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Capelin School Surface Area Index for NAFO Div. 3L during the 1989 Spawning Season

by

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Abstract

The 1989 aerial survey utilized 26.0 flying hours and provided repeat coverage of at least three times for three out of four transects. No surveys were conducted between June 19 and June 26 due to poor weather conditions. The maximum total school surface area was observed on June 17 in Trinity Bay and on June 16 in Conception Bay. The estimate of total school surface area of 635,863 m^2 was the second highest in the series. Comparison of relative abundance among four indices suggested that the 1989 spawning biomass was higher than in 1988 and very near the highest level estimated in 1987.

Introduction

Background information on the use of the surface area of capelin schools estimated from aerial photographs as an index of relative abundance was documented in previous reports (Nakashima 1985, 1986). This manuscript reports on the methods and results of the aerial photographic survey conducted in 1989 along the shorelines of Conception Bay and Trinity Bay in NAFO Div. 3L (Fig. 1). The index of total school surface area of capelin schools is compared to other indices of relative abundance.

Materials and Methods

Particulars of previous aerial surveys including aircraft type, camera and film used, survey time, and altitudes flown are listed in Table 1. Since 1982 the survey has covered four transects as often as possible during the spawning season. The four transects were the outside of Trinity Bay from the Horse Chops to Gooseberry Cove, the inside of Trinity Bay from Gooseberry Cove to Hopeall, the outside of Conception Bay from Caplin Cove to Harbour Grace Islands, and the inside of Conception Bay from Harbour Grace Islands to Portugal Cove (Fig. 1). The best photographic conditions were in the morning when the sun angle was less than 50° and winds were light. Afternoon photography was usually stopped when the sun angle declined to 20°. Photography in the afternoon was more likely to be negatively influenced by winds and land shadowing.

In each photograph, capelin schools were identified and their outlines traced on clear plastic sheets. The surface area of each school was measured with a compensating polar planimeter, corrected for altitude and expressed in m^2. For each transect flown, the mean and median school surface areas, the number of schools, and the total surface area of all schools observed were estimated. Small schools, generally less than 55 m^2, were not measured on photographs taken at 457 m because they were less than the resolving power of the planimeter used.

The school index for each year was estimated by summing the highest total school surface area observed on each of the four transects. I assumed that a peak in school surface area was indicative of maximum inshore abundance for each transect for that year. The trend in the index derived from 1982-89 was compared to trends in catch rates from capelin traps and purse seines (Nakashima and Harnum 1990) and to projections of mature biomass from acoustic surveys (Anon. 1982, 1983, 1984, 1985, 1986, 1987, 1988). Assumptions relevant to the interpretation of aerial photographic data were discussed by Nakashima (1985, 1986).

Results and Discussion

Coverage of the four transects was variable. The inside transect of Conception Bay was surveyed five times (Table 2d), the outside transects of both Trinity Bay and Conception Bay were covered three times (Table 2a, c) and the inside transect of Trinity Bay was photographed only twice (Table 2b). Due primarily to coastal fog no flights were conducted between June 19 and June 26. On June 27 we were able to fly between Bull Arm and Hopeall in Trinity Bay and between Bryants Cove and Portugal Cove in Conception Bay. Very few schools were observed in both areas, however no photographs were taken due to variable coastal fog conditions and low light levels at the time. Because we were experimenting with a new airborne sensor (the Compact Airborne Spectrographic Imager) to image capelin schools (see Nakashima et al. 1989), we moved our operations late on June 27 to Note Dame Bay where capelin schools were arriving and present in high concentrations. Approximately 12 hours of flight time were utilized for the CASI experiments. After collecting sufficient digital data were returned to Trinity Bay and Conception Bay on June 30 to continue the capelin school survey (Table 1).

The highest number of schools, the largest school sizes, and the maximum total surface area of capelin schools were observed between June 16 and June 18 in both bays (Tables 2a, b, c, and d). The peak occurrence in Conception Bay was on June 16 and in Trinity Bay on June 17. The size and prevalence of schools had already declined in Conception Bay by June 18 (Tables 2c, d). Although we were unable to survey Trinity Bay again until June 27, it was assumed that the same pattern had occurred there. It is likely that the peak occurrence of schools in Trinity Bay may have been underestimated. Evidence from examining capelin egg deposition on several beaches in Conception Bay (unpublished data) supported the assumption that the main spawning had occurred on June 16-18. Compared to 1988 when peak abundance as observed from aerial survey data was June 19-22 in Trinity Bay and June 24-25 in Conception Bay (Nakashima 1989), the highest total school surface areas estimated in 1989 were earlier, especially so for Conception Bay. From the non-photographic flight on June 27 and later photographic missions between June 30 and July 4 capelin schools had dramatically declined in number and in size since the June 16-18 flights.

The school surface area index was compared to the commercial catch rate series from the trap and purse seine fisheries and the projected mature biomass derived from Canadian acoustic surveys. The projected mature biomass for 1989 was estimated to be 3,345,000 t, the highest in the 1980's. The purse seine catch rate in 1989 was 24.3 t per day, the highest in that series, and continued a trend of increasing catch rates since 1987 (Table 3). The trap catch rate in 1989 was 6.7 t per day which was second to the 1987 rate of 8.8 t per day (Table 3). The school surface area index measured in 1989 was also the second highest in its series at 635,863 m^2, however unlike the trap catch rate the school surface index was 40% higher than the 1988 estimate (Table 3). It was noted by Nakashima and Harnum (1988) that the 1987 trap catch rate may have been biased up and the purse seine catch rate biased down. Despite the differences in the indices as to whether the spawning biomass in 1989 was the highest or second highest observed between 1982 and 1989, the indices do indicate that the mature biomass of capelin in Div. 3L in 1989 was higher than in 1988 and one of the highest in the 1980's.

The 1990 aerial survey will be conducted largely with the Compact Airborne Spectrographic Imager (CASI) and supported by aerial colour photography (Nakashima et al. 1989). This technique which records digital data will allow us to view the data following each flight, will permit us to collect data during less than ideal light conditions for aerial photography, and should reduce the time to analyze the data.

Acknowledgments

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References

Anon. 1982. NAFO Scientific Council Reports. p. 33-35.

1983. NAFO Scientific Council Reports. p. 52-54.

1984. NAFO Scientific Council Reports. p. 58-66.

1985. NAFO Scientific Council Reports. p. 74-77.

1986. NAFO Scientific Council Reports. p. 73-75.

1987. NAFO Scientific Council Reports. p. 73-75.

1988. NAFO Scientific Council Reports. p. 71-73.

Nakashima, B. S. 1985. The design and application of aerial surveys to estimate inshore distribution and relative abundance of capelin. NAFO SCR Doc. 85/84, Ser. No. N1058. 11 p.

1986. School surface area of capelin schools from aerial photographs as an index of relative abundance. NAFO SCR Doc. 86/14, Ser. No. N1126. 7 p.

1989. Capelin school surface area index for NAFO Div. 3L. NAFO SCR Doc. 89/44, Ser. No. N1621. 6 p.

Nakashima, B. S., G. A. Borstad, D. A. Hill, and R. C. Kerr. 1989. Remote sensing of fish schools: early results from a digital imaging spectrometer, p. 2044-2047. In Proc. of IGARSS '89, 12th. Canadian Symposium of Remote Sensing, Vancouver, B.C., July 10-14, 1989.

Nakashima, B. S., and R. W. Harnum. 1988. The inshore capelin fishery in NAFO Div. 3L in 1987. NAFO SCR Doc. 88/9, Ser. No. N1445. 16 p.

1990. The inshore capelin fishery in NAFO Div. 3L in 1989. NAFO SCR Doc. 90/60, 16 p.

Table 1. Summary of aerial surveys conducted from 1982 to 1989.

Year	Aircraft	Camera	Lens (mm)	Filter	Film	Radar altimeter	Survey period	Altitude (m)	Survey flight time (hrs)
1982	Piper Aztec	RC 10	152	Anti-vignetting	Aerocolour Neg. 2445	No	June 18-July 5	152-160	
1983	Aero-Commander 500B	Wild RC 10	152	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 19-July 9	457	21.8
1984	Cessna 310	Wild RC 10	152	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 17-July 7	457	38.5
1985	Aero-Commander 500 B	Wild RC 10	152	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 18-July 3	290-610	28.6
1986	Aero-Commander 500 B	Wild RC 10	152	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 19-July 5	381-579	13.4
1987	Piper Aztec	Zeiss RMK	153	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 16-July 3	457	37.0
1988	Piper Navajo Piper Aztec	Zeiss RMK	153	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 15-July 5	305-488	33.0
1989	Piper Navajo	Zeiss RMK	153	Anti-vignetting	Aerocolour Neg. 2445	Yes	June 16-27 June 30-July 4	434-732	26.0

Table 2a. Schooling data for the outside part of Trinity Bay from Horse Chops to Gooseberry Cove, 1982-89.

Date	No. of schools	Total surface area (m^2)	School area (m^2) Mean ± SD	Median
June 19, 1982	7	2963	423 ± 502	125
June 26, 1982	0	0		
July 3, 1982	1	522	522	522
June 23, 1983	7	11330	1619 ± 1315	1283
June 24, 1983	10	13671	1367 ± 1260	1088
June 25, 1983	7	11662	1666 ± 2151	725
June 29, 1983	8	2288	286 ± 228	195
June 30, 1983	13	18470	1420 ± 1613	1116
July 1, 1983	3	6417	2139 ± 2176	1172
June 18, 1984	9	3236	360 ± 423	223
June 19, 1984	8	3962	495 ± 703	279
June 25, 1984	22	30467	1385 ± 1959	502
June 26, 1984	38	37219	979 ± 1718	167
June 29, 1984	9	2790	310 ± 223	279
July 3, 1984	48	43412	904 ± 3010	223
July 6, 1984	34	16015	471 ± 485	167
June 21, 1985	0	0		
June 25, 1985	0	0		
June 29, 1985	18	15536	863 ± 983	316
July 1, 1985	32	48808	1525 ± 1622	893
July 2, 1985	24	49216	2051 ± 2965	949
July 3, 1985	9	2498	278 ± 183	270
June 18, 1987	59	41348	701 ± 985	391
June 22, 1987	81	45421	561 ± 780	279
June 28, 1987	15	5189	346 ± 384	223
July 3, 1987	9	12220	1358 ± 3042	279
June 19, 1988	41	45812	1117 ± 2569	279
July 5, 1988	13	10714	824 ± 617	502
June 17, 1989	78	97325	1248 ± 2664	433
June 30, 1989	4	1334	333 ± 307	203
July 3, 1989	0			

Table 2b. Schooling data for the inside part of Trinity Bay from Gooseberry Cove to Hopeall, 1982-89.

Date	No. of schools	Total surface area (m^2)	School area (m^2) Mean ± SD	Median
June 19, 1982	31	12724	411 ± 712	149
June 26, 1982	29	35607	1228 ± 2755	299
June 29, 1982	11	62397	5672 ± 8378	592
July 2, 1982	8	31365	3921 ± 9281	705
July 3, 1982	2	1920	960 ± 17	960
June 23, 1983	11	69583	6326 ± 6299	4241
June 24, 1983	26	39004	1500 ± 1880	753
June 25, 1983	30	174487	5816 ± 12759	781
June 29, 1983	35	152557	4359 ± 11139	781
June 30, 1983	46	199373	4334 ± 6927	558
July 1, 1983	25	189497	7580 ± 19791	2288
June 19, 1984	13	15624	1202 ± 1770	335
June 23, 1984	9	8314	924 ± 888	502
June 25, 1984	96	31526	328 ± 505	117
June 26, 1984	96	40510	422 ± 679	223
June 29, 1984	47	12053	256 ± 314	167
July 3, 1984	57	23827	418 ± 814	167
July 7, 1984	77	43245	562 ± 1124	223
June 21, 1985	13	7041	542 ± 706	270
June 25, 1985	35	22459	642 ± 1144	211
June 26, 1985	30	16540	551 ± 721	214
July 1, 1985	125	60245	482 ± 963	181
July 2, 1985	130	195659	1503 ± 6046[a]	179
June 28, 1986	59	95898	1625 ± 4502	340
June 17, 1987	45	167567	3724 ± 17727	223
June 19, 1987	91	399026	4385 ± 31197	167
June 27-28, 1987	37	59315	1603 ± 5612	446
July 3, 1987	5	1786	357 ± 322	279
June 16, 1988	27	18749	694 ± 902	391
June 19, 1988	50	104179	2084 ± 4546	502
June 22, 1988	67	112863	1685 ± 5749	391
June 25, 1988	20	87103	4338 ± 15287[a]	474
July 5, 1988	23	32252	1402 ± 3199	223
June 17, 1989	60	84349	1398 ± 5040[a]	191
July 3, 1989	0			

a calculation excludes capelin in traps

Table 2c. Schooling data for the outside of Conception Bay from Caplin Cove to Harbour Grace Islands, 1982-89.

Date	No. of schools	Total surface area (m^2)	School area (m^2) Mean ± SD	Median
June 29, 1982	10	6577	658 ± 366	642
July 2, 1982	2	1357	679 ± 554	679
June 23, 1983	34	51838	1374 ± 7266[a]	530
June 24, 1983	16	10658	666 ± 823	447
June 25, 1983	4	4408	349 ± 184	279
July 1, 1983	5	5413	1083 ± 1864	112
June 18, 1984	1	391	391	
June 19, 1984	0	0		
June 25, 1984	49	63779	1294 ± 2874[a]	391
June 26, 1984	67	65956	697 ± 1091[a]	279
June 30, 1984	21	22320	818 ± 1509[a]	223
July 3, 1984	4	1786	446 ± 599	195
June 20, 1985	0	0		
June 24, 1985	0	0		
June 27, 1985	30	8840	268 ± 378[a]	120
June 28, 1985	125	50837	368 ± 800[a]	132
June 29, 1985	22	19253	875 ± 1169[a]	291
July 1, 1985	28	28036	991 ± 1616[a]	264
July 2, 1985	66	69166	914 ± 2064[a]	223
June 19, 1986	88	132455	1462 ± 2853[a]	279
June 16, 1987	139	184307	1322 ± 2924[a]	391
June 19, 1987	143	112660	766 ± 1516[a]	279
June 27, 1987	21	12164	539 ± 559[a]	391
June 30, 1987	37	29462	790 ± 1481[a]	279
June 20, 1988	54	36993	679 ± 1099[a]	223
June 22, 1988	64	18916	230 ± 324[a]	112
June 25, 1988	116	87534	676 ± 1331[a]	279
July 4, 1988	51	39785	578 ± 805[a]	279
June 16, 1989	180	266878	1483 ± 5512[a]	335
June 18, 1989	162	197372	1132 ± 3607[a]	335
July 1, 1989	8	6140	730 ± 1359[a]	198

a calculation excludes capelin in traps

Table 2d. Schooling data for the inside of Conception Bay from Harbour Grace Islands to Portugal Cove, 1982-89.

Date	No. of schools	Total surface area (m^2)	School area (m^2) Mean ± SD	Median
June 26, 1982 AM	33	19408	571 ± 907[a]	135
June 26, 1982 PM	20	36513	1626 ± 1914[a]	2089
June 27, 1982	48	151214	3134 ± 6015[a]	527
June 29, 1982	27	30275	1121 ± 1707	418
July 4, 1982	3	13042	4347 ± 4951	1409
July 5, 1982	7	5127	732 ± 582	592
June 23, 1983	53	97595	1787 ± 2754[a]	558
June 24, 1983	30	56860	1819 ± 2965[a]	558
June 25, 1983	29	79961	2677 ± 3725[a]	781
June 30, 1983	7	8091	1156 ± 1181	558
July 1, 1983	1	2009	2009	
June 18, 1984	0	0		
June 23, 1984	8	17689	2085 ± 2556[a]	949
June 25, 1984	70	63891	879 ± 1789[a]	223
June 26, 1984	33	23603	703 ± 1708[a]	223
June 30, 1984	29	16852	508 ± 467[a]	335
July 3, 1984	18	9040	329 ± 254[a]	223
July 5, 1984	0	0		
June 20, 1985	0	0		
June 24, 1985	2	1600	800 ± 834	800
June 26, 1985	17	10124	596 ± 1145[a]	314
June 27, 1985	76	16552	214 ± 426[a]	78
June 28, 1985	120	33858	274 ± 938[a]	67
July 1, 1985	16	43228	2702 ± 5140	308
July 2, 1985	17	13436	676 ± 1872[a]	191
June 19, 1986	39	31574	786 ± 1105[a]	357
June 20, 1986	4	3515	698 ± 769[a]	363
June 22, 1986	86	30930	343 ± 616[a]	131
July 2, 1986	10	5019	502 ± 600	358
June 17, 1987	196	53066	263 ± 350[a]	167
June 19, 1987	365	205846	556 ± 1482[a]	167
June 21, 1987	179	74128	393 ± 699[a]	167
June 27, 1987	136	94747	681 ± 2389[a]	167
June 28, 1987	63	68969	1036 ± 2402[a]	167
June 30, 1987	41	51336	1226 ± 2892[a]	391
July 3, 1987	47	34863	742 ± 1400	279
June 19, 1988	77	25780	335 ± 599[a]	223
June 20, 1988	31	7742	240 ± 256[a]	167
June 24-25, 1988	289	201642	682 ± 1091[a]	391
July 4, 1988	24	32141	1295 ± 4242[a]	251
June 16, 1989	186	187311	991 ± 2032[a]	319
June 18, 1989	113	68283	686 ± 1422[a]	279
June 30, 1989	0			
July 1, 1989	22	13905	587 ± 512[a]	396
July 4, 1989	24	10707	446 ± 651	279

a calculation excludes capelin in traps

Table 3. Comparison of indices for estimating trends in relative spawning biomass. The catch/day index was based on capelin trap and purse seine data from logbook surveys (Nakashima and Harnum, 1990), the mature biomass index originated from NAFO Scientific Council Reports (Anon., 1982-88), and the school surface area index came from this study.

Year	Catch (t)/day		Mature biomass (t)	School surface area (m^2)
	Purse seine	Trap		
1982	16.4	3.1	≥346,000	223,150
1983	18.8	3.4	648,000	367,280
1984	14.3	2.9	384,000	216,500
1985	16.4	4.6	596,000	357,270
1986	19.0	4.6	1,300,000	283,150
1987	18.1	8.8	2,830,000	762,953
1988	20.7	6.2	900,000	447,851
1989	24.3	6.7	3,345,000	635,863

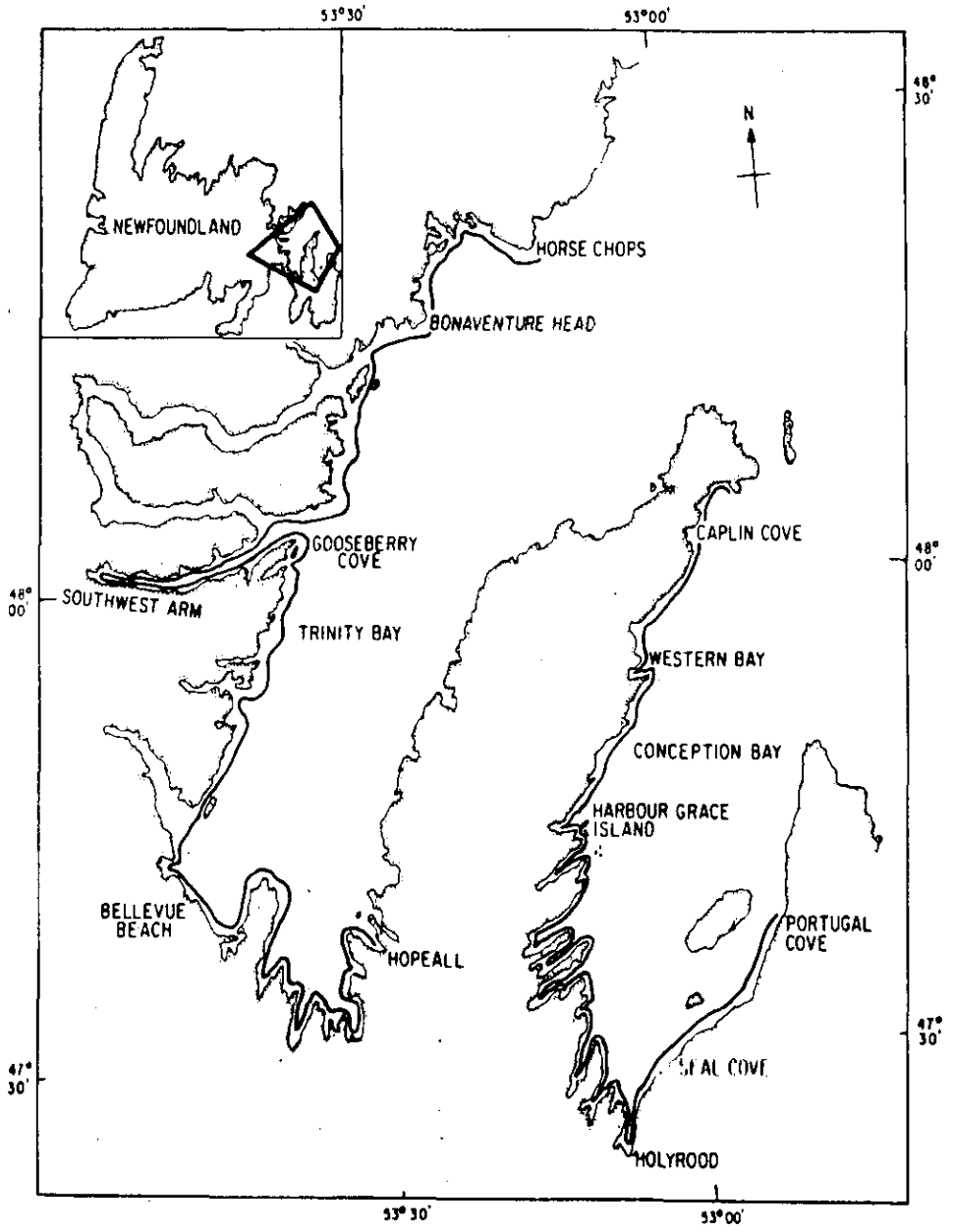

Fig. 1. Aerial survey track.