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**An Assessment of White Hake (*Urophycis tenuis*, Mitchill 1815)
in
NAFO Divisions 3NO, and Subdivision 3Ps**

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ABSTRACT

White Hake in Divisions 3NO and subdivision 3Ps inhabit the southern Grand Bank and St. Pierre Bank of Newfoundland & Labrador. The stock has persisted at very low levels since 2002. The spring index for Div. 3NOPS peaked in 2000, due to a very large 1999 year-class. However, average catch which was at its lowest levels from 1995-2001 (455 tons) increased to 6 752 tons in 2002 and 4 841 tons in 2003 following recruitment of the large 1999 year-class. From 2002 to 2008, the population has exhibited very poor recruitment as indicated by staged abundance analysis. Recovery of White Hake in 3NOPS will require a number of relatively strong year-classes that survive to maturity, rebuilding the spawner biomass.

INTRODUCTION

White Hake (*Urophycis tenuis*, Mitchill 1815) is a highly fecund, demersal gadoid species distributed in the Northwest Atlantic from Cape Hatteras to southern Labrador. Present knowledge of its biology for the Grand Banks has been summarized in previous assessments of this species (Kulka and Miri 2007).

Formerly one of the commercially important species in the Gulf of St. Lawrence (NAFO Division 4T) and the Scotian Shelf (Div. 4VWX and 5), White Hake stocks have declined in those regions in recent years. Their status as a commercial resource has been assessed most recently by the Department of Fisheries and Oceans Canada (2005) for the southern Gulf of St. Lawrence (Div. 4T), and by Bundy and Simon (2005) for Div. 4VWX/5.

An assessment of White Hake in NAFO Divisions 3NO and Subdivision 3Ps (Figure 1) is presented in this paper, focusing on the available fishery data and research survey information.

Fisheries and Management

A. TAC Regulation

White Hake in NAFO Divisions 3NO came under quota regulation in September 2004, when the Fisheries Commission decided that a TAC of 8 500 mt be established for 2005-2007. This allocation was between Canada at 2 500 mt, the EU at 5 000 mt, Russia at 500 mt, and remaining NAFO member countries at 500 mt. This TAC was maintained at 8 500 mt for 2008-2009.

B. Catch Trends

Reported catches of White Hake in Div. 3NO (all countries combined) peaked in 1985 and 1987 at approximately 8 100 tons, with about half of that reported by non-Canadian sources as bycatch, then declined to an average of 2 090 tons from 1988 to 1994 (Table 1, Fig. 2). With the restriction of fishing by other countries to areas outside Canada's 200-mile-limit (Div. 3NO in the NRA) in 1992, reported non-Canadian catches fell to zero. Average catch of White Hake in Div. 3NO was at its lowest in 1995-2001 (455 tons), but increased to 6 718 tons in 2002 and 4 823 tons in 2003. Catches declined to an average of 936 tons in 2004-2008 (Table 2). Although 87% of the total reported catches of White Hake in Div. 3NO (NRA) were taken as a target species by other countries in 2002-2003, Canada has taken a majority of catches in 2005-2008 (up to 89% in 2008); due to an absence of a White Hake-directed fishery by other countries during that period.

Catches in Subdivision 3Ps were less variable: averaging 1 114 tons in 1985-93, then decreasing to an average of 668 tons in 1994-2003. Subsequently, catches increased to an average of 1 397 tons in 2004-2007, and were at their lowest in 2008 (595 tons).

Size

Length distributions of White Hake taken in Canadian commercial directed fisheries in NAFO Div. 3O from 2005-2008 indicated that gillnets captured 32-104 cm fish (Mode~74 cm, Fig. 3a). Canadian longlines in Div. 3O caught larger White Hake, in the 41-111 cm range, Mean= 82 and 75 in 2007 and 2008 respectively (Fig. 3b). In Subdiv. 3Ps, Canadian longlines captured 39-105 cm fish with a mean length of 72 and 66 cm mode in 2008 (Fig. 3b).

Commercial bycatch of White Hake by Russian trawlers in the NRA of Div. 3NO in 2006-2007 contained 21-90 cm fish with a mean length of 53 cm (Fig. 4). In addition, Russia observed a peak of 24-36 cm White Hakes (mode at 27 cm) in 2006, and a main peak of 51-69 cm (mode of 63 cm) in the following year. Russia did not sample commercial White Hakes in 2008. Portuguese trawl fisheries (130 mm mesh) in the NRA of Div. 3NO in 2006-2007 captured very similar White Hakes as bycatch: 23-76 cm fish in 2006 (mean of 49 cm); and 26-65 cm fish in the following year (mean of 45 cm; main mode at 40 cm). In 2008, EU-Portugal collected only one sample of 31 trawled fish (range: 38-58 cm; mean: 48 cm), which precludes any conclusions to be drawn from it. EU-Spain did not sample White Hake bycatch from its commercial trawl fisheries in 2005-2008.

C. Research Vessel Surveys

Canadian Research Vessel Surveys -Spring

Stratified-random demersal surveys have been conducted by Canadian research vessels in the spring (April-June) of each year from 1971 to the present. The most significant alterations in Canadian standardized survey design are changes in survey gear. The spring survey can be separated into three time periods, based on the trawl used in each period: 1971-1983 (Yankee 41.5), 1984-spring 1995 (Engel 145), and spring 1996 to the present (Campelen 1800; see McCallum and Walsh 1996). McCallum and Walsh (1996) and Walsh and McCallum (1996) described the geometry and specifications of the Engel and Campelen gears. In addition to gear dimensions, the mesh size is different: 160 mm in the bellies and codend for Engel trawls, and 40 mm for Campelen gear. No size-based conversion factors for the two gears were derived from comparative surveys for White Hake; therefore, catch rate data and resulting biomass and abundance indices cannot be directly compared between both trawl types. Furthermore, an examination of Canadian research survey frequencies indicates differences in White Hake catchability at size (Kulka *et al.* 2005b). Similarly, no conversion factor exists for White Hake between the Yankee and Engel trawls.

In the 2006 Canadian spring survey, most of Subdivision 3Ps was not surveyed, and only shallow strata in Div. 3NO (to 77 m in Div. 3N; to 103 m in Div. 3O) were surveyed; due to Canadian research vessels' mechanical difficulties. Thus survey estimates for that year are not comparable to others in the Campelen time series.

Spring Survey Biomass and Abundance Indices

Spring survey estimates of relative biomass and abundance are presented in Table 3a for NAFO Divisions 3NO and Subdiv. 3Ps. Mean weights and numbers per tow with confidence intervals are presented in Figure 5a.

Following a decline in the early 1990s, relative biomass of White Hake on the Grand Banks increased rapidly in 1999-2000 to about 26 000 t, but then steeply declined and is presently at the lowest level observed in the Canadian Campelen survey years.

Canadian Research Vessel Surveys -Autumn

Stratified-random autumn demersal surveys have been conducted by Canada in NAFO Divisions 3NO from 1990 to the present. Beginning in autumn 1995, Canadian survey gear was changed from the Engel 145 otter trawl to the Campelen 1800 shrimp trawl. In addition, Canada does not survey Subdivision 3Ps in autumn. Therefore, autumn survey data are not directly comparable to spring survey data. Because the autumn series is not spatially complete over the designated stock area, Canadian spring surveys are used as the primary estimator of biomass and abundance trends for White Hake. It must also be noted that, due to Canadian research vessels' mechanical difficulties, deep strata in Div. 3NO were not surveyed in 2003, 2004, and 2006, and strata deeper than 730 m in the survey area were not surveyed in 2008.

Autumn Survey Biomass and Abundance Indices

Autumn biomass and abundance estimates (1990-2008) are restricted to Div. 3NO. These indices show a large increase in Div. 3NO between 1998 and 1999 (Table 3b, Fig. 5b); due mainly to the presence of large numbers of 1-year-old fish. Relative biomass in these areas doubled and abundance increased by 10 times. Of particular interest is the large increase in biomass in Div. 3N to levels never previously observed. The biomass index has drastically declined since 1999. The pattern of Campelen autumn indices is offset by one year (earlier) as compared to that from spring surveys, because autumn surveys catch newly settled Young-of-the-Year (YOY) that were spawned in the previous spring (Kulka *et al.* 2005b). About twenty-five weeks later, the next spring survey picks up the previous year's cohort as 1-year-olds. This pattern was most apparent when larger year classes were produced, such as in 1999. After 2003, biomass and abundance indices declined to low levels similar to those observed in 1995-1998.

EU-Spain Div. 3NO Spring Surveys

Spain initiated a survey of the NAFO Regulatory Area (NRA) of Div. 3NO in 1995. Initially, the survey was carried out in spring with the C/V *Playa de Mendiña* using a Pedreira bottom trawl. Since 2001, the R/V *Vizconde de Eza* replaced the C/V *Playa de Mendiña*, and a Campelen 1800 trawl replaced the Pedreira (González-Troncoso and Paz 2008). Results of this survey are available for White Hake from 2001 onward.

Spanish biomass indices were highest in 2001, declined to 2003, increased to a small peak in 2005, then declined to its lowest level in 2008. This trend is similar to that depicted by Canadian spring surveys which cover all of Div. 3NO; although the latter trend appears to include a peak in 2006 (Fig. 6). Both trends are also reflected in abundance at length data from Spanish and Canadian spring surveys (Fig. 7): the 2005 peak observed by Spain consisted primarily of 52-71 cm White Hakes with modes at 53, 58 (mainly), 62, 66, and 70 cm, while a small peak of 14-27 cm fish (1-year-olds; as described by Kulka *et al.* 2005a) appeared with modes of 14, 20, and 26 cm (although Canada caught a larger amount of young-of-the-year). These YOY represent the 2004 cohort. The 2006 peak observed by Canada consisted primarily of 36-46 cm White Hakes with a main mode of 42 cm; and probably included the 2004 cohort. Although abundance at length declined almost to zero in the 2008 Spanish survey of the NRA (Div. 3NO), a very small amount of 14-26 cm White Hakes was observed by Canada in addition to small numbers of 27-61 cm fish.

Catch/ Biomass Ratios

Using STACFIS-agreed commercial catch and Canadian spring survey biomass index, estimates of Relative F were calculated for White Hake in Div. 3NO and Div. 3NOPs. Relative fishing mortality (Rel. F = commercial catch/Can. spring biomass) declined to its lowest level in 1999-2001, increased to a high peak in 2002-2003, then declined to a low level in 2008 (Fig. 8). Relative F was higher in Div. 3NO than in Subdiv. 3Ps during 2002-2003, because of new directed fisheries for White Hake by EU-Spain, EU-Portugal, and Russia; coupled with very low recruitment after 1999.

D. Biological Studies

Stage-based Analysis

Maturity analysis from data collected by Canadian Campelen spring surveys in 1996-2008 indicated that length at 50% maturity is different between sexes; but similar among years and between areas (Div. 3NO *versus* Subdiv. 3Ps; Fig. 9). Females reach 50% maturity at 54 cm (52-56 cm; 1996-2008), and males do so at 38 cm (37-39 cm; 1996-2008).

Information on White Hake abundance by life stage from Canadian spring surveys are presented for 2004-2008 in Figure 10. White Hake in their first year correspond to lengths <26 cm, while 27-57 cm represents age 2+ juveniles, and 58+ cm fish are primarily mature adults (Kulka *et al.* 2005a). In the Upper Panel (Fig. 10), a 2004 cohort appeared as a peak of 1-year-olds in 2005, and as a peak of 2+ juveniles in 2006. Note that the almost zero values in Subdiv. 3Ps resulted from the fact that this area was not surveyed in spring 2006; due to Canadian research vessels' mechanical difficulties. In the Lower Panel, almost all of the Year Class-1 White Hakes were found in Div. 3NO. Except for a peak in 2006, 2+ juveniles were observed almost equally in Div. 3NO and in Subdiv. 3Ps for 2004-2008. For mature White Hakes (58+ cm), percent abundance was higher in Div. 3NO relative to the entire area of Div. 3NOPs. These three observations were similar to those reported for 1997-2003 by Kulka *et al.* (*ibid.*).

Partitioned by sex, relative numbers at length data from Canadian spring surveys of Division 3NO in 2005-2008 indicate that the peak of 1-year-olds observed in 2005 (16-28 cm) contained a majority of male White Hakes, with only 16% females (Fig. 11a). In addition, a small peak of 53-59 cm males was observed in 2005 (modes at 53 and 58); with a smaller number of females ranging from 51 to 86 cm in length. The 2006 peak noted previously consisted of 58% males 33-45 cm long, and 42% females 36-47 cm in length. Furthermore, a small number of males ranged between 53 and 78 cm; while females were observed between 50 and 94 cm. In 2007, 51% of the relative abundance was male, while 49% was female (no peaks). A small number of 1-year-olds (15-28 cm) was observed in 2008; containing 79% males and 21% females. In Subdivision 3Ps, 46% of the relative abundance in 2005 was male; with a main peak of 32-38 cm (main mode of 37 cm), and a small one at 55-61 cm (60 cm mode; Fig. 11b). Females in 2005 were observed primarily in a peak at 39-47 cm (45-47 cm mode). Data were not available for 2006 due to mechanical difficulties on Canadian research vessels. In 2007, 2 peaks of females were obvious: one at 44 cm in length, and another at 52-62 cm. Males comprised 37% of the 2007 survey results; with mainly 46-51 cm and 62-67 cm fish. Peaks of females were again observed in 2008: a small one at 30-32 cm in length, one at 37-45 cm, and a predominant one at 51-60 cm. Males constituted 41% of the 2008 results; with primarily 36-49 cm fish.

Stage-based analysis of abundance from Canadian spring surveys in Div. 3NOPs for 2004-2008 indicated that immature White Hakes (sexes combined) older than one year comprised the dominant component of the population (Fig. 12); similar to what was observed for this stock in the years prior to 2000 (Kulka *et al.* 2005b). A peak of young-of-the-year fish (sexes combined) was observed in 2005; depicting the 2004 cohort. In 2008, female spawning stock abundance declined to a low level not previously observed.

Recruits per spawner varied between 0.07 and 1.6 fish for each adult female in 2004-2007 (Fig. 13); with the largest value of that period occurring in 2004. However, the latter appears insignificant when compared to two large values observed over the whole time series: 13.5 recruits per spawner in 1998, and 35 in 1999 (see Kulka *et al.* 2005b for details on the latter).

E. Stock Distribution

White Hake in NAFO Div. 3NO and Subdiv. 3Ps are confined largely to an area associated with the warmest bottom temperatures (4-8°C) along the southwest fringe of the Grand Banks, edge of the Laurentian Channel and the south-west coast of Newfoundland (Kulka *et al.* 2005a).

Distributions of White Hake in Div. 3NOPs for 2007 and 2008 are shown in Figure 14. As in previous years, the stock continues to occupy shelf edge areas of Div. 3NO. In Subdiv. 3Ps, White Hake are distributed along the shelf edge, and the Laurentian and Hermitage Channels.

F. Assessment Results

Precautionary Reference Points

No precautionary reference points have been established for this stock.

Resource Status

Spring survey indices indicate that the White Hake stock size remains very low. From 2003 to 2006, the NAFO Division 3NOPs population remained at a low level, which further declined in 2007 to the lowest value observed in the Canadian Campelen time series. In 2008, the population of White Hake in Div. 3NOPs appears to have rebounded slightly to the very low levels observed in 2003-2006. This very low stock biomass is also indicated in the EU-Spain Div. 3NO spring survey, in which current biomass is the lowest observed for that index.

Age-structured assessment of this stock is currently not feasible. However, population abundance at length estimates from spring research surveys suggest that no significant recruitment has occurred for White Hake in Div. 3NO. In fact, there has been extremely low recruitment since 1999.

Given that good recruitment rarely occurs and remains unpredictable for this White Hake population, commercial fishing pressure should be regulated in the NRA of Div. 3NO by a TAC set at a level that will allow survival and growth to maturity of larger year classes. The current TAC of 8 500 tons far exceeds that level.

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Table 1. Reported catches of White Hake by NAFO Division and country (Canada versus other countries), 1985-2008.

Year	3N			3O			3NO		3Ps	3NOPs
	Can	non-Can	All	Can	non-Can	All	STATLANT	STACFIS	STATLANT Can	STACFIS Can + non- Can
1985	101	1,542	1,643	3,301	3,185	6,486	8,129	8,129	1,156	9,285
1986	297	21	318	1,980	1,252	3,232	3,550	3,550	1,242	4,792
1987	1,314	4,019	5,333	1,740	990	2,730	8,064	8,064	1,318	9,382
1988	828	867	1,695	1,115	111	1,226	2,921	2,921	695	3,616
1989	878	5	883	1,169	23	1,192	2,075	2,075	709	2,784
1990	830	228	1,058	1,226	7	1,233	2,291	2,291	1,441	3,732
1991	19	1,507	1,526	1,087	0	1,087	2,613	2,613	1,480	4,093
1992	18	0	18	1,640	0	1,640	1,658	1,658	1,244	2,902
1993	19	0	19	1,035	0	1,035	1,054	1,054	741	1,795
1994	16	20	36	1,977	4	1,981	2,017	2,017	382	2,399
1995	0	5	5	216	1	217	222	222	420	642
1996	0	28	28	490	1	491	519	519	362	881
1997	0	92	92	489	6	495	587	587	315	902
1998	0	81	81	133	8	141	222	222	562	784
1999	44	51	95	314	13	327	422	422	575	997
2000	21	124	145	404	29	433	578	578	1,110	1,688
2001	16	52	68	516	49	565	633	633	930	1,563
2002	0	1,220	1,220	1,013	3,133	4,146	5,366	6,718	918	7,636
2003	0	2,688	2,688	433	3,053	3,486	6,174	4,823	1,108	5,931
2004	6	170	176	375	1,364	1,739	1,915	1,267	1,361	2,628
2005	0	21	21	685	258	943	964	866	1,615	2,481
2006	2	73	75	950	178	1,128	1,203	1,066	1,484	2,550
2007	0	12	12	509	74	583	595	597	1,126	1,723
2008	0	8	8	781	38	819	826	882	595	1,477

Table 2. White Hake STACFIS estimates, STATLANT-21A reported catches, and Total Allowable Catch quotas (000s of tonnes) for NAFO Divisions 3NO and Subdivision 3Ps.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Div. 3NO:										
TAC	-	-	-	-	-	8.5	8.5	8.5	8.5 ³	8.5 ³
STATLANT-21A	0.6	0.6	5.4	6.2	1.9	1.0	1.1	0.6 ¹	0.8 ¹	
STACFIS	0.6	0.6	6.7	4.8	1.3	0.9	1.1	0.6	0.9	
Subdiv. 3Ps:										
STATLANT-21A	1.1	0.9	0.9	1.1	1.4	1.6	1.5	1.1 ¹	0.6 ^{1,2}	

¹Provisional

²Based on ZIF landings (STATLANT 21A not available)

³TAC applicable to 2008 and 2009

Table 3a. Biomass and abundance of White Hake from Canadian Spring research vessel surveys, 1971-2008. Surveys were conducted with a Yankee bottom trawl (1971-1983), an Engel trawl (1984-Spring 1995), and a Campelen trawl (Spring 1996-2008). NAFO Subdiv. 3Ps was not surveyed in 1971, 2006; NAFO Div. 3O was not surveyed in 1971, 1972, 1974, 1983; and NAFO Div. 3N was not surveyed in 1983. Note that deep strata in Div. 3NO were not surveyed in Spring 2006.

Canadian research vessel spring surveys								
Biomass (000s of tonnes)					Abundance (000,000s)			
Year	3N	3O	3Ps	3NOPs	3N	3O	3Ps	3NOPs
Yankee series - unconverted data								
1971	0				0			
1972	354		2,725	3,079	61		1,556	1,618
1973	36	1,532	465	2,033	11	327	247	585
1974	0		5,224	5,224	0		2,055	2,055
1975	0	3,173	4,491	7,664	0	1,080	2,646	3,726
1976	110	5,623	4,778	10,511	32	1,413	3,856	5,301
1977	50	1,339	7,168	8,557	43	466	3,935	4,444
1978	0	6,188	6,774	12,962	0	4,361	4,058	8,420
1979	165	1,978	6,310	8,453	34	1,065	3,077	4,176
1980	0	1,385	3,970	5,356	0	1,015	2,053	3,068
1981	139	96	7,448	7,682	28	93	4,743	4,865
1982	0	1,058	4,283	5,342	0	399	1,340	1,739
1983			0				0	
Engel series - unconverted data								
1984	258	3,531	2,558	6,348	57	1,085	1,179	2,321
1985	46	2,878	5,303	8,227	8	1,315	3,045	4,368
1986	356	2,438	11,105	13,899	70	574	4,186	4,830
1987	43	2,752	9,866	12,661	95	1,114	4,438	5,647
1988	32	5,431	13,005	18,469	63	690	5,533	6,286
1989	0	925	6,884	7,809	0	574	4,130	4,704
1990	0	754	3,988	4,742	0	236	2,941	3,177
1991	0	1,039	4,591	5,630	0	1,118	3,800	4,918
1992	0	1,039	3,008	4,047	0	574	2,699	3,274
1993	0	522	2,929	3,451	0	301	2,670	2,970
1994	0	1,079	2,433	3,512	0	885	2,274	3,159
1995	0	334	2,334	2,668	0	189	2,104	2,294
Campelen series								
1996	4	2,020	6,282	8,306	75	2,982	8,089	11,145
1997	4	2,221	8,507	10,733	91	2,987	12,432	15,510
1998	7	2,205	4,007	6,219	79	2,249	4,765	7,093
1999	20	12,194	8,236	20,450	29	26,010	8,654	34,693
2000	30	15,900	10,294	26,224	716	104,360	11,743	116,819
2001	269	14,908	8,092	23,269	517	39,384	13,792	53,692
2002	96	10,808	10,118	21,022	105	11,334	15,098	26,537
2003	234	7,981	5,762	13,977	176	7,250	6,904	14,330
2004	33	10,369	6,622	17,024	53	8,477	6,977	15,506
2005	20	5,932	5,249	11,201	35	9,725	5,506	15,266
2006	247	12,267		12,514	69	10,370		10,438
2007	2	3,510	2,678	6,190	7	2,734	1,980	4,721
2008	108	4,660	3,633	8,400	23	5,689	3,991	9,703

Table 3b. Biomass and abundance of White Hake from Canadian Autumn research vessel surveys in Div. 3NO, 1990-2008. Surveys were conducted with an Engel trawl (1990-Autumn 1994), and a Campelen trawl (Autumn 1995-2008). Note that deep strata in Div. 3NO were not surveyed in 2003, 2004, 2006, and strata deeper than 730 m in the survey area were not surveyed in 2008.

Canadian research vessel autumn surveys						
Biomass (000s of tonnes)				Abundance (000,000s)		
Year	3N	3O	3NO	3N	3O	3NO
Engel series - unconverted data						
1990	26,559	38,384	64,943	18,122	21,980	40,102
1991	40,929	29,735	70,664	25,260	12,264	37,524
1992	20,858	16,686	37,545	13,989	10,196	24,185
1993	13,987	25,313	39,300	12,840	17,100	29,940
1994	20,059	12,570	32,629	20,720	12,706	33,425
Campelen series						
1995	40,775	44,653	85,428	37,322	30,582	67,904
1996	28,629	36,969	65,598	22,694	45,145	67,839
1997	43,075	58,160	101,235	30,540	50,047	80,587
1998	34,279	39,280	73,558	21,132	29,785	50,917
1999	32,609	42,608	75,217	25,116	31,847	56,963
2000	61,202	40,861	102,063	31,419	39,918	71,336
2001	34,311	62,156	96,466	21,352	42,095	63,448
2002	52,855	40,593	93,449	30,925	24,488	55,413
2003	36,829	46,123	82,952	19,203	34,556	53,759
2004	45,678	26,361	72,039	21,068	32,343	53,411
2005	37,442	61,595	99,037	20,027	30,553	50,580
2006	54,372	50,605	104,977	23,211	27,688	50,899
2007	70,198	56,976	127,174	36,453	29,768	66,221
2008	56,976	83,861	140,836	48,011	40,944	88,955

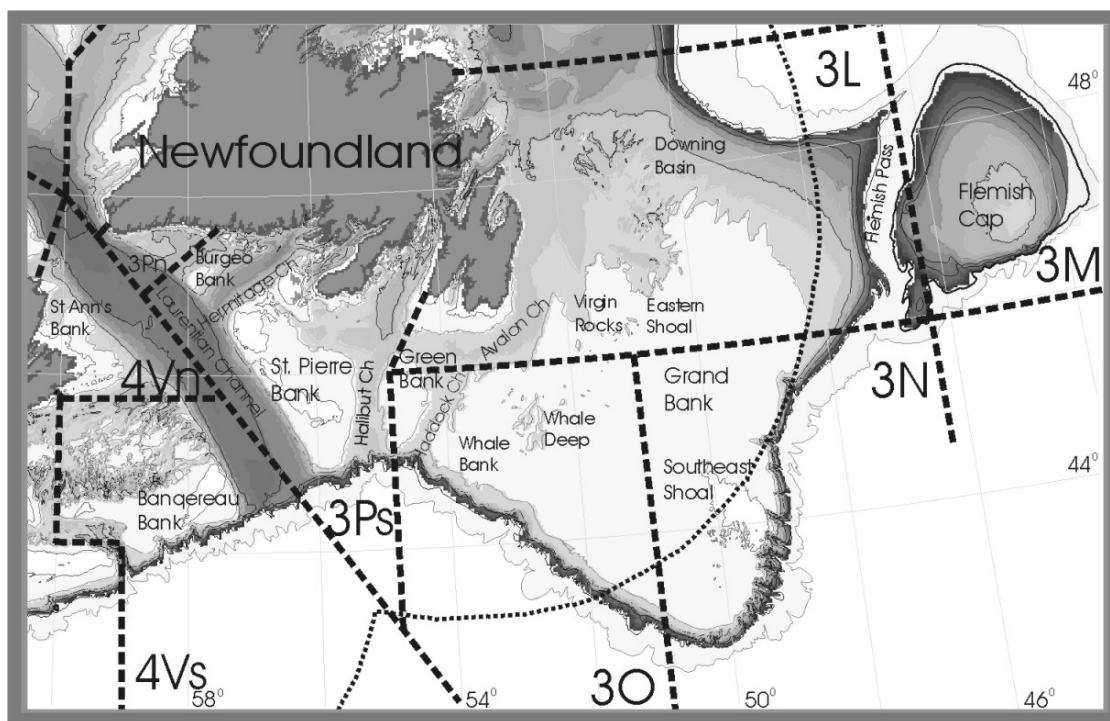


Figure 1. Map of the Grand Banks showing various banks, basins, and NAFO Divisions. Thick dotted lines delineate NAFO Divisions. The thin dotted curved line shows Canada's 200-mile-limit: delineating Canadian territory from the NAFO Regulatory Area.

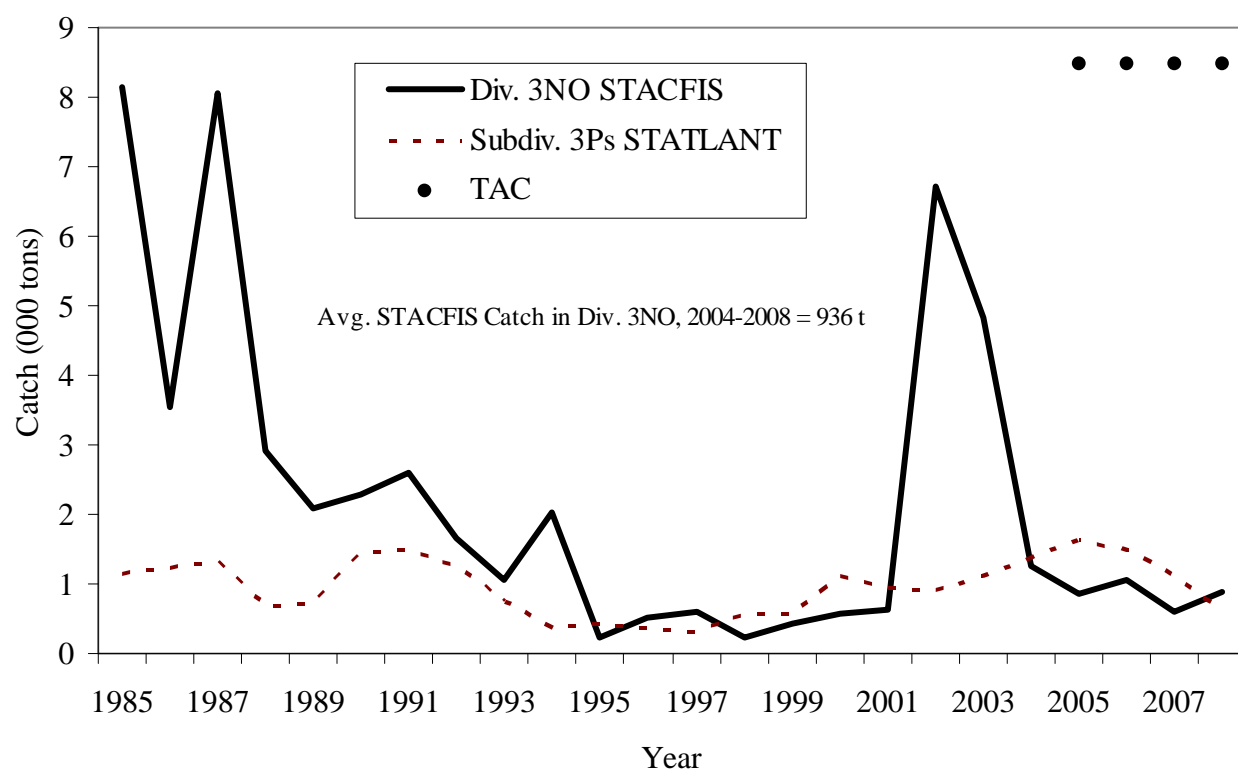


Figure 2. Total reported catch of White Hake for all countries and TAC in NAFO Div. 3NO and Subdivision 3Ps, 1985-2008. Discards are not included.

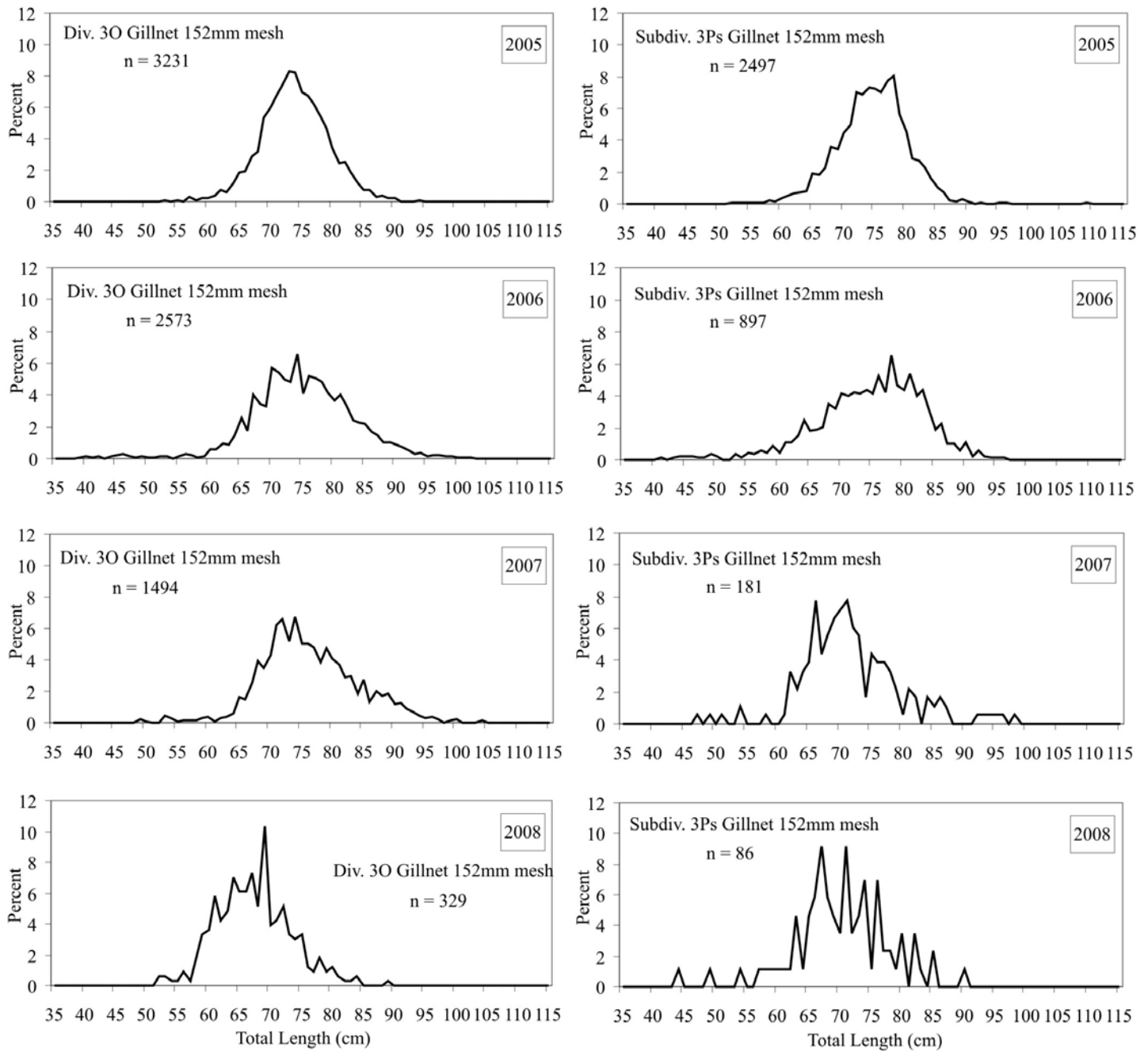


Figure 3a. Size of White Hake caught in NAFO Div. 3O and Subdiv. 3Ps by Canadian commercial gillnets, 2005-2008. Data are from Canadian Fisheries Observers.

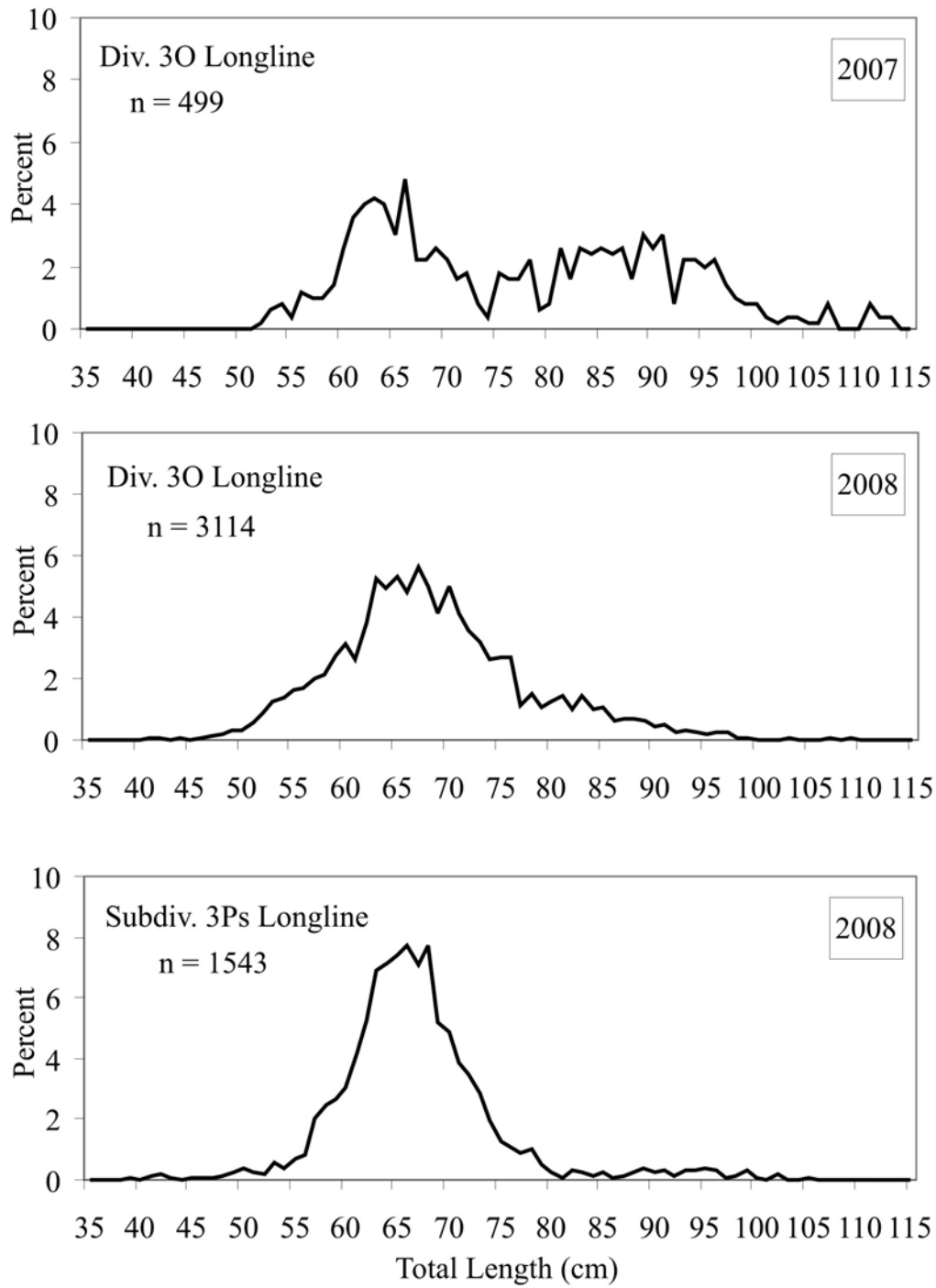


Figure 3b. Size of White Hake caught in NAFO Div. 3O and Subdiv. 3Ps by Canadian commercial longlines, 2007-2008. Data are from Canadian Fisheries Observers.

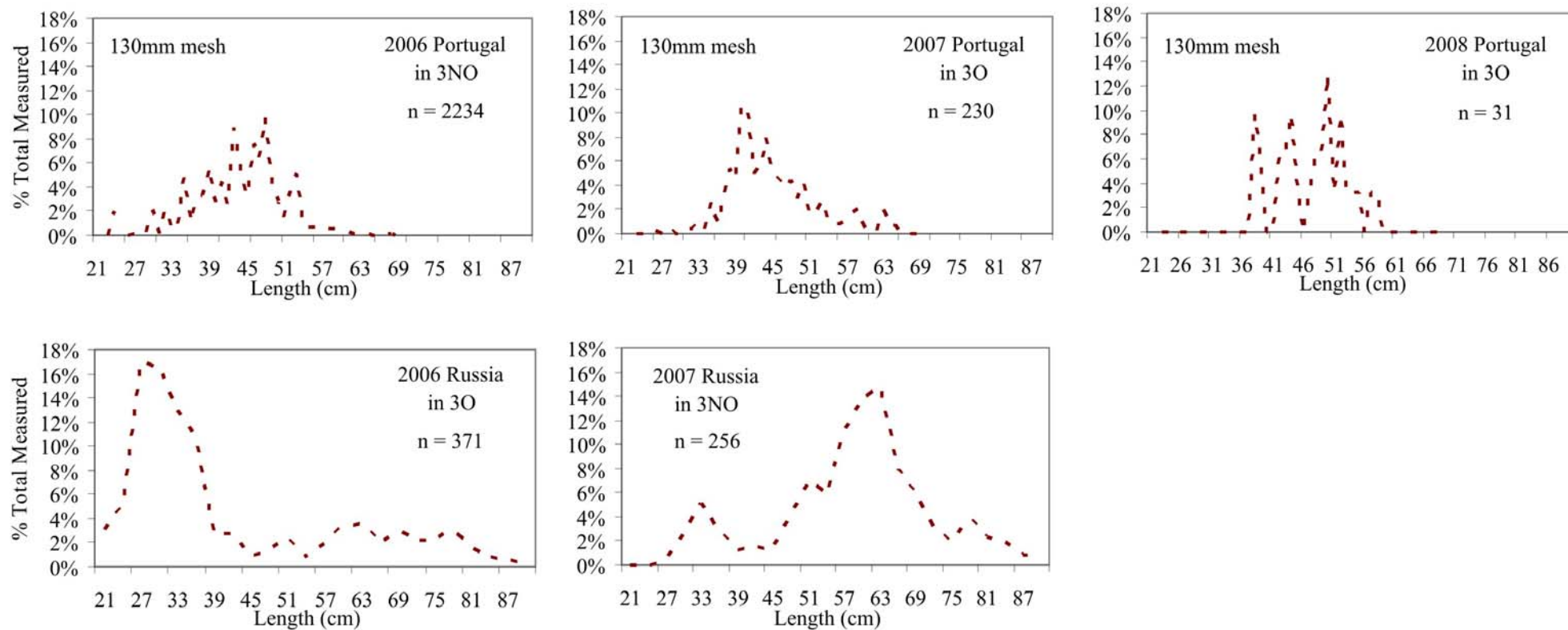


Figure 4. Available size frequency data for White Hake bycatch in non-Canadian commercial trawl fisheries in the NRA, 2006-2008.

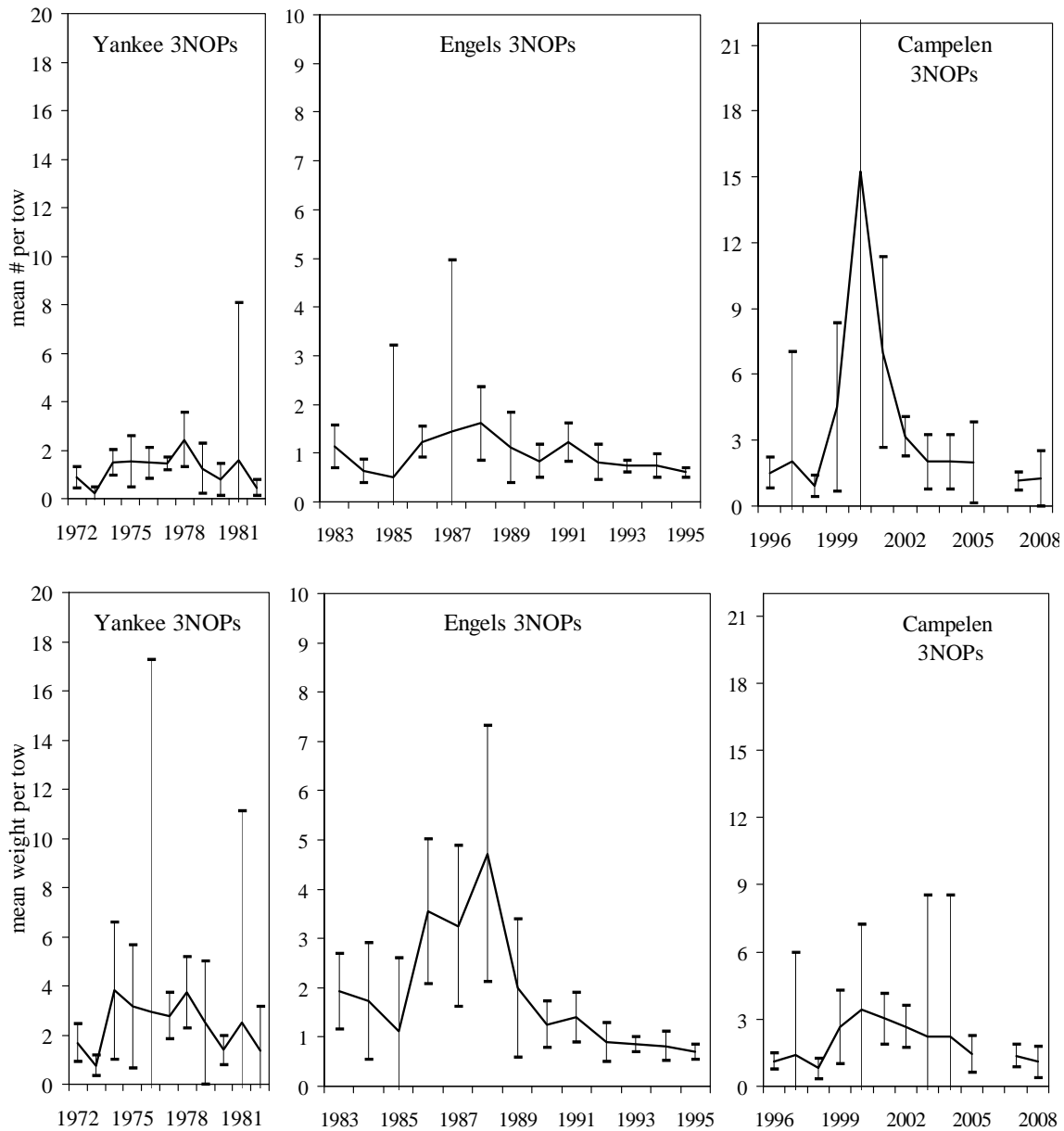


Figure 5a. Mean numbers (Upper panel) and mean weights (Lower panel) per tow of White Hake from Canadian Campelen spring research surveys in NAFO Divisions 3NO and Subdivision 3Ps. Yankee, Engel and Campelen time series are not standardized. Note that deep strata in Div. 3NO and all of Subdiv. 3Ps were not surveyed in spring 2006.

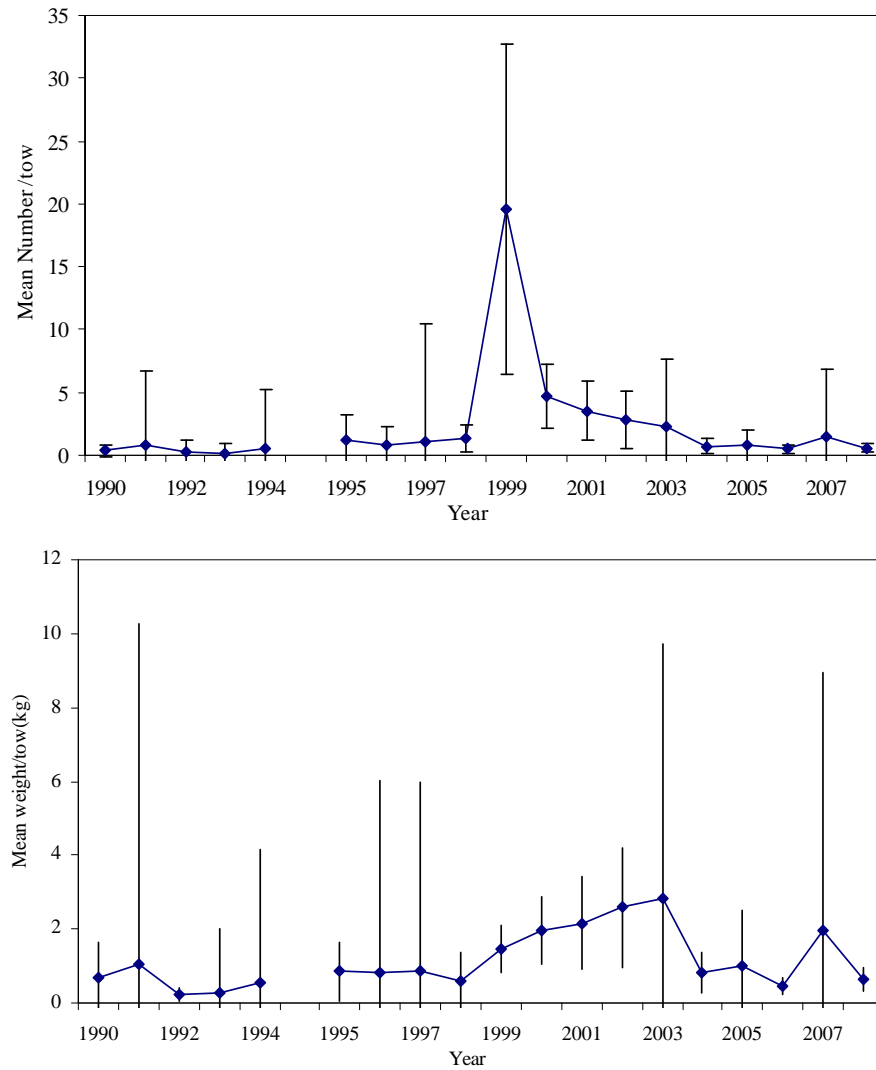


Figure 5b. Mean numbers and mean weights per tow of White Hake from Canadian Campelen Autumn research surveys in NAFO Divisions 3NO. Engel (1990-1994) and Campelen (1995-present) time series are not standardized. Note that deep strata in Div. 3NO were not surveyed in autumn of 2003, 2004, 2006, and strata deeper than 730 m in the survey area were not surveyed in autumn 2008; due to Canadian research vessels' mechanical difficulties

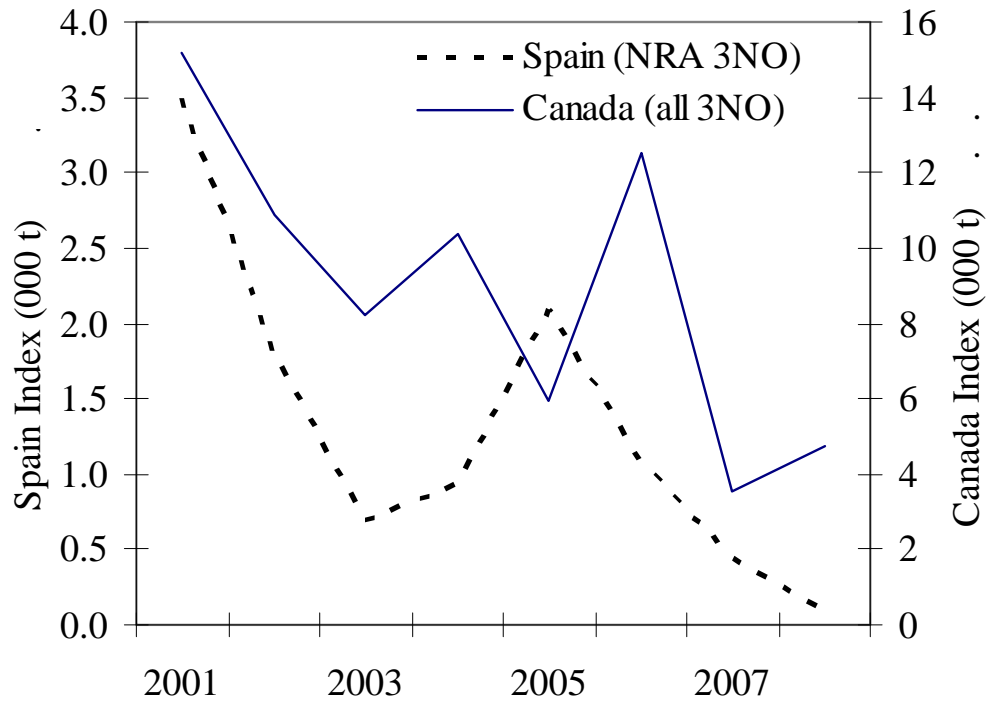


Figure 6. White Hake biomass indices in NAFO Div. 3NO: Spanish spring surveys in the NRA of Div. 3NO compared to Canadian spring surveys in all of Div. 3NO, 2001-2008. Note that deep strata in Div. 3NO were not surveyed by Canada in spring 2006, due to research vessels' mechanical difficulties.

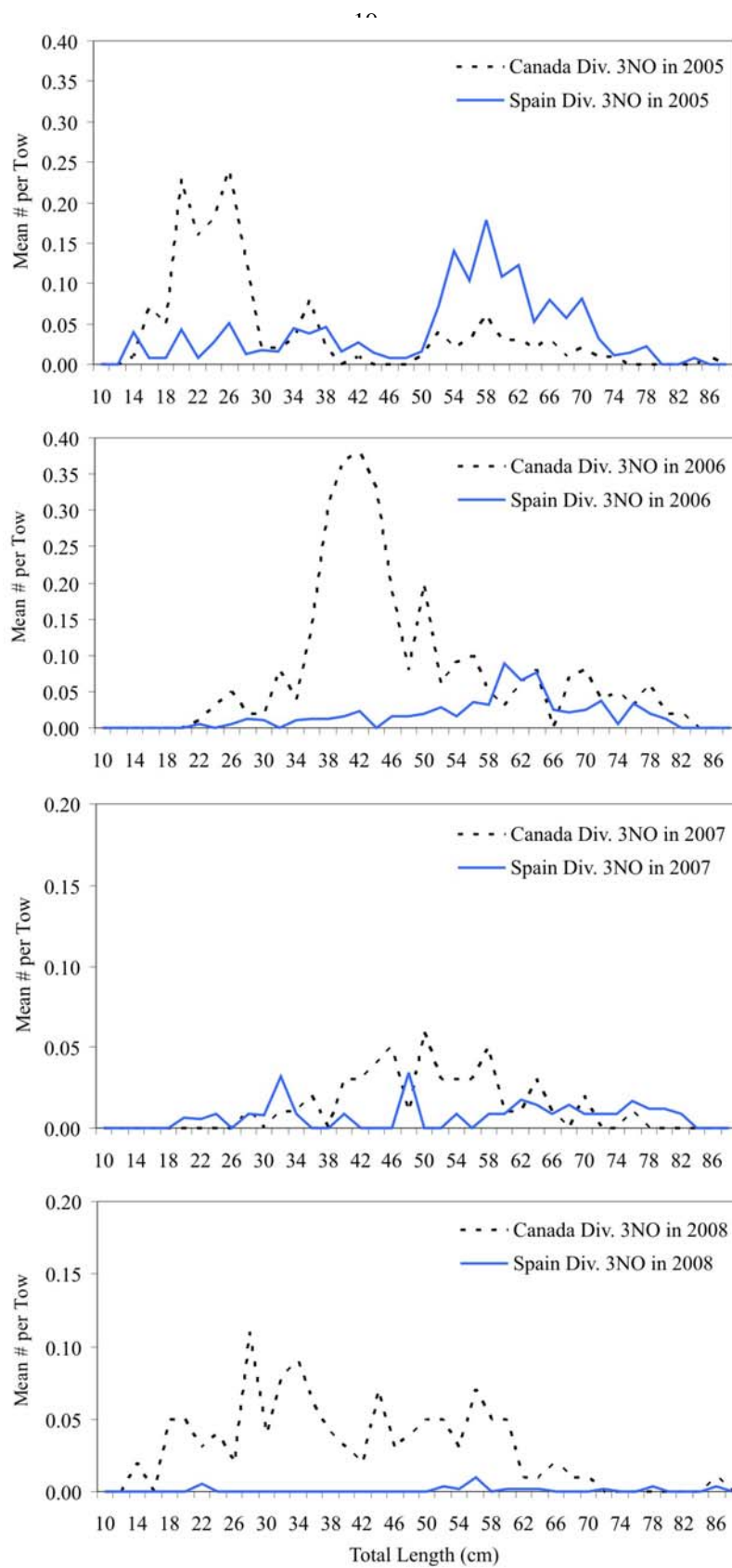


Figure 7. Abundance at length from Canadian Campelen and Spanish Campelen spring research surveys in NAFO Div. 3NO (Spanish surveys limited to NRA), 2005-2008. Number per tow was calculated using mean catches. Note that Y-axes for 2007-2008 are half the value of those for 2005-2006.

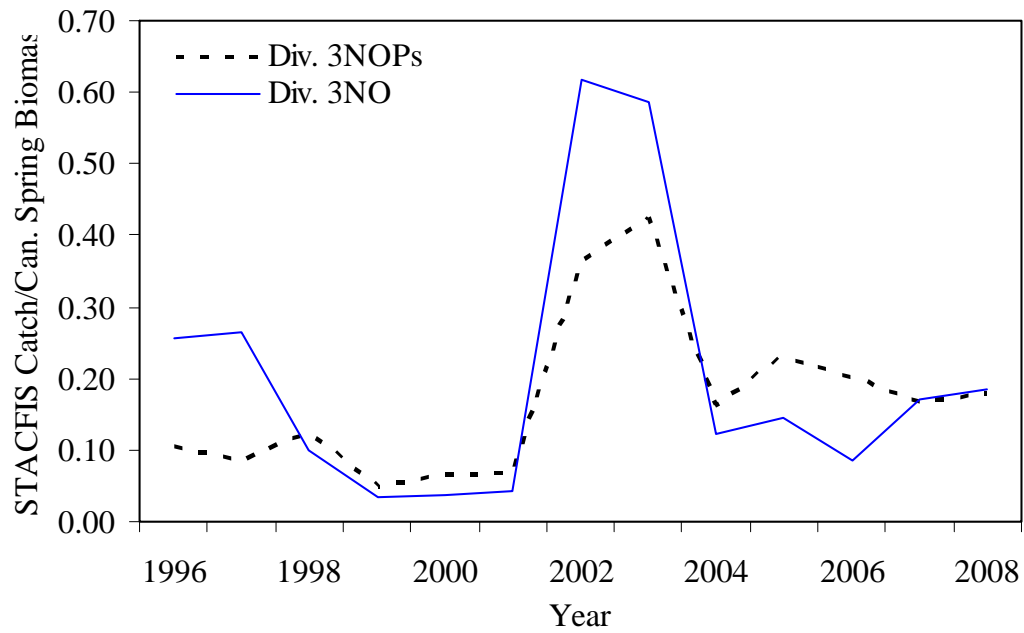


Figure 8. Relative F index (= STACFIS agreed commercial catch/Canadian Campelen spring survey biomass) for White Hake in NAFO Div. 3NO and 3NOPs, 1996-2008. Both time series are unstandardized. Note that deep strata in Div. 3NO and all of Subdiv. 3Ps were not surveyed in 2006; due to Canadian research vessels' mechanical difficulties.

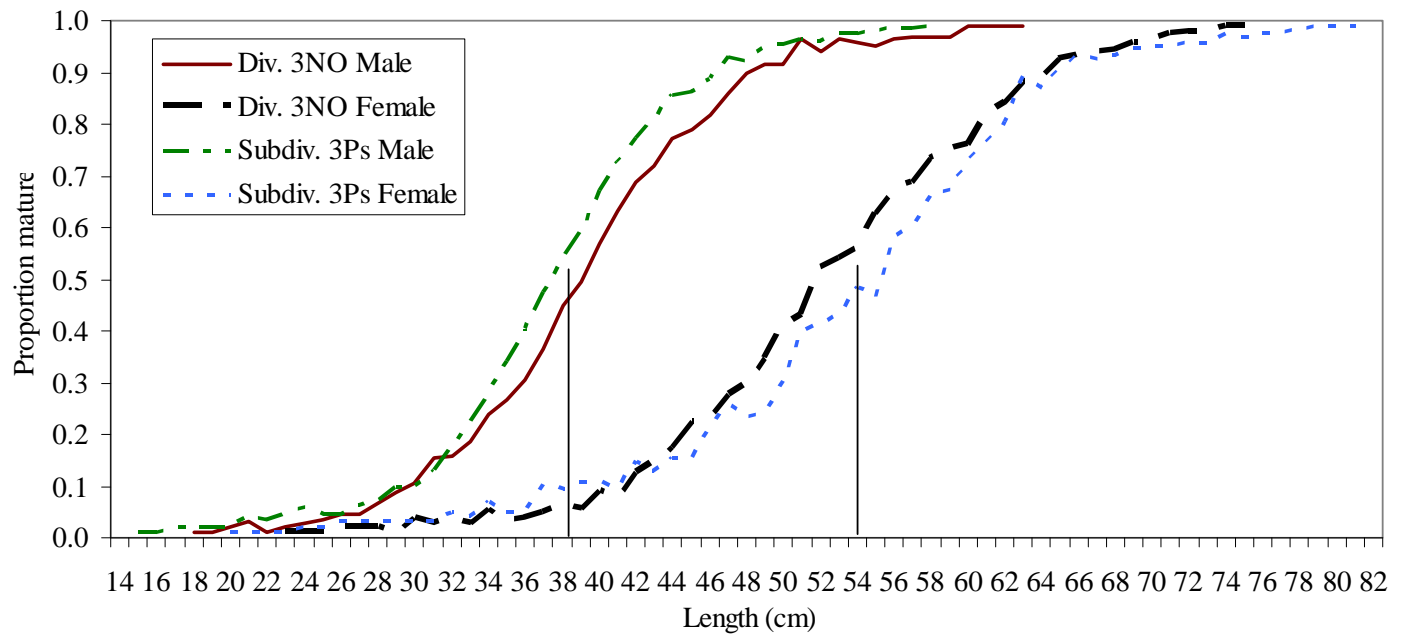


Figure 9. White Hake in Div. 3NO and Subdiv. 3Ps: ogives calculated for each sex from Canadian spring research surveys and averaged over 1996-2008.

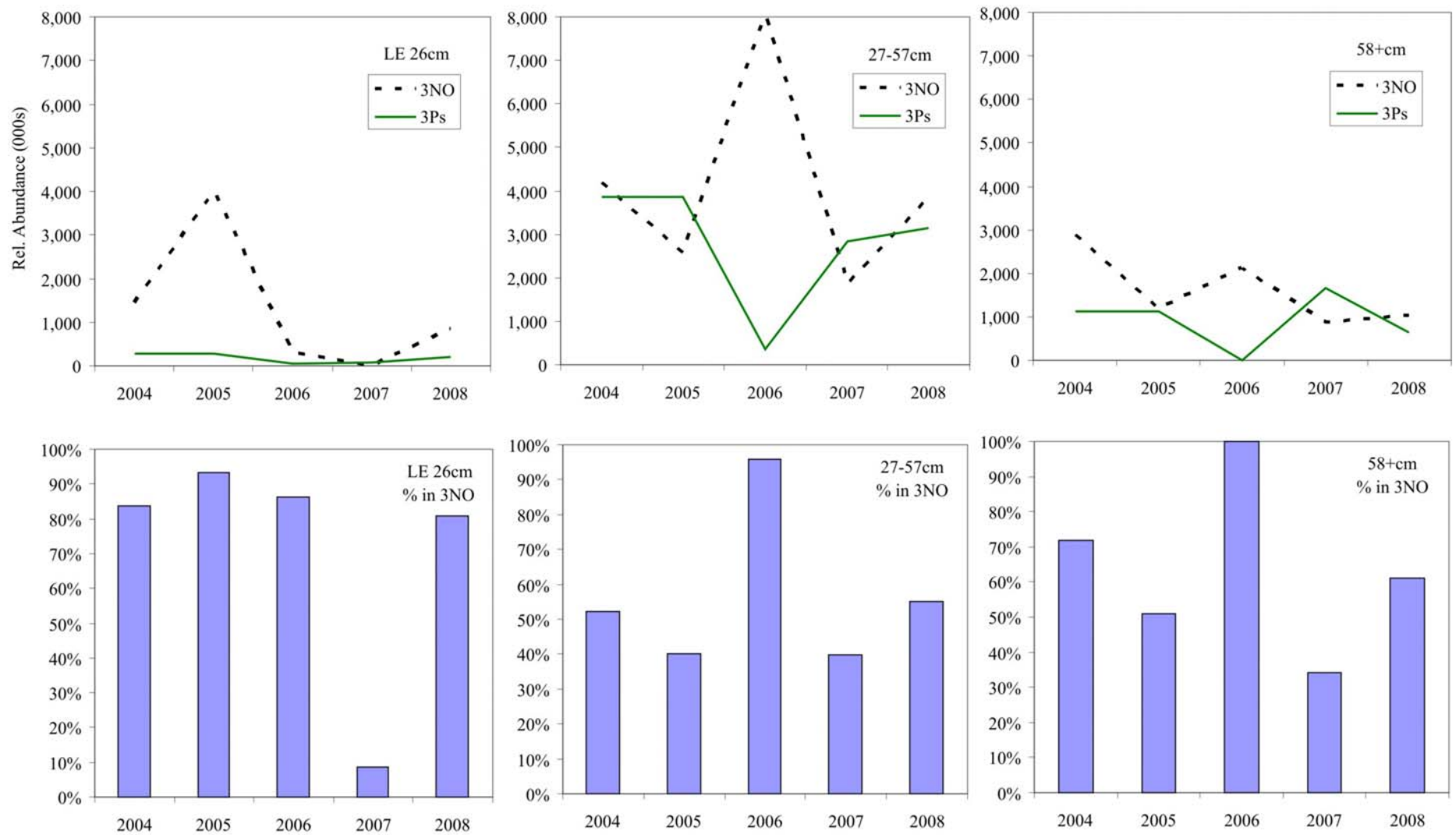


Figure 10. Relative abundance of White Hake by life stage, 2004-2008: Less than or Equal to 26 cm is mainly Year Class-1; 27-57 cm contains mainly juveniles; and 58+ cm is mainly mature fish. Upper panel: Relative abundance (000s). Lower panel: Percent abundance in NAFO Divisions 3NO as compared to the entire area of Div. 3NOPs. Note that deep strata in Div. 3NO and all of Subdiv. 3Ps were not surveyed in spring 2006; due to Canadian research vessels' mechanical difficulties.

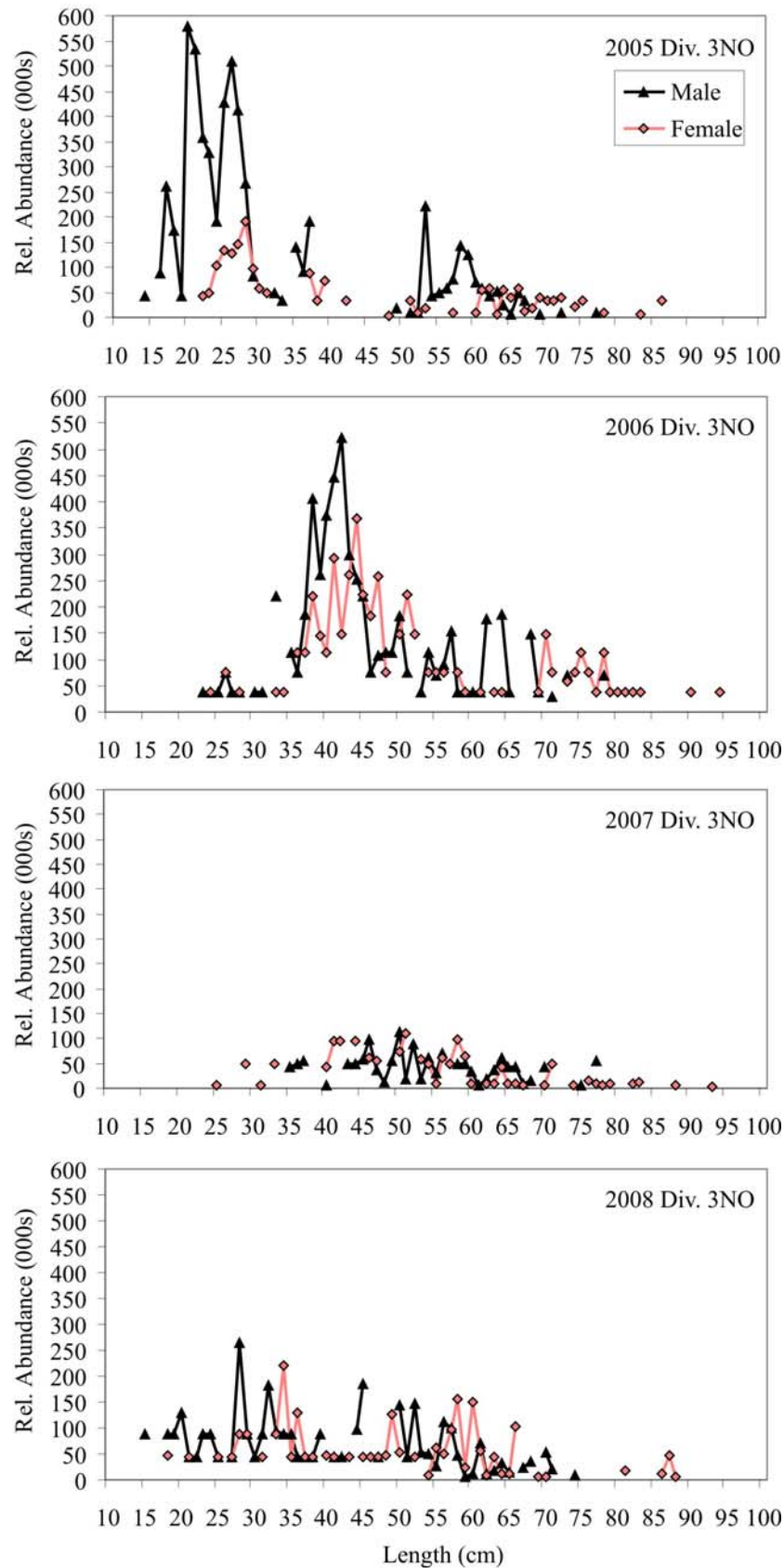


Figure 11a. Relative abundance at length of male and female White Hake from Canadian spring research surveys in NAFO Div. 3NO, 2005-2008. Note that deep strata in Div. 3NO was not surveyed in spring 2006; due to Canadian research vessels' mechanical difficulties.

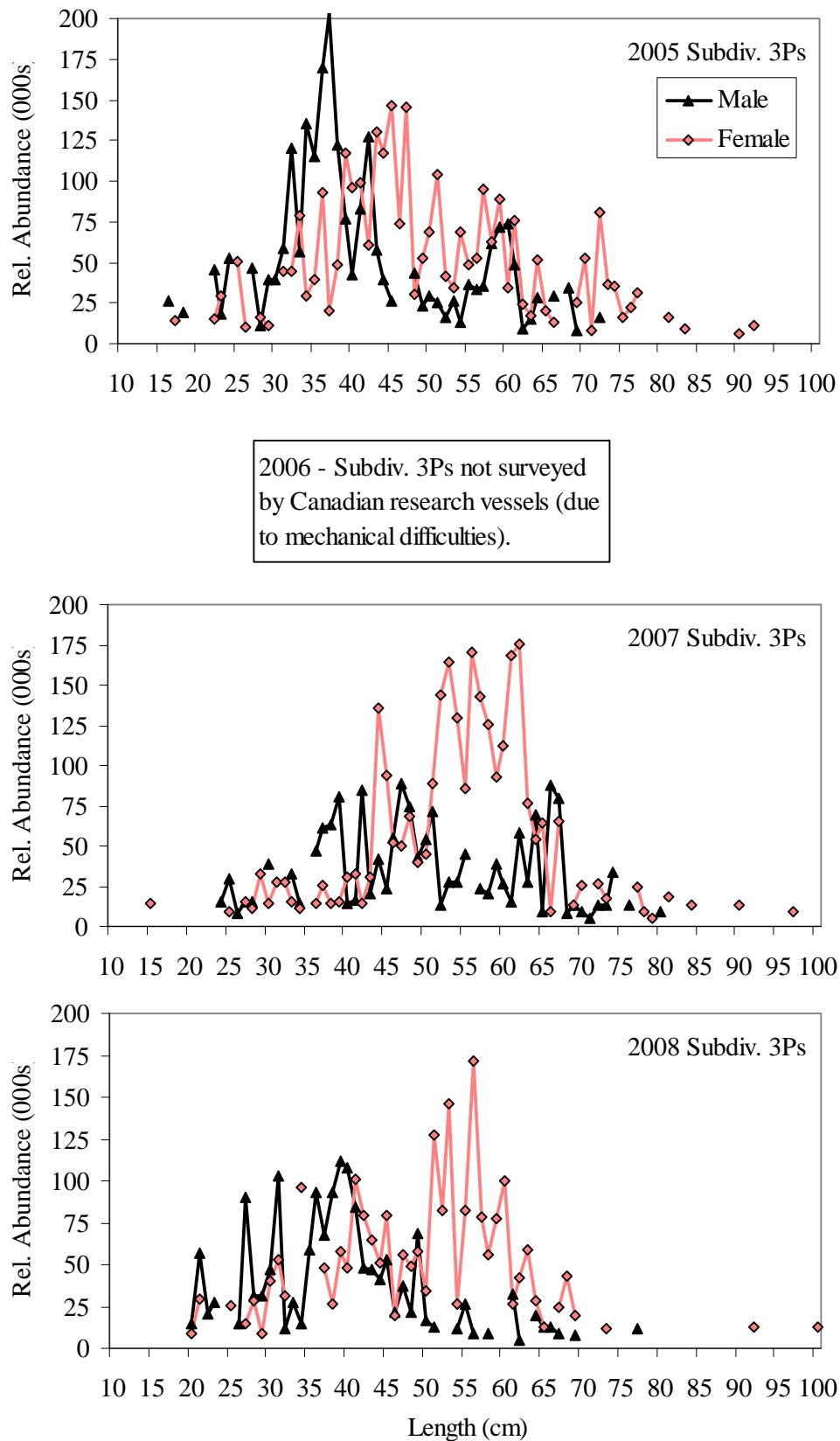


Figure 11b. Relative abundance at length of male and female White Hake from Canadian spring research surveys in NAFO Subdivision 3Ps, 2005-2008. Note that Subdiv. 3Ps was not surveyed in 2006; due to Canadian research vessels' mechanical difficulties.

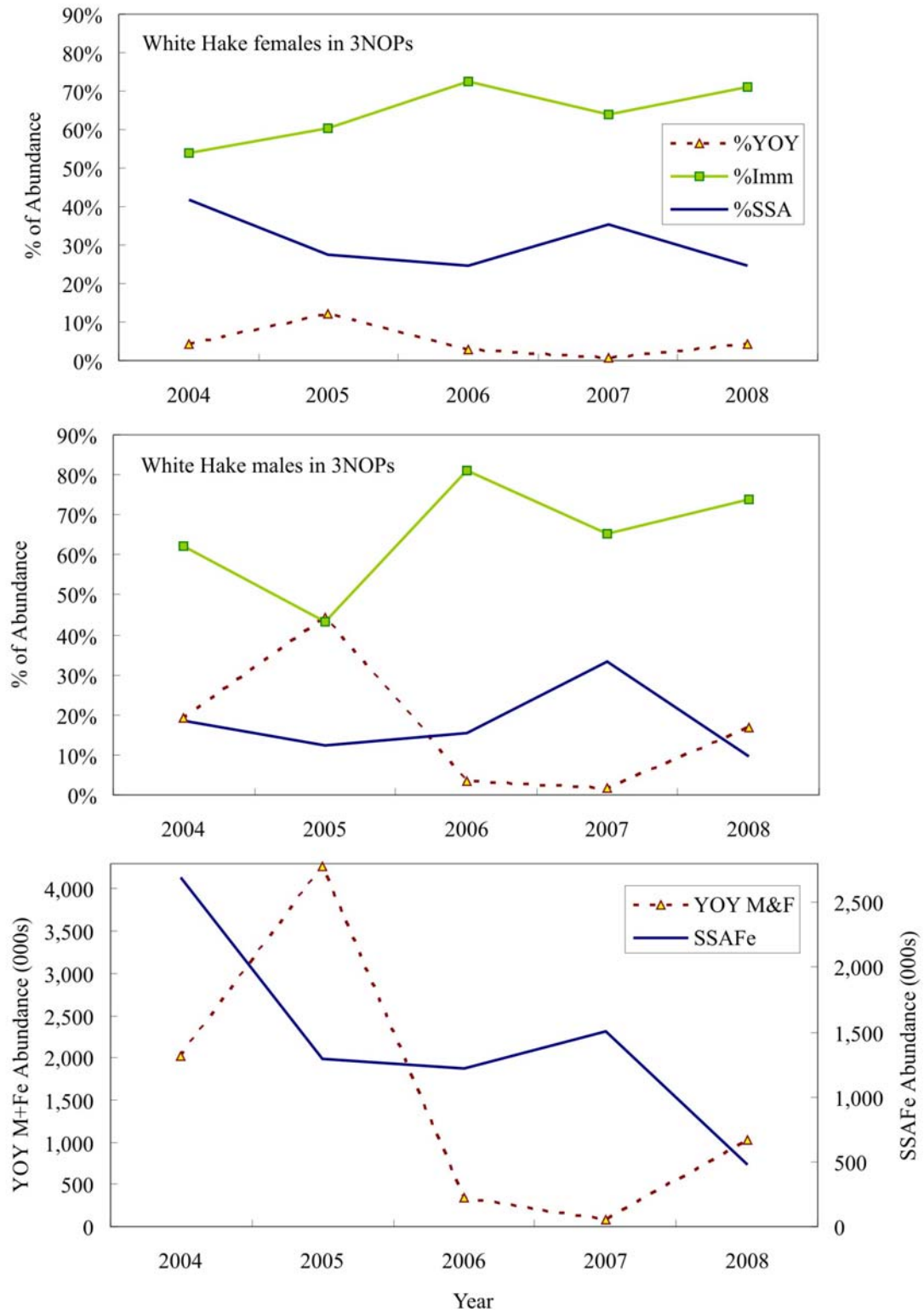


Figure 12. Staged trends in relative abundance of young-of-the-year (YOY) and female spawning abundance (SSAFe) from Canadian Campelen spring surveys in NAFO Div. 3NO and Subdiv. 3Ps, 2004-2008. Note that deep strata in Div. 3NO and all of Subdiv. 3Ps were not surveyed in 2006; due to Canadian research vessels' mechanical difficulties.

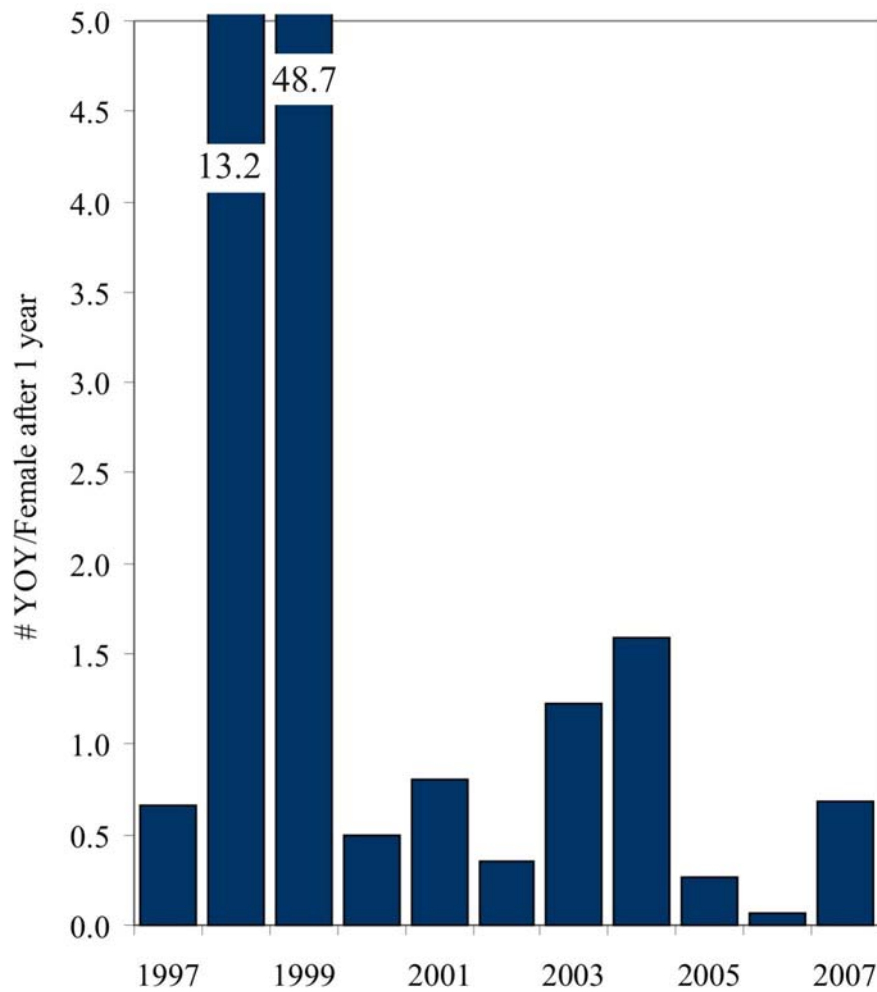


Figure 13. Recruits per spawner expressed as number of Young-Of-the-Year males and females (1-year-olds produced per adult female in Year-1) from Canadian Campelen spring surveys in NAFO Div. 3NO and Subdiv. 3Ps, 1997-2007. Note that numbers written in the breaks of the 1998 and 1999 bars indicate the number of YOY per female for those years. For the 2005 point, one-year-olds in 2006 are only from the shallow (< 103 m) portion of Div. 3NO; rather than the entire stock area because of incomplete survey coverage in that year.

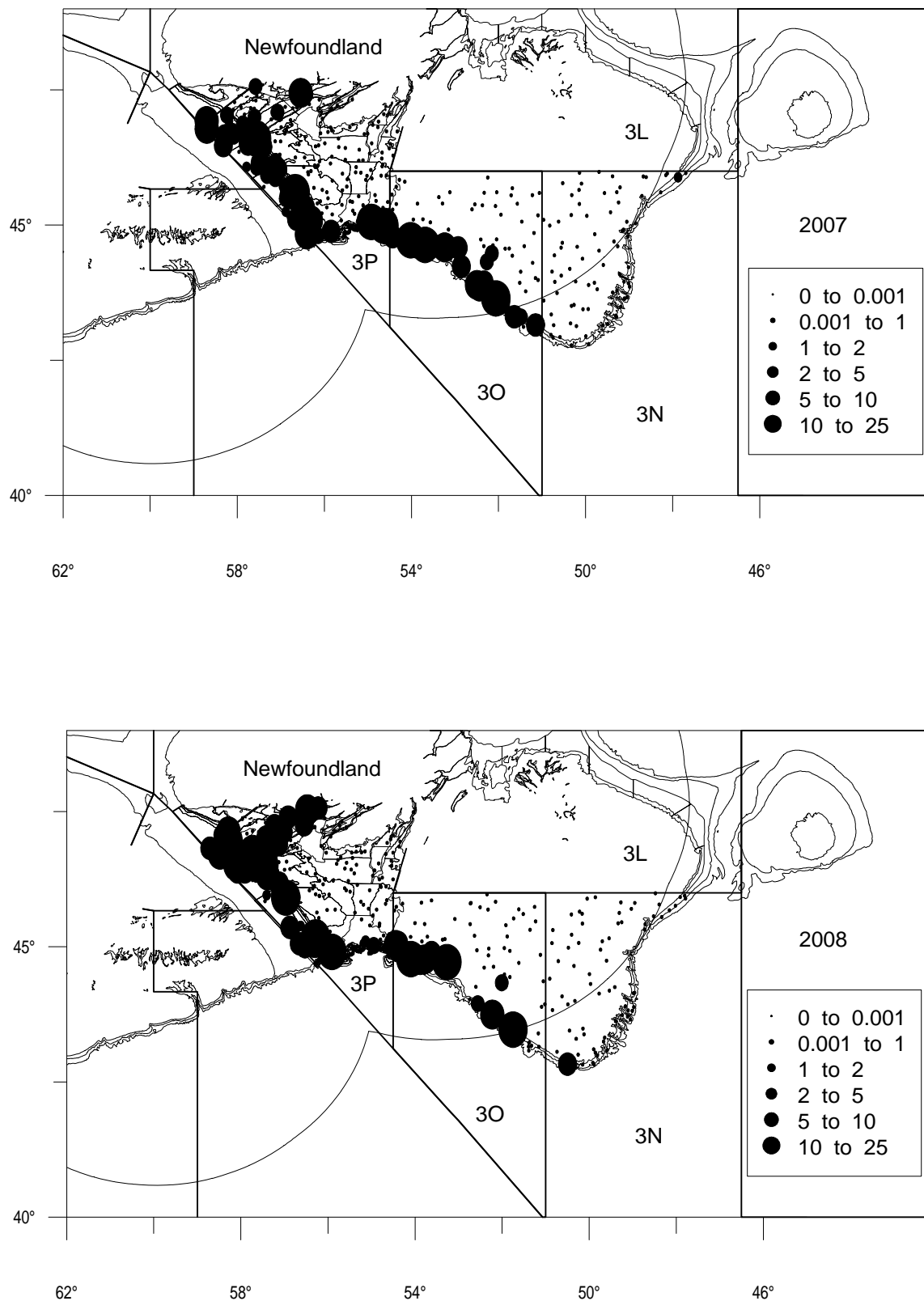


Figure 14. Distribution of White Hake, numbers per tow, in NAFO Div. 3NO and Subdiv. 3Ps; based on Canadian spring research surveys in 2007(Upper) and 2008(Lower).