A Comparison of Scallop (*Placopecten magellanicus*) Population and Community Characteristics Between Fished and Unfished Areas in Lunenburg County, N.S., Canada

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ABSTRACT

Brocken, F. and E. Kenchington. 1999. A comparison of scallop (*Placopecten magellanicus*) population and community characteristics between fished and unfished areas in Lunenburg County, N.S., Canada. Can. Tech. Rep. Fish. Aquat. Sci. 2258: vi + 93 p.

Bayport and Second Peninsula (Lunenburg County, N.S., Canada) were closed to all forms of sea scallop fishing from November 1995 until January 1998. Except for a small stock assessment in Second Peninsula in 1997, no extensive research on the population has been done before or since the closure. In June and August, 1998 scallops were sampled at several sites in three areas off Lunenburg County. Lunenburg and three sites at Second Peninsula were open for scallop fishing, the other samples at Second Peninsula and those at Bayport were in closed areas. Shell height, meat, gonad and soft tissue weight were recorded. A subsample of the meat was used for RNA/DNA ratio analysis to determine the nutritional state of the scallops. At each sample site the presence of filter feeders, potential predators, depth and bottom type were also recorded.

The primary difference between the open and closed areas was seen in the numbers of scallops less than 60 mm shell height. Both of the closed areas (Bayport and Second Peninsula) had high numbers of smaller scallops in contrast to the Lunenburg area which had very few animals in this size class. However, the sea scallop density and the percentage of clappers were not significantly different in the open and closed areas. Although not significant, RNA/DNA ratios correlated positively with lower % clappers suggesting that food limitation may be a factor in increases of natural mortality. The closed areas Bayport and Second Peninsula appear to be better growth environments than Lunenburg because the % yield for a standard shell height in these areas was significantly higher. Due to the presence of small scallops in the closed areas, significant effects on meat weight, gonad weight, soft tissue weight and shell height were found between open and closed areas. Within all areas the variability in the measured characters was high between dive locations. Bottoms with gravel showed higher densities than all other bottom groups found in this study. The main potential predators found were *Cancer irroratus, Homarus americanus* and *Asterias forbesi.*

Based on data on meat count and percentage of animals over 100 mm of this study, the SFA29 Inshore Scallop Advisory Committee increased the restriction of the minimum shell height from 100 mm to 110 mm for both open and closed areas, thereby protecting more large animals to provide future recruitment.

RÉSUMÉ

Brocken, F. and E. Kenchington. 1999. A comparison of scallop (*Placopecten magellanicus*) population and community characteristics between fished and unfished areas in Lunenburg County, N.S., Canada. Can. Tech. Rep. Fish. Aquat. Sci. 2258: vi + 93 p.

Toute forme de pêche au pétoncle a été interdite à Bayport et à Second Peninsula (comté de Lunenburg, N.-É., Canada) de novembre 1995 à janvier 1998. À l'exception d'une petite évaluation des populations effectuée à Second Peninsula en 1997, aucune recherche exhaustive sur les populations de pétoncles n'a été effectuée avant ou après la fermeture de la zone. En juin et août 1998, on a prélevé des échantillons de pétoncles à plusieurs sites dans trois zones au large du comté de Lunenburg. La pêche aux pétoncles était ouverte à Lunenburg et à trois des sites à Second Peninsula; les autres échantillons prélevés à Second Peninsula et à Bayport ont été pris dans des zones fermées. On a noté le poids de la chair, des gonades, et du tissu mou, ainsi que la hauteur des pétoncles. Un sous-échantillon de chair a été utilisé aux fins d'une analyse du ratio ARN/ADN afin de déterminer l'état nutritionnel des pétoncles. À chaque lieu de prise d'échantillons, on a également noté la présence de filtreurs et de prédateurs, ainsi que la pronfondeur de l'eau et le type de plancher.

La principale différence entre les zones ouvertes et les zones fermées s'est manifestée dans la proportion de pétoncles d'une hauteur inférieure à 60 mm. Dans les deux zones fermées (Bayport et Second Peninsula), on a constaté la présence d'un grand nombre de petits pétoncles, tandis que dans la région de Lunenburg, on a relevé la présence de très peu de pétoncles de cette dimension. Cependant, la densité des populations de pétoncles et le pourcentage de *claquettes* dans les zones ouvertes et fermées étaient sensiblement les mêmes. Bien que faible, la corrélation positive entre les ratios ARN/ADN et les pourcentages moins élevés de *claquettes* laisse supposer qu'un accès restreint à la nourriture pourrait constituer un facteur déterminant dans l'augmentation du taux de mortalité naturelle. Les zones fermées de Bayport et de Second Peninsula semblent favoriser davantage la croissance que la région de Lunenburg, puisque le rendement en pourcentage des pétoncles d'une hauteur standard était considérablement plus élevé dans ces zones. En raison de la présence de petits pétoncles dans les zones fermées, on a constaté des écarts importants au niveau du poids de la chair, des gonades et du tissu mou, et au niveau de la hauteur des coquilles entre les zones ouvertes et fermées. Dans toutes les zones, la variabilité des caractéristiques mesurées était forte entre les lieux de plongée. La densité des populations était plus importante dans les planchers recouverts de gravier que dans tous les autres types de planchers observés dans le cadre de l'étude. Les principaux prédateurs observés sont le *Cancer irrotatus*, le *Homarus americamis* et l'*Asterias forbesi*.

En se fondant sur les données sur le poids de la chair et le pourcentage de pétoncles d'une hauteur supérieure à 100 mm recueillies dans le cadre de cette étude, le Comité consultatif de la pêche côtière du pétoncle (zone de pêche du pétoncle 29) a augmenté de 100 mm à 110 mm la restriction sur la hauteur minimale dans les zones ouvertes et fermées, ce qui permettra de protéger un plus grand nombre de gros pétoncles en vue d'assurer le renouvellement des populations.

DEDICATION

This report is dedicated to the scallop fishermen Lunenburg County who have shown a genuine interest in developing a harvesting plan which supports the conservation of the sea scallop. Given the diversity of the fishing methods and the presence of both recreational and commercial interests in this area this task has required much compromise.

INTRODUCTION

PLACOPECTEN MAGELLANICUS

Placopecten magellanicus (Gmelin 1791), also called sea scallop, is a mollusc commonly reaching sizes between 100 and 150 mm. Larger sizes however, are not exceptional (Naidu, 1991). Animals can reach an age of 20 years (29 at maximum) and a shell height of approximately 21 cm, before they die of senescence (Naidu, 1991). Shell height (Figure 1) is measured as the distance from the middle of the hinge to the furthest ventral shell edge (Bourne, 1964). The shells or valves are made of calcium carbonate or calcite in an organic matrix (Bourne, 1964) and cannot, in contrast to other bivalves, be closed completely (Stewart & Arnold, 1994). Both valves are almost circular and roughly equal in diameter; the shape however, is different. The left shell is more convex, often reddish in color and ribbed, while the right valve is flat, white and smooth. The latter is the shell on which the scallop normally rests on the bottom (Figure 2). The rings on the ribbed shell are growth rings (*e.g.,* Young-Lai & Aiken, 1986; Naidu, 1991). The two valves are held together by a hinge made of flexible protein (Young-Lai & Aiken, 1986; Naidu, 1991; Stewart & Arnold, 1994). The symmetrical flarings of the shell at the hinge are called auricles (Naidu, 1991).

P. magellanicus is fished and cultivated for its meat or the adductor muscle (*e.g.,* Bourne, 1964; Young-Lai & Aiken, 1986; Naidu, 1991). This muscle consists of two parts which are divided by connective tissue. The catch muscle is composed of smooth fibers and the quick muscle of striated fibers. The larger quick muscle, 80% of the total, is responsible for rapid contractions of the valves that make the scallop swim. Contractions of the catch muscle keep the valves closed (Young-Lai & Aiken, 1986).

Distribution

The sea scallop occurs on the east coast of North America from the north shore of the Gulf of St. Lawrence to Cape Hatteras (North Carolina, U.S.A.) in the south (Figure 3) (Posgay, 1957; Bourne, 1964). However, the distribution has not been documented very accurately and recordings exist of scallops as far south as Virginia (Dadswell & Parsons, 1992) and north to the tip of Labrador. *P. magellanicus* occurs in water with depths ranging from just below low tide to over 150 m (Kenchington *et al.*, 1997). In the northern part of their geographical range, sea scallops occur in shallower water than in the southern part as a function of warmer water temperatures (Naidu, 1975; Young-Lai & Aiken 1986). In areas where environmental conditions such as temperature, bottom and food availability are good, scallops occur in persistent localized, dense aggregations called beds.

Feeding

Placopecten magellanicus is a filterfeeder that feeds on phytoplankton, detritus and associated bacteria (Shumway *et al.*, 1987; Grant & Cranford, 1991). Diatoms appear to form the main food source in the wild (Young-Lai & Aiken, 1986). Shumway *et al.* (1987) found that the food particles that have a size range of 10-350 μm, originated from both the pelagic zone and the bottom. Scallops filter 2 - 20 l hr^{-1} (Cranford & Gordon, 1992). The feeding rate and patterns are influenced by temperature, the particle concentration and size, and salinity (Cranford & Gordon, 1992; Stewart & Arnold, 1994). When high quality food concentrations are low, sea scallops try to compensate by maximizing the absorption of available resources (Cranford, 1995). Inorganic suspended material and sized particles can interfere with feeding; however, low concentrations (< 0.5 mg/l) of inorganic particulate matter in the sea scallops' diet enhance the efficient use of phytoplankton cells (Cranford & Gordon, 1992).

The general anatomy of the sea scallop is shown in Figure 4. The mantle controls the inflow and outflow of water into the mantle cavity and carries the sensory tentacles and eyes (Beninger & Le Pennec, 1991). These tentacles probably form the first selection for particle uptake by limiting the entry of relatively large particles into the mantle cavity (Stewart & Arnold, 1994). The gills with cilia generate a water current to catch food and embeds the particles in mucus (Young-Lai & Aiken, 1986; Cranford & Gordon, 1992). These are transported to the labial palps which reject some mucus and non-nutritious particles bound in it (Young-Lai & Aiken, 1986), thereby forming the second and final selection of food during uptake. The waste is stored inside the mantle cavity and periodically expelled as pseudofeces by contraction of the adductor muscle (Young-Lai & Aiken, 1986). From the mouth (surrounded by the labial palps), the esophagus leads directly to the stomach which is situated within the digestive gland, located ventral to the chrondrophore or resilium (Beninger & Le Pennec, 1991). The intestine goes through the gonad, over the adductor muscle and through the pericardium and ventricle before it forms the anus (Young-Lai & Aiken, 1986; Beninger & Le Pennec, 1991). Sea scallops remove their feces from the mantle cavity by rapid contractions of the valves. (Young-Lai & Aiken, 1986).

A component of the phytoplankton digested consists of dinoflagellates such as *Dinophysis spp.* and *Alexandrium spp.* that cause diarrhetic shellfish poisoning (DSP) and paralytic shellfish poisoning (PSP) (Shumway *et al.*, 1987). These toxins are mainly stored in the digestive gland and therefore do no affect the adductor muscle when it is not tainted during processing (Jamieson & Chandler, 1983; Yasumoto *et al.*, 1984).

Swimming

Among the pectinids, *Placopecten magellanicus* is one of the strongest swimmers (Stokesbury & Himmelman, 1996). By "clapping" the valves rapidly, the scallop can produce a jet stream. This swimming movement has probably evolved from a cleaning response (Yonge, 1936) to expel water and pseudofeces.

The sea scallop opens it valves, lets water in and presses the muscular edges of the mantle closely together. By closing its valves, a jet stream is produced through the incurrent and excurrent openings (Bourne, 1964; Young-Lai & Aiken, 1986; Cheng & DeMont, 1996). Depending on the position of the out streaming water, scallops can swim with their hinge forward or backward. Scallops are also able to swim upward (Bourne, 1964). Sea scallops can swim for 15 to 20 seconds (Bourne, 1964) using 25-35 contractions, before several hours of rest are required to let the muscle recover from fatigue and return to its pre-swimming physiological condition (Thompson *et al.*, 1980; Brand, 1991).

There are three different stages in the life cycle of scallops in terms of mobility (Figure 5). Juveniles (0.25-30 mm) are attached with byssal threads, but can detach these and swim. Scallops of 30 to 100 mm are unattached and can swim easily. Scallops over 100 mm are unattached, but are not very mobile due to the heavy body mass in relation to the water discharge activity which these scallop can generate (Gould, 1971; Caddy 1972; Dadswell & Weihs, 1990; Parsons *et al.* 1992a; Stokesbury & Himmelman, 1996). Juvenile scallops have a different trajectory than adults. The former has an ascent in steps with angles of 82^0 (Manuel & Dadswell, 1991). The adults, however, have a rapid ascent of several seconds at an angle of 30^0-50^0. This is followed by a horizontal movement over 2 to 3 meters and a passive descent in a series of side slips (Caddy, 1968; Chapman *et al.*, 1979; Morton, 1980). According to Bourne (1964) and Caddy (1968) scallops do not come off the bottom more than 0.3-0.6 m. The ground speed of swimming scallops is 67 cm/sec (Caddy, 1968). Rarely do scallops move more than 10 m horizontally per swimming period, but in combination with tides and currents they move greater distances. There is no evidence of seasonal migration (Baird, 1954; Dickie, 1955; Posgay 1963, 1981; Melvin *et al.*, 1985; Stewart & Arnold, 1994; Hatcher *et al.*, 1996).

Swimming is thought to have an escape function to avoid predators (Caddy, 1968; Gould, 1971; Thayer, 1972) and possibly a dispersal function to move to suitable habitat (Yonge, 1936; Stanley, 1970; Winter & Hamilton, 1985). To avoid starfish, scallops use their swimming ability frequently. To avoid crabs they often just close their valves during the encounters (Barbeau & Scheibling, 1994). Stokesbury and Himmelman (1996) found only a weak correlation of scallop movement with the abundance of the predator *Cancer irroratus*, although movement did reduce predation rate. They also found that even though scallops move away from unsuitable habitats more than from suitable habitats, the dispersal directions are random. Scallops did not appear to selectively migrate from unsuitable to suitable habitats.

Life Cycle and Growth

The time of spawning varies from area to area. In Digby spawning takes place annually in early September (Dickie, 1955) and on Georges Bank in late September or early October (Posgay & Norman, 1958). Dadswell and Parsons (1992) found that the spawning event occurred from late July to early September at both deep-water and shallow sites in Passamaquoddy Bay (N.B.) and during September and October for scallops from 15-25 m in Mahone Bay. They found that scallops from depths of 5 to 10 m in this bay spawned semi-annually from late June until late July and again in September through October. These semi-annual spawning events have been recorded for both offshore and inshore populations (Naidu, 1970; Savage 1980; DuPaul *et al.*, 1989; Schmitzer *et al.*, 1991; Parsons *et al.*, 1992b; Dibacco *et al.*, 1995). Bonardelli *et al.* (1996) found that multiple spawnings occurred more often at the outer bay of Baie des Chaleurs than at the sample sites on the inside of the bay.

Placopecten magellanicus has a synchronous spawning whereby the males (white gonads) are stimulated first and the presence of sperm in the water induces the females (red gonads) to spawn (Posgay, 1953). Several factors have been found to induce spawning. Bonardelli *et al.* (1996) found that spawning in Baie des Chaleurs was induced by changes in water temperature during downwelling events. They found no correlation with the abundance of phytoplankton, particulate organic content (POC) or nitrogen in the water, no relation to lunar and tidal phases or to the current velocity. Penney and McKenzie (1996) however, did find in Notre Dame Bay (Nfld.) that the time of spawning was related with a period of improved growth conditions for young bivalves. This did not only include a rise to maximum seasonal water temperatures but also a rise in organic particulate seston and the occurrence of a diatom bloom. In Passamaquoddy Bay (N.B.) Parsons *et al.* (1992b) during long-term research over 13 years found that spawning was related with the lunar/tidal cycle.

Culliney (1974) and Couturier (1990) conducted laboratory experiments at temperatures of 13-15^0 C to observe larval development. After an external fertilization, the eggs are buoyant for one day before they transform into a trochophore larva (Figure 5). This is the first mobile stage which is propelled by apical cilia that point forward. Three days later, the early veliger stage is reached. At this state the velum is used for locomotion and feeding. In the early stage, the larva has a hinged D-shaped shell which is deposited by the shell gland. In the late stage the shell begins to enlarge and change in shape, a light sensitive eye spot develops and a foot appears. The foot has a byssal gland that produces byssal threads by which the larva can attach itself to the substrate. The pediveliger larva possessing both a foot and a velum, starts showing adhesive tendencies. By swimming and crawling it tries to find a suitable substrate to settle. When it settles, the metamorphosis and the degeneration of the velum occur simultaneously. The larva is now approximately 30-35 days old and has a length of 230-280 μm (Figure 5). The newly settled scallops, also called spat, have a high growth rate (Black *et al.*, 1993). The byssus production gradually decreases as the scallops grow older until the foot becomes rudimentary in adults (Caddy, 1972; Young-Lai & Aiken, 1986).

In the early life stages, scallops have a relatively fast growth but the growth rate, described by a Von Bertalanffy growth curve, decreases to an asymptotic level as *P. magellanicus* gets older. However, growth varies spatially and temporally. Growth rate, the growth of somatic and gonadal tissue and the reproductive output depend on environmental factors such as food availability and temperature. Food and temperature not only vary between areas (*e.g.,* Claereboudt & Himmelman, 1996), but often also vary with depth. Differences in growth of offshore (deep water) and inshore (shallow water) scallop populations have been observed, with more favourable conditions for growth in shallow water (MacDonald & Thompson, 1985a, b, 1986, 1987; Schick & Shumway, 1988; Côté *et al.*, 1994; Claereboudt & Himmelman, 1996; Kenchington *et al.*, 1997). Naidu (1975) found that growth is also influenced by the composition of the bed sediment. Slower growth occurred in fine sediment, possibly due to increased energy requirements for filtration. Dadswell and Parsons (1992) found that the growth rate of spat from early spawning cohorts (late June until late July) to a size of 90 mm was faster than the late spawning (September through October) cohort studied in Mahone Bay. The growth rate of the latter has more in common with the growth rate of a late spawning population (late July to early September) investigated in Passamquoddy Bay.

Seasonal variation is due to changes in water temperatures and results in the deposition of growth rings in winter when growth is slow (Stevenson, 1936; Merill *et al.*, 1966). The rings have been verified to be annual (Stevenson & Dickie, 1954; Posgay, 1962; Naidu, 1969) and therefore function as a method to determine age.

Mortality

Mass mortalities of sea scallops have been recorded several times and in some cases the cause was established (Dickie & Medcof, 1963; Robinson *et al.*, 1992; Bergman *et al.*, 1996). The causes of mortality can be either biological or environmental (Young-Lai & Aiken, 1986).

Senescence can be the cause of death of healthy scallops on non-fished grounds; however, it is unlikely that it would cause a sudden (mass) mortality of scallops (Dickie & Medcof, 1963). When scallops are starving, it is reflected in a low GSI and in a low % yield because not much energy goes into the development of the gonads and meat (Dickie & Medcof, 1963). Robinson *et al.* (1992) thought that the high mortalities in the Cape Spencer area of the Bay of Fundy were due to starvation. The RNA/DNA ratios of survivors however, suggested good growth and it appeared that the highest levels of mortality were not found in the areas with the highest density. Dickie & Medcof (1963) do not see starvation as a plausible cause of mass mortality.

Low summer temperatures that do not reach the spawning threshold for scallops may result in a destruction of gametes and can delay larval development (Medcof & Bourne, 1964; MacKenzie, 1979). As the time of development is lengthened, there is a higher exposure to predators which increases larval mortality and decreases recruitment (Dickie, 1955). A greater weakness of scallops during their spawning period, however, has not been found to result in mortalities (Dickie & Medcof, 1963).

Especially in shallow areas (less than 12-20 m), warm water can reach the bottom due to oscillations in the thermocline. Scallops that are exposed to higher temperatures then their optimum 10^0-15^0 C (Young-Lai & Aiken, 1986), are weakened and more vulnerable to predators (Dickie, 1958; Dickie & Medcof, 1963). Temperatures in excess of 22.5^0 C are lethal to scallops. Mortalities due to unfavorable temperatures have been recorded (Johannes, 1957; Dickie & Medcof, 1963). The live scallops found during those studies were in good condition and the dead scallops showed no signs of abnormal pathologies.

Besides water temperature, tides, salinity, the amount of dissolved oxygen and suspended sediment are hydrographic causes of mortality. Heavy flushing of basins can sweep larvae out to sea were they are lost. Larvae with delayed development due to low water temperatures are especially vulnerable (Medcof & Bourne, 1964). Sea scallops need a salinity of at least 30 ‰ (Young-Lai & Aiken, 1986). In the case of lower salinities (16.5-25 ‰ is the low limit they can tolerate (Chiasson, 1952; Ledwell, 1995; Bergman *et al.*, 1996)) they are unable to adjust their osmotic system rapidly enough and will go into osmotic shock. This shock is characterized by a swelling of the tissues and depending on the severity, scallops may eventually die (Bergman *et al.*, 1996). The salinity of inshore waters can decrease to dangerous levels for scallops due to fresh water run-offs.

Unless discharges of organic matter are taking place, scallops in nature are rarely exposed to reduced oxygen levels (Stewart & Arnold, 1994). Sediment particles in the water dilute the nutritional value of particles ingested by scallops and they obstruct the gills (Cranford & Gordon, 1992). Reduced movement of the cilia causes a reduced oxygen transfer and in the longer term can cause suffocation (Larsen & Lee, 1978). concentrations as low as 10 mg/l can influence the energy balance and survival of the sea scallops (Cranford & Gordon, 1992). In shallow waters, storms can easily resuspend bottom sediment (Stewart & Arnold, 1994) thereby creating difficulty for the animals.

In the plankton stage, the larvae are preyed upon by zooplankton and planktivorous fish and in their benthic stage, larvae are eaten by almost anything that is big enough to ingest them (Young-Lai & Aiken, 1986; Stewart & Arnold, 1994). Post larval scallops are eaten by several predators including cod (*Gadus morhua*), starfish (*Asterias vulgaris*, *Crossaster papposus*), American plaice (*Hippoglossoides platessoides*), wolf fish (*Anarhichas lupus*) and whelks (*Buccinum spp.*) (Medcof & Bourne, 1964; Naidu & Meron, 1986). Moonsnails (*Euspira heros*) are able to prey on weakened scallops (Dickie & Medcof, 1963), and Caddy (1968, 1973) considered rock crabs (*Cancer irroratus*), groundfish (*Myoxocephalus spp.*), winter flounder (*Pseudopleuronectes americanus*) and starfish to be probable predators of scallops which had been damaged during dragging operations. Squires (1970) and Elner and Jamieson (1979) recorded lobster (*Homarus americanus*) as a predator of sea scallops. Only a few predators can handle a large healthy scallop. Depending on the predator involved, large scallops are less susceptible to predation than small ones (Elner & Jamieson, 1979; Barbeau & Scheibling, 1994). Jamieson et al. (1982) found that the rate of predation of scallops by crabs and lobsters was significantly higher for small size categories than for larger ones, and size preference was found to depend on the size of the predators. Prey size increases with predator size (Elner & Jamieson, 1979). The maximum size of scallops taken by rock crab and lobster was respectively 72 and 76 mm (Elner & Jamieson, 1979). Animals over 70 mm are able to resist attacks by many predators (Brand, 1991; Orensanz *et al.*, 1991).

Shell boring and encrusting species are more frequently observed on large, sedentary scallops of various species than on the small, mobile ones (Merill, 1960, 1961). Species such as boring sponges (*Cliona vastifica*) (Medcof, 1949; Warburton, 1958), shell worms (*Polydora spp. and Ceratonerus spp.*) (Kinoshita, 1939; Wells & Wells, 1962) and hydroids (*Hydractinia echinata*) (Medcof & Bourne, 1964) might not directly the scallops, but they can weaken them and make them more vulnerable to other causes of mortality.

The alga *Coccomyxa parasitica* is parasitic, but harmless in light infections (Stevenson & South, 1974) and the alga *Chlorella spp.,* while harmless, can color the tissues of the sea scallop bright green.

Gulka *et al.* (1983) describes a mass mortality (up to 100%) caused by an extensive prokaryotic infection. "Brown-spot" is a bacterial disease that causes 1 to 4 mm brown spots in white meats. When found in scallops (usually larger ones), it weakens them and makes them more vulnerable to predators. It also leads to the rejection of meats as unmarketable (Stewart & Arnold, 1994).

Sea scallops seem not to be affected by the post-larval and juvenile red hake (*Urophysis chuss*) (Wigley & Theroux, 1971) and the sea snail fish (*Liparis inquilinus*) (Able, 1973) that seek shelter in the mantle cavity.

Drag fishing causes mortalities both of the scallops caught in the drags as well as among the scallops left on the bottom. The latter group can be physically damaged or killed outright (13-17 % per tow) by the drags (Caddy, 1973). The mantle cavity of scallops can get packed with mud, or they might get completely buried in the bottom (Medcof & Bourne, 1964). Undersized scallops that are hauled up in a tow but which are not useful for shucking, are vulnerable to air exposure and dumping damage (Medcof & Bourne, 1964).

Clappers, or cluckers are empty valves that are still hinged together. The relative number of clappers to the total scallops caught, gives an estimate of the mortality (Dickie & Medcof, 1963; Robinson *et al.*, 1992). Annual natural mortality has been determined at 10 % (Dickie, 1955; Merill & Posgay, 1964; Orensanz *et al.*, 1991) and this number is frequently cited nowadays. Because crabs and lobsters crush the valves while opening scallops, determining the mortality by % clappers, may lead to underestimation (Elner & Jamieson, 1979).

The time that valves of dead scallops stay together depends on the water temperature, type of substrate, water movements and the size of the scallop because all these influence the decomposition rate of the ligament (Orensanz *et al.*, 1991). The largest influence on a clapper's lifetime depends on fishing activity in the area. Drags will tear the valves apart if an area is fished. The life of clappers has been found to vary from a few months in fished areas to three to four years with no sign of detachment in non fished areas (Young, MS 1930; Zinck, MS 1932; Chiasson, MS 1952; Dickie & Medcof, 1963).

SCALLOP FISHERY IN LUNENBURG COUNTY

Lunenburg County is one of the first areas where the sea scallop fishery developed. Willis (1862) recorded that people from Lunenburg frequently ate scallops caught in Mahone Bay and according to Bourne (1964) the first landings recorded in Canada date from 1886 when 300 dozen sea scallops were sold from Lunenburg County at 50 cents a dozen. This area (mainly Mahone Bay) was, together with the fishery at Digby, the predominant inshore fishery before 1945 (Stewart & Arnold, 1994).

Inshore scallops are caught by dragging, dipping and diving and through the use of tongs. The trawled gear, also called drags, dredges or rakes is composed of an iron frame and bag(s) made from steel ring mesh (Stewart & Arnold, 1994). Inshore boats are smaller than 20 m and have 2.5 m drags. These inshore drags consist of up to nine bags which operate independently of one another thereby allowing the set of drags to conform closely to bottom contours (Bourne, 1964; Naidu, 1991; Black *et al.*, 1993).

Resource management started in 1918. A $1 fee, a closed season from June 1 to September 15 and a size restriction (100 mm minimum shell height) were instituted to protect scallop populations in Mahone Bay and Chester Basin (Anonymous, 1920). In the Atlantic Fisheries Regulations of 1985 under No. 63.5 the seasonal closure from May 1 to October 31 was laid down for the Lunenburg area. Both commercial (dragging) and recreational divers and dippers had free access to the area from November 1 to April 30. For the latter group, a maximum of 100 scallops per day is specified in the Atlantic Fisheries Regulations (No. 69).

Especially in Second Peninsula, a lot of dragging took place during the 1950s. Days with 20 to 30 boats dredging in this small area were not uncommon. In the 1970s the scallop populations were harvested even more intensively when SCUBA diving for scallops increased. Not only residents of Lunenburg County, but also from Halifax came down to the area to fish for scallops (pers. comm., Chip Veinotte, Department of Fisheries and Oceans, Bridgewater, N.S.).

In 1993 the baglimit of 100 scallops per day was decreased to 50 scallops per day. However, this did not stop the concern from local commercial and recreational fishers for the scallop population. In the early 1990s this concern resulted in the establishment of the SFA29 Inshore Scallop Advisory Committee (ISAC) (pers. comm., Chip Veinotte, Department of Fisheries and Oceans, Bridgewater, N.S.). This committee provides input and advice to the Department of Fisheries and Oceans on the conservation, protection and management of the inshore scallop resource. It serves as the pre-eminent consultative forum for the development of the annual Inshore Scallop Fishing Plan (ISAC minutes, April 24, 1996).

On November 1, 1995 until April 30, 1996 Second Peninsula (as most productive fishery ground in the area) and Bayport were closed for all fisheries for the first time. This complete closure lasted until the end of December 1997. The open areas in Lunenburg County remained open for all fisheries from January 1 to March 31 every year with only the restriction of a maximum of 50 scallops a day for recreational licence holders (pers. comm., Chip Veinotte, Department of Fisheries and Oceans, Bridgewater, N.S.).

Bayport and Second Peninsula, Lunenburg County were partially opened in 1998 for the first time in three years. From January until April 30 they were accessible only for dipping. Besides this change in closing dates, the regulations also provides a size limit in 1998. Scallops have to be over 4 inches (100 mm) in shell height. The bag limit of 50 scallops per day is still retained. A temporary extra opening of Bayport and Second Peninsula may take place in November and December 1998 (pers. comm., Chip Veinotte, Department of Fisheries and Oceans, Bridgewater, N.S.).

In 1998, 34 commercial scallop licences (C) and 310 recreational scallop licences (R) were issued for Lunenburg County (Appendix 1). Of the 310 recreational, 263 were for dip net and 192 for SCUBA diving (some being for both dip and diving); 13 drag licences and 8 for the use of tongs were also issued (pers. comm. Linda Hunt, Department of Fisheries and Oceans, Halifax, N.S.). Part of the licence condition (Appendix 1) is the Scallop Report Document. Licence holders are required to fill in this form indicating when, where, how and how many scallops they have caught. These data provide the Department of Fisheries and Oceans with an overview of the landings of scallops. In Appendix 2, the 1998 landing information for scallops caught in the area from LaHave to Mahone Bay from January to April is given. In total 56 licence holders harvested 7801 scallops in the first months of 1998. 11 Licence holders harvested their scallops in the Bayport or Second Peninsula area. These 816 scallops made 10.5% of the total caught from LaHave to Mahone Bay. Because in some cases the precise locations were not clear (*e.g.,* Heckmans Island was included in all cases), this number is inaccurate.

The location of scallop fishing beds, in Southwest Nova Scotia, were mapped by some fishermen in 1997 through the SFA29 ISAC. The location of these beds, as originally mapped are given in Appendix 3. Not all communities provided maps and these can only be considered to be rough estimates of the distribution of the sea scallop in this area.

1998 RESEARCH PROJECT

No stock assessment research had been performed on the scallop population in Lunenburg County prior to or after the closure, until 1997. In January of that year, a small stock assessment was completed in Second Peninsula by the Department of Fisheries and Oceans. The data included a large number of clappers (Figure 6). These high percentages (Table 1) were not expected due to the fact that the area had been closed to any form of fishery at that time and they exceeded greatly the 10 % expected due to natural mortality (Dickie, 1955; Merril & Posgay, 1964; Orensanz *et al.*, 1991). Furthermore, the fact that all clappers were over 70 mm in shell height raised concern at the SFA29 ISAC meeting where the survey results were presented. Two questions were raised: 1) Is the closure benefiting the scallop stocks and 2) is the mortality of the larger animals a concern? There was strong support for continued research on the scallop population in the closed areas.

It is difficult to answer these questions without historical data on the stocks in question. However, it is possible to determine whether or not differences between the open and closed areas exist. It must be recognized that any differences observed may not be due to differences in fishing pressure but may be due to environmental considerations. In the current study we compare sites from closed areas with sites in an open area in Lunenburg County, in an effort to assess differences in the sea scallop population structure and community. Because of the history of the scallop fishery in Lunenburg County and the recent (partial) opening of the closed areas in Bayport and Second Peninsula, it is very important to get a clear understanding of the state of these scallop populations.

MATERIALS AND METHODS

SAMPLE SITES

The samples sites are situated in Lunenburg County, N.S., Canada (Figure 7). The sites in Lower South Cove are called 'Bayport' and the ones in Lunenburg Bay in Puffeycup Cove and off Masons Point are referred to as 'Lunenburg'. The sample sites from Second Peninsula and the ones off Hermans Island are referred to as 'Second Peninsula'. Bayport was closed to scallop fishing from November 1995 to January 1998. The sample sites from Second Peninsula, including B6 at Lucy Island are also closed to scallop fishing. Mahone Bay, where Hermans Island is situated, is an open area, as is Lunenburg Bay (Table 2). Some of the sites were also sampled during the 1997 survey of Second Peninsula (see Table 1 for locations).

Samples were taken on July 28, August 5 and August 26, 1998. The sampling areas were marked by local residents as areas were beds of scallops had a high probability of occurring. The sampling took place from a boat, provided by the Department of Fisheries and Oceans, Bridgewater, during the first two days of sampling. The third day a boat was provided by a local resident. The first had a GPS on board, making it possible to accurately record latitude and longitude data of these sites (Table 2).

DENSITY, MORTALITY, SIZE AND AGE DISTRIBUTION

At each site, two SCUBA divers made a circle within which all scallops, both live and dead (clappers) were collected. The initial size of the circle was 40 feet in radius. However, depending on circumstances such as number of scallops found (influencing dive time to remove samples from the circle), currents and depth it was not always possible to keep the circle that big and the size was adjusted. The exact radius for each dive was recorded and data were later standardized to a standard circle of 40 feet. Shell heights of the live scallops and clappers were measured to the nearest mm using calipers. Shell height frequencies were plotted.

Assumptions of analysis of variance of scallop density and % clappers for dives within an area, between areas, by open and closed status and by bottom were tested. The Levene test for homogeneity of variances was used and a visual examination of the normal quantile distribution of the residuals was made with the statistical package JMP. If the assumptions were met, an ANOVA was performed and in case of unequal variances a Welch ANOVA. Tukey-Kramer post-hoc tests of the means were run to identify significantly different pairs.

The fit of a regression model between percentage of clappers and scallop density was tested for a density dependent mortality relationship in the software package EXCEL. Assumptions of analysis of variance, as described above, were tested to compare the mean shell height on natural log scale between areas and between open and closed fishery status.

Shells of dive A1 at Bayport were aged if possible and a height-at-age Von Bertalanffy relationship was calculated in the package SPSS.

GROWTH AND PRODUCTION

Due to the size of the boat, no further processing of the scallops was possible while collecting them in the field. The scallops were kept in cotton bags in coolers and were left in a room overnight before further processing in the lab.

Wet weights of meat, gonad and soft tissue were cross-coded with shell heights and animals were visually sexed where possible. Subsamples were taken from the adductor mussels to determine RNA/DNA ratios. The tissue was wrapped in aluminum foil and stored in a -75 ^{0}C freezer until further processing.

Analyses of variance tests were made on dive means of the natural log transformed data of meat, gonad and soft tissue weight by area and by fishing status. The assumptions of analysis of variance were tested using the Levene test for homogeneity of variances and a visual examination of the normal quantile distribution of the residuals. If the assumptions were met an ANOVA was performed. If the variances were unequal a Welch ANOVA was performed. A Tukey-Kramer HSD post-hoc test of the means was run to identify significantly different pairs. The statistical package JMP was used to run the tests.

To examine the relationship of meat weight and gonad weight with scallop size, regression models were made in the software package EXCEL. The goodness-of-fit measurement used, was r^2. To correct for skewness these body components had to be transformed to a natural log scale.

A comparison of regression lines was made to compare the relationships of meat and gonad weight with shell height between sites and areas. The method used, is described in Chen *et al.* (1992).

The gonosomatic index (GSI) and the % yield were calculated as the percentage of total scallop tissue weight that consists of respectively gonad and meat. Assumptions of analysis of variance, as described above, were run to compare the mean % yield and GSI between areas and between open and closed status. The significance of a linear relationship between shell height and % yield and GSI was tested with r^2 after arcsin transformation them. The comparison of regression lines for the sites was to reveal if the regression models of areas could be combined to a single curve to compare open and closed areas.

Frequencies of gonad weight were plotted to determine if two groups with different weights were present, indicating that some scallops had spawned. Meat counts, the number of meats needed to make a weight of 50 g, were calculated for the different areas.

RNA/DNA Ratio Analysis

The ratio of RNA to DNA (in the cells of an organism) is a biochemical method used to measure the nutritional condition of an organism (*e.g.,* Kenchington 1994). DNA (deoxyribonucleic acid) forms the genetic code and the amount present in the nucleus is constant within the somatic cells of a species (Clemmensen, 1993). There is also DNA in mitochondria (and in chloroplasts and nucleomorphs in other organisms), but these are small amounts in comparison to nuclear DNA. DNA is transcripted by RNA polymerases into ribonucleic acid (RNA), which is translated into proteins in the cytoplasm. Three different forms of RNA are present in the nucleus and in the cytoplasm: messenger (mRNA), transfer (tRNA) and ribosomal RNA (rRNA). mRNA is the template for protein synthesis and tRNA brings amino-acids in an active form to the ribosome. Here the proteins are formed in the sequence determined by the mRNA. Nearly two-third of the ribosomes is made up of rRNA (Stryer, 1988). In eucaryotic cells there is also small nuclear RNA (snRNA), however, the amount is minor compared to the other three. Ribosomal RNA forms 80-90 % of the total amount of RNA (Young, 1970; Stryer, 1988).

As the amount of RNA per cell increases, the rate of protein synthesis increases. Therefore the amount of RNA varies with the level of protein synthesis. With a constant amount of DNA in a somatic cell, the ratio of RNA to DNA gives a measure of the amount of protein synthesis taking place The RNA/DNA ratio therefore, can be used as an index of growth or health (nutritional state) of an animal (*c.f.* Roddick, MSc 1997).

Spatial and temporal variations in RNA/DNA ratios have been observed by Robbins *et al.* (1990) and Kenchington (1994). Paon & Kenchington (1995) observed variation in adductor muscle and gonad RNA/DNA ratios during conditioning and spawning of sea scallops. Also, the amount of total RNA in the cell varies greatly with age, life-stage, organism size, disease-state and changing environmental conditions such as food availability, temperature and pollution (Pease, 1976; Bulow 1987).

RNA/DNA Measurement Protocol

For the RNA/DNA ratio analysis, 20 samples were taken from the dives from each of Bayport and Lunenburg. These dives showed % clappers at the extreme percentage of high and low. The mean shell height of the Bayport samples did not differ significantly from the mean shell height of the 20 scallops from Lunenburg (ANOVA with equal variances P = 0.420). Therefore any differences in the ratio between sites will not be due to size variation.

The method used to measure the RNA/DNA ratios fluorometrically is that of Karsten & Wollenberger (1972, 1977) as modified by Kenchington (1994). For this procedure a 1 mm transverse section was made midway through the adductor muscle. This tissue sample was homogenized with a Brinkman Polytron homogeniser in 7 ml of ice cold heparin solution (3.75 µg/ml) and centrifuged at 2000 rpm for 5 minutes at 4^0C. From the three layers that were formed due to this centrifugation, only the middle was used. The bottom layer is a cellular debris phase, the top layer contains only foam. The middle phase with the nucleic acids was split into five 200 µl samples for analysis.

As described in Kenchington (1994), 200 µl heparin was added to the replicate total nucleic acid (NA) samples and 200 µl heparin and 200 µl RNAase were added to the replicate DNA samples. A tissue blank, the fifth sample, had 200 µl heparin and 400µl distilled water added. All five samples were than incubated in a 37^{0}C water bath for 30 minutes. This allows the RNAase to execute its reaction in a sample without any degradation of DNA. As a last step, ethidium bromide (EtBr) was added to the total nucleic acid and DNA samples after incubation.

EtBr is a fluorophor that reacts with nucleic acids at concentrations down to 0.05 μg/ml for DNA and 0.1 μg/ml for RNA (Robinson *et al.*, 1992). The fluorescence produced with a given concentration of EtBr solution is proportional to the amount of nucleic acid added (Le Pecq & Paolettie, 1966). EtBr has an excitation wave length of 365 nm and an emission wavelength of 590 nm.

The fluorescence was measured with a Perkin-Elmer fluorometer using a 365 nm excitation filter and an emission filter of 590 nm. Calf thymus DNA and yeast RNA were used for the calibration of standard curves so fluorescence readings could be converted into nucleic acid concentrations. A reagent blank made of 200μl heparin, 400 μl distilled water and 200 μl EtBr was used to correct for deviations of the fluorometer. Analytical grade reagents were used for all the procedures.

The DNA concentration was calculated directly from the RNAase treated samples. The RNA concentration was calculated as the difference between the concentrations of the total nucleic acid and the RNAase treated samples. The RNA/DNA ratio was calculated as a mass ratio.

Assumptions of analysis of variance of the RNA/DNA ratio between the areas and between dive sites were tested using the Levene test for homogeneity of variances and a visual examination of the normal quantile distribution of the residuals was made. If the assumptions were met, an ANOVA was performed, otherwise a Welch ANOVA. A Tukey-Kramer post-hoc test was used to determine significantly different pairs. Calculations were done with the statistical package JMP.

COMMUNITY & ABIOTIC CONDITIONS

At each site, depth, bottom type, presence of filterfeeders (mainly mussels) and potential predators in the circle were recorded. In the lab, encrusting species on the shells of the scallops were identified. Animals found in the samples were also identified and recorded.

The Jaccard coefficient of similarity was calculated for bottom type, predators and molluscs and for all species found (including predators and molluscs) for the sample sites in the Numerical Taxonomy and Multivariate Analysis System package NTSYS. In the statistical package JMP these coefficients were clustered into a dendrogram using an UPGMA clustering algorithm. The fit of a regression model between depth and scallop density was tested.

RESULTS AND DISCUSSION

DENSITY, MORTALITY, SIZE AND AGE DISTRIBUTION

Density and Mortality

Scallop density and the % clappers found at the dive sites is shown in Table 3. Site A2 in Bayport, B7 and B9 in the Second Peninsula collection and C2, C3, C5 and C7 from the Lunenburg area did not contain any scallops.

The ANOVA test showed a significant difference between the scallop density for the dive sites within an area ($F = 4.48$, $P = 0.02$) but there was no significant difference for the scallop density between areas ($F = 3.10$, $P = 0.07$), nor did scallop density have a significant difference between the open (Lunenburg and dive site B8) and closed areas (Bayport and sites B1-B6) ($F = 0.65$, $P = 0.43$). The correlation of density with bottom type was also tested. No evidence for significant differences was found ($F = 0.65$, $p > 0.60$). The trend; however, was higher densities in the gravel group, followed by the mud group, the Kelp group and the sand group.

The analysis of variance showed no variability in the % clappers for dives within an area (ANOVA $F = 3.41$, $P = 0.07$), between areas ($F = 0.15$, $P = 0.86$) or fishing status of the areas ($F = 3.35$, $P = 0.08$). The % clappers was also not significantly correlated with bottom type ($F = 0.06$, $P = 0.82$).

The scallop density plotted against % clappers (Figure 8) shows no sign of density dependent mortality. This is consistent with observations of Côté *et al.* (1994).

Size Distribution

The absolute shell height frequencies are given in Figure 9 for Bayport, Second Peninsula and Lunenburg. Because of the various sizes of the sampling circles, the absolute numbers were converted to a standard circle of 40 feet in diameter. The average number of scallops per standard dive by shell height increment for the three areas is illustrated in Figure 10. The relative frequency of the same data is given in Figure 11. Dive site B8 was left out in all of these figures. This site in the open section of Second Peninsula held 9 scallops in a size range of 75-155 mm and no clappers.

The average number of scallops per standard dive (Figure 10) show that, in both Bayport and Lunenburg, scallops were found in the smaller size categories. This indicates that recruitment is taking place. This is in contrast to the Lunenburg area and in sample site B8, where no small scallops were found. The size range of clappers is similar to the range for live scallops in each area. This means that in Lunenburg, only clappers of 70 mm and over were found, but in Bayport and Second Peninsula they ranged from 30 mm to 150 mm; however, the majority of clappers were found in the larger size classes and only a few among the pre-recruits. This is consistent with data found by Kenchington & Lundy (1996) for a part of fishing area

SFA29, which has been closed for over 10 years. The average number of total scallops per standard dive was much higher in Bayport and Second Peninsula as compared to Lunenburg.

The relative frequency figure (Figure 11) shows a mode of the live scallops at Bayport in the 110 - 135 mm shell height range. The mode for clappers was also in this size range. For Second Peninsula and Lunenburg there was no concentration of live animals in a single size group. The clappers at Second Peninsula frequently fall in the 100-115 mm size range but relatively high percentages of clappers were also found in the 70 - 85 mm range.

The means of the shell height for each dive site are given in Figure 12. The natural log of the means of the shell height per area were tested for differences between the three areas. Bayport, Second Peninsula and Lunenburg significantly differed in mean shell height ($F= 9.57$, $P <0.01$). The mean shell height on log scale was higher for Lunenburg than for Bayport and Second Peninsula. This is due to the fact that in Lunenburg no recruitment is taking place. The Tukey-Kramer post-hoc test showed that the ln (mean shell height) also differed significantly between the open and closed areas ($F = 9.3$, $P = 0.01$). The open areas had a significantly higher ln (mean shell height) than the closed areas.

In the 1997 survey of Second Peninsula, samples were taken by diving and dredging. Sample sites B1, B3, B4 and B5 from the present research correspond to the 1997 dive sites D7, D6, D4 and D2. Therefore a comparison of these sites can be made.

When comparing the density and % clappers found in Second Peninsula in 1997 with 1998, 1997 shows much lower scallop densities (Table 1 and 3). In both years the same places had the highest densities. In 1997, no clappers were found at site D4. This year at the same site, B4, 16.67 % clappers were found and at B1, the percentage increased from 16.22% to 31.31 % in 1998. Figure 13 illustrates the average number per standard dive for the corresponding dives in 1997 and 1998. For 1998 the numbers found are much higher and the clappers were not only in the "over 70 mm" shell height size.

When comparing the sites from these two years, it was observed that the high percentages of clappers, mainly observed by dredging in 1997 were not found in the present study. The size selective mortality of animals over 70 mm was not observed in 1998.

Three to four years ago, a raw sewage outlet of the town of Lunenburg into Second Peninsula was relocated to Lunenburg harbour. After that, numerous mussels died in Second Peninsula (pers. comm. Chip Veinotte, Department of Fisheries and Oceans, Bridgewater; Dale Cook, Lunenburg, N.S.). These filterfeeders apparently relied on food in the sewage. It is plausible that the high numbers of clappers found in 1997, were the remainders of this food depletion after the relocation. Probably the scallop population has stabilized because in the present study no extreme high percentages of clappers were found in Second Peninsula.

Age Distribution

The relatively high numbers of scallops in Bayport, which are concentrated in the larger sizes (Figure 11), were exceptional. Site A1 was a very large bed with a lot of scallops. It appeared that in November 1990 Hatcher *et al.* (1996) conducted a seeding experiment at the exact same place of sample site A1. 10,220 scallops were released of which 40 % had survived at day 248 of the experiment. It was hypothesized that the many large scallops are the remainders of this experiment. The relative frequency of dive A1 (Figure 14) points out that the highest percentages of scallops were found in the size range 110 - 130 mm. Aging of the shells and calculating a growth curve for the height at age resulted in a Von Bertalanffy function $L_t = L_{inf}(1\text{-exp.}(-K(t-t_0)))$ with $L_{inf} = 166.32$ as the asymptotic length, the growth coefficient K = 0.16 and t_0, the age at which length is 0 = -0.21 (Figure 15). Using this growth curve, the animals from the 110-130 size range were calculated to be 7 to 10 years old and therefore can be the remainders of the experiment.

In 1997 two growth curves were calculated after aging of scallops from Second Peninsula. The Von Bertalanffy parameters for the fit to the annual rings were: $L_{inf} = 153.81$, K = 0.19 and $t_0 = 0.71$. The parameters for the height at age fit were: $L_{inf} = 153.84$, K = 0.19 and $t_0 = -0.10$. A comparison of the growth curves of height at age of 1997 and 1998 (Chen *et al.*, 1992) showed no significant difference between the regression models ($F = 1.25$ (3,287), $P = 0.05$). The Von Bertalanffy parameters describing both data sets are: $L_{inf} = 161.84$, K = 0.17 and $t_0 = -0.19$.

Growth rate has been found to vary between deep water (offshore) and shallow water (inshore) and within areas of the same depth (*e.g.*, MacDonald & Thompson, 1985a; Schick & Shumway, 1988; Claereboudt & Himmelman, 1996). These variances were found to be due to differences in food availability and temperatures. The Von Bertalanffy growth parameters found in the present study are different than some of the values found for shallow water in other studies. The shallow water sites (10 m) from Newfoundland and St. Andrews of the study by MacDonald & Thompson (1985a) had a lower growth rate, but the four study sites in Baie des Chaleurs at a depth of 22 m (Claereboudt & Himmelman, 1996) had lower K values than the present research and therefore have a faster growth. With a few exceptions, the growth rate of areas in the Bay of Fundy is lower than in Bayport (Kenchington *et al.* 1997). The depths of all the areas in the Bay of Fundy were much greater than of Bayport. Although the estimates of the values of L_{inf} and t_0 are poorer than that of K, almost all values of L_{inf} were smaller than Bayport. For the other areas mentioned above, the L_{inf} values were variable.

GROWTH AND PRODUCTION

Body Components Variation With Size And Between Sites

The average meat weight, soft tissue weight and gonad weight are illustrated in Figure 16. Dive B6 from Second Peninsula is omitted due to the fact that it contained only 1 scallop. Analysis of variance showed a significant effect of area on ln (meat weight) (Welch F= 6.92, P =

0.001). Second Peninsula had a significant lower meat weight than Bayport and Lunenburg, which had indistinguishable means. A significant effect of fishing status on mean ln meat weight was found (Welch $F = 5.52$, $P = 0.01$) and the post-hoc test showed a higher mean for the open areas. There was a significant effect of area (Welch $F = 20.11$, $p<0.01$) and fishing status (Welch $F = 36.40$, $P <0.01$) with significant higher mean ln (soft tissue weight) in the open areas. The Welch ANOVA determined a significant difference of the mean ln (gonad weights) between the areas ($F = 16.13$, $P <0.01$). The Tukey-Kramer post-hoc test showed that Bayport and Second Peninsula had means that were indistinguishable from each other and were lower than the mean for Lunenburg. Means were significantly higher in the open areas compared to the closed areas (Welch $F = 41.53$, $P <0.01$).

Except for the meat weight, the Tukey-Kramer tests show equal or lower means for Bayport and Second Peninsula than the means of Lunenburg. For all body components the natural log transformed means were significantly lower in the closed areas than in the open area. This is due to the presence of smaller animals which were only found in the closed areas.

The regression models with the function ln (meat weight) = b * ln (shell height) + c (with b the slope and c the intercept) were all significant for each site except for sample site C4. Combinations of functions were evaluated to determine whether one curve could be used per area or whether the dives within an area required different functions to describe the ln (meat weight), ln (shell height) relationship. There was a significant difference ($F = 2.40$ (6,254), $P = 0.05$) between the regression models for all dives at Bayport combined; however there was no significant difference for dive A3, A4 and A5 combined ($F = 1.09$ (4,113), $P = 0.05$). These dive sites could be described with one function: ln (meat weight) = 2.46x * ln (shell height) -8.66 (Figure 17). For Second Peninsula, all combinations of dives tested, showed significant differences (B1/B3/B4/B5/B8: $F = 2.31$ (8,135), $P = 0.05$), (B1/B3/B4/B5: $F = 2.73$ (6,128), $P = 0.05$) and (B1/B3/B5: $F = 3.49$ (4,115), $P = 0.05$). For the Lunenburg area sites C1, C6 and C8, there was evidence for significant differences ($F = 7.76$ (4,72), $P = 0.05$) for the meat weight, shell height relationship on a natural log scale. Therefore these sites could not be described by one function.

The regression models describing the gonad weight, shell height relationship on a natural log scale were all significant for each site. The same comparison of regression models for gonad weight was done for the meat weight to compare sites within an area. It revealed no significant difference for all sites in Bayport combined ($F = 2.01$ (6,254), $P = 0.05$). The function that described the combined data was: ln (gonad weight) = 4.43x * ln (shell height) -18.99 (Figure 18). The data of all dives at Second Peninsula combined (B1/(B2+B6)/B3/B4/B5/B8) could also be described with one function because the comparison of regression models showed no significant differences ($F = 1.33$ (10,137), $P = 0.05$) (Figure 18). The combined data for all dives from Lunenburg did reveal significant differences for the ln (gonad weight), ln (shell height) regression models ($F = 3.80$ (6,81), $P = 0.05$).

An attempt was made to reveal whether one single function could be used to describe the ln (gonad weight), ln (shell height) relationship for the dives from Bayport and Second Peninsula (without B8). There was however, evidence for significant differences between these closed areas ($F = 28.8$, $P = 0.05$). For both the meat weight relation with shell height and the gonad weight relationship a lot of variation was found between dive sites in an area and between areas. This made comparing open with closed areas difficult or impossible with our limitations on sampling.

Bonardelli & Himmelman (1995) found in Baie des Chaleurs that the relation of gonad weight to shell height varied between maturing and fully mature scallop. The regression model describing meat weight to shell height that they found, could be described with one model for maturing and mature scallops. Penny & McKenzie (1996) found for scallops of Notre Dame Bay, Newfoundland that total weight of all soft body organs as well as meat weight and gonad weight could be described differently for immature scallops (< 70 mm) and mature scallops (> 70 mm) over time. No sign of this separation into mature and maturing was found in the present study.

% Yield Variation With Size And Between Sites

The average % yield for each dive is given in Figure 19. The ANOVA test showed a significant difference between the mean % yield for the dive sites within an area ($F = 2.41$, $P = 0.01$), between areas ($F = 74.69$, $P < 0.01$) and the ANOVA showed a significant effect of fishing status on % yield ($F = 149.56$, $P < 0.01$). The % yield was significantly higher in Bayport and Second Peninsula, the closed areas, than in Lunenburg and dive site B8 (open areas). It suggests that Bayport and Second Peninsula are more favorable environments for growth than Lunenburg.

The regression models with the function arcsin (% yield) = b* shell height + c were not significant for every sample site. For Second Peninsula, dive B2, B4 and B8 and for Lunenburg dive C4 were not significant. These dive sites had very few observations. A comparison of the regression models for Bayport showed significant differences for the data of all dives combined ($F = 3.64$ (6,254), $P = 0.05$). Only A3 and A4 ($F = 2.47$ (2,86), $P = 0.05$) and A3 and A5 ($F = 32.38$ (2,75), $P = 0.05$) could be combined and described by two functions (Figure 20). The significant regression models of sites B1, B3 and B5 of Second Peninsula showed no significant differences ($F = 1.88$ (4,115), $P = 0.05$) and the combined data of the sites at Lunenburg, C1, C6 and C8 also revealed no significant difference ($F = 2.00$ (4,72), $P = 0.05$). Therefore these sites could be described by one regression model per area (Figure 24).

Comparing the two regression models describing respectively sites A3/A4 and A3/A5 of Bayport with the model describing the data from sites B1/B3/B5 gave evidence for significant differences. Neither could the data from sites B1, B3, B5 and C1, C6 and C8 be described with one regression model.

It was not possible to compare the % Yield of the dives sites with bottom type (see below). For the gravel group, sites A3, A4 and A5 are combined and those already showed a significant difference. If the non significant models describing the regression line and sites without scallops were left out, only sites A1 and C4 were left for the mud group. Using only these two dives would not be a good representation of the whole group and therefore no comparison was made of the regression models.

GSI Variation With Size And Between Sites

The average GSI for each dive is given in Figure 19. The Welch ANOVA test of the mean GSI by area demonstrated significant differences ($F = 26.25$, $P < 0.01$). The Tukey-Kramer post-hoc analysis showed that the mean GSI of Bayport was significantly lower than Second Peninsula and Lunenburg. The latter two, however, were not significantly different. Testing the mean GSI by fishing status demonstrated a significantly higher mean for the open areas ($F = 27.45$, $P < 0.01$).

Although a lower GSI due to recruitment influences the data, a significantly lower mean GSI in Bayport than the other areas might mean that spawning in this area has taken place. A decrease in GSI over time is used by several authors to determine the spawning event in sea scallops (*e.g.*, Parsons *et al.*, 1992; Parsons & Dadswell, 1994).

The regression models of sites B2, B8 (Second Peninsula), C1 and C6 (Lunenburg) were not significantly describing the arcsin (GSI), shell height relation. For these sites there were too few observations or the sampling variability was very high. The significant models were tested to see if the data per area could be described with a single curve. No significant difference for all sites in Bayport combined were found ($F = 1.92$ (6,254), $P = 0.05$), for the sites B1, B3 and B5 of Lunenburg ($F = 2.21$ (2,119), $P = 0.05$) and for Lunenburg C4 and C8 ($F = 2.6$ (2,29), $P = 0.05$). The combined data with the significant regression models describing these data, however, showed an increased scattering with shell height.

The hypothesis was that under-developed or small gonads interfered with the comparison. Therefore, the data was split into two groups, below 80 mm in shell height and 80 mm and over, for Bayport and Second Peninsula. Because there were too few observations in Lunenburg this comparison was not possible (Figure 21). Although the data of a shell height smaller than 80 mm still showed some scatter, evidence was found for significant differences between the two groups for the arcsin GSI, shell height relation (Bayport: $F = 15.60$ (3,257), $P = 0.05$ and Second Peninsula: $F = 19.13$ (2,117), $P = 0.05$). Small animals with immature gonads have a different GSI than mature scallops.

No quantitative evaluation of the size at maturity was made as suggested in Bonardelli & Himmelman (1995). The 80 mm size was chosen to keep enough observations in both data sets. Bonardelli & Himmelman (1995) found a size at full maturity of 95 mm in Baie des Chaleurs for sites at depths of 13 m and 26 m. Parsons *et al.* (1992b) found that GSI becomes independent of size at about 80 mm in the Passamaquoddy Bay at depths of 10 m and 60 m. In the present research, the arcsin (GSI) of mature scallops increased slightly with height. Parsons *et al.* (1992b) found a mainly constant GSI in mature animals and did not find evidence for a decreasing GSI with shell height (reproductive senescence) as described by Bonardelli & Himmelman (1995).

It was not possible to combine the GSI regression models of the = 80 mm animals from Bayport (A1, A3, A4, A5) and Second Peninsula (B1, B3, B5) because significant differences were found between the two (F = 50.17 (1,272), P = 0.05). Therefore, no comparison between open and closed areas could be made.

Meat Counts

The mean, standard deviation and range of meat weights for Bayport, Second Peninsula and Dive B8 and the Lunenburg area were calculated for scallops with a shell height of 100 mm and over (Table 4). This size was chosen because a minimum shell height restriction of 4 inches (100 mm) is effective for Lunenburg County. The meat count from sample site B8 is much lower than the three other areas. Only 13.5 meats are required to get a weight of 500 g, whereas in Lunenburg it takes 24.5 meats. The percentage of the scallops with a shell height over 100 mm for each sample site is given in Table 5. In all most all dives the percentage is over 50 %.

Jamieson *et al.* (1981) found a meat count of 21 in the western part of the Northumberland Strait and 37 for the eastern Strait in 1981 which were respectively lower and higher than the average meat count of 1980 due to absence and presence of recruitment. By taking only animals with a shell height over 100 mm, recruitment is not an influence on our data as it was for Jamieson *et al.* (1981). Commercial meat counts from the Bay of Fundy for the past decade (which should have few small meats included) at Lucher Shoal and Brier Island are, in most years, much higher than the data found in this study. Meat counts for St. Mary's Bay for the past few years are sometimes lower (down to 11.7 in June 1993) than the numbers found in the present study (Kenchington *et al.*, 1997). This study also shows highly different meat counts from the same area but in different months. Kenchington *et al.* (1994) found a 30-40% increase in adductor muscle wet weight after spawning, with a peak weight in the winter months.

Gonad Weight Frequency

The gonad weight frequency was taken only from animals over 100 mm to make sure that only fully developed gonads were investigated. Only for Bayport could a separation into two groups be made (Figure 22). A large group of animals with gonad weights in the range of 8 - 16 g and a smaller group of scallops with gonad weights over 18 g were found. It is expected that the first have spawned and the latter have not yet spawned, or have (partially) recovered from their spawning. These results are consistent with the low GSI found in Bayport (§ 4.2.3) which suggested that the scallops had spawned.

In Mahone Bay, Dadswell & Parsons (1992) found a semi-annual spawning at depths from 5 to 10 m (late June until July and September through October) and an annual spawning at depths of 15 to 25m (September and October). It is not known however, when spawning in Lunenburg County takes place. Nor is it know whether it takes place in one main event or with a minor spawning prior to a main period. At the end of May, the scallops in Bayport (sample site A1) were observed to be spawning (pers. comm. B. MacDonald, Department of Fisheries and Oceans, Dartmouth). While sampling at this site, the gonads also appeared as if they had been spawning and not yet fully recovered. These direct observations confirm the other data.

The spawning observed in May was probably a minor spawning, with the major event taking place after the sampling had occurred. Whether this was the only minor spawning event that took place, or whether minor spawning occurred between sampling is not clear.

RNA/DNA Ratios

The mean ratios and the accompanying % clappers for each dive site is given in Table 6. Although the mean % of clappers of the Bayport samples was significantly higher than the mean at Lunenburg ($F = 11.90$, $P = 0.01$), no significant difference for the mean RNA/DNA ratio could be found between these areas ($F = 1.43$, $P = 0.24$). The trend, of a higher mean ratio in Lunenburg was tested for the two dive sites with the highest % clappers (both from Bayport) and the two dive sites with the lowest percentage (both from Lunenburg). An F-ratio of 3.32 was found at a significance level of 0.09. Although not significant at the 0.05 level, it was consistent with the trend. The power of this analysis was 0.41 and a sample size of 26 would have detected differences at the 0.05 significance level. Similarly, no significant difference could be found between the mean ratios by dive sites ($F = 2.10$, $P = 0.07$). The significance of the results at the $P = 0.1$ level suggests that larger sample sizes would have been needed to detect differences at the $P = 0.05$ level. The power of the test was low (0.71) and a sample size of 44 would have been necessary to detect a significant difference.

The ratios found in this study are lower than those found in the literature however the samples were not handled properly and so the absolute valued of the results cannot be relied upon. It is important to sample the tissue immediately and put the samples at an ultracold temperature to avoid degradation. In this case the live animals were left in the fridge for several days prior to sampling. The mean ratios determined varied between 0.25 and 0.35. Kenchington (1994) found ratios as low as 0.42 and 0.43 only in two cases, with all other RNA/DNA ratios from scallops from Digby, Bay of Fundy ranging from 0.5 to as high as 1.02. Paon and Kenchington (1995) found values of 0.68 to 0.94 for RNA/DNA ratios in the muscle. The scallops were conditioned for spawning and they found a strong negative correlation between gonad and muscle RNA/DNA throughout the conditioning. Roddick (MSc 1997) found a mean ratio ranging from 0.48 to 1.34 in studies on scallops from Digby and under various food conditions in flow tanks.

Kenchington (1994) found spatial variances in RNA/DNA ratios on both a large and fine scale in Digby and Paon and Kenchington (1995) found differences due to the actual spawning and between conditioning locations which they thought, were due to variations in food quality or quantity. For juvenile scallops under experimental conditions, Roddick (MSc 1997) found a response to nutritional stress on a time scale of 2-3 weeks.

The low ratios observed might also be low due to the spawning season (Paon & Kenchington, 1995) and due to low food availability. Seston values are normally low during summer months. Claereboudt *et al.* (1995) found a general decrease in phytoplankton from May to November with a diatom bloom in late October in the Baie of Chaleurs and Penny & McKenzie (1996) found low values of diatoms in June and early July in Notre Dame Bay, Newfoundland, with a peak in late July and August, just as MacDonald & Thompson (1985a) found at various sites and depths in Newfoundland.

COMMUNITY & ABIOTIC CONDITIONS

Community

No extreme numbers of filter feeders or predators were recorded by the divers in all areas. The complete diversity list including bottom types found at the various dive sites is presented in Appendix 4. Figure 23 illustrates the results of the clustering of the sites according to scallops, potential predators and molluscs present. The sites were clustered into four main groups. The group of B8 and B9 had only the green crab *Cancer maenas* in common. The second group from the bottom shared presence of the rock crab *Cancer irroratus* and lobster *Homarus americanus*. The group of sites A2, B2, and B3 had *C. irroratus* and *Asterias forbesi* in common. Within the top group, only C1 had *Anomia simplex* as a common factor, the rest had both *C. irroratus* and *A. simplex*.

The dendrogram for all species found (including *P. magellanicus*, molluscs and predators) is illustrated in Figure 24. The clustering resulted in a group with no scallops and two groups with scallops of which the smaller one (B6 and B8) had *H. americanus* and hydroids in common. For the larger group, all except C1 had hydroids and *C. irroratus* as common factors. The hydroids were found on the shells of the scallops as encrusting species, which explains the absence of hydroids in sites without scallops. The rock crab *C. irroratus* was present in all sites (with or without scallops) except for dives C1 and B8. This species group, together with *H. americanus* and *A. forbesi,* formed the main potential predators.

For suspended cultures at high densities Côté *et al.* (1994) found food depletion causes decreased growth but that density did not affect mortality rates. In this study neither scallop nor filter feeder densities were found to be so high that food depletion would be expected to interfere with growth or viability.

Our findings of *Cancer irroratus*, *Homarus americanus* and *Asterias forbesi* as main potential predators are consistent with work of Caddy (1968, 1973), Elner and Jamieson (1979), Naidu and Cahill (1986), Barbeau *et al.* (1994, 1996), Cliche *et al.* (1994) and Hatcher *et al.* (1996). *A. vulgaris* is also recorded in these references as an important predator, however in the present study this species was not found to be very abundant at the various sites.

Abiotic Conditions

In Figure 25 the dive sites are clustered according to bottom type into four main groups. From bottom to top of this dendrogram these groups are "only sand bottom", "*Laminaria*/Kelp bottom", "gravel group" and "mud group". The two latter had respectively gravel and mud as main bottom type, but at most dive sites they were found in combination with other components such as rock and *Zostera marina*. Comparing the bottom types with the presence or absence of scallops revealed the following. Mud alone (C5 and C7) is not a good scallop bottom, however, mud in combination with gravel/rock or plants provided a better scallop bottom. Sample sites with a bottom of gravel and sand (A2 and B9) did not have scallops, but gravel without sand (and in combination with other components) provided a good scallop bottom. A bottom with only *Laminaria* (C2) contained no scallops, but *Laminaria* in combination with rocks (C6) proved to be a better environment. The sandy bottoms (B7 and C3) did not contain scallops at all. These results correspond with the trend found in the density, bottom type relation. No relationship between scallop density and depth could be found (Figure 26).

Beds of scallops are usually strongly associated with gravel or gravel and sand substratum (Langton & Robinson, 1990; Thouzeau *et al.*, 1991; Stokesbury & Himmelman, 1993). Thouzeau *et al.* (1991) found significantly more scallops on gravel than on any other type of sediment. Although sea scallops can tolerate some mud (Cranford & Gordon, 1992), Brand (1991) records that areas with the highest abundance and the fastest growth are normally areas with little mud. Sand substratum might be resuspended by currents (Stokesbury & Himmelman, 1993) thereby making it an unsuitable substratum. These observations are consistent with the results found in the present study.

CONCLUSIONS

It is difficult to determine what effect the stress associated with fishing disturbance could have on scallop populations and communities; a negative impact of drag fishing is easily envisioned with immediate survivors suffering from broken or damaged shells, exposure (in the case of small animals returned to the sea) or left exhausted from swimming to avoid the gear. Dragging will also cause damage to non-target species and changes to bottom surface topography. However, even dragging the bottom may in some instances produce a positive influence on survivors if food particles are disturbed or fine sediments removed. Other forms of fishing such as diving, tonging or dip netting are far more selective in the removal of animals and are less likely to disturb bottom and other species, although the action of diver's fins can greatly disturb certain bottom types. In the present study there is no "before" comparison or time series of annual variability to statistically examine whether the closure has had an impact on the scallop population or associated community. Nevertheless, this research has been useful in providing baseline data on a number of scallop beds in Lunenburg County.

The scallops in the inshore waters of Lunenburg County show a high degree of variability in a number of characteristics. In terms of differences between areas which are opened to fishing and those which are closed to fishing, the primary difference was the presence of small animals in the unfished areas. This alone is an important observation and if it can be demonstrated that this recruitment success is caused by the closure, then one of the primary objectives for establishing the closure, that is stock recovery, has been met. Another factor which may have contributed to the establishment of smaller scallops in the closed areas is the apparent superior growth conditions present in the closed locations as seen in certain indicators (percentage yield, RNA/DNA ratio). Presumably those conditions are not related to the fishing status but rather to oceanographic factors.

The sea scallop density was not significantly different in the open and closed areas in Lunenburg County. The better growth conditions observed in the closed areas, combined with reduced fishing mortality on spawners, may in the longer term lead to a difference in density. Importantly, the percentage of clappers did not differ significantly between open and closed areas addressing one of the concerns raised by the SFA29 ISAC. The high mortality on the larger animals in the closed areas seen in 1997 was not present in 1998. On a community basis, there was no observable effect of the closure. In particular, scallops were not replaced by other filter feeders and there was little evidence of changes in predator species composition.

Due to the presence of small animals in the closed areas, significant effects of the fishing status of the areas were found in meat weight, gonad weight, soft tissue weight and of course, shell height. At almost all sites, more than 50 % of the animals were over 100 mm and at three, all animals were over 100 mm. To protect these large animals, which contribute greatly to the total spawning output, the November 1998 SFA29 Inshore Scallop Advisory Committee increased the restriction of the minimum shell height from 100 mm to 110 mm for both open and closed areas, based on data from this study. This will protect more large animals (Table 5) which are needed to provide recruitment for the future. In the same meeting of the ISAC it was resolved to temporarily open Bayport and Second Peninsula from November 16 to December 31, 1998, but only for harvesting by dipping. Re-examination of the sites in the closed area in 1999 in light of the this fishing activity is recommended as a before/after comparison of sites would then be possible.

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Table 1. Absolute numbers of live scallops, clappers, scallop density and the % clappers found in Second Peninsula in 1997 in the dives (D) and in the tows (T). Corresponding stations from the 1998 survey are also listed (see Table 2 for details of locations of 1998).

station 1997	station 1998	live scallops	clappers	scallop density (N/m^2)	% clappers
D1		6	1	0.013	14.29
D2	B5	3	0	0.006	0
D3		4	1	0.009	20
D4	B4	1	0	0.002	0
D5		18	2	0.039	10
D6	B3	23	5	0.049	17.86
D7	B1	31	6	0.066	16.22
T1		107	76	no data	41.53
T2		146	107	no data	42.29
T3		37	26	no data	41.27

Table 2. Area, fishing status, longitude, latitude and depth of the dive sites. Data marked with a * is not accurate.

area	dive	fishing status	latitude	longitude	depth (in feet)
Bayport	A1	closed	$44^0$20.52' N	$64^0$18.92' W	23-24
Bayport	A2	closed	$44^0$20.24' N	$64^0$19.06' W	15-16
Bayport	A3	closed	$44^0$19.65' N	$64^0$18.57' W	12.8
Bayport	A4	closed	$44^0$19.63' N	$64^0$18.58' W	11.8-12
Bayport	A5	closed	$44^0$19.90' N	$64^0$18.95' W	10.7
Second Peninsula	B1	closed	$44^0$23.99' N	$64^0$17.62' W	64.5-70
Second Peninsula	B2	closed	$44^0$23.78' N	$64^0$17.29' W	18.2
Second Peninsula	B3	closed	$44^0$23.56' N	$64^0$16.79' W	15.7-16.7
Second Peninsula	B4	closed	$44^0$23.63' N	$64^0$16.42' W	15-16
Second Peninsula	B5	closed	$44^0$23.61' N	$64^0$15.85' W	9.5
Second Peninsula	B6	closed	$44^0$24.10' N	$64^0$14.99' W	14
Second Peninsula	B7	open	$44^0$24.51' N	$64^0$19.01' W	9.5
Second Peninsula	B8	open	$44^0$25.24' N	$64^0$19.08' W	20
Second Peninsula	B9	open	$44^0$25.33' N	$64^0$19.06' W	10
Lunenburg	C1	open	*$44^0$21.5' N	*$64^0$19.0' W	20-22
Lunenburg	C2	open	*$44^0$21.5' N	*$64^0$19.0' W	*16
Lunenburg	C3	open	*$44^0$21.5' N	*$64^0$19.0' W	*6
Lunenburg	C4	open	*$44^0$21.5' N	*$64^0$19.0' W	26
Lunenburg	C5	open	*$44^0$21.5' N	*$64^0$19.0' W	*12
Lunenburg	C6	open	*$44^0$21.5' N	*$64^0$19.0' W	25
Lunenburg	C7	open	*$44^0$21.5' N	*$64^0$19.0' W	30
Lunenburg	C8	open	*$44^0$21.5' N	*$64^0$19.0' W	30

Table 3. Scallop density and percentage of clappers per sample site.

dive	scallop density (N/m^2)	% of clappers
A1	1.233	41.22
A2	0	0
A3	0.107	30.56
A4	0.343	37.50
A5	0.248	21.62
B1	1.830	31.31
B2	0.103	0
B3	1.370	16.67
B4	0.514	16.67
B5	0.445	0
B6	0.002	0
B7	0	0
B8	0.019	0
B9	0	0
C1	0.154	21.74
C2	0	0
C3	0	0
C4	0.094	15.38
C5	0	0
C6	0.325	11.63
C7	0	0
C8	0.188	4.35

Table 4. Meat weight statistics for Bayport, Second Peninsula, Lunenburg and dive B8 in Mahone Bay.

Area	Meat Weight (g)				sample size	Meat count
	Mean	Min	Max	s.d.	(N meats)	per 500 g
Bayport	24.866	7.15	96.86	8.783	167	20.107
SecPen	22.287	12.4	43.79	6.827	58	22.434
Lunenb	20.420	4.65	37.72	7.092	55	24.486
Dive B8	37.120	15.72	53.25	16.683	7	13.469

Table 5. Percentage of scallops with a shell height of 100 and 110 mm and over for each sample site.

Sample Site	% SH ≥ 100 mm	% SH ≥ 110 mm
A1	58.33	51.38
A3	62.00	60.00
A4	67.50	65.00
A5	86.21	72.41
B1	44.12	32.35
B2	100.00	66.67
B3	30.00	20.00
B4	60.00	40.00
B5	30.77	23.08
B6	100.00	100.00
B8	77.78	66.67
C1	55.55	33.34
C4	100.00	100.00
C6	57.89	47.37
C8	54.55	23.36

Table 6. Percentage of clappers and mean RNA/DNA ratios with standard deviations.

area	% clappers	mean RNA/DNA	standard deviaton
Bayport	32.73	0.278	0.056
Lunenburg	13.28	0.296	0.051
A1	41.22	0.296	0.055
A3	30.56	0.291	0.075
A4	37.50	0.254	0.035
A5	21.62	0.271	0.051
C1	21.74	0.302	0.032
C4	15.38	0.253	0.035
C6	11.63	0.287	0.058
C8	4.35	0.343	0.035

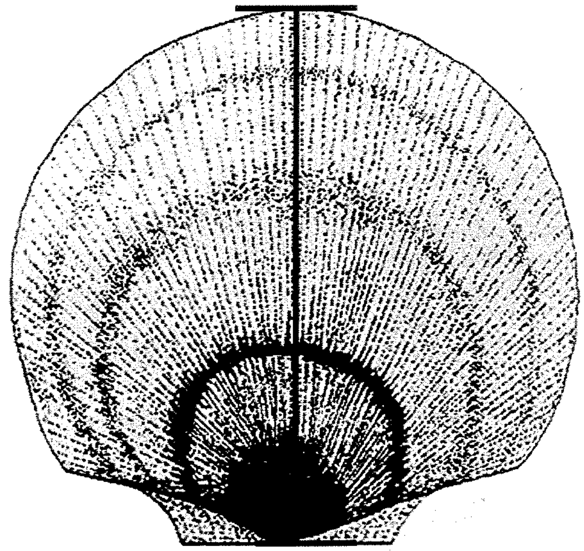


Figure 1. Shell height is measured as the distance from the middle of the hinge to the furthest ventral shell edge.

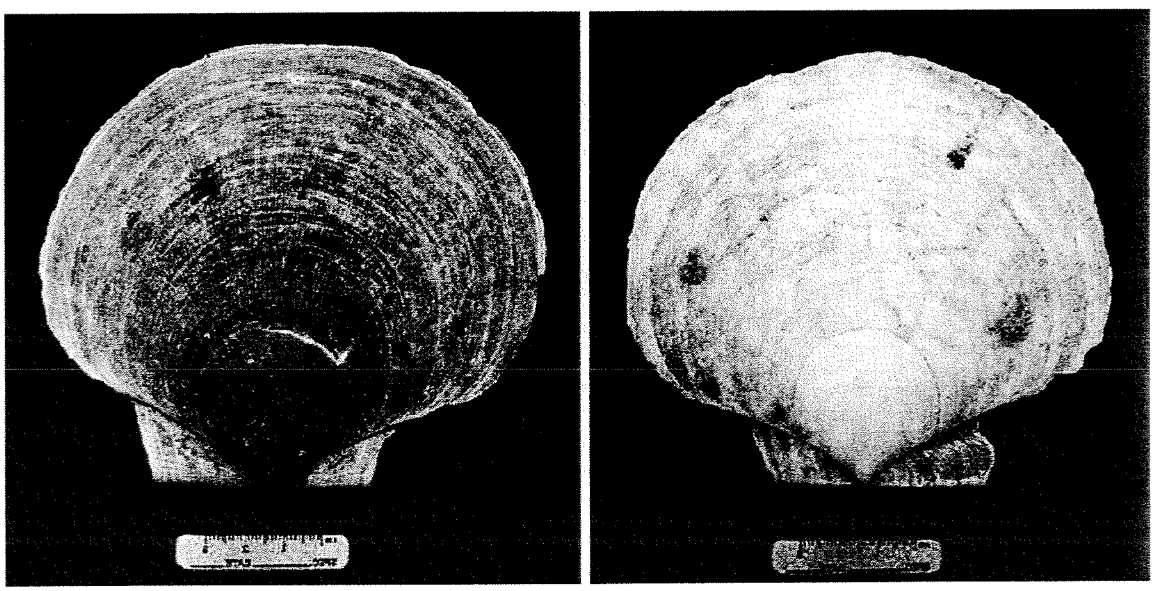


Figure 2. Left valve (left) and right valve (right) of *Placopecten magellanicus*.

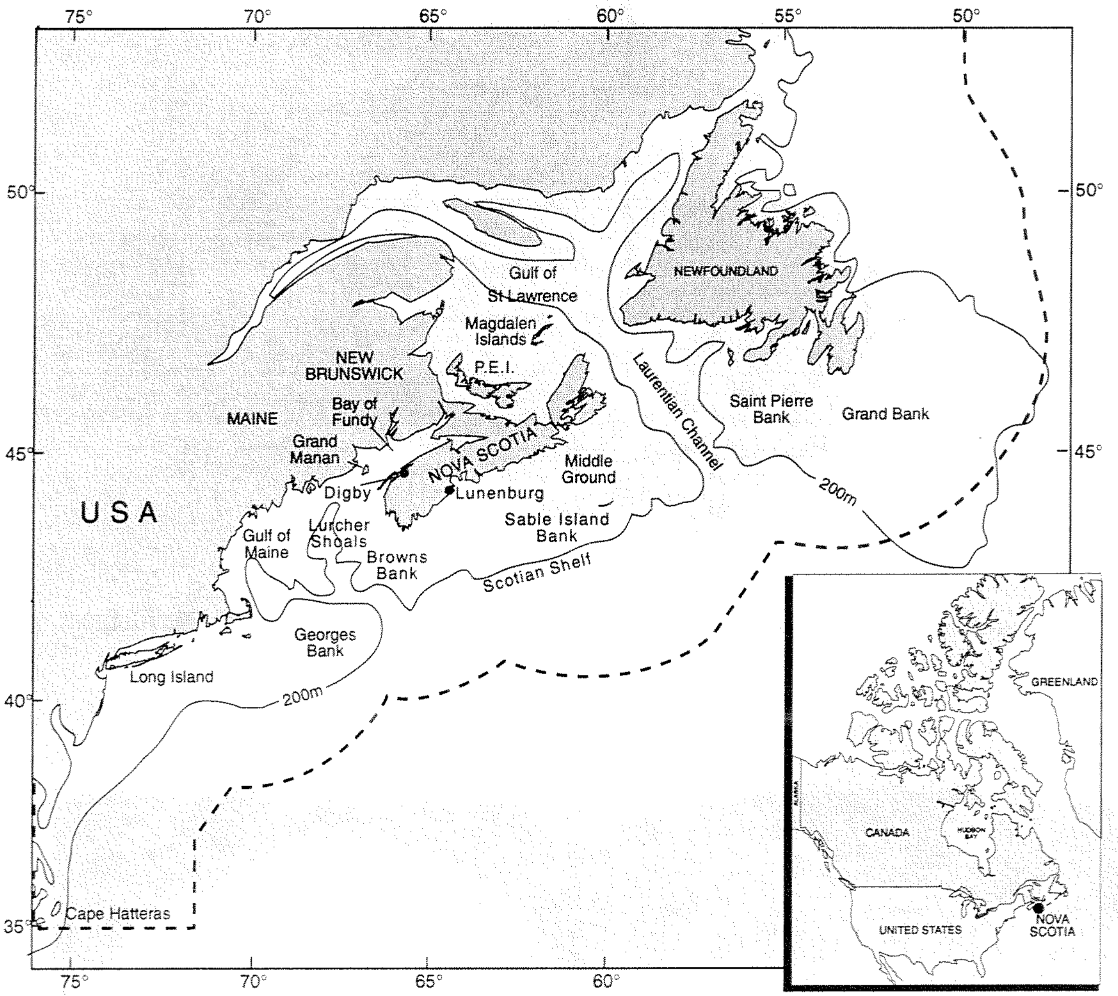


Figure 3. Distribution of *Placopecten magellanicus* from the Gulf of St. Lawrence to Cape Hatteras with its major fishing grounds.

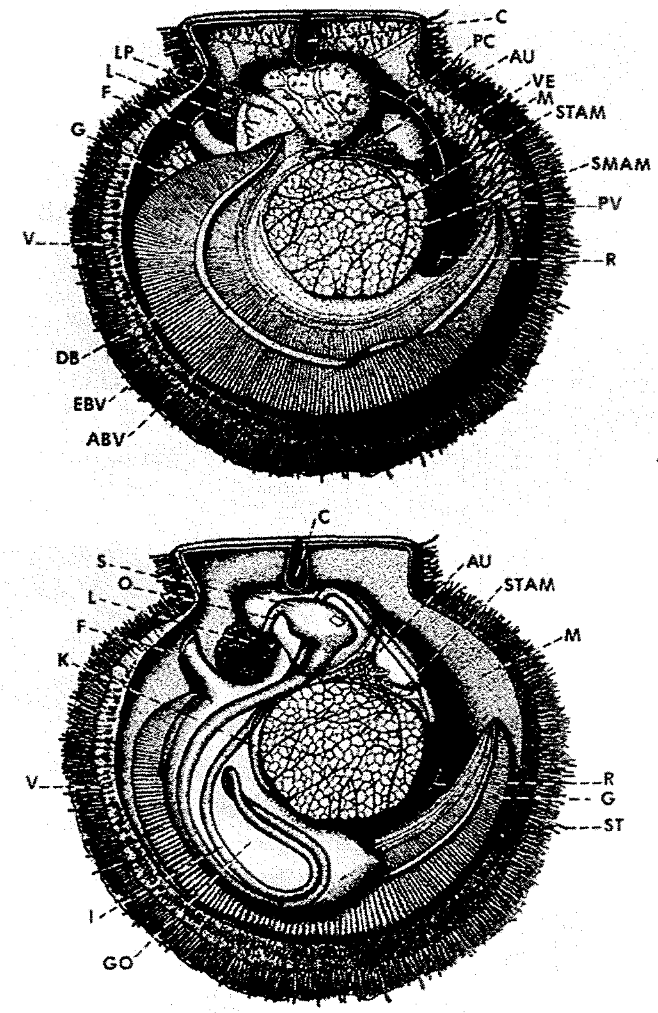


Figure 4. General anatomy of *Placopecten magellanicus.* Top: Left shell and mantle removed. Bottom: Left shell, mantle and gill removed.

Abbreviations: ABV, afferent branchial vessel; AU, auricle; C, chondrophore; DB, dorsal bend of gill filaments; EBV, efferent branchial vessel; F, foot; G, gill; GO, gonad; I, intestine; K, kidney; L, lips; LP, labial palp; M, mantle; O, oesophagus; PC, pericardium; PV, pallial vessels; R, rectum; S, stomach; ST, sensory tentacles; SMAM, smooth adductor muscle; STAM, striated adductor muscle; V, velum; VE, ventricle (reprinted from Shumway, S.E., Scallops: Biology, Ecology and Aquaculture, 1991 with permission from Elsevier Science).

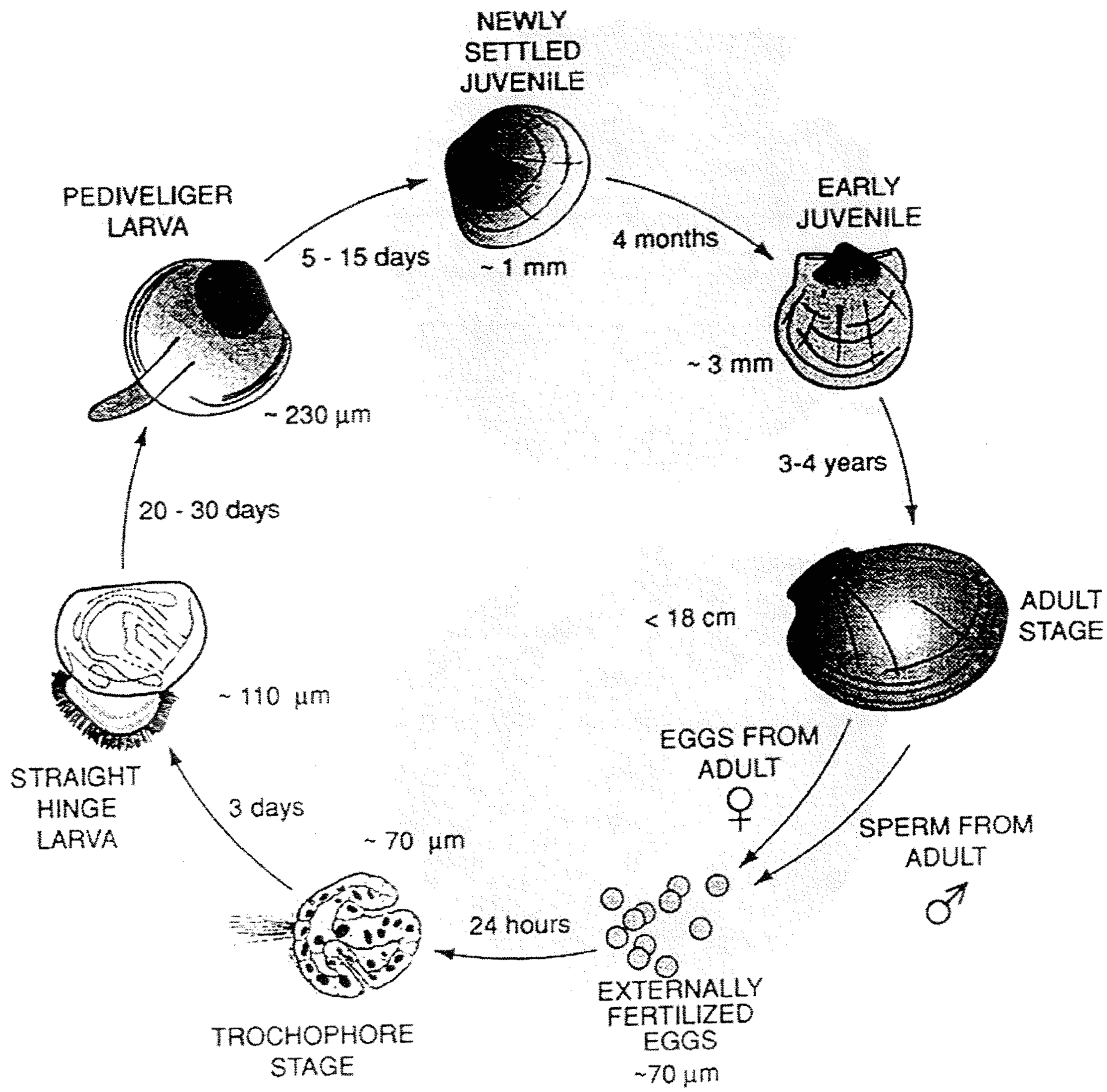


Figure 5. The life cycle of the sea scallop *Placopecten magellanicus* (after Black *et al.*, 1993).

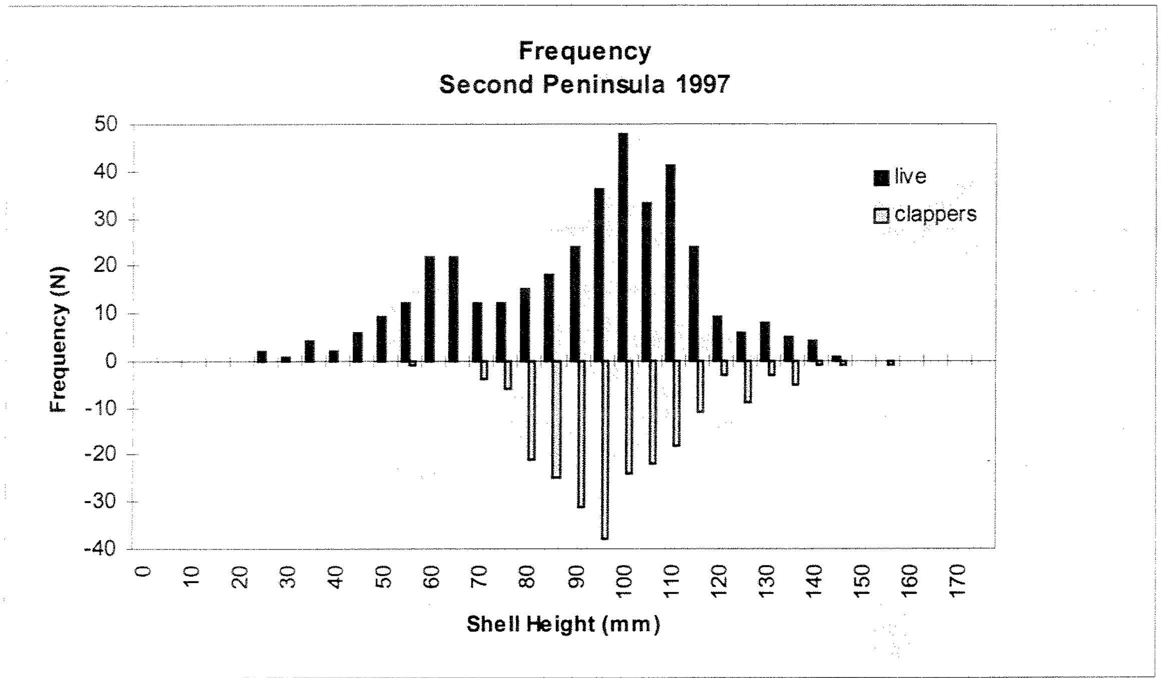


Figure 6. Shell height frequency distribution (absolute numbers) of live and dead (clappers) scallops caught in Second Peninsula in 1997.

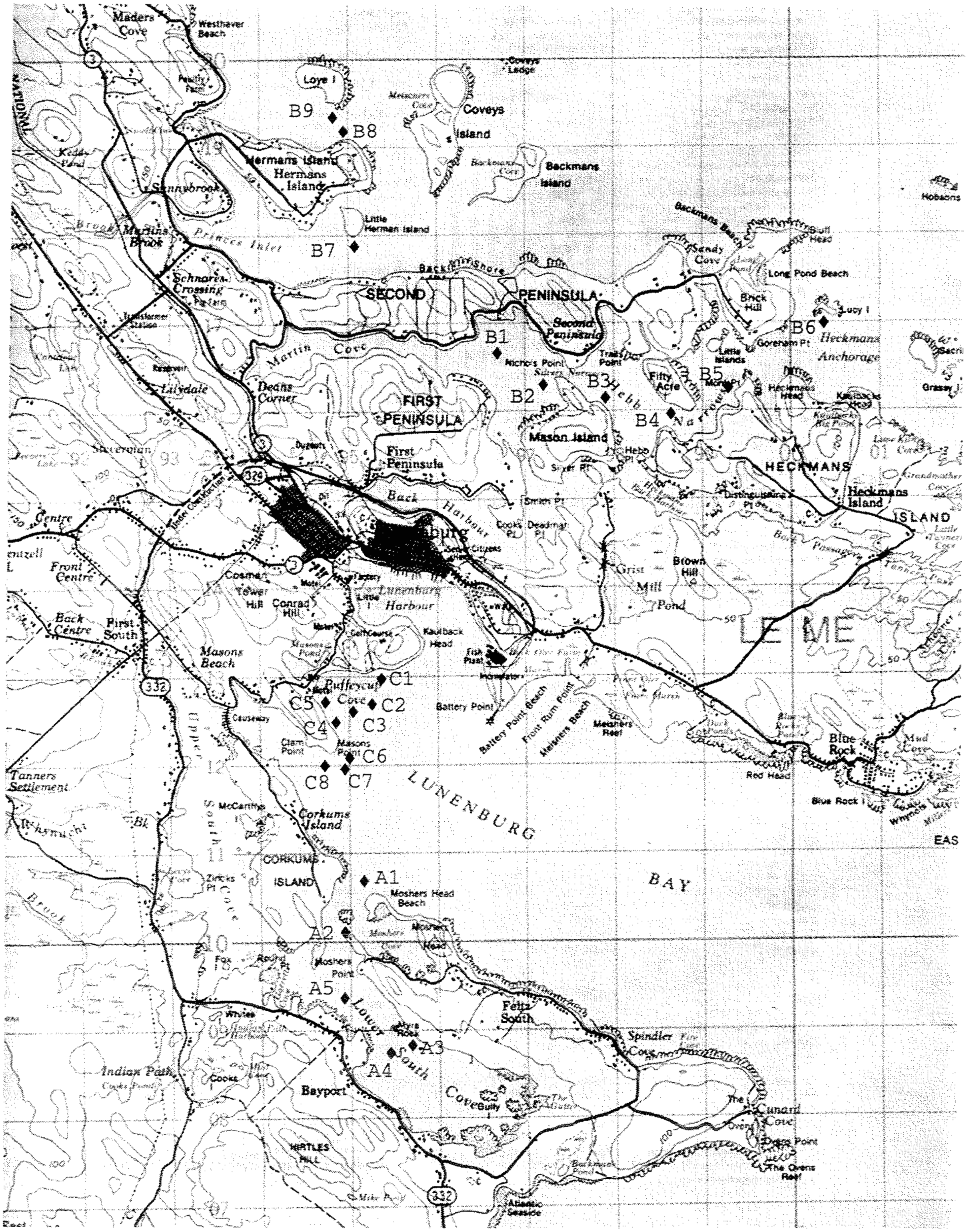


Figure 7. Locations of the 22 sampling stations in Lunenburg County, N.S. The sites are divided into three areas: Bayport (A1-A5), Second Peninsula (B1-B9) and Lunenburg (C1-C8).

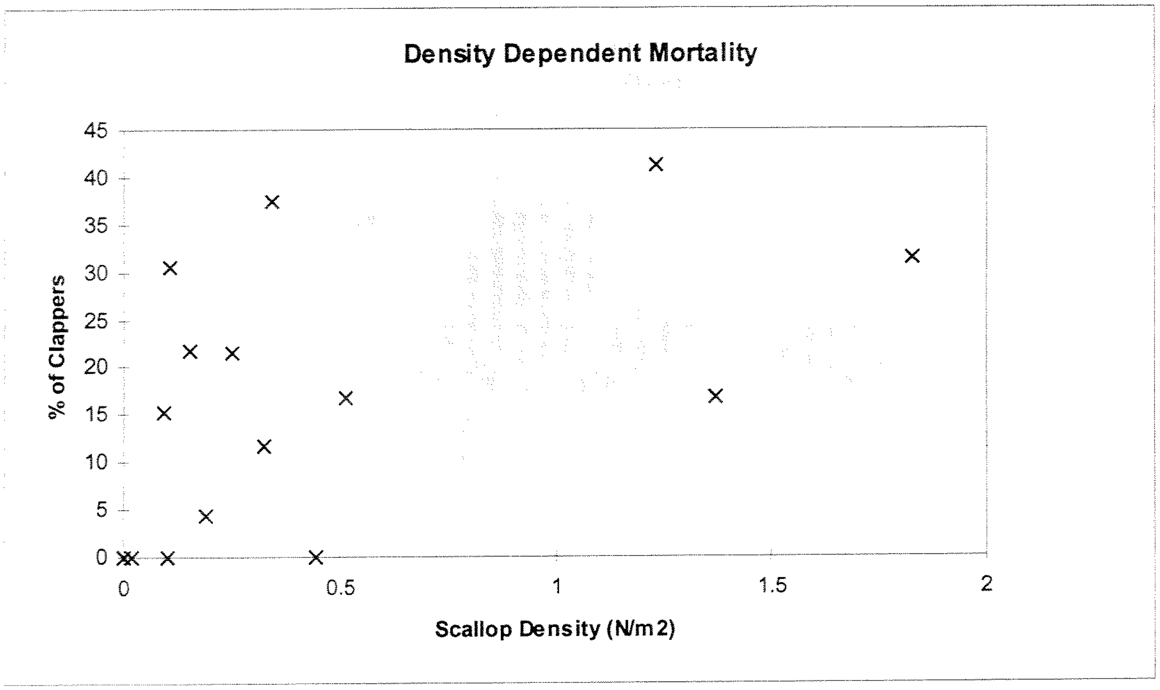


Figure 8. Density dependent mortality. Scallop density plotted against the percentage of clappers.

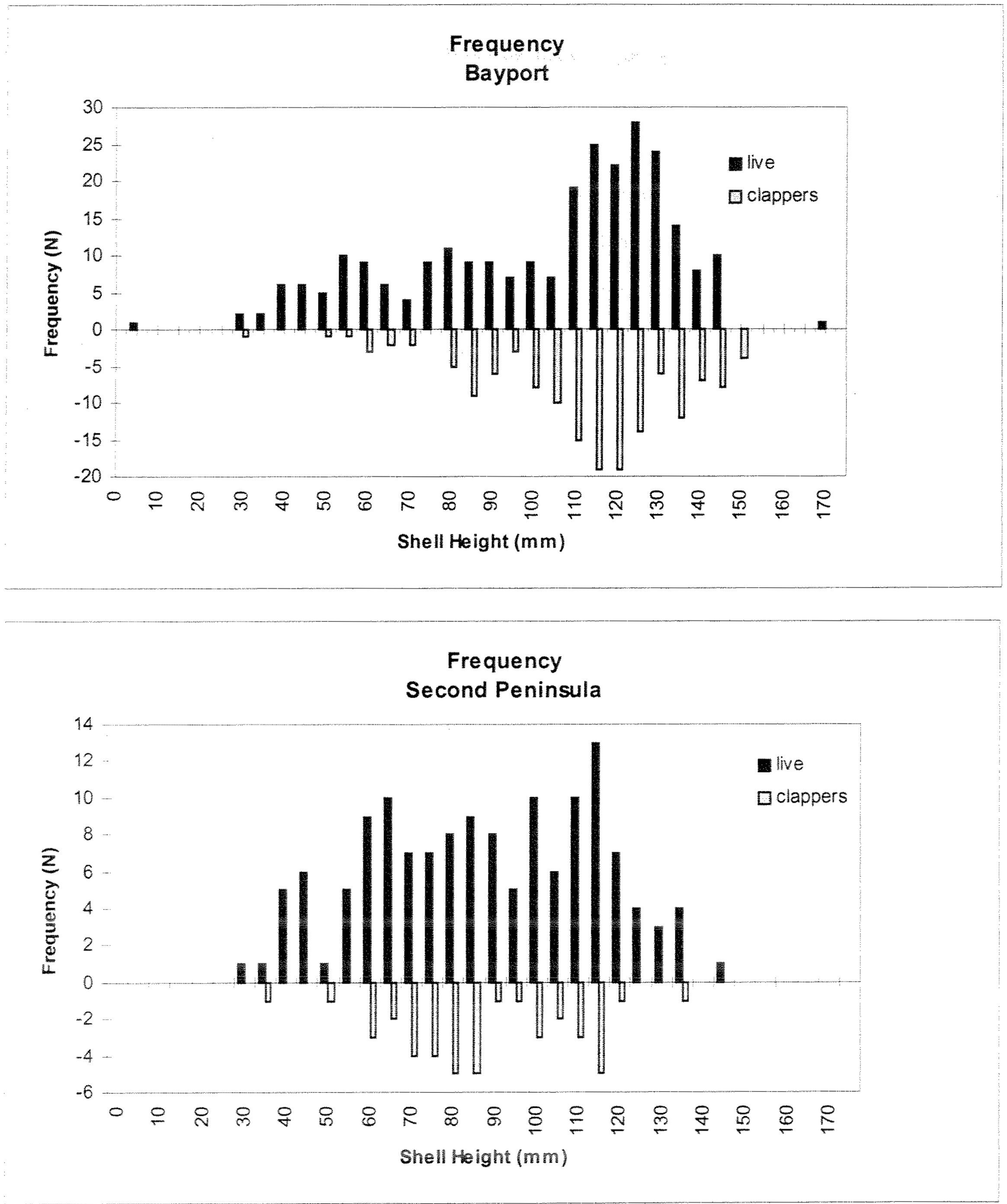


Figure 9. Shell height frequency distribution (absolute numbers) of live and dead scallops (clappers) in Bayport (top) and Second Peninsula (bottom). Note the different scales. Figure continues on next page.

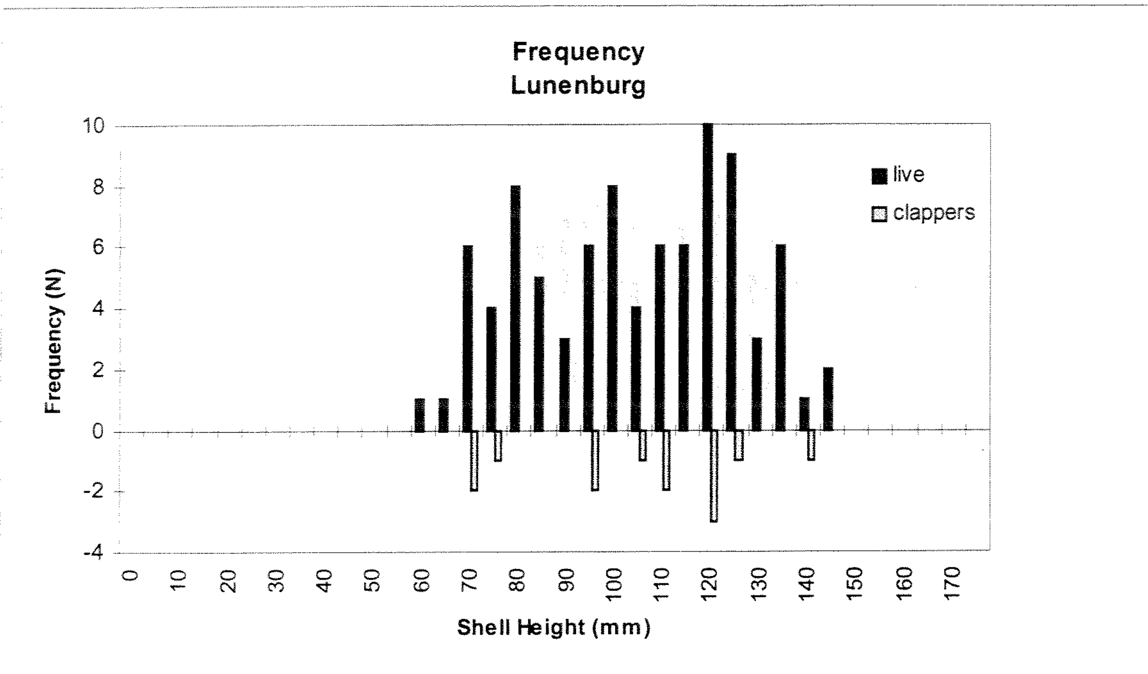


Figure 9 cont'd. Shell height frequency distribution (absolute numbers) of live and dead scallops (clappers) in Lunenburg. Note the different scales

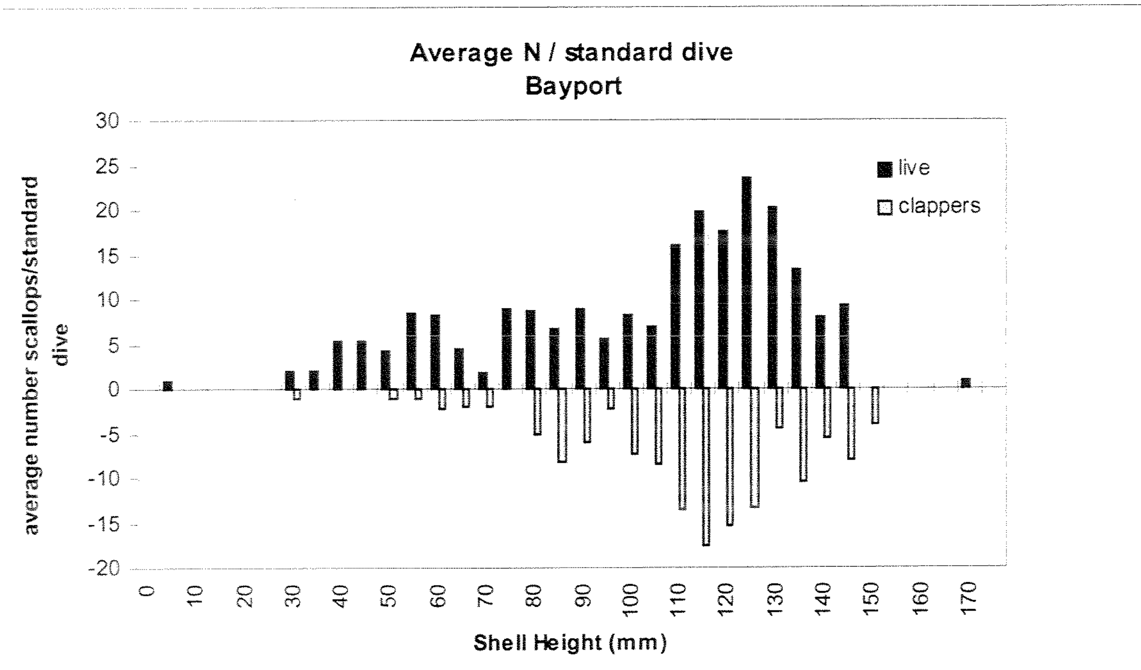
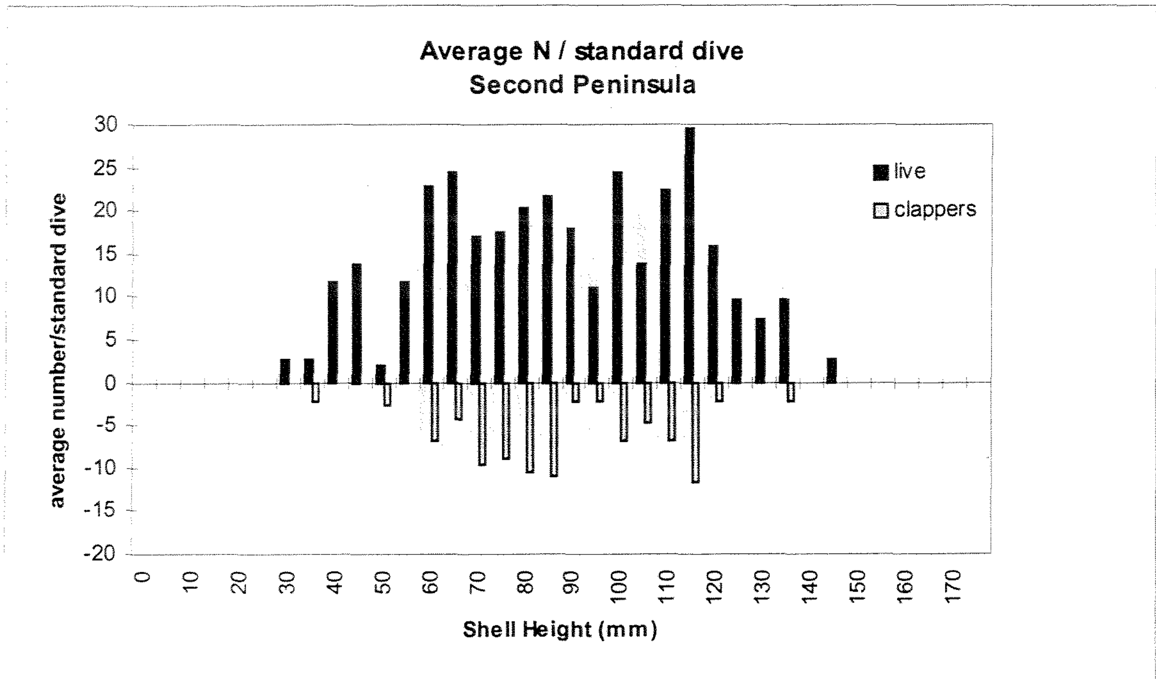


Figure 10. Average number of scallops per standard dive (40 feet circle) of live scallops and clappers in Bayport. Note the different scales. Figure continues on next page.



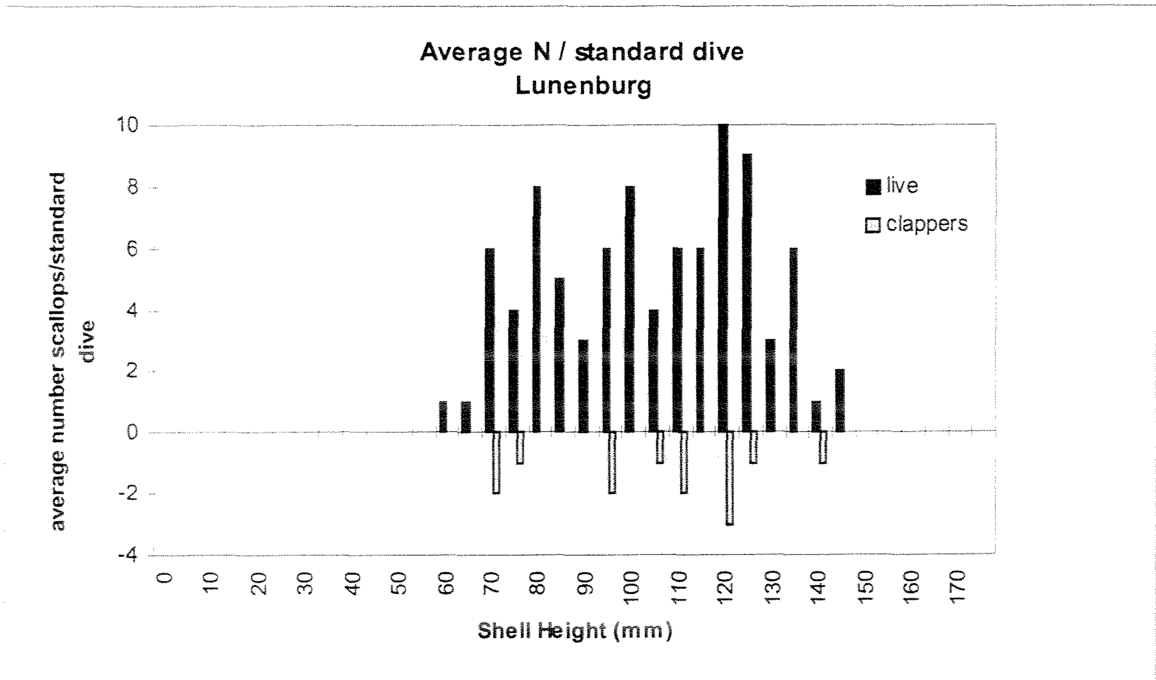
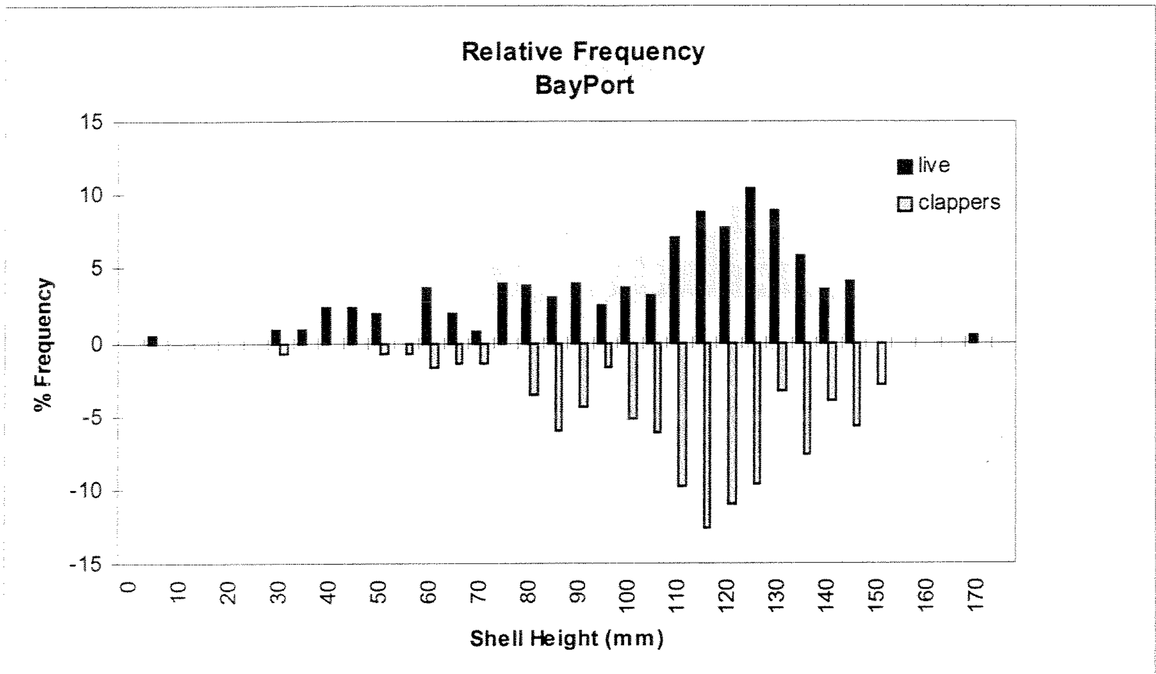


Figure 10 cont'd. Average number of scallops per standard dive (40 feet circle) of live scallops and clappers in Second Peninsula (top) and Lunenburg (bottom). Note the different scales.



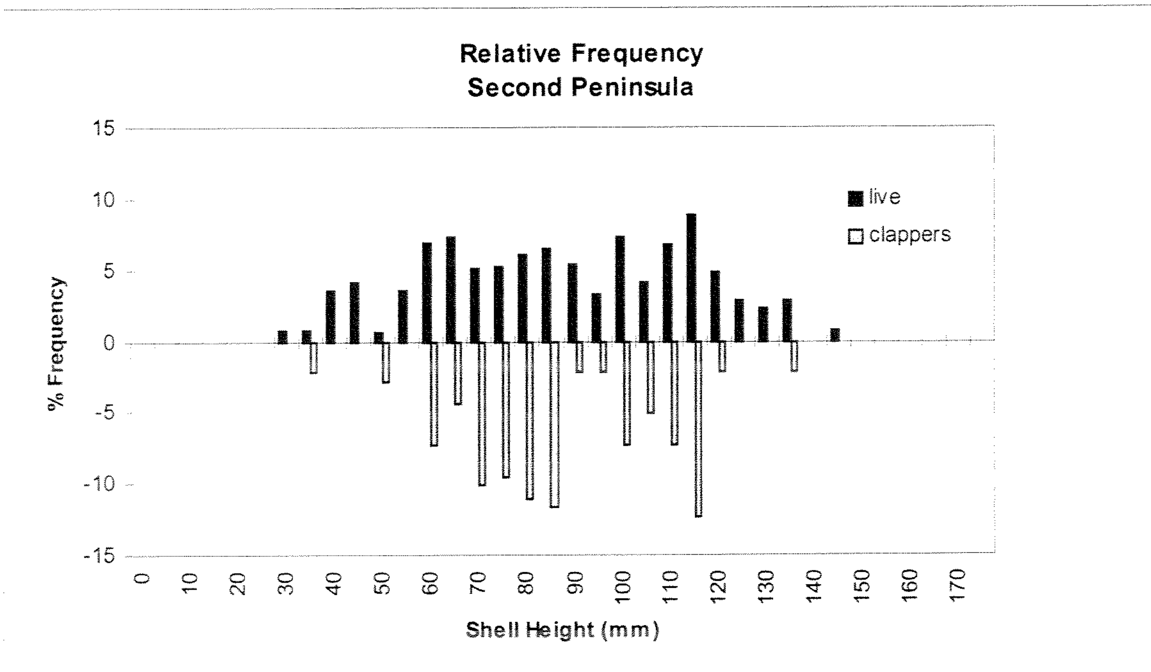


Figure 11. Relative frequency (of live and dead scallops (clappers) of the average number per standard dive) in Bayport (top) and Second Peninsula (bottom). Note the different scales. Figure continues on next page.

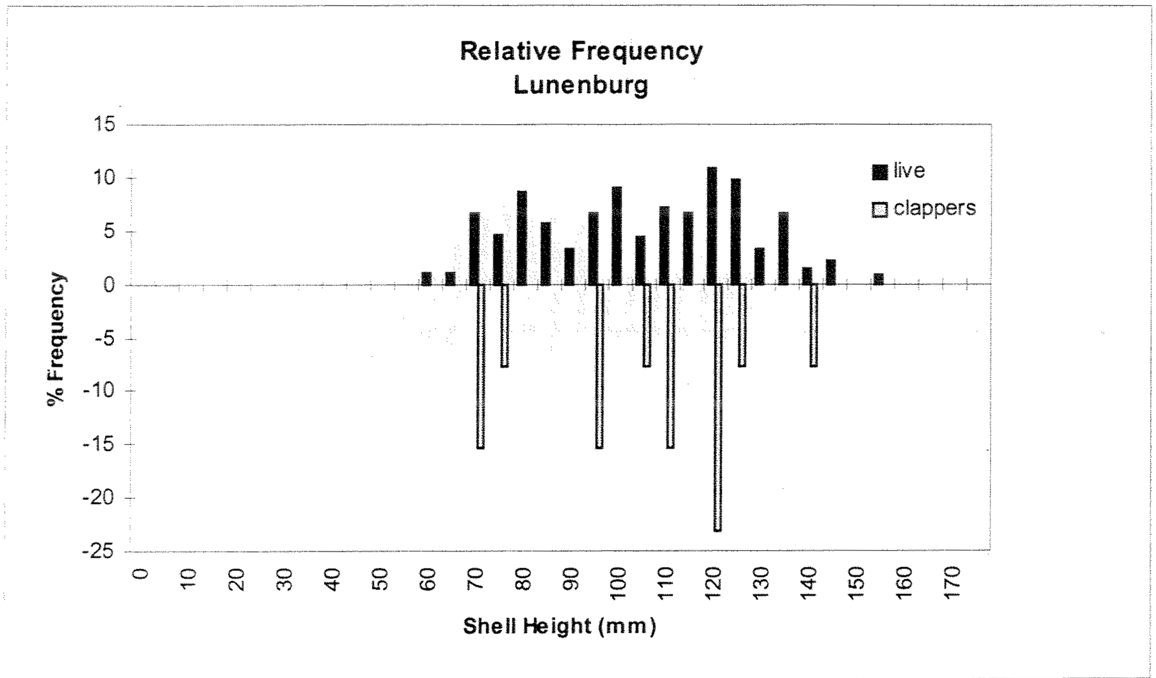


Figure 11 cont'd. Relative frequency (of live and dead scallops (clappers) of the average number per standard dive) in Lunenburg. Note the different scales.

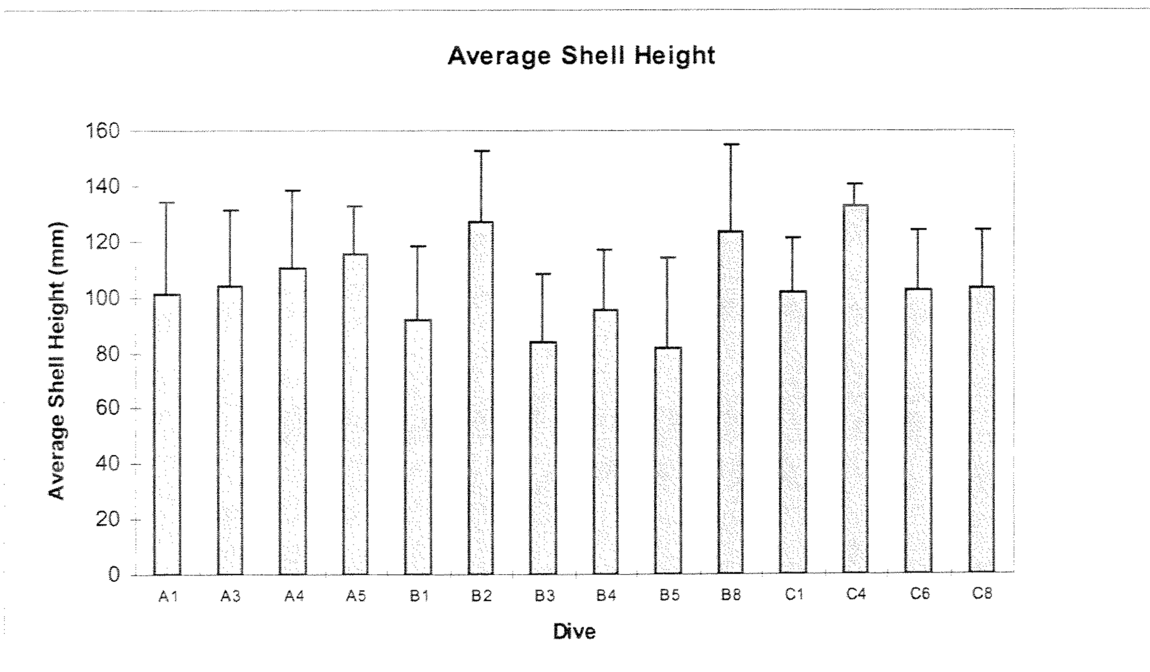
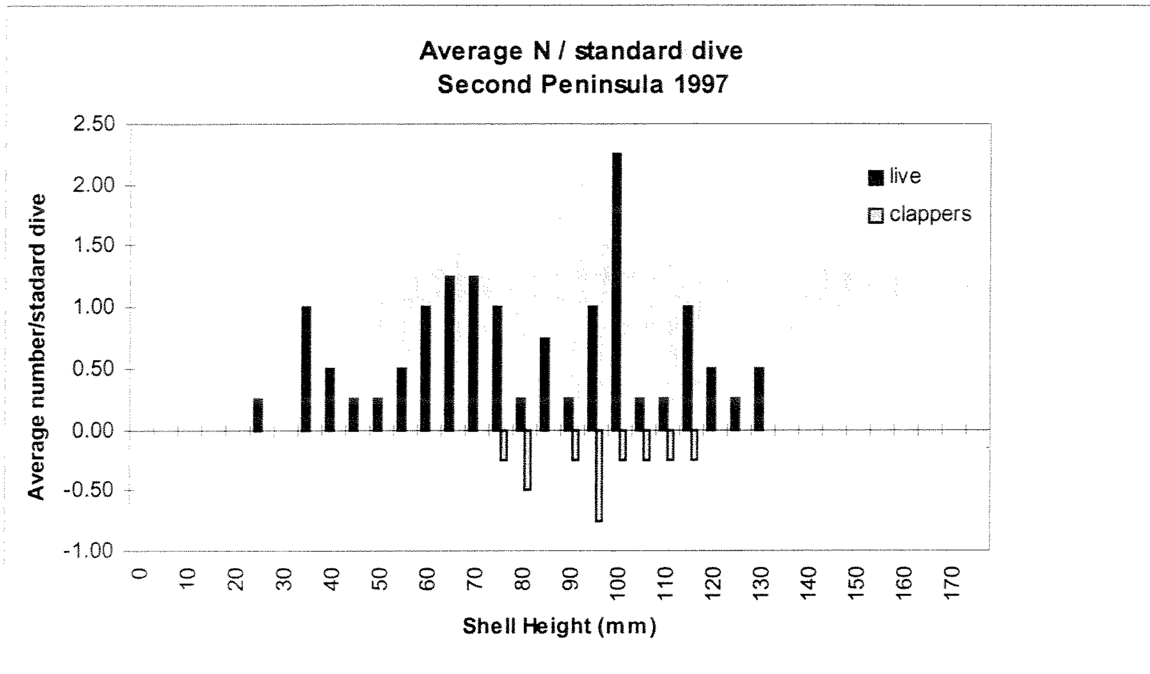


Figure 12. Average shell height with standard deviations for all dives, except B6 which had only 1 observation.



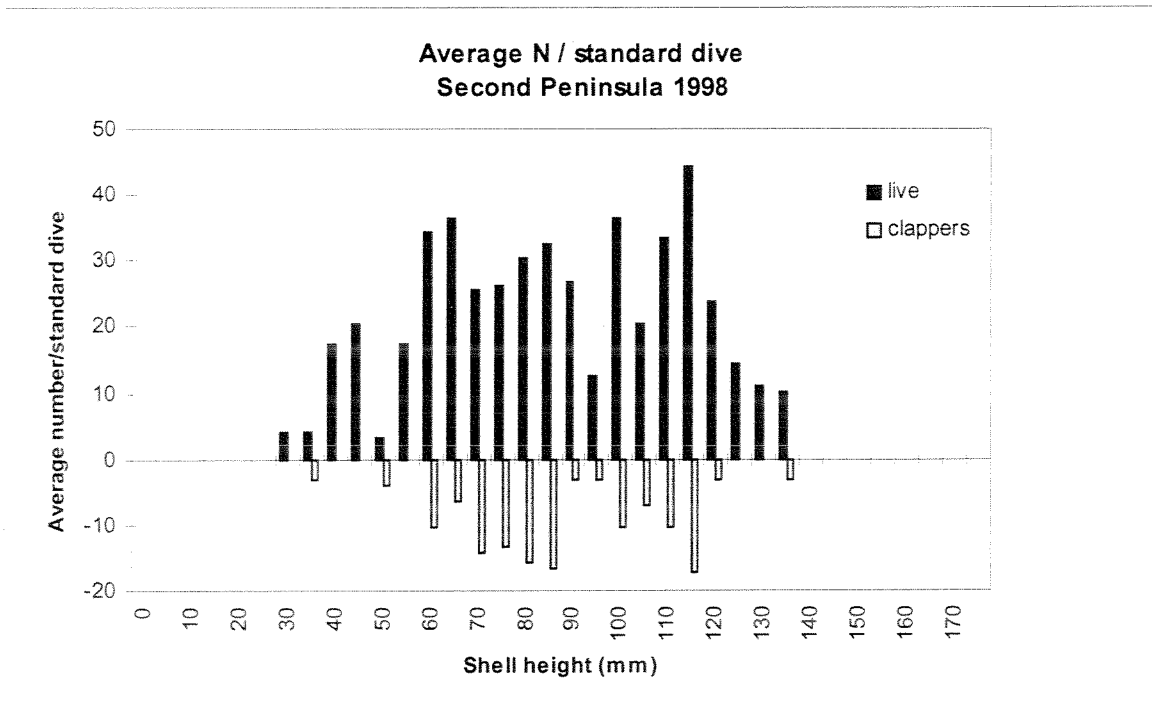


Figure 13. Average number of live and dead (clappers) scallops per standard dive (40 feet circle) of corresponding dives of Second Peninsula in 1997 (D7, D6, D4, D2) and 1998 (B1, B3, B4, B5).

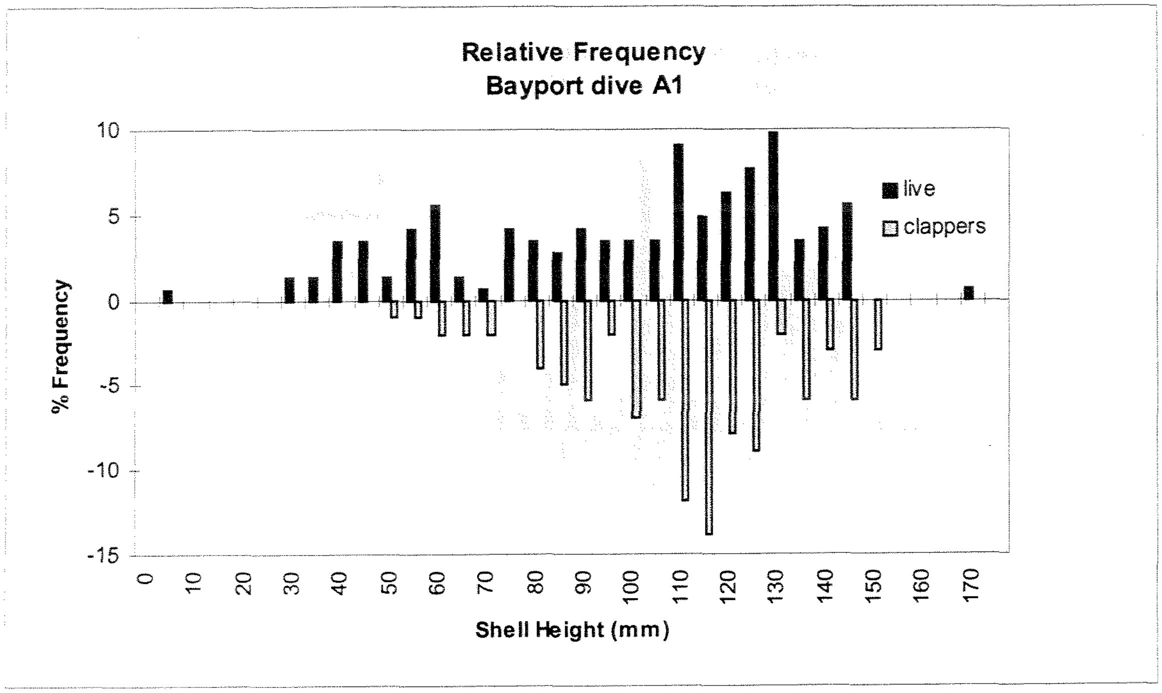
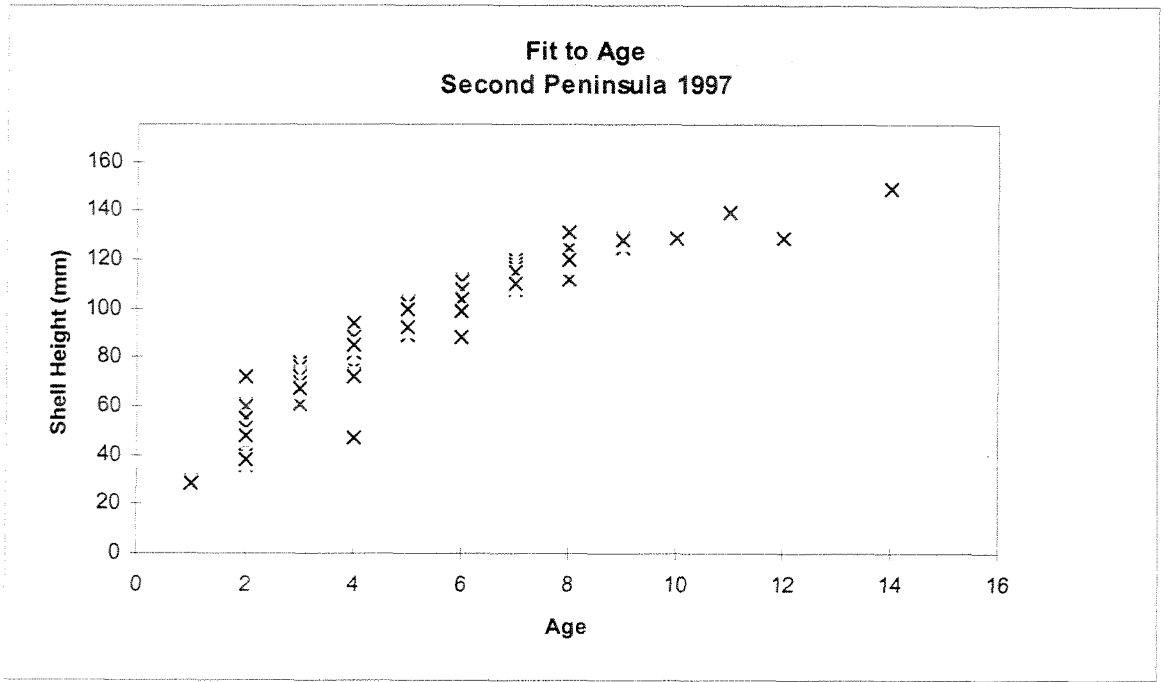


Figure 14. Relative frequency (of the average number of scallops per standard dive) of dive A1 from Bayport.



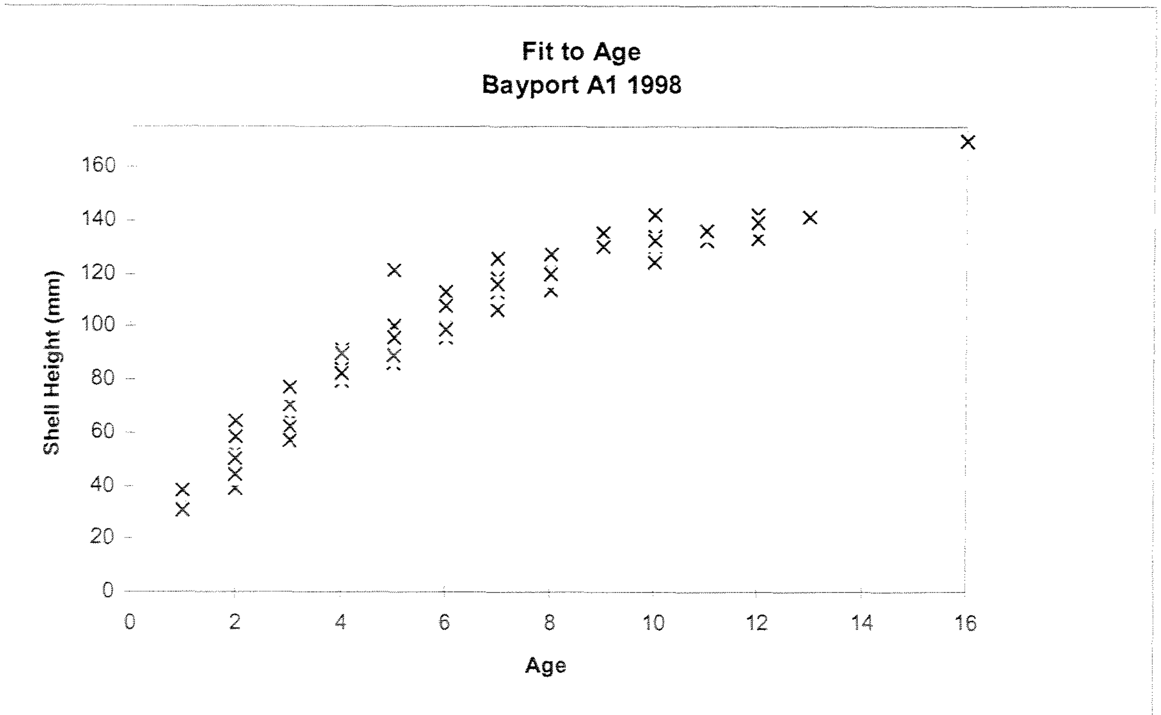
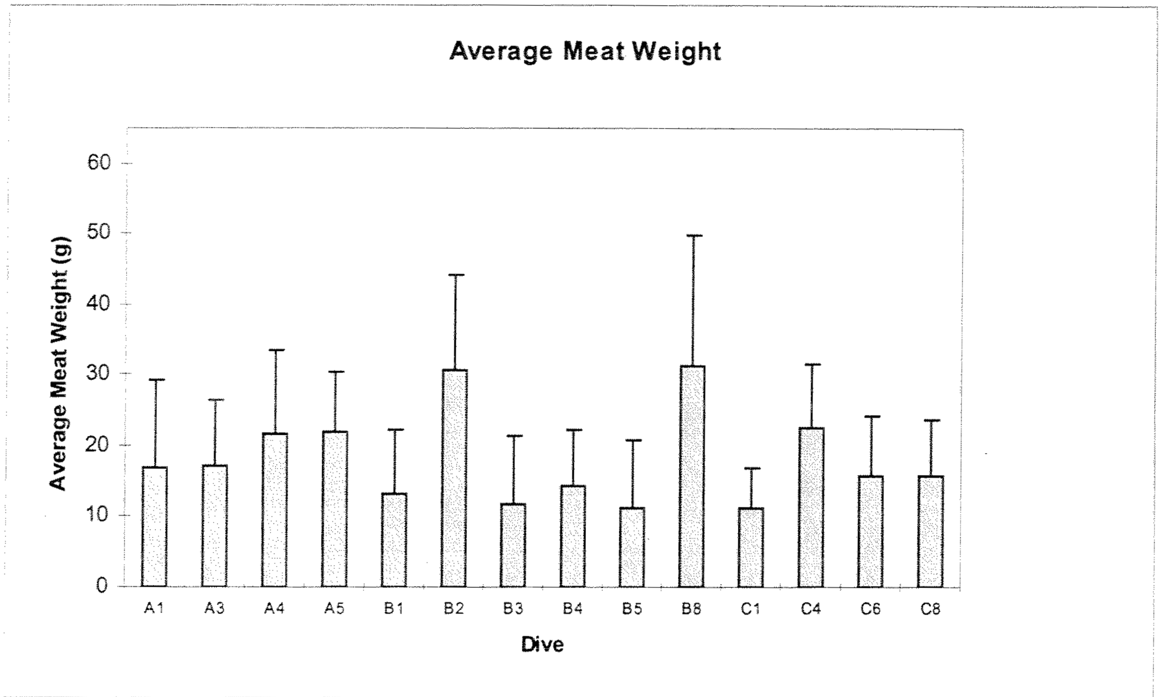


Figure 15. Growth curves of scallops of Second Peninsula from 1997 (top) and 1998 (bottom). Von Bertalanffy parameters of 1997: L_{inf} = 153.84, K = 0.19 and t_0 = -0.10. Von Bertalanffy parameters of 1998: L_{inf} = 166.32, K = 0.16 and t_0 = -0.21.



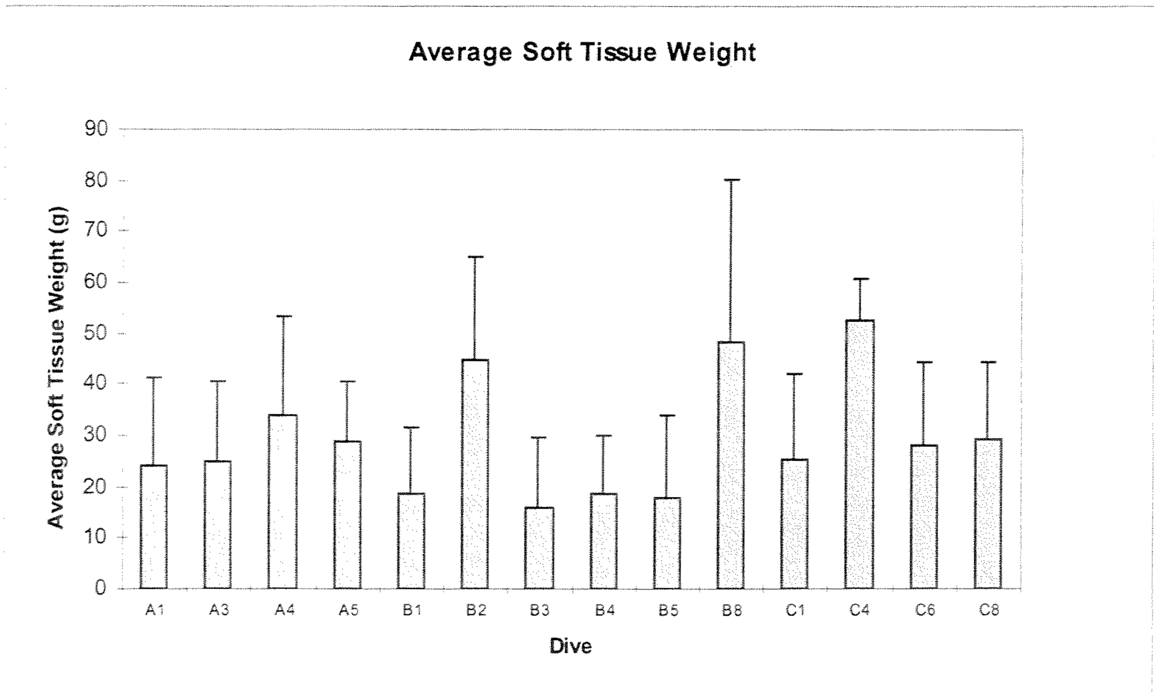


Figure 16. Average meat weight (top), soft tissue weight (bottom) and gonad weight (next page) with the standard deviations for the various dive sites. Dive site B6 is left out due to only 1 observation. Figure continous on next page.

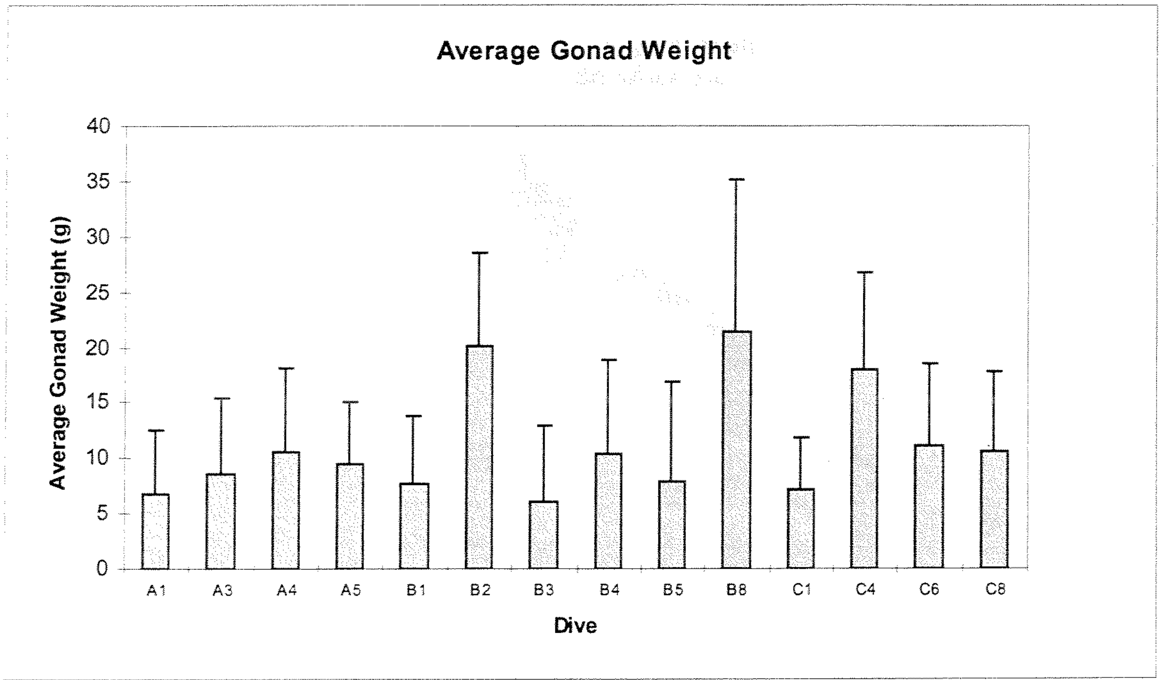


Figure 16 cont'd. Average meat weight (previous page), soft tissue weight (previous page) and gonad weight with the standard deviations for the various dive sites. Dive site B6 is left out due to only 1 observation.

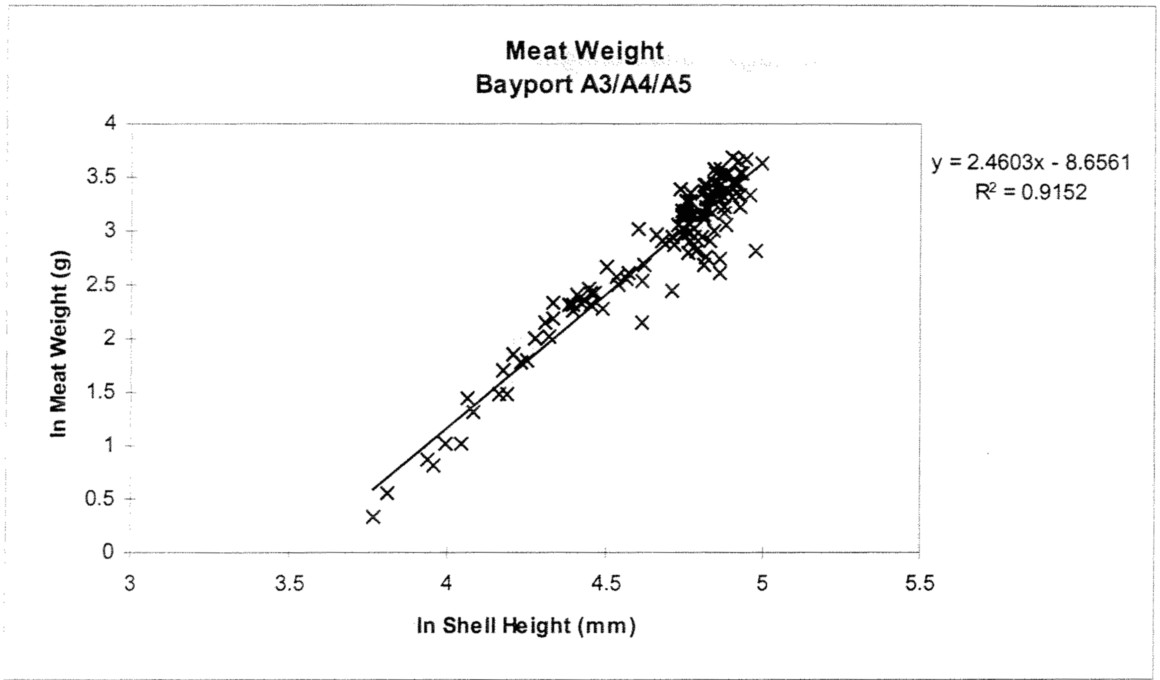
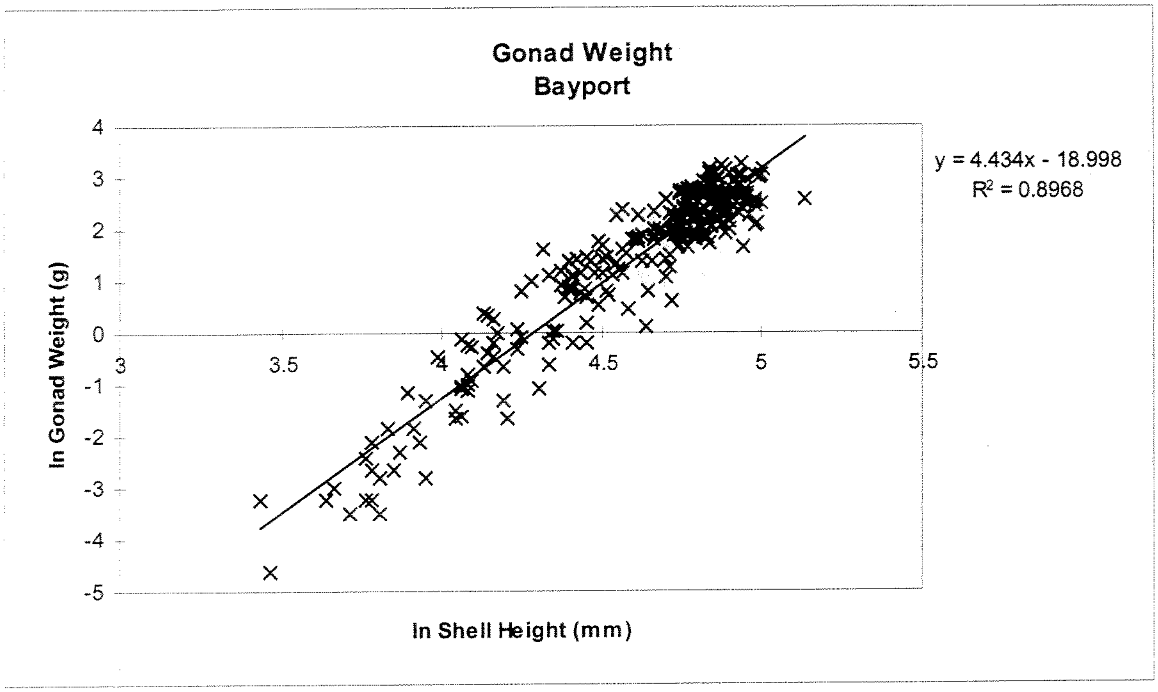


Figure 17. Ln (shell height), ln (meat weight) relation for dives A3, A4 and A5 of Bayport combined into one single regression model.



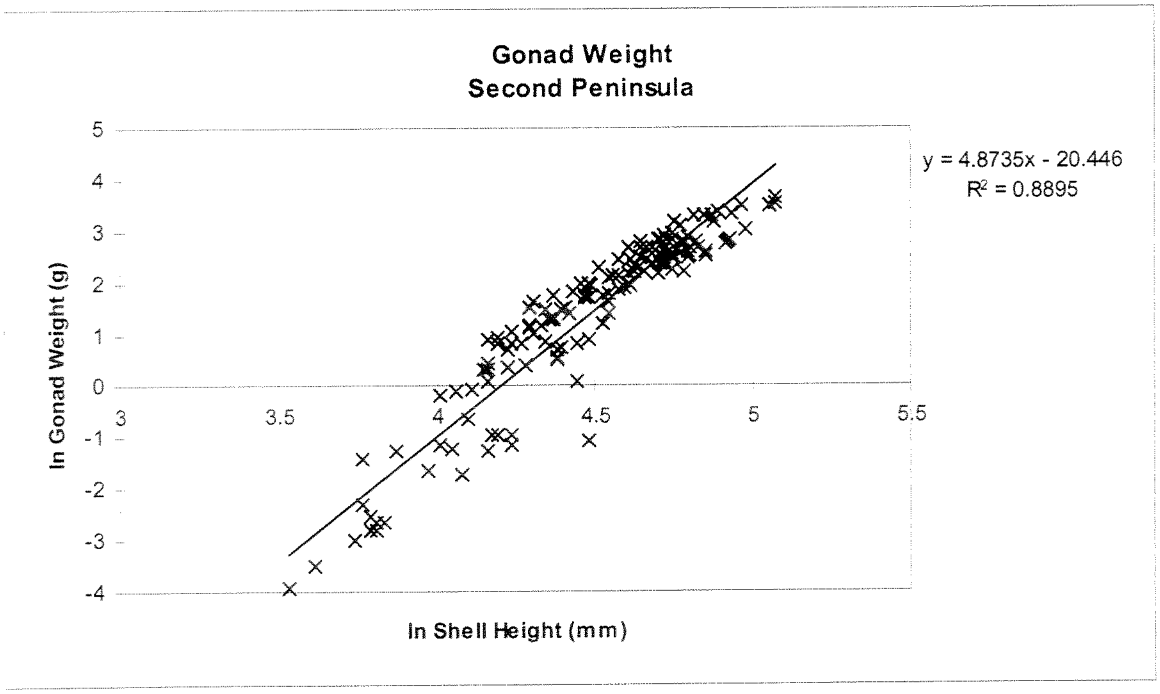
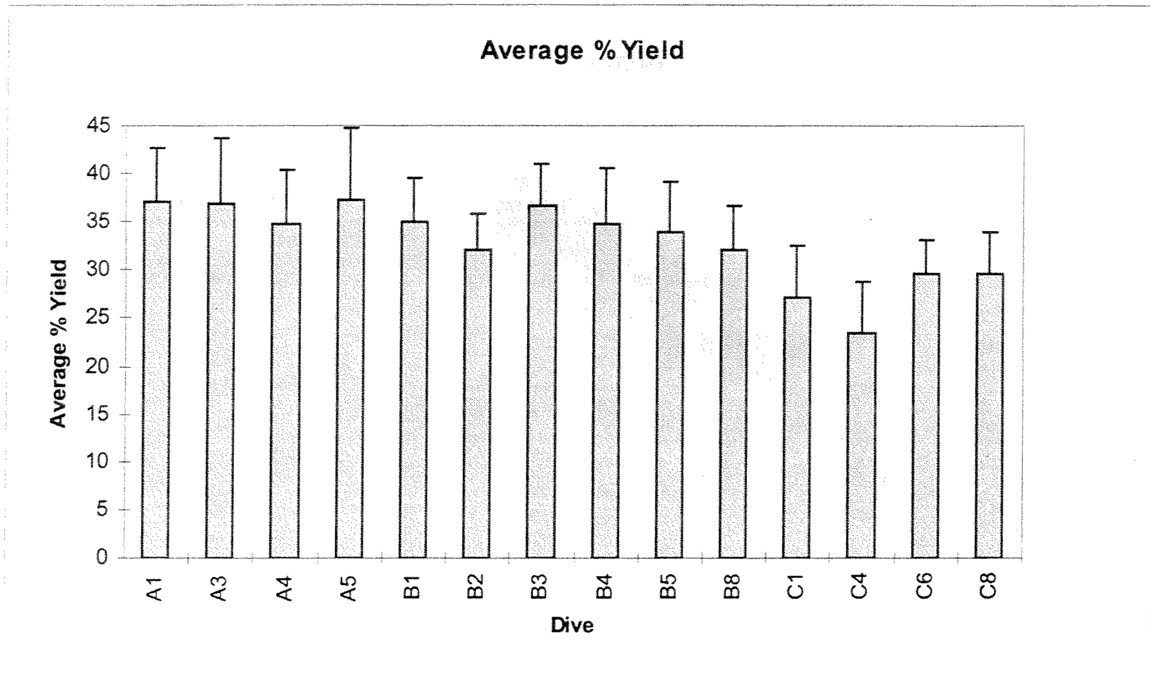


Figure 18. Ln (shell height), ln (gonad weight) relation for all dives of Bayport combined (top) into one regression model and the relation for all dives of Second Peninsula combined (bottom) into one single regression model.



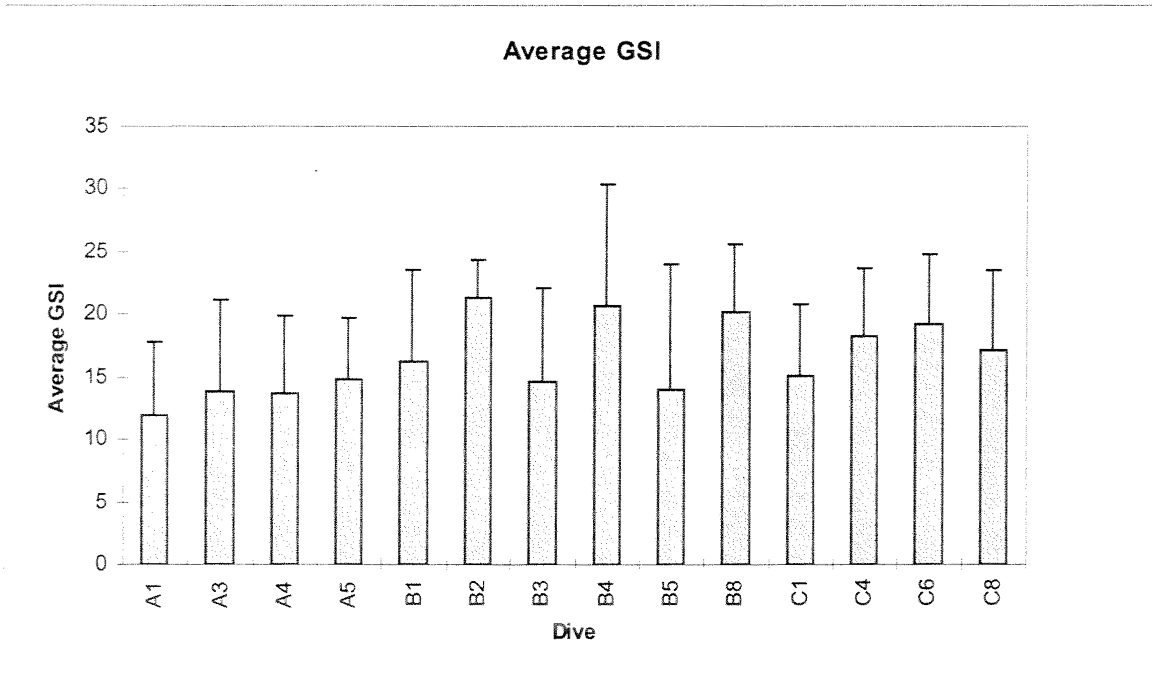
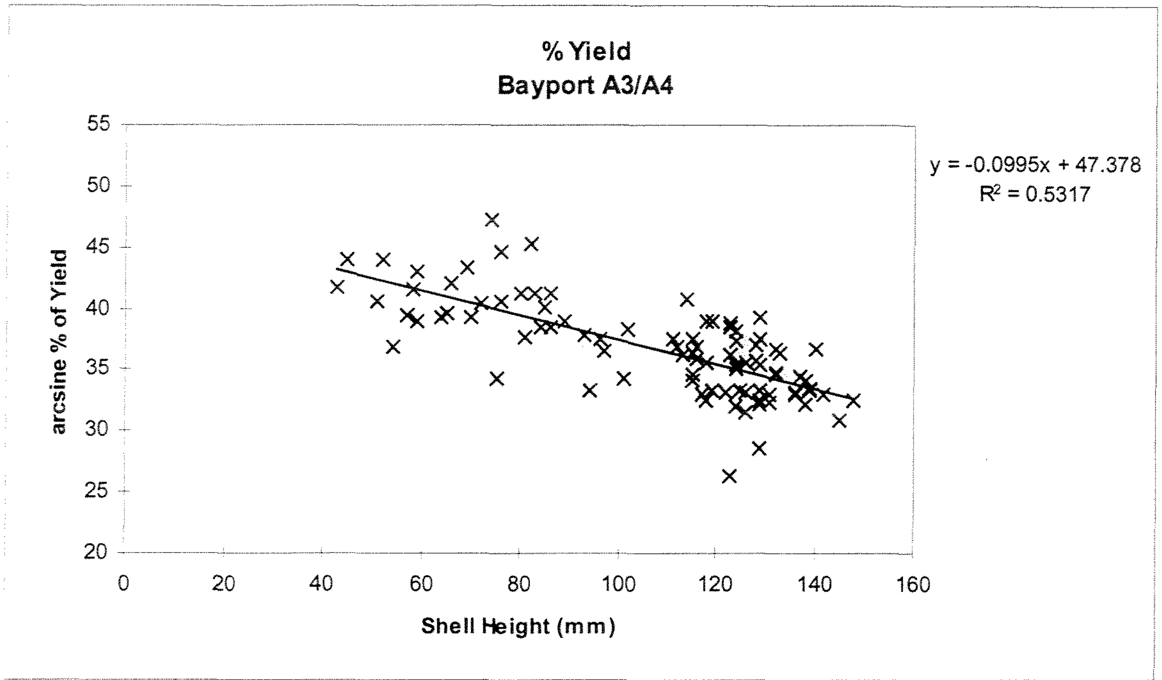


Figure 19. Average % yield (top) and average GSI (bottom) with standard deviations for all dives except B6 (had only 1 observation). Note the different scales.



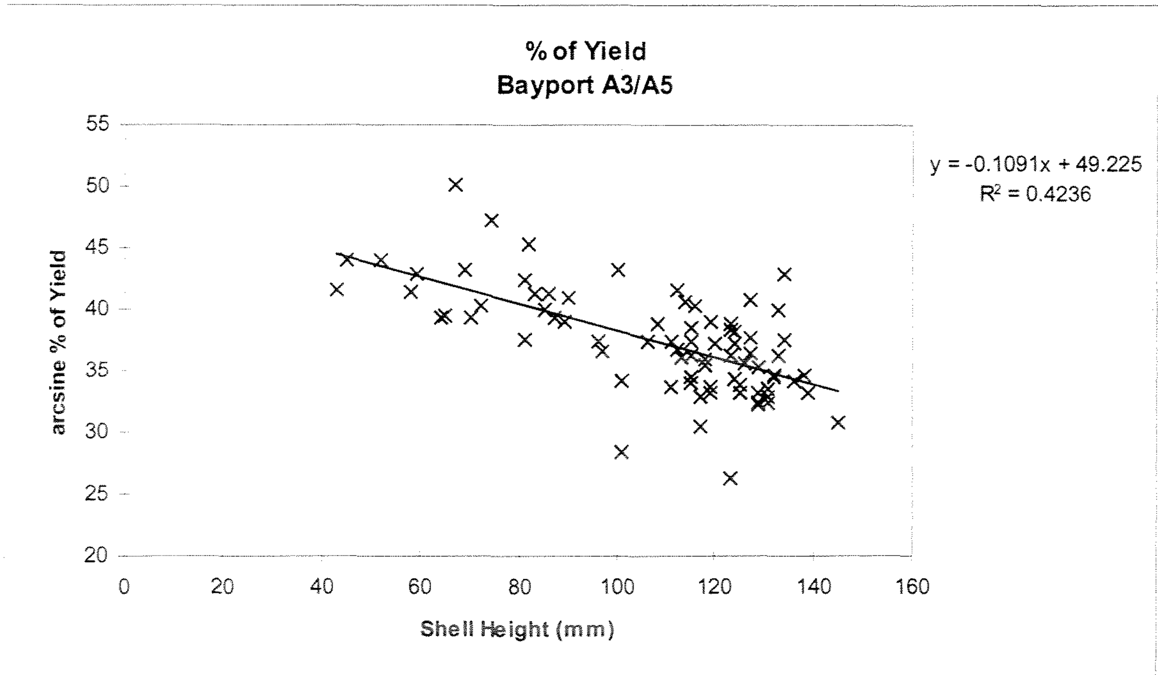
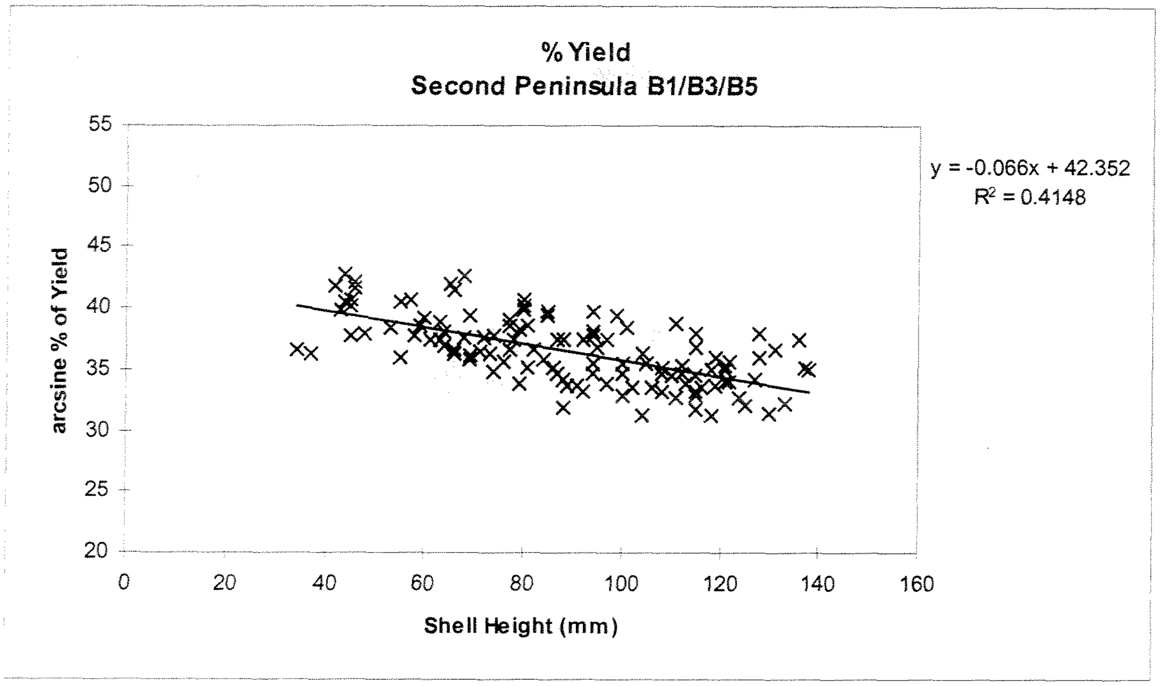


Figure 20. The arcsin (% yield), shell height relation for dive A3 and A4 of Bayport combined into one regression model at the top and the arcsin (% yield), shell height relation for dive A3 and A5 of Bayport combined into one regression model at the bottom. Figure continues on next page.



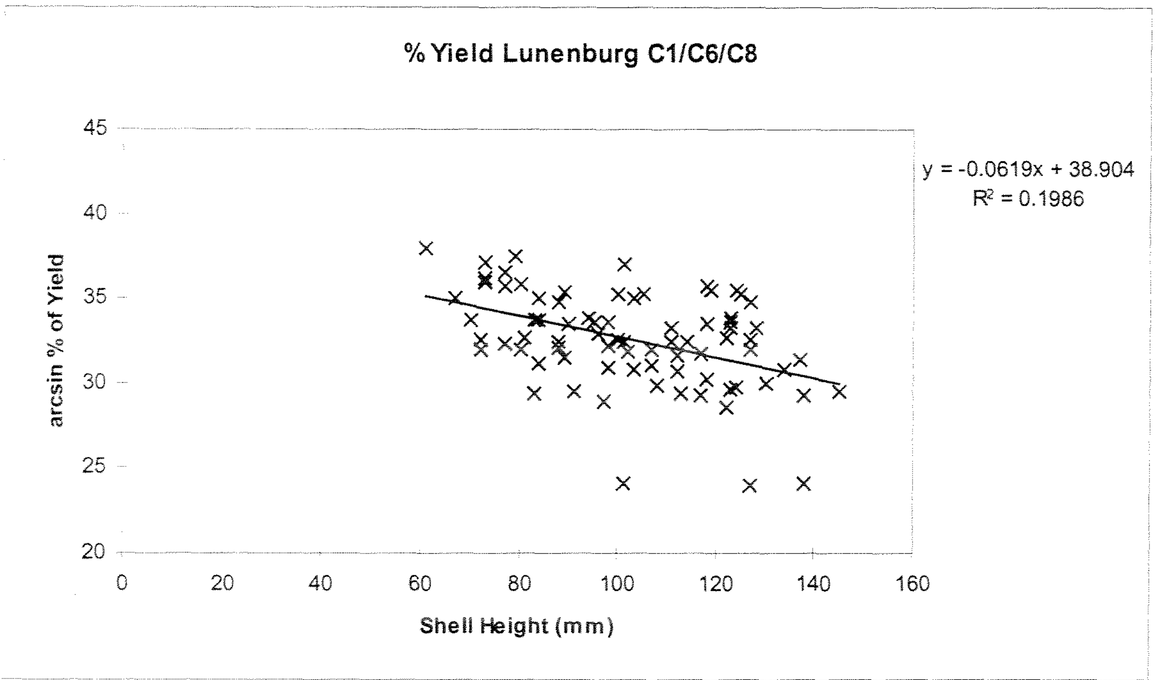
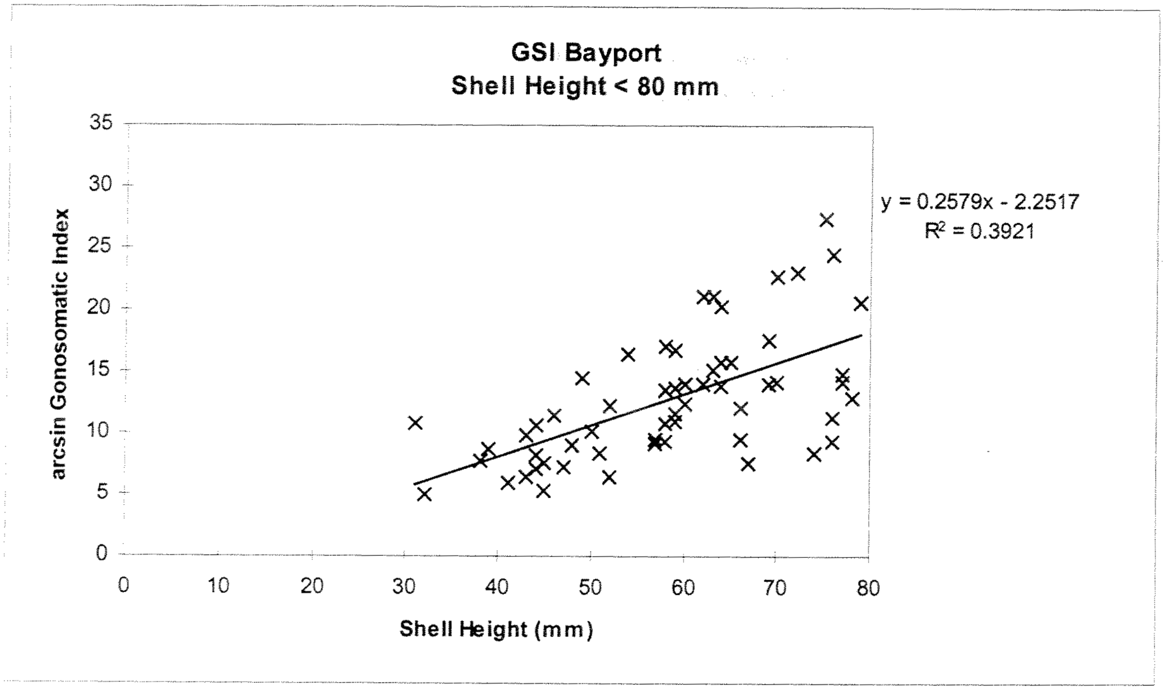


Figure 20 cont'd. The arcsin (% yield), shell height relation for dives B1, B3 and B5 of Second Peninsula combined into one regression model at the top and the arcsin (% yield), shell height relation for dives C1, C6 and C8 of Lunenburg combined into one regression model at the bottom. Note the different scales.



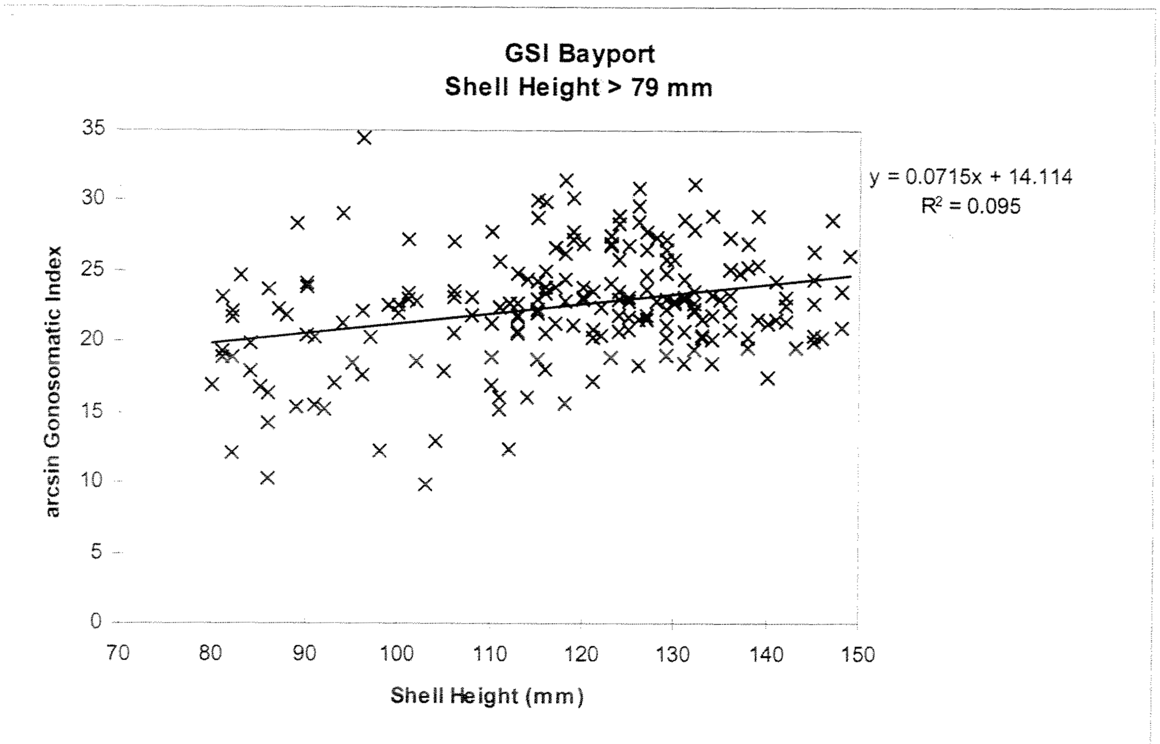
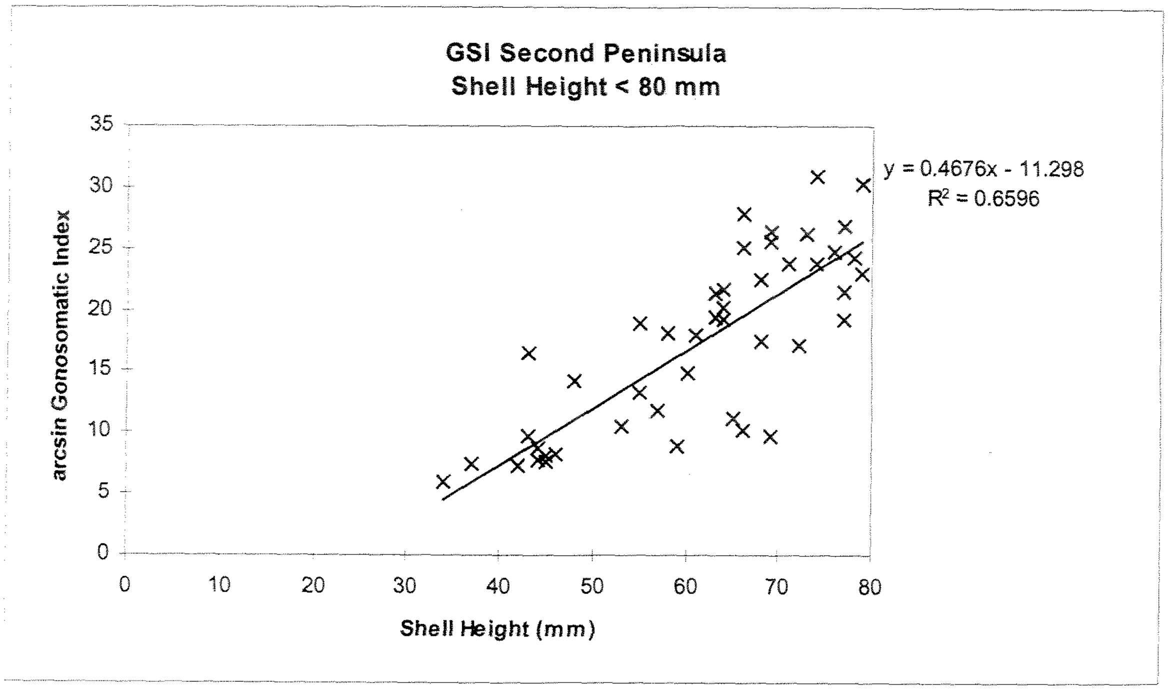


Figure 21. The arcsin (gonosomatic index -GSI-), shell height relationship for scallops smaller than 80 mm (top) and scallops of 80 mm and bigger (bottom). All dive sites of Bayport are combined into one regression model describing the relation. Figure continues on next page.



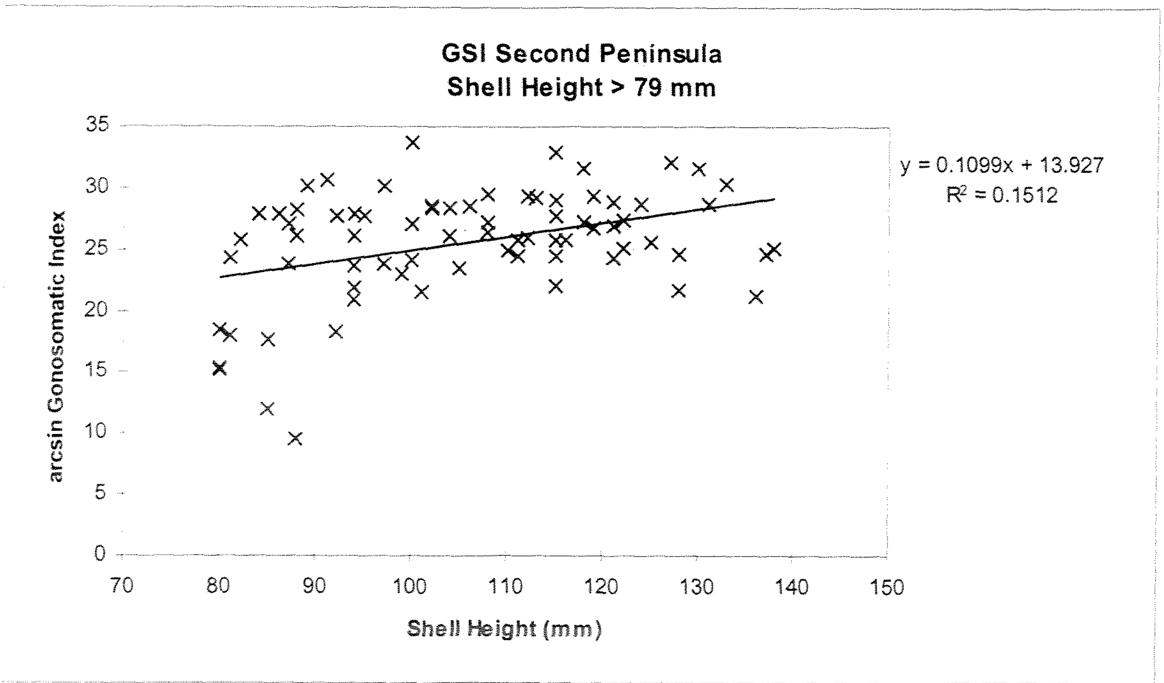


Figure 21 cont'd. The arcsin (gonosomatic index -GSI-), shell height relationship for scallops smaller than 80 mm (top) and scallops of 80 mm and bigger (bottom). Dive sites B1, B3 and B5 of Second Peninsula are combined into one regression model describing the relation. Figure continues on next page.

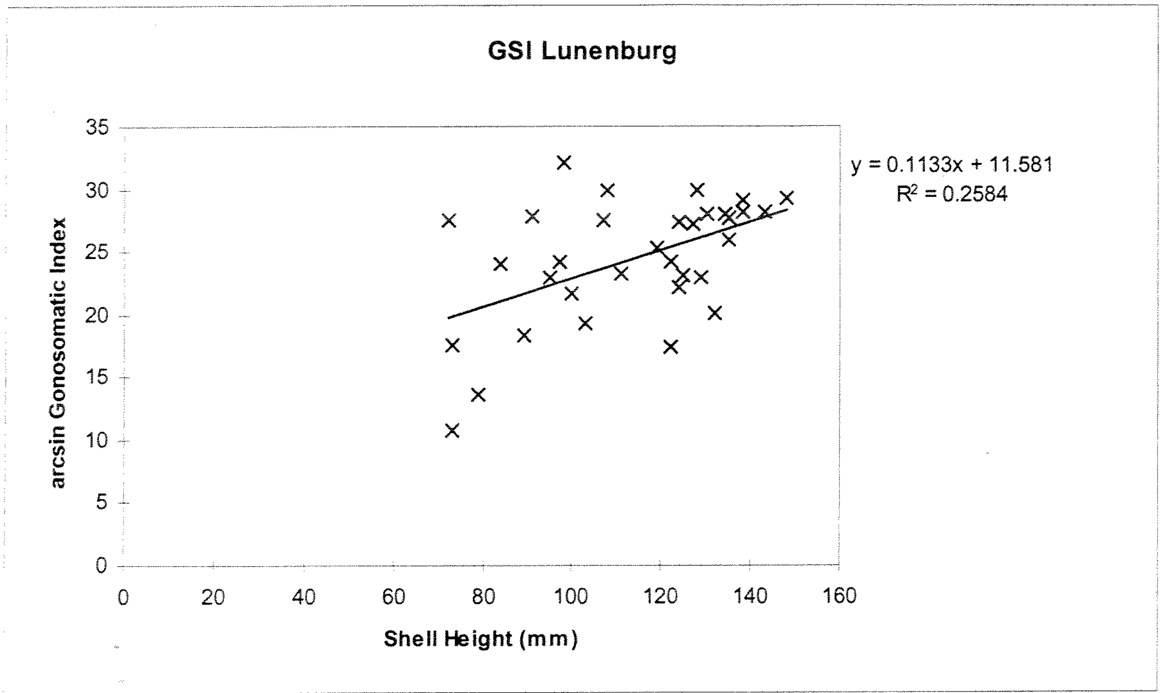


Figure 21 cont'd. The arcsin (gonosomatic index -GSI-), shell height relationship for dive sites C4 and C8 of Lunenburg with a regression model describing the relation.

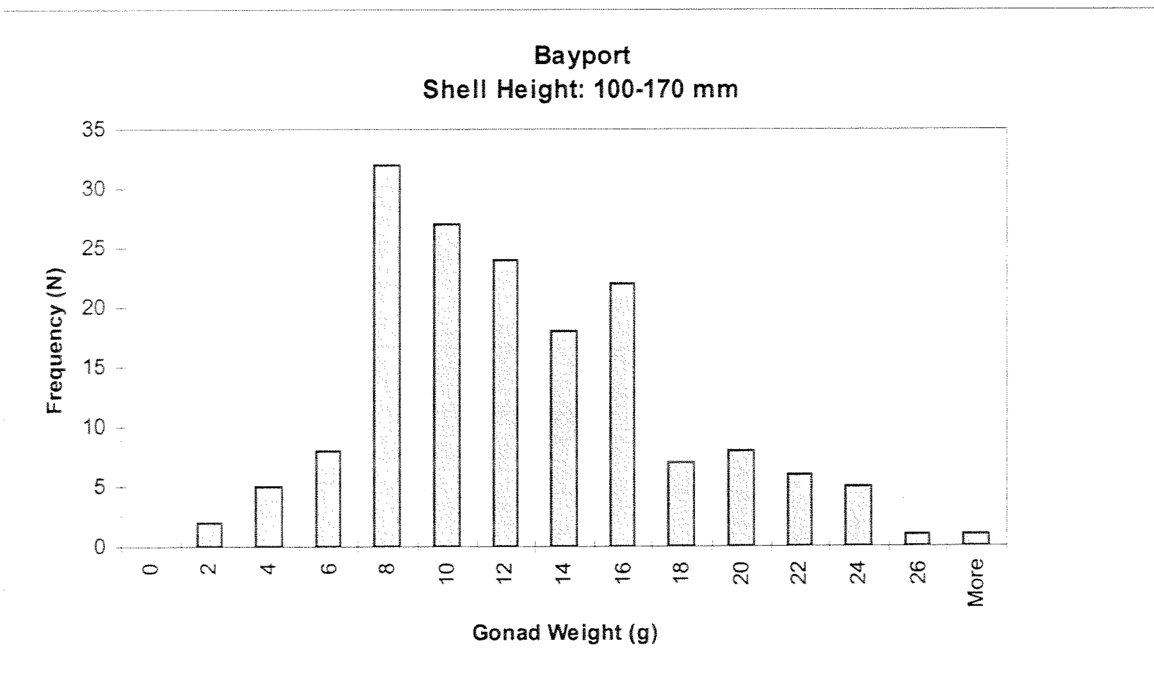


Figure 22. The gonad weight frequency (absolute numbers) of scallops of Bayport with a shell height over 100 mm.

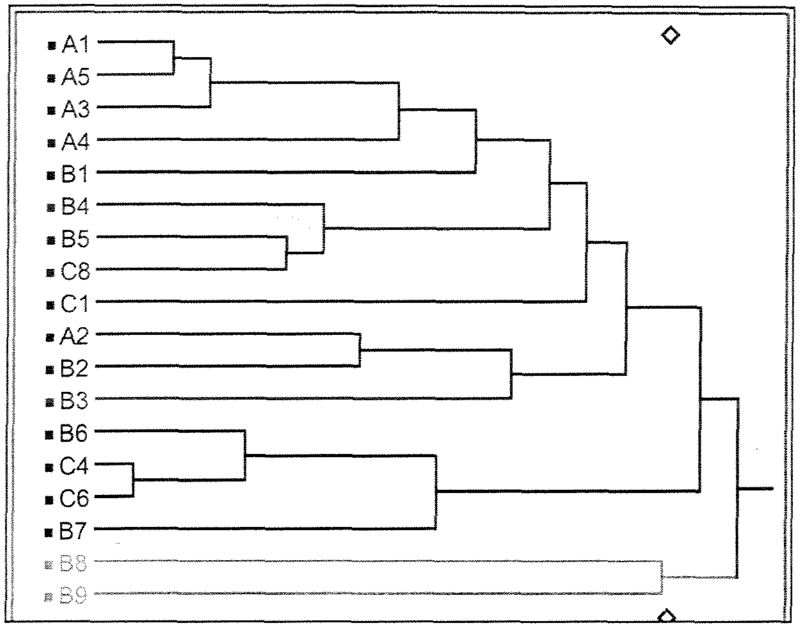


Figure 23. Dendrogram of sampling sites clustered according to predator and molluscan species composition similarity.

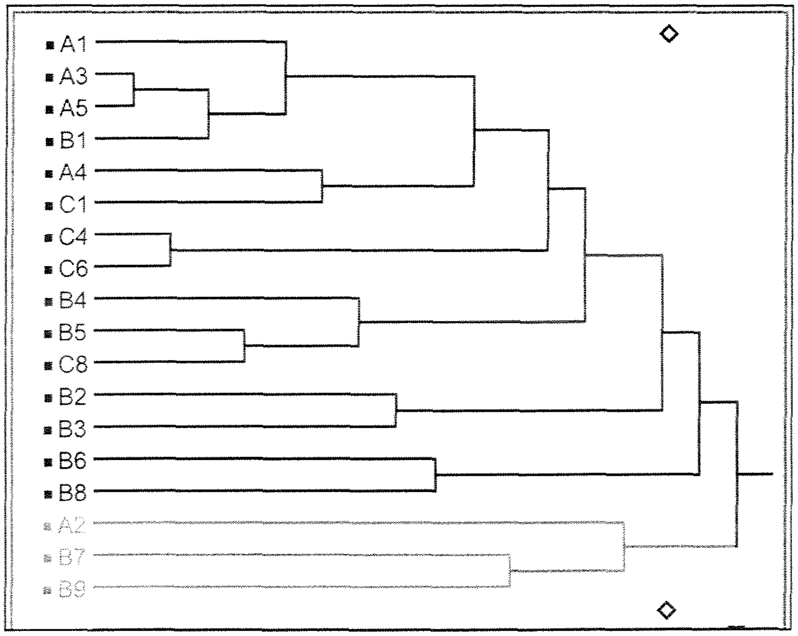


Figure 24. Dendrogram of sampling sites clustered according to similarity of species using all species present in the data set.

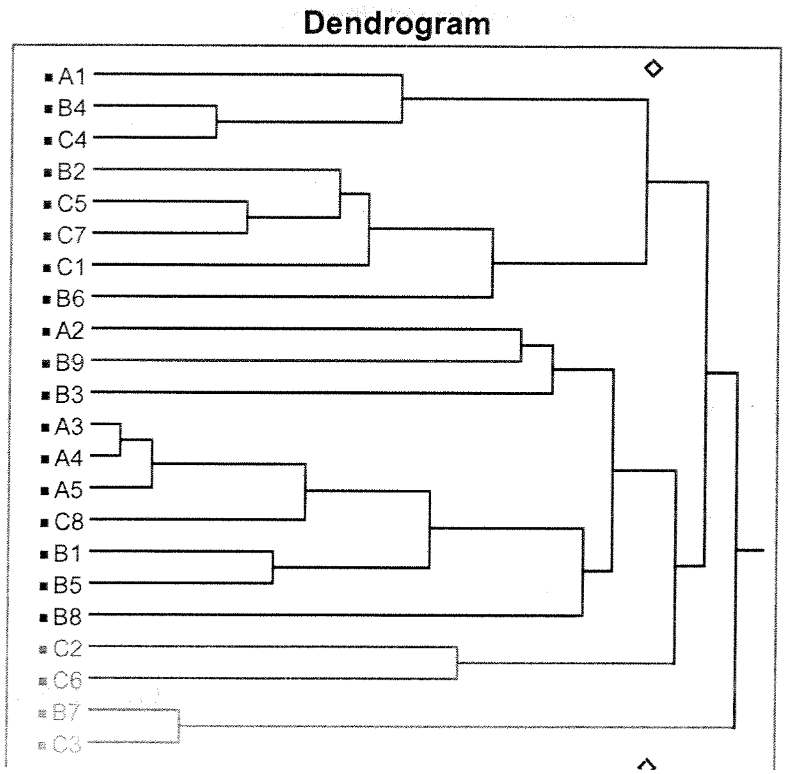


Figure 25. Dendrogram of sampling sites clustered according to bottom type.

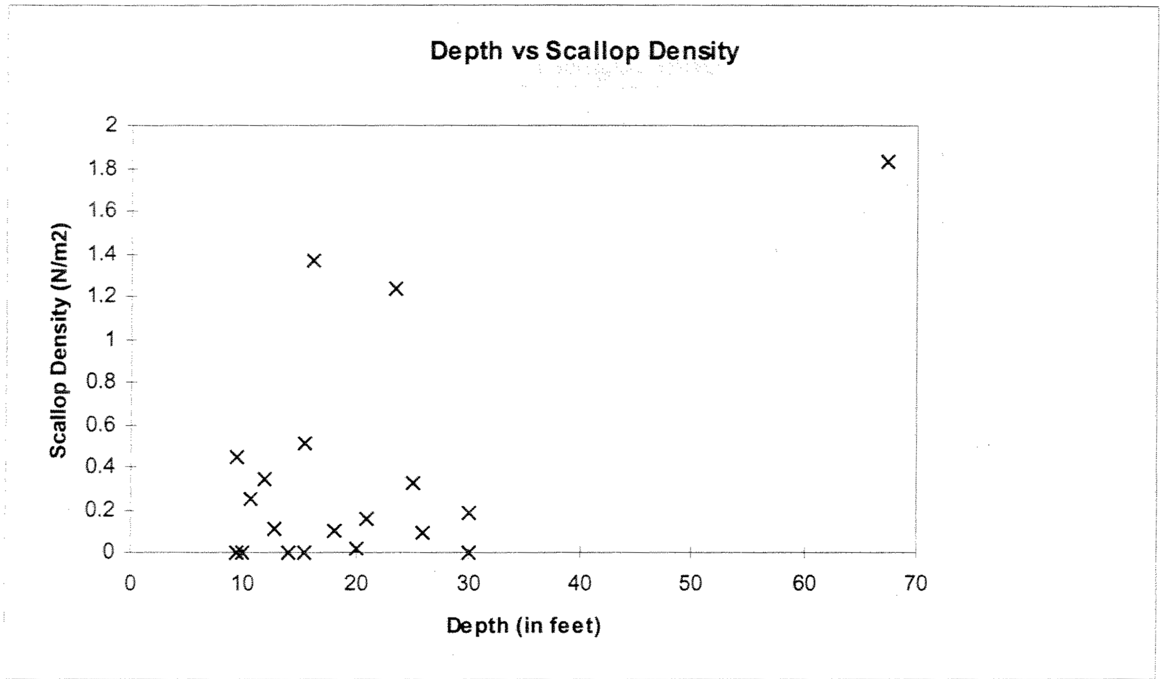


Figure 26. Plot of the scallop density against depth of dives of Bayport, Second Peninsula and Lunenburg combined.

Appendix 1. Scallop Licence Conditions for SFA29 for 1989 and 1999 with the Scallop Reporting Document.

Fisheries & Oceans Pêches et Océans

MAY 15, 1998

SCALLOP LICENCE CONDITION FOR COMMERCIAL AND RECREATIONAL LICENCE HOLDERS SCALLOP FISHING AREA 29

Pursuant to subsection 22.(1) of the ***Fishery (General) Regulations***, as amended, the following conditions are specified for scallop licence control number _____________ and where applicable, issued in respect of the fishing vessel ______________________, vessel registration number ______________________, while fishing for scallops in Scallop Fishing Area 29 (as defined by the ***Atlantic Fishery Regulations, 1985***).

FISHING SEASONS / AREAS

1. Subject to any variation orders that may be issued and the restrictions contained within this licence condition, these licence conditions are valid for the fishing of scallops during the period beginning May 15, 1998 and ending December 31, 1998.

2. You are not permitted to fish for scallops by any means in that portion of Scallop Area 29 described as follows:

The waters adjacent to Nova Scotia (from the Yarmouth County line to Pennant Point, Halifax County) and between the bounds of two lines, the first beginning at Latitude 43°33'N., Longitude 65°45'W., thence running 180 ° (T) to the outer boundary of the Territorial Sea ,the second beginning at Latitude 44°26'N., Longitude 63°38.6'W., thence running 180° (T) to the outer boundary of the Territorial Sea. (The Territorial Sea as prescribed by the Territorial Sea and Fishing Zone Act, R.S.C., 1985,C. T-8.).

REPORTING REQUIREMENTS

3. Pursuant to section 61 of the ***Fisheries Act*** you are required to provide information concerning your fishing activities in the Scallop Reporting Document for Scallop Fishing Area 29 available from the Department of Fisheries and Oceans. You are also required to complete the document in accordance with the supplied instructions. You are further required to supply the Department of Fisheries and Oceans at the end of each month with a copy of all monitoring document entries. You are also required to provide any documents requested by a Fishery Officer immediately upon demand.

Failure to comply with item three (3) will be a relevant factor, as an aspect of conservation and management of scallops, in the decision whether or not a licence and condition of licence for scallops will be issued to you for the 1999 scallop season.

DISCARDS

4. You are required to return all species of fish caught incidentally to the water. Every person who catches a fish incidentally shall forthwith return it,

to the place from which it was taken; and where it is alive, in a manner that causes it the least harm.

GENERAL PROVISIONS

5. I requested and received this licence condition in English.

6. I understand and acknowledge these conditions issued with and attached to my scallop licence.

7. The licence holder is required to sign this licence condition.

8. Fishers are reminded that it is an offense under the ***Atlantic Fishery Regulations, 1985*** to transport fish caught by another vessel or to put fish on board another vessel without a fish transporting licence.

____

Signature of Licence Holder

____

Signature of Licensing Authority

____

Date Place of Issue

<u>PLEASE NOTE:</u> For information regarding areas open or closed to fishing, variation orders, and for clarification of any provisions contained in this licence condition contact your local fishery officer. Dockside Monitoring Companies are not agents of the Department of Fisheries and Oceans. Companies are not authorized, on behalf of the Department of Fisheries and Oceans, to provide any information to fishers. You are also reminded that failure to comply with the requirements of your Licence or Conditions of Licence may subject you to prosecution.

Fisheries & Oceans | Pêches et Océans

NOVEMBER 10, 1998

SCALLOP LICENCE CONDITION
RECREATIONAL DIPNET LICENCE HOLDERS
SCALLOP FISHING AREA 29

Pursuant to subsection 22.(1) of the ***Fishery (General) Regulations***, as amended, the following conditions are specified for scallop licence control number _______________ ____________________ while fishing for scallops in Scallop Fishing Area 29 (as defined by the ***Atlantic Fishery Regulations, 1985***).

FISHING SEASONS / AREAS

1. Subject to any variation orders that may be issued and the restrictions contained within this licence condition, these licence conditions are valid for the fishing of scallops during the period beginning November 16, 1998 and ending December 31, 1998.

2. You are only permitted to fish for scallops by dipnet in that portion of Scallop Area 29 described as follows:

   The waters adjacent to Nova Scotia (Lunenburg County to Pennant Point, Halifax County) and between the bounds of two lines; the first beginning at Latitude 44°09' N., Longitude 64°33' W., thence running 180 ° (T) to the outer boundary of Scallop Fishing Area 29; the second beginning at Latitude 44°25'51"N., Longitude 63°39'W., thence running 180° (T) to the outer boundary of Scallop Fishing Area 29.

SIZE LIMITS

3. You are not authorized to catch and retain or have on board a vessel any scallop with the scallop shell height less than 110 mm. (Measured from the hinge to the farthest point on the outer edge of the shell)

4. All scallops retained must be whole. No scallops may be shucked until after they are landed.

REPORTING REQUIREMENTS

5. Pursuant to section 61 of the ***Fisheries Act*** you are required to provide information concerning your fishing activities in the Scallop Reporting Document for Scallop Fishing Area 29 available from the Department of Fisheries and Oceans. You are also required to complete the document in accordance with the instructions in the reporting document. You are further required to supply the Department of Fisheries and Oceans

at the end of each month with a copy of all monitoring document entries. You are also required to provide any documents requested by a Fishery Officer immediately upon demand.

Failure to comply with item five (5) will be a relevant factor, as an aspect of conservation and management of scallops, in the decision whether or not a licence and condition of licence for scallops will be issued to you for the 1999 scallop season.

DISCARDS

6. You are required to return all species of fish caught incidentally to the water. Every person who catches a fish incidentally shall forthwith return it,

to the place from which it was taken; and where it is alive, in a manner that causes it the least harm.

GENERAL PROVISIONS

7. I requested and received this licence condition in English.
8. I understand and acknowledge these conditions issued.
9. The licence holder is required to sign this licence condition.
10. The licence holder is required to attach these licence conditions to his/her 1998 scallop licence.
11. Fishers are reminded that it is an offense under the ***Atlantic Fishery Regulations, 1985*** to transport fish caught by another vessel or to put fish on board another vessel without a fish transporting licence.

Signature of Licence Holder　　　　Signature of Licencing Authority

Date　　　　Place of Issue

PLEASE NOTE: For information regarding areas open or closed to fishing, variation orders, and for clarification of any provisions contained in this licence condition contact your local fishery officer.

NOTICE

RECREATIONAL SCALLOP FISHING

The Regional Director -General, Maritimes Region, Department of Fisheries and Oceans, hereby gives notice that the fishing quota for scallops in Scallop Fishing Areas 28A, 28B, 28C and 28D (Bay of Fundy) and Scallop Fishing Area 29 (the Yarmouth County line to Cape North, Victoria County) is varied to be 50 (fifty) scallops.

The Maritimes Region Variation Fishing Quota Order 1998-079 is hereby revoked.

For further information please refer to Variation Order 1998-154 or your local Fishery Officer.

N.A. Bellefontaine
Regional Director-General
Maritimes Region

Fisheries & Oceans   Pêches et Océans

JANUARY 01, 1999

RECREATIONAL SCALLOP LICENCE CONDITION FOR RECREATIONAL LICENCE HOLDERS IN SCALLOP FISHING AREA 29

Pursuant to subsection 22.(1) of the ***Fishery (General) Regulations***, as amended, the following conditions are specified for scallop licence control number ______________ ____________________ while fishing for scallops in Scallop Fishing Area 29 (as defined by the ***Atlantic Fishery Regulations, 1985***).

FISHING SEASON

1. Subject to any variation orders that may be issued and any other restrictions contained within this licence condition including those set out in **SCHEDULE I** attached, these licence conditions are valid for the fishing of sea scallops during the period beginning January 01, 1999 and ending December 31, 1999.

SIZE LIMIT

2. In that portion of Scallop Fishing Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 65°30' W.(Bacarro, Shelburne County)

(a)you are not authorized to catch and retain or have on board a vessel any scallop with the scallop shell height less than 110 mm. (Shell height means the distance from the outer edge of the shell at the midpoint of the hinge to the farthest point on the outer edge of the shell opposite to the hinge, measured in a staright line)

(b)You are prohibitted from landing shucked scallop meats and they must be attached to at least one half of the shell. You must still be able to measure the shell height.

REPORTING REQUIREMENTS

3. Pursuant to section 61 of the ***Fisheries Act*** you are required to provide information concerning your fishing activities in the Scallop Reporting Document for Scallop Fishing Area 29 available from the Department of Fisheries and Oceans. You are also required to complete the document in accordance with the instructions in the reporting document. You are further

required to supply the Department of Fisheries and Oceans with a copy of all monitoring document entries no later than January 20, 2000. You are also required to provide any documents requested by a Fishery Officer immediately upon demand.

Failure to comply with item three (3) will be a relevant factor, as an aspect of conservation and management of scallops, in the decision whether or not a licence and condition of licence for scallops will be issued to you for the year 2000 scallop season.

DISCARDS

4. You are required to return all other species of fish caught incidentally to the water. Every person who catches a fish incidentally shall forthwith return it,

(a)to the place from which it was taken; and

(b)where it is alive, in a manner that causes it the least harm.

FISHING GEAR AND AREAS

5. You are only permitted to fish with the type of gear identified in your licence in the areas and times described in **SCHEDULE I** attached.

6. In addition you are only authorized to fish with or have on board your vessel one gear type (dipnet or diving gear or drag gear) at any time you are fishing.

GENERAL PROVISIONS

7. No person shall engage in any commercial fishing of any kind while engaged in recreational scallop fishing.

8. I requested and received this licence condition in English.

9. I understand and acknowledge these conditions.

10.The licence holder is required to sign this licence condition.

11.The licence holder is required to attach these licence conditions to his/her 1999 scallop licence.

12. Fishers are reminded that it is an offense under the ***Atlantic Fishery Regulations, 1985*** to transport fish caught by another vessel or to put fish on board another vessel without a fish transporting licence.

____________________________ ____________________________

Signature of Licence Holder   Signature of Licencing Authority

____

Date   Place of Issue

PLEASE NOTE: For information regarding areas open or closed to fishing, variation orders, and for clarification of any provisions contained in this licence condition contact your local fishery officer.

SCHEDULE I

DIVING, DRAGGING AND DIPNET
(Pennant Point to Cape North)

1. You are only permitted to fish for scallops by diving, scallop dragging or dipnet in that portion of Scallop Fishing Area 29 east of Longitude 63°39' W. (Pennant Point, Halifax County to Cape North, Victoria County) from January 1, 1999 to December 31, 1999.

DIVING AND DRAGGING
(Pennant Point to Lunenburg/Queens County Boundary)

2. You are only permitted to fish for scallops by diving or scallop dragging in that portion of Scallop Fishing Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 64°34' W (the Lunenburg/Queens Counties boundary) during the period January 01, 1999 to March 31, 1999 except for the following areas which are closed to diving and scallop dragging:

(a) the closed area inside a line beginning at a point at Latitude 44°23.8'N., Longitude 64°14.4'W., thence running in a straight line to a point at Latitude 44°24.8'N., Longitude 64°15'W., (commonly known as the Second Peninsula); and

(b) the closed area inside a line beginning at a point at Latitude 44°20.7'N., Longitude 64°18.4'W., thence running in a straight line to a point at Latitude 44°21.5'N., Longitude 64°19'W. (commonly known as Bayport).

DIPNET
(Pennant Point to Lunenburg/Queens County Boundary)

3. You are only permitted to fish for scallops by dipnet in that portion of Scallop Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 64°34' W (Lunenburg/Queens Counties boudary) during the period January 01, 1999 to April 30, 1999 and November 1, 1999 to December 31, 1999.

DIVING AND DIPNET
(Lunenburg/Queens County Boundary to Bacarro) and (Bacarro Point to Latitude 43°40'North)

4. You are permitted to fish for scallops by diving or dipnet in that portion of Scallop Fishing Area 29 east of Longitude 65°30' W.(Bacarro, Shelburne County) to Longitude 64°34' W (the Queens/Lunenburg Counties boundary) during the period April 1, 1999 to June 30, 1999 and November 1, 1999 to November 30, 1999; and west of Longitude 65°30' W(Bacarro, Shelburne County) and south of Latitude 43°40'North from January 1, 1999 to December 31, 1999.

NOTICE

RECREATIONAL SCALLOP FISHING

The Regional Director -General, Maritimes Region, Department of Fisheries and Oceans, hereby gives notice that the fishing quota for scallops in Scallop Fishing Areas 28A, 28B, 28C and 28D (Bay of Fundy) and Scallop Fishing Area 29 (the Yarmouth County line to Cape North, Victoria County) is varied to be 50 (fifty) scallops;
except for that portion of Scallop Fishing Area 29 in Shelurne County west of Bacarro (Longitude Longitude 65°30'West) and Queens County where the fishing quota is varied to be 25 (twenty-five) scallops.

The Maritimes Region Variation Fishing Quota Order 1998-154 is hereby revoked.

For further information please refer to Variation Order 1999-003 or your local Fishery Officer.

N.A. Bellefontaine
Regional Director-General
Maritimes Region

Fisheries & Oceans	Pêches et Océans

JANUARY 01, 1999

RECREATIONAL SCALLOP LICENCE CONDITION FOR RECREATIONAL LICENCE HOLDERS IN SCALLOP FISHING AREA 29

Pursuant to subsection 22.(1) of the ***Fishery (General) Regulations***, as amended, the following conditions are specified for scallop licence control number _______________ ____________________ while fishing for scallops in Scallop Fishing Area 29 (as defined by the ***Atlantic Fishery Regulations, 1985***).

FISHING SEASON

1. Subject to any variation orders that may be issued and any other restrictions contained within this licence condition including those set out in **SCHEDULE I** attached, these licence conditions are valid for the fishing of sea scallops during the period beginning January 01, 1999 and ending December 31, 1999.

SIZE LIMIT

2. In that portion of Scallop Fishing Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 65°30' W.(Bacarro, Shelburne County)

(a)you are not authorized to catch and retain or have on board a vessel any scallop with the scallop shell height less than 110 mm. (Shell height means the distance from the outer edge of the shell at the midpoint of the hinge to the farthest point on the outer edge of the shell opposite to the hinge, measured in a staright line)

(b)You are prohibitted from landing shucked scallop meats and they must be attached to at least one half of the shell. You must still be able to measure the shell height.

REPORTING REQUIREMENTS

3. Pursuant to section 61 of the ***Fisheries Act*** you are required to provide information concerning your fishing activities in the Scallop Reporting Document for Scallop Fishing Area 29 available from the Department of Fisheries and Oceans. You are also required to complete the document in accordance with the instructions in the reporting document. You are further

required to supply the Department of Fisheries and Oceans with a copy of all monitoring document entries no later than January 20, 2000. You are also required to provide any documents requested by a Fishery Officer immediately upon demand.

Failure to comply with item three (3) will be a relevant factor, as an aspect of conservation and management of scallops, in the decision whether or not a licence and condition of licence for scallops will be issued to you for the year 2000 scallop season.

DISCARDS

4. You are required to return all other species of fish caught incidentally to the water. Every person who catches a fish incidentally shall forthwith return it,

(a)to the place from which it was taken; and

(b)where it is alive, in a manner that causes it the least harm.

FISHING GEAR AND AREAS

5. You are only permitted to fish with the type of gear identified in your licence in the areas and times described in **SCHEDULE I** attached.

6. In addition you are only authorized to fish with or have on board your vessel one gear type (dipnet or diving gear or drag gear) at any time you are fishing.

GENERAL PROVISIONS

7. No person shall engage in any commercial fishing of any kind while engaged in recreational scallop fishing.

8. I requested and received this licence condition in English.

9. I understand and acknowledge these conditions.

10.The licence holder is required to sign this licence condition.

11.The licence holder is required to attach these licence conditions to his/her 1999 scallop licence.

12.Fishers are reminded that it is an offense under the ***Atlantic Fishery Regulations, 1985*** to transport fish caught by another vessel or to put fish on board another vessel without a fish transporting licence.

Signature of Licence Holder

Signature of Licencing Authority

Date Place of Issue

PLEASE NOTE: For information regarding areas open or closed to fishing, variation orders, and for clarification of any provisions contained in this licence condition contact your local fishery officer.

SCHEDULE I

DIVING, DRAGGING AND DIPNET
(Pennant Point to Cape North)

1. You are only permitted to fish for scallops by diving, scallop dragging or dipnet in that portion of Scallop Fishing Area 29 east of Longitude 63°39' W. (Pennant Point, Halifax County to Cape North, Victoria County) from January 1, 1999 to December 31, 1999.

DIVING AND DRAGGING
(Pennant Point to Lunenburg/Queens County Boundary)

2. You are only permitted to fish for scallops by diving or scallop dragging in that portion of Scallop Fishing Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 64°34' W (the Lunenburg/Queens Counties boundary) during the period January 01, 1999 to March 31, 1999 except for the following areas which are closed to diving and scallop dragging:

(a) the closed area inside a line beginning at a point at Latitude 44°23.8'N., Longitude 64°14.4'W., thence running in a straight line to a point at Latitude 44°24.8'N., Longitude 64°15'W., (commonly known as the Second Peninsula); and

(b) the closed area inside a line beginning at a point at Latitude 44°20.7'N., Longitude 64°18.4'W., thence running in a straight line to a point at Latitude 44°21.5'N., Longitude 64°19'W. (commonly known as Bayport).

DIPNET
(Pennant Point to Lunenburg/Queens County Boundary)

3. You are only permitted to fish for scallops by dipnet in that portion of Scallop Area 29 west of Longitude 63°39' W. (Pennant Point, Halifax County) to Longitude 64°34' W (Lunenburg/Queens Counties boudary) during the period January 01, 1999 to April 30, 1999 and November 1, 1999 to December 31, 1999.

DIVING AND DIPNET
(Lunenburg/Queens County Boundary to Bacarro) and (Bacarro Point to Latitude 43°40'North)

4. You are permitted to fish for scallops by diving or dipnet in that portion of Scallop Fishing Area 29 east of Longitude 65°30' W.(Bacarro, Shelburne County) to Longitude 64°34' W (the Queens/Lunenburg Counties boundary) during the period April 1, 1999 to June 30, 1999 and November 1, 1999 to November 30, 1999; and west of Longitude 65°30' W(Bacarro, Shelburne County) and south of Latitude 43°40'North from January 1, 1999 to December 31, 1999.

NOTICE

RECREATIONAL SCALLOP FISHING

The Regional Director -General, Maritimes Region, Department of Fisheries and Oceans, hereby gives notice that the fishing quota for scallops in Scallop Fishing Areas 28A, 28B, 28C and 28D (Bay of Fundy) and Scallop Fishing Area 29 (the Yarmouth County line to Cape North, Victoria County) is varied to be 50 (fifty) scallops;
except for that portion of Scallop Fishing Area 29 in Shelurne County west of Bacarro (Longitude Longitude 65°30'West) and Queens County where the fishing quota is varied to be 25 (twenty-five) scallops.

The Maritimes Region Variation Fishing Quota Order 1998-154 is hereby revoked.

For further information please refer to Variation Order 1999-003 or your local Fishery Officer.

N.A. Bellefontaine
Regional Director-General
Maritimes Region

Canada

SCALLOP REPORT DOCUMENT (INFORMATION BOX ABBREVIATED)
SCALLOP FISHING AREA 29

You must complete this REPORT DOCUMENT if you are fishing for scallops in Scallop Fishing Area (SFA) 29, (a) under a recreational scallop fishing licence or (b) under a commercial scallop fishing licence for a vessel less than 65 feet in length.

Please check the box corresponding to your type of licence:
Recreational Commercial

Name

Licence number

Year

DATE **DATE**	**MONTH**	**Location**	**Gear (for each day fished indicate gear - drag, diving, dip net or tongs)**	**Quantity (number of scallops)**	**Comments**

You must provide this completed report to **Jim Jamieson**, Resource Management Branch, **Fisheries & Oceans, P.O. Box 550, Halifax, NS, B3J 2S7**, no later than twenty days from the conclusion of your fishing season.

Appendix 2. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
47818	R	3	8	1998	Queensport	Diving	50		
47818	R	5	8	1998	Queensport	Diving	50		
47818	R	6	8	1998	Queensport	Diving	50		
47818	R	8	8	1998	Queensport	Diving	50		
47818	R	10	8	1998	Queensport	Diving	50		
47818	R	12	8	1998	Queensport	Diving	50		
47818	R	23	8	1998	Queensport	Diving	50		
47818	R	31	8	1998	Queensport	Diving	50		Diving Completed for 1998
2052	C	4	8	1998	Half Island C.	Drag		18.5	Gear Problems
2052	C	6	8	1998	Half Island C.	Drag		28	
2052	C	7	8	1998	Half Island C.	Drag		31	
2052	C	10	8	1998	Half Island C.	Drag		39.5	
2052	C	11	8	1998	Half Island C.	Drag		32	Bad Weather
2052	C	14	8	1998	Half Island C.	Drag		41	Over 10-15 knot winds; Can't drag
2052	C	21	8	1998	Half Island C.	Drag		35	
2052	C	26	8	1998	Half Island C.	Drag		26	
2052	C	27	8	1998	Half Island C.	Drag		30	5-6 lbs per hour
2052	C	28	8	1998	Half Island C.	Drag		33.5	
2052	C	7	7	1998	Half Island C.	Drag		47.5	
2052	C	8	7	1998	Half Island C.	Drag		39	
2052	C	10	7	1998	Half Island C.	Drag		55	Approx. 61 lbs. per hour
2052	C	11	7	1998	Half Island C.	Drag		27	
2052	C	13	7	1998	Half Island C.	Drag		67	
2052	C	14	7	1998	Half Island C.	Drag		63.5	
2052	C	15	7	1998	Half Island C.	Drag		47	
2052	C	16	7	1998	Half Island C.	Drag		42	
2052	C	17	7	1998	Half Island C.	Drag		29	Windy days
2052	C	21	7	1998	Half Island C.	Drag		31	
2052	C	21	7	1998	Half Island C.	Drag		44	
2052	C	22	7	1998	Half Island C.	Drag		25	Over 15km, wind can't drag
2052	C	27	7	1998	Half Island C.	Drag		38	
2052	C	28	7	1998	Half Island C.	Drag		34.5	
2052	C	31	7	1998	Half Island C.	Drag		58.5	Approx. 61 lbs. per hour
15877	R	3	8	1998	Scaferie Island	Diving	47		Great dive
15877	R	4	8	1998	Scaferie Island	Diving	41		Great dive
15877	R	5	8	1998	Scaferie Island	Diving	50		Great dive. Alot of garbage on bottom old wires & chains.
12374	R	29	4	1998	Heckmans Island	dip net			three scallops
15983	R	15	4	1998	Heckmans Island	dip net	2		Slim pickens -lots of clappers

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
2052	R	2	6	1998	Guyshorough	drag		32	Part-time lab fishing 4&5 hours a day
2052	R	3	6	1998	Guyshorough	drag		26.5	
2052	R	4	6	1998	Guyshorough	drag		18	
2052	R	6	6	1998	Guyshorough	drag		20	
2052	R	9	6	1998	Guyshorough	drag		21	
2052	R	10	6	1998	Guyshorough	drag		24	
2052	R	12	6	1998	Guyshorough	drag		25.5	
7494	R	29	3	1998	Mahone Bay	dip net	41		
SCX127	R	15	3	1998	Upper South C.	dip net	21		
SCX128	R	26	3	1998	Lower South C.	dip net	17		
SCX129	R	12	4	1998	Rose Bay	dip net	5		
SCX130	R	16	5	1998	LaHave I	dip net	25		
5861	R			1998			Nil		Did not fish
7622	R			1998			Nil		Did not fish
53191	R	28	4	1998	Covey Island	dip net	10		
53191	R	29	4	1998	Mahone Bay	dip net	20		
53191	R	30	4	1998	Mahone Bay	dip net	23		
4302	R	1	2	1998	Rouse Island	diving	19		
4302	R	12	2	1998	Hermans Island	diving	31		
4302	R	23	2	1998	Bluff shore	diving	26		
4302	R	11	3	1998	Mash Island	diving	41		
4302	R	21	3	1998	Bill's Island	diving	18		
5734	R	7	2	1998	Indian Point	diving	32		
5734	R	8	2	1998	Zwicker Island	diving	6		
5734	R	28	3	1998	Blue rocks	diving	50		
5734	R	29	3	1998	Blue rocks	diving	12		
39482	R	7	2	1998	Indian Point	diving	50		
39482	R	8	2	1998	Zwicker Island	diving	10		
39482	R	28	3	1998	Blue Rocks	diving	50		
39482	R	29	3	1998	Blue Rocks	diving	50		
39482	R	28	4	1998	Indian Point	diving	3		
11023	R	28	3	1998	Blue Rocks	diving	45		
2052	C	2	4	1998	Guysborough	drag		45.5	Bad weather
2052	C	8	4	1998	Guysborough	drag		26	
2052	C	12	4	1998	Guysborough	drag		45	
2052	C	13	4	1998	Guysborough	drag		40	
2052	C	14	4	1998	Guysborough	drag		34	
2052	C	16	4	1998	Guysborough	drag		25.5	Same amount for time spent
2052	C	19	4	1998	Guysborough	drag		22	
2052	C	25	4	1998	Guysborough	drag		30	
2052	C	26	4	1998	Guysborough	drag		31.5	
2052	C	30	4	1998	Guysborough	drag		18	Getting to old to put in many hours
16372	R			1998				Nil	Did not fish this year
5040	R	7	2	1998	Area 29	dip net	12		

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number Pounds	Comments
8684	R	30	4	1998	Rose Bay	dip net	46	Alot of dead scallops
6536	R	3	1	1998	Zwicker I	dip net	41	
6536	R	30	1	1998	Zwicker I	dip net	18	
6536	R	4	2	1998	Zwicker I	dip net	30	
6536	R	7	2	1998	Spetacul Island	dip net	26	
6536	R	9	2	1998	Spetacul Island	dip net	46	
6536	R	23	3	1998	Spetacul Island	dip net	35	
6536	R	10	4	1998	Spetacul Island	dip net	30	
17097	R	17	1	1998	Martins Point	dip net	32	
17097	R	31	1	1998	Martins Point	dip net	44	
17097	R	7	2	1998	Martins Point	dip net	20	
17097	R	28	2	1998	Martins Point	dip net	7	
34543	R	9	3	1998	Martins Point	dip net	21	
34543	R	26	3	1998	Martins Point	dip net	18	To have a better map showing where to go, that tells you where to dip and where not to dip.
34543	R	8	4	1998	Hermans Island	dip net	50	
34543	R	18	4	1998	Lun Youth Club	dip net	50	
38456	R	14	2	1998	Indian Point	dip net	50	
38456	R	15	2	1998	Indian Point	dip net	48	
38456	R	21	2	1998	Indian Point	dip net	35	
38456	R	23	2	1998	Indian Point	dip net	48	
38456	R	7	3	1998	Indian Point	dip net	45	
38456	R	15	3	1998	Indian Point	dip net	50	
38456	R	28	3	1998	Indian Point	dip net	50	
38456	R	4	4	1998	Indian Point	dip net	50	
38456	R	5	4	1998	Indian Point	dip net	40	
16590	R	15	2	1998	Indian Point	dip net	50	
16590	R	22	2	1998	Indian Point	dip net	40	
16590	R	23	2	1998	Indian Point	dip net	50	
16590	R	8	3	1998	Indian Point	dip net	50	
16590	R	15	3	1998	Indian Point	dip net	50	
16590	R	28	3	1998	Indian Point	dip net	50	
16590	R	4	4	1998	Indian Point	dip net	45	
16590	R	5	4	1998	Indian Point	dip net	40	
16590	R	12	4	1998	Indian Point	dip net	50	
10932	R	23	2	1998	Heckman I	dip net	50	
10932	R	20	3	1998	Heckman I	dip net	24	
10932	R	25	3	1998	Heckman I	dip net	30	
10932	R	8	4	1998	Stonehurst	dip net	20	
10932	R	30	4	1998	Stonehurst	dip net	50	
53184	R	1 to 31	3	1998			Nil	No fishing, water too dirty & windy
53148	R	1 to 15	4	1998			Nil	No fishing
6664	R			1998			Nil	No fishing

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
16851	R	8	3	1998	Martins Point	dip net	20		If I had more time I would have went more
17181	R	25	4	1998	2 Peninsula	dip net	15		
17181	R	30	4	1998	2 Peninsula	dip net	50		
729037604	R	4	4	1998	Lahave I Land	dip net	17		
729037604	R	5	4	1998	Lahave I Land	dip net	6		
10880	R	28	3	1998	Lunenburg	dip net	20		
10880	R	5	4	1998	Lunenburg	dip net	10		
10880	R	18	4	1998	Lunenburg	dip net	15		
10880	R	26	4	1998	Lunenburg	dip net	25		
53183	R & C		4	1998	SFA29	drag	12		
16605	R	27	4	1998	Mahone Bay	dip net	35		
16605	R	29	4	1998	Mahone Bay	dip net	29		
39933	R	23	1	1998	Martins Point	dip net	50		Divers don't leave much for dippers.
39933	R	27	3	1998	Mush Island	dip net	17		
39933	R	28	3	1998	Ralph Bells	dip net	36		
39933	R	29	4	1998	Oak Island	dip net	40		
39933	R	30	4	1998	Oak Island	dip net	22		
17010	R	7	3	1998	Area 29	diving	41		Water 32
17010	R	21	3	1998	Area 29	diving	39		Water 32
17010	R	22	3	1998	Area 29	diving	21		Water 32
17010	R	28	3	1998	Area 29	diving	38		Water 34
17010	R	29	3	1998	Area 29	diving	44		Water 34
17010	R	4	4	1998	Area 29	diving	28		Water clear then came the wind
17010	R	27	4	1998	Area 29	diving	11		Water clear then came the wind
16364	R & C	3	2	1998	Murder's Point	dip net	50		
16364	R & C	9	4	1998	Young Island	dip net	27		
16364	R & C	16	4	1998	Mash Island	dip net	32		
16364	R & C	30	4	1998	Young Island	dip net	28		
39326	R	28	1	1998	Loyd Island	dip net	29		
39326	R	20	2	1998	Herman Island	dip net	32		
39326	R	10	3	1998	Mash Island	dip net	38		
39326	R	3	4	1998	Westers Beach	dip net	14		
39326	R	15	4	1998	Gifford Island	dip net	41		
39326	R	21	4	1998	Anders Island	dip net	35		
39326	R	25	4	1998	Heckmans Island	dip net	24		
39326	R	29	4	1998	Martins Point	dip net	30		
5021		10	3	1998	Stonehuist	dip net	50		
5021		11	3	1998	Stonehuist	dip net	50		
5021		20	3	1998	Stonehuist	dip net	50		
5021		23	3	1998	Stonehuist	dip net	50		
5021		29	3	1998	Stonehuist	dip net	50		
5021		8	4	1998	Stonehuist	dip net	50		
5021		30	4	1998	Stonehuist	dip net	50		

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
11840	R			1998			Nil		Received license late in scallop season didn't get to fish
13179	R	24	1	1998	Mahone Bay	dip net	42		4"-5"
13179	R	31	1	1998	Mahone Bay	dip net	18		5"-7"
13179	R	21	2	1998	Mahone Bay	dip net	37		4"-5
13179	R	7	3	1998	Mahone Bay	dip net	16		4.5"-6"
13179	R	28	3	1998	Mahone Bay	dip net	23		Many sea urchins
731052601	R	20	4	1998	Long Island	dip net	12		
17314	R	19	1	1998	Mahone Bay	dip net	10		
17314	R	20	2	1998	Mahone Bay	dip net	5		
17314	R	6	4	1998	Mahone Bay	dip net	8		
17314	R	23	4	1998	Mahone Bay	dip net	12		
17314	R	24	4	1998	Mahone Bay	dip net	15		
14203	R			1998			Nil		No fishing
2052	C	19	4	1998	Guysborough	drag		35	Bad weather
2052	C	22	4	1998	Guysborough	drag		37	
2052	C	24	4	1998	Guysborough	drag		5	
2052	C	25	4	1998	Guysborough	drag		31	
2052	C	28	4	1998	Guysborough	drag		38	
32327	R			1998		dip net		Nil	I was unable to dive or dip for scallops due to being pregnant. Better luck next year.
715085702	R			1998			Nil		No scallops were fished, due to lack of callops, weather,time
13339	R	5	3	1998	St. Margaret's B.	scuba	50		34 F/good vis
13339	R	18	3	1998	St. Margaret's B.	scuba	50		37 F/poor vis
13061	R						Nil		No diving or dipping relocated to area during season.
16228	R	30	4	1998	2 Peninsula	dip net	33		
5947	R			1998			Nil		No diving done.
13314	R	5	2	1998	Lunenburg	dip net	16		
13314	R	12	2	1998	Lunenburg	dip net	29		
13314	R	27	3	1998	Lunenburg	dip net	11		
13314	R	30	3	1998	Lunenburg	dip net	50		
13314	R	29	4	1998	Lunenburg	dip net	46		
39653	R	30	1	1998	Chester Area	dip net	26		
39653	R	2	2	1998	Chester Area	dip net	42		
39653	R	3	2	1998	Chester Area	dip net	32		
39653	R	9	4	1998	Chester Area	dip net	50		
39653	R	12	4	1998	Chester Area	dip net	50		
39653	R	22	4	1998	Chester Area	dip net	50		
39653	R	30	4	1998	Chester Area	dip net	50		

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Quantity Pounds	Comments
7705	R	17	1	1998	Area 29 Lun. Co.	dive gear		28	
7705	R	8	2	1998	Area 29 Lun. Co.	dive gear		20	
7705	R	28	2	1998	Area 29 Lun. Co.	dive gear		42	
7705	R	14	3	1998	Area 29 Lun. Co.	dive gear		18	
7705	R	29	3	1998	Area 29 Lun. Co.	dive gear		14	
7705	R	5	4	1998	Area 29 Lun. Co.	dip pole	7		
7705	R	27	4	1998	Area 29 Lun. Co.	dip pole	10		
39532	R	2	2	1998		dip net	37		
39532	R	4	2	1998		dip net	42		
39532	R	23	2	1998		dip net	45		
39532	R	19	3	1998		dip net	34		
39532	R	22	4	1998		dip net	48		
39532	R	30	4	1998		dip net	45		
10121	R	12	4	1998	Outer Lunen. B.	dip net	18		
10121	R	30	4	1998	Outer Lunen. B.	dip net	22		
39303	R	13	1	1998	Mash Island	dip net	25		If the divers were made to dip our scallops would come back
39303	R	15	4	1998	Oak Island	dip net	35		
39303	R	25	4	1998	Winters Island	dip net	20		
104	R	14	1	1998	Backmans I.	dip net	14		
104	R	31	1	1998	Little Hermans I.	dip net	11		
104	R	2	2	1998	Little Hermans I.	dip net	9		
104	R	17	2	1998	Rous Island	dip net	17		
104	R	11	3	1998	Loye Island	dip net	28		
104	R	25	3	1998	Little Hermans I.	dip net	29		
104	R	28	3	1998	Covey Island	dip net	31		
104	R	4	4	1998	Rous Island	dip net	33		
104	R	16	4	1998	Peninsula Shore	dip net	47		
31259	R	18	3	1998	Mahone Bay	diving	48		unsure as to where to disposal of remains n shoreline
31259	R	28	3	1998	Mahone Bay	diving	50		
10295	R	18	3	1998	Mahone Bay	diving	48		unsure as to where to dispose of remains on shoreline
10295	R	28	3	1998	Mahone Bay	diving	50		
16303	R	25	3	1998	Long Island	diving	27		
16303	R	26	3	1998	Long Island	diving	48		
16303	R	30	3	1998	Long Island	diving	49		
16303	R	31	3	1998	Long Island	diving	50		
16303	R	16	4	1998	Long Island	dipping	3		
16303	R	30	4	1998	Eastern Points	dipping	17		

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
39531	R	8	1	1998	Mahone Bay	dip net	16		
39531	R	10	1	1998	Mahone Bay	dip net	48		
39531	R	27	1	1998	Mahone Bay	dip net	16		
39531	R	2	2	1998	Mahone Bay	dip net	20		
39531	R	16	2	1998	Mahone Bay	dip net	18		
39531	R	21	2	1998	Mahone Bay	dip net	30		
39531	R	19	3	1998	Mahone Bay	dip net	15		
39531	R	27	3	1998	Mahone Bay	dip net	32		
39531	R	30	3	1998	Mahone Bay	dip net	25		
39531	R	27	4	1998	Mahone Bay	dip net	27		
39531	R	30	4	1998	Mahone Bay	dip net	39		
11800	R	11	1	1998	Queens Country	scuba	40		
11800	R	2	3	1998	Queens Country	scuba	0		
11800	R	28	3	1998	Queens Country	scuba	50		
	R	1	1	1998	Martins River	diving	37		
	R	11	1	1998	Mahone Bay	diving	42		
	R	25	1	1998	Mahone Bay	diving	27		
	R	15	2	1998	Mahone Bay	diving	32		
	R	28	2	1998	Mahone Bay	diving	49		
	R	14	3	1998	Mahone Bay	diving	50		
	R	29	3	1998	Mahone Bay	diving	50		
12147	R	1	1	1998	Mahone Bay	diving	29		
12147	R	11	1	1998	Mahone Bay	diving	36		
12147	R	15	2	1998	Mahone Bay	diving	50		
12147	R	14	3	1998	Mahone Bay	diving	39		
12147	R	29	3	1998	Mahone Bay	diving	41		
16652	R	10	2	1998	Heckmans Island	dip net	24		Bad conditions
16652	R	16	2	1998	Heckmans Island	dip net	12		Same
16652	R	17	2	1998	Heckmans Island	dip net	42		Condition good
16652	R	19	2	1998	Heckmans Island	dip net	12		Condition fair
16652	R	8	3	1998	Heckmans Island	dip net	12		Poor condition
16547	R	28	2	1998	Heckmans Island	dip net	26		
16547	R	30	4	1998	Heckmans Island	dip net	50		
16767	R	7	3	1998	Port L'Hebert	diving	50		Lots of scallops
16767	R	18	3	1998	Port L'Hebert	diving	50		Nice day
16767	R	26	3	1998	Port Midway	diving	50		Water cloudy
150	C	14	3	1998	Lunenburg Bay	drag	22		
150	C	16	3	1998	Lunenburg Bay	drag	37		
150	C	18	3	1998	Rose Bay	drag	102		
150	C	23	3	1998	Rose Bay	drag	25		
150	C	26	3	1998	Rose Bay	drag	70		
150	C	28	3	1998	Rose Bay	drag	98		
11188	R	22	2	1998	Chamcook H.	diving	50		
11188	R	7	3	1998	Chamcook H.	diving	32		
11188	R	28	3	1998	Chamcook H.	diving	19		
11025	R	32	2	1998	Eastern Point	dip net	32		
11025	R	20	3	1998	Eastern Point	dip net	20		

Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
32408	R	27	1	1998	Mahone Bay	dip net	50		
32408	R	30	1	1998	Mahone Bay	dip net	50		
32408	R	31	1	1998	Mahone Bay	dip net	50		
32408	R	2	2	1998	Mahone Bay	dip net	47		
32408	R	17	2	1998	Mahone Bay	dip net	23		
32408	R	21	2	1998	Mahone Bay	dip net	25		
32408	R	8	3	1998	Mahone Bay	dip net	32		
32408	R	27	3	1998	Mahone Bay	dip net	50		
32408	R	12	4	1998	Mahone Bay	dip net	50		
32408	R	16	4	1998	Mahone Bay	dip net	25		
32474	R	26	1	1998	Sacrifice area	dip net	30		
32474	R	27	1	1998	Sacrifice area	dip net	20		Water cloudy
32474	R	3	2	1998		dip net			
32474	R	0	0	1998	Second Pen.	dip net	30		Cloudy
32474	R	21	2	1998	Second Pen.	dip net	37		
32474	R	23	2	1998	Second Pen.	dip net	50		Calm & sunny
32474	R	28	2	1998	Second Pen.	dip net	14		Windy & cloudy
32474	R	7	3	1998	Sacrifice area	dip net			
32474	R	0	0	1998	Sacrifice area	dip net	50		Calm & sunny
32474	R	27	3	1998		dip net			Good sign
32474	R	0	0	1998	Sacrifice area	dip net	45		Small scallops
32474	R	11	4	1998		dip net	36		
32474	R	21	4	1998	50 acres	dip net	50		
32474	R	22	4	1998	50 acres	dip net	50		
32474	R	27	4	1998	50 acres dip net	41			Calm & sunny
32474	R	30	4	1998	50 acres	dip net	50		Calm & sunny, good look out for scallops
16547	R	28	2	1998	Chester	dip net	26		
16547	R	30	3	1998	Chester	dip net	50		
	R	1	2	1998	Area 29	diving	14		Water cold
	R	7	3	1998	Area 29	diving	43		Water clear
7757	R	27	2	1998	Young Island	diving	43		
7757	R	26	3	1998	Young Island	diving	45		
10035	R	15	1	1998	Young Island	diving	50		
10035	R	20	1	1998	Young Island	diving	50		
10035	R	10	3	1998	Young Island	diving	50		
10035	R	11	3	1998	Young Island	diving	50		
10035	R	20	3	1998	Young Island	diving	50		
5843	C	2	2	1998	137780-304389	drag	84		
5843	C	3	2	1998	137780-304389	drag	193		
5843	C	4	2	1998	137780-304389	drag	341		
5843	C	7	2	1998	Back Harbour	drag	42		
5843	C	10	2	1998	137780-304389	drag	117		
5843	C	11	2	1998	137780-304389	drag	248		
5843	C	17	2	1998	Pig Rock	drag	40		
5843	C	1	3	1998	137780-304389	drag	260		

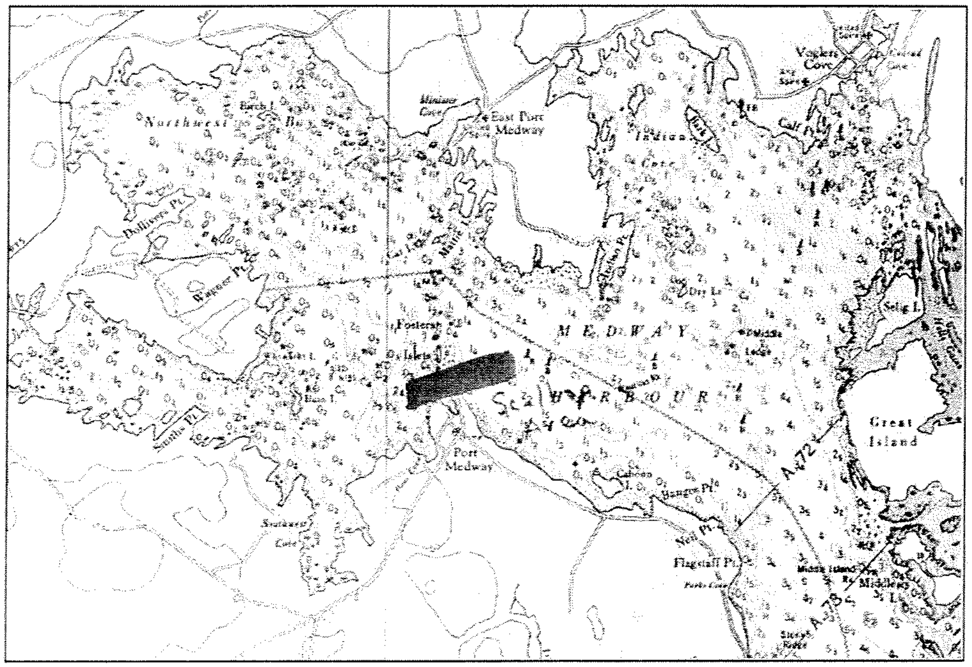
Appendix 2cont'd. 1998 Landing Information for SFA29.

Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number Pounds	Comments
17180	R	14	3	1998	Blue Rocks	diving	14	Water dirty
17180	R	28	3	1998	Mason's Beach	diving	24	Rough, surge
17180	R	30	3	1998	Mosher's Head	diving	50	Old scallops, many clappers
38492	R	22	3	1998	Indian Point	diving	3	Mud Bottom
38492	R	29	3	1998	Mahone Bay	diving	12	Big scallops
15964	R	7	1	1998	Mahone Bay	diving	22	YUMMY!!!
15964	R	8	1	1998	Dublin Bay	diving	22	
15964	R	10	1	1998	Indian Point	diving	29	
15964	R	11	1	1998	Dublin Bay	diving	1 returned	
15964	R	3	2	1998	Dublin Bay	diving	5	
15964	R	4	2	1998	Mahone Bay	diving	30	
15964	R	22	2	1998	Indian Point	diving	3	
15964	R	24	3	1998	Mahone Bay	diving	44	
15964	R	26	3	1998	Mahone Bay	diving	24	
15964	R	27	3	1998	Mahone Bay	diving	18	
15964	R	29	3	1998	Mahone Bay	diving	22	
53183	R & C	31	3	1998	SFA29	drag		No catch
576	C	20	2	1998	441528-642222	drag	420	
576	C	14	3	1998	441528-642222	drag	310	
576	C	18	3	1998	441528-642222	drag	200	
576	C	22	3	1998	441528-642222	drag	240	
576	C	29	3	1998	441528-642222	drag	190	
32410	R	26	3	1998	Westhavers Beach	diving	20	Well spread out
32410	R	28	3	1998	Westhavers Beach	diving	5	
32410	R	29	3	1998	Westhavers Beach	diving	17	
32401	R	24	3	1998	Port l'hebert	diving	50	
32401	R	28	3	1998	Port Midway	diving	50	
32401	R	31	3	1998	Port Midway	diving	50	
17097	R	7	2	1998	Southside Oak I.	dip net	20	
17097	R	28	2	1998	Southside Oak I.	dip net	7	
53184	R			1998				Water to cloudy, no fishing
53183	R & C		2	1998	SFA29			Bad weather
5079	R	17	1	1998	Martin's Pt. Oak I.	dip net	32	
5079	R	31	1	1998			44	
53183	R & C		1	1998				No fishing
129	C	14	1	1998	Stonehurst	drag	50	
226	R		1	1998		dip net		
53184	R			1998				No fishing due to bad weather.
47634	R	15	8	1998	Jeddove Hbr.	diving	25	
47634	R	9	9	1998	Jeddove Hbr.	diving	0	
47634	R	20	9	1998	Jeddove Hbr.	diving	20	
47634	R	9	10	1998	Jeddove Hbr.	diving	40	
6546	R	18	6	1998	Jeddove Hbr.	diving	50	
6546	R	16	7	1998	Jeddove Hbr.	diving	20	
6546	R	24	8	1998	Jeddove Hbr.	diving	20	
6546	R	4	9	1998	Jeddove Hbr.	diving	50	

Appendix 2cont'd. 1998 Landing Information for SFA29.

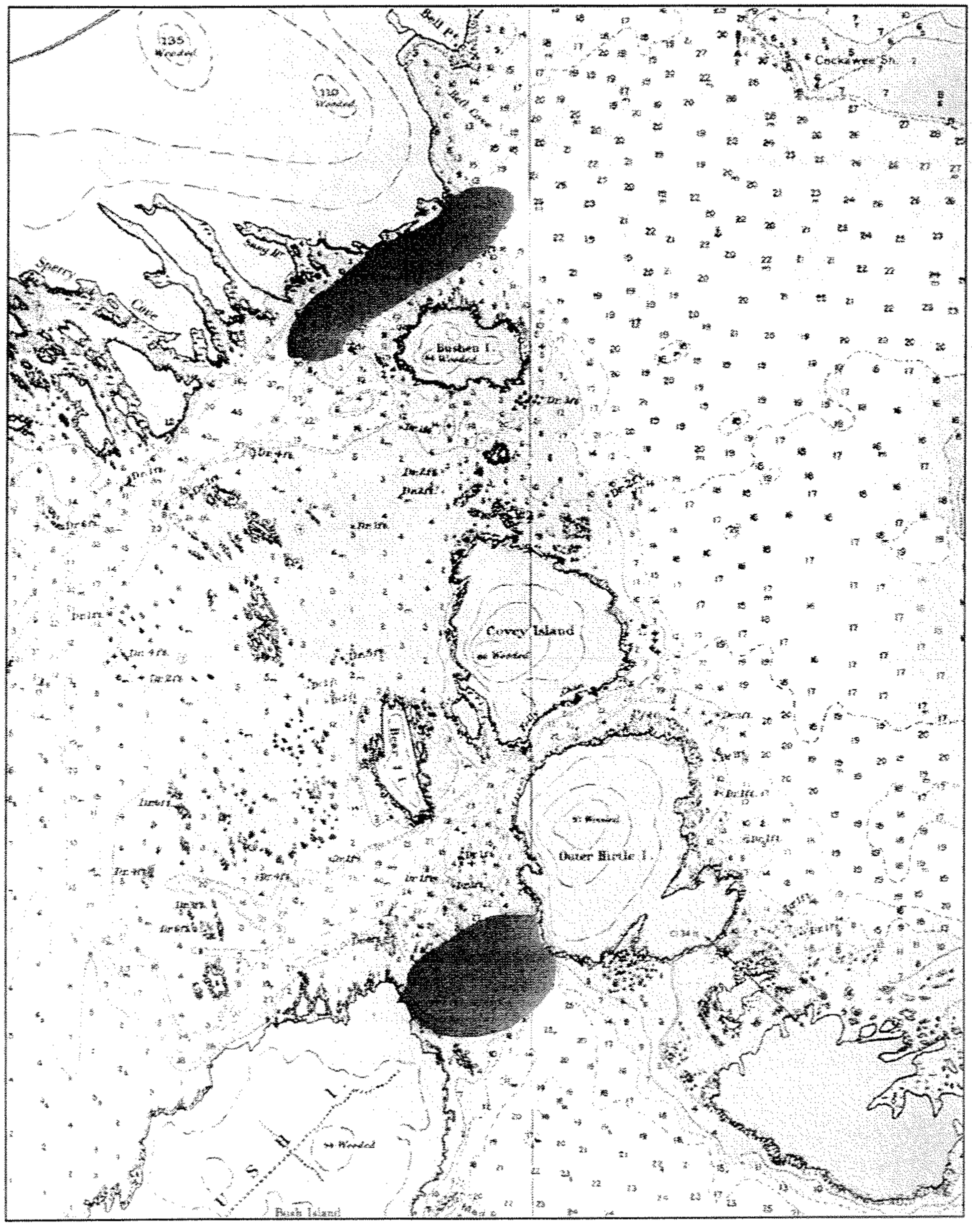
Licence No.	Licence Type	Date Day	Month	Year	Location	Gear	Quantity Number	Pounds	Comments
SCX19ZR							nil		
303	R	21	2	1998	Young Isl.	dip	30		Sorry for late return
303	R	7	3	1998	Narrows dip	50			
303	R	21	3	1998	Narrows dip	40-50			
303	R	4	8	1998	Coveys Isl	dip	18		
303	R	12	8	1998	Coveys Isl	dip	20		

Appendix 3. Location of Scallop Beds in Specified Areas of SFA29 as Indicated by Fishermen. Scallop Beds are Shaded Gray.



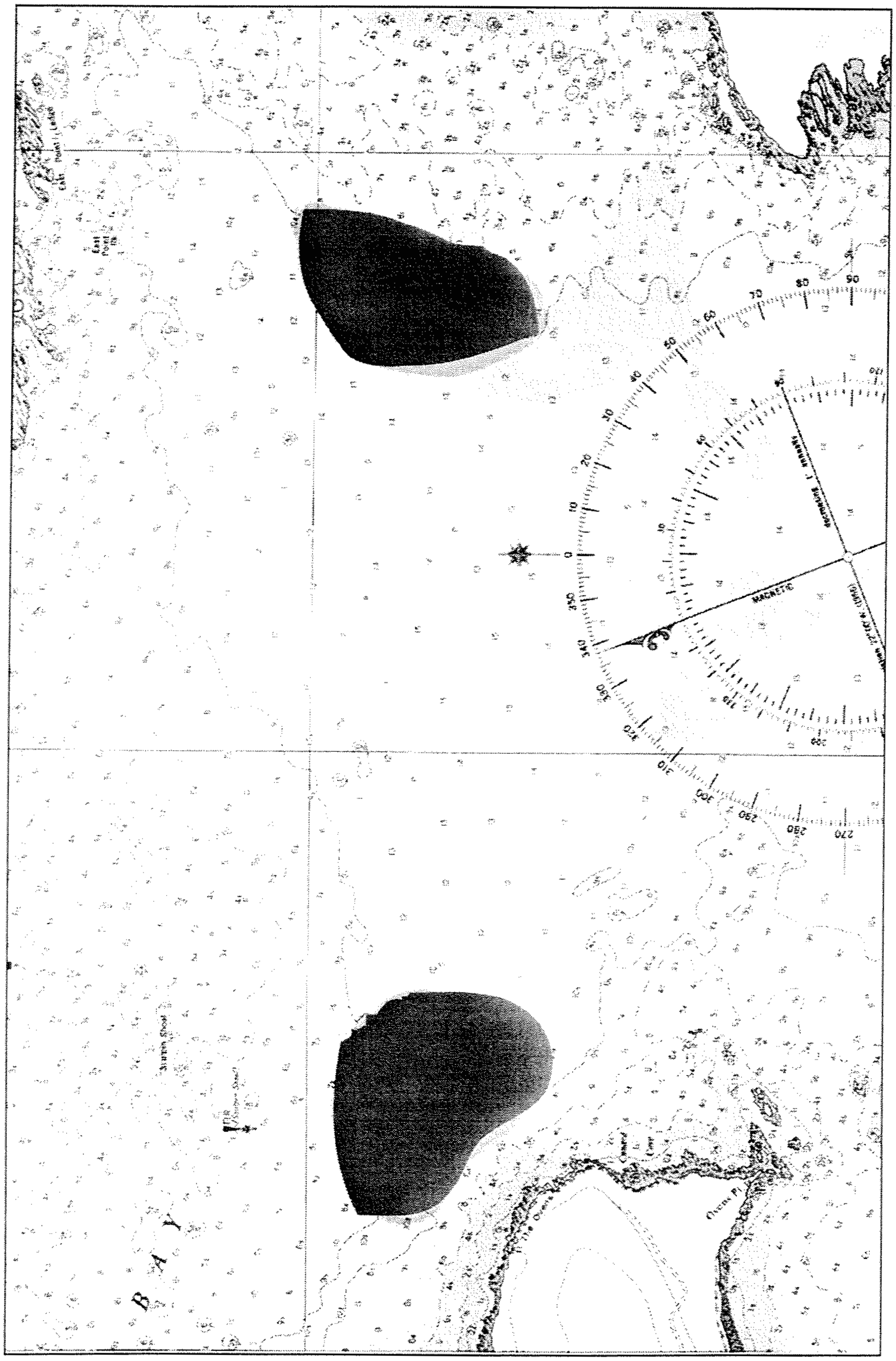
Medway, Lunenburg County, Nova Scotia (soundings in fathoms).

Appendix 3 cont'd. Location of Scallop Beds in Specified Areas of SFA29 as Indicated by Fishermen. Scallop Beds are Shaded Gray.



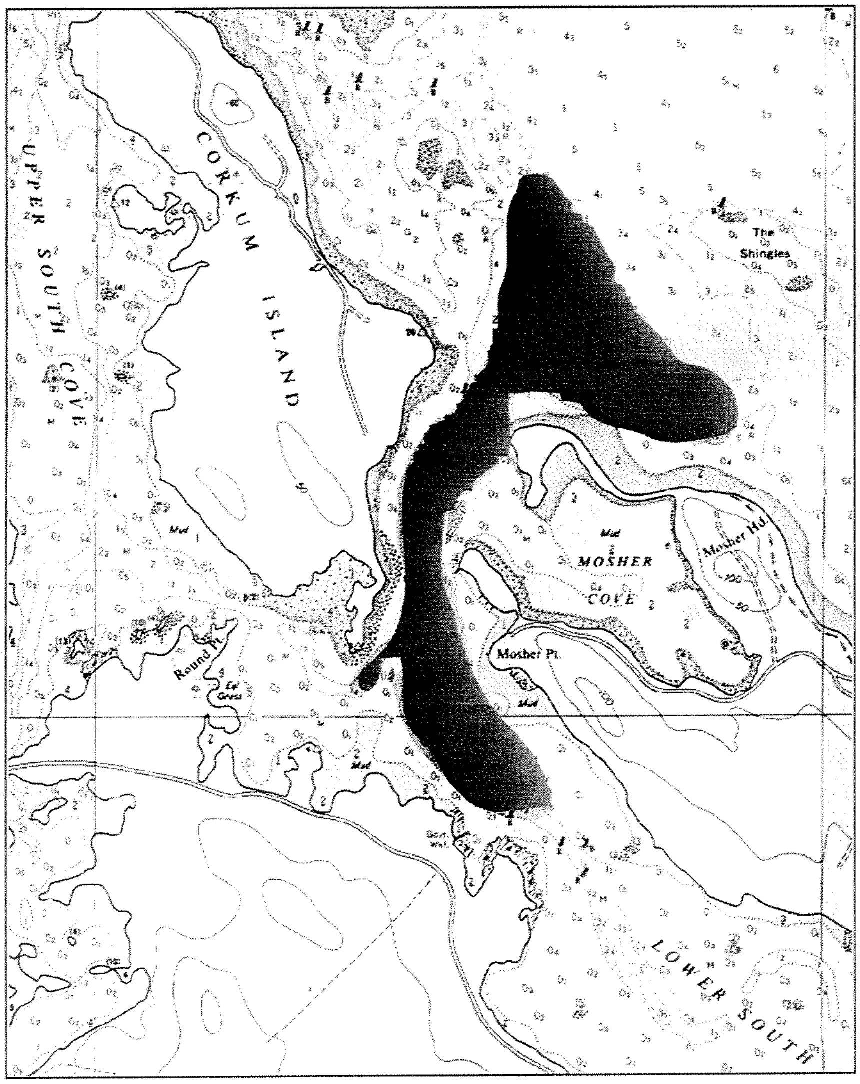
LaHave, Lunenburg County, Nova Scotia (soundings in feet).

Appendix 3 cont'd. Location of Scallop Beds in Specified Areas of SFA29 as Indicated by Fishermen. Scallop Beds are Shaded Gray.



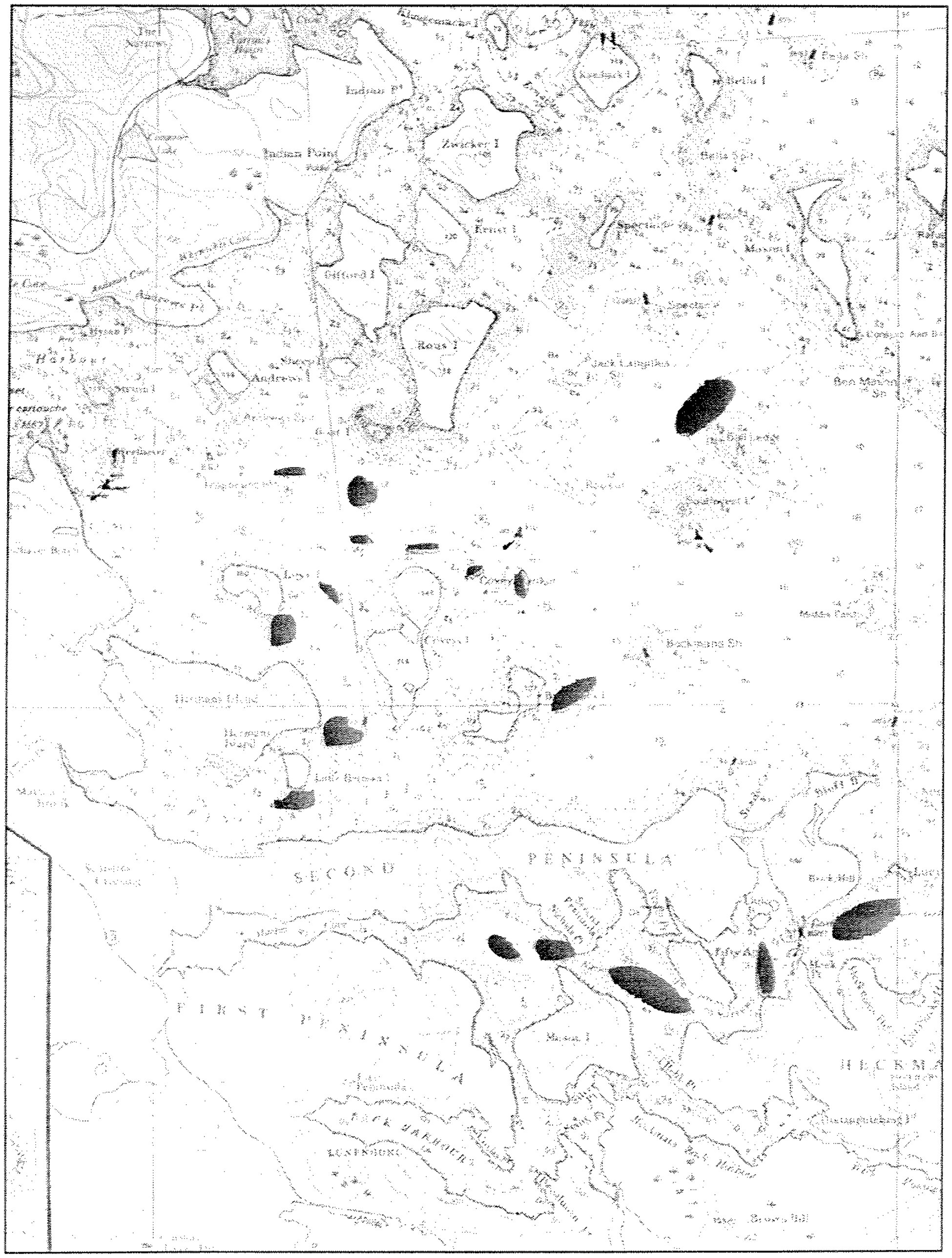
Lunenburg (The Ovens), Lunenburg County, Nova Scotia (soundings in fathoms).

Appendix 3 cont'd. Location of Scallop Beds in Specified Areas of SFA29 as Indicated by Fishermen. Scallop Beds are Shaded Gray.



Mosher Cove, Lunenburg County, Nova Scotia (soundings in fathoms).

Appendix 3 cont'd. Location of Scallop Beds in Specified Areas of SFA29 as Indicated by Fishermen. Scallop Beds are Shaded Gray.



Second Peninsula, Lunenburg County, Nova Scotia (soundings in fathoms and feet).