	29	178
2008	10-Apr 08	23-May-08	44	169
2009	08-Apr-09	13-May-09	35	175
2010	08-Apr-10	08-May-10	31	177
2011	07-Apr-11	08-May-11	32	174
2012	31-Mar-12	26-Apr-12	27	177
2013	26-Mar-13	23-Apr-13	29	179

Table 3. Biomass estimates (kg) for Haddock by depth stratum from Canadian spring surveys in NAFO Subdiv. 3Ps. from 1972-95. Data from Murphy and Bishop 1995.

Depth (m)	Stratum	‘72	‘73	‘74	‘75	‘76	‘77	‘78	‘79	‘80	‘81	‘82	‘83	‘84	‘85	‘86	‘87	‘88	‘89	‘90	‘91	‘92	‘93	‘94	‘95
<=56	314	0	.	0	.	7	0	0	.	0	0	7	63	0	0	0	0	0	0	0	0	0	0	0	0
<=57	320	.	0	.	.	0	.	.	.	0	0	105	94	111	0	0	0	0	0	0	0	0	0	0	0
Sub-total		**0**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**112**	**157**	**111**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
57-92	308	.	0	0	0	0	0	0	0	0	19	0	0	32	0	0	0	0	0	0	0	0	0	0	0
57-92	312	72	.	0	0	0	0	0	0	.	0	0	5	1327	0	0	0	0	0	0	0	0	0	0	0
57-92	315	0	0	0	.	0	0	.	0	0	0	0	31	1	0	0	0	1	0	0	0	0	0	0	0
57-92	321	0	0	.	.	0	.	0	.	8	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
57-92	325	.	.	.	.	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57-92	326	.	.	.	.	.	.	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0
Sub-total		**72**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**19**	**0**	**36**	**1360**	**0**	**0**	**0**	**1**	**0**	**0**	**8**	**0**	**0**	**0**	**0**
93-183	307	323	0	152	111	0	30	0	19	74	0	342	22	185	12	390	1408	331	30	0	2	0	0	0	0
93-183	311	117	0	85	22	393	221	0	1	0	1	0	20	1178	9	4	0	90	0	8	0	0	0	0	0
93-183	317	155	3	89	13	92	204	.	20	0	87	333	192	56	0	0	0	1	0	0	0	0	0	0	0
93-183	319	17	12	34	141	84	1358	.	0	0	0	293	633	3509	1108	129	164	332	74	.	0	0	6	0	17
93-183	322	.	.	.	.	3	.	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
93-183	323	5	.	.	.	0	0	0	.	0	0	0	0	0	3	0	1	0	0	0	0	0	0		0
93-183	324	.	.	.	.	0	.	.	0	0	.	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Sub-total		**617**	**15**	**360**	**287**	**572**	**1813**	**0**	**40**	**74**	**88**	**968**	**867**	**4928**	**1137**	**523**	**1573**	**755**	**104**	**8**	**2**	**0**	**6**	**0**	**17**
184-274	306	.	.	21	0	86	0	0	136	0	142	28	67	0	1195	105	841	307	15	102	0	0	1	11	0
184-274	309	292	195	16	10	0	0	54	10	0	7	0	15	0	354	239	286	527	217	34	24	0	98	0	0
184-274	310	804	79	195	215	.	2	42	14	0	0	213	7	0	4105	762	1180	116	43	0	0	0	79	117	0
184-274	313	742	64	160	79	202	103	22	40	133	149	152	929	0	917	511	2598	19	508	7	26	5	0	8	28
184-274	316	140	340	169	45	35	74	.	80	106	31	.	156	28	493	401	362	38	158	36	8	55	55	14	5
184-274	318	371	10	0	9	0	3	.	14	105	.	69	51	9	.	7878	307	42	194	.	129	23	128	6	1094

Table 3. Continued.

Depth (m)	Stratum	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95
Sub-total		**2349**	**688**	**561**	**358**	**323**	**182**	**118**	**294**	**344**	**329**	**462**	**1225**	**37**	**7064**	**9896**	**5574**	**1049**	**1135**	**179**	**187**	**83**	**361**	**156**	**1127**
275-366	705	.	.	15	0	37	179	0	6	0	0	0	0	0	3026	2357	139	176	0	193	3	0	161	174	158
275-366	706	.	.	36	.	.	0	.	87	373	0	0	0	0	670	1237	907	652	665	603	102	409	74	13	43
275-366	707	.	.	.	0	0	112	.	307	0	.	.	0	0	.	1817	234	960	576	.	240	502	149	5	73
275-366	715	.	.	.	20	0	0	0	37	29	12	26	60	5	.	37	25	67	69	60	3	42	43	25	0
275-366	716	.	.	.	.	.	0	0	0	0	25	0	0	0	20392	1912	1243	1380	3070	2089	4	0	0	101	26
Sub-total		**0**	**0**	**51**	**20**	**37**	**291**	**0**	**437**	**402**	**37**	**26**	**60**	**5**	**24088**	**7360**	**2548**	**3235**	**4380**	**2945**	**352**	**953**	**427**	**318**	**300**
367-549	708	.	.	.	0	.	.	.	0	0	.	.	0	0	.	37	211	176	83	.	0	0	0	2597	7
367-549	711	.	.	.	.	.	0	.	.	0	0	0	0	0	0	393	113	0	0	0	24	0	0	0	0
367-549	712	.	.	.	.	.	.	.	0	0	0	0	0	.	61	32	37	0	0	26	0	0	0	0	0
367-549	713	.	.	.	0	.	.	.	.	0	0	0	0	.	0	14	36	0	0	0	15	0	0	0	0
367-549	714	.	.	.	.	.	.	.	.	0	0	0	0	.	.	54	0	27	49	0	0	9	0	0	0
Sub-total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**61**	**530**	**397**	**203**	**132**	**26**	**39**	**9**	**0**	**2597**	**7**
550-731	709	.	.	.	.	.	.	.	.	.	.	.	0	0	.	.	.	.	0	.	0	.	.	.	.
550-731	710	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	.	0	.	.	0	.	.	.	.
Sub-total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total		**3038**	**703**	**972**	**665**	**939**	**2286**	**118**	**771**	**828**	**473**	**1568**	**2345**	**6441**	**32350**	**18309**	**10092**	**5243**	**5751**	**3158**	**588**	**1045**	**794**	**3071**	**1451**

Table 4. Biomass estimates (kg) for Haddock by depth stratum from Canadian spring surveys in NAFO Subdiv. 3Ps. from 1996-2013.

Depth (m)	Stratum	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<=56	314	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
<=56	320	0	0	0	6	2	0	0	0	0	0	.	0	0	0	0	13	1	0
Sub-total		**0**	**0**	**0**	**6**	**2**	**0**	**0**	**0**	**0**	**0**		.	**0**	**0**	**0**	**13**	**1**	**0**
57-92	308	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
57-92	312	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
57-92	315	0	0	0	0	12	0	0	0	0	0	.	0	0	0	0	120	79	0
57-92	321	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
57-92	325	0	0	0	1	0	0	0	0	0	0	.	0	0	0	0	0	0	1
57-92	326	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
Sub-total		**0**	**0**	**0**	**1**	**12**	**0**	**0**	**0**	**0**	**0**	**.**	.	**0**	**0**	**0**	**120**	**79**	**1**
93-183	307	0	0	0	45	5	6	0	0	0	0	.	0	0	0	9	51	0	0
93-183	311	0	0	0	595	0	0	0	0	0	1	.	1	0	6	407	194	0	1
93-183	317	0	0	0	9	0	0	0	0	0	31	.	1	41	4	608	0	78	1
93-183	319	768	1	4347	427	4017	1607	4092	6	5226	3128	.	168	69	1044	2607	1601	854	3319
93-183	322	0	0	0	0	0	0	0	0	0	0	.	2	0	0	0	19	2	11
93-183	323	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	1	10
93-183	324	0	0	0	0	0	0	0	0	0	0	.	1	0	0	0	0	1	7
Sub-total		**768**	**1**	**4347**	**1076**	**4022**	**1613**	**4092**	**6**	**5226**	**3160**	**.**	.	**110**	**1054**	**3631**	**1865**	**936**	**3349**
184-274	306	0	0	0	0	0	0	0	0	0	0	.	0	14	6	14	0	0	0
184-274	309	0	0	67	0	0	22	0	0	0	0	.	0	0	0	0	0	0	6
184-274	310	26	36	0	1	0	109	0	8	0	19	.	73	67	4	0	0	0	132
184-274	313	0	47	0	77	13	82	137	208	0	67	.	0	157	179	63	68	233	54
184-274	316	1	12	183	0	0	292	173	214	313	281	.	931	51	0	36	0	76	421
184-274	318	32	3	0	1	0	65	300	359	19	65	.	28	0	0	14	0	0	0

Table 4. Continued.

Depth (m)	Stratum	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Sub-total		**59**	**98**	**250**	**79**	**13**	**570**	**610**	**789**	**332**	**432**	**.**	.	**289**	**189**	**127**	**68**	**309**	**613**
275-366	705	118	0	197	0	0	0	0	64	93	0	.	137	0	44	0	0	0	332
275-366	706	0	0	48	0	0	0	28	56	0	0	.	0	0	0	0	0	0	63
275-366	707	13	4	0	0	0	0	11	0	0	0	.	0	0	0	4	0	0	0
275-366	715	32	34	0	22	0	9	0	0	18	0	.	28	0	0	0	0	0	0
275-366	716	199	0	0	76	0	0	0	0	0	0	.	0	194	0	13	0	0	474
Sub-total		**362**	**38**	**245**	**98**	**0**	**9**	**39**	**120**	**111**	**0**	**.**	**165**	**194**	**44**	**17**	**0**	**0**	**869**
367-549	708	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
367-549	711	0	0	0	0	0	0	0	0	0	0	.	1	0	0	0	0	0	0
367-549	712	0	0	0	0	0	0	0	0	34	0	.	0	0	0	0	0	0	0
367-549	713	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
367-549	714	0	0	0	0	0	7	0	0	0	0	.	0	0	0	0	0	0	0
Sub-total		**0**	**0**	**0**	**0**	**0**	**7**	**0**	**0**	**34**	**0**	**.**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
550-731	709	0	.	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
550-731	710	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sub-total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**.**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total		**1189**	**137**	**4842**	**1260**	**4049**	**2199**	**4741**	**915**	**5703**	**3592**	**.**	**1371**	**593**	**1287**	**3775**	**2066**	**1325**	**4832**

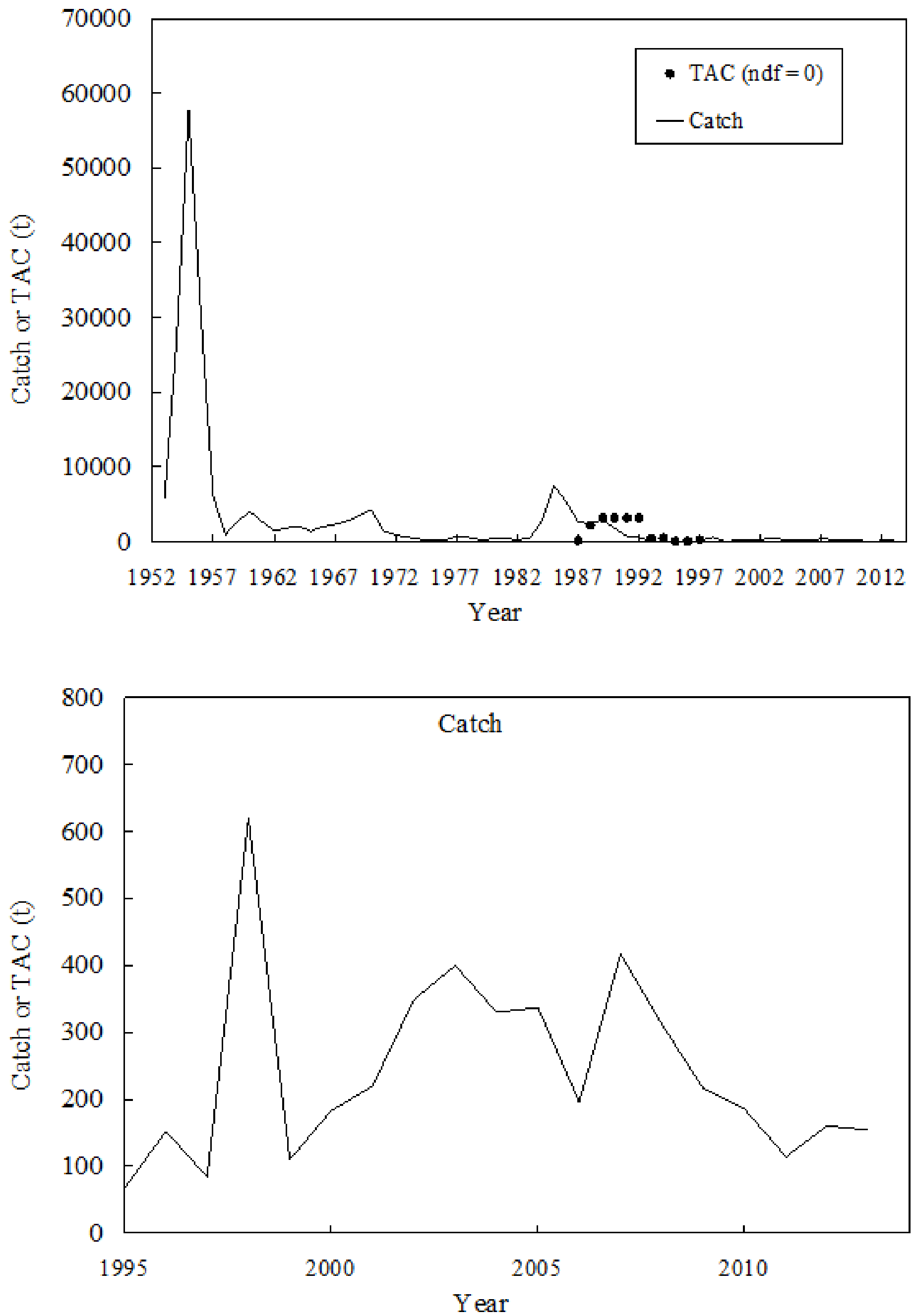

Figure 1. NAFO Subdiv. 3Ps Haddock landings and TACs from 1952 to 2013 (upper panel) and from 1995-2013 (lower panel).

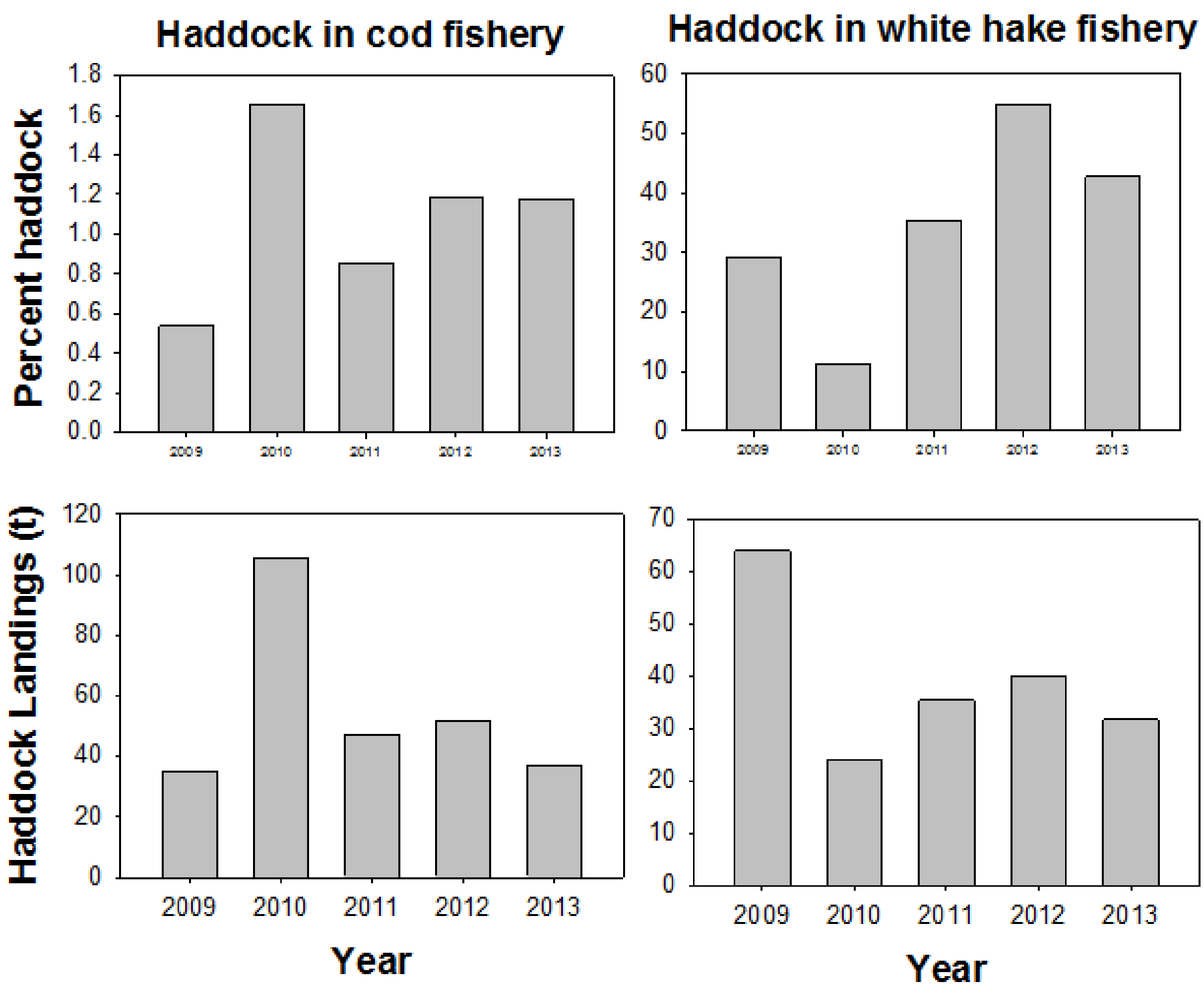

Figure 2. Haddock landings from bycatch in the Atlantic Cod and White Hake fisheries from 2009 and 2013 expressed as landings by fishery (lower panel) and as percent of the targeted species landings (upper panel).

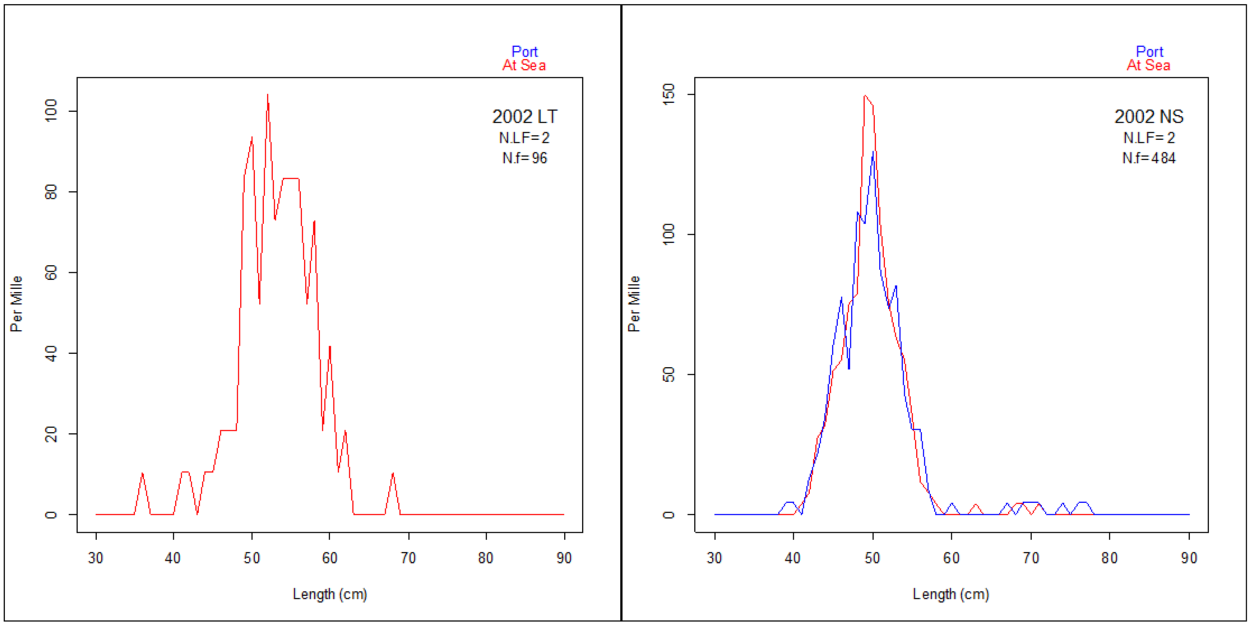

Figure 3. Length frequencies (per mille) of Haddock in Subdiv. 3Ps from port samplers (blue) and observers (at sea; red) for 2002 from linetrawl (left panel) and Norwegian seiner (right panel).

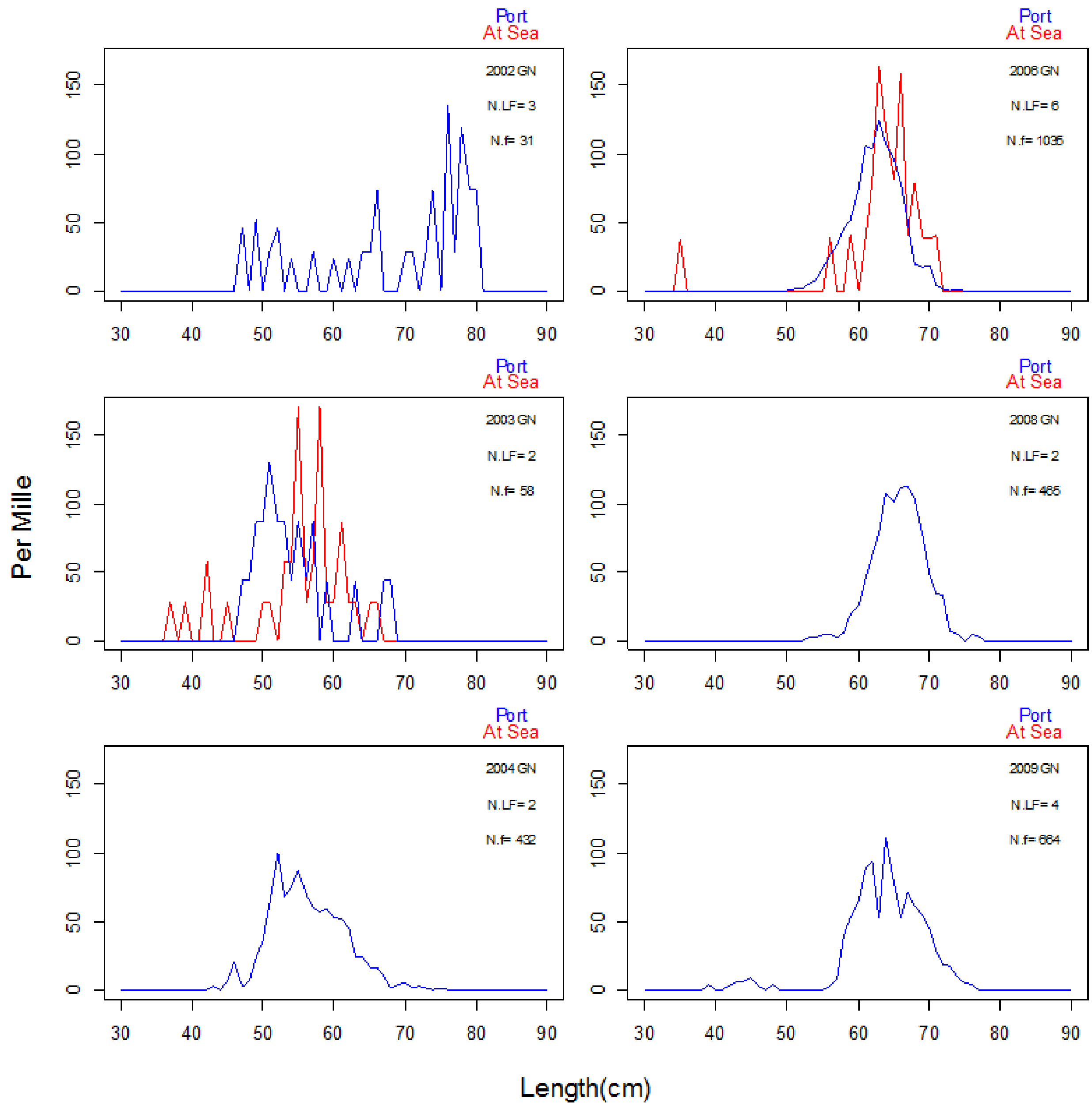

Figure 4. Length frequencies (per mille) of Haddock in Subdiv. 3Ps from port samplers (blue) and observers (at sea; red) from 2002-09 (no data collected in 2005) from the gillnet fisheries.

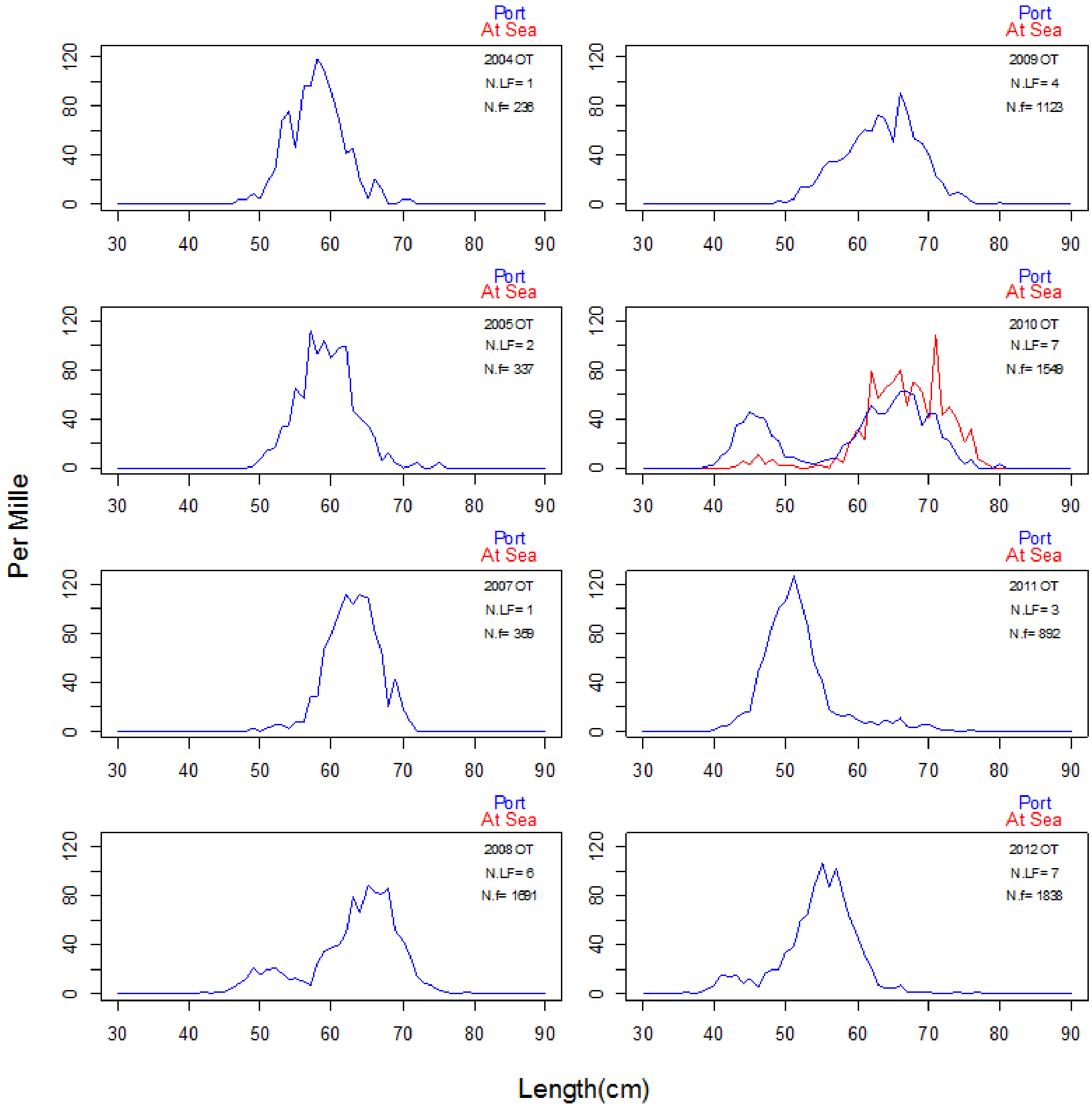

Figure 5. Length frequencies (per mille) of Haddock in Subdiv. 3Ps from port samplers (blue) and observers (at sea; red) from 2004-12 (no data collected in 2006) from the otter trawl fisheries.

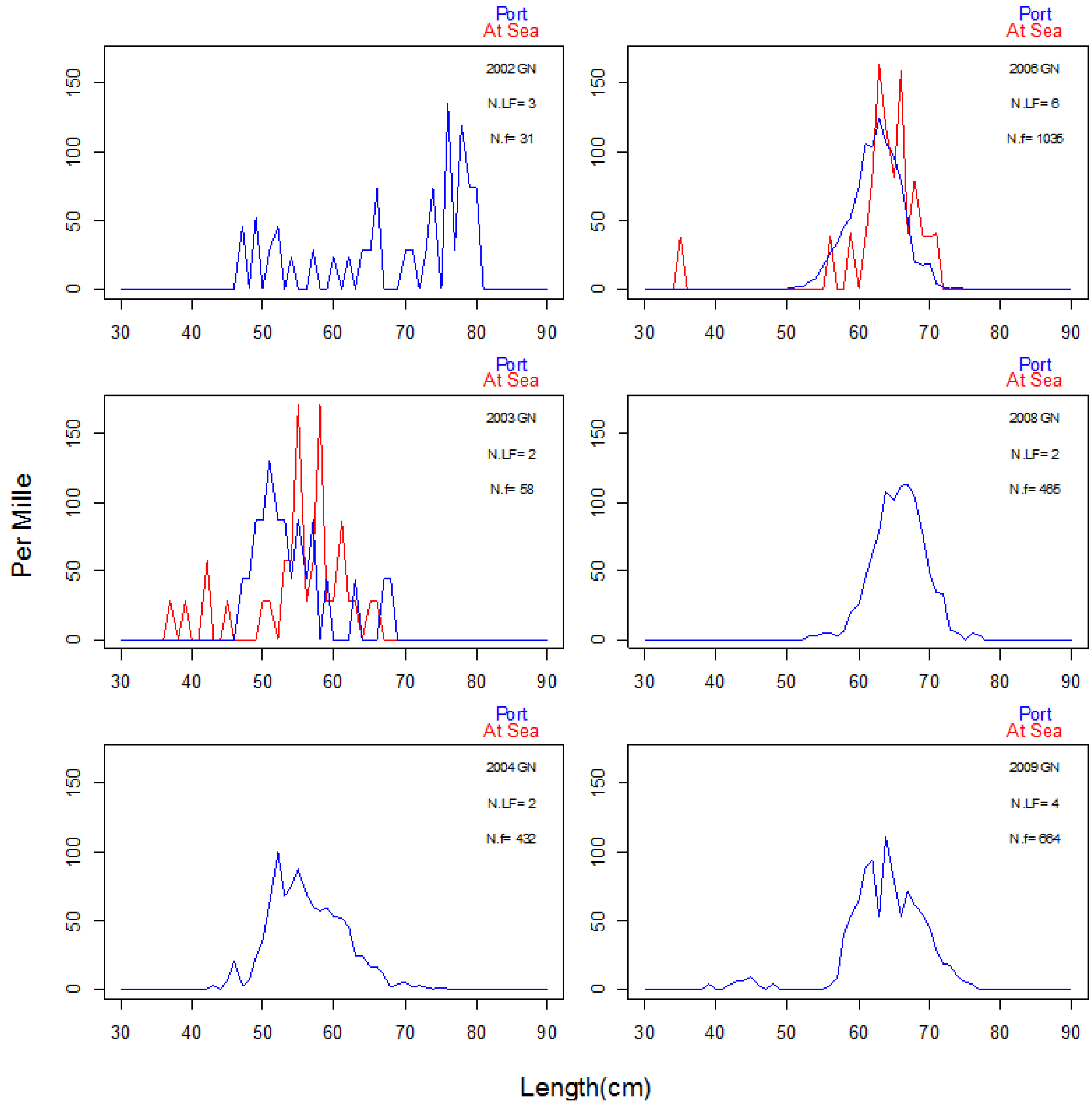

Figure 6. Length frequencies (per mille) of Haddock in Subdiv. 3Ps from port samplers (blue) and observers (at sea; red) from 2000-09 (no data collected in 2005 or 2007) from gillnet fisheries.

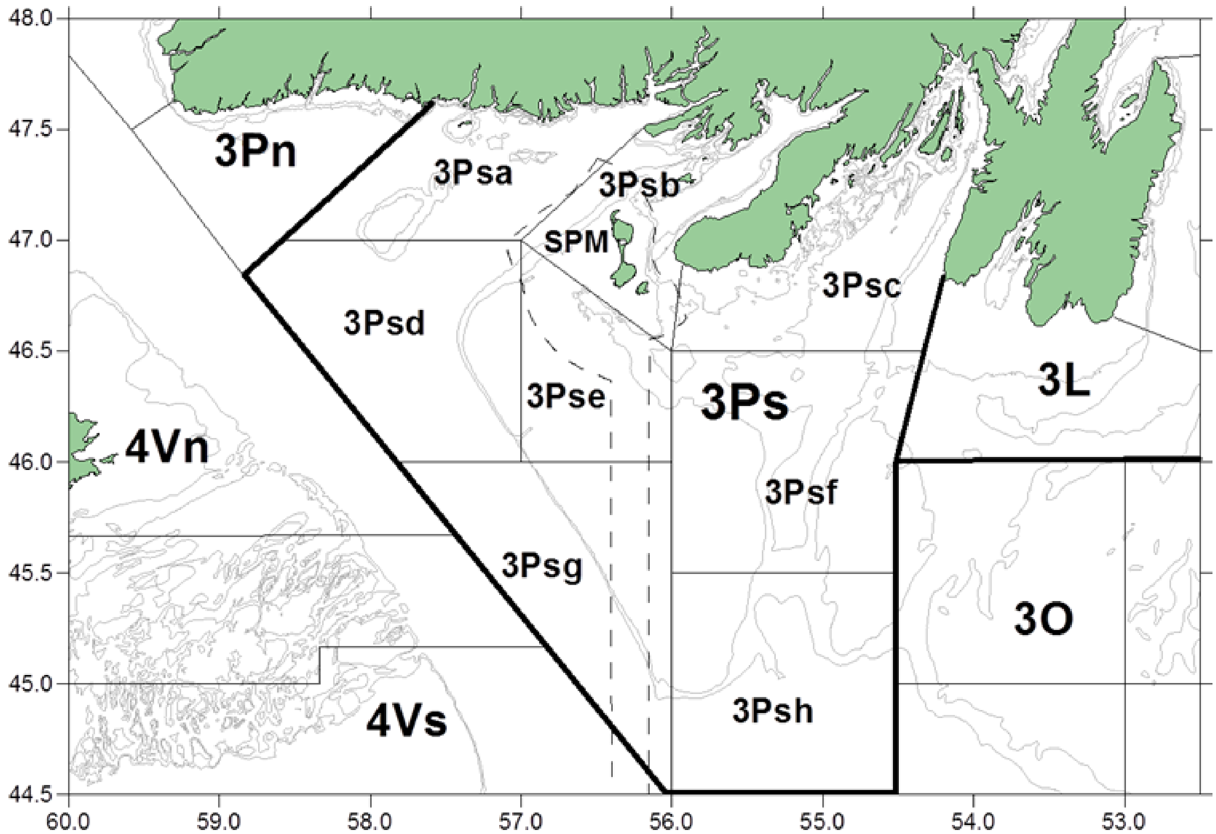

Figure 7. Map of NAFO Subdiv. 3Ps showing the unit areas within the Subdivision as well as the 100 m, 200 m, and 1000 m depth contours.

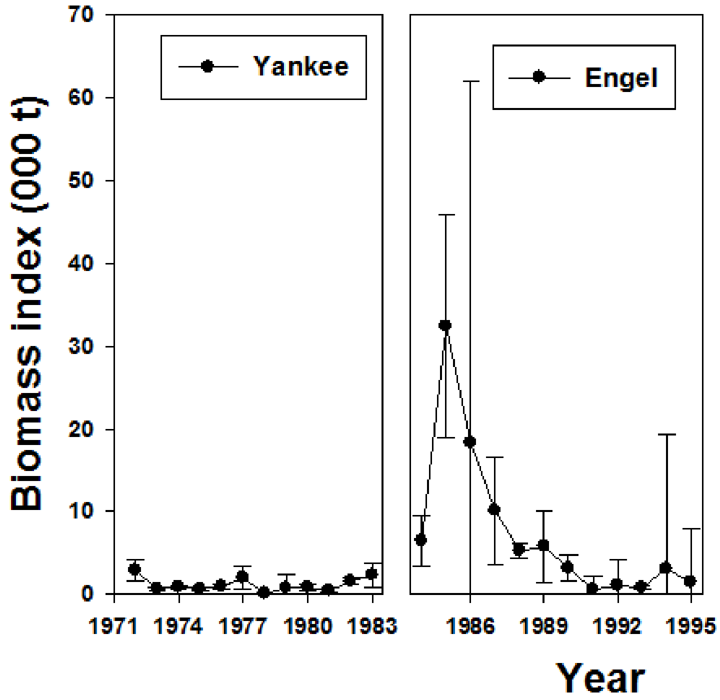

Figure 8. Biomass index for Subdiv. 3Ps Haddock in the Canadian spring research vessel survey from 1972 to 2013. Data are not converted between gear types. 95% confidence intervals are shown. Data from 1972-95 taken from Murphy and Bishop 1995.

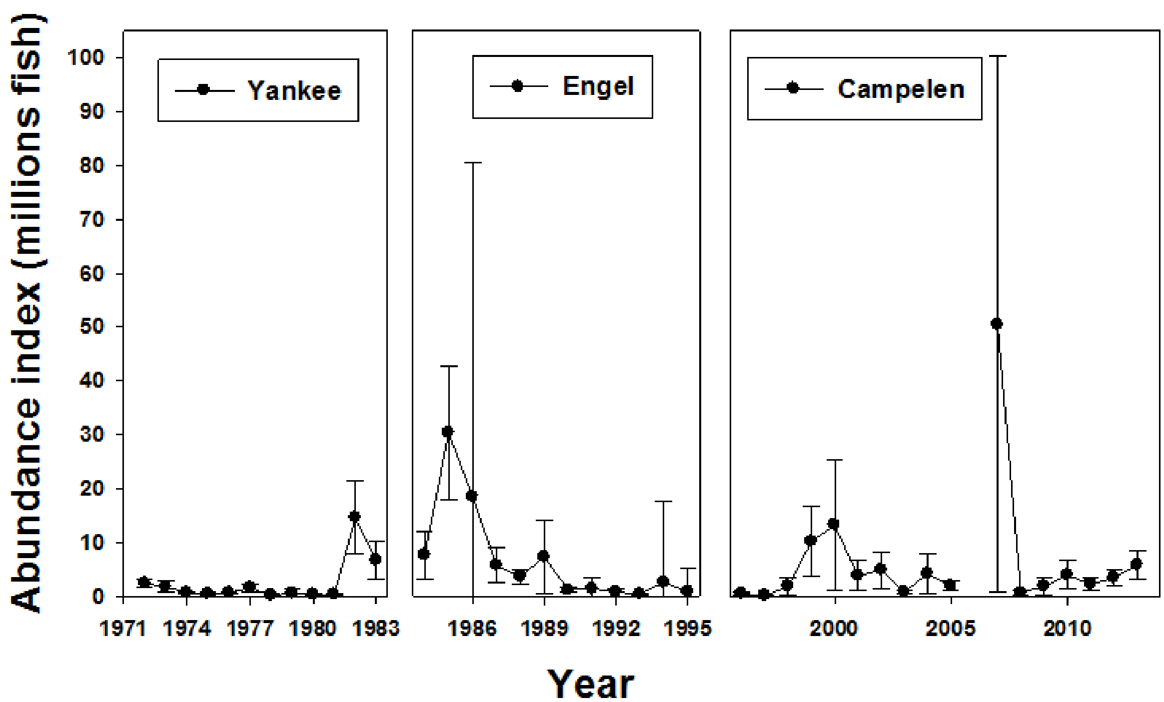

Figure 9. Abundance index for Subdiv. 3Ps Haddock in the Canadian spring research vessel survey from 1972 to 2013. Data are not converted between gear types. 95% confidence intervals are shown. Data from 1972-95 taken from Murphy and Bishop 1995.

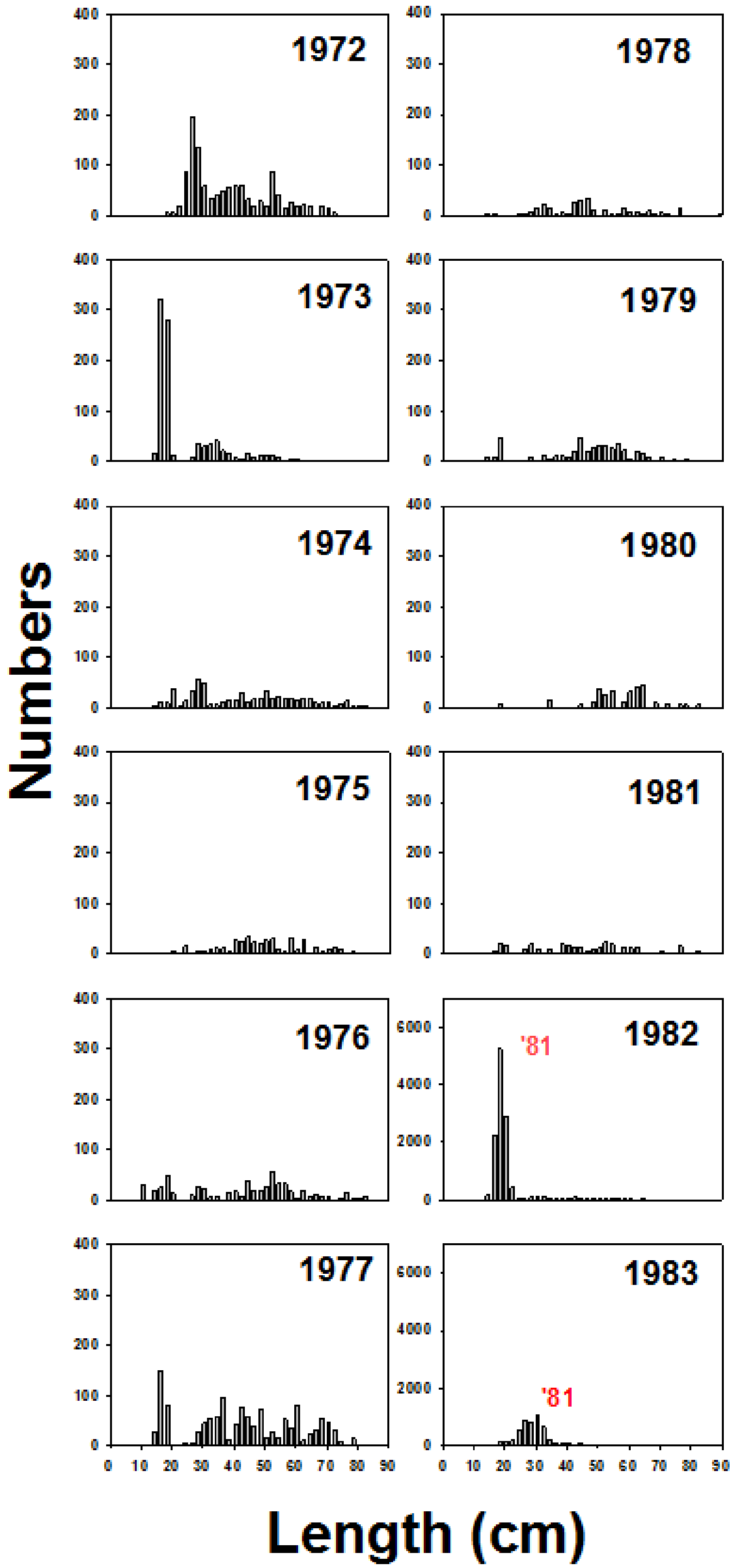

Figure 10. Length frequency distributions for Subdiv. 3Ps Haddock in the Canadian spring research vessel survey from 1972-83 using Yankee gear data. Please note the different scales on each plot.

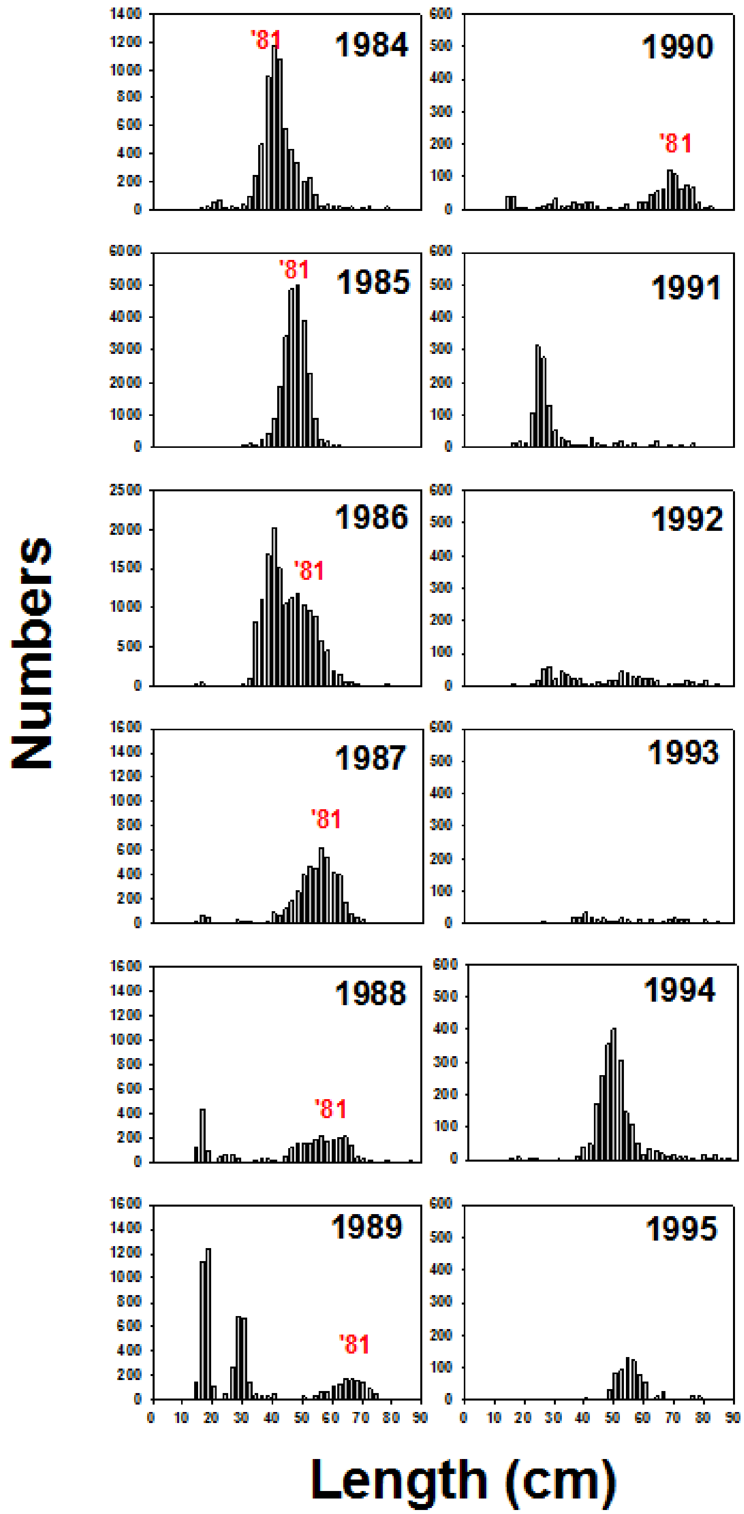

Figure 11. Length frequency distributions for Subdiv. 3Ps Haddock in the Canadian spring research vessel survey from 1984-95 using Engel gear data. Please note the different scales on each plot.

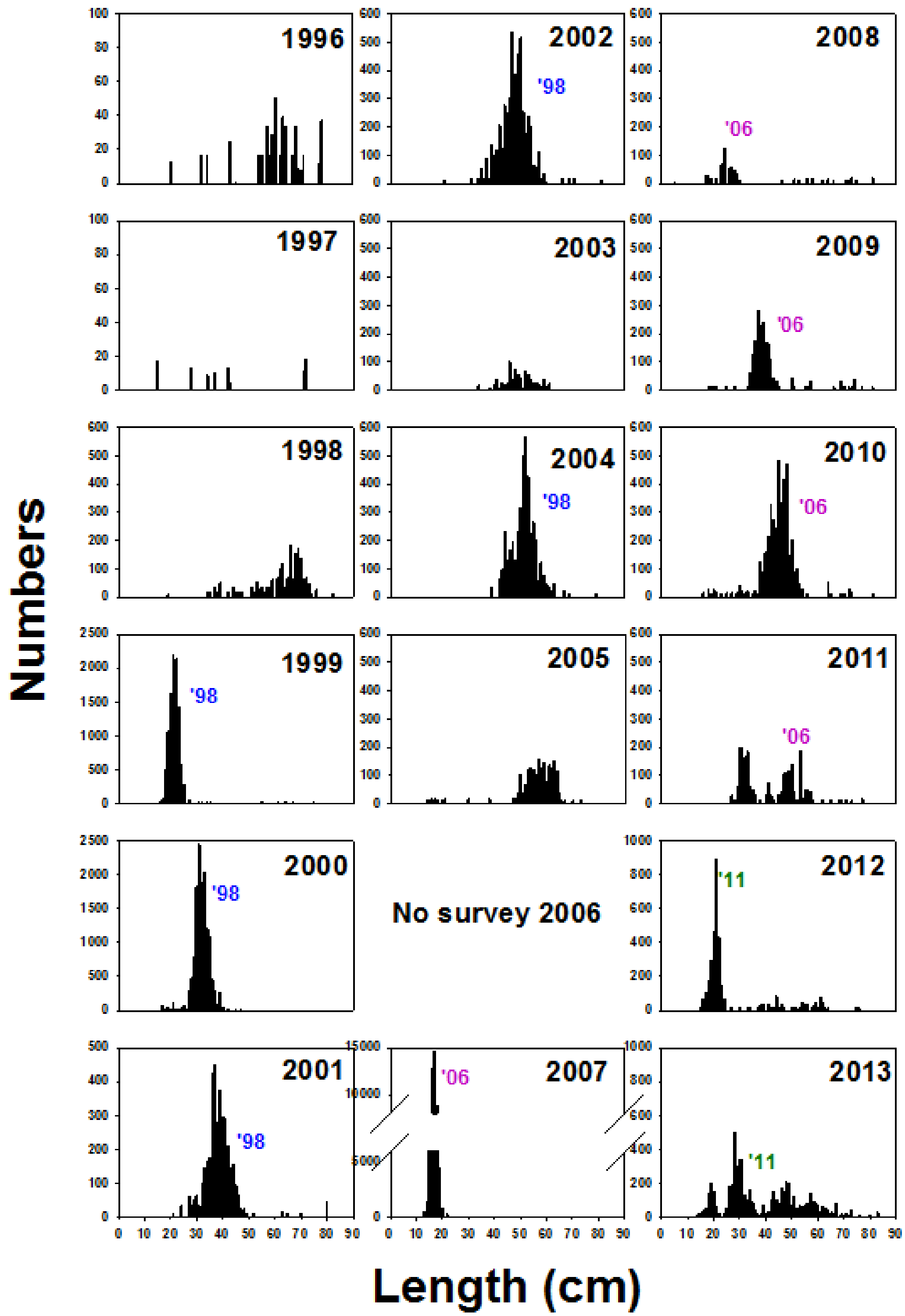

Figure 12. Length frequency distributions for Subdiv. 3Ps Haddock in the Canadian spring research vessel survey from 1996-2013 using Campelen gear data. Please note the different scales on each plot.

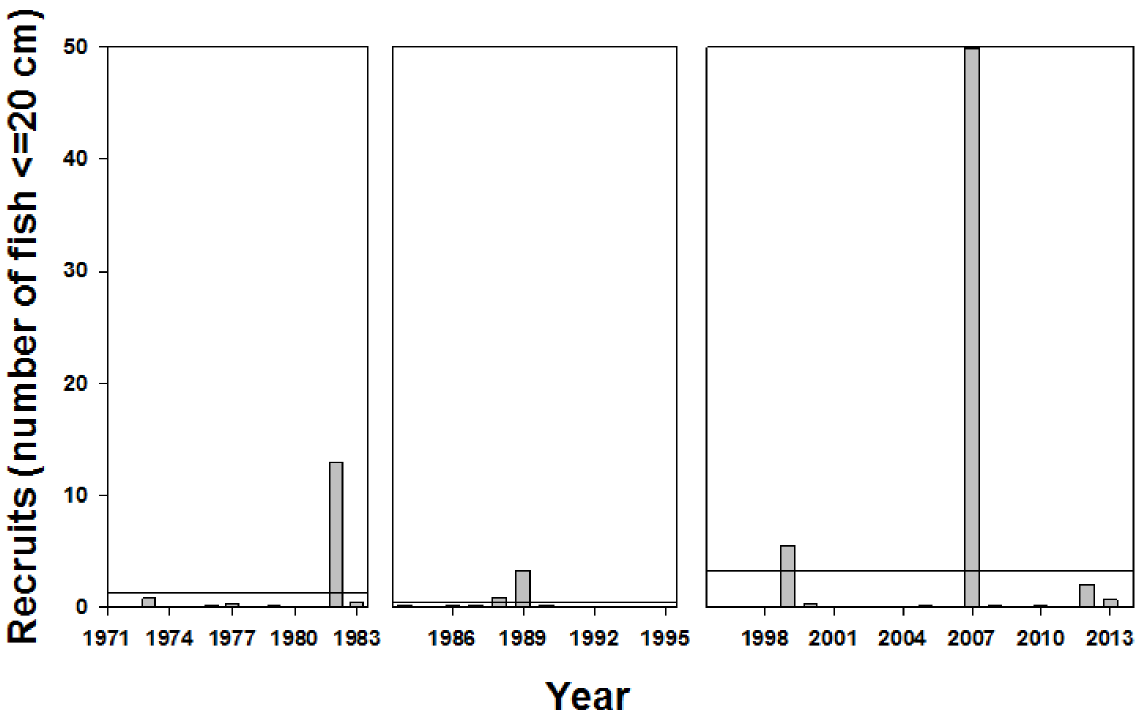

Figure 13. Recruits (as measured by numbers of fish less than 20.5 cm) from 1972-2013.

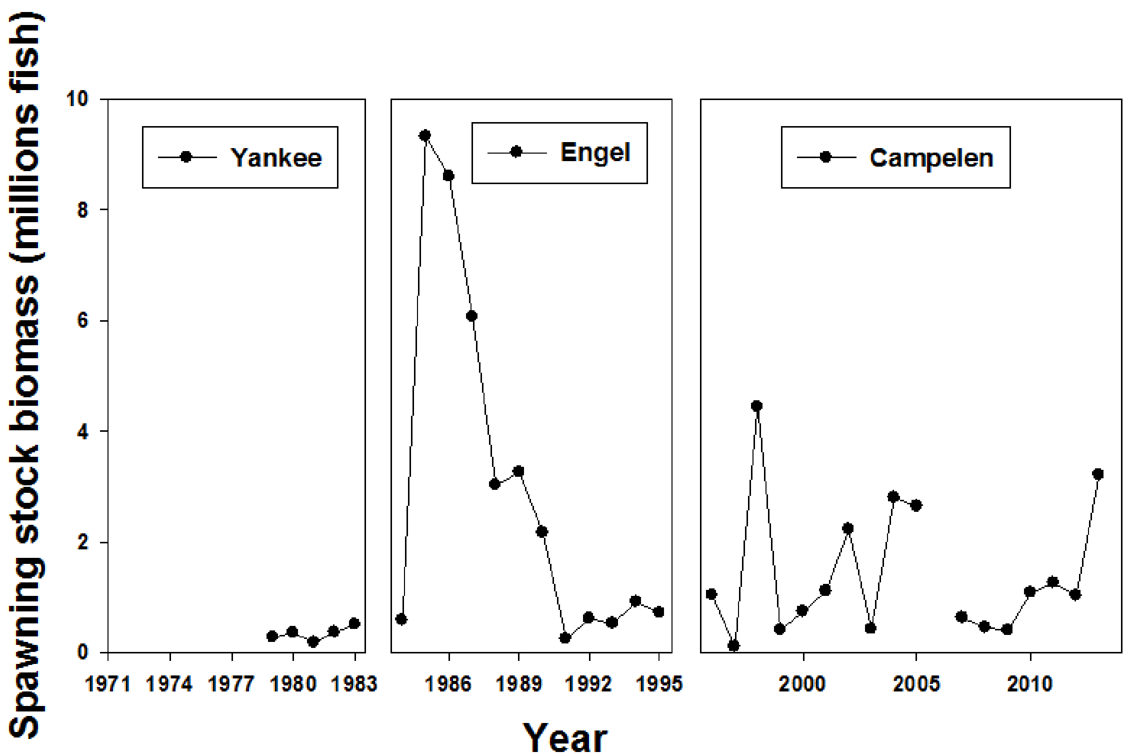

Figure 14. Spawning stock biomass (upper panel) from 1979-2013. Data are not converted between gear types.

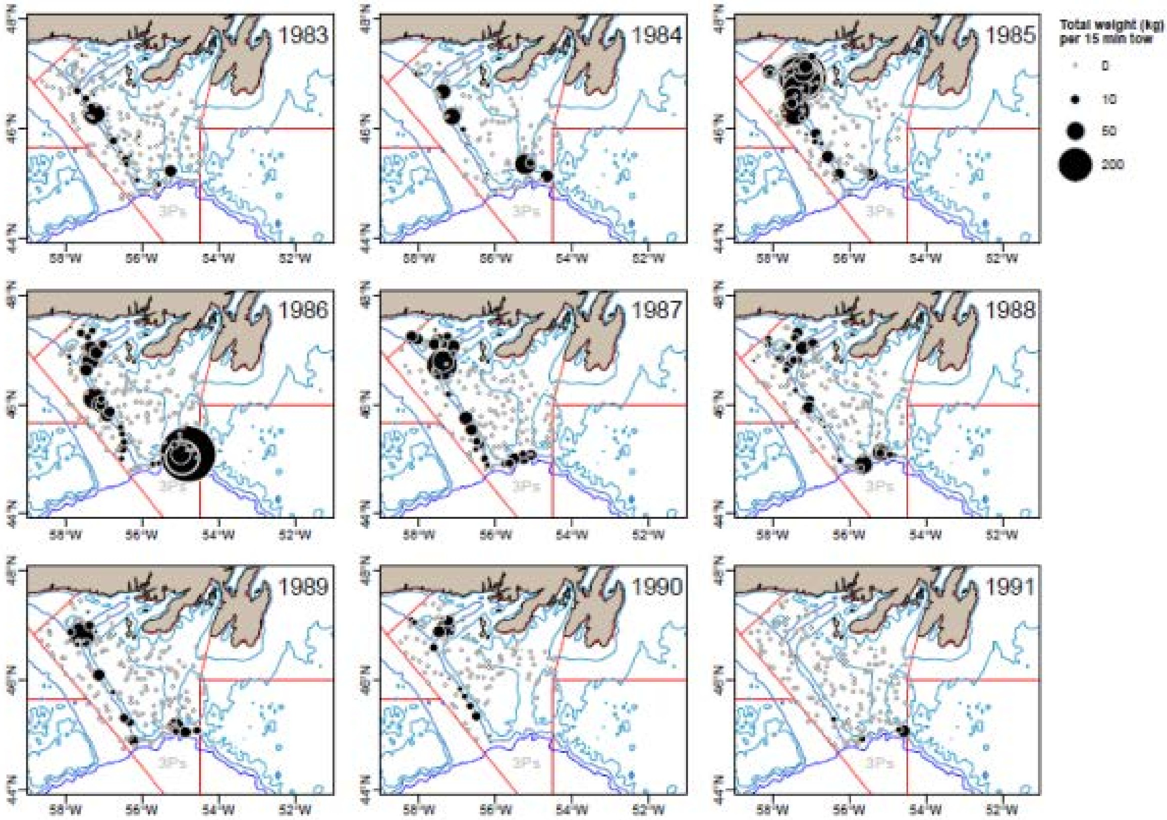

Figure 15. Distribution of Subdiv. 3Ps Haddock biomass in the Canadian spring research vessel survey from 1983-91.

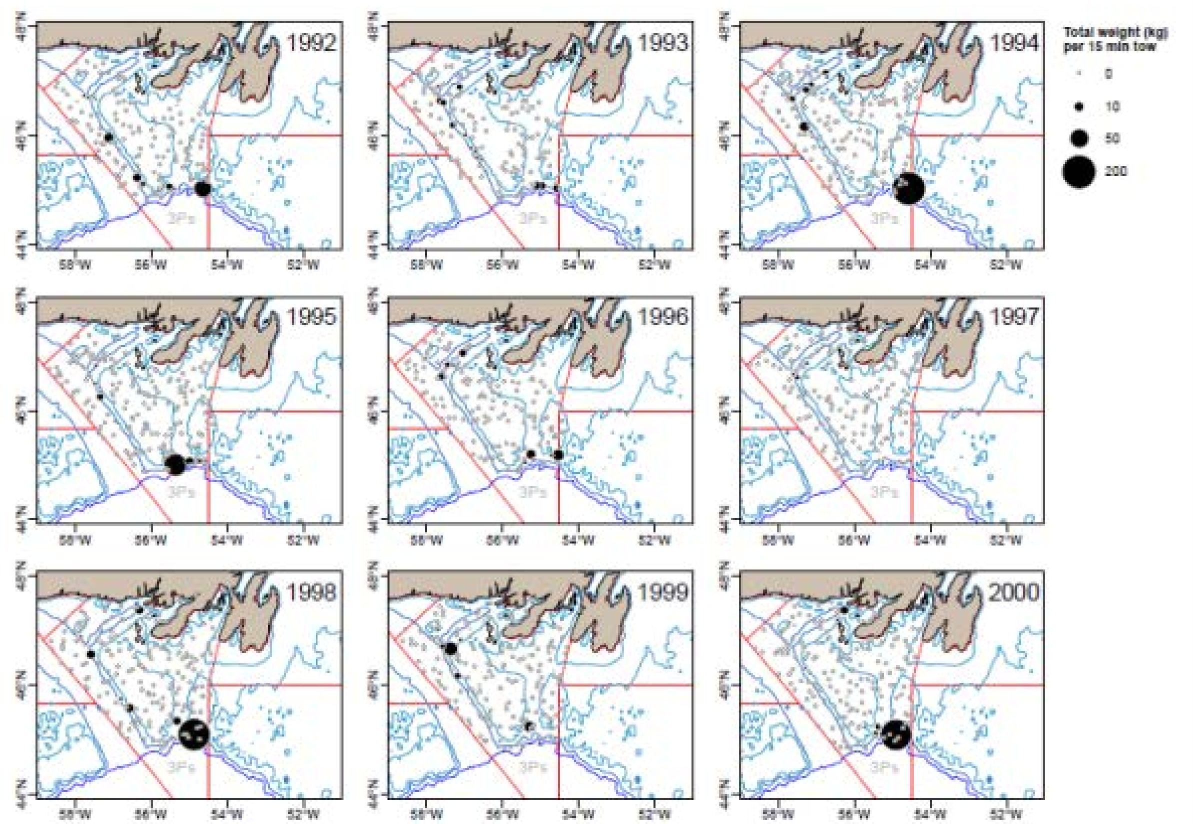

Figure 16. Distribution of Subdiv. 3Ps Haddock biomass in the Canadian spring research vessel survey from 1992-2000.

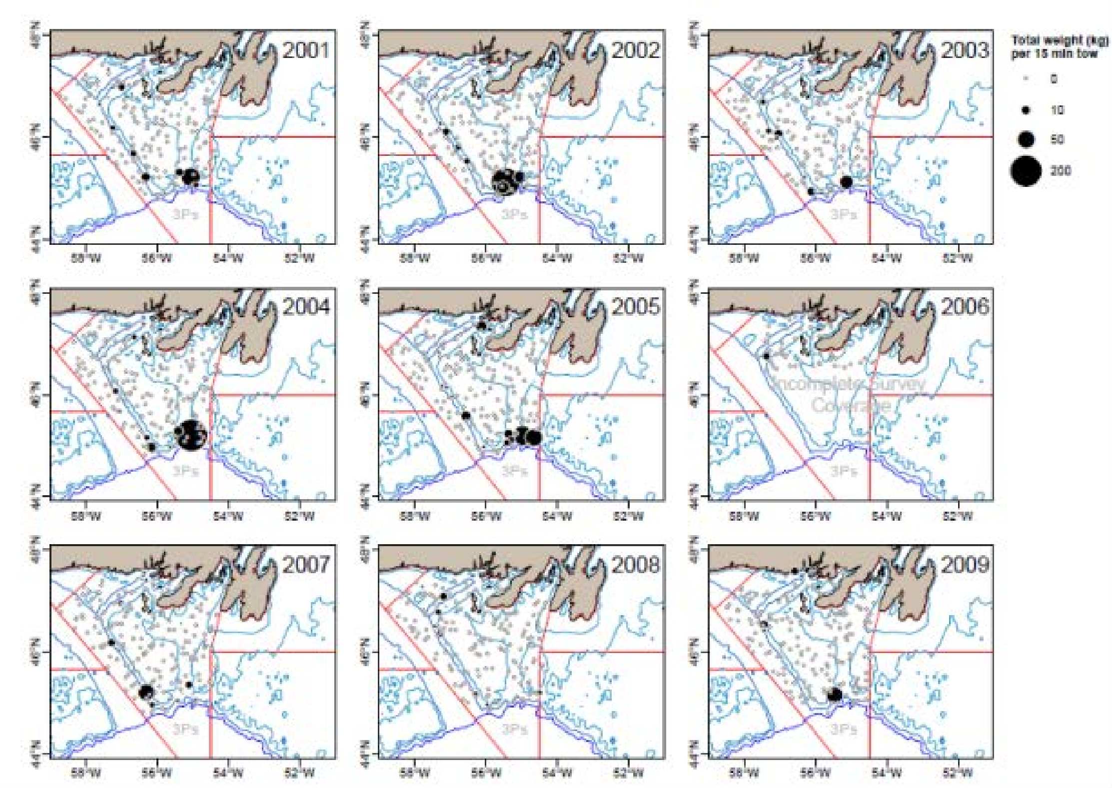

Figure 17. Distribution of Subdiv. 3Ps Haddock biomass in the Canadian spring research vessel survey from 2001-2009. The 2006 survey was incomplete.

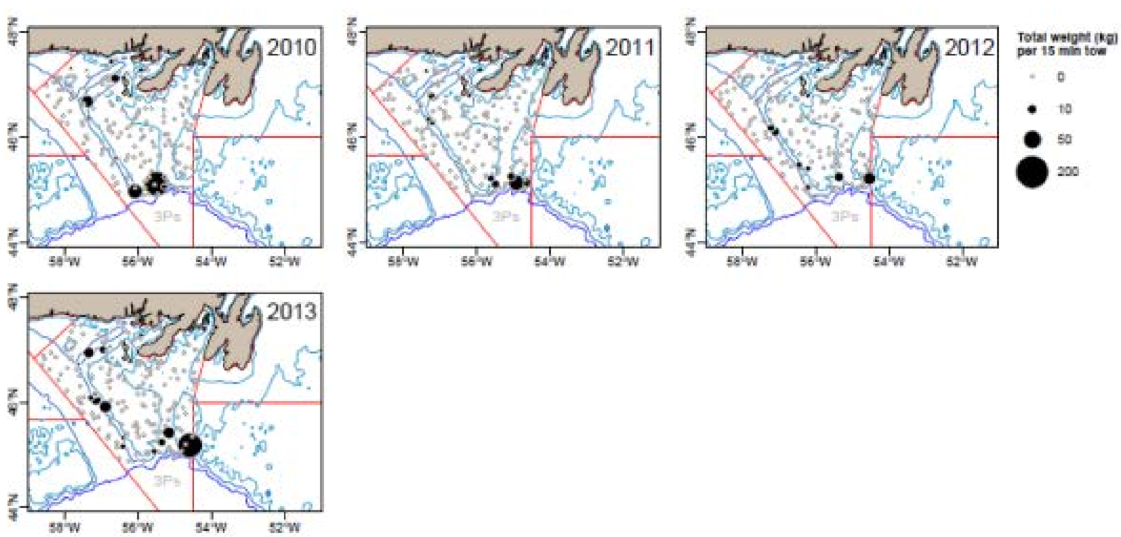

Figure 18. Distribution of Subdiv. 3Ps Haddock biomass in the Canadian spring research vessel survey from 2010-13