1991 Digby (Bay of Fundy) Scallop Stock Assessment

by

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ABSTRACT

The strong recruitment pulse first observed in the 1986 research stock survey is now largely gone. This pulse of animals has kept landings high for almost five years. At present the number of scallops in the traditional beds have returned to average abundance levels. Low numbers of 2 year old scallops (prerecruits) detected in the 1991 survey foreshadows lower catches predicted for 1992-93.

Despite lower scallop abundance, 1991 landings in the Bay of Fundy remain high with over 1600 t landed at Digby (statistical district 38) alone. This is partly due to the exploitation of scallop beds below Brier Island by the Bay of Fundy fleet from May through to October of 1991. Meat yield for the inside zone was very high when the grounds opened in October.

With poor log compliance and irregular fleet movements through the year, it is extremely difficult to establish an estimate of scallop production. Log compliance, however, has increased and if this trend continues better CPUE estimates should be available in the future.

RÉSUMÉ

La forte vague de recrutement observée depuis la campagne d'évaluation des stocks de 1986 est maintenant épuisée. Elle a tenu les débarquements à des niveaux élevés pendant près de cinq ans. À l'heure actuelle, dans les gisements traditionnels, l'abondance des pétoncles est revenue à la moyenne. Le petit nombre de pétoncles de deux ans (pré-recrues) observé dans la campagne d'évaluation de 1991 laisse présager des prises plus basses pour 1992-1993.

Malgré la moindre abondance, les débarquements de 1991 dans la baie de Fundy sont demeurés élevés. À Digby seulement (district de statistique 38), on a débarqué plus de 1 600 t de pétoncles. Ce phénomène est imputable en partie à l'exploitation de gisements de pétoncles situés au-delà de l'île Brier par la flottille de la baie de Fundy, de mai à octobre 1991. Le rendement en chair à l'intérieur de la baie s'est avéré très élevé en octobre, à l'ouverture des lieux de pêche.

Il est extrêment difficile d'estimer la production de pétoncles en raison des mouvements irréguliers des flottilles et du faible taux d'établissement des journaux de pêche. Ce dernier est toutefois à la hausse; si cette tendance se maintient, on devrait être en mesure d'établir de meilleures estimations des PUE.

BACKGROUND

The scallop beds off Digby, N.S. have been in a state of flux over the last six years. Two strong recruitment pulses, first observed in 1986 and 1987 as 2 year old animals, contributed to unprecedentedly high landings in 1988 through to 1991. While scallop abundance increased in many parts of the Bay due to these year classes, the greatest concentration of scallops was centered on the inside fishing zone from Parkers Cove to Gulliver's Head and off Cape Spencer, N.B. (Fig. 1). In the spring of 1989, the incidence of "clappers" (empty paired shells) off Digby rose from an average of 3% over the previous four years to an estimated 23%. By the fall, this value further increased to 51%, with over 90% dead in some areas. Consequently, the fleet targeted the Cape Spencer bed during the winter of 1989-90. The fleet returned to fish the inside zone in October 1990, with the depletion of the Cape Spencer bed. In May 1991, poor catches in the outside zone led to fishing off Brier Island and the Lurcher Shoals. The fleet returned to the inside zone in October of 1991. Meat yield was exceptionally high for this area at the beginning of the season. However it is expected that poor catches throughout the Digby grounds will force the fleet to become much more mobile. In a fishery where log compliance is negligible, such movements off the traditional beds further erode the management database by complicating interpretation of the landings.

This document presents data on scallop abundance on the Digby grounds and a record of fleet activity throughout the year with predictions for landings in 1992.

METHODS

Fishery Data

Information on fishing effort is calculated using data from two main sources: logbooks and sales slips.

Captains of all scallop vessels over 25.5 G.T. are legally required to maintain logbooks. Logbooks provide information on catch location and effort data. While many small vessel operators (less than 25.5 G.T. and/or under 14 m L.O.A.) provide log information, they are not required to do so by law. Vessel compliance with log regulations has been very poor over recent years; only 28% of the over 25.5 G.T. full Bay of Fundy licensed vessels submitted logs in 1991 (Table 1). This is an improvement over 1990 when only 14% of the logs of the Bay of Fundy licences were submitted.

Fleet activity has been monitored through sales slip records and port sampling information.

Survey Procedures

The 1991 stock assessment survey was carried out from June 17 to June 28 following the protocols used in previous years (Robert et al. 1985).

Due to the small amount of fishing log information during the past two years it was not possible to set up meaningful catch strata for this survey as has previously been done (Kenchington and Lundy,1991). 100 stations were assigned to each of 3 areas as follows:

Core Area (Gulliver's Head to Delaps Cove)	75
Above Core area (Parkers Cove to Hampton)	15
Below Core area (Gulliver's Head to Centerville)	10

giving considerably more weight to the traditional beds off Digby Gut (Fig. 1).

Seven sub-areas were further defined by 3 mile wide bands extending toward mid-Bay from shore landmarks (e.g. Gullivers Head, Fig. 1), except for the Digby Gut band which was 5.5 miles wide. The total area of each sub-area was calculated as well as the area between the seven sub-area bands (e.g. between Digby Gut and Delaps Cove) within the Core Area. The percentage of the total Core Area occupied by each band was calculated. This percentage was then used to weight the number of stations per designated band in the Core Area. The locations of each station within a sub-area were selected randomly.

The research vessel "J.L. Hart" was used to sample the survey stations. A 4-gang Digby drag was used with alternating lined (38 mm stretch mesh shrimp netting) and unlined buckets. At each station the catch per bucket (live animals plus clappers(dead paired shells)) is weighed and the number of animals in 5 mm increment shell height classes is recorded. Live animals are processed separately from "clappers". Only data from the inside lined bucket and the outside unlined bucket are used. The number of 2 - 4 year olds (prerecruits) from the lined bucket are added to the number of 5+ year olds (recruits) from the unlined bucket to give a single catch value. The data are prorated to 7-gang catches and 800 m tow distance to provide comparison with historical data fished with conventional gear. Concern was voiced in 1991 of the use of only two of the four buckets to estimate abundance. Accordingly, the numbers of animals at age from the survey were calculated using the traditional approach and by averaging across both buckets after combining the lined and unlined bucket data. The difference in the estimates were neglible (Table 8) and so data were analyzed as previously done in order to maintain consistency of the data set.

Spatial distribution of the scallops was contoured using ACON 5.08 (Black 1988) derived from Delaunay triangles and inverse distance weighted interpolation (Watson and Phillip 1985) as detailed in Robert et al. (1990). The resulting "volume" estimates (i.e. abundance integrated over area) are less accurate in areas of low station densities (Fig. 1).

Biological Data

Three depth-dependent von Bertalanffy growth curves have been established using data from 1982-85 to convert shell height to numbers-at-age matrices (Robert et al. 1985, Robert et al. 1990). The parameters of the curves are as follows:

Depth (m)	Asymptotic Shell Height (mm)	t_0	k
00-85	143.210	1.3800	0.2221
86-105	133.763	1.4011	0.2414
>105	125.989	1.4469	0.2610

Meat weight distribution in a vessel's catch was collected by a port sampler. 500 g meat samples were collected from the vessels as they landed. Individual meat weights and numbers were recorded from each sample. Port sampling was conducted from May through to November 1991.

RESULTS

Fishery Performance

The number of Bay of Fundy licences remained the same in 1991 as in 1990 (Table 1). However, the number of active licences declined to 93; 6 vessels over 25.5 G.T. were inactive. All of these 6 vessels hold dual licences (scallop and groundfish) and were active solely in the groundfish fishery. There has been an improvement in the overall log compliance of this fleet (an increase from 1990 of 100% to give 28% coverage) and the quality and quantity of logs per vessel has improved which reflects a directed effort by the Department of Fisheries and Oceans to increase submissions.

As in previous years, the majority of Bay of Fundy scallop licence holders carried additional licences (Table 2). These include groundfish, swordfish, squid, herring, shrimp and lobster. With the exception of groundfish licences, and one lobster licence, none of these were used for commercial purposes in 1991. Over 55% of the groundfish licences held by these fishermen were in use at some time during the year. Figure 2 shows the overall increase in groundfishing by month in 1992 compared to 1991. In particular more of the dual licence vessels were groundfishing in May, June, November and December as compared to the previous year.

Annual landings on the Nova Scotia side of the Bay of Fundy may indicate general trends in this fishery. Table 3 gives an historical profile of landings for statistical districts 37 (Digby Neck), 38 (Digby) and 39 (Annapolis). The landings data do not identify the location of the catch. In the last decade varying proportions of the landings of vessels over 25.5 G.T. have been attributable to fishing scallop beds outside the Bay (Robert et al. 1990). However in 1988 the high abundance of scallops in the Bay led to negligible fishing outside. In 1989 and 1990 the catches in these districts were supplemented by Cape Spencer catches. The 1991 preliminary landings are down by approximately 600 t for these statistical areas, compared to 1990 values. Over 1600 t were landed in statistical district 38. This level is still high in comparison to previous years and represents the fourth highest landing values on record. However landings in districts 37 and 39 are negligible.

The total catch landed in the Bay of Fundy in 1991 by all licence types (NAFO 4Xr & 4Xs) was approximately 2200 t. 72% of this was landed in Digby by the vessels over 25.5 G.T.

The traditional beds off Digby are fished on a seasonal basis according to zones. The inside fishing zone is closed from May 1 to September 30. Therefore catches from October to April are normally assumed to come from this inside zone. Statistical catches for NAFO sub-subarea 4Xr covering that time period normally match the catches from the inside zone. However, logbook compliance is inadequate and when the fleet lands catches from other parts of the Bay in Digby, estimates for the inside zone are seriously compromised. Table 4 gives the 1991 landings in tons of scallop meats by statistical district throughout the Bay. In 1990-91 a large proportion of the landings were fished in the inside zone from Oct. 1990 through to January 1991. From January -April 1991 logbook data indicates that 42% of the landings were fished in the outside zone.

Table 5 shows monthly catches from the Digby to Yarmouth statistical areas. Landings in Yarmouth increased 500% in 1991 (Table 4). This was a direct result of exploitation of the Brier Island / Lurcher Shoal scallop beds (Lundy and Kenchington 1992) and illegal fishing on Browns Bank. A large proportion of the fleet concentrated in these areas from June to September. Landings in Districts 37 to 39 include landings from these grounds. This is particularly true for June landings when most of the fleet moved south.

Prior to 1980-81 catch rates of about 7 kg/hm and catches of about 250 t per season were maintained in the inside zone. Catches and CPUE then fluctuated throughout the decade. In 1986-87 both indices were low and the inside fishing zone was closed prematurely. In 1988-89 catch and CPUE were at all time record highs (Table 5, Robert et al. 1990).

Estimations of CPUE have improved with the increase in log data and Class 1 data. In 1991-92 CPUE in the inside and outside zones were the same as that reported for 1990-91. (Table 6). This is reflective of the more even distribution of scallops on these grounds. Monthly CPUE was also stable at moderate levels (Fig.3).

Meat weights in the inside zone reached an exceptionally large size in October with an average weight of 30.9 g (Table 7). This is the largest size recorded for October since 1978-79 when sampling was initiated. The meat count in October was well under the 55 meats per 500 g legal limit. Even with growth slowing through the winter, it is expected that counts will be well below legal limits during the 1991-92 inside zone fishing season.

In summary, overall catches by the Bay of Fundy fleet remained high with landings of over 1600 t in 1991. However, this catch was supplemented during the summer months from effort expended on the Brier Island / Lurcher Shoal area. Catches within the Bay of Fundy are expected to decline in 1991-92. Catches and CPUE for the inside zone have assumed more typical levels.

Stock Survey

Annual stock surveys have been carried out for a number of years (Robert et al. 1990) with slight changes in sampling design according to fishery performance. The strong recruitment pulses that settled off Digby were concentrated between 3 - 8 mile from shore from Delaps Cove to Gulliver's Head. Hence more stations were targeted in that area in the 1989 survey. With minimal log information from the inside zone in 1989, the 1990 survey used the same catch strata as the 1989 survey. Analysis of this data showed that abundances were higher in the low catch strata than in the higher catch strata. Consequently in 1991, survey stations were stratified according to geographic area, and stations were randomized within these areas (Fig. 1). Tables 8 and 9 present the results of the 1991 stock survey. Abundances were calculated by two methods (Table 9). There is very little difference in the values whether calculated as in previous years, or by averaging. The distribution of scallops by area (Tables 8, 9), shows that the areas off Digby Gut, Delaps Cove and Young Cove have the lowest abundance. No substantial numbers of pre-recruits were collected in any of the areas. The large number of scallops entering the fishery in 1987 and 1988 are still detected in the larger relative numbers of 6, 7 and 8 year old animals at most areas (Table 9,10), however, overall abundance is low.

The distribution of these year classes is given in figure 4 using contour plots. The scale on each figure varies with the darkest shadings given to the highest abundance for that age. The inside fishing zone has a paucity of scallops less than 7 years of age, except for the area off Centerville where moderately high numbers of 5 year and older scallops are found. The largest numbers of scallops are found off Centerville and Gulliver's Head, although the area off Hampton has similar abundances. Over the whole survey area there were few 2 year old scallops. This represents the fourth consecutive year of low recruitment.

Abundance estimates were derived from the survey data by calculating volumes under the contoured surface (Tables 11,12). Subtriangulation of the surface may be used as an interpolation technique to smooth the contours, hence adding refinement to the volume estimates. The beds around Digby have been subdivided into 3 sectors (Fig.1): 1) the Core Area from south of Gulliver's Head to north of Delaps Cove, 2) the area below Digby (Centreville)

and 3) the area above Digby (Parkers Cove to Hampton). The Core Area has the greater number of stations and hence the data from that area is more accurate. Abundance in the Core Area fell by 58% from 1989 to 1990 (Table 11), and a further 22% from 1990 to 1991. The area below Digby showed a 17% fall in abundance, while the area above Digby declined by 50% from 1990 abundance levels. In the Core Area, the numbers of scallops have fallen to levels below 1985 values. The distribution pattern of the scallops has also returned to a pattern observed before the large recruitment pulses entered the fishery (Fig. 5). The scallops are distributed fairly evenly over the grounds. Table 12 shows the volume estimates of the number of scallops at age caught in the Core Area and in the total area. It can be seen that the remainder of the scallops left from the 1986 and 1987 recruitment pulse (6,7 and 8 year olds) are still mainstaying the fishery in both areas. The number of clappers (paired empty shells) has declined, but at 24% is still high when compared to the pre-die-off long term average of 3%. The wear on the shells of these clappers suggests that these are remnants from the mass mortality event of 1989 (Kenchington and Lundy 1991). There is no evidence of a recurrence of the massive die-off observed at that time.

SUMMARY

Landings for the 1991-92 fishing season remain high to date - the fourth highest on record. These landings were supplemented by the exploitation of scallop beds off Brier Island and Lurcher Shoal. However, the future does not look prosperous. The pulse first observed in the 1986 stock survey is now largely gone, however it is still seen in higher numbers of 6, 7 and 8 year old animals throughout the beds, resulting in large meats in the catches. On the traditional beds, scallop abundance is at an average level with no indication of exceptional recruitment to the fishery in 1992. The distribution of scallops of all ages is now more or less uniform across the inside and outside zones, which is a change from 1986-1989 when the inside zone had markedly higher scallop densities. Landings in 1992 are expected to decrease slightly from those reported here for 1991.

ACKNOWLEDGEMENTS

We would like to thank the crew of the "J.L. HART" for their help in the 1991 scallop survey.

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Table 1.- Number of (1) Bay of Fundy licensed vessels (Source: Licensing Unit, Fisheries and Oceans, Halifax , (2) active fishing licenses for vessels over 25.5 G.T. supposed to follow log procedures, and (3) vessels complying with log procedures.

Year	(1)	(2)	(3)
1981	96	68	65
1982	94	66	63
1983	95	77	74
1984	96	82	76
1985	94	70	67
1986	93	67	57
1987	91	80	44
1988	98	91	16
1989	99	96	14
1990	99	94	13
1991	99	93	26

Table 2.- Additional licenses carried by Bay of Fundy scallop license-holders for the year 1991. Source: Licensing Unit, Department of Fisheries and Oceans, Halifax.

Types and number of other licenses	
Groundfish (otter trawl, long lining, etc.)	64
Swordfish	40
Herring	10
Lobster	5
Squid	14
Shrimp	2
total	135

Number of Bay of Fundy scallop license-holders with ' n' additional licenses.

20	license-holders	do not carry	additional license(s).		
37	"	carry	1	additional license.	
31	"	"	2	additional licenses.	
9	"	"	3	"	"
1	"	"	4	"	"
1	"	"	5	"	"

Table 3.- Annual landings Jan. 1 - Dec. 31 (t of scallop meats) by statistical district (Digby Neck 37, Digby 38, and Annapolis 39); by vessel tonnage, (1): ≤ 25.5 G.T., (2): > 25.5 G.T. Prior to 1967, landings were not segregated by vessel tonnage. Source: Statistics Division, Fisheries and Oceans, Halifax.

District	37		38		39	
Tonnage	(1)	(2)	(1)	(2)	(1)	(2)
1960		102.17		157.23		0.84
1961		80.60		303.49		1.93
1962		-		355.42		8.43
1963		17.47		512.29		0.48
1964		90.48		530.48		2.89
1965		-		476.99		19.16
1966		-		234.94		7.23
1967	0.96	5.42	39.04	115.66	-	4.94
1968	-	5.42	53.49	329.28	-	5.42
1969	4.10	56.27	33.13	176.87	-	6.75
1970	2.29	74.82	18.55	161.93	0.48	1.81
1971	4.94	69.88	10.00	104.34	3.61	3.61
1972	17.23	24.94	16.75	222.77	-	4.10
1973	0.96	10.00	16.39	130.24	-	7.23
1974	-	0.60	11.69	54.22	-	3.13
1975	-	-	22.29	96.99	-	6.27
1976	-	21.81	24.46	479.76	-	21.33
1977	10.00	96.75	35.66	766.99	1.08	24.22
1978	-	120.00	33.49	570.24	1.45	20.96
1979	2.29	54.94	22.53	685.42	6.27	15.90
1980	10.60	42.65	18.31	677.39	4.34	5.90
1981	28.55	141.33	3.98	1059.16	0.48	1.69
1982	28.31	106.51	21.20	904.58	-	7.83
1983	12.05	43.61	19.28	722.53	0.60	26.99
1984	6.20	53.73	7.83	564.22	0.24	29.88
1985	-	28.31	8.07	554.34	0.48	18.31
1986	-	45.18	2.53	398.55	1.57	10.48
1987	-	56.51	21.57	844.34	-	26.87
1988	-	59.40	27.71	2735.54	-	75.54
1989	-	58.31	55.42	3447.11	16.39	79.76
1990	-	9.64	1.45	2147.11	0.48	39.40
1991*	-	15.54	0.12	1597.35	-	25.91

*Preliminary

Table 4.- Yearly landings in t of scallop meats by statistical districts. Yarmouth Co. 34, Digby Co.: 36,37,38; Annapolis Co.: 39; King's Co.: 40; Colchester Co.: 43; Cumberland Co.: 24,44; Saint John: 48,49; Grand Manan: 50; Campobello: 51; Charlotte Co.: 52,53; Albert Co.: 79. (1 indicates landings from vessels < 25.5 G.T., 2 indicates landings from vessels ≥ 25.5 G.T.) Source: Statistics Division, D.F.O., Halifax.

	34		35		36		37		38		39		40	
Year	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1986	-	n/a	-	-	-	3.37	-	45.18	2.53	398.55	1.57	10.48	0.72	-
1987	-	n/a	-	-	-	21.08	-	56.51	21.57	844.34	-	26.87	0.60	-
1988	-	3.37	-	-	-	16.02	-	59.40	27.71	2735.54	-	75.54	3.49	-
1989	-	-	-	-	-	7.47	-	58.31	55.42	3447.11	16.39	79.76	10.96	-
1990	-	1.93	-	0.36	-	44.46	-	9.64	1.45	2147.11	0.48	39.40	4.34	-
1991*	-	54.45	-	-	0.12	27.84	-	15.54	0.12	1597.35	-	25.91	9.38	-

	43		44		48		49		50		51		52	
Year	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1986	-	-	2.53	-	4.46	0.84	22.17	1.45	130.72	42.53	17.95	27.23	0.96	-
1987	-	-	21.20	-	9.52	0.72	33.37	4.10	87.95	45.06	35.06	16.02	1.69	0.84
1988	0.72	-	42.41	-	30.24	4.10	16.99	3.13	130.24	121.69	34.58	76.02	3.01	0.24
1989	0.36	-	53.61	-	95.42	13.13	37.23	11.33	109.40	253.98	74.94	110.48	2.89	-
1990	0.12	-	58.92	13.86	120.00	41.33	41.20	12.29	99.40	210.48	84.22	102.89	1.93	-
1991*	-	-	51.54	15.67	57.00	16.63	33.24	6.26	75.18	107.82	60.23	87.83	2.16	-

	53		79		24	
Year	1	2	1	2	1	2
1986	6.87	4.10	15.42	-	-	-
1987	9.64	4.82	15.78	-	1.57	-
1988	13.61	0.72	28.67	-	4.82	-
1989	24.70	2.05	52.04	1.81	6.99	-
1990	12.77	8.55	61.08	13.73	12.05	0.12
1991*	2.52	1.80	36.26	18.33	7.83	-

*Preliminary

Table 5.- 1991 monthly landings in t of scallop meats by statistical districts. Yarmouth Co. 34, Digby Co.: 36,37,38; Annapolis Co.: 39. (1 indicates landings from vessels < 25.5 G.T., 2 indicates landings from vessels ≥ 25.5 G.T.) Source: Statistics Division, D.F.O., Halifax.

	34		36		37		38		39	
Month	1	2	1	2	1	2	1	2	1	2
Jan.	-	-	-	2.05	-	-	-	88.92	-	1.57
Feb.	-	-	-	1.08	-	-	-	140.00	-	3.37
Mar.	-	-	-	1.57	-	-	-	107.22	-	0.36
April	-	-	-	0.72	-	2.29	-	180.00	-	1.45
May	-	-	-	2.89	-	2.53	-	180.60	-	1.33
June	-	20.24	-	5.06	-	2.17	-	181.08	-	4.10
July	-	14.70	-	6.27	-	2.05	-	147.83	-	6.27
Aug.	-	15.54	-	2.41	-	1.20	-	141.57	-	3.49
Sept.	-	3.97	-	2.05	-	2.89	-	99.64	-	0.84
Oct.	-	-	-	2.17	-	1.45	0.12	194.70	-	2.53
Nov.	-	-	-	1.45	-	0.72	-	99.28	-	0.24
Dec.	-	-	0.12	0.12	-	0.24	-	36.51	-	0.36
Total	-	54.45	0.12	27.84	-	15.54	0.12	1597.35	-	25.91

Table 6.- Fishery characteristics for Bay of Fundy licensed vessels (14-19m) on a fishing zone basis. Statistical catches (Stats) for the inside zone corresponds to NAFO sub-subarea 4Xr; statistical catches for the outside zone are for NAFO sub-subareas 4Xr plus 4Xs. Class 1 logged catches were used to estimate CPUE.

Year	Inside zone (Oct-Apr)			Outside zone (May-Sep)		
	Catches (t meats)		CPUE	Catches (t meats)		CPUE
	Stats	Class 1	kg/hm	Stats	Class 1	kg/hm
1976-77	251.71	99.83	7.99	122.80	24.33	3.38
1977-78	238.27	180.18	7.29	188.02	141.84	4.88
1978-79	247.70	220.01	6.85	214.02	167.89	4.54
1979-80	280.22	245.44	6.95	161.33	131.80	3.88
1980-81	413.60	290.15	6.87	390.07	173.04	4.78
1981-82	417.80	304.40	6.86	429.65	160.74	4.65
1982-83	565.16	372.57	5.03	479.49	205.00	4.71
1983-84	319.15	267.66	3.59	397.35	267.22	3.06
1984-85	270.26	277.85	3.15	322.77	262.13	2.56
1985-86	121.33	142.37	2.36	282.51	274.86	2.25
1986-87	39.24	**21.21	1.81	90.54	56.62	1.92
1987-88	*1096.28	103.78	12.73	***129.97	26.39	3.52
1988-89	*3034.52	263.26	15.09	*929.41	86.13	6.06
1989-90	*625.47	63.44	6.96	*1827.06	113.92	5.05
1990-91	*955.84	112.06	5.09	****1911.00	115.59	3.87
1991-92#	*279.69	37.46	4.08	*****1041.04	66.10	3.42

#preliminary
*our estimate.
**the inside zone was closed from Jan. 1 to April 30, 1987 (end of season). During that time period, CPUE was 2.09 kg / hm in the remainder of the Bay (NAFO 4Xr plus 4Xs).
***we estimate over 100 t. to have been caught in the inside zone during Aug - Sept.
****Jan. 1 to Sept. 30, 1990.
*****we estimate a minimum of 300 t. to have been caught in the Brier Island / Lurcher Shoal area during June - Aug.

Table 7.- Characteristics of the meat size distribution in the commercial fishery while fishing the inside zone.

Season	Month	Meat weight				Sample size	Meat count
		Mean	Min	Max	S.E.	(n meats)	per 500 g
1978-79	Apr	17.9	5.6	33.7	0.4	78	27.9
1979-80	Oct	20.6	6.5	86.4	0.4	229	24.3
	Nov	21.8	5.3	44.4	0.3	374	23.0
1980-81	Oct	26.0	5.6	60.2	0.5	329	19.2
	Dec	24.5	5.1	59.5	0.8	137	20.5
	Feb	22.0	5.2	50.5	0.3	681	22.8
	Mar	22.0	6.3	50.0	0.3	572	22.8
1981-82	Oct	27.2	5.7	54.2	0.6	177	18.4
	Nov	24.1	3.7	77.9	0.3	849	20.8
1982-83	Oct	24.9	5.0	69.4	0.4	632	20.1
	Nov	27.4	5.9	62.6	0.6	231	18.3
1983-84	Apr	18.8	2.3	55.5	0.1	1807	26.6
1984-85	Oct	25.1	4.2	63.6	0.1	2250	19.9
	Apr	19.6	3.7	57.5	0.3	503	25.5
1985-86	Oct	28.5	5.9	56.2	0.2	809	17.6
1986-87	Oct	17.7	2.3	57.5	0.2	1743	28.2
1987-88	Oct	10.0	2.5	55.1	0.1	3215	50.3
1988-89	Oct	13.5	3.3	48.0	0.1	3770	37.1
	Nov	15.1	5.5	51.2	0.1	1100	33.0
	Apr	10.7	5.4	23.7	0.3	103	46.7
1989-90	Oct	18.9	2.3	58.9	0.2	1802	26.4
1990-91	Oct	26.3	6.9	66.4	0.2	1300	19.0
	Nov	24.1	6.6	47.0	0.5	90	20.7
1991-92	Oct	30.9	8.3	62.7	0.3	573	16.2

Table 8.- 1991 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from (1) an end unlined bucket for recruits (age >4 years) and from a centre lined bucket for prerecruits (age ≤4 years) and (2) an end plus a center unlined bucket for recruits (age >4 years) and from an end plus a centre lined bucket for prerecruits (age ≤4 years).

	Age (years)										
	2	3	4	5	6	7	8	9	10+	Total	No. of Stations
Area stratum:											
Centreville (1)	4	8	13	47	69	48	40	23	29	281	10
(2)	3	6	10	43	71	49	35	22	29	268	10
Gulliver's Head (1)	1	4	6	23	57	47	36	23	24	221	27
(2)	1	4	6	20	51	45	38	22	22	209	27
Digby Gut (1)	6	4	4	12	22	26	36	28	37	175	29
(2)	5	6	4	14	22	27	32	26	35	171	29
Delaps Cove (1)	1	2	4	8	22	37	31	23	22	150	19
(2)	1	2	2	8	21	37	32	22	20	145	19
Parker's Cove (1)	-	-	-	24	39	64	36	20	4	187	3
(2)	-	-	4	37	48	57	28	15	5	194	3
Young Cove (1)	-	5	12	36	44	54	4	-	-	155	2
(2)	-	4	11	41	39	55	9	-	-	159	2
Hampton (1)	-	2	8	35	46	50	38	13	14	206	10
(2)	-	2	9	32	39	41	33	13	14	183	10
Zone stratum:											
inside 6-mile (1)	3	4	6	15	32	29	24	17	24	154	38
(2)	3	4	5	14	29	27	25	18	24	149	38
outside 6-mile (1)	2	3	6	25	44	47	41	27	27	222	62
(2)	2	4	6	24	43	46	39	24	25	213	62

Table 9.- 1991 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age ≤4 years).

	Age (years)										
	2	3	4	5	6	7	8	9	10+	Total	No. of Stations
Area stratum:											
Centreville	4	8	13	47	69	48	40	23	29	281	10
Gulliver's Head	1	4	6	23	57	47	36	23	24	221	27
Digby Gut	6	4	4	12	22	26	36	28	37	175	29
Delaps Cove	1	2	4	8	22	37	31	23	22	150	19
Parker's Cove	-	-	-	24	39	64	36	20	4	187	3
Young Cove	-	5	12	36	44	54	4	-	-	155	2
Hampton	-	2	8	35	46	50	38	13	14	206	10
Zone stratum:											
inside 6-mile	3	4	6	15	32	29	24	17	24	154	38
outside 6-mile	2	3	6	25	44	47	41	27	27	222	62

Table 10.- 1986-1991 stock surveys: Average number of scallops at age caught in a seven gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age ≤ 4years).

	Age (years)									
	2	3	4	5	6	7	8	9	10+	Total
Centreville										
1986	77	24	22	13	29	37	33	22	35	292
1987	14	76	53	31	66	52	56	38	92	478
1988	-	-	-	-	-	-	-	-	-	-
1989	23	329	167	229	261	221	81	22	31	1364
1990	2	13	77	134	93	73	52	19	29	492
1991	4	8	13	47	69	48	40	23	29	281
Gullivers Head										
1986	201	72	20	22	29	33	30	19	27	453
1987	220	195	208	83	28	22	21	15	24	816
1988	153	446	930	848	368	69	22	13	22	2871
1989	12	185	157	319	350	183	45	21	27	1299
1990	1	9	26	72	70	75	50	22	21	346
1991	1	4	6	23	57	47	36	23	24	221
Digby Gut										
1986	671	176	22	20	21	24	25	22	34	1015
1987	276	554	775	182	25	19	14	11	34	1890
1988	4	235	552	1239	514	48	11	7	23	2633
1989	1	8	33	218	253	137	35	11	8	704
1990	1	2	8	14	37	68	55	24	20	229
1991	6	4	4	12	22	26	36	28	37	175
Delaps Cove										
1986	744	97	19	24	20	21	19	13	24	981
1987	208	641	824	101	20	18	22	8	19	1861
1988	2	103	217	1010	226	24	15	9	20	1626
1989	2	4	26	245	228	114	21	5	2	647
1990	0	2	5	15	44	61	34	14	5	180
1991	1	2	4	8	22	37	31	23	22	150

Table 10.- Continued. 1986-1991 stock surveys.

	Age (years)									
	2	3	4	5	6	7	8	9	10+	Total
Parkers Cove										
1986	15	5	3	34	44	25	10	2	4	142
1987	19	154	48	18	32	21	11	3	3	309
1988	12	60	85	173	36	22	21	12	7	428
1989	1	8	84	326	41	16	6	4	2	488
1990	0	2	17	186	127	41	15	5	1	394
1991	0	0	0	24	39	64	36	20	4	187
Young Cove										
1986	40	4	0	27	51	69	6	4	6	207
1987	39	82	13	37	42	24	7	6	13	263
1988	5	43	68	98	32	31	16	6	8	307
1989	3	5	11	119	140	48	12	4	2	344
1990	0	4	15	110	120	38	14	2	1	304
1991	0	5	12	36	44	54	4	0	0	155
Hampton										
1986	48	7	7	45	51	39	8	7	7	219
1987	55	189	20	13	23	26	11	3	1	341
1988	29	106	149	91	50	41	22	7	2	497
1989	4	21	92	348	103	30	16	8	4	626
1990	3	12	22	111	63	26	10	4	7	258
1991	0	2	8	35	46	50	38	13	14	206

Table 11.- Number of scallops (N 10^6) per survey area calculated from the June survey volume estimates.

Year	Total Area	Core Area	Below Core Area	Above Core Area	Area Surveyed (km^2)
1985	79.54	52.30	5.67	21.57	1823.53
1986	255.88	188.52	8.42	42.21	1719.27
1987	389.13	351.78	4.82	31.39	1649.80
1988	438.99	376.42	N/A	62.04	1222.55
1989	182.17	123.08	16.88	41.89	1262.34
1990	100.61	51.56	11.50	38.42	1505.07
1991	69.02	40.20	9.50	19.17	1380.98

Table 12.- Surveyed areas of the traditional Digby grounds. The area has been subdivided: below Core Area; Core Area; above Core Area as, except for the Core Area, the other ones are not always represented at the same level (see text). Survey catch-rates (Numbers are in 10^6) on an age basis have been derived by volume calculations (smoothing interpolation technique with 16 subtriangles).

Area (km^2)

Year	Below	Core	Above	Total
1985	134.87	1085.40	603.26	1823.53
1986	113.89	1036.95	568.43	1719.27
1987	77.52	959.38	612.91	1649.80
1988	0.00	683.22	539.32	1222.55
1989	51.47	735.06	475.80	1262.34
1990	94.46	868.41	542.21	1505.07
1991	116.10	866.87	398.02	1380.98

Abundance (x 10^6)	Age (years)							
	2	3	4	5	6	7	8	9
Core Area only (N 10^6)								
1985	0.40	1.06	2.27	4.51	7.18	8.62	8.73	6.15
1986	117.79	26.94	4.76	5.81	6.44	6.73	6.18	5.00
1987	57.17	98.33	139.20	31.97	5.93	5.09	4.28	2.64
1988	3.10	35.24	75.48	192.70	53.68	7.46	2.75	1.70
1989	0.58	7.13	8.33	34.02	42.30	21.72	5.06	1.78
1990	0.19	0.97	2.53	7.20	11.10	12.99	8.81	3.73
1991	0.64	0.75	0.91	3.32	7.79	8.05	7.89	5.51
Clappers 1989	0.38	1.06	5.04	19.56	13.75	5.87	1.39	0.43
Clappers 1990	0.03	0.83	3.75	18.76	27.23	20.39	7.28	2.28
Clappers 1991	0.22	0.14	0.45	1.80	4.12	3.83	2.11	1.06
Total Area (N 10^6)								
1985	0.44	1.20	3.27	10.52	14.45	15.11	12.13	7.29
1986	137.43	30.54	6.93	16.98	16.71	14.36	10.99	7.62
1987	61.70	114.47	143.12	33.86	9.07	7.75	5.86	3.28
1988	4.99	46.67	92.88	209.02	60.61	11.02	5.32	2.83
1989	1.07	10.96	14.71	59.66	55.58	26.97	7.37	2.53
1990	0.39	1.77	6.29	28.05	25.08	18.86	11.40	4.60
1991	0.99	1.21	1.80	6.81	14.54	15.21	13.20	7.91
Clappers 1989	0.53	1.55	5.75	21.44	14.51	6.39	1.54	0.55
Clappers 1990	0.10	1.53	5.37	25.81	32.43	22.64	7.98	2.62
Clappers 1991	0.22	0.18	0.59	3.22	6.17	5.15	2.71	1.17

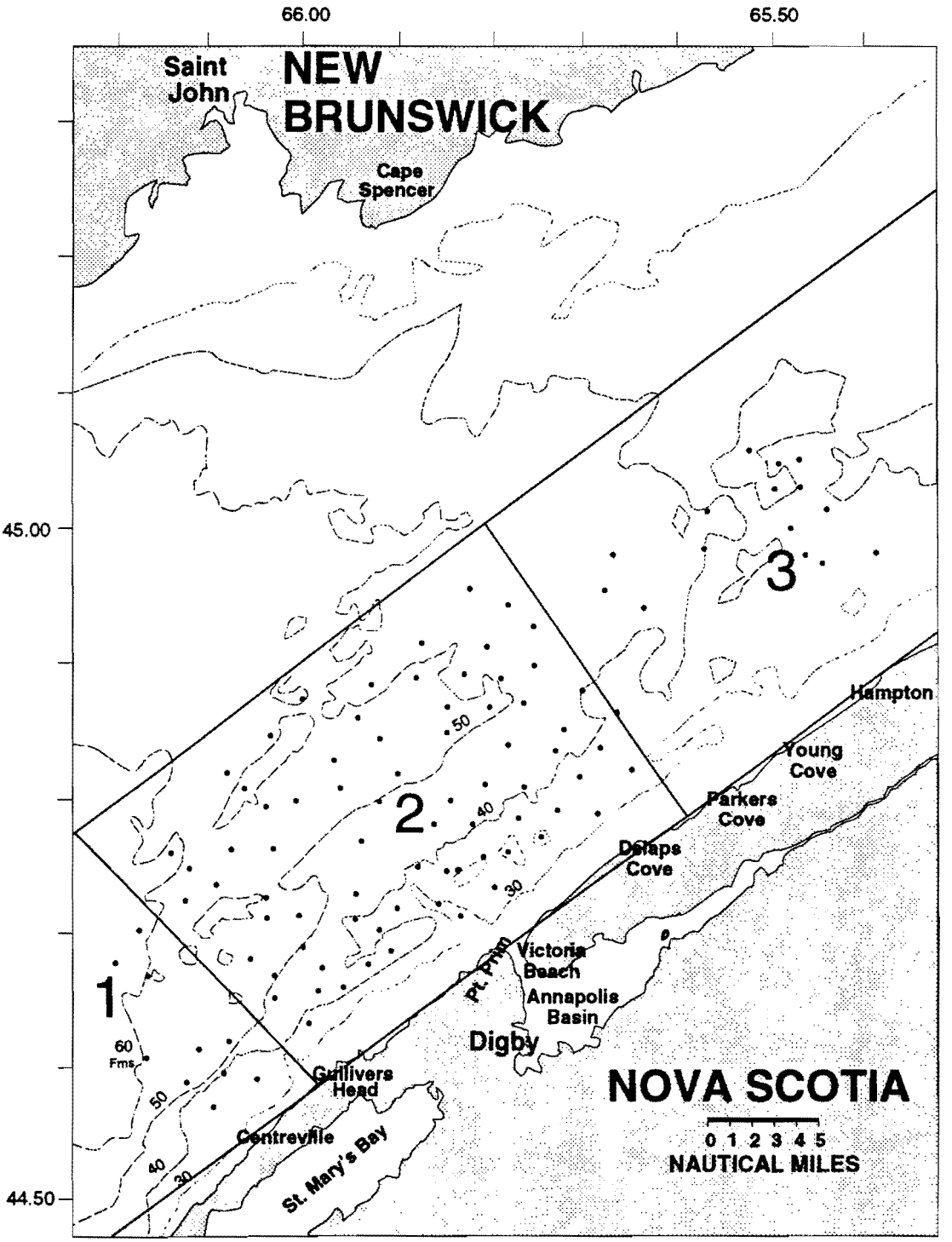

Figure 1.- The traditional Digby grounds with 1991 survey stations indicated by solid dots. The survey area has been divided into three areas (1. Below Core Area, 2. Core Area, 3. Above Core Area) for establishing abundance estimates.

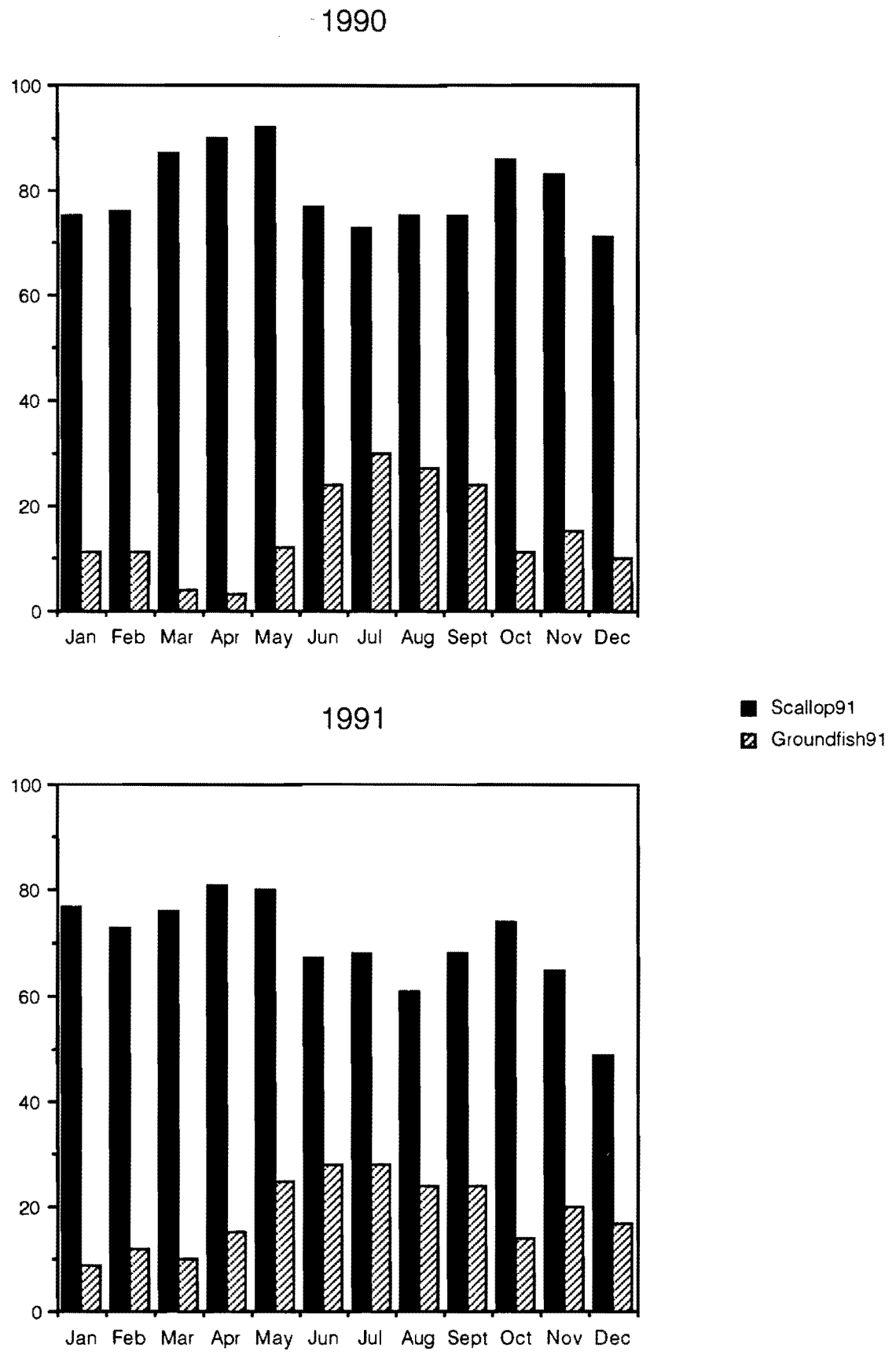

Figure 2.- Number of Bay of Fundy licensed vessels fishing scallops and/or groundfish in 1990 and 1991.

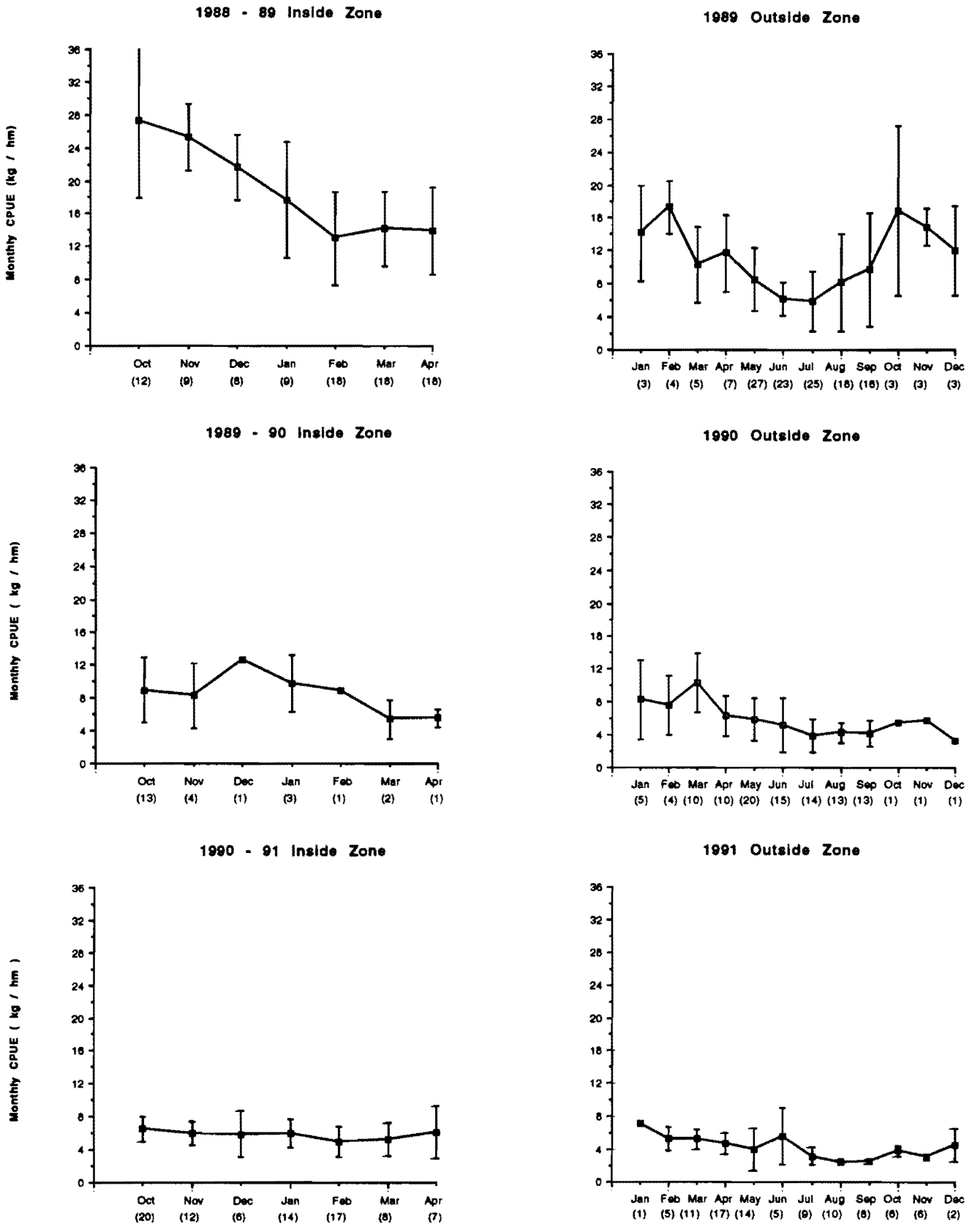

Figure 3.- Monthly CPUE for the inside and outside fishing zones. Values are calculated from Class 1 log data. The number of areas fished incorporated into the calculation are listed below the month on the x-axis.

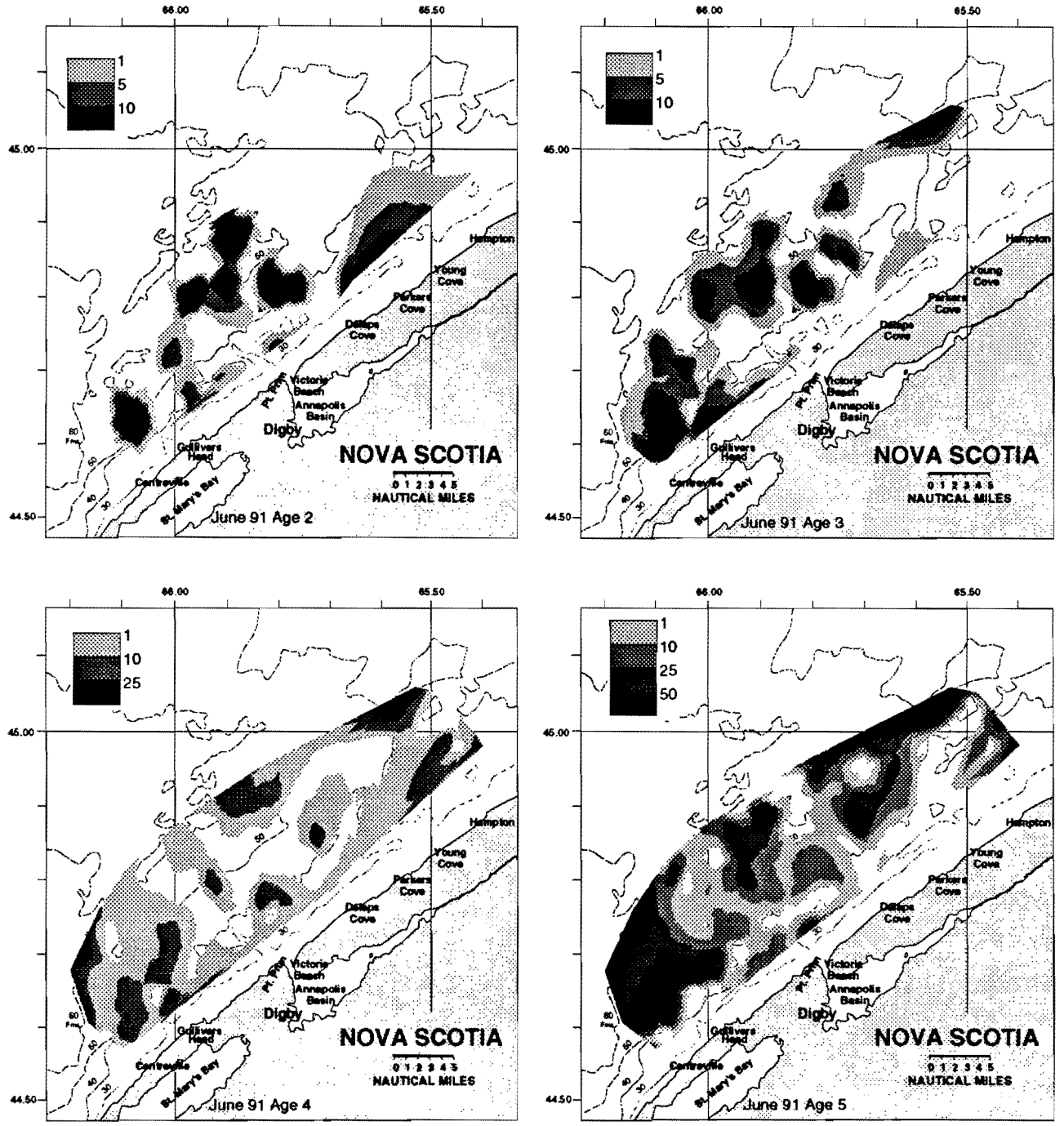

Figure 4.- 1991 survey catch rates. Scallop distribution on an age basis from abundance isopleths of survey data. Darkening shades of grey within isopleths refer to increasing number of scallops per standard tow (grey scale in upper corner of plot).

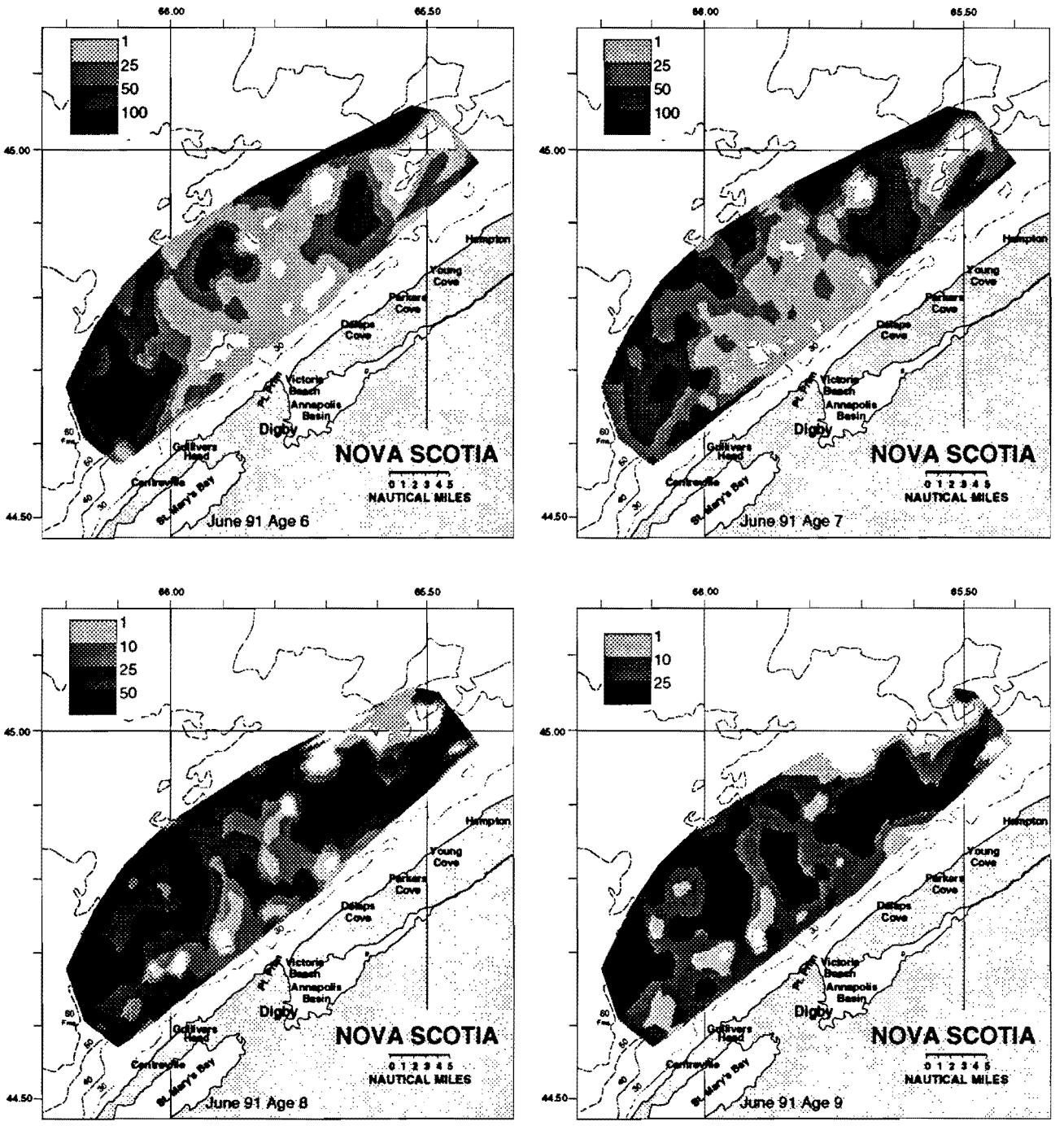

Figure 4. - Continued. 1991 survey catch rates.

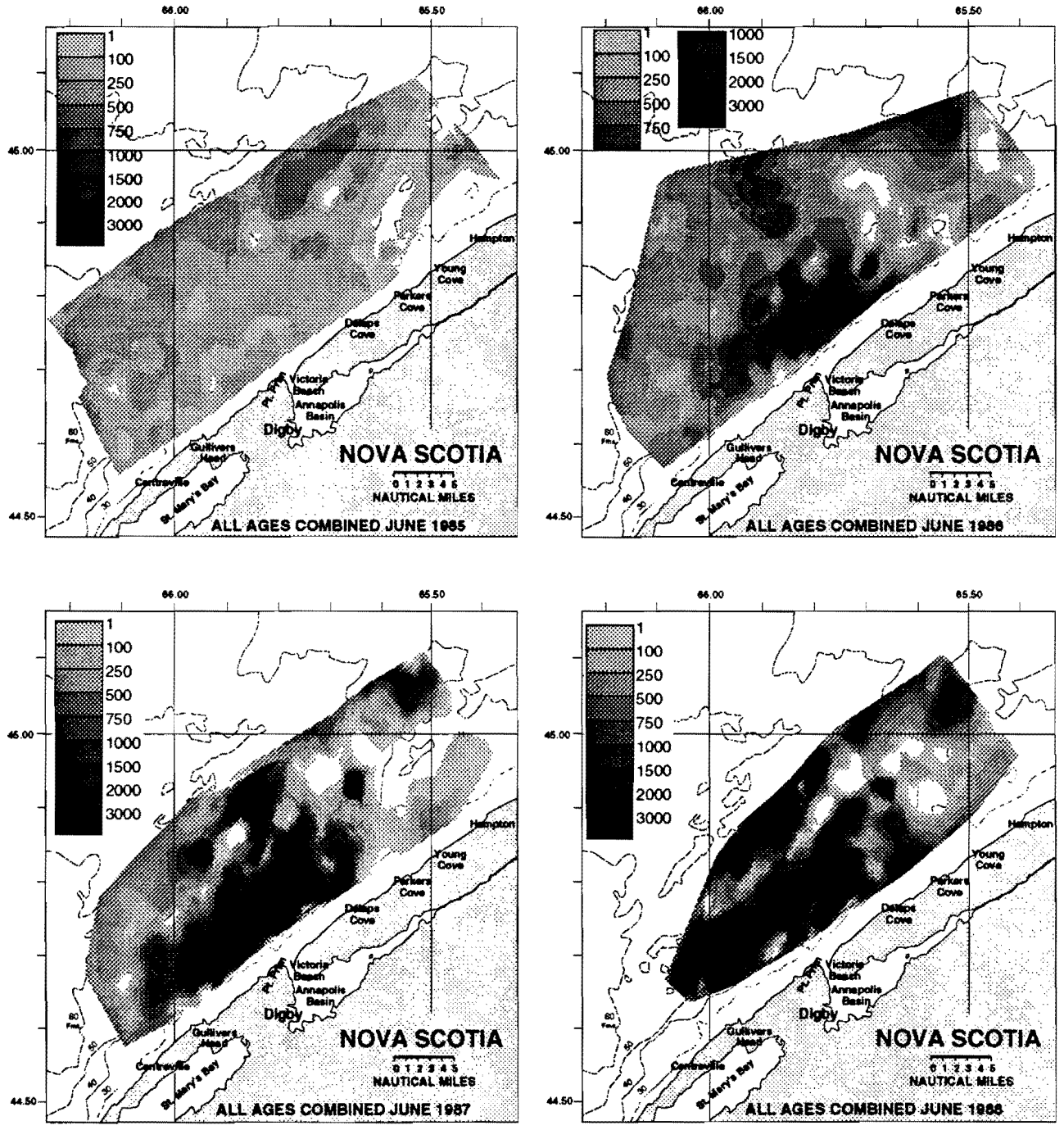

Figure 5.- 1985-91 survey catch rates. Scallop distribution of all ages combined on a yearly basis from abundance isopleths of survey data. Darkening shades of grey within isopleths refer to increasing number of scallops per standard tow (grey scale in upper corner of plot).

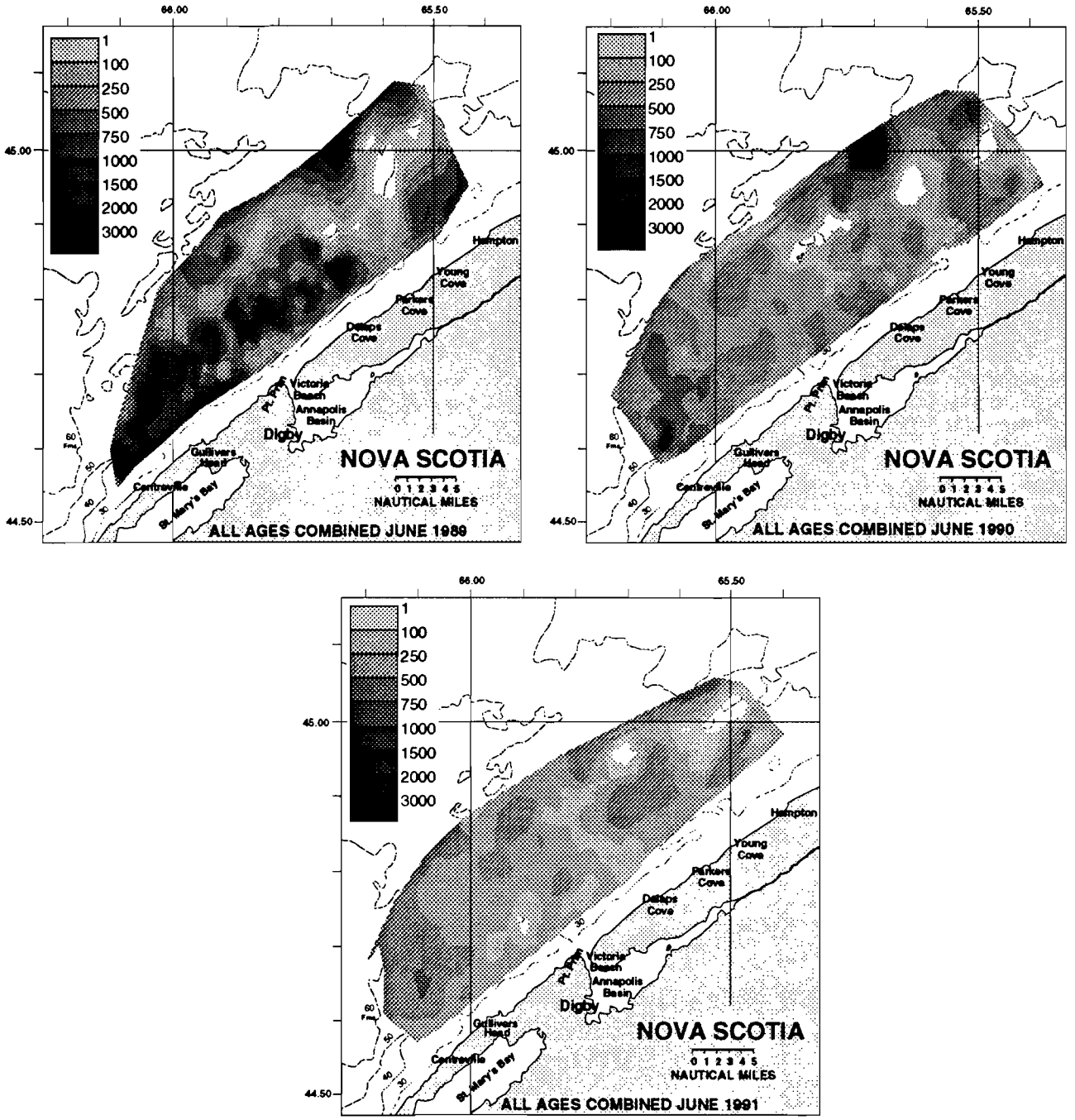

Figure 5. - Continued. 1985 - 91 survey catch rates.