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Recent Events in the Scallop Fishery  
of the Bay of Fundy and Its Approaches

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## ABSTRACT

Scallop beds off Digby, N.S. have been exploited on a commercial basis since the 1920's. Other fishing grounds at the entrance of the Bay of Fundy, German Bank and Lurcher Shoals, and near Brier Island are also exploited on an irregular basis. The scallop fishing fleet has three main components: the inshore fleet (tonnage less than 25.5 G.T.) and, of bigger tonnage (tonnage over 25.5 G.T.) the Bay of Fundy fleet (L.O.A. less than 19.8 m) and the deep-sea fleet (L.O.A. over 19.8 m). Lately, the Bay of Fundy scallop fleet has supplemented its catches by fishing on German/Lurcher and the approaches of the Bay of Fundy to the extent that nearly half of the fleet's landings originated from outside their traditional fishing grounds in the Bay of Fundy. Despite a freeze on the issuing of Bay of Fundy scallop licenses in 1973, this type of licensees has increased steadily to near 100 licences. An additional number of inshore licenses may potentially contribute to Bay of Fundy scallop landings, although their input is fairly small if one excludes the late performance of the Grand Manan-based inshore fleet. The deep-sea fleet may fish the approaches of the Bay of Fundy and German/Lurcher. Landing statistics of major ports like Digby are no longer indicative of Bay of Fundy stock status since the fishing activities of the Bay of Fundy fleet are no longer confined to the extent of the Bay. There are also discrepancies between catch statistics reported by NAFO subareas for the Bay of Fundy and deep-sea fleets and logged catches from these respective subareas (logged catches being greater than official catches in some instances). The German/Lurcher area provided an average 750 t of scallop meats annually with CPUE's from 3.00 to 25.00 kg/hm. Within the Bay of Fundy itself, stocks near Brier Island were exploited over a short time, yielding about 170 t annually. Traditional fishing grounds off Digby have performed well above average recently. However, the annual average CPUE drops noticeably in 1983 to 64% of the previous 4-yr mean (5.62 kg/hm). According to the age frequency distribution of catch data from the outside 6-mile fishing zone the latest above-average stock level did not result from exceptional recruitment from a single year-class but rather several year-classes. There is a general concordance between survey catches and logged Digby catches both with respect to the main age-classes present and with relative abundance levels of different scallop beds. Yields from these beds have been maintained at near optimal levels. In 1983, fishing grounds of the approaches of the Bay of Fundy contributed relatively little to overall catches contrary to previous years. With declining catch-rates on the remaining traditional grounds off Digby, prospects are less positive for the Bay of Fundy fleet.

## RESUME

Des bancs de pétoncles près de Digby, N.-E. font l'objet d'une pêche commerciale depuis 1920. D'autres bancs de pêche à l'embouchure de la Baie de Fundy, German Bank et Lurcher Shoals, et près de Brier Island sont exploités de façon irrégulière. La flottille de pétoncliers a 3 composantes principales: la flottille côtière (tonnage moins de 25.5 G.T.) et, de plus gros tonnage, (tonnage supérieur à 25.5 G.T.) la flottille de la Baie de Fundy (L.H.T. inférieure à 19.8 m) et la flottille hauturière (L.H.T. dépassant 19.8 m). Dernièrement la flottille de pétoncliers de la Baie de Fundy a ajouté à ses prises en pêchant sur German/Lurcher et les approches de la Baie de telle sorte que près de la moitié des débarquements de la flottille ne provenaient pas des lieux de pêche traditionnels dans la Baie. Malgré un gel sur l'émission des licences type Baie de Fundy en 1973, ce type de participant a augmenté graduellement jusqu'à près de 100 licences. Un nombre additionnel de licences côtières peut possiblement contribuer aux débarquements de pétoncles pour la Baie; leur part est relativement minime si on exclue la flottille côtière de Grand Manan. La flottille hauturière peut pêcher les approches de la Baie et German/Lurcher. Les débarquements officiels de ports principaux comme Digby ne peuvent plus représenter les conditions de stock de la Baie étant donné que la flottille de la Baie de Fundy ne limitent plus ses activités qu'aux confins de la Baie. Il y a aussi des différences importantes entre les prises officielles par sous-region de l'OPANO tant pour la flottille de la Baie que pour la flottille hauturière et les prises d'après les journeaux de bords pour ces régions (à quelques occasions, les prises d'après les journaux sont supérieures aux prises officielles). German/Lurcher a récemment fourni une moyenne annuelle de 750 t de chairs de pétoncles avec des PUEs de 3.00 à 25.00 kg/hm. A l'intérieur de la Baie des stocks près de Brier Island ont subi une brève exploitation, 170 t par année. Les bancs de pêche traditionnels près de Digby ont produit bien au-dessus de la normale récemment. Cependant, la PUE moyenne annuelle a diminué de façon importante en 1983; elle n'est plus que 64% de la moyenne des quatre dernières années (5.62 kg/hm). D'après la distribution des fréquences d'âge des prises de la zone de pêche en dehors de 6 milles, le niveau supérieur des stocks observé récemment ne résultait pas du recrutement exceptionnel d'une seule classe d'âge mais plutôt de plusieurs classes d'âge. Il y a beaucoup de similarité entre les résultats des inventaires de stocks et les prises près de Digby tant au point de vue des principales classes d'âge représentées qu'au point de vue de l'abundance relative des différents bancs de pétoncles. Les rendements de ces bancs se sont maintenus à des niveaux presque optimaux. En 1983, les lieux de pêche des approches de la Baie ont contribué relativement très peu aux prises totales

contrairement aux années précédentes. Des taux de capture à la baisse sur les bancs traditionnels de Digby offrent peu d'optimisme pour la flottille de la Baie de Fundy.

## INTRODUCTION

Scallop beds off Digby, Nova Scotia, have been exploited on a commercial basis since the 1920's. On occasion, the Bay of Fundy scallop fleet has supplemented its catches by fishing on German/Lurcher and the approaches of the Bay of Fundy (Fig. 1). Lately, this has occurred to the extent that nearly half of the fleet's landings originated from outside their traditional fishing grounds in the Bay of Fundy.

The recent trends (from 1979 on) in the scallop fishery of the Bay of Fundy and approaches, excluding Grand Manan waters, are presented in this report. Bay of Fundy stock evaluations of the traditional fishing grounds near Digby prior to 1981 have been reported in Jamieson and Lundy (1979) and Jamieson et al. (1980 and 1981). Results from surveys conducted in 1981, 1982, and 1983 are presented for both the summer closure zone (inside 6-mile fishing zone) and the outside 6-mile fishing zone.

## METHODS

### Fishing Information

If one excludes Grand Manan waters (lobster district No. 2) and the area within 7 nautical miles of the New Brunswick coastline in the Bay of Fundy, the majority of vessels operating under scallop licenses are over 25.5 G.T. and their catches are compiled as offshore landings. Less than 10 vessels operate in the upper reaches of the Bay of Fundy under a special "3-mile" permit and land approximately 10 t of scallop meats per year. They will not be considered here.

All catches compiled as offshore landings are supposed to be accompanied by fishing effort information through logkeeping. For ease of understanding, vessel types (L.O.A. < 19.8 m) have been divided into four categories (Table 1).

Daily log records provide information on the nature of the catch, its origin and fishing effort. When complete effort data and catch location are recorded, catch-rate estimates may be computed. Number of crew, width of gear, number of tows per day, and mean duration of tow are the main components of scallop fishing effort. Log completion could be improved by better

reporting of location of the catch. Usually, a general area, e.g. 6 miles off lighthouse, is mentioned, yielding little valuable information on the nature of specific scallop beds.

#### Sampling of the Catch

Port sampling activities were carried out in Digby, N.S., home port of two-thirds of the Bay of Fundy scallop fleet. These vessels fish neighboring scallop beds year round, venturing farther during the summer season. Inclement weather during December to February and the relatively small size of these vessels (<19.8 m) usually lower their activity level at that time. Annual sampling coverage of the catch is very uneven, mainly because of resource personnel difficulties. The sampling of the outside 6-mile zone, where fishing takes place primarily between May and September inclusive, is more or less adequate (due almost entirely to summer student hiring programs). However, coverage of fishing activities taking place in the inside 6-mile zone, October to May, is nonexistent or inadequate, with regular personnel paying occasional visits at best.

#### Survey Procedures in the Digby Area

Distribution of the catch in the Digby area according to log records is used to randomly stratify survey stations. For both fishing zones to be represented, log information available from the present year and from the last 8 months of the previous year are examined. Annual surveys are performed during June on a chartered Digby scallop fishing vessel. Distribution of stations in 3-mile bands running perpendicular to the shore is detailed in Jamieson and Lundy (1979) (Fig. 2).

Survey gear (Fig. 3) is a commercial seven-gang 76.5 cm wide Digby drags with 75-mm (3-inch) rings. Middle buckets No. 3, 4, and 5 are fitted for research purposes with 38-mm stretch mesh lining. Gear behaviour has been studied by Jamieson and Lundy (1979) and Jamieson et al. (1980). To provide catch values more typical of the commercial fishery, the catch from an unlined, end bucket is projected to establish catch of the drag per tow for recruited scallops (age 4+). Tows were 8 minutes duration; the distance towed was determined either from Loran C bearings, start-end of tow, or from continuous recording via a desktop computer (1982 and 1983). Catches were later standardized to a tow length of 800 m, with a sweep area of 4,256 square m. Strata and substrata designations followed Jamieson et al. (1981) (Fig. 2). For each tow, the following data were recorded: 1) shell heights in 5-mm intervals for all

live scallops and cluckers fished by each bucket (1983) or from at least two randomized buckets, both lined and unlined (1981 and 1982); 2) tow location with Loran C bearings; 3) depth (m); 4) compass bearing for direction of tow; 5) duration of tow in minutes; 6) substrate type; 7) count of the number of vertical bucket rings which were covered by the catch; and 8) total scallop catch as a round weight.

#### Growth Functions for the Bay of Fundy

Scallop age was inferred from shell height. Shell height is the distance between the umbo and the farthest point on the ventral margin in a straight line. Von Bertalanffy growth parameters were obtained by analysis of shell "rings" of samples collected during the 1982 and 1983 surveys. 1982 growth parameters were also applied to the 1981 survey results. As previously reported (Caddy et al. 1970) depth appears to be an environmental factor important to growth-rate. For each of 1982 and 1983 data, observed heights-at-age 3-10 were clustered in 10-m depth intervals (from 35 to 125 m) and in "distance" groups (0-6 miles, 6-10 miles, >10 miles from shore). A one-way analysis of variance yielded greatest significance when heights-at-age were clustered into two groups: 1) depths less or equal to 85 m; 2) depths greater than 85 m. The two groups of heights-at-age were then analyzed separately to produce two Von Bertalanffy growth curves (Table 2). The 85-m isobath approximates the "6-mile line" relatively well so for all practical purposes, the <85 m growth curve applies to the inside 6-mile zone while the >85 m growth curve applies to the outside 6-mile zone.

#### Meat Yield-Shell Height Relationship for the Bay of Fundy

Least squares regression techniques were used to determine adductor muscle weight relative to shell height for samples collected during the 1982 and 1983 surveys. An analysis of variance indicated no statistical significance between sets of allometric samples grouped by depth or by distance, contrary to a previous study (Jamieson et al. 1981); 1982 samples were statistically different ( $P < 0.05$  level) from 1983 samples, though. Therefore, 1982 allometry results ( $n=891$ ) were used for 1981 and 1982 survey data:

$$\ln(\text{meat weight}) = -11.421 + 3.018 \ln(\text{shell height})$$

and 1983 allometry results ( $n=1050$ ) for 1983 survey data:

$$\ln(\text{meat weight}) = -13.692 + 3.448 \ln(\text{shell height})$$

Unlike Jamieson et al. (1980, 1981), no prorating by a distance factor was applied to meat weight.

With respect to port sampling data, 1982 ageing and meat yield results are applied to the period 1979 to 1982; 1983 results are used with 1983 data only.

## RESULTS

### The Bay of Fundy Scallop Fishery

#### Bay of Fundy Scallop Fleet

Despite a freeze on the issuing of Bay of Fundy scallop licenses in 1973, this type of licensee has increased steadily, even during the last five years (Table 3). A little over half the fleet has been replaced since 1970. There is a trend toward bigger vessels when replacement time comes, up to the maximum (19.8 m) L.O.A. allowed. Even though the prime activity of these vessels is scallop fishing, about 80% hold one or more licenses for other fisheries, especially for groundfish. The vast majority of these vessels are based in Nova Scotia with the remainder in Charlotte County, southwest New Brunswick. Digby is a well-known scallop landing port; Long Island ports and Yarmouth are also used when fishing occurs in the vicinity of Brier Island or on German/Lurcher.

An additional number of "inshore" licenses (Table 4) may potentially contribute to Bay of Fundy scallop landings, although their input is fairly small. Table 5 summarizes the numbers of both types of scallop licenses potentially landing scallop meats along the coast of southwest Nova Scotia for vessels under 19.8 m L.O.A.

Most Bay of Fundy vessels licensed for scallop fishing do involve themselves in that fishery (Table 6) and complete log records which provide effort data. Over 75% of the catches reported in logs from Bay of Fundy waters and over 60% for the German/Lurcher area provided complete effort data. However, 25 to 40% of the total catches from those areas were not recorded in log forms. Log completion rate could also be improved as to the origin of the catch.

## Scallop Fishing Gears

### Bay of Fundy Waters

Gear specifications of the Bay of Fundy scallop fleet are quite uniform, consisting in most instances of seven individual buckets each 0.76 m wide, with 75-mm rings, attached to a single tow bar. All vessels are side-draggers to accommodate the large total width of the gear. Overall gear width was restricted to 5.5 m in 1938. Gear configuration has changed very little since then (MacPhail, 1954). In 1979, a regulation was reintroduced to restrict the maximum overall gear width towed by a vessel to 5.5 m in Bay of Fundy waters.

### Approaches to the Bay of Fundy

The Bay of Fundy fleet mainly use sweep chain drags on the Scotian Shelf. Only one drag averaging 3 m in width is fished at a time. The deep-sea fleet (vessels over 19.8 m) fish two drags simultaneously, one on each side; these drags are slightly wider than the ones used by the Bay of Fundy fleet.

### Profile of Landings

In an analysis of long-term trends of the Bay of Fundy scallop fishery Caddy (1976) showed the existence of production cycles with an eight to nine yr periodicity by correlating fluctuations in catch data with temperature. The last "low" year he noticed was 1967; landings from major ports (Table 7) indicate that 1974 and 1975 landings would coincide with the low point of the next production cycle.

Prior to 1977, the Bay of Fundy fleet fishing activities were somewhat confined to the extent of the Bay. Therefore, landings from major ports, mainly Digby, could confidently be interpreted as representative of the productivity of the neighboring scallop beds, especially the inside 6-mile zone closed during the summer months (Fig. 2). Since 1977, Scotian Shelf scallop beds, and, since 1979, fishing grounds in the vicinity of Brier Island, have contributed significantly to overall landings so that data in Table 7 are, for recent times, misleading in some respects.

Statistical districts 37, 38, and 39 include the majority of landing ports of the Bay of Fundy licensed vessels. Lately, record high landings have originated from the offshore component of the fleet, moreso from vessels over 14 m L.O.A. (Table 8). Inshore vessels from these districts landed relatively



negligible quantities. However, the long-term average (1950-1977) landing on an annual basis has been determined by Jamieson et al. (1980) as 325 t of scallop meats.

#### Characteristics of the Fishery for the Past Five Years

A summary of annual catches (Table 9) illustrates in general terms the recent performance of the scallop stocks discussed here. Following an increase of almost 300% from 1979 to 1980, catch levels remained high for two more years followed by a decline in 1983. Figure 1 presents a general perspective of the geography of those stocks and their statistical reporting.

#### The German/Lurcher Area

During the early 1970's the deep-sea fleet exploited scallop beds in the German/Lurcher area, then exploitation stopped until 1979 (Fig. 4). These grounds are mainly harvested by vessels based in Yarmouth and Saulnierville, N.S. (Table 10). These may be called "catches of opportunity". When Georges Bank catch levels started to rise after 1975, the need to drag the rocky bottoms of German/Lurcher became less pressing for the deep-sea fleet. When catches within Bay of Fundy waters increased from 1980 on, it was no longer necessary for the Bay of Fundy fleet to venture farther away, on the Scotian Shelf. In 1981, similar catch-rates but smoother bottoms on Georges Bank and a relaxed meat count regulation resulted in an artificial decline of German/Lurcher catches by the deep-sea fleet.

Catch data provided with complete effort information (Class 1 catch) according to logs of the Bay of Fundy fleet represents a low fraction of statistical catches (Table 10). This fraction improves when logged catches are supplemented by catches recorded by sales slips but not logged. It appears that in 1982, there was more logged catch (Bay of Fundy fleet) from German/Lurcher than officially reported by the Statistics Division.

Assuming that logged catch and effort are representative of the behaviour of the fleets, CPUE's of the deep-sea fleet are higher than the ones of the Bay of Fundy fleet except for 1979 (Table 11). CPUE's have been continuously and steadily declining for both fleets in this area.

## The Bay of Fundy Waters

Statistical catches from the Bay of Fundy are somewhat difficult to interpret. They encompass scallop beds in the vicinity of Brier Island, around Grand Manan Island and the more traditional grounds in the Digby area. Table 12 gives a general idea of catch levels according to different components of the scallop fleet.

The inshore fleet (vessels less or equal to 25.5 G.T.) does not provide data on catch origin nor effort levels. It is assumed that the inshore catch is landed at ports adjacent to the main beds exploited by this fleet. The vast majority of catches of the inshore fleet is landed on Grand Manan, Deer, and Campobello Islands in southwest New Brunswick (Table 13). This area of the Bay of Fundy experienced well-above-average catches recently after a strong recruitment pulse (Robert et al. 1984). The contribution of the Nova Scotia-based inshore fleet is small relative to the catch levels of the New Brunswick-based inshore fleet and the Bay of Fundy fleet.

Catches from offshore vessels (>25.5 G.T.) within the Bay of Fundy (Table 12) have to be allocated between Brier Island, Grand Manan Island, and the Digby area for a meaningful exercise. Moreover, both the Bay of Fundy fleet and the deep-sea fleet may fish scallop grounds in the vicinity of Brier Island. A further assumption is that Class 1 catch and effort data of these respective subareas within the Bay are representative of total catch and effort levels for any particular subarea.

### Brier Island and Vicinity

One segment of the Bay of Fundy fleet and some of the deep-sea scallop draggers initiated the late exploitation of scallop grounds on rocky ledges to the southwest, west, and northwest of Brier Island (Table 14). Annual catches of the Bay of Fundy fleet are two to three times the deep-sea fleet catch levels. However in 1983, the amount of scallops caught by the Bay of Fundy fleet has drastically decreased. CPUE's of the Bay of Fundy fleet are superior to the ones of the deep-sea fleet, a situation opposite to the one encountered on German/Lurcher (Table 15). During the time period under study, CPUE levels have also decreased near Brier Island. Geographically speaking, these scallop grounds make up the northern portions of the Lurcher Shoals or are adjacent to Lurcher. It is therefore not surprising that fishery trends are fairly similar.

## Grand Manan Island and Neighboring Areas

Landings from the Grand Manan Island (Table 14) are mentioned here to put an order of magnitude on the productivity of these grounds since they are included in the Bay of Fundy catch statistics. This topic is discussed more appropriately in Robert et al. (1984). Bay of Fundy licensed vessels based in New Brunswick fish the south side of the Bay quite extensively during the summer season and often land their catches in Digby, N.S. They derived a major portion of their total catches from the Grand Manan Island area in 1981 but considerably less in other years.

## Traditional Grounds Near Digby, N.S.

Fishing grounds near Digby, N.S. have been exploited on a continuous basis since 1922 (Dickie, 1955). Recent catches are well above average (Table 14) according to the Class 1 catch data, but it is difficult to estimate which fraction of the total Digby area catches the Class 1 data represent. Annual average CPUE (Table 16) drops noticeably in 1983 to 64% of the previous 4-yr mean (5.62 kg/hm). In comparison, these are lower than German/Lurcher and Brier Island values. On an annual basis, inshore (within 6 nautical miles from shore) grounds have been the best yielding (Table 17) four years out of five and with mean CPUE's higher than the average CPUE of Digby grounds considered as a whole. The highest catch-rates were from inshore beds off Digby and Gulliver's Head (a discontinuity between the two, or continuity for that matter, is not established). Offshore (from 6 to 15 nautical miles) grounds off Digby rank second or third four years out of five. Nevertheless, the three top-ranked locations make up for 61% of the Class 1 catches from Digby grounds from 1979 to 1981 and 48% in 1982 and 1983. Upstream from Digby, there are scallop concentrations off Delaps Cove, Parker's Cove, and Young Cove but they were not significantly exploited prior to 1983; although their CPUE's are slightly higher than around Digby. Downstream from Digby, concentrations have been exploited off Centreville, on Digby Neck and yielded high catch-rates but these did not last. Consequently, these are considered catches of opportunity. According to local fishermen these scallop beds are not a permanent feature.

Table 14 also provides annual summation of catches from Bay of Fundy waters by the Bay of Fundy fleet for the three most recent years which are compiled from information recorded on sales slips. These are relatively important amounts but specific origin of these catches cannot be determined. The quantity of scallops caught by the deep-sea fleet according to

log information is far greater than the catches assigned to Bay of Fundy waters for the fleet by Statistics Division, Management Services Branch, Scotia-Fundy Region. In contrast, total accountable catch from the Bay of Fundy fleet (Table 14) is closer to the statistical figure for this vessel class.

#### Catch Sampling Data

Catch sampling data are only available for the outside 6-mile fishing zone in the Bay of Fundy, mostly scallop beds off Digby Gut. For most years data have been collected every month that fishing is occurring in this zone (Table 18), giving good time coverage. The number of scallop meats weighted per fishing season is relatively uniform except in 1980. Average monthly meat weights are high in 1980 and 1981 and decrease in 1982. Values for 1979 and 1983 are similar and lower than values of intermediate years.

It is not possible at this time to establish total amount of scallops caught in the outside 6-mile zone; therefore, a catch-at-age matrix may not be computed from the age frequency distribution of the sampled catch. On a percentage basis, the main age-classes fished are 7, 8, and to a lesser extent 9 (Table 19). Age 6 scallops (shell height=92mm) is the youngest age-class noticeably shucked. Less than 5% of the sampled catch correspond to ages 12+. In 1979, age-classes 7 and 8 make up 65% of the catch while in other years the two major age-classes never reach the 50% level.

Selecting catch-at-age on a percentage basis for ages fulfilling assumptions of constant recruitment and natural mortality rate ( $M=0.1$ ) an annual instantaneous mortality ( $Z$ ) rate was established for this fishing zone (Table 20).  $Z$  varies very little between 1980 and 1982 inclusive, then rises slightly in 1983. However, all those values are lower than the 1979 rate.

#### Stock Analysis

Survey stations have been stratified according to catch data (Table 21). Since fishing activities are very often located according to shore reference points, survey results have also been post-stratified on an area basis. It is also useful to analyse survey data according to a zone stratum because of the existence of two fishing zones, one on each side of a 6 nautical miles line which runs parallel to the Nova Scotia shore between Parker's Cove and Sandy Cove.

The three latest stock surveys are presented in this report. Tables 22, 23, and 24 show for each survey-year the average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits and from a centre, lined bucket for prerecruits for different stratum types. The mean total number of scallops per tow decreases throughout the time period under investigation. It appears that the survey gear never catches many individuals younger than 5 years old. In the Centreville area, the age frequency distribution reveals an important concentration of scallops ages 7-8 years in 1981 and 1982, then ages 8-9 years in 1983. The Gulliver's Head and Digby Gut areas have a mode of ages 7-8 scallops. Locations upstream from Digby show less abundant age-classes in general. Delaps Cove has a mode of age 11+ scallops in 1981 and 1982 in addition to age 6 in 1982 (age 7 in 1983). When surveyed, the greatest number of scallops belonged to the oldest age group. In summary, while a mode of ages 7-8 scallops is always present in the outside 6-mile zone, in the inside zone, ages 6-7 scallops were most numerous in 1981 and 1982 with stable numbers of ages 7. All age-specific abundances declined in 1983. There are no obvious strong recruitment pulses but year-classes show up most strongly around ages 6-8 then get gradually depleted through fishing.

Whether one looks at catch, area or zone strata (Tables 25, 26, and 27) survey catch-rates of prerecruits are always much lower than for recruits and older recruits (age 8+) are more abundant than relatively younger recruits (ages 4-7). Centreville and Gulliver's Head supported large numbers of recruits in 1981 and 1982 (Table 26) but by 1983, Centreville had dropped by about 50% and Gulliver's Head by approximately 25%.

The amplitude of variations in recruited abundance for other areas is much smaller. Recruited age-classes are more abundant in the outside 6-mile fishing zone (Table 27). This is a long-standing phenomenon as it had already been pointed out by Dickie in 1955 (Dickie, 1955) and Caddy in 1968 (Caddy et al., 1970).

## DISCUSSION AND CONCLUSIONS

### Adequacy of Catch Data

Since 1979, scallop beds in the Bay of Fundy and Approaches have produced record level catches, up to 2,000 t of scallop meats annually, levels never encountered since a scallop fishery began near the beginning of the twentieth century. Catch-rates in some areas have concordantly been high, over 10 kg/hm. While the inshore fleet, based mainly on Grand Manan Island was enjoying boom catches, the Bay of Fundy fleet was exploiting

traditional grounds near Digby to levels last observed in the 1940's (Caddy, 1976) and beds in the Brier Island area which seem to yield abundantly on an irregular basis. Scallop stocks of the German/Lurcher area may produce heavily but not constantly. Part of the deep-sea fleet fished those grounds in 1970-71 and returned for significant catches only in 1980. At that time, the Georges Bank stocks, the main resource exploited by the deep-sea fleet, were decreasing after the last above-average production rates.

In the Bay of Fundy per se, production cycles noticed by Caddy (1976) may be extended to the present. Despite limiting entry to the fishery in 1973, the number of participants in the Bay of Fundy scallop fleet has steadily increased to almost 100 vessels. Historically, there has never been that many vessels in the fishery (Caddy, 1976). Rough calculations estimate that recent annual catch per vessel, despite extremely high catches, are approximately at long-term low levels for the inside 6-mile fishing zone.

When the Bay of Fundy fleet was limiting its fishing expeditions to the Digby area, Digby landings could be used to determine stock biomass variations in the Bay. Nowadays, with the fleet venturing far afield of the Scotian Shelf and landing it all in Digby, Digby landings are no longer representative of any stock. They become at best, an indicator of the fleet overall performance.

To estimate trends in the biomass of scallop stocks by observing variations in catch levels is somewhat complicated by the way statistical catches are reported. Scallop stocks of the German/Lurcher area (NAFO Subdivision 4XQ) extend beyond the northern boundary between 4XQ and 4XR statistical areas (Figs. 1 and 4). In some cases, it is impossible to assign origins to catches for statistical purposes. This may possibly lead to huge discrepancies between catch levels according to statistics or from log information. This may explain why in 1982, logged catches of the Bay of Fundy fleet are greater than the respective statistical catches for 4XQ. For some reason, the deep-sea fleet statistical catches in the Bay of Fundy (4XR and 4XS) (Table 12) are considerably lower than amounts provided with a location in log records (Table 14). The artificial statistical boundaries presently used are meaningless.

Approximating productivity of different scallop beds within the Bay itself requires the help of a crystal ball. Since Grand Manan scallop beds are exploited to a very large extent by small inshore boats, we feel confident that Grand Manan stocks relate in a significant way to landings of the Grand Manan area. However, partitioning the remainder of Bay of Fundy catches is a

difficult exercise. Logged catch and Class I catch data help to a certain extent but too high a fraction of fished stocks are recorded only in terms of sales slips with "Bay of Fundy" as origin or worse, "4X" given as area fished. Log completion rate by the Bay of Fundy fleet should be improved in addition to better catch-reporting mechanisms.

Traditional grounds near Digby are given slightly better coverage through catch-sampling, at least during the summer season. According to the age frequency distribution of the catch data the latest above-average stock level did not result from exceptional recruitment of a single year-class, but rather several year-classes. While in 1979, ages 7 and 8 scallops made up 65% of the catch; in later years those same age-classes amounted to less than 50% of the total catch.

#### Measuring Catch-Rate

CPUE is measured in kg per hour-meter (kg/hm); it considers the time duration that the gear is dragging on the bottom and the overall width of the fishing gear(s). By contrast, CPUE for the deep-sea fleet is measured as kg per crew-hour-meter as crew members are an important effort factor in trips of a maximum twelve day duration, the catch being processed at sea. The Bay of Fundy fleet (this also goes for the inshore fleet) conducts daily trips as a rule; a multi-day trip does not usually extend beyond three days. If scallops are plentiful, the first objective of the captain is to load the deck to the gallows with scallops in the shell, then sail to sheltered waters or to shore where extra hired hands help shuck the catch. Deck-loading practices impede the true representation of the number of crew as an effort measure. In this respect, Bay of Fundy fleet CPUE's are overestimated in comparison to the ones of the deep-sea fleet.

No study has yet been carried out to investigate the compatibility of catch-rates assigned to the different fleets. The deep-sea fleet and the Bay of Fundy fleet generally use sweep-chain scallop drags when fishing German/Lurcher, but in the Brier Island area sweep-chain drags and Digby drags are both used. Different gears possibly have different fishing behaviour. It is not possible at this time to estimate catch-rate for the inshore fleet. Since the catch input of this fleet is small, this becomes of lesser concern.

## Stock Abundance Near Digby - Survey vs Commercial Catch-Rates

During previous surveys in 1966 and 1967, scallop beds within 7 miles of the coast produced poorly (Caddy et al. 1970), with conditions very similar to what are presently encountered. Regular recruitment appears to occur only on nearshore (<6 miles) grounds. Stock abundance is higher on offshore (>6 miles) grounds yet, about 65% of the Class 1 catch from the Digby area comes from nearshore grounds.

There is a general concordance between survey catches and logged Digby catches both with respect to the main age-classes present and with relative abundance levels of different scallop beds. Age 8 scallops, predominant feature of the catch-at-age data for the outside 6-mile zone, is also a principal element of the survey data for this particular stratum. Previous surveys (Jamieson et al. 1980; 1981) indicated the same general trends. High-yielding concentrations were identified by survey work in the "inside" area of Gulliver's Head, amongst the long-standing grounds and these were confirmed by superior commercial catch levels.

## Yield Per Recruit

As previously mentioned in Jamieson et al. (1980), yields from the traditional grounds off Digby are at near optimal levels. We repeated the analysis with the Thompson and Bell yield per recruit model (Ricker, 1975) given a natural mortality rate,  $M$  equal to 0.1. For scallops of similar shell heights the yield per recruit is greater in the inside 6-mile fishing zone (Fig. 5) than in the outside zone; this differential gradient increases for larger scallops. If the size at first capture is held constant over a range of fishing mortality ( $F$ ) values, for each size highest yields occur at low  $F$  and for each  $F$ , yield increases as size at first capture increases.

Using the catch-at-age distribution from Table 19 and  $F$  values derived from Table 20, it appears that 1979 yields were less than optimal. Yields subsequently improved from 1980 onward when scallops ranging in size from 97 to 115 mm (shell height) were harvested at much lower  $F$  values (mean=0.45). Yields were maintained at a near optimal level in 1983 although  $F$  seems to be slightly higher (Table 20) and directed at slightly larger scallops (105-120 mm).

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Table 1.- Categories of vessels plying Bay of Fundy waters. By regulation, any vessel greater than 25.5 G.T. or longer than 14m (45') L.O.A. has to fill logs reporting daily activities. Landings from vessels greater than 25.5 G.T. are recorded as "offshore" while "inshore" landings refer to vessels less or equal to 25.5 G.T.

	<25.5 G.T.	>25.5 G.T.
L.O.A. ≤14m (45')	1 no reporting; inshore	3 reporting; offshore
14m<L.O.A.<19.8m (45') (65')	2 reporting; inshore	4 reporting; offshore

Table 2.- Von Bertalanffy growth parameters from 1982 and 1983 surveys. N: number of shell samples, Z: depth(m).

1982	n=270	Z≤85	$H_t = 153.748(1 - e^{-0.2088[t-1.3874]})$
	n=624	Z>85	$H_t = 150.973(1 - e^{-0.2059[t-1.4405]})$
1983	n=570	Z≤85	$H_t = 153.729(1 - e^{-0.1992[t-1.3509]})$
	n=480	Z>85	$H_t = 144.509(1 - e^{-0.2187[t-1.4459]})$

Table 3.- Number of vessels by category carrying a Bay of Fundy scallop license from 1979 to 1983. A Bay of Fundy license entitles the holder to drag for scallops in the Bay of Fundy and other areas of NAFO Division 4X and, under special trip-permit, in Subdivision 5Ze. Source: Licensing Unit, Fisheries and Oceans, Halifax. Number of vessels based in Nova Scotia + number of vessels based in New Brunswick.

Year	Vessel category				Total
	1	2	3	4	
1979	9 + 13	2 + 0	1 + 0	41 + 7	73
1980	5 + 13	1 + 0	2 + 0	52 + 7	80
1981	8 + 14	1 + 0	3 + 0	64 + 6	96
1982	8 + 8	1 + 0	4 + 4	65 + 4	94
1983	3 + 7	1 + 0	7 + 5	67 + 5	95

Table 4.- Number of vessels by category based in Nova Scotia from Shelburne Co. to Kings Co. carrying an inshore scallop license from 1979 to 1983. Source: Licensing Unit.

Year	Vessel category				Total
	1	2	3	4	
1979	21	0	0	3	24
1980	27	0	1	3	31
1981	29	0	6	0	35
1982	14	0	5	0	19
1983	10	0	5	0	15

Table 5.- Number of vessels by category and by year potentially landing scallop meats along the shoreline of southwest Nova Scotia.

Year	Vessel category				Total
	1	2	3	4	
1979	43	2	1	51	97
1980	45	1	3	62	111
1981	51	1	9	70	131
1982	30	1	13	69	113
1983	20	1	17	72	110

Table 6.- Number of Bay of Fundy scallop licensed vessels, on an annual basis (A) supposed to fill logs reporting daily fishing activities; (B) which fished according to sales slips; (C) which filled at least one log record; (D) which provided complete effort data for at least one log record.

Year	A	B	C	D
1981	74	68	65	62
1982	78	66	63	63
1983	84	77	74	69

Table 7 .- Annual landings (t of scallop meats) by statistical district (Digby Neck, Digby and Annapolis); by vessel tonnage, (1):  $\leq 25.5$  G.T., (2):  $> 25.5$  G.T. Prior to 1967, landings were not segregated by vessel tonnage. Source: Statistics Div., 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	49.40	18.31	696.02	4.34	5.90
1981	28.55	147.35	3.98	1080.24	0.48	1.69
1982	28.31	106.51	21.20	915.42	-	7.95
1983	12.05	43.61	19.28	722.53	0.72	26.99

Table 8 .- Annual landings (t of scallop meats) by vessel categorie for Digby Neck (statistical district 37), Digby (38), and Annapolis (39). Inshore landings originate from vessels <25.5 G.T. while offshore landings refer to vessels >25.5 G.T. Source: Statistics Div., Fisheries and Oceans, Halifax.

Year	37		38		39				
	IN	OFF	IN	OFF	IN	OFF			
	<u>&lt;14m</u>	<u>&gt;14m</u>	<u>&lt;14m</u>	<u>&gt;14m</u>	<u>&lt;14m</u>	<u>&gt;14m</u>			
1979	2.29	-	54.82	22.53	10.60	647.71	6.27	-	15.90
1980	10.48	6.02	36.63	18.19	8.67	668.80	4.34	-	5.90
1981	28.31	30.84	110.60	4.10	12.77	1046.39	0.48	-	1.81
1982	28.43	19.28	87.11	21.08	15.90	888.43	-	0.36	7.59
1983	12.05	20.00	21.93	19.28	24.10	698.31	0.72	2.89	23.98

Table 9.- Summary of annual catches (t of scallop meats) from the Bay of Fundy and German/Lurcher areas by different components of the scallop fleet.

	<25.5 G.T.	>25.5 G.T.		Total
		L.O.A.<19.8m	L.O.A.>19.8m	
1977	-	464.06	-	464.06
1978	40.38	493.28	5.42	539.08
1979	59.57	698.35	102.32	860.24
1980	188.25	852.28	1286.57	2327.10
1981	495.63	1148.52	382.22	2026.37
1982	289.46	1120.85	659.79	2070.10
1983	191.46	866.59	600.79	1658.84

Table 10.- I. Annual catches (t of scallop meats) from the German/Lurcher area by different components of the scallop fleet. Source: Statistics Div., Fisheries and Oceans, Halifax. II. Class 1 catch and total logged catch, (catch from sales slips only).

	≤25.5 G.T.	>25.5 G.T.		Total
		19.8m>L.O.A.>19.8m		
I.				
1979	-	293.82	102.32	396.14
1980	0.09	113.72	1269.71	1383.51
1981	1.36	194.73	379.69	575.78
1982	0.34	99.06	659.75	759.15
1983	-	43.68	587.77	631.45
II.				
1979	-	180.07, 259.35	139,141	
1980	-	65.33, 90.45	871,969	
1981	-	66.54, 126.26(46)	173,191	
1982	-	79.49, 121.29(16)	404,536	
1983	-	16.76, 29.38(6)	360,400	

Table 11.- CPUE (kg/hm) by vessel size for the German/Lurcher area.

	L.O.A.<19.8m	L.O.A.>19.8m
1979	25.01	14.60
1980	9.72	9.81
1981	7.61	9.46
1982	6.18	6.43
1983	2.93	6.20



Table 12.- Annual catches (t of scallop meats) from the Bay of Fundy and approaches (i.e. Brier Island and vicinity, Grand Manan Island and southwest New Brunswick, and the Digby area) by different components of the scallop fleet. Source: Statistics Div., Fisheries and Oceans, Halifax.

	<25.5 G.T.	≥25.5 G.T.		Total
		L.O.A.<19.8m	L.O.A.≥19.8m	
1977	-	463.74	-	463.74
1978	40.38	490.43	5.42	536.23
1979	59.58	404.53	-	464.11
1980	188.16	738.56	16.86	943.58
1981	494.27	953.78	2.53	1450.58
1982	289.12	1021.79	0.03	1310.94
1983	191.46	822.91	13.02	1027.39

Table 13.- Bay of Fundy catch statistics by the 'inshore' (<25.5 G.T.) fleet as per landing ports on a province basis. Source: Statistics Div., Fisheries and Oceans, Halifax.

	New Brunswick	Nova Scotia	Total
1979	28.20	31.37	59.58
1980	149.60	38.56	188.16
1981	451.70	42.57	494.27
1982	230.60	58.52	289.12
1983	266.80*	32.05	191.46

\*New Brunswick inshore landings originate mainly in the Bay of Fundy; in 1983, waters west and southwest of Grand Manan (NAFO 5YB) recorded 116.75 t caught by the inshore fleet.

Table 14.- Fragmentation of Bay of Fundy catches for different areas within the Bay.

L.O.A. > 19.8m		Deep-sea fleet			accountable catch
Brier Island and vicinity					
	class 1 catch	logged catch			
1979	-	-			-
1980	59	63			63
1981	43	46			46
1982	58	87			87
1983	54	66			66
L.O.A. < 19.8m Bay of Fundy fleet					
Brier Island area	Grand Manan I.	Digby area	(Sales slips)		
class 1 catch	landings	class 1 catch			
1979	0.05	1.90	333.22	-	335
1980	105.70	14.30	418.23	-	538
1981	120.71	109.80	397.74	(132.13)	760
1982	158.34	63.40	523.50	(315.56)	1061
1983	29.63	80.10	542.42	(116.85)	769

Table 15.- CPUE (kg/hm) by vessel size for the Brier Island area in the Bay of Fundy.

	L.O.A.<19.8m	L.O.A.≥19.8m
1979	4.72	-
1980	11.72	7.58
1981	9.34	4.85
1982	7.57	5.78
1983	4.98	5.63

Table 16.- Class 1 catches, effort levels and CPUE values for traditional grounds off Digby, N.S.

	Catch t	Effort hm	CPUE kg/hm
1979	333.22	63881	5.22
1980	418.23	70312	5.95
1981	397.74	73311	5.43
1982	523.50	89050	5.88
1983	542.42	151915	3.57

Table 17.- Percentage of the Class 1 catches and respective mean CPUE values (kg/hm) coming from the three most productive areas within the Digby grounds on an annual basis. cf. Figure 2. I: inside 6-mile, closed zone from May to October, O: outside 6-mile fishing zone, DG: Digby Gut, GH: Gulliver's Head.

1979	DG-O	21%	4.56	GH-I	21%	7.57	DG-I	18%	7.21	60%
1980	DG-I	24%	7.41	DG-O	23%	6.31	GH-I	12%	8.28	59%
1981	DG-I	27%	7.92	GH-I	18%	7.93	DG-O	18%	5.67	63%
1982*	GH-I	21%	7.68	DG-I	15%	6.78	DG-O	12%	5.46	48%
1983*	DG-I	20%	4.64	DG-O	18%	3.64	GH-O	10%	3.89	48%

\* in 1982-3, an important portion of the catch cannot be assigned, therefore the total is underestimated.

Table 18.- Average monthly meat weight (g) on an annual basis for the outside 6-mile fishing zone. N: sample size.

Year	Month	N	Mean	Min.	Max.	S.E.
1979	May	2527	13.52	2.56	35.00	0.06
	June	2111	11.76	1.16	52.75	0.05
	July	4286	12.13	2.97	73.73	0.04
	Aug	2351	14.49	1.78	38.57	0.06
	Sept	440	16.71	5.27	47.12	0.19
		<hr/> 11715				
1980	May	648	16.83	5.76	40.27	0.16
	June	3646	16.45	3.37	43.65	0.07
	July	4475	14.52	2.43	41.00	0.06
	Aug	3607	15.45	2.52	79.43	0.07
	Sept	1788	18.01	1.65	83.74	0.12
		<hr/> 14164				
1981	May	2067	14.92	2.57	39.16	0.09
	June	2703	16.82	4.59	43.33	0.09
	July	3228	17.03	3.51	50.27	0.08
	Aug	2193	16.38	4.05	42.00	0.09
	Sept	1489	17.00	3.91	45.40	0.12
		<hr/> 11680				
1982	May	0	-	-	-	-
	June	3870	14.30	3.05	41.87	0.07
	July	3500	13.20	3.32	37.59	0.05
	Aug	3754	14.12	2.62	48.27	0.06
	Sept	0	-	-	-	-
		<hr/> 11124				
1983	May	3294	12.09	2.54	36.89	0.06
	June	2184	12.60	2.44	32.34	0.07
	July	1998	13.84	3.66	50.27	0.07
	Aug	2880	14.23	3.77	31.68	0.05
	Sept	0	-	-	-	-
		<hr/> 10356				

Table 19.- On a percentage basis, number of scallops at age from the catch of the outside 6-mile fishing zone.

Year	Age (years)											
	6	7	8	9	10	11	12	13	14	15	16	17
1979	16.0	37.8	27.3	11.5	3.8	1.2	0.4	0.2				
1980	13.0	21.5	22.7	19.2	10.7	5.5	2.6	1.4	0.7	0.4	0.2	0.1
1981	11.6	19.6	21.9	19.9	12.3	6.3	3.2	1.5	1.0	0.5	0.3	0.2
1982	18.7	28.9	20.4	15.0	8.5	2.6	1.5	0.6	0.3	0.2	0.1	0.1
1983	5.4	16.0	24.0	22.8	16.1	8.3	3.7	1.6	0.7	0.4	0.2	0.1

Table 20.- Annual instantaneous mortality rate (Z) estimated from catch at age on a percentage basis for the outside 6-mile fishing zone.

Year	Z	s.e.	95% confidence interval
1979	0.963	0.1537	0.655 - 1.270
1980	0.544	0.0696	0.405 - 0.683
1981	0.503	0.0624	0.378 - 0.628
1982	0.553	0.0639	0.426 - 0.681
1983	0.630	0.0882	0.454 - 0.807

Table 21.- Number of survey stations in the Digby area by year and by stratum types.

	1981	1982	1983
<b>Catch stratum:</b>			
low (0-1%)*	15	29	40
medium (1-3%)*	17	20	20
high (>3%)	38	22	15
exploratory	-	30	25
<b>total</b>	<b>70</b>	<b>101</b>	<b>100</b>
<b>Area stratum:</b>			
Centreville	3	19	20
Gulliver's Head	22	20	28
Digby Gut	41	49	35
Delaps Cove	4	9	14
Parker's Cove	-	4	3
<b>Zone stratum:</b>			
inside 6-mile	27	50	40
outside 6-mile	43	51	60

\* 2% in 1981.

Table 22.- 1981 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >3 years) and from a centre, lined bucket for prerecruits (age ≤3 years). (u): unlined, (l): lined.

	Age (years)										Mean	s.d.
	2	3	4	5	6	7	8	9	10	11+		
Catch stratum:												
low (u)	0	1	8	7	30	58	58	57	41	25	305	188
(l)	0	2	12	13	27	42	45	35	28	17	222	197
medium (u)	0	1	35	68	41	78	94	62	28	11	419	335
(l)	0	11	32	23	33	45	59	52	21	9	285	154
high (u)	0	1	3	23	47	66	56	37	28	24	284	151
(l)	0	13	43	233	101	36	32	23	16	17	513	1543
Area stratum:												
Centreville (u)	0	1	1	0	42	74	106	87	50	37	397	245
(l)	0	2	16	13	68	79	98	54	47	18	396	308
Gulliver's Head (u)	0	0	30	69	47	79	82	40	29	16	411	322
(l)	0	21	72	382	162	52	53	41	21	17	822	1994
Digby Gut (u)	0	1	4	15	42	65	60	49	27	18	281	138
(l)	0	5	18	24	25	34	34	27	16	12	194	117
Delaps Cove (u)	0	0	0	3	12	14	9	44	64	64	209	128
(l)	0	2	5	6	9	2	7	23	22	35	112	76
Zone stratum:												
inside 6-mile (u)	0	1	5	20	49	60	34	34	34	35	282	164
(l)	0	4	16	293	136	43	21	25	20	26	585	1820
outside 6-mile (u)	0	1	16	37	37	71	86	56	29	12	345	247
(l)	0	14	45	35	27	37	53	37	19	8	276	242



Table 23.- 1982 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >3 years) and from a centre, lined bucket for prerecruits (age ≤3 years). (u): unlined, (l): lined.

	Age (years)										Mean	s.d.
	2	3	4	5	6	7	8	9	10	11+		
Catch stratum:												
low (u)	0	0	2	21	35	51	69	55	29	18	280	189
(l)	0	0	2	13	19	17	29	25	9	7	125	106
medium (u)	0	2	4	18	35	27	45	53	33	19	237	132
(l)	0	2	2	11	16	10	16	18	12	9	97	79
high (u)	0	1	1	44	64	66	50	36	20	25	307	149
(l)	0	4	3	24	29	28	19	16	11	18	152	104
exploratory (u)	0	0	2	28	45	56	55	43	19	23	300	178
(l)	0	4	8	30	28	32	30	20	12	17	201	139
Area stratum:												
Centreville (u)	0	1	2	18	49	80	108	69	37	23	386	179
(l)	0	8	7	20	34	37	45	30	14	12	207	116
Gulliver's Head (u)	0	1	3	36	62	61	52	61	36	26	340	143
(l)	0	4	5	32	33	31	27	21	9	16	187	123
Digby Gut (u)	0	0	2	30	39	43	48	39	18	17	240	151
(l)	0	1	3	19	17	16	20	16	9	10	114	106
Delaps Cove (u)	0	0	2	27	38	31	24	31	24	35	214	137
(l)	0	0	0	10	23	20	9	22	20	24	128	102
Parker's Cove (u)	0	0	0	3	0	0	1	7	7	15	64	72
(l)	0	0	0	0	0	4	2	7	6	13	66	74
Zone stratum:												
inside 6-mile (u)	0	1	2	21	39	37	34	34	24	32	232	159
(l)	0	5	2	18	23	19	15	15	11	21	137	98
outside 6-mile (u)	0	0	2	34	49	65	78	60	27	11	331	160
(l)	0	0	6	23	24	27	33	25	11	5	156	132

Table 24.- 1983 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >3 years) and from a centre, lined bucket for prerecruits (age ≤3 years). (u): unlined, (l): lined.

	Age (years)										Mean	s.d.
	2	3	4	5	6	7	8	9	10	11+		
Catch stratum:												
low (u)	0	0	2	6	35	53	58	44	21	19	266	157
(l)	0	4	7	10	17	23	24	19	11	14	173	101
medium (u)	0	0	2	11	23	49	57	37	27	11	291	174
(l)	0	3	11	16	15	20	21	22	13	9	162	94
high (u)	0	0	0	4	13	30	30	20	9	30	186	86
(l)	1	13	9	28	15	29	26	18	10	22	214	102
exploratory (u)	0	0	1	6	21	54	67	39	24	16	286	166
(l)	0	4	12	15	20	29	37	21	9	13	211	149
Area stratum:												
Centreville (u)	0	0	0	1	12	36	65	42	20	11	249	146
(l)	0	4	12	8	10	14	32	29	15	10	179	111
Gulliver's Head (u)	0	0	2	10	36	62	68	42	19	14	307	171
(l)	1	9	10	19	21	33	34	22	10	15	222	125
Digby Gut (u)	0	0	1	6	27	46	49	34	22	25	246	112
(l)	0	4	10	18	23	33	26	20	11	13	191	103
Delaps Cove (u)	0	1	4	11	31	60	48	40	31	25	270	214
(l)	0	2	6	14	8	10	13	8	8	21	125	95
Parker's Cove (u)	0	0	0	0	0	0	3	0	0	0	10	0
(l)	0	0	0	0	0	0	0	3	0	0	10	0
Zone stratum:												
inside 6-mile (u)	0	0	1	8	12	26	27	20	19	28	191	118
(l)	0	9	10	17	9	14	17	10	9	20	148	103
outside 6-mile (u)	0	0	2	6	35	64	75	49	23	12	307	161
(l)	0	2	9	14	22	32	34	27	12	10	212	114

Table 25.- Summary of average number of scallops at age caught for prerecruits and recruits by catch stratum.

	Age (year)		
	1-3	4-7	8 +
<hr/>			
1981			
<hr/>			
low	2	102	182
medium	11	222	196
high	13	138	145
1982			
<hr/>			
low	0	109	170
medium	3	84	151
high	4	174	132
exploratory	4	130	140
1983			
<hr/>			
low	4	96	143
medium	3	86	132
high	14	47	89
exploratory	4	83	146

Table 26.- Summary of average number of scallops at age caught for prerecruits and recruits by area stratum.

	Age (year)		
	1-3	4-7	8 +
<u>1981</u>			
Centreville	2	117	280
Gulliver's Head	21	225	167
Digby Gut	5	126	154
Delaps Cove	2	29	180
<u>1982</u>			
Centreville	8	149	236
Gulliver's Head	4	163	175
Digby Gut	1	114	121
Delaps Cove	0	99	115
Parker's Cove	0	3	29
<u>1983</u>			
Centreville	4	48	138
Gulliver's Head	10	110	143
Digby Gut	4	80	130
Delaps Cove	2	106	144
Parker's Cove	0	0	3

Table 27.- Summary of average number of scallops at age caught for prerecruits and recruits by zone stratum.

	Age (year)		
	1-3	4-7	8 +
<u>1981</u>			
inside 6-mile	4	134	137
outside 6-mile	14	162	183
<u>1982</u>			
inside 6-mile	5	98	123
outside 6-mile	0	150	174
<u>1983</u>			
inside 6-mile	9	48	95
outside 6-mile	3	107	159

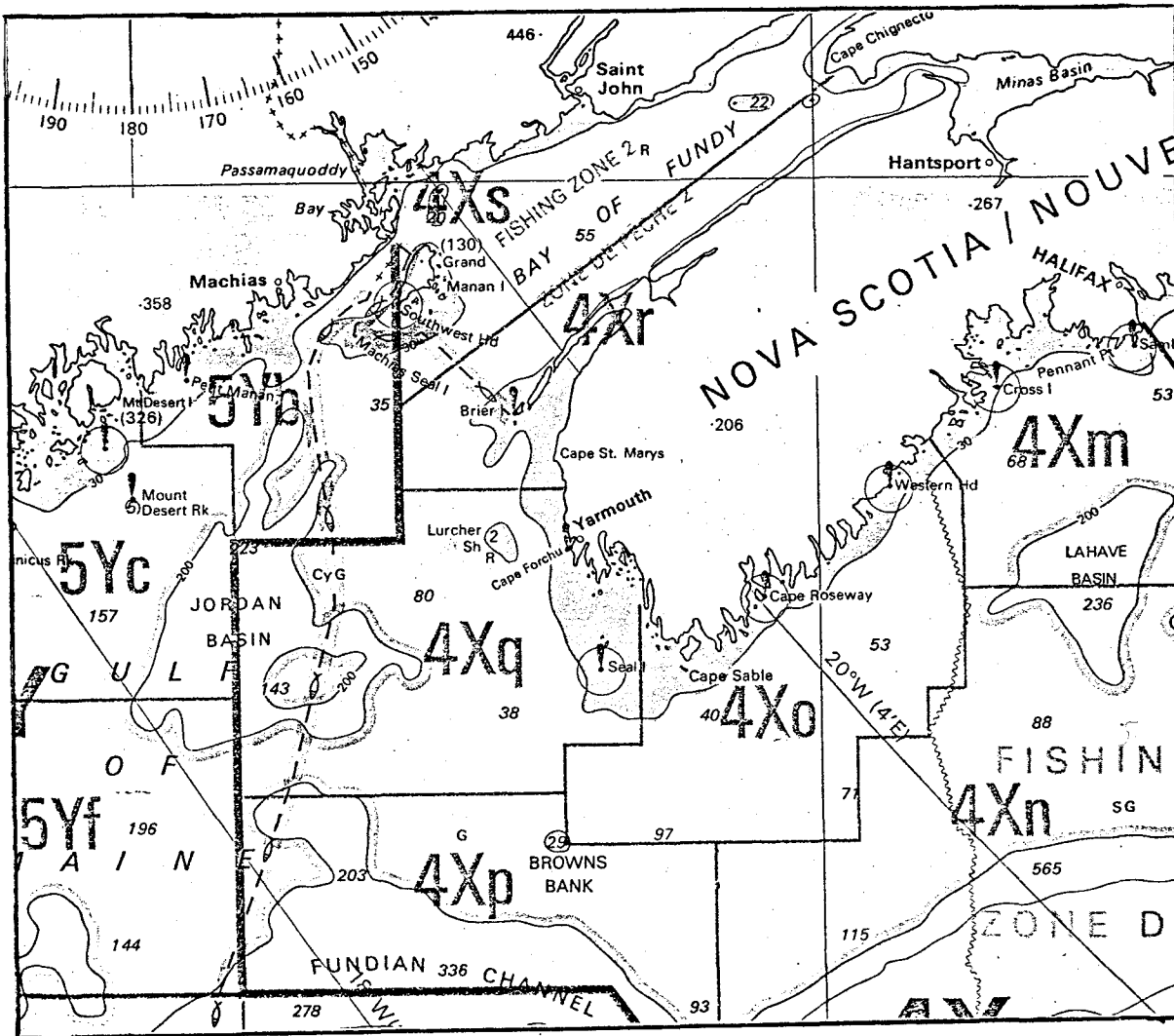


Figure 1.- Bay of Fundy, its approaches, and the western portion of the Scotian Shelf with their respective NAFO subarea appellations for statistical purposes.

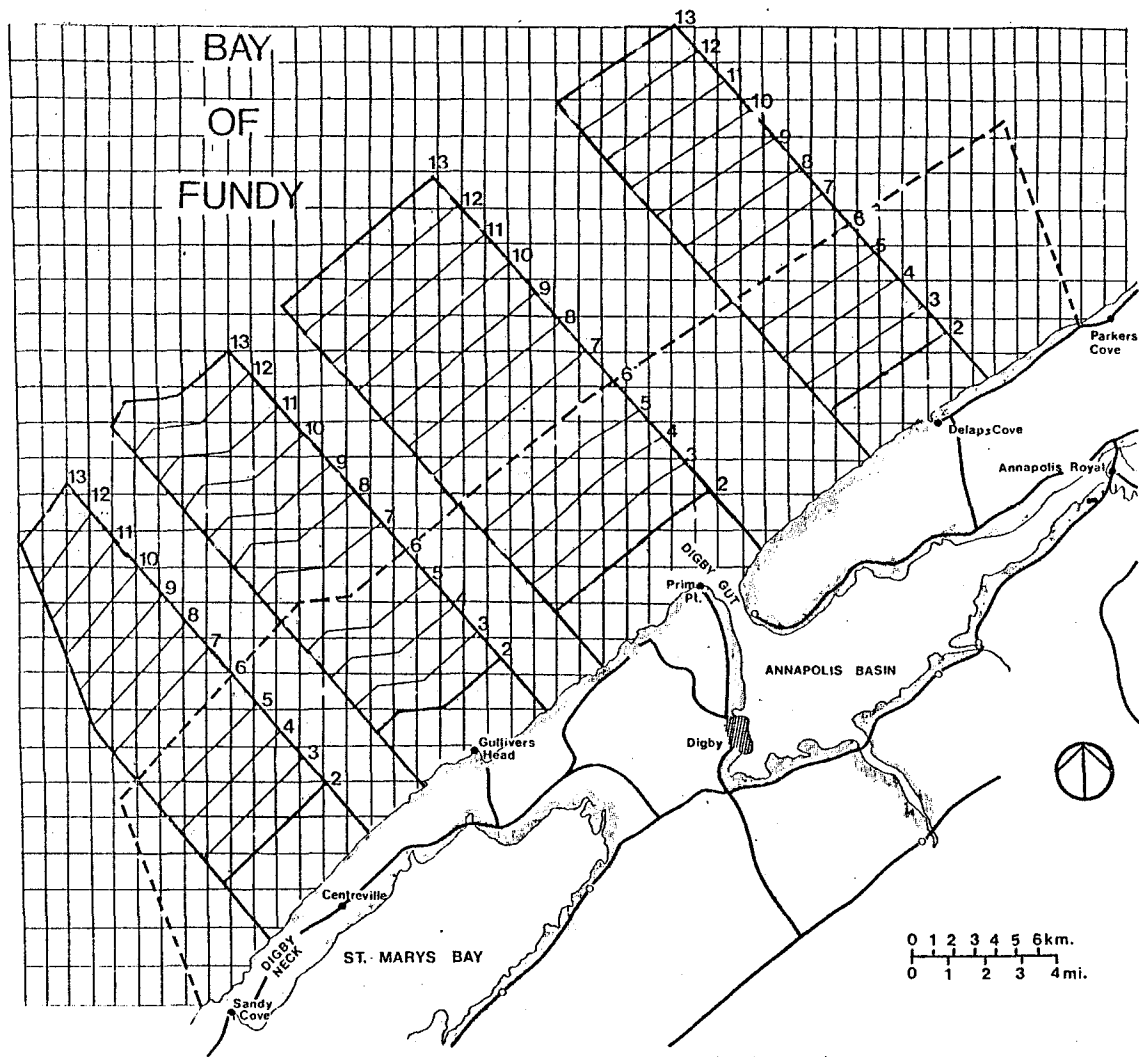


Figure 2.- Map showing 3-mile bands perpendicular to the shoreline with one mile interval starting two miles from shore. Those bands are located near main reference points for identification of catch origin e.g. Centreville, Gulliver's Head, Digby Gut, Delaps Cove, and Parker's Cove. The dotted line encloses the 'inside 6-mile winter fishing zone from Parker's Cove to Sandy Cove.

# 7 Gang Digby Scallop Drag

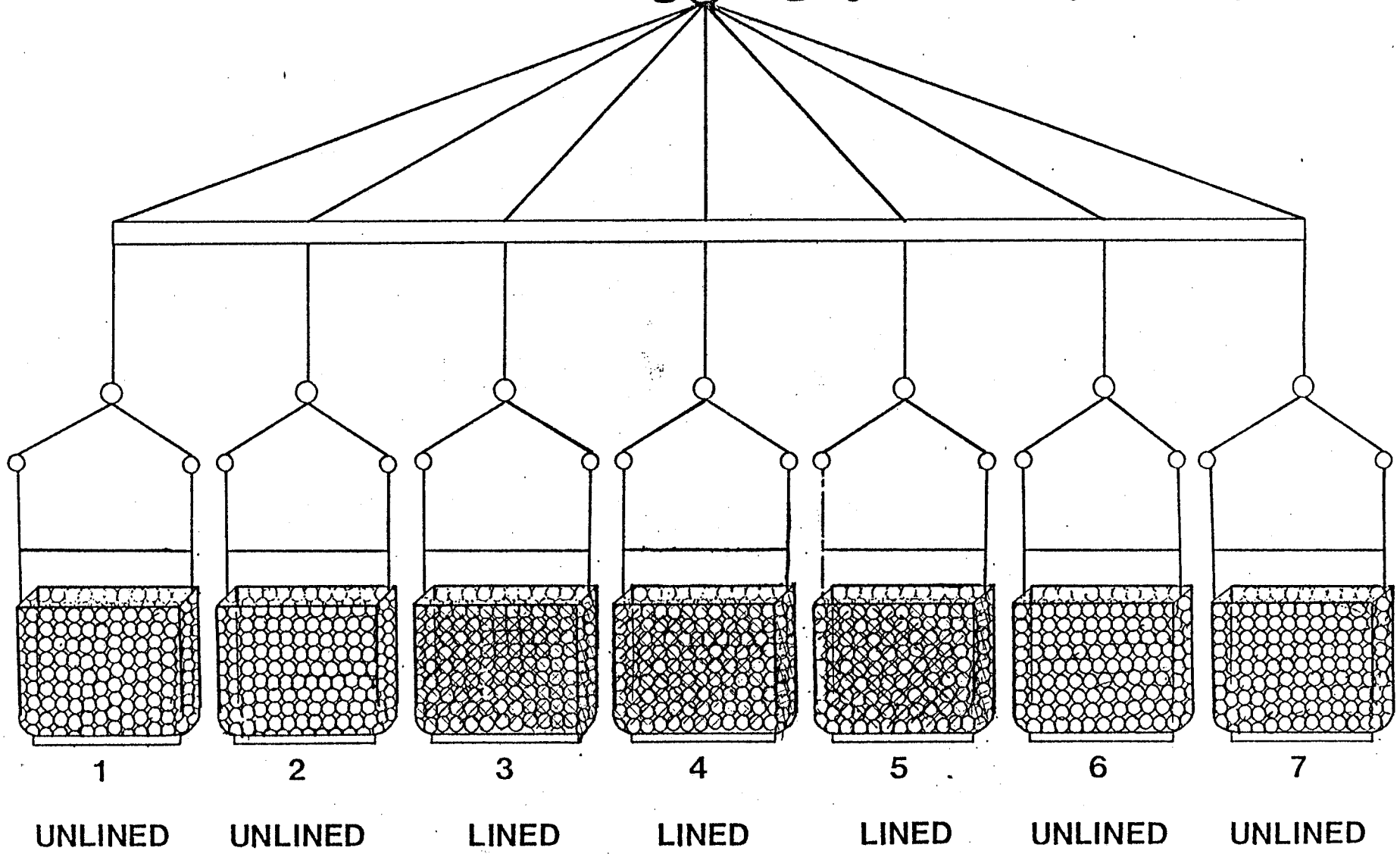


Figure 3.- Specifications of a seven-gang Digby drag used in resource stock surveys in the Bay of Fundy with lined, centre buckets and unlined, end buckets.



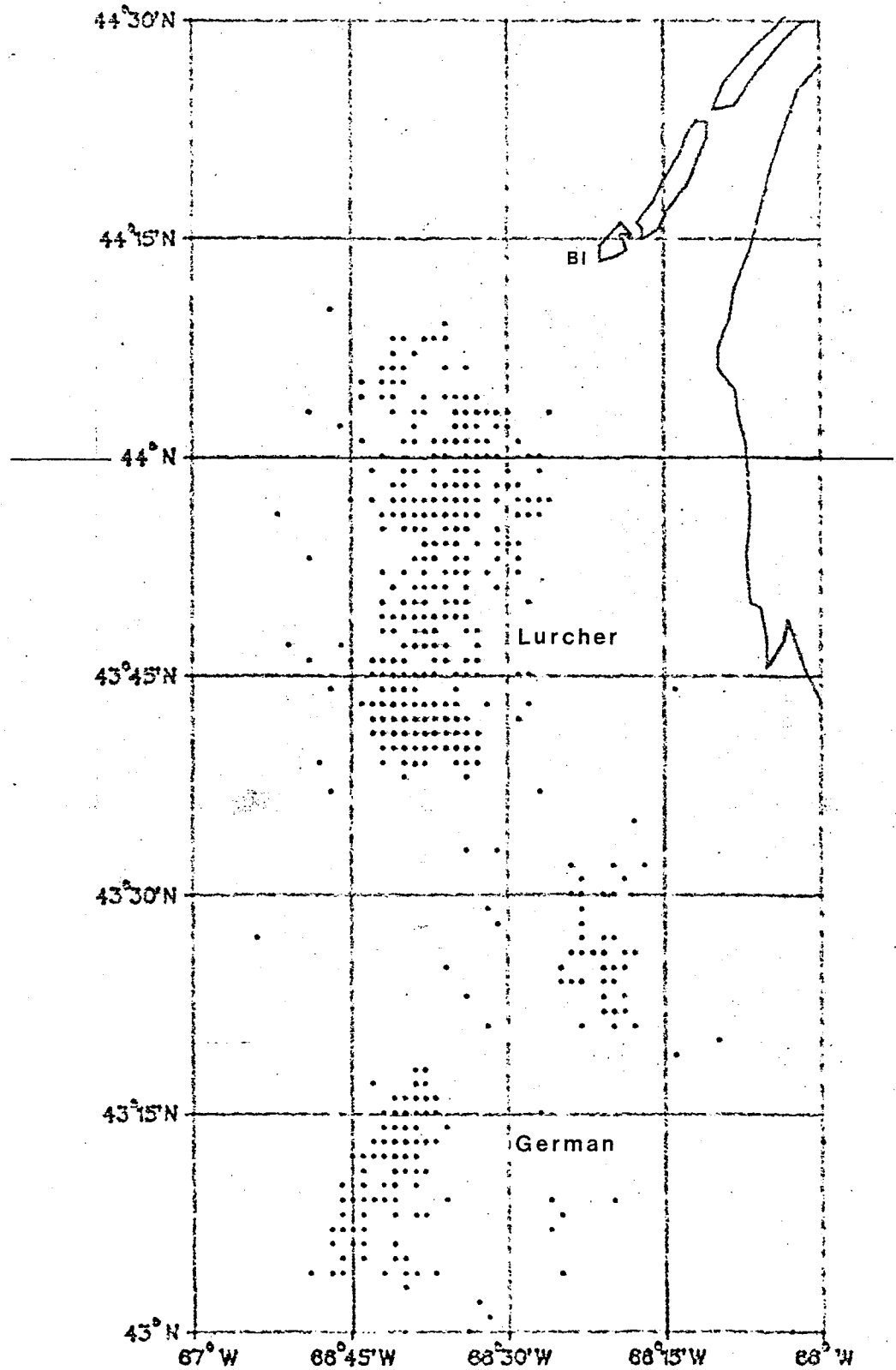


Figure 4.- Fishing areas on German/Lurcher, NAFO subdivision 4XQ, (south of 44° lat. north) and at the mouth of the Bay of Fundy, NAFO subdivision 4XR. Fishing areas in the immediate vicinity of Brier Island (BI) are not shown here. Each dot represents a minimum of one visit to a fishing location.

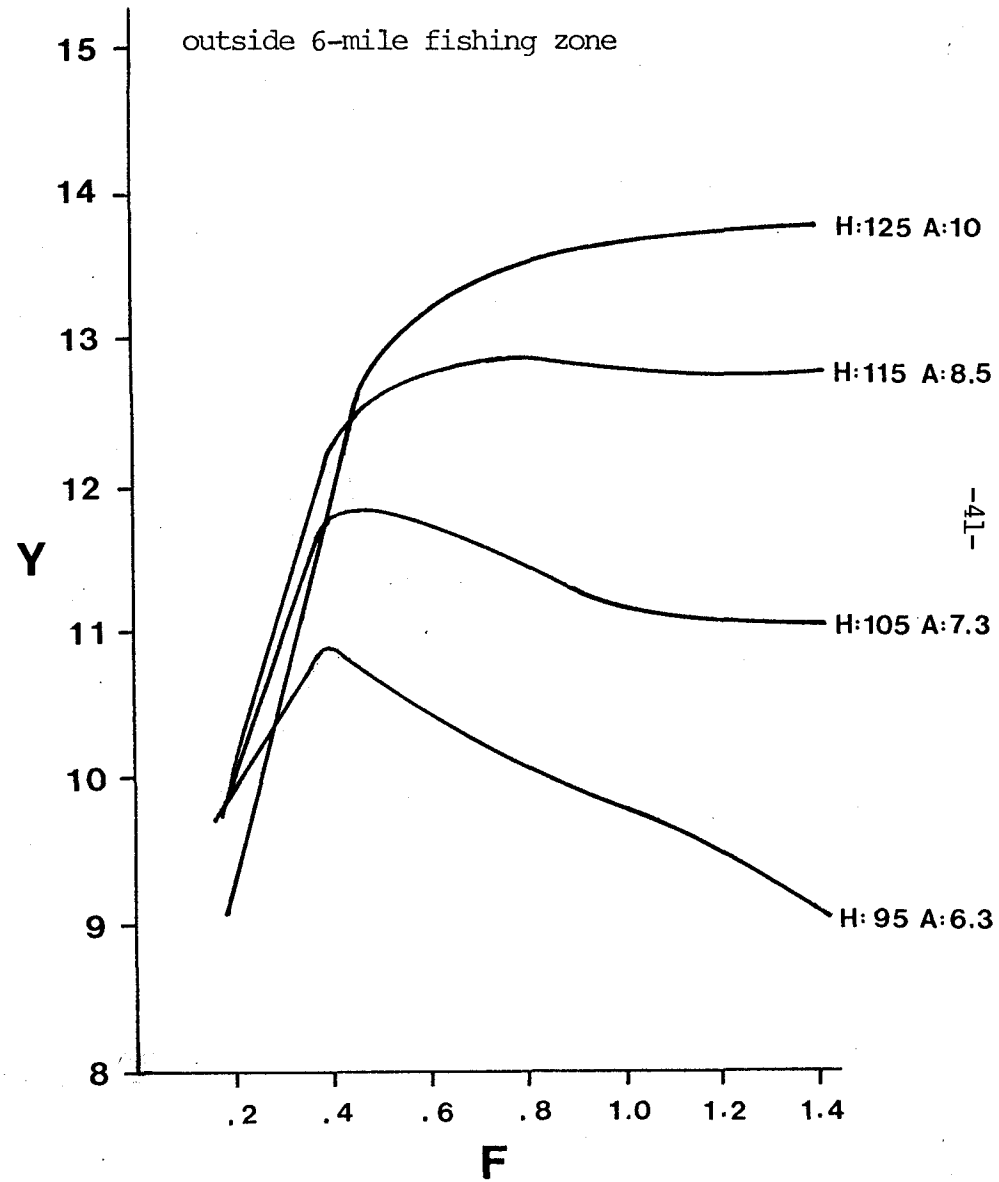
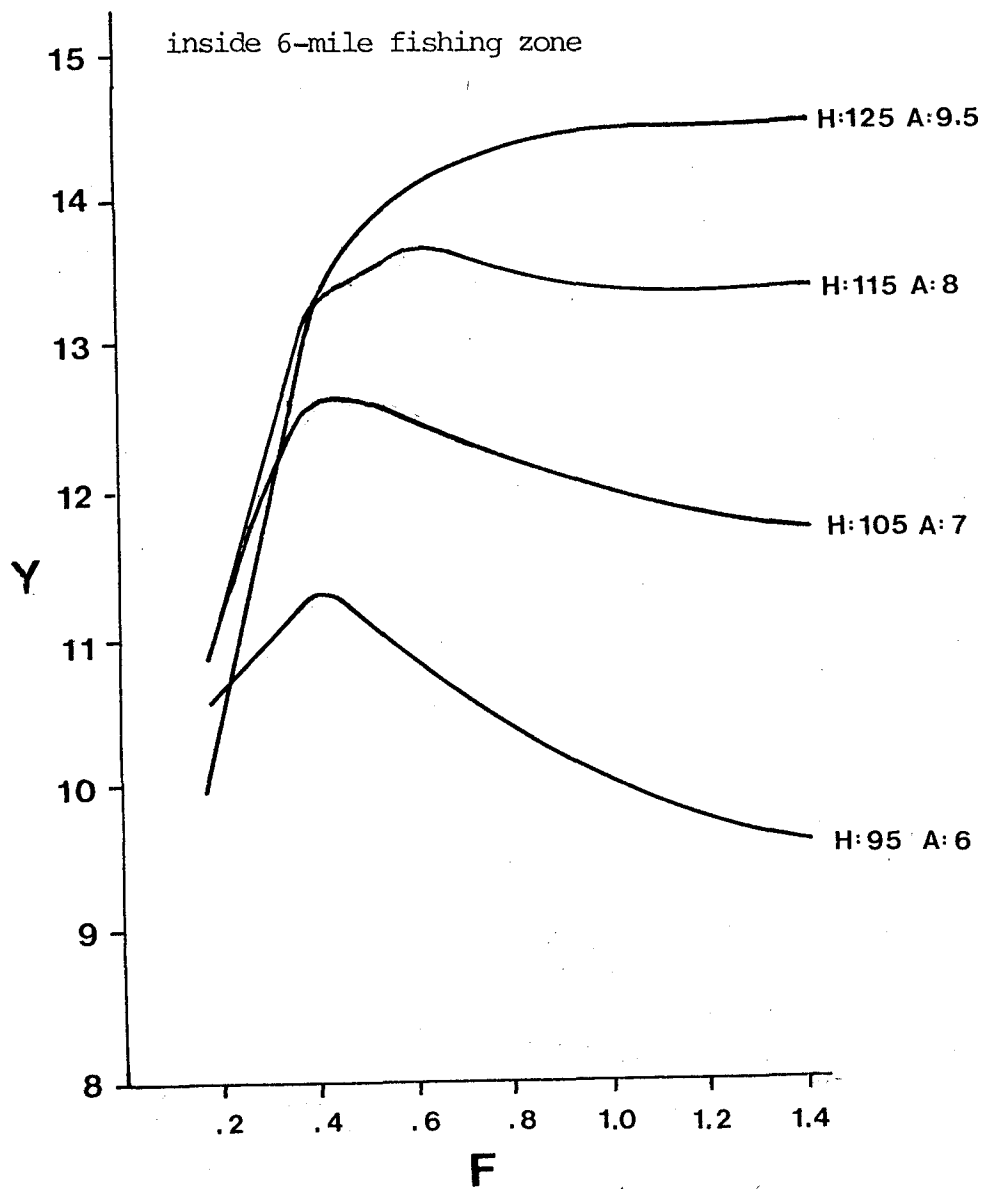


Figure 5.- Yield per recruit,  $Y$  (g), according to the Thompson and Bell yield model for the inside 6-mile and outside 6-mile fishing zones in the Bay of Fundy as a function of fishing mortality ( $F$ ) for different shell height sizes ( $H$ ) in mm or various ages ( $A$ ) in years at first capture.