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Diel Variability in Catches of Yellowtail Flounder
on the Grand Bank Divisions 3LNO

by

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Introduction

In using catch per unit effort data from research surveys as indices of abundance of the pre-recruits (juvenile) and the recruited adult population, errors may arise if there is a demonstrated diel trend in the availability of various sizes (or ages) to the sampling gear.

Diel variability in catches of flatfish has been well documented in the literature, with differences within species and between closely related species being noted. Beamish (1966) and Langton (1983) reported that there were larger catches of juvenile yellowtail at night than by day but no difference in adult catches.

This paper will present information on (1) the results of a 24 hour diel study on trawl catches of yellowtail; (2) the examination of diel variability in trawl catches in NAFO Div. 3LNO from two Canadian surveys in 1985 and 1986 that were designed to give independent day and night biomass estimates of yellowtail; (3) and the effect diel trends has on estimation of recruitment indices of juvenile yellowtail derived from juvenile surveys.

Material and Methods

A. Twenty-four hour diel study

In September of 1986 a 24 hour diel study was conducted in Stratum 376 of NAFO Div. 3N (Fig. 1). Sixteen fishing sets of 30 min. duration were made at 2½-3½ hour intervals using a No. 41 Yankee shrimp trawl aboard the Canadian R.V. W. TEMPLEMAN. The trawl was fished with a tickler chain attached to the footrope and then repeated without the tickler chain. Towing speed was 2.5 knots and the same tow direction (heading) was repeated for each set.

B. 1985 and 1986 Juvenile flatfish biomass surveys

Both surveys were conducted aboard the research vessel WILFRED TEMPLEMAN using a No. 41 Yankee shrimp trawl. Each fishing set was 30 minutes in duration using a towing speed of 2.5 knots. Fishing sets were selected using a stratified-random sampling design for all strata inside the 100 m depth contour on the Grand Bank, NAFO Div. 3L, 3N, and 3O. The WEBBER Sampling Scheme was used to generate independent day and night biomass estimates of yellowtail (Walsh 1986).

C. Distribution of juvenile yellowtail

Three hundred and eighty-nine fishing sets from juvenile surveys, using shrimp trawls, in 1981, 1982, 1983, 1985, and 1986 were used to delineate distribution of age 1-4 year-old yellowtail on the Grand Banks in comparison to the adult population.

SAMPLING ANALYSIS

A. Diel study

Length distribution of catches (numbers) were illustrated using mean catch per tow per

length group for day and night catches. Age composition of the catch was tabulated using actual numbers caught in each fishing set.

B. 1985 and 1986 Juvenile biomass surveys: NAFO Divisions 3L, 3N, and 3O

Mean numbers and weights per tow per stratum along with total biomass and abundance estimates were generated from the stratified-random surveys by day and by night using STRAP analysis computer program (Smith and Somerton, 1981).

In order to test the null hypothesis that there is no significant difference in day and night biomass and abundance estimates of yellowtail, a Mann-Whitney U one-tailed statistical test was generated with SAS (1985) procedure NPARIWAY ($\alpha = .05$). Since Woodhead (1969) reported that catches of North Sea plaice increased at sunrise it was decided that in testing the diel hypothesis catches one-half hour before to one-half hour after both sunrise and sunset be deleted. Because yellowtail are concentrated in certain areas of the Grand Bank and catches are low or non-existent in other areas only those strata showing historically high abundance were used in the analysis. In addition only those selected strata which had both day and night fishing sets were used (Fig. 1).

Additional data from the Canadian regular groundfish biomass surveys in the spring of 1985 and 1986 were analyzed for comparison. The standard otter trawl used in both of these surveys was an Engel 145 High-Rise trawl (Table 1). Statistical analysis using a Mann-Whitney U test followed the procedure outlined above.

Results

A. Diel study

Both numbers and weights of yellowtail catches increased during darkness and dropped off during daylight (Table 2). Length distribution of catches were tabulated for three combinations of the gear: (1) with no tickler chain; (2) with tickler chain attached to footgear; and (3) a combination of catches from both gears. Yellowtail in the size range 4-42 cm were more abundant during night catches (Fig. 2). Ratio of night to day catches showed that the numbers of juvenile yellowtail were 18.88 times higher and adults were 4.87 times higher at night in catches with no tickler chain attached to the footgear (Table 3; Fig. 2A).

In sets with tickler chain attached, catches of juveniles were 10.36 times higher and adults 5.33 times higher at night (Table 3; Fig. 2B). Catches from combination of both gear riggings showed catches of juveniles were 9.64 times higher and adults 4.22 times higher in night catches (Table 3; Fig. 2C).

Age composition of the catches over the 24 hour period showed that the highest catches of all age groups occurred at 1919 hrs, approximately $\frac{1}{2}$ hr after sunset (Fig. 3). Catches of all age groups decreased gradually during the night to sunrise.

Comparison of the relative efficiency of the shrimp trawl fished with and without the tickler chain on juvenile and adult yellowtail catches during day and night fishing sets was also evaluated (Table 4). During daylight the tickler chain increased the catches of juveniles (ratio = 3.75:1) and adults (ratio = 1.98:1). During darkness the tickler chain increased the catches of juveniles (ratio = 2.06:1) and adults (ratio = 2.17:1) (Table 4).

B. 1985 and 1986 Biomass surveys

Because a diel trend was seen in the diel studies of 1981 and 1982 (Walsh, unpubl.) and confirmed in the 1986 study, juvenile biomass surveys for yellowtail, using a small mesh shrimp trawl, were designed in 1985 and 1986 to give independent day and night estimates of abundance and biomass by proportioning the number of sets in each stratum on a 50:50 split in day and night sets prior to beginning of each survey. Abundance and biomass estimates of yellowtail during night fishing sets were 2.06 and 1.91 times higher, respectively, than day estimates in 1985 and 2.38 and 1.66 times higher, respectively, than day estimates in 1986 (Table 5).

Statistical analysis of the difference in catches of yellowtail from selected strata of the biomass surveys in fall of 1985 and 1986 showed both mean number per tow and mean weight per tow were significantly higher during night catches ($P < .05$) (Tables 6, 7, and 10). Data was extrapolated from the Canadian regular groundfish biomass surveys in the spring of 1985 and 1986 and divided into day and night estimates for selected strata in order to compare the standard otter trawl with the small mesh shrimp trawl (Tables 8 and 9). Mean number and weight per tow also showed significantly higher catches at night ($P < .05$) (Table 10).

C. Juvenile yellowtail surveys

Survey results from data collected during 1981, 1982, 1983, 1985, and 1986 Canadian juvenile flatfish surveys show that the distribution of age 1 yellowtail flounder on the Grand Banks is not as wide spread as the adult population (Fig. 4). Juveniles were distributed mainly in and around the Southeast Shoals with strata 375, 376, 360, 361, and 352 being the sites of any amount of concentrations (Fig. 5).

Given that a diel variability trend has been shown to exist in trawl catches of yellowtail, average number per set at age were generated from selected strata listed above and compared with the results from the entire (combined) survey for both 1985 and 1986 (Table 11; Fig. 6 and 7). Indices of both juvenile and adult yellowtail were higher in night surveys of selected strata than in either the day surveys or the combined surveys. Estimates of juveniles were low in 1985 due to coverage of selected strata in 1985 not being as extensive as in 1986 (Table 12, 13, 14, and 15).

Conclusions

1. A 24-hour diel study has shown that higher catch rates of juvenile and adult yellowtail occurred during the hours of darkness than in daylight.
2. Diel variability in trawl catches of yellowtail flounder have been shown statistically to exist in both spring and fall surveys of Div. 3LNO in 1985 and 1986 with biomass and abundance estimates being higher during night surveys.
3. Average number per set at age of juvenile yellowtail (and adults) was higher during night survey results in selected strata when compared with day and combined survey results in 1985 and 1986.
4. Limited distribution and diel variability are important parameters in the design of surveys for juvenile yellowtail and estimation of recruitment indices.

References

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Table 1. Summary of survey designs and various trawl's riggings used in the analysis of catches of yellowtail flounder on the Grand Bank: NAFO Divisions 3L, 3N, and 3O.

Time	Survey type	Trawl design	Maximum headline height (m)	Maximum wing spread (m)	Trawl mesh size (mm)	Codend liner (mm)	Towing speed (knots)	Vessel
Sept. 2-3, 1986	24 hr-diel	No. 41 Yankee shrimp trawl with and without tickler chain	2.70	13.20	38.10	12.70	2.5	W. TEMPLEMAN
Aug. 30-Sept. 17, 1985	Random-stratified	No. 41 Yankee shrimp	2.70	13.20	38.10	12.70	2.5	W. TEMPLEMAN
Aug. 23-Sept. 18, 1986								
Apr. 10-May 27, 1985	Random-stratified	Engels 145 High Rise	6.69	15.20	117.80 to 130.30	28.70	3.5	W. TEMPLEMAN A. NEEDLER
Apr. 17-May 25, 1986								

Table 2. Total numbers and weights of all yellowtail catches during the 24 hour diel survey. Fishing gear used: No. 41 Yankee Shrimp trawl with and without a tickler chain attached. 1986.

Set no.	Time (hrs) (NST) midpoint	Gear	Total no.	Total wt (kg)	Light conditions ^a
1	0457	No chain	268	61.00	Darkness
2	0559	Chain	227	109.70	Sunrise - clear
3	0753	Chain	163	32.50	Daylight - clear
4	0902	No chain	114	38.50	Daylight - clear
5	1201	No chain	169	79.00	Daylight - clear
6	1310	Chain	322	64.96	Daylight - heavy fog
7	1427	Chain	314	98.60	Daylight - heavy fog
8	1531	No chain	68	23.80	Daylight - clear
9	1647	No chain	82	35.40	Daylight - clear
10	1747	Chain	206	49.30	Daylight full cloud cover
11	1922	Chain	2571	493.71	Darkness
12	2144	No chain	1332	240.60	Darkness
13	2343	No chain	1241	110.75	Darkness
14	0154	Chain	1210	136.50	Darkness
15	0305	No chain	766	169.00	Darkness
16	0533	Chain	338	98.00	Sunrise

^aSunrise 0520 hrs; sunset 1841 hrs.

Table 3. Mean catch per tow of yellowtail ≤ 22 cm and ≥ 22 cm from day and night catches during the 24 hour diel study with different combinations of fishing gears.

$$\text{Ratio} = \frac{\text{Average night catch}}{\text{Average day catch}}$$

Year	Fishing gear	≤ 22 cm Day			≤ 22 cm night			Ratio	> 22 cm Day			> 22 cm night			Ratio
		No. of sets	\bar{X}	S.E.	No. of sets	\bar{X}	S.E.		No. of sets	\bar{X}	S.E.	No. of sets	\bar{X}	S.E.	
1986	No. 41 shrimp trawl	4	26.75	5.19	4	505.00	185.07	18.88:1	4	81.50	23.55	4	396.50	93.96	4.87:1
1986	No. 41 shrimp trawl with tickler chain	6	100.33	16.23	2	1039.50	299.10	10.36:1	6	161.50	22.93	2	860.50	393.67	5.33:1
1986	No. 41 shrimp trawl with and without chain	10	70.90	15.36	6	683.17	179.68	9.64:1	10	130.50	21.10	6	551.77	152.84	4.22:1

Table 4. Comparison of the relative efficiency of using a tickler chain in day and night sets of yellowtail (≤ 22 cm and > 22 cm) with fishing sets without a tickler chain. Data derived from 1986 diel survey.

≤ 22 cm Day			≤ 22 cm Night			> 22 cm Day			> 22 cm Night		
No chain \bar{X}	Chain \bar{X}	Ratio	No chain \bar{X}	Chain \bar{X}	Ratio	No chain \bar{X}	Chain \bar{X}	Ratio	No chain \bar{X}	Chain \bar{X}	Ratio
26.75	100.33	3.75:1	505.00	1039.50	2.06:1	81.50	161.50	1.98:1	396.50	860.50	2.17:1
<u>S.E.</u>	<u>S.E.</u>		<u>S.E.</u>	<u>S.E.</u>		<u>S.E.</u>	<u>S.E.</u>		<u>S.E.</u>	<u>S.E.</u>	
5.19	16.23		185.07	299.10		23.55	22.93		93.96	393.67	

Table 5. Average numbers and weights of yellowtail per 30 minute tow for Div. 3LNO. Abundance and biomass estimates are given at bottom of the table. Day and night and surveys, 1985 and 1986.

Division	Stratum		1985		1986	
			Day survey	Night survey	Day survey	Night survey
3Ø	338	No. of sets	-	-	3	-
		Ave. no./set			86.67	
		Ave. wt/set			41.17	
3L	350	No. of sets	2	3	-	5
		Ave. no./set	8.00	93.00		9.40
		Ave. wt/set	3.50	40.17		4.30
3Ø	351	No. of sets	2	1 ^a	5	4
		Ave. no./set	108.50	281.00	142.00	218.00
		Ave. wt/set	44.00	103.0	47.70	88.88
3Ø	352	No. of sets	-	-	7	6
		Ave. no./set			78.29	365.33
		Ave. wt/set			37.86	115.47
3Ø	353	No. of sets	-	-	3	2
		Ave. no./set			97.69	148.50
		Ave. wt/set			60.17	81.63
3N	360	No. of sets	3	-	7	7
		Ave. no./set	57.67		20.57	497.71
		Ave. wt/set	26.83		5.50	34.43
3N	361	No. of sets	4	2	4	4
		Ave. no./set	58.50	182.50	160.00	217.00
		Ave. wt/set	26.13	63.50	72.81	50.75
3N	362	No. of sets	5	4	5	2
		Ave. no./set	117.80	228.25	110.80	105.00
		Ave. wt/set	45.00	77.63	43.56	42.00
3L	363	No. of sets	3	2	3	2
		Ave. no./set	44.00	68.50	42.81	58.00
		Ave. wt/set	17.67	26.00	19.95	42.00
3L	371	No. of sets	2	2	-	-
		Ave. no./set	0.00	4.50		
		Ave. wt/set	0.00	3.75		
3L	372	No. of sets	5	4	4	4
		Ave. no./set	86.90	100.75	33.00	169.60
		Ave. wt/set	35.08	45.00	17.13	79.13

Table 5 (Cont'd.)

Division	Stratum		1985		1986	
			Day survey	Night survey	Day survey	Night survey
3N	373	No. of sets	5	5	4	3
		Ave. no./set	34.80	286.80	160.50	49.50
		Ave. wt/set	17.40	133.80	69.88	22.56
3N	374	No. of sets	2	2	-	3
		Ave. no./set	10.50	21.50		14.67
		Ave. wt/set	5.25	9.75		7.83
3N	375	No. of sets	4	3	2	3
		Ave. no./set	60.50	452.00	4.10	391.69
		Ave. wt/set	36.50	194.33	1.40	191.05
3N	376	No. of sets	1 ^a	1 ^a	3	1 ^a
		Ave. no./set	41.00	256.00	69.67	1094.00
		Ave. wt/set	27.00	68.50	19.70	542.75
3N	383	No. of sets	2	2	-	-
		Ave. no./set	0.00	0.00		
		Ave. wt/set	0.00	0.00		
3L	384	No. of sets	2	2	-	-
		Ave. no./set	69.50	1.00		
		Ave. wt/set	44.75	1.00		
Mean number			59.27	157.95	84.70	204.72
Abundance (no.x10 ⁻³)			152,171	313,012	229,555	546,255
Mean number			26.29	65.15	36.08	61.73
Biomass ('000 t)			67.5	129.1	97.8	164.7

^aStratum with less than 2 set deleted from calculation of indices by the STRAP program (Smith and Somerton 1981).

Table 6. Mean number per standard tow of yellowtail from selected strata of Divisions 3LNO, 1985 and 1986 juvenile biomass surveys. Sets ½ hr before and after sunrise and sunset were deleted as well as stratum that had fishing sets in only 1 time period. Trawl: No. 41 Yankee shrimp; Time: August-September

NAFO Division	Stratum	1985								1986							
		Day				Night				Day				Night			
		No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.
3Ø	351	2	217	108.50	69.50	1	281	-	-	5	710	142.00	49.05	4	872	218.00	54.10
3Ø	352	-	-	-	-	-	-	-	-	7	548	78.29	13.70	6	2192	365.33	83.38
3Ø	353	-	-	-	-	-	-	-	-	3	293	97.67	79.43	2	297	148.50	145.15
3N	360	-	-	-	-	-	-	-	-	6	144	24.00	24.00	7	3484	497.71	192.06
3N	361	4	234	58.50	26.66	2	365	182.50	110.50	4	640	160.00	62.26	4	868	217.00	85.27
3N	362	5	589	117.80	52.80	4	913	228.25	69.94	5	554	110.80	21.12	2	210	105.00	46.00
3L	372	5	435	86.90	44.42	4	403	100.75	70.57	3	104	34.67	15.67	4	676	169.00	63.93
3N	373	4	59	14.75	13.14	4	1345	336.00	204.38	3	249	83.00	41.36	3	149	49.50	41.81
3N	375	4	242	60.50	26.89	3	1356	452.00	177.96	1	5	-	-	3	1175	391.69	139.84
3N	376	1	41	-	-	1	256	-	-	3	209	69.67	31.75	1	1094	-	-
Overall total		25	1817	72.68	14.52	19	4919	258.89	56.66	40	3456	86.40	13.01	36	11017	306.03	52.63

Table 7. Mean weight per standard tow of yellowtail from selected strata in Divisions 3LNO, 1985 and 1986 juvenile biomass surveys. Sets ½ hr before and after sunrise and sunset were deleted as well as stratum that had fishing sets in only 1 time period. Trawl: No. 41 Yankee shrimp; Time: August-September.

NAFO Division	Stratum	1985								1986							
		Day				Night				Day				Night			
		No. sets	Total wt.	X	S.E.	No. sets	Total wt.	X	S.E.	No. sets	Total no.	X	S.E.	No. sets	Total wt.	X	S.E.
3Ø	351	2	88.00	44.00	27.00	1	103.00	-	-	5	238.50	47.70	11.05	4	355.50	88.88	22.59
3Ø	352	-	-	-	-	-	-	-	-	7	265.00	37.86	7.28	6	692.80	115.47	23.53
3Ø	353	-	-	-	-	-	-	-	-	3	180.50	60.17	50.26	2	163.26	81.63	80.13
3N	360	-	-	-	-	-	-	-	-	6	38.50	6.42	64.42	7	241.00	34.43	12.85
3N	361	4	104.50	26.13	10.98	2	127.00	63.50	35.50	4	291.25	72.81	29.45	4	203.00	50.75	13.09
3N	362	5	225.00	45.00	19.91	4	310.50	77.63	28.71	5	217.80	43.56	7.10	2	84.00	42.00	18.00
3L	372	5	175.40	35.08	19.10	4	180.00	45.00	31.40	3	53.50	17.83	8.38	4	316.50	79.13	33.31
3N	373	4	26.50	6.63	5.82	4	633.00	158.25	100.40	3	118.00	39.33	20.70	3	67.67	22.56	19.06
3N	375	4	146.00	36.50	19.22	3	583.00	194.33	84.46	1	1.30	-	-	3	573.16	191.05	80.57
3N	376	1	27.00	-	-	1	68.50	-	-	3	59.10	19.70	11.14	1	542.75	-	-
Overall total		25	792.40	31.70	6.71	19	2005	105.53	26.79	40	1463.45	36.59	5.81	36	3239.64	89.99	17.50

Table 8. Mean number per standard tow of yellowtail from selected strata in Divisions 3LN0, 1985 and 1986 regular biomass surveys. Sets ½ hr before and after sunrise and sunset were deleted as well as stratum that had fishing sets in only 1 time period. Trawl: Engel 145 High-Rise; Time: April-May.

NAFO Division	Stratum	1985								1986							
		Day				Night				Day				Night			
		No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.	No. sets	Total no.	X	S.E.
3Ø	351	4	419	104.75	58.60	5	487	97.40	27.61	6	405	67.50	15.79	6	813	135.50	50.34
3Ø	352	7	238	34.00	8.66	3	325	108.33	78.55	8	387	48.38	14.88	4	676	169.00	98.37
3Ø	353	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3N	360	6	272	45.33	27.48	7	1507	215.29	66.80	6	8	1.33	0.88	4	318	79.50	31.28
3N	361	4	188	47.00	11.68	3	827	275.67	108.69	9	387	43.00	7.54	1	600	-	-
3N	362	7	302	43.14	11.98	3	563	187.67	53.43	3	166	55.33	14.31	10	2151	215.10	71.84
3L	372	3	98	32.67	28.20	8	1375	171.88	51.54	9	444	49.33	18.27	5	591	118.20	42.53
3N	373	4	232	58.00	20.00	4	97	24.25	11.32	-	-	-	-	-	-	-	-
3N	375	4	423	105.75	23.78	4	932	233.00	112.74	3	70	23.33	14.68	4	3412	853.00	144.81
3N	376	2	155	77.50	69.50	4	613	153.25	35.38	4	36	9.00	4.95	5	1339	267.80	123.95
Overall total		41	2327	56.76	8.84	41	6726	164.05	22.53	48	1903	39.65	5.62	39	9900	253.85	46.19

Table 9. Mean weight per standard tow of yellowtail from selected strata in Divisions 3LN0, 1985 and 1986 regular biomass surveys. Sets ½ hr before and after sunrise and sunset were deleted as well as stratum that had fishing sets in only 1 time period. Trawl: Engel 145 High-Rise; Time: April-May.

NAFO Division	Stratum	1985								1986							
		Day				Night				Day				Night			
		No. sets	Total wt.	X	S.E.	No. sets	Total wt.	X	S.E.	No. sets	Total wt.	X	S.E.	No. sets	Total wt.	X	S.E.
3Ø	351	4	186.80	46.70	25.86	5	193.50	38.70	11.22	6	179.50	29.92	7.08	6	332.90	55.48	19.79
3Ø	352	7	116.00	16.57	4.19	3	154.50	51.50	37.55	8	195.00	24.38	7.68	4	281.50	70.38	40.00
3Ø	353	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3N	360	6	124.50	20.75	11.85	7	672.00	96.00	28.94	6	6.50	1.08	0.69	4	161.50	40.38	15.85
3N	361	4	91.50	22.88	4.44	3	344.50	114.83	44.09	9	190.50	21.17	3.26	1	250.00	-	-
3N	362	7	125.00	17.86	5.06	3	232.00	77.33	21.91	3	79.50	26.50	7.47	10	931.00	93.10	29.05
3L	372	3	50.50	16.83	14.59	8	586.50	73.31	22.00	9	224.50	24.94	9.29	5	283.50	56.70	19.90
3N	373	4	106.00	26.50	8.66	4	51.00	12.75	5.33	-	-	-	-	-	-	-	-
3N	375	4	251.50	62.88	15.04	4	482.50	120.63	56.55	3	35.20	11.73	6.59	4	1772.10	443.03	70.98
3N	376	2	79.00	39.50	32.00	4	264.50	66.13	15.43	4	18.20	4.55	2.16	5	744.75	148.95	74.12
Overall total		41	1130.80	27.58	4.29	41	2981.00	72.71	10.16	48	928.90	19.35	2.73	39	4757.25	121.88	23.44

Table 10. Statistical analysis of day and night catches of yellowtail using a Mann-Whitney U test. NAFO Div. 3L, 3N and 3O. Untransformed data ($\alpha = .05$) from selected strata. Sets $\frac{1}{2}$ hr before and $\frac{1}{2}$ hr after sunrise and sunset removed. Only stratum with fishing sets in both day and night times used.

Survey trawl	Year	Category	No. of sets	Mean score	Z value	p value
No. 41 Yankee shrimp trawl	85	Number	Day =25 Night=19	16.68 30.16	3.44	.0003
		Weight	Day =25 Night=19	17.00 29.74	3.25	.0006
No. 41 Yankee shrimp trawl	86	Number	Day =40 Night=36	28.81 49.26	4.03	.0001
		Weight	Day =40 Night=36	31.70 46.06	2.83	.0002
Engel-145 High-rise otter trawl	85	Number	Day =41 Night=41	31.49 51.51	3.80	.0001
		Weight	Day =41 Night=41	31.65 51.35	3.74	.0000
Engel-145 High-rise otter trawl	86	Number	Day =48 Night=39	31.33 59.59	5.19	.0000
		Weight	Day =48 Night=39	31.81 59.00	4.99	.0000

Table 11. Comparison of average number per set at age by day and night surveys from selected strata in NAFO Divisions 3NO with the combined surveys of Divisions 3LNO during 1985 and 1986.

Age	1985				1986			
	Day survey (11 sets)	Night survey (5 sets)	Total (18 sets)	Combined survey (76 sets)	Day survey (23 sets)	Night survey (20 sets)	Total (44 sets)	Combined survey (99 sets)
1	0.22	5.35	4.72	1.47	0.50	49.03	21.48	8.02
2	1.13	1.97	2.76	0.98	1.23	35.30	16.95	6.31
3	0.74	1.91	1.43	1.23	3.74	51.98	27.29	10.22
4	1.39	21.39	7.29	4.93	3.25	17.21	10.05	4.02
5	4.87	17.93	9.98	4.75	5.76	32.39	18.99	8.20
6	5.94	42.28	14.67	14.83	11.23	59.69	41.41	24.87
7	17.43	106.35	35.32	44.95	21.69	76.88	53.87	51.27
8	21.20	99.15	35.45	28.00	14.98	49.52	41.66	30.56
9	5.25	11.42	7.10	3.71	1.52	9.07	8.07	3.94
10	0.44	0.27	0.36	0.13	0.25	0.78	0.62	0.26
11					0.0	0.15	0.08	0.03
Unknown	0	0	0	0	0	0	0	0.01
Average no. per set	58.61	308.01	119.08	104.99	64.15	382.01	240.46	147.71

Table 15. Distribution of numbers at age from night survey of selected strata: 1986.

Age/set	Stratum 352				Stratum 360				Stratum 361			Stratum 375		Stratum 376							
	47	48	110	113	114	121	90	91	93	94	100	101	102	74	46	111	112	55	57	58	56
1	2	6	7	0	0	0	172	106	173	125	0	390	36	2	1	9	3	0	0	1	5
2	2	3	5	8	0	0	33	10	186	98	0	315	24	5	2	9	20	1	10	6	30
3	6	1	3	11	2	0	5	0	519	171	1	253	32	9	4	11	28	3	16	9	71
4	38	1	12	18	8	0	2	0	127	18	0	13	14	13	4	10	37	3	22	9	18
5	84	5	35	59	22	0	4	0	184	11	0	9	25	19	16	35	85	10	37	15	47
6	213	56	96	129	88	1	4	1	126	2	0	32	61	20	23	60	57	68	101	52	267
7	150	175	239	142	139	1	1	4	19	2	0	17	38	24	28	43	149	31	164	148	257
8	40	58	158	48	77	1	4	12	10	6	1	13	28	18	12	23	75	14	202	146	316
9	3	2	10	2	24	0	2	6	3	1	0	0	5	3	1	2	8	7	60	27	81
10	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-

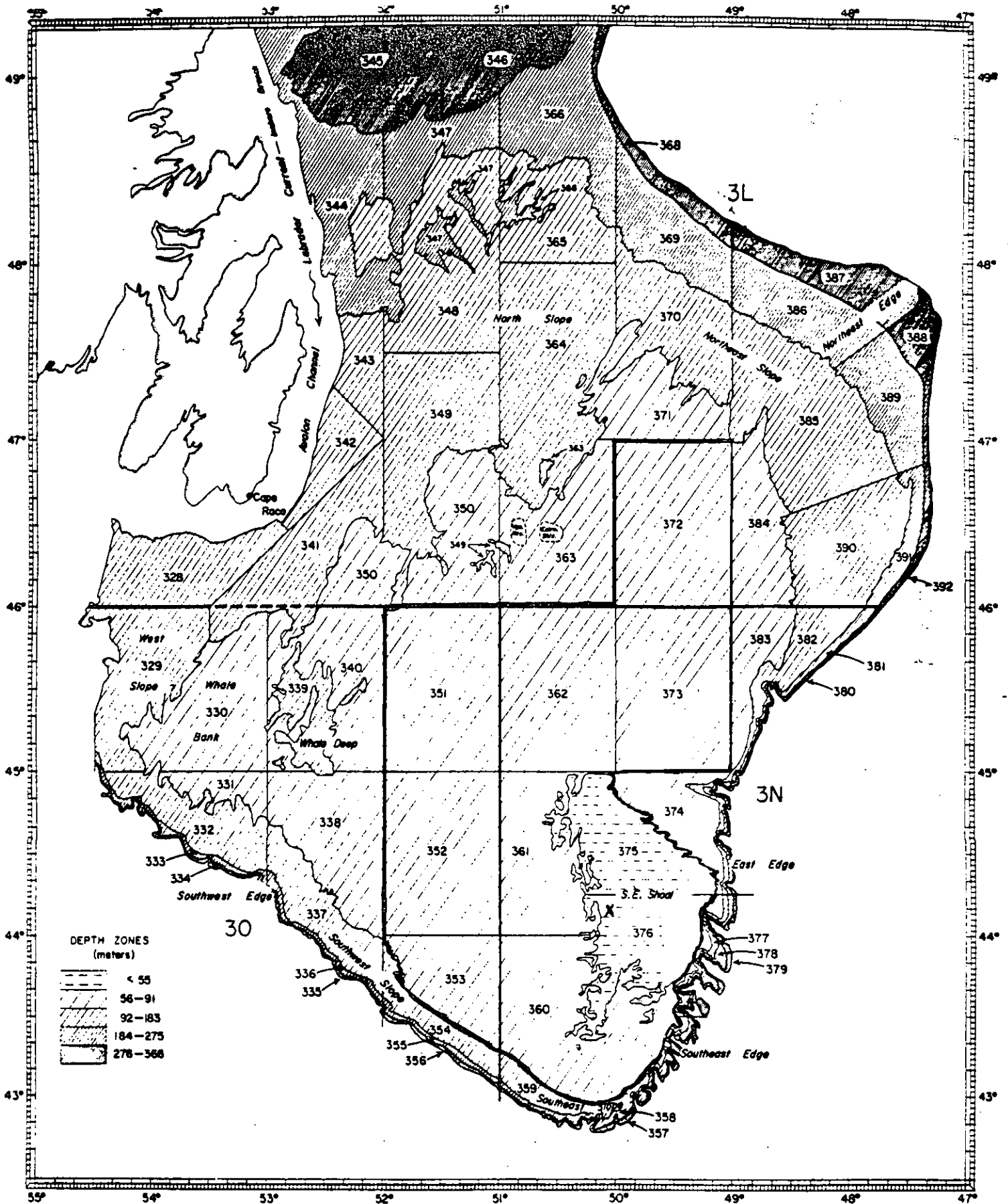


Fig. 1. Stratification chart of the Grand Bank, NAFO Divisions 3L, 3N, and 30 showing selected strata (heavy inked) used in biomass estimates. Twenty-four hour diel station is denoted as "X" in Stratum 376.

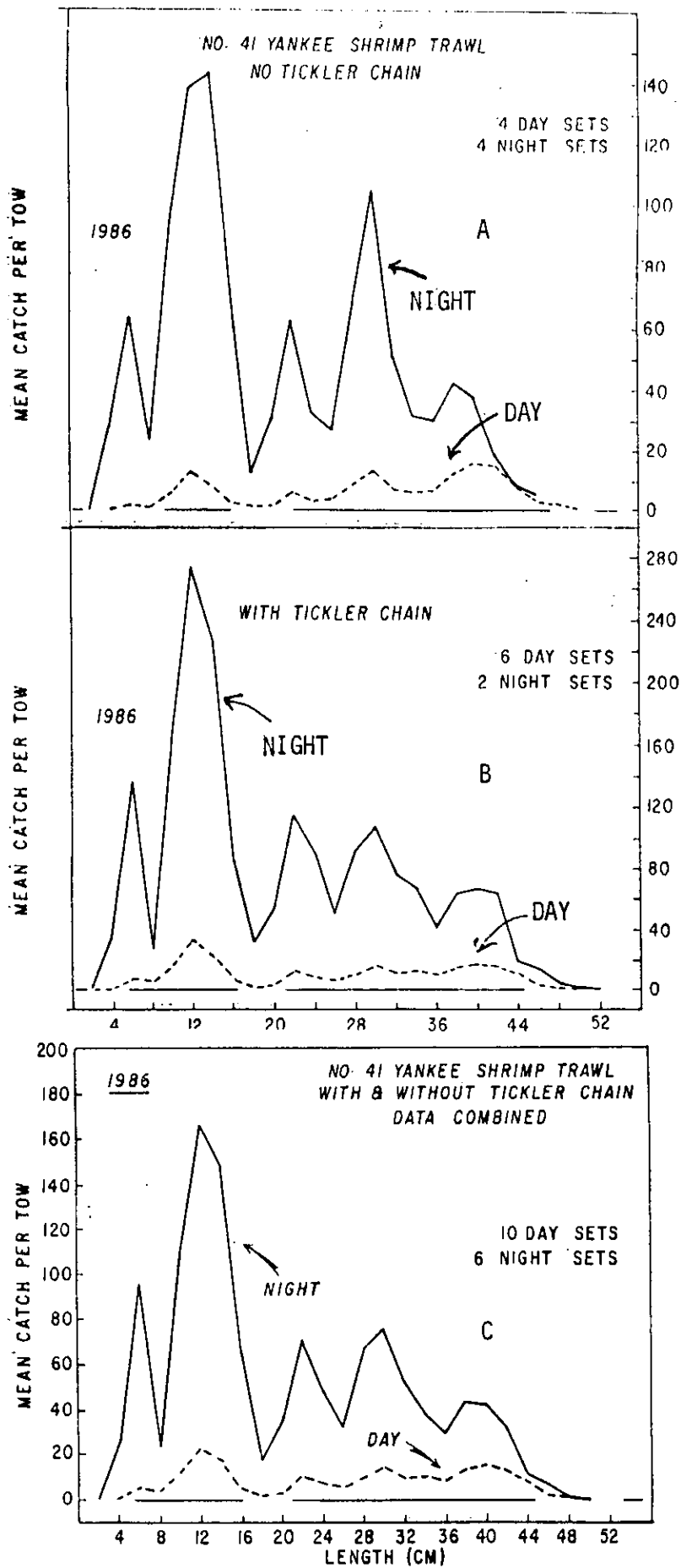


Fig. 2. Length distribution of catches of yellowtail flounder during the 1986 diel study: Combinations of rrigings of footgear on the trawl. NAFO Division 3N, 1986.

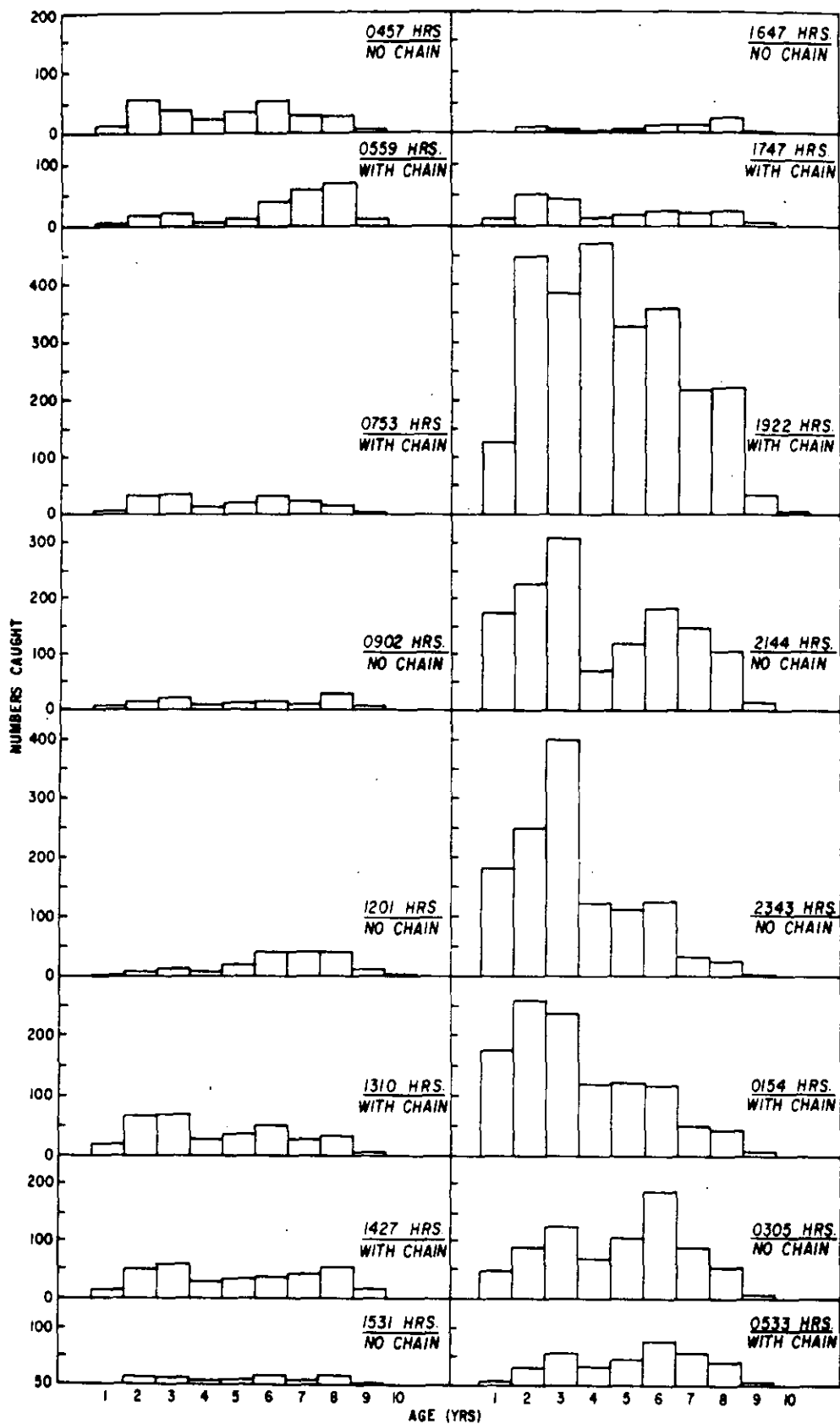


Fig. 3. Numbers caught at each diel set of yellowtail over the 24 hour diel study. NAFO Division 3N, 1986.

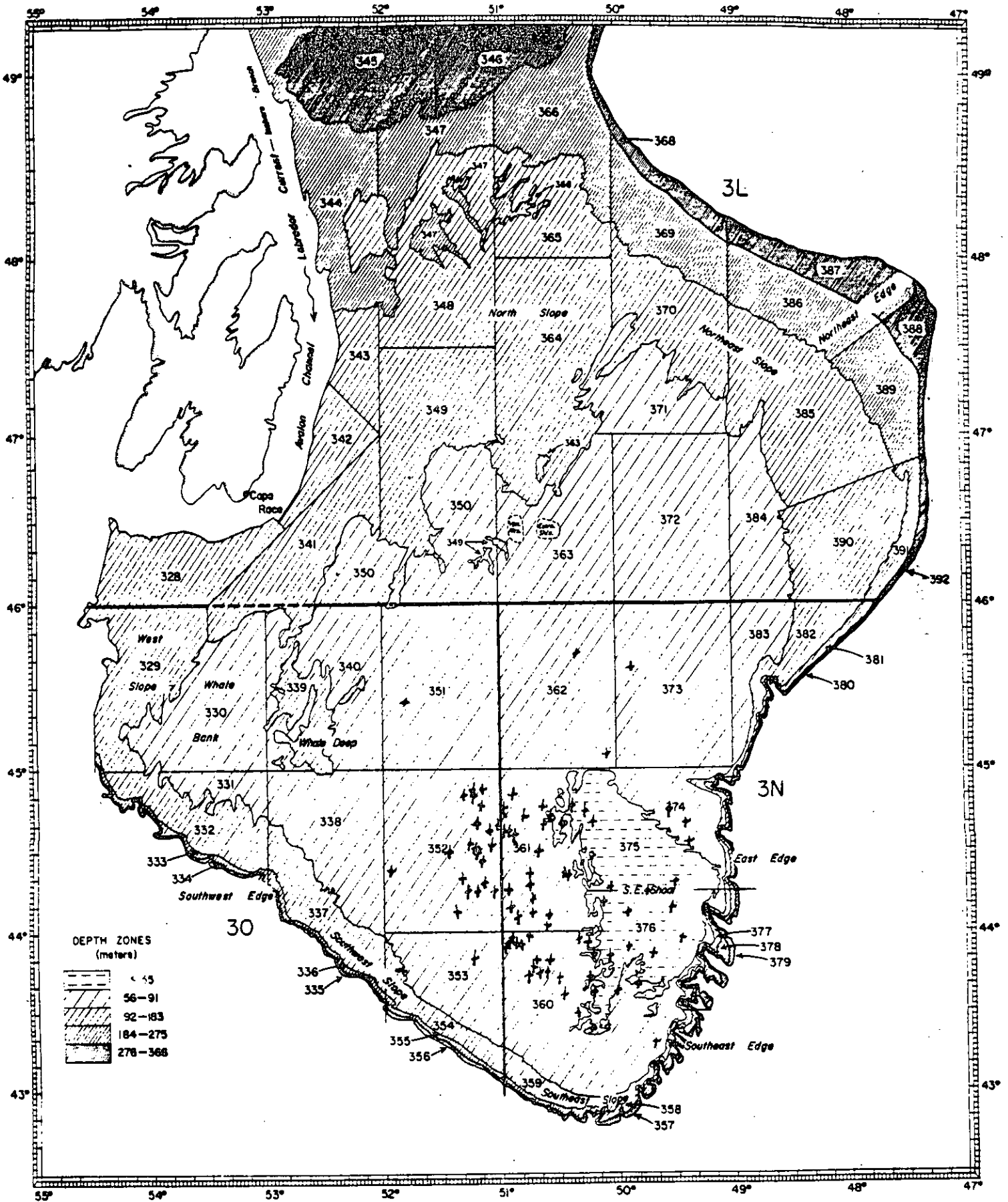


Fig. 4. Distribution of catches of 1 year yellowtail flounder from surveys in 1981-83, 1985-86.

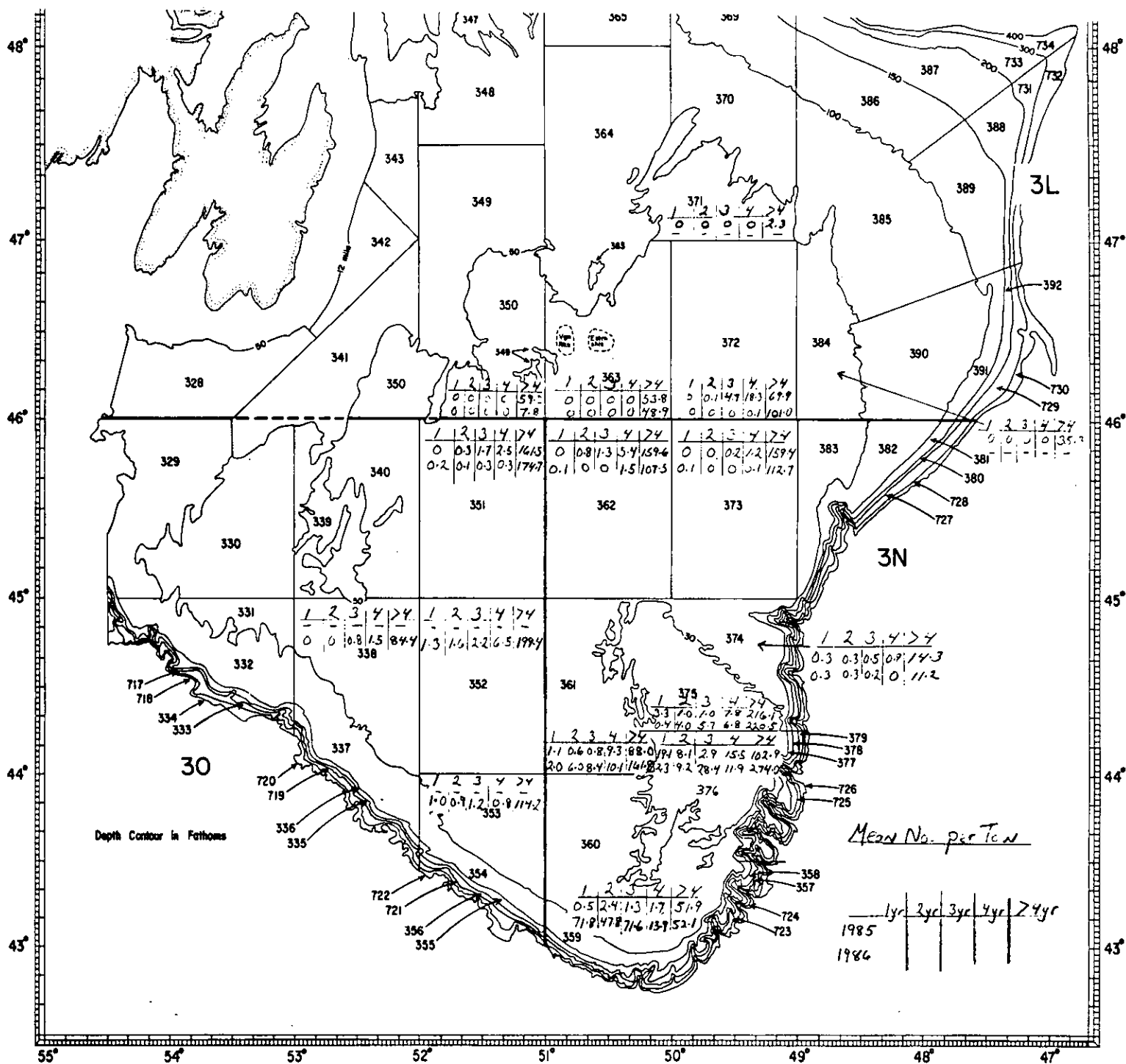


Fig. 5. Distribution and relative abundance of juvenile (1-4yr) and the adult yellowtail population (> 4yr olds) from the 1985 and 1986 juvenile surveys: NAFO Div. 3LNO.

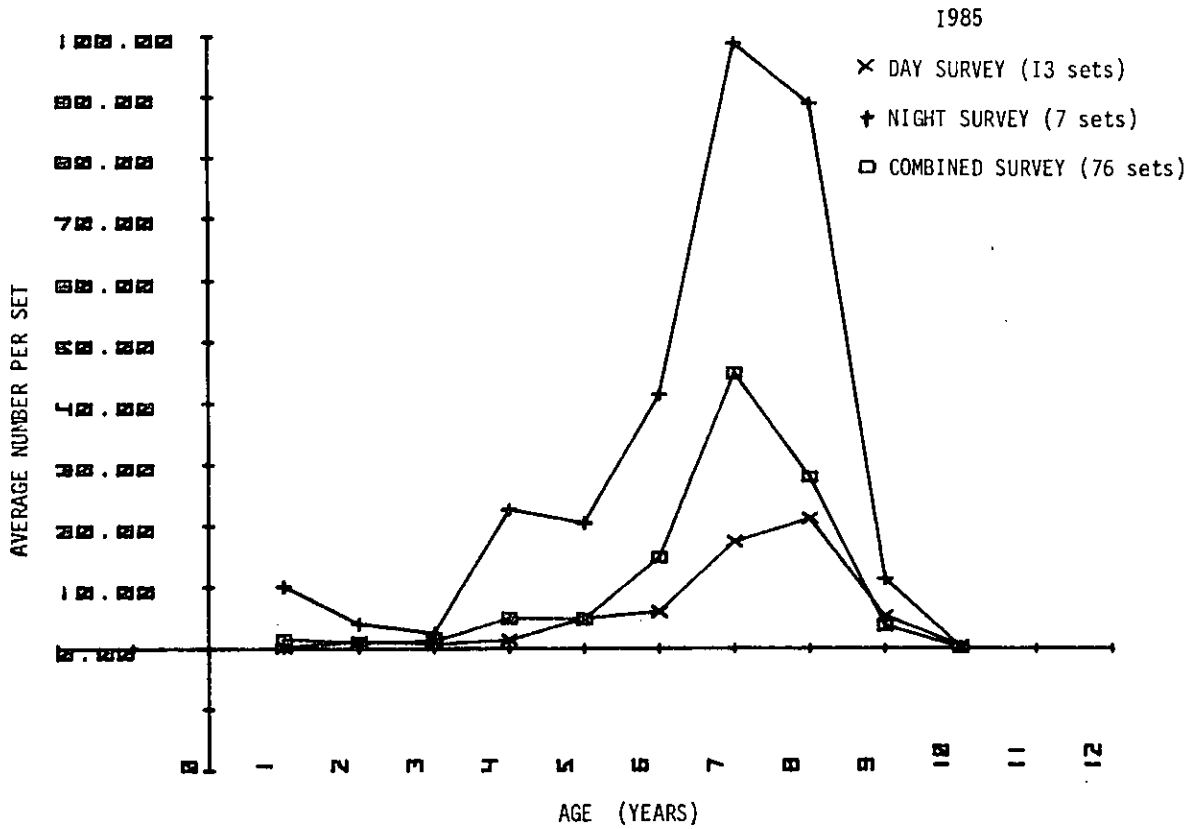


Fig. 6. Average number per set at age of yellowtail in selected strata from day and night surveys, Div. 3NO and the combined survey of Div. 3LNO, 1985

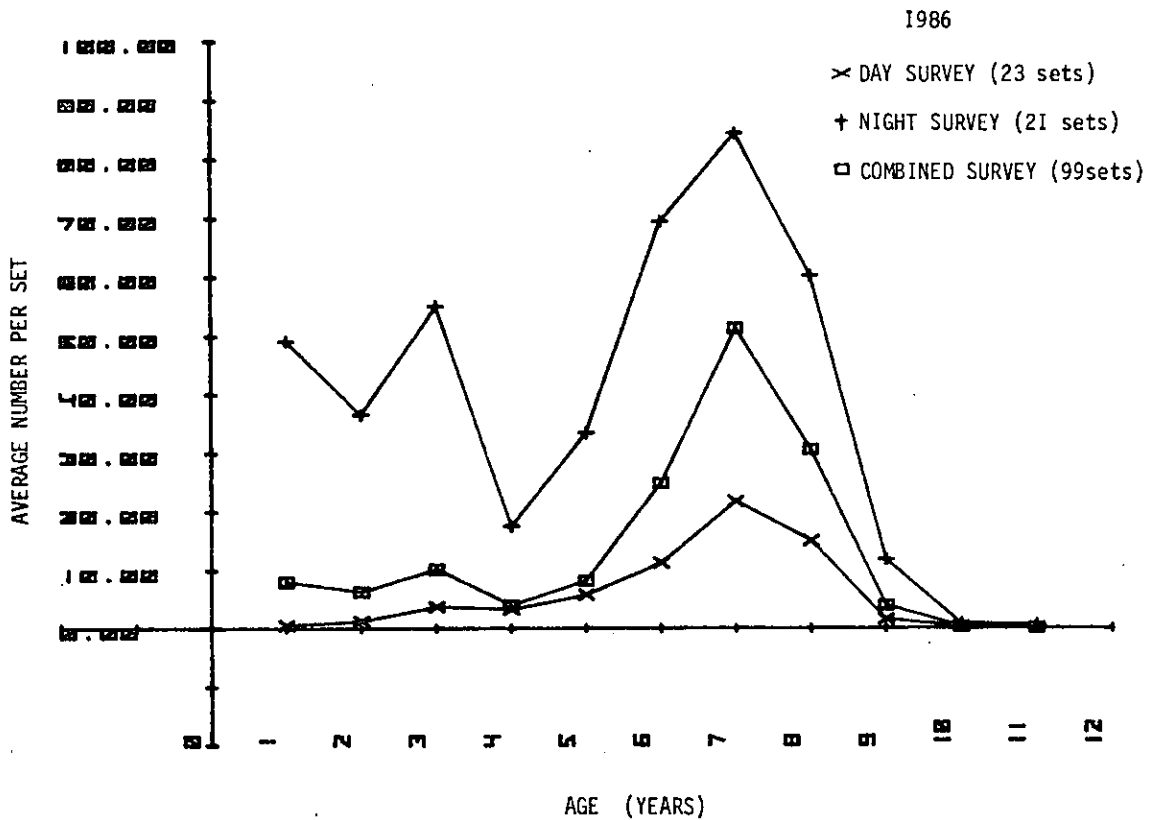


Fig. 7. Average number per set at age of yellowtail in selected strata from day and night surveys, Div 3NO and the combined survey of Div. 3LNO, 1986.