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Juvenile Yellowtail Surveys on the Grand Banks (NAFO Division 3LNO)

by

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INTRODUCTION

Knowledge of the size of recruiting year-classes is an important need in evaluating a total allowable catch and a successful stock assessment. In 1981, DFO's Newfoundland Region instituted a program dedicated to the determination of indices of year-class strength of juvenile flatfish, particularly yellowtail flounder on the Grand Banks. Juvenile flatfish surveys have been carried in the North Sea by Belgium, England, the Netherlands, and the Federal Republic of Germany during the 1970's and 1980's. Emphasis has been placed on estimation of indices of year-class strength in I, II, and III year old age groups in hopes of finding functional relationships between these indices from research surveys and the estimated number of fish in the sea at the age of recruitment from virtual population analysis. This approach has had mixed success with some abundance indices correlating well with independent estimates for some flatfish (Anon 1983). Since 1981 the Grand Bank juvenile yellowtail project has been concentrating its efforts on three main objectives: adequate sampling gear to catch I-II-III year olds; an appropriate survey design; and calculation of abundance estimates of recruiting year-classes.

This paper will provide information on developments that have been made since 1981 and provide preliminary assessment of juvenile yellowtail on the Grand Banks.

MATERIAL

Fishing gears

In 1980 experimentation of small mesh fishing gears began with two research vessel surveys; one in the northern Gulf of St. Lawrence, NAFO Div. 4R for American plaice, witch flounder, and Greenland halibut; and the second one on the southern Grand Banks, NAFO Div. 3N for plaice and yellowtail. In the northern Gulf of St. Lawrence fishing sets were made using a #41 semi-balloon trawl and a Yankee 36 shrimp trawl while a Yankee #36 otter trawl and a Yankee #36 shrimp trawl were used on the southern Grand Banks. The Yankee #36 shrimp trawl gave the most promising results in catching 1, 2, and 3 year old flatfish as well as commercial sized flatfish (Walsh 1984). This fishing gear has a 1½" mesh throughout and used a ½" stretched mesh nylon liner in the codend. It has a headline height of 8 ft and a wing spread of 34 ft. The ground ropes were modified to fish on rough bottom. The shrimp trawl was used in a survey cruise in August 1981 aboard the chartered vessel NEWFOUNDLAND HAWK and in August 1982 aboard the chartered vessel LADY HAMMOND on the southern Grand Bank, NAFO Div. 3NO. All sets were of 30 minute duration at a speed of 3.5 knots.

Based on the success of the Yankee No. 36 shrimp trawl in catching juvenile yellowtail and the fact that this type of trawl is commonly used on vessels less than 100 ft, it was decided that in 1983 a larger version of this type of trawl, namely the Yankee No. 41 shrimp trawl be used. The November survey in 1983 and the September survey in 1985 aboard the research vessel R.V. WILFRED TEMPLEMAN used a Yankee No. 41 shrimp trawl with a headline height of 9 ft, a wing spread of 44 ft. Both surveys used 30 minute fishing sets with a reduction in speed from 3.5 knots (1983) to 2.5 knots (1985). The former towing speed was felt to be too fast in relation to burst speeds of 1, 2, and 3 year old flatfish and it was suspected that the bridles were not herding these fish properly, resulting with an increase in escapement (burst speed of 30 cm flatfish is 1½ knots: John Foster, Nordco Ltd., St. John's, Newfoundland; pers comm.).

Research vessel survey designs

Both 1981 and 1982 surveys were based on line transects in Div. 3NØ (Fig. 1).

Stations were approximately 10 miles apart. The main purpose for choosing line transects was to delineate distribution of both juvenile American plaice and yellowtail across varying depth zones on the southern Grand Bank as well as estimates of relative abundance via mean catch per tow.

In 1983, it was decided to abandon line transects in favor of a more statistical related sampling scheme. Random sampling in a well defined area of Div. 3NO, inside the 50 fath. depth contour incorporating areas of major concentrations of yellowtail (derived from previous surveys) was introduced (Fig. 2). High numbers of fishing sets would reduce the variance associated with within strata catch estimates. Unfortunately, the success of the trip was hindered by vessel problems as was the case in 1984.

In 1985 the WEBBER[1] sampling design was formulated based on the random stratified design used in regular groundfish biomass estimates. Since previous groundfish surveys of the Grand Bank have shown that yellowtail are for the most part concentrated inside the 50 fath. contour, it was decided that all survey work would be concentrated in those areas of NAFO Divs. 3LNO (Fig. 3). Survey results from juvenile surveys and regular groundfish surveys were used to estimate areas of concentrations and divided into three categories: heavy concentrated strata, medium concentrated strata, and light concentrated strata (Table 1). Total square mile area was derived for each of the categories and the area of each stratum in each category was expressed as a percentage. In the survey the maximum number of fishing sets would be determined with 2/3 of the sets being reserved for heavy and medium concentrated categories (55% and 45% respectively). Number of fishing sets in each stratum was determined by the weighted area percentage in each category. (See Table 1 for example). Sampling units within each stratum were randomly generated.

The WEBBER sampling design has an additional feature in that it is designed to give a biomass estimate by day and one by night. Based on results of 1981 and 1982 24 hour diel surveys conducted during the juvenile surveys (Walsh, unpub. data) and results of Beamish's (1966) report on catch rates of yellowtail per day being one-half those of night, it was decided to investigate the effect of diel variation on biomass estimates. Sets within each stratum were randomly assigned day or night status on a 50:50 proportion.

ASSESSMENT

Research vessel surveys

The 1981, 1982, and 1983 surveys in Div. 3NO were post-stratified using strata boundaries of the random stratification surveys (Fig. 3). These surveys as well as the survey results for 1985, in the form of mean numbers and weight per tow per stratum are presented in Table 2. Since Yankee 41 shrimp trawl is a larger version of No. 36 shrimp trawl, actual wing spreads, towing speeds, and towing distance were used in the generated analysis (Smith and Somerton, 1981). Several points should be remembered when looking at the survey data:

1) 1981 and 1982 surveys were conducted by two different vessels: NEWFOUNDLAND HAWK and LADY HAMMOND, using a Yankee No. 36 shrimp trawl. Surveys were based on line transects and then post-stratified: Div. 3NØ only.

2) 1983 survey was conducted by R.V. W. TEMPLEMAN using a Yankee No. 41 shrimp trawl. Survey methodology was random sampling and then post-stratified. Limited area of Div. 3NØ. Depths less than 50 fath.

3) No survey was conducted in 1984.

4) 1985 survey was conducted by R.V. W. TEMPLEMAN using a Yankee No. 41 shrimp trawl. Survey methodology was random stratification Div. 3LNØ. Depth less than 50 fath.

An attempt was made to look at a series of selected strata, in Div. 3N, used in yellowtail assessment work (Brodie 1985) to try to obtain an index of abundance that could be comparable for the four sampling years (Table 3). Yellowtail biomass from these strata show a decline from 1981 to 1983 and a large increase in 1985. Interpretation of these biomass estimates are confounded by different vessels and sampling schemes. The confidence limits on the 1983 biomass estimate, based on 2/4 selected strata makes any interpretation of that data invalid.

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[1]An ancronym for researchers of the Newfoundland Region who design this double biomass sampling scheme: S. J. Walsh, W. Brodie, J. Baird, and J. Rice. First letter of the surnames were used with the letter e injected in appropriate places.

Mean number per set and abundance estimates at age are listed in Tables 4 and 5. Table 6 contains abundance estimates at age for the selected strata used in the attempt to standardize the series. As noted above, with the combination of fishing gears, vessels, and survey design, an attempt to evaluate any functional relationships between year-class strength of juveniles and an independent source such as cohort analysis could be highly suspicious. It does, however, show that these small mesh gears appropriately rigged for hard bottom were efficient at catching yellowtail at all age groups.

1985 - Day and night survey

The double biomass survey results are presented in Tables 7-9 respectively. Abundance and biomass estimates of yellowtail differ by a factor of 2.06 and 1.91 respectively in day catches versus night catches. Night estimates were higher than the pooled (combined survey) estimates for the whole survey. Higher numbers at age seen in night catches suggests strong, diel movements of juvenile and adult yellowtail (Table 9). Ratio of total numbers at age of day versus night differ by a factor of approximately 2 except in age groups 3 and 10 where day catches were higher (Table 10). Statistical analysis of numbers and weights of day and night catches were generated with SAS procedure NPARIWAY (Table 11). Only stratum that had catches in both day and night times were used. Night catches were significantly different ($p < .05$) using one way analysis of variance but the non-parametric tests gave no significant differences ($p > 0.05$). Further surveys will again look at this diel effect on abundance and biomass estimates. This one point estimate from the 1985 survey needs additional surveys to be able to detect trends in a larger time frame.

Results of the juvenile survey in September of 1985 were compared with results of the regular biomass survey in the spring of 1985. (Data obtained from W. Brodie 1986 yellowtail assessment of Div. 3LN in this NAFO session). Selected strata used to generate yellowtail abundance and biomass estimates were used in both data sets (Tables 12-14). Biomass estimates from the juvenile survey were 34,000 metric tons higher. Abundance estimates also differed but one must keep in mind that the shrimp trawl is more selective in catching younger age-classes (Table 12 and 13). Table 13 shows that the shrimp trawl is also very effective in catching age 4+ yellowtail compared with regular survey trawl (Engel's high rise) used in the yellowtail assessment work. Both of these trawls have similar wing spread (44 ft and 45 ft respectively). Larger catches of different age classes in the fall survey may point of a seasonal component in distribution or a strong difference in fishing gear catchability. The footgear of the shrimp trawl is designed to be as close to the bottom as possible to rout out juveniles and hence will rout out adults just as effectively. It may be that the towing speed of the net used in the spring surveys is too fast for yellowtail (3.5 knots), recalling that a 30 cm flatfish has a burst speed of 1.5 knots. As mentioned previously, if the towing speed is too fast, the bridles may not be as efficient in herding the fish ahead and in the path of the mouth opening of the trawl.

CONCLUSIONS

Interpretation of previous juvenile yellowtail surveys are suspect because of vessel-gear-survey design combinations. But these data (prior to 1985) may be of some use when a time series has been developed using the 1985 survey methodology. The 1986 survey will again look at diel variation in catches of yellowtail on the Grand Banks.

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Table 1. WEBBER sampling design used in the 1985 survey for juvenile yellowtail survey: example for 150 sets.

	Stratum	Div.	Area (sq. miles)	% Of Total area	No. of sets (rounded)
Heavy	361	3N	1853	16	9
concentrated	375	3N	1593	14	7
areas	360	3N	2992	25	14
	376	3N	1499	13	7
	352	30	2580	22	12
	355	30	1282	11	6
Total	6		11799	101	55
Medium	372	3L	2460	22	10
concentrated	373	3N	2520	23	10
areas	362	3N	2520	23	10
	374	3N	931	9	5
	351	30	2520	23	10
Total	5		10951	100	45
Light	384		1120	9	4
concentrated	363		1780	14	6
areas	350		2071	16	7
	383		674	5	4
	340		1716	13	6
	338		1898	15	7
	331		456	4	4
	330		2089	16	8
	371		1121	9	4
Total	9		12925	101	50

Table 2. Average number and weights of yellowtail per 30 minute set for Div. 3LNO, Abundance and biomass estimates with their respective 95% confidence limits are given at bottom of table. 1981-85 juvenile surveys.

Division	Stratum	Sets	1981	1982	1983	1984	1985
30	329	No.of Sets	-	2	-	-	-
		Av.No./Set	-	0.00	-	-	-
		Av.Wt./Set	-	0.00	-	-	-
30	330	No.of Sets	2	3	-	-	-
		Av.No./Set	14.40	2.40	-	-	-
		Av.Wt./Set	6.90	1.40	-	-	-
30	337	No.of Sets	-	4	-	-	-
		Av.No./Set	-	0.00	-	-	-
		Av.Wt./Set	-	0.00	-	-	-
30	338	No. of Sets	3	4	-	-	-
		Av. No./Set	10.00	2.70	-	-	-
		Av.Wt./Set	4.00	1.35	-	-	-
30	339	No. of Sets	2	2	-	-	-
		Av. No./Set	0.60	0.60	-	-	-
		Av.Wt./Set	0.24	0.36	-	-	-
30	340	No. of Sets	2	2	-	-	-
		Av. No./Set	1.80	6.00	-	-	-
		Av.Wt./Set	0.90	3.00	-	-	-
3L	350	No. of Sets	-	-	-	-	5
		Av. No./Set	-	-	-	-	59.00
		Av.Wt./Set	-	-	-	-	25.50
30	351	No. of Sets	4	7	-	-	3
		Av. No./Set	18.30	28.63	-	-	166.00
		Av.Wt./Set	8.25	9.57	-	-	63.67
30	352	No. of Sets	5	7	-	-	-
		Av.No./Set	130.56	28.63	-	-	-
		Av.Wt./Set	36.30	9.57	-	-	-
30	353	No. of Sets	5	2	-	-	-
		Av.No./Set	56.40	16.80	-	-	-
		Av.Wt./Set	36.36	7.80	-	-	-
30	354	No. of Sets	2	2	-	-	-
		Av. no./set	0.00	0.00	-	-	-
		Av. wt./set	0.00	0.00	-	-	-
3N	359	No. of Sets	4	3	-	-	-
		Av. no./set	0.00	0.00	-	-	-
		Av. wt./set	0.00	0.00	-	-	-
3N	360	No. of Sets	11	12	18	-	3
		Av. no./set	106.69	50.50	165.50	-	57.67
		Av. wt./set	38.36	18.70	67.44	-	26.83
3N	361	No. of Sets	6	7	30	-	6
		Av. no./set	207.60	96.69	42.37	-	99.83
		Av. wt./set	71.12	31.46	11.80	-	38.58
3N	362	No. of Sets	7	5	-	-	9
		Av. no./set	92.60	56.16	-	-	166.89
		Av. wt./set	34.90	17.76	-	-	59.50
3L	363	No. of Sets	-	-	-	-	5
		Av. no./set					53.80
		Av. wt./set					21.00

Table 2 (Cont'd.)

Division	Stratum	Sets	1981	1982	1983	1984	1985
3L	371	No. of Sets	-	-	-	-	4
		Av. no./set					2.25
		Av. wt/set	-	-	-	-	1.88
3L	372	No. of Sets	-	-	-	-	9
		Av. no./set	-	-	-	-	93.06
		Av. wt./set	-	-	-	-	39.49
3N	373	No. of Sets	4	4	-	-	10
		Av. no./set	33.90	23.10	-	-	160.80
		Av. wt./set	11.31	10.65	-	-	75.60
3N	374	No. of Sets	3	3	-	-	4
		Av. no./set	38.03	105.20	-	-	16.00
		Av. wt./set	18.08	33.40	-	-	7.50
3N	375	No. of Sets	4	4	2	-	7
		Av. no./set	224.70	45.00	158.50	-	228.29
		Av. wt./set	86.04	17.25	76.50	-	104.14
3N	376	No. of Sets	8	7	3	-	2
		Av. no./set	188.10	100.80	394.00	-	148.50
		Av. wt./set	64.05	33.48	168.67	-	47.75
3N	383	No. of Sets	-	2	-	-	4
		Av. no./set	-	23.40	-	-	0.00
		Av. wt./set	-	10.80	-	-	0.00
3L	384	No. of Sets	-	-	-	-	4
		Av. no./set	-	-	-	-	35.25
		Av. wt./set	-	-	-	-	22.88
	Upper		293,545	138,872	156,237	-	381,656
	Abundance (nos X 10^{-3})		219,141	101,333	108,767	-	206,114
	Lower		144,738	63,793	61,297	-	190,573
	Upper		102.2	47.9	69.2	-	156.1
	Biomass ('000t)		79.2	36.0	45.9	-	118.2
	Lower		56.3	24.1	22.7	-	80.3

Table 3. Average numbers and weights of yellowtail per 30 minute set for selected strata in Div. 3N. Abundance and biomass estimates with their respective 95% confidence limits are given at the bottom of the table. 1981-85 juvenile surveys.

Div.	Stratum	Sets	1981	1982	1983	1984	1985
3N	361	No. of sets	6	7	30	No survey	6
		Av.No./Set	207.60	96.69	11.80		99.83
		Av.Wt./Set	72.12	31.46	42.37		38.58
	362	No.of sets	7	5	-	-	9
		Av.No./Set	92.60	56.16	-	-	169.89
		Av.Wt./Set	34.90	17.76	-	-	59.50
	373	No.of sets	4	4	-	-	10
		Av.No./Set	33.90	23.10	-	-	160.80
		Av.Wt./Set	11.31	10.65	-	-	75.60
	375	No. of sets	4	4	2	-	7
		Av.No./Set	224.70	45.00	76.50	-	229.29
		Av.Wt./Set	86.04	17.25	158.50		104.14
		Upper	156,241	73,282	163,563	-	215,010
Abundance (nos X 10^{-3})			105,450	44,764	25,411	-	146,097
		Lower	54,659	16,,247	-112,739	-	77,184
		Upper	54.2	24.3	58.0		92.9
Biomass ('000t)			38.3	15.6	11.0		61.4
		Lower	22.3	7.0	-36.0		29.9

Table 4. Average number per set at age and totals for yellowtail from juvenile surveys of Div. 3LNO: 1981-1985

Age	1981[a] Div. 3NO	1982[a] Div. 3NO	1983[b] Div. 3NO	1984	1985[c] Div. 3LNO
1	1.30	0.09	4.00	No survey	1.47
2	2.49	1.20	2.09		0.98
3	7.28	1.01	5.20		1.23
4	9.74	3.24	9.34		4.93
5	3.25	3.40	6.70		4.75
6	2.57	1.04	0.13		14.85
7	0.10	-	-		44.95
8	-	-	-		28.00
9	-	-	-		3.71
10	-	-	-		0.13
Unknown	53.01[d]	23.23[d]	82.71[d]		0
Av. no./set	79.74	33.21	110.16		104.99

[a]Yankee No. 36 shrimp trawl - line transects post-stratified survey.

[b]Yankee No. 41 shrimp trawl - post stratified random sampling survey.

[c]Yankee No. 41 shrimp trawl - random stratified survey.

[d]Age data collected on fish 30 cm and less.

Table 5. Abundance (nos X 10^{-3}) of yellowtail by age from juvenile surveys of Div. 3LNO: 1981-1985.

Age	1981[a] Div. 3NO	1982[a] Div. 3NO	1983[b] Div. 3NO	1984	1985[c] Div. 3LNO
1	3,555	272	4,178	No Survey	4,003
2	6,795	3,647	2,182		2,683
3	19,874	3,075	5,436		3,356
4	26,571	9,893	9,760		13,446
5	8,879	10,377	6,998		12,949
6	7,001	3,173	133		40,427
7	262	-	-		122,580
8	-	-	-		76,354
9	-	-	-		10,126
10	-	-	-		361
Unknown	144,692[d]	70,892[d]	86,416[d]		0
Total	217,632	101,333	115,106		286,289

[a]Yankee No. 36 shrimp trawl - line transects post-stratified survey.

[b]Yankee No. 41 Shrimp trawl - post-stratified Random sampling survey.

[c]Yankee No. 41 Shrimp trawl - random stratified survey.

[d]Age data collected only on fish 30 cm and less.

Table 6. Comparison of abundance estimates at age (nos X 10^{-3}) of yellowtail in Div. 3N from juvenile surveys. Strata used are listed below: 1981-85.

Age	1981[a]	1982[a]	1983[b]	1984	1985[b]
1	588	71	860	No survey	776
2	3,834	1,401	485	-	499
3	9,181	1,357	1,256	-	739
4	11,233	4,946	1,757	-	4,880
5	2,946	4,592	1,092	-	5,932
6	2,070	1,318	52	-	24,110
7					61,130
8					43,268
9					4,843
10					119
Unknown	75,548[c]	31,077[c]	19,905[c]	-	0
Total	105,403	44,764	25,411	-	146,097

Strata used	1981 No. of sets	1982 No. of sets	1983 No. of sets	1985 No. of sets
361	6	7	30	6
362	7	5	-	9
373	4	4	-	10
375	4	4	2	7

[a]Yankee No. 36 shrimp trawl.

[b]Yankee No. 41 shrimp trawl.

[c]Age data collected only on fish up to 30 cm in length.

Table 7. Average numbers and weights of yellowtail per 30 minute set for Div. 3LNO. Abundance and biomass estimates with their respective 95% confidence limits are given at the bottom of the table. Surveys are divided into Day, Night, and Combined surveys. Juvenile survey , 1985.

Division	Stratum	# Sets	Day Survey	Night Survey	Combined Survey
3L	350	No. sets	2	3	5
		Av.No./set	8.00	93.00	59.00
		Av.Wt./set	3.50	40.17	25.50
3O	351	No. sets	2	-	3
		Av.No./set	108.50	-	166.0
		Av.wt./set	44.00		63.67
3N	360	No. sets	3	-	3
		Av. no./set	57.67	-	57.67
		Av.wt./set	26.83	-	26.83
3N	361	No. sets	4	2	6
		Av.no./set	58.50	182.50	99.83
		Av.wt./set	26.13	63.50	38.58
3N	362	No. sets	5	4	9
		Av. no./set	117.80	228.25	166.89
		Av.wt./set	45.00	77.63	59.50
3L	363	No. sets	3	2	5
		Av. no./set	44.00	68.50	53.80
		Av. wt./set	17.67	26.00	21.00
3L	371	No. sets	2	2	4
		Av.no./set	0.00	4.50	2.25
		Av.wt./set	0.00	3.75	1.88
3L	372	No. sets	5	4	9
		Av.no./set	86.90	100.75	93.06
		Av.wt./set	35.08	45.00	39.49
3N	373	No. sets	5	5	10
		Av.no./set	34.80	286.80	160.80
		Av.wt./set	17.40	133.80	75.60
3N	374	No. sets	2	2	4
		Av.no./set	10.50	21.50	16.00
		Av.wt./set	5.25	9.75	7.50
3N	375	No. sets	4	3	7
		Av.no./set	60.50	452.00	228.29
		Av.wt./set	36.50	194.33	104.14
3N	376	No. sets	-	-	2
		Av. no./set	-	-	148.50
		Av. wt./set	-	-	47.75
3N	383	No. sets	2	2	4
		Av. no./set	0.00	0.00	0.00
		Av. wt./set	0.00	0.00	0.00
3L	384	No. sets	2	2	4
		Av. no./set	69.50	1.00	35.25
		Av. wt./set	44.75	1.00	22.88
		Upper	88.92	233.10	139.96
		Mean catch/set	59.27	157.95	104.92
		Lower	29.61	82.80	69.89
		Upper	228,309	461,934	381,656
	Abundance (nos X 10^{-3})		152,171	313,012	286,114
		Lower	76,032	164,090	190,573
		Upper	37.76	99.84	57.24
		Mean catch/set	26.29	65.15	43.35
		Lower	14.81	30.46	29.46
		Upper	97.0	197.9	156.1
	Biomass ('000t)		67.5	129.1	118.2
		Lower	38.0	60.4	80.3

Table 8. Average number per set at age and totals for yellowtail from the juvenile surveys of Div. 3LNO: Day, Night, and Combined Surveys. 1985.

Age	Day Survey (43 sets)	Night Survey (33 sets)	Combined Survey (76 sets)
1	0.06	1.01	1.47
2	0.32	0.63	0.98
3	1.06	0.87	1.23
4	3.73	5.98	4.93
5	1.80	6.14	4.75
6	6.15	23.18	14.85
7	26.02	69.64	44.95
8	17.37	46.20	28.00
9	2.66	4.37	3.71
10	0.00	0.11	0.13
Unknown	0	0	0
Average no. per set	59.29	158.12	104.99

Table 9. Abundance (nos X 10^{-3}) of yellowtail by age from juvenile surveys of Div. 3LNO: Day, Night, and Combined surveys. 1985.

1	151	2,008	4,003
2	829	1,241	2,683
3	2,716	1,719	3,356
4	9,586	11,844	13,446
5	4,626	12,166	12,949
6	15,779	45,936	40,427
7	66,798	138,000	122,580
8	44,599	91,546	76,354
9	6,833	8,661	10,126
10	303	225	361
Unknown	0	0	0
Total	152,225	313,350	286,289

Table 10. Ratio of day catch/night catch by age for yellowtail in Div. 3LNO. 1985 juvenile surveys.

Age	Day Total Nos.	Night Total Nos.	Ratio
r			
1	151,448	2,008,937	13.26
2	829,208	1,241,052	1.50
3	2,716,422	1,719,153	0.63
4	9,586,575	11,844,268	1.24
5	4,626,812	12,166,821	2.63
6	15,779,638	45,936,544	2.91
7	66,798,736	138,000,272	2.07
8	44,599,904	91,546,768	2.05
9	6,833,430	8,661,677	1.27
10	303,602	225,031	.74

Table 11. Anova, Mann-Whitney Wilcoxon Rank, T-test approximation & Kruskal-Wallis test (chi-square approximation) statistic results on difference of abundance and biomass estimates of Day and Night Surveys for yellowtail Div. 3LNO, 1985 Untransformed data.

Type	# Sets	Mean	F value	P value	Wilcoxon Mean score	Z value	P value	T-test P value	K.W.-test P value
Numbers									
Day	36	55.04	6.93	.0106	29.90	1.8527	.0639	.0639	.0630
Night	31	159.39			38.76				
Weights									
Day	36	24.93	5.36	.0238	30.38	1.6385	.1013	.1061	.1000
Night	31	66.81			38.21				

Table 12. Comparison of average numbers and weights of yellowtail per 30 minute set for selected strata in Div. 3LN. Abundance and biomass estimates with their 95% confidence limits are given below. Spring biomass survey and fall juvenile survey, 1985.

Div.	Stratum	No. sets Spring	No. sets Fall	Av. No./ Set Spring	Av. No./ Set Fall	Av. Wt./ Set Spring	Av. Wt./ Set Fall
3L	350	12	5	8.50	59.00	3.68	25.50
3N	361	7	6	156.71	99.83	67.07	38.58
3N	362	11	9	88.36	166.89	33.64	59.50
3L	363	8	5	33.25	53.80	15.17	21.00
3L	372	12	9	129.50	93.06	56.46	39.49
3N	373	9	10	68.44	160.80	31.98	75.60
3N	375	8	7	180.37	228.29	97.78	104.14
	Total	67	51				
			Upper	120.34	170.88	54.55	73.30
			Mean	92.47	123.09	42.34	51.71
			Lower	64.60	75.29	30.12	30.13
				Spring	Fall		
			Upper	133,663	268,773		
		Abundance	(Nos X 10^{-3})	102,706	193,598		
			Lower	71,748	118,423		
			Upper	60.6	115.3		
		Biomass	('000t)	47.0	81.3		
			Lower	33.5	47.4		

Table 13. Comparison of abundance (nos X 10^{-3}) of yellowtail by age from spring and fall surveys of Div. 3LN selected strata 1985.

Age	Spring Survey	Fall Survey
1	0	776
2	0	530
3	355	1,972
4	1,258	9,704
5	6,442	6,054
6	26,395	26,264
7	45,465	87,085
8	21,018	55,205
9	1,628	6,058
10	137	119
Unknown	0	0
Total	102,705	193,773

Table 14. Comparison of average number per set at age and totals for yellowtail from spring and fall surveys of Div. 3LN using selected strata 1985. Towing distance in spring survey was 1.75 miles (at 3.5 knots) and towing distance in fall survey was 1.25 miles at (2.5 knots).

Age	Spring Survey (57 sets)	Fall Survey (51 sets)
1	0.0	0.49
2	0.0	0.34
3	0.32	1.25
4	1.13	6.17
5	5.80	3.85
6	23.76	16.70
7	40.94	55.37
8	18.92	35.10
9	1.42	3.85
10	0.12	0.08
Unknown	0	0
Average No./Set	92.46	123.20

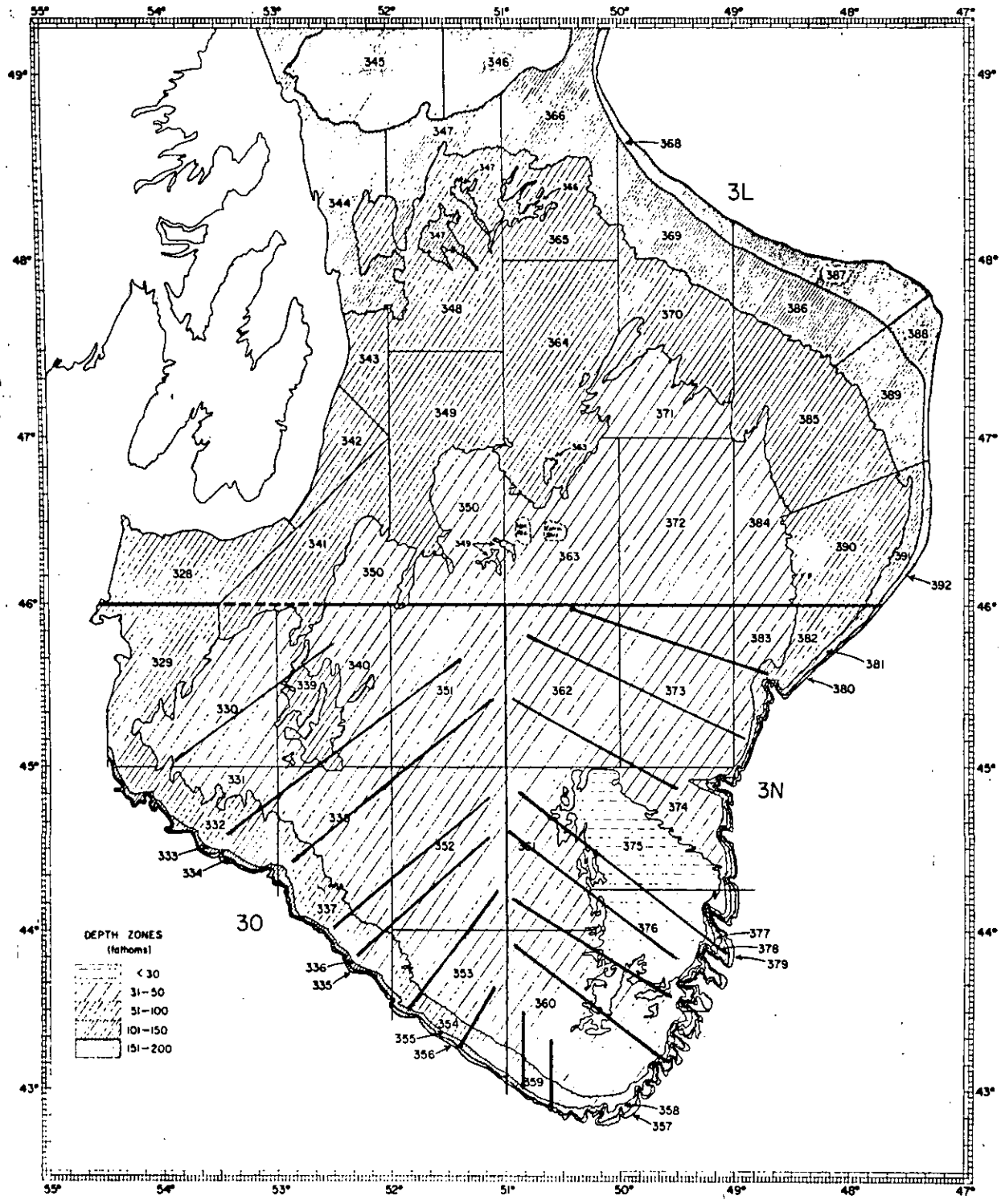

Fig. 1. Line transects used in the 1981 and 1982 juvenile flatfish surveys.

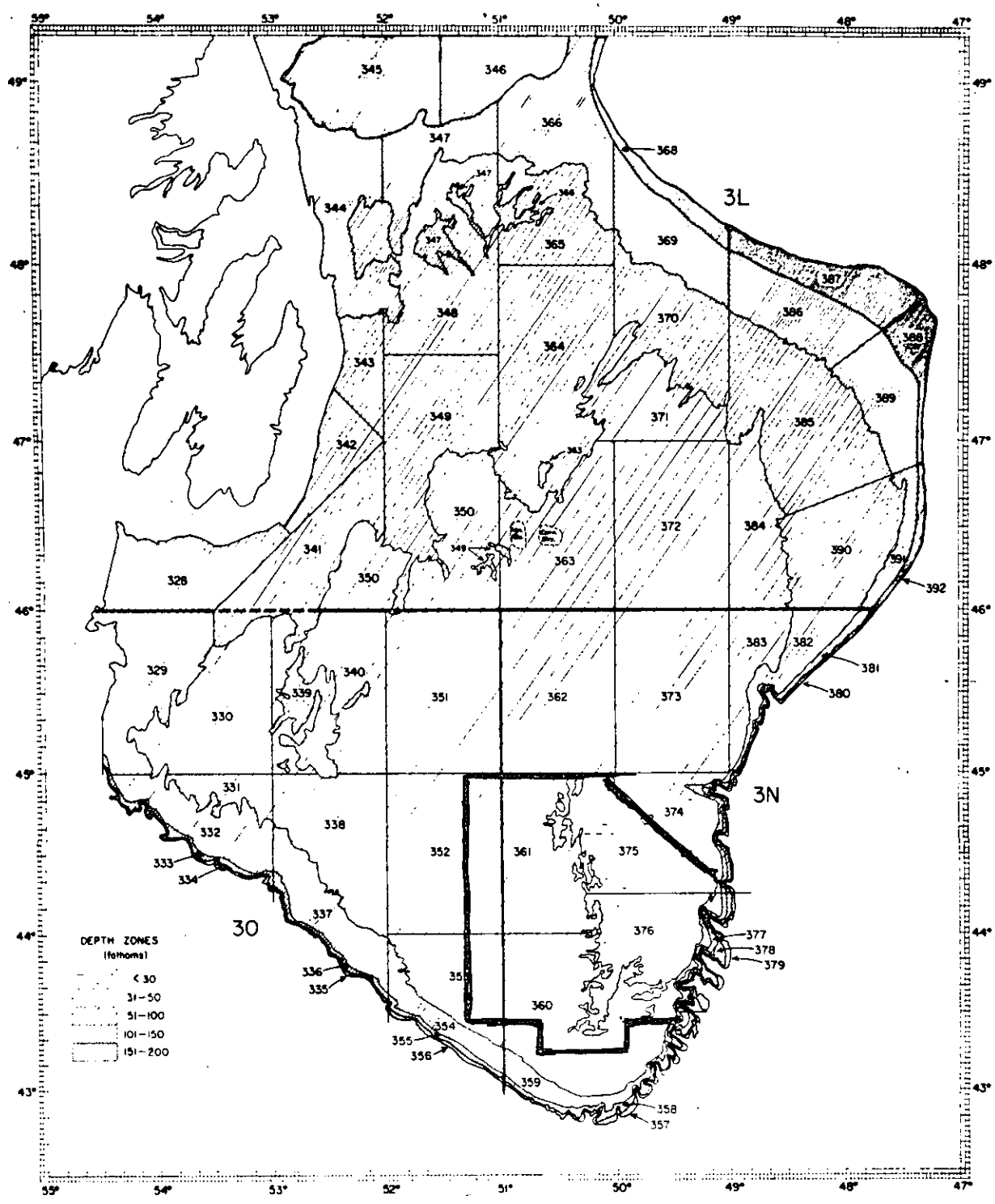

Fig. 2. Random sampling survey area used in 1983.

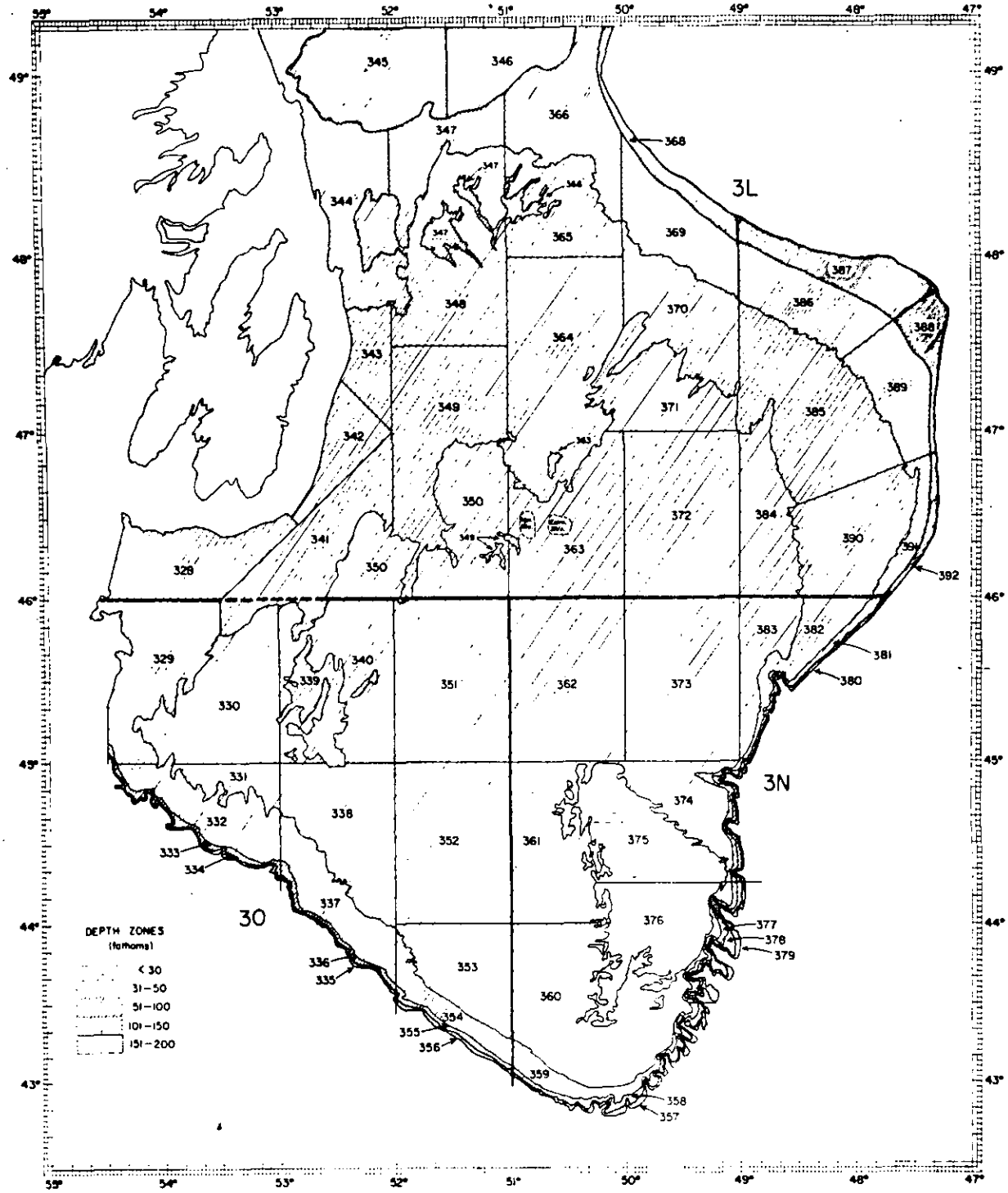

Fig. 3. Random stratified survey in 1985. Only strata inside the 50 fathom contour used.