Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 99/197

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 99/197

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Review of the Area 7 Manila Clam Fishery

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ISSN 1480-4883
Ottawa, 1999

Canada

Abstract

The Area 7 clam fishery commenced in the winter of 1992/93. The fishery was managed under a total allowable catch of 113.6 t for each of Manila, littleneck and butter clams. There was one insignificant landing of littlenecks, and no butter landings. Manila landings peaked at 114.1 t in 1994/95, and averaged 73.5 t per season through 1998/99. This report reviews the development of the fishery, collects and interprets survey activities by the Heiltsuk Fisheries Program and Fisheries and Oceans Canada, characterizes stock status, assesses the effect of the fishery on stock status, and provides recommendations for continuation of a sustainable Manila clam fishery in the area.

A relatively small number of subareas have sufficiently regular recruitment to support a sustainable fishery. Most other subareas showed patterns of initial depletion of accumulated stocks, with limited recovery. Seven subareas were unfished or had extremely limited landings, although they had been open for several years.

The paper recommends a reduction in the total allowable catch to a level below average annual production, continuation of the assessment program, development of harvest log cards to obtain catch and effort information, and in-season monitoring of the fishery.

Résumé

La pêche de la palourde dans la zone 7 a débuté pendant l’hiver de 1992-93. La pêche a été gérée par l’imposition d’un total autorisé des captures de 113,6 t pour, respectivement, les palourdes japonaise, du Pacifique et jaune. Il y a eu un débarquement négligeable de palourde du Pacifique et aucun débarquement de palourde jaune. Les débarquements de palourde japonaise ont atteint un maximum de 114,1 t en 1994-95 et la moyenne saisonnière pour la période se terminant en 1998-99 a été de 73,5 t. On trouve dans le rapport une description du développement de la pêche, une présentation et une interprétation des relevés réalisés dans le cadre du Programme des pêches des Heiltsuk et par Pêches et Océans Canada, une description de l’état des stocks, une évaluation de l’incidence de la pêche sur l’état des stocks et des recommandations pour la poursuite d’une pêche durable de la palourde japonaise dans cette zone.

Un nombre relativement faible de sous-zones présentent un recrutement suffisamment régulier pour alimenter une pêche durable. La plupart des autres sous-zones ont subi un appauvrissement initial des stocks accumulés suivi d’un rétablissement limité. Sept sous-zones n’ont pas été exploitées ou ont donné lieu à des débarquements extrêmement faibles, en dépit du fait que la pêche y soit autorisée depuis plusieurs années.

Il est recommandé que l’on réduise le total autorisé des captures à une valeur inférieure à la production annuelle moyenne, que l’on poursuive le programme d’évaluation, que l’on utilise des cartes d’enregistrement afin d’obtenir des renseignements sur les captures et l’effort et que l’on procède à une surveillance de la pêche en cours de saison.

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Introduction

Intertidal clams have long been a traditional source of food for First Nations people in British Columbia (B.C.), and have supported commercial fisheries since the late 1800s (Quayle and Bourne 1972). In the late 1970s, market demand in the commercial fishery shifted to live steamer clams, both Manila, *Venerupis philippinarum*, and native littleneck, *Protothaca staminea*, clams, from the traditional fishery for butter clams, *Saxidomus gigantea*. The intertidal clam fishery currently focuses on Manila clams, with relatively minor landings of littlenecks, butters, and razor clams, *Siliqua patula* (Figure 1).

Intertidal clam fisheries in the North Coast of B.C., Pacific Fishery Management Areas (PFMA) 1-10, have been closed since 1963 due to Paralytic Shellfish Poisoning (PSP), and the lack of monitoring programs to detect hazardous algal blooms and elevated levels of faecal coliform contamination. Surveys conducted in the early 1990's identified significant populations of Manila clams that might support commercial harvest. The pilot Manila clam fishery in Area 7 exists through special arrangements for water quality certification and monitoring.

This report reviews development and performance of the pilot clam fishery in Area 7, reviews survey efforts by Fisheries and Oceans Canada (DFO) and the Heiltsuk Fisheries Program (HFP), characterizes stock status, assesses the effect of the fishery on stock status, and provides recommendations for continuation of a sustainable Manila clam fishery in the area.

Manila Clam Biology

Manila clams, also called Japanese littlenecks, are not native to British Columbia. The first specimens found in Ladysmith Harbour in 1936 (Quayle 1964) were described as a new species, *Paphia bifurcata* (Quayle 1938). It was decided they were accidentally introduced into British Columbia with seed of the Pacific oyster, *Crassostrea gigas*, from Japan (Quayle 1941; Bourne 1982). They quickly spread throughout Georgia Strait and, after introduction into Barkley Sound, spread up the west coast of Vancouver Island (Quayle 1964). Intentional introductions in the North Coast and Queen Charlotte Islands failed to produce sustainable populations (Gillespie and Bourne 1998, Gillespie and Bourne 2000). Recruitment into the North Coast is believed to have come into the area as pelagic larvae from Quatsino Sound (Bourne 1982).

In the South Coast, Manila clams soon became of economic importance and were gradually accepted by the commercial fishery (Quayle and Bourne 1972). Landings increased dramatically in the 1980's and peaked in 1988 at 3,909 t (Figure 1). Landings subsequently decreased, and currently are stable at around 1,000 t/yr. Decreased landings are a result of more restrictive management measures in response to concerns of overharvest, decreased opportunity due to toxic algal blooms and loss of beaches to faecal contamination (Webb and Hobbs 1997). Exploratory surveys in the early 1980's first found Manila clams in the area around Waglisla, and subsequent surveys have attempted to define the northern limit of their distribution in B.C., presently the head of Laredo Inlet, 52°59'N (Gillespie and Bourne 2000).

Manila clams are found in the upper half of the intertidal zone in B.C., in mixed substrates of mud, sand and gravel (Quayle 1960). No subtidal populations of Manila clams have been found in B.C. (Bernard 1983). They live shallow in the substrate, and are susceptible to extremes of temperature, including catastrophic mortalities ("winter kills"). These occur when low tides coincide with low air temperatures and strong winds (Bower *et al*. 1986; Bower 1992).

Sexes are separate and at spawning, gametes are released into the water column, where fertilization occurs. Spawning usually occurs between June-September in the Strait of Georgia (Bourne 1982). The planktonic period is approximately three to four weeks, depending upon temperature and availability of food, after which larvae settle and take up an infaunal existence. Recruitment, the introduction of adults into a population, is variable due primarily to environmental conditions (Bourne 1982; Quayle and Bourne 1972). Size at first maturity is 20-25 mm total length (TL) (Holland and Chew 1974). Fecundity increases with size, with estimates ranging from 432,000 eggs/female at 20 mm TL to 2,350,000 eggs/female at 40 mm TL for a population in Hawaii (Yap 1977), and 188,000 eggs/female at 19 mm TL to 1,503,000 eggs/female at 42 mm TL in China (Ponurovsky and Yakovlev 1992). Maximum size of 75 mm TL occurs after 8-10 years, and maximum age in B.C. is 14 years (Bourne 1987). Age at recruitment to legal size (38 mm TL) varies from beach to beach and between areas on a single beach, depending on tidal height and substrate conditions. Under optimal conditions, Manila clams can reach legal size in approximately 3-4 years in Georgia Strait (Quayle and Bourne 1972; Bourne 1982), 4 years on the west coast of Vancouver Island (Bourne and Farlinger 1982), and 3-4.5 years in the North Coast (Bourne and Cawdell 1992; Bourne *et al*. 1994; Bourne and Heritage 1997; Heritage *et al*. 1998).

Warmer water temperatures in the South Coast have allowed Manila clams to become established there (Bourne 1982). However, even in the South Coast, Manila clam recruitment can be irregular (Gillespie *et al*. 1998). Early surveys in Area 7 indicated that recruitment was erratic, and that close management would be required to ensure a sustainable fishery (Bourne and Cawdell 1992; Bourne *et al*. 1994; Heritage *et al*. 1998).

The Area 7 Clam Fishery

In 1988, the Heiltsuk Tribal Council (HTC) requested establishment of a clam fishery in the North Coast. Exploratory surveys conducted by DFO in 1990 (Bourne and Cawdell 1992) indicated there were harvestable densities of Manila clams on beaches in the Waglisla area. Based on this information, and after consultation with the HTC, DFO established a pilot communal commercial fishery for the Heiltsuk First Nation in Area 7.

In 1993, the Heiltsuk Clam Fishery Agreement was drafted and ratified, allowing a framework for co-operative management of a pilot fishery that covered aspects of licencing, regulation, monitoring, PSP sampling and enforcement. This agreement was a sub-agreement to the main Fisheries Agreement and was amended in subsequent years until its expiration on March 31, 1999. The sub-agreement was not renewed until an assessment of the sustainability of the commercial fishery was completed.

Fishery Management Framework

Under the original agreement, participation in the clam fishery was restricted to 75 Heiltsuk First Nation members, with 50 of those participating in Manila harvest and 25 in littleneck harvest. As with diggers in the South Coast, they were required to carry a Fisher's Registration Card while harvesting as well as a licence issued by the HTC. Through an enforcement protocol set out in the main fisheries agreement, monitoring and enforcement of the fishery is done primarily by the Heiltsuk Guardians, with local C&P staff providing expertise in enforcement when required.

Management plans included total allowable catches (TAC's) of 113.6 t (250,000 lb) for each of three species: Manila, littleneck and butter clams. However, landings have been almost exclusively Manilas. Little interest was shown in landing littleneck clams, and none in butter clams. The lack of interest is primarily economic; prices offered for littleneck and butter clams are less than Manilas, and fishers decline to harvest for the prices offered (HFP 1998). In 1993/94, 1994/95 and 1996/97, pre-harvest samples of butter clams indicated PSP levels above human health standards, and the butter fishery was postponed (HFP 1994, 1995, 1997). Similar problems affected some subareas in 1995/96 (HFP 1996).

Clams are harvested during low tides, which in the winter are primarily early in the morning or late at night. The processing plant in Waglisla receives all harvests and they are marketed through buyers in the South Coast. Size limits in the fishery are consistent with regional standards, as are requirements for tagging sacks and wet storage of clams. However, lack of information regarding recruitment patterns of Manila clams in the North Coast has raised concern that a minimum size limit, as the only management tactic, may not be sufficient to ensure sustainability of the fishery.

The co-management plan developed by the HTC and DFO requires the HTC to provide catch, effort and assessment information on Manila, littleneck and butter clams in the areas open to harvest. Survey work was carried out by HFP, in consultation with DFO Stock Assessment personnel, but the documentation and results of these surveys were not forwarded to DFO, and inconsistencies in methods and documentation have limited the utility of the survey results. Catch and effort reporting has similarly suffered due to lack of continuity in standards and methods.

In 1996, an amending agreement required that quota recommendations be developed and reviewed through the Pacific Stock Assessment Review Committee (PSARC). In 1998, after reading statements in the HFP annual report, DFO Fish Management questioned whether the 113.6 t (250,000 lb) quota was sustainable. Stock status information was not available from either DFO or HFP to evaluate sustainability. Because the Heiltsuk were suggesting that new subareas needed to be opened to sustain harvest levels, DFO managers were concerned that the open areas for the fishery may have been depleted, and that the fishery was not sustainable. Managers were particularly concerned that beaches in subareas closest to Waglisla had experienced the heaviest fishery pressure, and that recruitment and growth rates had not been sufficient to offset harvests.

Water Quality Monitoring

Under the Canadian Shellfish Sanitation Program, there are requirements for growing water quality testing. These surveys are conducted on a three year rotation by Environment Canada, with funding assistance from the HTC. There are a number of areas around Waglisla that have been designated as closed to harvesting due to contamination (Table 1). The last growing water surveys were completed in 1997, and the area is due for re-testing in 2000.

A biotoxin monitoring program is carried out by the HFP, in conjunction with the Canadian Food Inspection Agency (CFIA), to ensure that PSP contaminated shellfish do not present a human health risk. HFP staff establish mussel monitoring stations, and collect and send samples to CFIA in Vancouver. Stations were sampled every week in the summer (April 1 to October 30), and every other week in the winter (November 1 to March 31). In 1997/98, sampling stations were established at Reid Passage (7-9), Grief Island (7-12), Troup Passage (7-15), Spirit Island and Lizzie Cove (7-17), Wakesiu Passage (7-21), Dundivan Inlet (7-22), Gow Island (7-23), Raymond Passage (7-24), Sans Peur Pass (7-25) and Raby Islets (7-32). In addition to mussels, samples of shellstock (geoduck viscera, littleneck and butter clams) were assessed for levels of PSP.

Assessment of Stock Status

Methods

Landings

For each delivery in the 1992/93 to 1996/97 seasons, all clams were weighed and the data recorded by subarea and digger. The data were relayed to DFO after each season. Due to many problems, collection of weights by subarea was not completed consistently in the last two seasons.

During the short 1997/98 season, personnel present during the first three deliveries collected weight by subarea data for each fisher. For the final delivery, weight by subarea data was not collected. This information was obtained from fisher’s log cards by proportioning catch for each subarea from the fishers’ total landings.

During the 1998/99 season no clam weights were separated by subarea. Subarea landings were estimated using fisher’s log cards to proportion total landings by each fisher. This process was complicated by inconsistent use of units to record landings on log cards, and, in some instances, total landings.

DFO Exploratory Surveys (1990-1996)

In 1990, DFO began a series of exploratory surveys to determine distribution, abundance and biological characteristics of intertidal clams in the North Coast. Portions of Area 7 related to the pilot fishery were examined in 1990 (Bourne and Cawdell 1992), 1991 (Bourne *et al*. 1994), 1994 and 1996 (Heritage *et al*. 1998) (Table 3).

The 1990 survey (Bourne and Cawdell 1992) examined beaches in St. John Harbour (PFMA 7-32), Seaforth Channel (7-12), Joassa Channel (7-23), Lama Passage, Hunter Channel and Gunboat Passage (7-17), Raymond Passage (7-24) and the McNaughton Group (7-25). The 1991 survey (Bourne *et al*. 1994) examined beaches in Seaforth Channel (7-12), Spiller Channel (7-13), Return Channel (7-15), Gale Passage (7-21), Thompson Bay (7-19), Stryker Island (7-18), Louise Channel (7-23) and Spider Anchorage (7-27). The 1994 survey (Heritage *et al*. 1998) examined beaches in Troup Passage (7-15), Gunboat Passage (7-17), Spiller Channel (7-13) and Bullock Channel (7-14). The 1996 survey (Heritage *et al*. 1998) examined beaches in Kakushdish Harbour (7-17), Return Channel (7-15), Bullock Channel (7-14), Troup Passage (7-15), Gale Passage (7-21), and Joassa and Louise Channels (7-23).

In these surveys, emphasis was placed on visiting as many beaches in an area over the course of a tidal cycle to gather information on the distribution and extent of Manila clam populations along as much of the coast as possible, rather than developing statistically rigorous stock estimates. Beaches were selected for survey by examining charts or from previous knowledge, information provided by Fishery Officers or local knowledge.

At the time of sampling, a brief exploration was made of each beach to assess the presence or absence of intertidal clams and determine the approximate area of the clam bearing part of the beach. Slope, type of substrate, and estimated area of beaches were recorded .

Considerable exploratory digging was undertaken on many beaches. Exploratory quadrats (generally 0.25 m^2) were dug in sand-gravel areas in the mid intertidal area to determine the presence or absence of Manila clams and to delineate the extent of the area inhabited by Manila clams. If Manila clams were found in these areas, survey quadrats were established in order to make an accurate assessment of the population. Scattered survey quadrats of 0.25 m^2 were dug with rakes or scrapers to a depth of 15 cm. The substrate was worked through the fingers and reworked back into the quadrats. All detectable clams were removed, placed in plastic bags and labelled for later measurement.

Total length (TL) of each clam from sampled quadrats was measured to the nearest millimeter (mm) with vernier calipers. Age of all Manila clams was determined by interpreting and counting annuli (Quayle and Bourne 1972). Shell length was measured to the nearest mm at each annulus of a pooled sample of Manila clams from all areas and littleneck clams from most areas that showed normal growth (i.e. were not stunted). Means and standard errors of shell lengths at annuli were calculated. This provided growth rates for the unstunted portion of Manila clam populations at all locations. Length-weight relationships were calculated for Manila clams when use of an analytical balance allowed.

HFP Assessment Surveys (1992-1997)

The HFP undertook assessment surveys of clam stocks on selected beaches within the pilot fishery area beginning in 1992 (Table 4). Resulting data from 43 surveys were recovered from HFP files in 1998, proofed and collated, and forwarded to DFO Stock Assessment for subsequent analysis.

Survey methodology changed from year to year. In general, survey areas were not determined *a priori*, and no randomization was used in the design of surveys. Quadrat size was 0.25 m^2, although this was not explicitly reported for the 1995 surveys. All clams were excavated from the quadrats, measured for total length, and returned to the beach. The resulting length by species data from each quadrat were collated to provide counts of legal and sublegal Manila, littleneck and butter clams, and total counts of other species.

In 1992, quadrats were arranged in a semi-systematic design involving transects placed across the beach. In most cases, survey areas were not well documented, and had to be estimated later. One survey, Soulsby Point 1, appeared to utilize randomly selected quadrat locations (*i.e.*, no pattern for quadrat placement could be determined), but the method used to select the locations was not documented. No data were available for two surveys in Canal Bight and one in Bachelor Bay.

In 1993, various surveys utilized either a semi-systematic transect design or apparently random selection, although in some cases design and quadrat locations were not documented. In most cases, the survey area was not recorded, and was estimated later. Only counts of legal and sublegal clams were recorded for three surveys in 1993: Rainbow Island 4, Kakushdish Harbour 1 and Kakushdish Harbour 2 (*i.e.*, no length data were recorded). No data were available for surveys in Hunter Channel and at Kingsley Point.

In 1994, survey designs were either semi-systematic transects or purposive sampling (*i.e.*, quadrat locations were deliberately selected, without randomization). No documentation was available for the survey at Odin Cove.

Although HFP annual reports indicate that no survey activities were undertaken in 1995 (HFP 1996), length data by quadrat and field notes were found for a survey at Kakushdish Harbour 4; data but no supporting documentation for surveys at Troup Passage, Odin Cove and Dearth Island; and field notes but no data for surveys at Kakushdish Harbour 2, Rainbow Island 2 and two beaches in Yeo Cove. In two cases, field notes indicated that quadrats were abandoned if they did not yield “enough clams”, indicating that data were collected selectively only where abundances were high. This renders calculation of mean estimates of density meaningless, leaving only maximum density and length frequency data.

In 1996, the only survey documentation found, field notes for a survey at Rainbow Island on March 22, indicated that a semi-systematic transect design was utilized. Although not equivocal, the quadrat labelling format may indicate that other 1996 surveys utilized a similar design. No data were available that matched the survey location and date from the field notes.

In 1997, data were available from 10 surveys, but no documentation of design was found.

HFP Index Beach Surveys (1999)

In the summer of 1999, HFP and DFO developed a program to conduct regular assessments on index beaches within subareas that provided the greatest production. Beach selection was based on discussions with HFP staff and fishers, and previous survey history. The ten beaches selected, and the subareas they represent, were: Bachelor Bay 1 and Odin Cove (7-12), Troup Passage (7-15), Kakushdish Harbour 1/2 (a design that combined historic beaches 1 and 2, considering each beach as distinct strata), Kakushdish Harbour 5 and Rainbow Island 3 (7-17), Gale Passage 2 and Gale Creek (7-21), Joassa Channel (7-23), and Raymond Passage (7-24).

Survey methodology followed Gillespie and Kronlund (1999). Beaches were pre-surveyed to determine the spatial limits of clam abundance, and divided into strata. Each stratum was randomly sampled at a rate of 30 quadrats/ha, with a minimum of 5 quadrats taken in small strata. Quadrat size was 0.25 m^2. All species and sizes were collected, and transported to a lab for processing.

Samples were divided into species, and those species managed with a size limit further divided into legal and sublegal size classes. The number and aggregate weight of each species/size class was recorded for each quadrat. Quadrats were selected randomly from each stratum until a biological sample of at least 200 Manila clams was obtained. These clams were measured for individual weight and TL (to the nearest mm), and age determined by interpreting and counting annual rings on the exterior of the shell (Quayle and Bourne 1972). Age and length frequency distributions were tabulated and graphed.

Mean density, in terms of abundance and biomass, and estimates of total abundance and total biomass were prepared using the methods of Gillespie and Kronlund (1999). At the time of writing, a report is in progress and will be submitted when complete.

Qualitative Examination of General Trends

Overall Fishery Performance

The Heiltsuk clam fishery has completed seven seasons, starting in 1992/93. The fishery usually lasts from November to March. In 1997/98, agreement on a management plan could not be reached, and the season did not open until January of 1998.

Landings have consisted almost exclusively of Manila clams. Minor landings totalling 1.1 t (2,459 lb) of littleneck clams occurred in 1993/94, but prices were insufficient to attract digger interest (HFP 1994). Price considerations and retention of PSP by butter clams have limited interest in a commercial butter clam fishery.

Manila clam landings have fluctuated between a low harvest of 25.4 t (55,927 lb) in 1997/98 season to a high of 114.1 t (251,035 lb) in 1994/95 season; averaging 73.5 t (161,629 lb) (Table 2). Peak landings coincided with the opening of 7 new subareas (7-8, 7-13, 7-15, 7-22, 7-25, 7-27 and 7-28), which accounted for 55% of that years' harvest. Low landings were a result, at least in part, to reduced harvest opportunity due to a shortened season when co-management discussions continued into January 1998 before agreement was reached and the fishery opened.

The only significant loss of opportunity due to PSP closures was the complete closure of Subareas 7-15 and 7-17 for the balance of the 1995/96 season (Subareas 7-27 and 7-28 were also closed for the entire season, but were not major harvesting areas).

Subareas 7-17 (Gunboat Passage/Hunter Channel/ Lama Passage), 7-21 (Gale Passage), 7-15 (Troup Passage/Return Channel) and 7-12 (Seaforth Channel) accounted for 22.6%, 20.1%, 17.0% and 15.8% of the total landings, an aggregate contribution of 75.5%. Subareas 7-18 (Tribal Group), 7-25 (Queens Sound) and 7-32 (St. John Harbour) have each recorded landings in one year only; <0.1 t (<200 lb) each for the first two and approximately 0.7 t (1,600 lbs) in the 1998/99 season from the last. Subareas 7-19 (Thompson Bay), 7-20 (Wakesiu Passage), 7-27 (Lower Kildidt Sound) and 7-28 (Upper Kildidt Sound) have no reported landings, though all have been open to the fishery for at least five seasons.

Various problems prevent direct assessment of population trends from historic survey information, including inconsistent choice of beaches within subareas; inconsistencies in the data collected (lengths only, or in some cases numbers only from HFP surveys); survey designs that are poorly documented (early HFP surveys) or that preclude simple calculation of mean densities (DFO exploratory surveys and some HFP surveys). The following section draws together landing information and survey results to develop a qualitative description of population trends within each subarea.

Subarea 7-8 (Berry Inlet)

Due to a misunderstanding of PFMA subarea boundaries, most if not all landings reported from PFMA 7-8 were from Reid Passage in PFMA 7-9. Peak landings of 5.9 t were reported in 1994/95, the first season the area was open to fishing (Table 2; Figure 5). Average landings over the five seasons the area was open were 2.4 t. Due to peak landings in the first year of harvesting, there appears to be a general decreasing trend, although landings may be too small to consider the trend meaningful.

Subarea 7-12 (Seaforth Channel)

Peak landings of 24.1 t were reported in 1992/93, the first season the area was opened for fishing (Table 2; Figure 6). Average landings over the seven seasons the area was open were 11.6 t. Landings declined from 1992/93 to 1995/96, with some increased production in 1996/97 and 1998/99. Low landings in 1997/98 were due in part to the late start and short season.

Manila clams were not abundant on two beaches examined at Dearth Island by DFO in 1990 (Table 3). Maximum abundance was 56 clams/m^2. Length information was unavailable, but the age distribution was dominated by the 1984 year class (6 year-olds). Manila clams were abundant in Ormidale Harbour and Ardmillan Bay, with maximum densities of 392 and 300 clams/m^2, respectively. Length frequency distribution from Ormidale Harbour was similar to other areas surveyed, dominated by legal-sized clams (≥38 mm TL). The length frequency distribution from Ardmillan Bay had considerably more sublegal clams. Age data were pooled with Norman Morrison Bay, and the resulting distribution was roughly bimodal, With a large mode made up of 1987 and 1986 year classes (3-4 year-olds), and a smaller mode made up of 1984 and 1983 year classes (6-7 year-olds).

DFO surveys in 1991 indicated that Manila clams were present in the Foote Islands, but maximum density was 4 clams/m^2. Manilas were abundant in Wigham Cove, with a maximum density of 252 clams/m^2 recorded. Length and age data were combined with beaches in Yeo Cove and Return Channel. Eighty-four percent of the clams measured were legal size, and the age distribution was dominated by the 1985 and 1986 year classes (5-6 year-olds).

HFP surveys in 1992 indicated that Manila clams were abundant at Defeat Point, with densities of 0-560 clams/m^2 recorded (Table 5). The mean density was 182.7 clams/m^2, 45% of the clams measured were legal size and few clams were < 29 mm TL. Manila clams were also abundant at Ardmillan Bay, with densities of 0-348 clams/m^2 recorded. The mean density was 73.8 clams/m^2, 37% of the clams measured were legal size, and few clams were <29 mm TL.

HFP surveys in 1993 examined two beaches in Bachelor Bay and Defeat Point (Table 5). Manila densities at Bachelor Bay 1 ranged from 36-512 clams/m^2, with a mean density of 220.0 clams/m^2. Fifty-six percent of the clams measured were legal size, and few clams were <32 mm TL. Manila densities at Bachelor Bay 2 ranged from 0-484 clams/m^2, with a mean density of 166.6 clams/m^2. Seventy-six percent of the clams measured were legal size, and few clams were <34 mm TL. Manila densities at Defeat Point ranged from 10-720 clams/m^2, with a mean density of 306.3 clams/m^2. Eighty-five percent of the clams measured were legal size, and few clams were <35 mm TL.

Mean Manila clam densities at Bachelor Bay 1 in 1999 were 23.15 legal clams/m^2 and 59.36 sublegal clams/m^2, for an overall mean density of 82.52 clams/m^2 (Table 6). Twenty-two percent of the clams measured were legal size, and most clams measured were between 26 and 39 mm TL (Figure 7). Age distribution (Figure 7) was dominated by the 1996 and 1997 year classes (2 and 3 year-olds).

Mean Manila densities at Odin Cove in 1999 were 27.87 legal clams/m^2 and 19.47 sublegal clams/m^2, for an overall density of 47.33 clams/m^2 (Table 7). Forty-one percent of the clams measured were legal size, and the length frequency shows a broad range of sizes (Figure 8). Age distribution was dominated by the 1996 and 1997 (2 and 3 year-olds) year classes, but still had strong contributions from the 1995 and 1994 year classes (4 and 5 year-olds) (Figure 8).

The area appears to be producing relatively consistently, or at least has recovered from initial depletion of accumulated stocks. Results of index surveys in 1999 are encouraging, showing reasonable densities of legal clams at both beaches, and evidence of recent recruitment at Bachelor Bay. Odin Cove does not appear to be as heavily harvested as Bachelor Bay, based on size distribution and mean legal density. However, Bachelor Bay has had significantly stronger recruitment from the 1996 and 1997 year classes.

Subarea 7-13 (Spiller Channel)

Peak landings of 15.6 t were reported in 1995/96, the second season the area was open (Table 2; Figure 10). Average landings for the five seasons the area was open were 5.9 t.

DFO surveys in 1991 indicated that Manila clams were abundant in Yeo Cove, with a maximum density of 304 clams/m^2 (Table 3). Length and age data were pooled with beaches in Wigham Cove and Return Channel. Eighty-four percent of the clams measured were legal size, and the age distribution was dominated by the 1985 and 1986 year classes (5-6 year-olds).

DFO surveys in 1994 indicated that Manila clams were present on eight of 10 beaches explored in Spiller and Bullock Channels (Table 3). Of these beaches, only Mosquito Harbour in Spiller Channel has been open to fishing. Densities ranged from 0-320 clams/m^2, and 88% of the clams measured were legal size. The 1988, 1989 and 1990 age classes dominated the age distribution (4-6 year-olds).

DFO surveys in 1996 indicated that Manila populations were sparse in southern Bullock Channel, with densities on one beach ranging between 56-72 clams/m^2 (Table 3). Ninety-four percent of clams measured were legal size. The 1988 year class (8 year-olds) was most frequent, with lesser contributions from the 1989 and 1987 year classes (7 and 9 year-olds).

Survey and landing information suggests that an accumulation of older legal size clams were depleted in the 1994/95 and 1995/96 seasons, with no subsequent recruitment to support harvests in the following two seasons. There is no survey information to determine whether the increase in landings in 1998/99 are due to new recruits or to discovery of new beaches in the area.

Subarea 7-15 (Return Channel/Troup Passage)

Peak landings of 43.5 t were reported in 1994/95, the first season the area was open (Table 2; Figure 11). Average landings for the five seasons the area was open were 17.5 t. There was a general declining trend through 1997/98, with some increased landings in 1998/99. Landings of 24.5 t (53,849 lb) were reported in 1995/96, despite the area remaining closed for PSP contamination throughout the season. Extremely low landings in 1997/98 may be an artefact of the short season.

DFO surveys in 1991 indicated that Manila clams were moderately abundant in Morehouse Bay and abundant in Raven Cove, with maximum densities of 88 and 156 clams/m^2, respectively (Table 3). Length and age data were pooled with beaches in Yeo and Wigham Coves. Eighty-four percent of the clams measured were legal size, and the age distribution was dominated by the 1985 and 1986 year classes.

DFO surveys in 1994 indicated that Manila clams were abundant on 4 beaches examined in Troup Passage, with densities of 0-408 clams/m^2 recorded (Table 3). The three beaches that opened onto Troup Passage directly were dominated by legal-sized clams, with over 90% of the clams legal size and with age classes prior to 1990 dominating the age structure. On the fourth beach, a lagoon on Cunningham Island, 46% of the clams measured were legal size, and the 1990 and 1992 age classes dominated. Some evidence of poor growth was found at the fourth beach.

A single beach in southern Return Channel was examined by DFO in 1996 (Table 3). No live Manila clams were found. Manila clams were moderately abundant on two beaches in Troup Passage, with densities ranging from 13-176 clams/m^2. Overall, 57% of the clams measured were legal size, with 79% of the sample from north of the narrows and 48% of the sample from south of the narrows being legal size. Age distributions differed as well: the northern beach had the 1988-1991 year classes (5-8 year-olds) well represented, and moderately strong contribution from the 1993 (3 year-olds) year class; while the southern beach was dominated by the 1993 year class.

Also in 1996, HFP surveys were conducted on one beach in Troup Passage and two beaches in Raven Cove (Table 5). In Troup Passage, densities ranged from 0-112 clams/m^2, with a mean density of 28.8 clams/m^2. Eighty-nine percent of the clams measured were legal size. At Raven Cove 2, densities ranged from 0-116 clams/m^2, with a mean density of 34.2 clams/m^2. Sixty-six percent of the clams measured were legal size, and few clams <29 mm were collected. At Raven Cove 4, densities ranged from 12-200 clams/m^2, with a mean density of 106.1 clams/m^2. Sixty-six percent of the clams measured were legal size, and the length frequency distribution was bimodal, with a large mode between 40-56 mm TL and a smaller one between 20-29 mm TL, indicating some recent recruitment.

In 1997, HFP surveyed one beach in Troup Passage (Table 5). Manila densities ranged from 0-72 clams/m^2, with a mean density of 27.7 clams/m^2. Eighty-nine percent of clams measured were legal size, and few clams were <36 mm TL, indicating little recent recruitment.

Mean Manila densities from the 1999 survey in Troup Passage were 22.46 legal clams/m^2 and 9.63 sublegal clams/m^2, for an overall mean density of 32.09 clams/m^2 (Table 8). Seventy-two percent of the clams measured were legal size, and the length frequency had a large contribution of clams >40 mm TL (Figure 12). Age distribution had strong contributions from the 1996, 1995 and 1994 year classes (3-5 year-olds) (Figure 12).

Survey and landing information suggests that accumulated stocks of older legal size clams were depleted between 1994/95 and 1997/98. A large proportion of the 1993 year class and most of the 1994 year class should have grown to legal size through the summer of 1998. It is possible that these recruits supported increased landings in 1998/99.

Although size distribution in 1999 was dominated by legal size clams, legal density was the second lowest recorded in the 1999 index surveys. While the area will support harvest in the short term, a lack of recruits will result in decreased production for at least 2-3 years.

Subarea 7-17 (Lama Passage/ Gunboat Passage/Hunter Channel)

Peak landings of 33.3 t were reported in 1996/97, the fifth season that the area was open (Table 2; Figure 13). Average landings for the seven seasons that the area was open were 16.6 t.

There is no clear trend in landings. Low production in 1995/96 was due to the area remaining closed for PSP contamination, and low production in 1997/98 may be a result of the short season.

DFO surveys in 1990 indicated that Manila clams were present, but not abundant in Lama Passage, with maximum densities of 52 clams/m^2 (Table 3). Most Manilas (89%) were legal size, and the age distribution was dominated by the 1983 year class (7 year-olds). Manila clams were not abundant in Gunboat Passage, with six of eight beaches having maximum densities of less than 36 clams/m^2, and a maximum density of 96 clams/m^2 recorded from the area. No length or age information is available from the survey.

In 1992 HFP surveys were conducted on two beaches near Soulsby Point and one beach at Basil Carpenter Camp (Table 5). Manila densities at Soulsby Point 1 ranged from 4-152 clams/m^2, with a mean density of 72.4 clams/m^2. Fifty-two percent of clams measured were legal size, with broad representation of smaller size clams. Manila densities at Soulsby Point 2 ranged from 0-720 clams/m^2, with a mean density of 221.0 clams/m^2. Thirty-three percent of clams measured were legal size, and the length frequency distribution had a broad mode between 27-40 mm TL. At Basil Carpenter Camp, Manila densities ranged from 0-360 clams/m^2, with a mean density of 117.0 clams/m^2. Thirty-three percent of clams measured were legal size, and the length frequency distribution consisted of a single broad mode centered at 35 mm TL. Whether the abundance of smaller size classes was due solely to strong recruitment events, or a combination of recent recruitment and poor growth cannot be determined, as no age information is available.

HFP surveys in 1993 examined two beaches at Rainbow Island and two beaches in Kakushdish Harbour (Table 5). Manila densities at Rainbow Island 3 ranged from 0-380 clams/m^2, with a mean density of 195.3 clams/m^2. Eighty-eight percent of clams measured were legal size, and the length frequency had a single broad mode centered around 45 mm TL. Manila densities at Rainbow Island 4 ranged from 0-268 clams/m^2, with a mean of 77.4 clams/m^2. Eighty percent of clams were legal size. Manila densities at Kakushdish Harbour 1 ranged from 0-404 clams/m^2, with a mean of 141.2 clams/m^2. Eighty-six percent of clams were legal size. Manila densities at Kakushdish Harbour 2 ranged from 140-272 clams/m^2, with a mean of 203.0 clams/m^2. Eighty-seven percent of clams were legal size. No length or age data were taken.

DFO surveys in 1994 indicated that Manila clams were abundant on all three beaches explored on Rainbow Island in Gunboat Passage, with densities ranging from 24-420 clams/m^2 (Table 3). Sixty-one percent of the clams measured were legal size, and a fairly wide range of age classes were represented, with the 1991, 1989, 1988 and 1987 age classes most frequent (3 and 5-7 year-olds).

HFP surveys in 1994 examined Kakushdish Harbour 1 and Rainbow Island 3 (Table 5). Manila clam densities at Kakushdish Harbour ranged from 0-144 clams/m^2, with a mean density of 28.0 clams/m^2 (Table 5). Eighty- six percent of the clams measured were legal size, the length frequency distribution exhibited a single mode at 46-47 mm TL, and few clams < 35 mm TL. Manila densities at Rainbow Island ranged from 8-296 clams/m2, with a mean density of 89.2 clams/m2. Ninety percent of the clams measured were legal size, and the length frequency was dominated by a large mode centered about 47 mm TL, and few clams legal size.

DFO surveys in 1996 indicated that Manila clams were abundant in Kakushdish Harbour, with densities ranging from 61-165 clams/m^2 (Table 3). Sixty-one percent of the clams measured were legal size. The 1989 year class (7 year-olds) was dominant in samples from the head and mouth of the harbour, but the 1992 year class (4 year-olds) was strong at the head of the harbour.

In 1996, HFP surveys examined four beaches in Kakushdish Harbour, two beaches on Rainbow Island and one beach on Cypress Island (Table 5). All four beaches in Kakushdish Harbour were surveyed in July, and beaches 1 and 2 were re-surveyed in November and December, respectively (Table 5). Manila density (86.8 and 85.0 clams/m^2) and percent legal (63% in both cases) were remarkably similar at Kakushdish Harbour 1 in the summer and fall surveys, given the change in survey area (Table 4). Results from Kakushdish Harbour 2 were also consistent, with density increasing from 42.9 to 48.0 clams/m^2 and percent legal increasing from 63 to 87%. This could be the result of growth of sublegal clams into legal size between July and December. Manila densities at Kakushdish Harbour 3 ranged from 0-236 clams/m^2, with a mean of 60.5 clams/m^2. Fifteen percent of clams measured were legal size, and the length frequency had modes at 8, 30 and 38 mm TL. The smallest mode likely represents recent recruitment (1995 or 1994 year class), but without age data, it is impossible to determine whether the latter modes were recent age classes, or a product of poor growth. Manila densities at Kakushdish Harbour 4 ranged from 0-124 clams/m^2, with a mean of 47.0 clams/m^2. Twenty-six percent of clams measured were legal size, and the length frequency had modes at 34 and 24 mm TL. As at Kakushdish Harbour 3, the smaller size classes cannot definitely be attributed to recruitment without age information. Manila density at Rainbow Island 1 ranged from 0-220 clams/m^2, with a mean of 108.3 clams/m^2. Sixty-one percent of clams measured were legal size, and the length frequency had modes at 40 and 30 mm TL. Manila density at Rainbow Island 2 ranged from 28-188 clams/m^2, with a mean of 99.6 clams/m^2. Eighty-one percent of clams measured were legal size, and the length frequency had a mode at 42 mm TL. Manila densities at Cypress Island ranged from 0-64 clams/m^2, with a mean of 31.7 clams/m^2. Seventy-seven percent of clams measured were legal size, and the length frequency had modes at 48 and 42 mm TL.

HFP surveys in 1997 examined four beaches in Kakushdish Harbour. All four were surveyed in May, and beaches 1 through 3 were re-examined in November (Table 5). Mean Manila density increased from 42.1 to 76.0 clams/m^2 at Kakushdish Harbour 1 between May and November. Percent legal was similar in each survey, 47% in May and 49% in November. Length frequencies in both cases had modes near the size limit, at 35 and 40 mm TL in May and at 38 and 35 mm TL in November. Mean Manila density decreased from 51.8 to 39.0 clams/m^2 at Kakushdish Harbour 2. Percent legal decreased from 70% to 52%, and the large mode at 47 mm TL in the May survey was not apparent in November. Mean Manila density increased from 34.1 to 51.6 clams/m^2 at Kakushdish Harbour 3. Percent legal increased from 47 to 53%, and a mode of small clams centered around 15 mm TL was present in November, that had not been detected in May. Differences might be accounted for by different survey areas on the first two beaches, but stratum size is consistent on the third (Table 4). Manila densities at Kakushdish Harbour 4 ranged from 20-140 clams/m^2, with a mean of 64.5 clams/m^2. Forty percent of clams measured were legal size, and the length frequency had modes at 40 and 30 mm TL.

In 1999, index surveys were carried out on two beaches in Kakushdish Harbour and one beach on Rainbow Island. Mean Manila densities at Kakushdish Harbour 1/2 were 68.17 legal clams/m^2 and 76.53 sublegal clams/m^2, for an overall mean density of 144.71 clams/m^2 (Table 9). Thirty-nine percent of clams measured were legal size, and the size frequency was dominated by clams 30-40 mm TL (Figure 14). The age distribution was dominated by the 1996 year class (3 year-olds) (Figure 14). Mean Manila densities at Kakushdish Harbour 5 were 40.78 legal clams/m^2 and 53.99 sublegal clams/m^2, for an overall mean density of 94.772 clams/m^2 (Table 10). Forty-nine percent of clams measured were legal size, and the size frequency was dominated by clams >30 mm TL (Figure 15). The age distribution was dominated by the 1996 and 1995 year classes (3 and 4 year-olds) (Figure 15). Mean Manila densities at Rainbow Island were 28.15 legal clams/m^2 and 83.46 sublegal clams/m^2, for an overall mean density of 111.62 clams/m^2 (Table 11). Fourteen percent of the clams measured were legal size, and the size frequency was primarily made up of clams 25-38 mm TL (Figure 16). The age distribution was dominated by the 1996 year class (3 year-olds) (Figure 16).

Time series of Manila clam densities do not reveal any general decreasing trend (Figure 17). The 1993 and 1994 surveys of historic beach 1 (stratum 1 of the 1999 survey) show a decrease in legals which was likely accounted for by harvest removals. The slight decline in sublegal density may represent clams that had grown into the legal size class, natural mortality, or both. The 1996 surveys indicate little change in density, and decreased densities in the summer 1997 survey possibly reflect harvest removals in the 1996/97 season. Increased sublegal density in the fall 1997 survey possibly reflects growth of the 1996 year class above the threshold size for detection by the survey methods. The increase in legal abundance is not understood. The 1999 survey indicated that sublegal abundance was at an historic high, and legal abundance was moderate compared to historic surveys. Abundance trends for historic beach 2 (stratum 2 of the 1999 survey) are less clear, indicating only that abundance in 1996 and 1997 was considerably reduced from 1993 levels, and that the 1999 surveys indicate recovery of both legal and sublegal densities. The time series for Rainbow Island 3 is based on only two surveys six years apart, and is not useful, other than to suggest that sublegal density is higher in 1999 than in 1993 (Figure 18).

Survey and landing information suggests that more frequent recruitment events have allowed relatively consistent production from the area. Although trends in abundance are difficult to assess due to changing size of survey areas and different survey methodologies, biological information from the 1996, 1997 and 1999 HFP surveys suggests that smaller size classes are more frequently abundant in Kakushdish Harbour than other parts of PFMA 7.

Subarea 7-18 (Tribal Group)

Although the area was open for six seasons since 1993/94, landings were reported for only one season, 1995/96, totalling 0.1 t (Table 2; Figure 19).

DFO surveys in 1991 indicated that Manila clams were present on beaches on the southern side of Stryker Island, but not abundant. There is no recent survey information to indicate whether significant stocks currently exist in the area.

Subarea 7-19 (Thompson Bay)

Although the area has been open for seven seasons, no landings were reported (Table 2). The area was closed to fishing in 1994 due to PSP levels (J. Rogers, DFO Operations, pers. comm.).

DFO surveys in 1991 indicated that Manila clams were moderately abundant on three beaches in Thompson Bay, with a maximum density of 208 clams/m^2 recorded (Table 3). Eighty-five percent were legal size, and the age frequency distribution was dominated by the 1984, 1985 and 1986 year classes (5-7 year-olds). These results suggest that recruitment events were relatively rare in the late 1980's, and there are no landings or recent survey information to indicate whether significant stocks still exist in the area.

Subarea 7-20 (Wakesiu Passage)

Although the area has been open for seven seasons, no landings were reported (Table 2). The area was closed in 1994 due to PSP levels (J. Rogers, DFO Operations, pers. comm.). There is no information available to determine whether significant stocks are available in the area.

Subarea 7-21 (Gale Passage)

Peak landings of 22.6 t were reported in 1995/96, the fourth season the area was open (Table 2; Figure 20). Average landings for the seven seasons the area was open were 14.8 t.

DFO exploratory surveys in 1991 indicated that Manila clams were abundant in Gale Passage, with a maximum density of 500 clams/m^2 recorded (Table 3). Ninety-four percent of the clams measured were legal size, and age frequency distribution was dominated by the 1984, 1985 and 1986 year classes (5-7 year-olds).

In 1994, HFP surveyed one beach in Gale Passage (hereafter referred to as Gale Passage 1). Densities ranged from four to 328 clams/m^2, with a mean density of 161.3 clams/m^2 (Table 5). Sixty-one percent of the clams measured were legal size, and few clams were <30 mm TL.

In 1996, a full assessment survey was undertaken on a small beach in Gale Passage. Manila clams were reasonably abundant, with a mean density of 45.7 clams/m^2, and densities ranging from 0-192 clams/m^2 (Table 3). Fifty-four percent of the sample was legal size, and the age frequency was dominated by the 1991 and 1993 year classes (3 and 5 year-olds). A pooled sample from Gale Passage 1 had a density of 93 clams/m^2, with 50% of the sample legal size. Age frequency was dominated by the 1993 year class (3 year-olds).

In 1997, HFP surveyed Gale Passage 1 and a second beach at the mouth of Gale Creek (Table 5). Densities at Gale Passage 1 ranged from 0-272 clams/m^2, with a mean density of 38.7 clams/m^2. Fifty-four percent of the clams measured were legal size, and few clams were <32 mm TL. Densities at Gale Creek ranged from 0-156 clams/m^2, with a mean density of 14.9

clams/m^2. Fifty-one percent of the clams measured were legal size, although the sample size was small (n=45).

Mean Manila densities from Gale Passage 1 in 1999 were 64.80 legal clams/m^2 and 263.60 sublegal clams/m^2, for an overall mean density of 328.40 clams/m^2 (Table 12). Six percent of the clams measured were legal size, and size frequency was dominated by clams 19-30 mm TL (Figure 21). Age distribution was dominated by the 1997 year class (2 year-olds) (Figure 21).

Mean Manila densities from Gale Creek in 1999 were 4.00 legal clams/m^2 and 14.40 sublegal clams/m^2, for an overall mean density of 18.40 clams/m^2 (Table 13). Although the biological sample size was small (n=45), 22% of the clams measured were legal size, and the size frequency was predominantly clams 19-29 mm TL (Figure 22). Age distribution was dominated by the 1997 and 1996 year classes (2-3 year-olds) (Figure 22).

Gale Passage has provided relatively consistent production for the last seven seasons, and survey results indicate that recruitment is more frequent and stronger than in other areas. Recent survey results support the contention that Gale Passage can continue to support similar levels of production in the short term.

The survey area at Gale Creek does not appear to be representative of the harvested beaches in the area, as densities are too low to attract harvesters. Another beach in Gale Passage should be considered for future index surveys.

Subarea 7-22 (Dundivan Inlet)

Peak landings of 5.4 t were reported in 1994/95, the first season the area was open (Table 2; Figure 24). Average landings for the five seasons the area was open were 1.2 t.

The pattern of landings suggests that accumulated stocks were quickly depleted between 1994/95 and 1996/97. There is no recovery evident from the landings, and no survey information to suggest that populations have recovered.

Subarea 7-23 (Joassa Channel/Louise Channel)

Peak landings of 20.5 t were reported in 1993/94, the first season the area was open (Table 2; Figure 25). Average landings for the seven seasons the area was open were 5.5 t.

DFO surveys in 1990 indicated that Manila clams were abundant in Joassa Channel, where maximum density was 248 clams/m^2 (Table 3). Most Manilas (91%) were legal size, and the age frequency distribution was dominated by the 1984 year class (7 year-olds).

DFO surveys in 1991 indicated that Manila clams were abundant on beaches in Louise Channel to the north of Stryker Island, with a maximum density of 368 clams/m^2 recorded (Table 3). Ninety-one percent of the clams measured were legal size, and the age frequency distribution was dominated by the 1984, 1985 and 1986 year classes (5-7 year-olds).

DFO surveys in 1996 indicated that Manila clams were abundant on four of five beaches examined in Joassa and Louise Channels, with densities ranging from 52-296 clams/m^2 (Table 3). Fifty-four percent of clams measured were legal size. Age distribution was dominated by the 1993 year class (3 year-olds).

Mean Manila densities from the index beach in Joassa Channel in 1999 were 34.16 legal clams/m^2 and 22.05 sublegal clams/m^2, for an overall mean density of 56.21 clams/m^2 (Table 14). Sixty percent of the clams measured were legal size, and size frequency was dominated by clams >35 mm TL (Figure 26). Age distribution was dominated by the 1994 and 1995 year classes (4-5 year-olds) (Figure 26).

The pattern of landings suggests depletion of accumulated stocks between 1992/93 and 1996/97, with no subsequent recovery. The 1993 year class detected in the 1996 survey should have been available in the last two seasons, as well as the 1994 and 1995 year classes detected in 1999, but landings did not increase. Legal densities are low relative to other areas, and the lack of recent age classes indicates that recruitment was poor in the short term. Harvest may be possible in the short term, but there is no evidence that harvests will be consistently sustainable.

Subarea 7-24 (Raymond Passage)

Peak landings of 7.5 t were reported in 1993/94, the second season the area was open (Table 2; Figure 27). Similar landings of 7.4 t were reported in 1992/93. Average landings for the seven seasons the area was open were 4.9 t.

DFO surveys in 1990 indicated that Manila clams were abundant in Norman Morrison Bay, where maximum recorded densities were 276 clams/m^2 (Table 3). Size frequency distribution indicated a large proportion of sublegal clams. Age data was pooled with Ardmillan Bay and Ormidale Harbour, and the resulting distribution was roughly bimodal, with a large mode made up of 1987 and 1986 year classes (3-4 year-olds), and a smaller mode made up of 1984 and 1983 year classes (6-7 year-olds).

Mean Manila densities in Raymond Passage in 1999 were 41.60 legal clams/m^2 and 11.80 sublegal clams/m^2, for an overall mean density of 53.40 clams/m^2 (Table 15). Twenty-six percent of the clams measured were legal size, and the size frequency was primarily made up of clams >20 mm TL (Figure 28). Age distribution was dominated by the 1995 and 1996 year classes (4-5 year-olds) (Figure 28).

Recent survey results suggest that the index beach has not been heavily impacted by harvest. Legal density was the third highest recorded in the 1999 index surveys. However, there has not been significant recruitment since 1995, as evidenced by the lack of clams <4 years old, and the second lowest density of sublegal clams recorded in the 1999 index surveys. The area can likely support harvest in the short term, but new recruits should not be expected for at least three years.

Subarea 7-25 (Queen Sound)

Although the area was open for five seasons, landings of only 0.1 t were reported for 1994/95, the first season the area was open (Table 2; Figure 29).

DFO surveys in 1990 indicated that Manila clams were moderately abundant in the McNaughton Group in Hunter Channel, with a maximum density of 124 clams/m^2 recorded (Table 3). Most of the clams measured (88%) were legal size, and age distribution was dominated by the 1984 and 1985 year classes (5-6 year-olds).

There has been little or no interest in PFMA 7-25. Landings are not significant, and the 1990 survey indicated that a small stock composed of older legal size clams was present. There is no recent survey information to determine whether significant stocks of Manilas still exist in Queen Sound.

Subarea 7-27 (Lower Kildidt Sound) and 7-28 (Upper Kildidt Sound)

Although both areas have been open for seven seasons, no landings were reported (Table 2).

Results of DFO surveys in 1994 indicated that Manila clams were present but not abundant on beaches surveyed in the Spider Anchorage area, with a maximum density of 60 clams/m2 recorded (Table 3). Eighty-eight percent of the clams measured were legal size, and the age frequency distribution was dominated by the 1983, 1984 and 1985 year classes (9-11 year-olds).

There has been no interest in PFMA 7-27 and 7-28. The 1994 survey indicated that only a very small stock of very old legal size clams was present. There is no recent survey information to determine whether significant stocks of Manilas still exist in Kildidt Sound.

Subarea 7-32 (St. John Harbour)

Although the area has been open since 1992/93, landings of 0.7 t were only reported in 1998/99 (Table 2; Figure 30).

Manila clams were found on two of eight beaches examined by DFO in 1990, but only in significant abundance on one (Table 3). Densities ranged from 0-236 clams/m^2. Most of the clams sampled (91.4%) were legal size, and the age distribution was dominated by the 1983 year class (seven year-olds).

Survey information indicated that a relatively small stock composed of primarily one year class was present in 1990. Although minor landings reported in 1998/99 suggest that Manilas still exist in the area, there is no recent survey information to determine the current status of Manila clam stocks in St. John Harbour.

Discussion

There are several factors to be considered when examining the results presented above, including implications of survey methods and subsequent analyses, general patterns in qualitative assessment of stock status in subareas, and the implications of biological characteristics of Manila clam stocks to fishery assessment and management.

Commercial Harvest Data

The commercial landings data presented in this report were best estimates of catch from harvest log cards, sales slips and HFP annual reports. Unreported harvests, mis-reporting of harvest locations, and inconsistent units of measure all could have led to biases in estimated landings. However, lack of supplementary information makes it impossible to determine whether landings are biased upwards or downwards, or to quantify the possible bias.

Information from the Heiltsuk indicates that food harvests are almost exclusively butter clams. Manila clams are not a prized food resource in the community, and it is unlikely that food harvests are significant relative to commercial harvest levels.

Assessment Survey Methods and Analysis

There are several problems associated with analyzing data collected from a semi-systematic design using probability statistics. An unbiased variance can only be calculated under the assumption that the population is distributed completely at random with respect to the sampling frame (Kronlund *et al*. 1998). Manila clams are highly aggregated, with density gradients associated with tidal elevation and substrate type (Gillespie *et al*. 1998; Gillespie and Kronlund 1999). Thus, probability sampling estimators cannot be used to develop unbiased estimates of the variance in these surveys.

Additionally, purposive sampling or abandonment of low-density quadrats will bias the estimated mean density upwards (by sampling only high density areas). This results in unrealistically high estimates of density and total population size, with downward biased variance estimates, painting an unrealistically optimistic picture of the confidence associated with the estimates.

Model-based approaches using spatial statistics (Bourne *et al*., unpublished manuscript; Kronlund *et al*. 1998) cannot be utilized in this situation, because of the problems establishing survey areas, stratum boundaries and the lack of documentation of quadrat locations.

Inconsistent selection of survey design on a given beach over time prevent direct comparison of mean densities or total abundance estimates. If survey areas are decreased in size by excluding low density areas, then surveys can give an upwardly biased estimate of density on the beach. The survey designs established in 1999 must be maintained to allow rigorous interpretation of changes in density and biological characteristics on index beaches over time.

When examining length and/or age frequencies to assess recruitment, size selectivity of survey methods might be an alternative hypothesis to recruitment failure. We discount this alternative, as surveys that exhibited a dearth of small Manilas collected small size classes of littlenecks (*e.g.*, Defeat Point 1993, Figure 31).

Summary of Stock Status

Trends in subarea production fall generally into two patterns. Three subareas (7-17, 7-21 and 7-24) have exhibited relatively consistent production, although production from Raymond Passage (7-24) has been at a relatively low level. There is evidence from assessment surveys that recruitment events have been more frequent in these areas, replenishing stocks that have been reduced by harvest. Although many areas experienced strong recruitment from the 1996 year class, sublegal densities were highest in Gale Passage, Rainbow Island and Kakushdish Harbour. Gale Passage also experienced strong recruitment of the 1997 year class.

Six subareas (7-9, 7-12, 7-13, 7-15, 7-22 and 7-23) had peak landings in their first or second season, exhibited general declining trends in production, and have produced average landings that are less than half of the peak landings. This suggests that these areas had an accumulated stock of older clams from one or a few significant recruitment events, and that subsequent recruitment has been poor, failing to replenish populations after harvest.

The remaining areas have either not attracted fishing effort (7-19, 7-20, 7-27 and 7-28) or have had production levels too low to allow meaningful discussion of trends (7-18, 7-25 and 7-32).

The fishery occurs primarily in areas immediately adjacent to Waglisla. The lack of production from areas open to Queen Charlotte Sound (7-18, 7-19, 7-20, 7-25, 7-27, 7-28 and 7-32) may be due in part to the distances involved and the logistics of reaching the areas safely in winter weather conditions. However, survey information indicates that recruitment in these areas is not as frequent as in more protected areas, as is evidenced by the lack of the 1996 year class at index beaches in Joassa Channel and Raymond Passage in 1999. It is fortunate that the areas most accessible to fishers are also the most productive areas for Manila clam populations in the North Coast.

Management Considerations

Several characteristics of Manila clams and other clam species should be considered when developing management plans.

Target Species

There is insufficient information to judge whether the arbitrary quotas of 113.6 t (250,000 lb) each for butter and littleneck are sustainable. There is no history of harvest production and only limited information on littlenecks from assessment surveys. There have been no directed butter clam surveys. Before the sustainability of the quota can be assessed, littleneck survey information needs to be analyzed, and directed butter clam surveys are required. Given the economic limitations facing commercial harvest of littleneck and butter clams, consideration could be given to limiting commercial communal opportunity to Manila clams only. This would allow the Heiltsuk First Nation to support food, social and ceremonial requirements with littleneck and butter clams, the species traditionally available to them, and still maintain a commercial fishery on an exotic species.

Growth

Growth rates for Manila clams in the North Coast are generally similar to the South Coast rates. Manila clams in Area 7 generally required 3.5-4 years growth to attain legal size (Bourne and Cawdell 1992; Bourne *et al*. 1994; Heritage *et al*. 1998). Manilas from areas further north grew somewhat slower, requiring 4-4.5 years to attain legal size in Mathieson Channel (Bourne *et al*. 1994) and Laredo Inlet (Heritage *et al*. 1998). There is variability in growth within an age class, and thus some clams will reach legal size with three years growth, while others living higher on the tide might take five or more years (Gillespie, pers. obs.).

Survey methods used (hand-digging) do not detect young-of-the-year or one-year-old clams. Given this, and the growth information, sublegal clams detected by the survey will likely grow to legal size within 2-3 years, depending on age distribution. With sufficiently low harvest rates, significant recruitment events could support a fishery for 3-4 years after attaining legal size (Gillespie and Bond 1997).

Recruitment

Previous authors have stressed the importance of recruitment in determining stock productivity and have emphasized its importance to fishery management in the North Coast (Bourne and Cawdell 1992; Bourne *et al*. 1994; Heritage *et al*. 1998). Their concerns are reiterated here.

Recruitment events in the North Coast are probably less frequent, and weaker, than in the South Coast. Survey data indicate that recruitment events are relatively stronger and more frequent in protected areas, such as Gale Passage, Kakushdish Harbour and Rainbow Island than in areas open to Queen Charlotte Sound. Temperature in open areas may be too cool to support successful spawning in most years (Bourne *et al*. 1994), and recruitment to these areas could result from larvae that have drifted from warmer inlet areas, not from larvae produced locally. Beaches in the Waglisla area and Gale Passage will likely continue to drive production from the fishery, with outlying areas producing occasional benefits when sufficient stocks accumulate.

Water temperatures in British Columbia have been warmer than normal in recent years, including El Niño conditions in 1998. These warmer temperatures may have supported higher than normal recruitment of Manila clams in the northernmost part of their range. If temperatures return to ore normal levels in coming years, recruitment may decrease.

Recruitment rates may be determined by spawning and setting success, or may be greatly affected by post-settlement mortality. Winter kills may affect smaller clams, which live shallower in the substrate than large clams, and also affect clams living at higher tidal elevations, which are exposed longer on low tides. Bourne and Cawdell (1992) found considerable concentrations of dead Manila shell on some beaches, and suggested that severe weather during low night-time tides may have caused the mortality. Winter kills in some years may significantly deplete smaller size classes, resulting in recruitment failure, in addition to increasing mortality on larger clams.

Fishery Management

The current TAC of 113.6 t (250,000 lbs) of Manila clams may not be sustainable, given information on stock productivity and fishery performance. The TAC was based on minimal information from the 1990 exploratory surveys (G. Thomas, DFO Operations, pers. comm.), and was suggested with the *caveat* that these levels would not likely be sustainable over the long term.

The TAC was only filled in the 1994/95 season, and only then by depleting accumulated stocks of older clams in several subareas newly opened to the fishery. Following the peak, landings fell to a level approximately 65% of peak production. Mean production for the fishery was 73.5 t, approximately 64% of the peak production. This pattern of rapid escalation to unsustainable levels, followed by a crash to lower production is common in “gold-rush” fisheries (Caddy and Gulland 1983; Gunderson 1984; Hilborn and Sibert 1988), and was the pattern of development for the South Coast Manila clam fishery (Gillespie and Bond 1997; Webb and Hobbs 1997). If stock levels are reduced to the point of dependence on annual recruitment for production, North Coast fisheries will likely be of a “boom-and-bust” nature, with production greatly reduced in low recruitment periods.

South Coast clam fisheries are no longer managed passively under a minimum size limit, but also using production histories and in-season catch and effort data (Gillespie and Bond 1997). As production for a given area approaches historic production levels, often pro-rated to account for loss of beaches to contamination closures, managers closely monitor landings for symptoms of low stock levels. These symptoms include increased incidence of sublegal clams, littleneck clams or detritus in clam sacks; decreases in CPUE or effort; or digging in marginal habitats or closed areas. Given production concerns, North Coast clam fisheries should be managed at least as conservatively as South Coast fisheries.

Evaluation of Potential Reference Points for Management

A number of authors have suggested the use of Biological Reference Points (BRP’s) as targets and limits to guide management actions (*e.g.*, Quinn *et al*. 1990; Smith *et al*. 1993; Caddy and Mahon 1995; Caddy and McGarvey 1996; Die and Caddy 1997; Caddy 1998; National Research Council 1998; Caddy 1999). A Target Reference Point (TRP) is a measure of stock status that management actions aim towards, *i.e.*, a TRP represents a goal to be attained by management action. A Limit Reference Point (LRP) is a measure of stock status that management actions should avoid.

In a general situation, management actions are implemented in a fishery to achieve a TRP. If in some years the TRP is exceeded, or if stock dynamics change and the TRP is no longer appropriate, then stock status will shift to a state closer to the LRP. As assessments document stock status approaching the LRP, then more restrictive management actions must be undertaken to avoid the LRP. If stock status parameters exceed the LRP, then strict actions (likely complete closure) are invoked until stock status recovers.

Most BRP's are based on estimates of spawning stock biomass or fishing mortality with theoretical targets derived from stock-recruitment relationships or production models, which rely on availability of age-structured data and stock and recruitment information gathered over a significant period of time (Caddy 1998). Relatively few have been suggested that have modest data requirements.

One suggested LRP (Die and Caddy 1997; Caddy 1998) is currently in use in the Area 7 clam fishery. Die and Caddy (1997) suggested that size at maturity combined with mortality estimates defined the LRP:

$$Z^* < \frac{K(L_\infty - L_M)}{(L_M - L_C)}$$

where K and L_{∞} are the von Bertalanffy growth parameters, L_M is the size of 50% maturity and L_C is length at first capture. The objective of this LRP is to maintain conditions whereby a 50% chance of spawning at least once is assured (Caddy 1998).

The 38 mm TL size limit enforced in Manila and littleneck clam fisheries is similarly designed to ensure that clams are not harvested until they have had at least one opportunity to spawn (Bourne 1987). This size limit proved ineffective when used as the only management action in South Coast clam fisheries, which utilize licence limitation, area licencing, and time and area closures to prevent overharvest of clam resources (Webb and Hobbs 1997; Gillespie and Bond 1997; Gillespie *et al*. 1998). Major beaches and entire PFMA's have been closed for conservation reasons.

Size at 50% maturity in this case is defined on the basis of physiological ability to spawn under the appropriate environmental conditions. Because this ability is limited at lower temperatures, and water temperatures are generally lower in the North Coast than in the South Coast, it can be expected that a size limit alone will be less effective in the north than in the south. Therefore, other reference points must be established for North Coast fisheries.

The Area 7 fishery is data-limited: available data include an incomplete time series of size and age distribution for various beaches, and estimates of density from the same surveys that are not comparable due to methodological differences. Surveys carried out on selected beaches can be collected into a time series that would be useful as an index of overall biomass, but no estimate of total biomass by subarea or for the entire fished area is available. There are reported landings from the inception of the fishery, with some concerns regarding mis-reporting of weights or harvest locations and lack of information on subsistence and illegal removals (which are presumed to be insignificant in the first case, and unquantifiable in the latter).

Annala (1993) outlined the use of historic yields to define reference points for fisheries in New Zealand. He defined the reference point Maximum Constant Yield (MCY) as the maximum constant catch that is estimated to be sustainable, with an acceptable level of risk, at all probable future levels of biomass. For the situation where available data are limited to catch data and some information, either qualitative or quantitative, regarding fishing effort or fishing mortality, MCY is calculated as:

$$MCY = cY_{av}$$

where Y_{av} is the average catch over an appropriate time period, and c is a natural variability factor which ranges between 0.6 and 1.0. The period over which to estimate Y_{av} depends on:

- no systematic changes in fishing effort (or fishing mortality, if available) time series;
- no large change in quotas or overall management approach;
- no systematic change in catch in the time series; and
- the period should be (at least) half of the species exploited life span.

The catch data series for Area 7 meets most of these criteria. The only change in fishing effort over the fishery was reduced opportunity in 1997/98 due to a delayed opening. The quota did not change, and was only achieved once during the period. There does not appear to have been a systematic change in catches, given that 1997/98 was an unusually short season, and that landings recovered in 1998/99. The seven year time series represents nearly the entire exploited life span of Manila clams, which grow to legal size in approximately 4-5 years and rarely exceed 10 years of age in fished populations.

Unfortunately, there is little additional information to aid in the selection of an appropriate value for c. The suggested range is 0.6 to 1.0 and depends on the estimated natural mortality rate M. In the absence of a scaling factor for M, we calculated Y_{av} using catches from 1992/93 through 1998/99, and derived estimates of MCY using values of 0.6, 0.8 and 1.0 for c. Estimated MCY ranged between 44.1 and 73.5 t (96,978 and 161,629 lb)(Table 16).

Annala (1993) notes that if the data are from a fully exploited fishery then the method will provide a good estimate of MCY; if the stock was under-exploited, then the method gives a conservative estimate of MCY. Because this is a relatively young fishery, and early landings could potentially represent reductions of accumulated stock (*i.e.*, unrealistically high levels of yield relative to the long term), managers should consider a precautionary approach when selecting a TAC from within the range of options.

As further data are developed in this fishery, another technique that can be used to establish TAC's is the Magnussen-Stefansson feedback gain rule (Caddy 1998). Target yield for the upcoming fishery is calculated as:

$$Y_t = Y_{t-1} * \left(1 + \left(\frac{g\,(B_{t-1} - B_{t-2})}{B_{t-2}} \right) \right)$$

where Y is catch in year t, B is biomass (or an index of biomass) and g is the feedback gain. Values of $g \geq 1$ in simulations contributed to precautionary approaches, but high values did so through more frequent closures. The use of this rule is particularly useful in restoring a depleted fishery which has been gradually declining in stock size to a productive condition.

Recommendations

With the preceding considerations in mind, the following recommendations are offered:

1. **Managers should consider reducing the annual Manila clam quota from the preliminary estimate of 113.6 t (250,000 lbs) to a level that reflects a more realistic expectation based on historic production.** Since the long-term average production from the area is 73.5 t (161,629 lb), a quota at or below this level is suggested, with options based on MCY in Table 16.
2. **The HFP should continue their stock assessment program with annual assessment of index beaches from each subarea fished.** The index beaches in each area should be reviewed annually in light of verified catch and effort from each years' harvest, to assess whether surveyed beaches are representative of the stock condition in the subarea (*i.e.*, to ensure that index beaches are not deliberately under-harvested, biasing indices of stock condition). The assessment program should include surveys of non-harvested (control) beaches to determine whether population dynamics are a result of fisheries effects, environmental effects or both.
3. **DFO and HFP should develop a harvest log card that would allow assignment of catch and effort to each subarea harvested in each delivery.** Log card entries should be verified during each delivery, the resulting data keypunched and collated, and verified catch and effort statistics provided to DFO to provide a basis for in-season management actions.
4. **Monitor catch and effort by subarea during the fishery, and re-distribute effort should concerns arise in any subarea.** South Coast fisheries are monitored for CPUE, overall effort levels and increased incidence of sublegal clams or less desirable species in the catch. Reconstruction of historic catch and effort data could provide representative levels of CPUE and continued collection of these data can be used to index stock status within a subarea. Information from harvesters is also crucial to in-season monitoring. Subareas of concern might be closed for the remainder of the season, and be targets of assessment effort in the following summer.

Acknowledgements

We thank the staff of the Heiltsuk Fisheries Program for their efforts in conducting surveys and monitoring and documenting the Area 7 clam fishery. Almudena Supple (DFO Aboriginal Fisheries Section, Prince Rupert) expended considerable effort recovering and formatting HFP clam survey data. Klaus Schallie (Canadian Food Inspection Agency) shared information related to PSP monitoring. We thank Neil Bourne, Juanita Rogers and the members of the Pacific Scientific Advice Review Committee for their review of this document.

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Table 1. Contamination closures in PFMA 7.

Closure	PFMA	Description
General	all	Any Canadian fisheries waters of the Pacific Ocean within 125 m of any wharf, dock, platform or other structure used for vessel moorage; or any permanently anchored floating structures, including float homes, barges, platforms and vessels.
Higgins Pass	7-3	The waters and foreshore of Higgins Passage, at the north end of Price Island, lying inside a line drawn from a point on land at 52°28.25' north latitude and 128°39.00' west longitude thence north-westerly to a point on the opposite shore at 52º28.40' north latitude and 128º39.10' west longitude.
Klemtu	7-5	The waters and foreshore of Trout Bay, Klemtu, lying inside a line drawn from Klemtu Point to the northern headland of the bay.
Berry Inlet	7-8	The waters and foreshore of the head of Berry Inlet, at the south end of Don Peninsula, lying inside a line drawn from a point on land at 52°28.25’ north latitude and 128°17.90’ west longitude, thence northwesterly to a point on the opposite shore at 52°17.00’ north latitude and 128°18.10’ west longitude.
Tuno Creek	7-9	The waters and foreshore of the mouth of Tuno Creek, at the south end of Don Peninsula, lying inside a line drawn from a point on land at 52º16.80' north latitude and 128º19.45' west longitude, thence north-westerly to a point on the opposite shore at 52º16.95' north latitude and 128º19.50' west longitude.
Wigham Cove	7-12	The waters and foreshore of Wigham Cove, Yeo Island, inside a line drawn from the headland at the eastern end of the cove entrance at 52º16.64' north latitude and 128º10.40' west longitude, thence west to the opposite shore at 52º16.64' north latitude and 128º10.51' west longitude. MAY 31 TO SEPTEMBER 30
Spiller Channel	7-13	The waters and foreshore of Spiller Channel, at the south-east end of Don Peninsula, lying inside a line drawn from a point on land at 52º17.50' north latitude and 128º15.60' west longitude, thence north-easterly to a point on the opposite shore at 52º17.60' north latitude and 128º15.49' west longitude.
Yeo Cove	7-13	The waters and foreshore of Yeo Cove lying inside a line drawn from Dove Point on the northern headland of the Cove thence south to the westernmost point of land on the southern headland.
Return Channel	7-15	The waters and foreshore of Return Channel lying inside a line drawn from the headland west of McArthur Point, Yeo Island at 52º18.00' north latitude and 128º06.95' west longitude, thence south-west to the south end of the foreshore at 52º17.80' north latitude and 128º07.10' west longitude.
Chatfield Island	7-15	The waters and foreshore at the head of the large unnamed bay on the north-eastern side of Chatfield Island, inside a line drawn from the point at the western end of the bay at 52º16.61’ north latitude and 128º02.60’west longitude, thence east to the eastern shore at 52º16.60’ north latitude and 128º02.33’ west longitude.
Chatfield Island	7-15	The waters and foreshore at the head of the small unnamed cove on the southeastern side of Chatfield Island, inside a line drawn from the rock outcrop at 52º13.87' north latitude and 128º05.90' west longitude, thence east to the headland on the eastern side of the cove entrance at 52º13.95' north latitude and 128º05.74' west longitude.
Bella Bella	7-17	The waters and foreshore of Bella Bella, lying south of a line drawn from the western headland of Cavin Cove to the northern tip of Spirit Island thence to Robins Point, and north of a line drawn from the northern headland of McLoughlin Bay due east to the shore of Denny Island.
Cultus Sound	7-25	The waters and foreshore of Cultus Sound, at the west end of Hunter Island, lying inside a line drawn from a point on land at 51º53.84' north latitude and 128º12.50' west longitude, thence north-westerly to the north end of the unnamed island at 51º53.89' north latitude and 128º12.60' west longitude, thence westerly to a point on the opposite shore at 51º53.89' north latitude and 128º12.90' west longitude.
Goose Island	7-25	The waters and foreshore lying inside a line drawn from the south-western most point of Goose Island to the northern most tip of Duck Island, thence along the eastern foreshore to the southernmost point of the Island, thence south-easterly to the westernmost point on Gosling Island and continuing north along the western foreshore to the northernmost tip of Gosling Island, thence north-westerly to the 51º55.98' north latitude and 128º26.72' west longitude on Goose Island.
Spider Island	7-27	The waters and foreshore of the unnamed bay at the south end of Spider Island, on the east side of Queens Sound, lying inside a line drawn from a point on land at 51º50.20' north latitude and 128º15.10' west longitude, thence north-westerly to a point on the opposite shore at 51º50.35' north latitude and 128º15.20' west longitude.
Bainbridge Cove	7-30	The waters and foreshore of Bainbridge Cove, Cunningham Island, inside a line drawn from the point at the southern end of the cove entrance at 52º11.62' north latitude and 127°54.22' west longitude, thence north to the point on the northern end of the cove entrance at 52º11.75' north latitude and 127º54.28' west longitude.
St. John Harbour	7-32	The waters and foreshore of St. John Harbour, Athlone Island, lying inside a line drawn from a point on land at 52º10.73' north latitude and 128º27.34' west longitude, thence northerly to a point on the opposite shore at 52º10.87' north latitude and 128º27.35' west longitude.
Athlone Island	7-32	The waters and foreshore of the south-west portion of Athlone Island lying inside a line drawn from a point on land at 52º09.90' north latitude and 128º29.70' west longitude, thence northwesterly to a point on the opposite shore at 52º10.10' north latitude and 128º29.90' west longitude.
Dyer Cove	7-32	The waters and foreshore of Dyer Cove, in St. John Harbour, bounded between a line drawn from the first outcrop at 52º11.08' north latitude and 128º28.30' west longitude to 52º11.19' north latitude and 128º27.85' west longitude and a line drawn at the narrow entrance to the inner harbour. MAY 31 TO SEPTEMBER 30

Table 2. Landings (t) from the Area 7 Manila clam fishery by Pacific Fishery Management Subarea and season.

Season	Subarea																Total
	8/9	12	13	15	17	18	19	20	21	22	23	24	25	27	28	32	
92/93		24.1			8.8		0.0	0.0	18.5		20.5	7.4				0.0	79.3
93/94		12.1			24.7	0.0	0.0	0.0	16.7		3.7	7.5				0.0	64.8
94/95	5.9	9.0	8.0	43.5	19.3	0.0	0.0	0.0	8.3	5.4	9.0	5.5	0.1	0.0	0.0	0.0	114.1
95/96	0.3	9.0	15.6	24.5	0.0	0.1	0.0	0.0	22.6	0.4	2.7	6.7	0.0	0.0	0.0	0.0	81.9
96/97	1.6	13.2	0.9	9.6	33.3	0.0	0.0	0.0	9.6	0.3	0.6	2.0	0.0	0.0	0.0	0.0	71.1
97/98*	2.4	2.6	1.0	2.2	4.7	0.0	0.0	0.0	11.0	0.0	0.7	0.2	0.0	0.0	0.0	0.0	25.4
98/99*	1.7	11.0	3.9	7.9	25.3	0.0	0.0	0.0	16.7	0.1	1.1	5.2	0.0	0.0	0.0	0.7	77.6

N.B. – a blank cell indicates the subarea was not open; a zero indicates the subarea was open, but no landings were reported.

* - Total landings for 1997/98 include 0.7 t that could not be assigned to a subarea; total landings for 1998/99 include 3.9 t that could not be assigned to a subarea.

Table 3. Results of DFO exploratory surveys for Manila clams in PFMA 7, 1990-96.

Date	Location	PFMA	Density (clams/m^2)	% Legal	Dominant Year Classes	Comments
			1990			
6/23	St. John Harbour	7-32	0-236	91	83	
6/24	Dearth Island	7-12	0-56	N/A	84, 83, 87	
6/24	Joassa Channel	7-23	32-248	91	83, 85, 84	
6/25	Lama Passage	7-17	4-52	89	83	
6/25	McNaughton Group	7-25	4-124	88	84, 85	
6/26	Seaforth Channel	7-12	0-392	51	86, 87, 84, 83	Age data pooled
6/26	Raymond Passage	7-24	156-300	57		
6/27	Gunboat Passage	7-17	0-96	N/A	N/A	
			1991			
7/8	Seaforth Channel	7-12	4	50		
7/8	Spiller Channel	7-13	204-304	80	86, 85, 84	Age data pooled
7/8	Return Channel	7-15	4-252	87		
7/9-10	Gale Passage	7-21	28-500	94	85, 86, 84	
7/10	Thompson Bay	7-19	12-208	85	84, 85, 86	
7/11	Stryker Island	7-18	0-368	91	85, 86, 84	
7/4-6,12	Spider Anchorage	7-27	0-60	88	83, 84, 85	
			1994			
7/20-21	Troup Passage	7-15	0-408	79	89, 88, 90	Open beaches
					91, 90, 92	Lagoon
7/21	Gunboat Passage	7-17	24-420	61	91, 89, 88, 87	
7/22	Spiller Channel	7-13	320	81	88, 89, 90	Age data pooled
7/22	Bullock Channel	7-14	0-172	91		
			1996			
6/28-29	Kakushdish Harbour	7-17	61-165	61	89, 90	Mouth of harbour
					92, 89	Head of harbour
6/30	Return Channel	7-15	0	-	-	
6/30	Bullock Channel	7-14	56-72	94	88, 87, 89	
6/30	Troup Passage	7-15	13-176	57	92, 90, 94	North of narrows
					94, 93, 92	South of narrows
7/1	Gale Passage	7-21	0-192	54	91, 93, 92	South passage
					93, 94	Inner passage
7/3	Joassa Channel	7-23	52-296	54	93, 92, 91	Age data pooled
7/3	Louise Channel	7-23	80	55		

Table 4. Documentation of methods for HFP assessment surveys for Manila clams, 1992-1997.

Beach	Date	PFMA	Survey Area (m^2)	Quadrat Size (m^2)	n	Data Available: Density	Length	Age
			1992					
Defeat Point	3/19	7-12	1,222	0.25	12	+	+	-
Quinoot Beach 1	3/25	7-23	1,482	0.25	9	+	+	-
Quinoot Beach 2	3/25	7-23	17,596	0.25	6	+	+	-
Soulsby Point 1	4/7	7-17	1,813 or 1,300	0.25	11	+	+	-
Soulsby Point 2	4/8	7-17	5,400	0.25	12	+	+	-
Admiral Island	4/9	7-18	1,287	0.25	9	+	+	-
Raymond Passage	4/14	7-23	4,000	0.25	12	+	+	-
Basil Carpenter Camp	4/15	7-17	1,140	0.25	12	+	+	-
Hanna’s Camp	4/28	7-18	1,200	0.25	9	+	+	-
Ardmillan Bay	5/8	7-12	6,815	0.25	9	+	+	-
			1993					
Rainbow Island 4	5/21	7-17	2,100	0.25	9	+	-	-
Kakushdish Harbour 1	5/25	7-17	13,600	0.25	12	+	-	-
Kakushdish Harbour 2	5/25	7-17	3,328	0.25	4	+	-	-
Bachelor Bay 1	5/26	7-12	6,815	0.25	12	+	+	-
Bachelor Bay 2	5/27	7-12	14,040	0.25	12	+	+	-
Defeat Point	11/10	7-12	598	0.25	12	+	+	-
Rainbow Island 3	11/11	7-17	2,691	0.25	12	+	+	-
			1994					
Gale Passage 2	2/12	7-21	7,800	0.25	12	+	+	-
Odin Cove	2/16	7-22	600	0.25	12	+	+	-
Kakushdish Harbour 1	3/2	7-17	13,600	0.25	12	+	+	-
Rainbow Island 3	3/3	7-17	750	0.25	12	+	+	-
			1996					
Kakushdish Harbour 1	7/2	7-17	441	0.25	15	+	+	-
Rainbow Island 1	7/3	7-17	600	0.25	15	+	+	-
Kakushdish Harbour 2	7/4	7-17	1,800	0.25	30	+	+	-
Kakushdish Harbour 3	7/5	7-17	1,500	0.25	15	+	+	-
Kakushdish Harbour 4	7/6	7-17	1,600	0.25	15	+	+	-
Kakushdish Harbour 1	11/8	7-17	1,500	0.25	15	+	+	-
Rainbow Island 2	11/9	7-17	400	0.25	10	+	+	-
Cypress Island 3	11/10	7-17	800	0.25	16	+	+	-
Troup Passage 4	11/11	7-15	1,800	0.25	25	+	+	-
Raven Cove 2	12/18	7-15	900	0.25	15	+	+	-
Raven Cove 4	12/19	7-15	625	0.25	15	+	+	-
Kakushdish Harbour 2	12/20	7-17	900	0.25	15	+	+	-
			1997					
Kakushdish Harbour 1	5/23	7-17	1,200	0.25	15	+	+	-
Kakushdish Harbour 2	5/24	7-17	1,500	0.25	20	+	+	-
Kakushdish Harbour 3	5/26	7-17	600	0.25	15	+	+	-
Kakushdish Harbour 4	5/27	7-17	400	0.25	15	+	+	-
Troup Passage 1	6/19	7-17	800	0.25	15	+	+	-
Gale Creek	6/20	7-21	800	0.25	14	+	+	-
Gale Passage 2	6/26	7-21	400	0.25	13	+	+	-
Kakushdish Harbour 1	11/2	7-17	500	0.25	15	+	+	-
Kakushdish Harbour 2	11/4	7-17	600	0.25	20	+	+	-
Kakushdish Harbour 3	11/5	7-17	600	0.25	20	+	+	-

Table 5. Results of HFP assessment surveys for Manila clams in Area 7, 1992-1997.

Location	Date	PFMA	Density Range	Mean Density (clams/m^2) Legal	Sublegal	Total	% Legal	Length (mm TL) Median	Modes
				1992					
Defeat Point	3/19	7-12	24-560	82.7	100.0	182.7	45	37	
Quinoot Beach 1	3/25	7-23	0-280	101.3	24.9	126.2	80	44	
Quinoot Beach 2	3/25	7-23	12-364	32.6	54.3	86.9	38	35	
Soulsby Point 1	4/7	7-17	4-152	41.2	31.2	72.4	57	39	43,32,50
Soulsby Point 2	4/8	7-17	0-720	72.3	148.7	221.0	33	35	35,38,30
Admiral Island	4/9	7-18	0-52	10.7	1.3	12.0	89	44	45
Raymond Passage	4/14	7-23	0-344	44.7	35.0	79.7	56	38	42,35,45
Basil Carpenter Camp	4/15	7-17	0-360	38.3	78.7	117.0	33	35	36
Hanna’s Camp	4/28	7-18	0-1000	17.3	277.3	294.6	6		
Ardmillan Bay	5/8	7-12	0-348	27.1	46.7	73.8	37		
				1993					
Rainbow Island 4	5/21	7-17	0-268	67.6	9.8	77.4	87	na	na
Kakushdish Harbour 1	5/25	7-17	0-404	89.2	14.4	141.2	86	na	na
Kakushdish Harbour 2	5/25	7-17	140-272	176.0	27.0	203.0	87	na	na
Bachelor Bay 1	5/26	7-12	36-512	130.0	90.0	220.0	56	39	38
Bachelor Bay 2	5/27	7-12	0-484	126.1	40.5	166.6	76	42	37
Defeat Point	11/10	7-12	10-720	260.3	46.0	306.3	85	42	42,38
Rainbow Island 3	11/11	7-17	0-380	171.3	24.0	195.3	88	44	45
				1994					
Gale Passage	2/12	7-21	4-328	98.0	63.3	161.3	61	40	42,32
Odin Cove	2/16	7-22	32-264	99.3	33.3	132.6	75	42	44
Kakushdish Harbour 1	3/2	7-17	0-144	24.0	4.0	28.0	86	46	46,35
Rainbow Island 3	3/3	7-17	8-296	80.7	8.7	89.2	90	45	47
				1996					
Kakushdish Harbour 1	7/2	7-17	0-324	54.5	32.3	86.8	63	40	44,35
Rainbow Island 1	7/3	7-17	0-220	65.9	42.4	108.3	61	40	40,30
Kakushdish Harbour 2	7/4	7-17	0-180	26.9	16.0	42.9	63	40	45,35,26
Kakushdish Harbour 3	7/5	7-17	0-236	9.3	51.2	60.5	15	27	8,30,38
Kakushdish Harbour 4	7/6	7-17	0-124	12.3	34.7	47.0	26	31	34,24
Kakushdish Harbour 1	11/8	7-17	0-216	53.3	31.7	85.0	63	39	40,46,30
Rainbow Island 2	11/9	7-17	28-188	80.4	19.2	99.6	81	42	42
Cypress Island 3	11/10	7-17	0-64	24.5	7.2	31.7	77	43	48,42
Troup Passage 4	11/11	7-15	0-112	25.8	3.0	28.8	89	45	42,46
Raven Cove 2	12/18	7-15	0-116	22.7	11.5	34.2	66	44	52,29,35
Raven Cove 4	12/19	7-15	12-200	69.9	36.3	106.1	66	42	45,26
Kakushdish Harbour 2	12/20	7-17	0-196	41.6	6.4	48.0	87	44	43,50
				1997					
Kakushdish Harbour 1	5/23	7-17	0-120	20.0	22.1	42.1	47	37	35,40
Kakushdish Harbour 2	5/24	7-17	0-176	36.4	15.4	51.8	70	43	47,36
Kakushdish Harbour 3	5/26	7-17	0-88	16.0	18.1	34.1	47	37	25,40
Kakushdish Harbour 4	5/27	7-17	20-140	26.1	38.4	64.5	40	36	40,30
Troup Passage 1	6/19	7-17	0-72	24.8	2.9	27.7	89	46	49
Gale Creek	6/20	7-21	0-156	9.3	5.6	14.9	51	43	
Gale Passage 2	6/26	7-21	0-272	21.1	17.6	38.7	54	36	33,37
Kakushdish Harbour 1	11/2	7-17	28-192	37.6	38.4	76.0	49	37	38,35
Kakushdish Harbour 2	11/4	7-17	0-104	19.2	18.8	39.0	52	37	37
Kakushdish Harbour 3	11/5	7-17	4-132	29.8	26.2	51.6	53	38	39,29,15

Table 6. Results of HFP Manila clam survey at Bachelor Bay 1, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	2,500	29.538	6.487	77.846	25.448	26	73,846	32,436	194,615	127,238
2	800	3.200	1.304	1.600	0.883	10	2,560	2,087	1,280	1,413
Total	3,300	23.153	4.925	59.362	19.280	36	76,406	33,471	195,895	131,034
				df Legals	25.53		t Legals	2.0595	Leg precision	43.8%
				df Subl	25.02		t Subl	2.0595	Subl precision	66.9%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	2,500	0.613	0.121	0.569	0.185	26	1,533	606	1,421	923
2	800	0.082	0.031	0.011	0.006	10	66	49	9	9
Total	3,300	0.484	0.092	0.433	0.140	36	1,598	627	1,430	950
				df Legals	25.84		t Legals	2.0595	Leg precision	39.2%
				df Subl	25.01		t Subl	2.0595	Subl precision	66.4%

Table 7. Results of HFP Manila clam survey at Odin Cove, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	1,200	27.867	6.971	19.467	4.790	30	33,440	16,730	23,360	11,496
Total	1,200	27.867	6.971	19.467	4.790	30	33,440	17,109	23,360	11,756
				df Legals	29.00		t Legals	2.0452	Leg precision	51.2%
				df Subl	29.00		t Subl	2.0452	Subl precision	50.3%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	1,200	0.607	0.159	0.132	0.032	30	728	380	158	77
Total	1,200	0.607	0.159	0.132	0.032	30	728	389	158	79
				df Legals	29.00		t Legals	2.0452	Leg precision	53.4%
				df Subl	29.00		t Subl	2.0452	Subl precision	49.7%

Table 8. Results of HFP Manila clam survey at Troup Passage, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	1,250	25.200	6.472	16.400	5.035	10	31,500	16,181	20,500	12,588
2	1,375	18.800	3.723	8.400	3.064	10	25,850	10,238	11,550	8,426
3	1,400	23.600	4.104	4.800	1.767	10	33,040	11,491	6,720	4,948
Total	4,025	22.457	2.774	9.632	1.980	30	90,390	23,097	38,770	16,740
				df Legals	23.08		t Legals	2.0687	Leg precision	25.6%
				df Subl	18.88		t Subl	2.1009	Subl precision	43.2%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	1,250	0.772	0.215	0.096	0.030	10	903	539	120	74
2	1,375	0.517	0.114	0.065	0.024	10	710	314	89	65
3	1,400	0.737	0.141	0.041	0.013	10	1,032	396	58	37
Total	4,025	0.657	0.092	0.066	0.013	30	2,645	765	267	109
				df Legals	22.59		t Legals	2.0739	Leg precision	40.8%
				df Subl	22.13		t Subl	2.0739	Subl precision	28.9%

Table 9. Results of HFP Manila clam survey at Kakushdish Harbour 1 and 2, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	3,200	45.533	14.487	57.867	20.226	15	155,307	92,715	185,173	129,448
2	2,000	99.600	22.828	106.400	30.205	10	199,200	91,311	212,800	120,821
Total	5,200	68.174	12.513	76.533	17.026	25	354,507	136,183	397,973	184,682
				df Legals	19.66		t Legals	2.0930	Leg precision	38.4%
				df Subl	20.38		t Subl	2.0860	Subl precision	46.4%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	3,200	0.954	0.291	0.523	0.183	15	3,053	1,864	1,674	1,173
2	2,000	2.028	0.481	0.958	0.286	10	4,057	1,922	1,916	1,144
Total	5,200	1.367	0.257	0.690	0.157	25	7,109	2,802	3,590	1,714
				df Legals	19.02		t Legals	2.0930	Leg precision	39.4%
				df Subl	19.79		t Subl	2.0930	Subl precision	47.7%

Table 10. Results of HFP Manila clam survey at Kakushdish Harbour 5, August 1999.

Abundance

Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	1,166	45.200	10.057	46.000	11.661	10	52,703	23,452	53,636	27,193
2	1,416	37.143	13.164	60.571	19.417	7	52,594	37,280	85,769	54,988
Total	2,582	40.781	8.529	53.991	11.879	17	105,297	49,816	139,405	70,730
				df Legals	9.31		t Legals	2.2622	Leg precision	47.3%
				df Subl	8.07		t Subl	2.3060	Subl precision	50.7%

Biomass

Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	1,166	0.927	0.174	0.369	0.100	10	1,081	405	430	233
2	1,416	0.768	0.244	0.512	0.182	7	1,088	691	725	514
Total	2,582	0.840	0.155	0.448	0.109	17	2,169	923	1,156	668
				df Legals	8.89		t Legals	2.3060	Leg precision	42.6%
				df Subl	7.75		t Subl	2.3646	Subl precision	57.8%

Table 11. Results of HFP Manila clam survey at Rainbow Island, August 1999.

Abundance

Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	1,980	30.000	12.977	25.200	15.064	10	59,400	51,390	49,896	59,654
2	1,050	24.667	8.843	193.333	66.234	6	25,900	18,570	203,000	139,092
Total	3,030	28.152	9.017	83.464	24.974	16	85,300	59,528	252,896	185,164
				df Legals	12.30		t Legals	2.1788	Leg precision	69.8%
				df Subl	6.12		t Subl	2.4469	Subl precision	73.2%

Biomass

Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	1,980	0.683	0.342	0.194	0.113	10	1,352	1,355	383	449
2	1,050	0.409	0.148	1.175	0.391	6	429	311	1,233	820
Total	3,030	0.588	0.229	0.534	0.154	16	1,781	1,549	1,617	1,144
				df Legals	10.51		t Legals	2.2281	Leg precision	86.9%
				df Subl	6.84		t Subl	2.4469	Subl precision	70.8%

Table 12. Results of HFP Manila clam survey at Gale Passage, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	3,000	64.800	16.580	263.600	69.193	10	194,400	99,481	790,800	415,156
Total	3,000	64.800	16.580	263.600	69.193	10	194,400	112,520	790,800	469,575
				df Legals	9.00		t Legals	2.2622	Leg precision	57.9%
				df Subl	9.00		t Subl	2.2622	Subl precision	59.4%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	3,000	1.436	0.402	0.710	0.189	10	4,307	2,413	2,130	1,132
Total	3,000	1.436	0.402	0.710	0.189	10	4,307	2,730	2,130	1,280
				df Legals	9.00		t Legals	2.2622	Leg precision	63.4%
				df Subl	9.00		t Subl	2.2622	Subl precision	60.1%

Table 13. Results of HFP Manila clam survey at Gale Creek, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	3,192	4.000	2.458	14.400	8.642	10	12,768	15,689	45,965	55,169
Total	3,192	4.000	2.458	14.400	8.642	10	12,768	17,746	45,965	62,400
				df Legals	9.00		t Legals	2.2622	Leg precision	139.0%
				df Subl	9.00		t Subl	2.2622	Subl precision	135.8%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	3,192	0.139	0.079	0.045	0.031	10	444	503	142	196
Total	3,192	0.139	0.079	0.045	0.031	10	444	569	142	222
				df Legals	9.00		t Legals	2.2622	Leg precision	128.2%
				df Subl	9.00		t Subl	2.2622	Subl precision	156.4%

Table 14. Results of HFP Manila clam survey at Joassa Channel, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	126	6.800	3.236	10.800	4.798	10	857	816	1,361	1,209
2	399	42.800	17.269	25.600	7.309	10	17,077	13,781	10,214	5,833
Total	525	34.160	13.148	22.048	5.673	20	17,934	15,614	11,575	6,737
				df Legals	9.06		t Legals	2.2622	Leg precision	87.1%
				df Subl	9.76		t Subl	2.2622	Subl precision	58.2%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	126	0.158	0.081	0.062	0.029	10	20	20	8	7
2	399	1.016	0.420	0.265	0.072	10	405	335	106	58
Total	525	0.810	0.320	0.217	0.055	20	425	380	114	66
				df Legals	9.07		t Legals		Leg precision	89.4%
				df Subl	9.29		t Subl		Subl precision	57.7%

Table 15. Results of HFP Manila clam survey at Raymond Passage, August 1999.

Abundance										
Stratum	Area (m^2)	Mean No. Legals (clams/m^2)	S.E. Legals (clams/m^2)	Mean No. Sublegals (clams/m^2)	S.E. Sublegals (clams/m^2)	n	Estimated Legal Stock (clams)	95% CI	Estimated Sublegal Stock (clams)	95% CI
1	1,360	41.600	8.123	11.800	2.961	20	56,576	22,094	16,048	8,053
Total	1,360	41.600	8.123	11.800	2.961	20	56,576	23,122	16,048	8,428
				df Legals	19.00		t Legals	2.0930	Leg precision	40.9%
				df Subl	19.00		t Subl	2.0930	Subl precision	52.5%

Biomass										
Stratum	Area (m^2)	Mean Wt Legals (kg/m^2)	S.E. Legals (kg/m^2)	Mean Wt Sublegals (kg/m^2)	S.E. Sublegals (kg/m^2)	n	Estimated Legal Stock (kg)	95% CI	Estimated Sublegal Stock (kg)	95% CI
1	1,360	1.016	0.199	0.103	0.025	20	1,381	542	140	69
Total	1,360	1.016	0.199	0.103	0.025	20	1,381	567	140	72
				df Legals	19.00		t Legals	2.0930	Leg precision	41.1%
				df Subl	19.00		t Subl	2.0930	Subl precision	51.2%

Table 16. Estimates of maximum constant yield (MCY) for the Area 7 Manila clam fishery, based on average catch (Y_{av}) from the 1992/93 through 1998/99 seasons and natural variability factors (*c*) ranging from 0.6 to 1.0.

Y_{av} (t)	*c*	MCY (t)	MCY (lb)
73.5	0.6	44.1	96,978
73.5	0.8	58.8	129,304
73.5	1.0	73.5	161,629

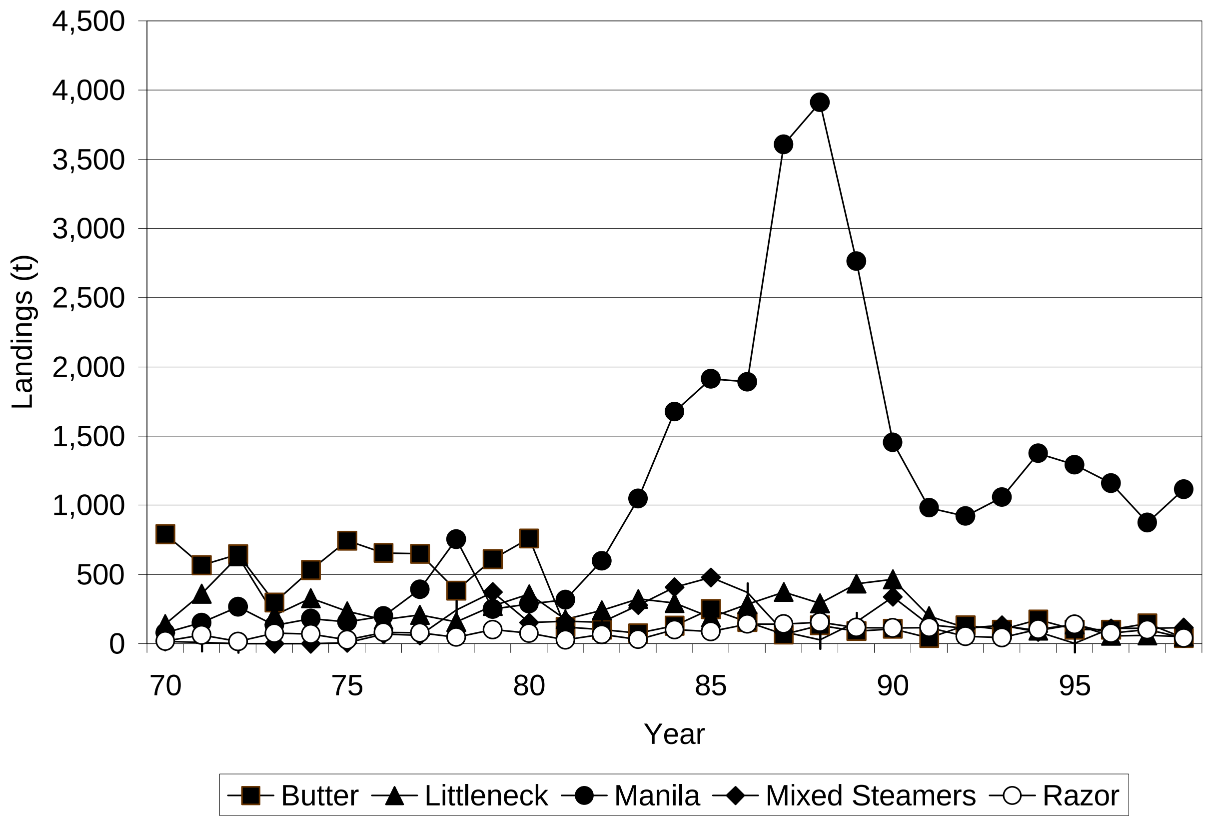


Figure 1. Annual landings (t) of intertidal clams from commercial clam fisheries in British Columbia, 1970-98. 1997 and 1998 statistics are preliminary.

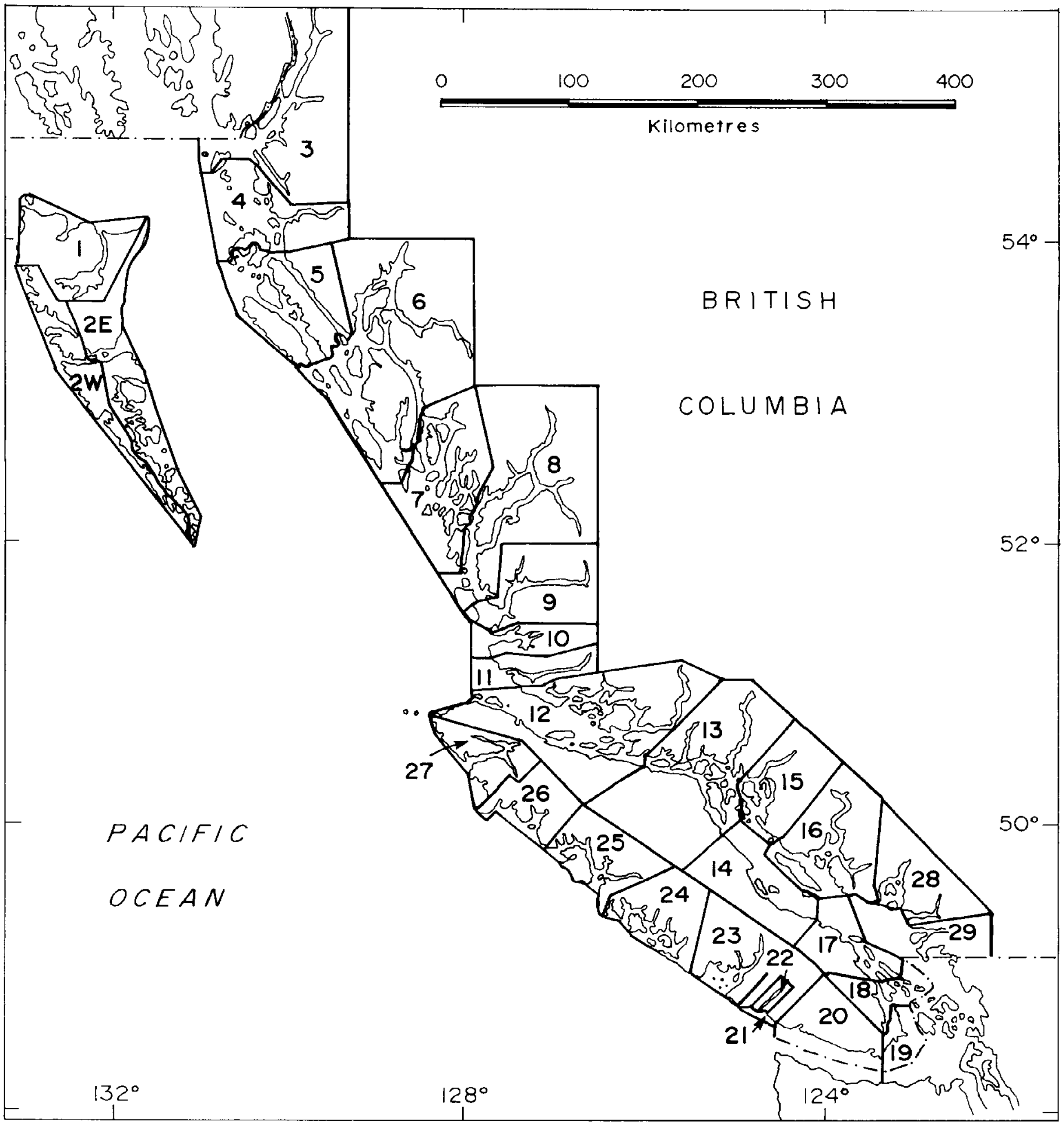


Figure 2. Pacific Fisheries Management Area boundaries for coastal British Columbia.

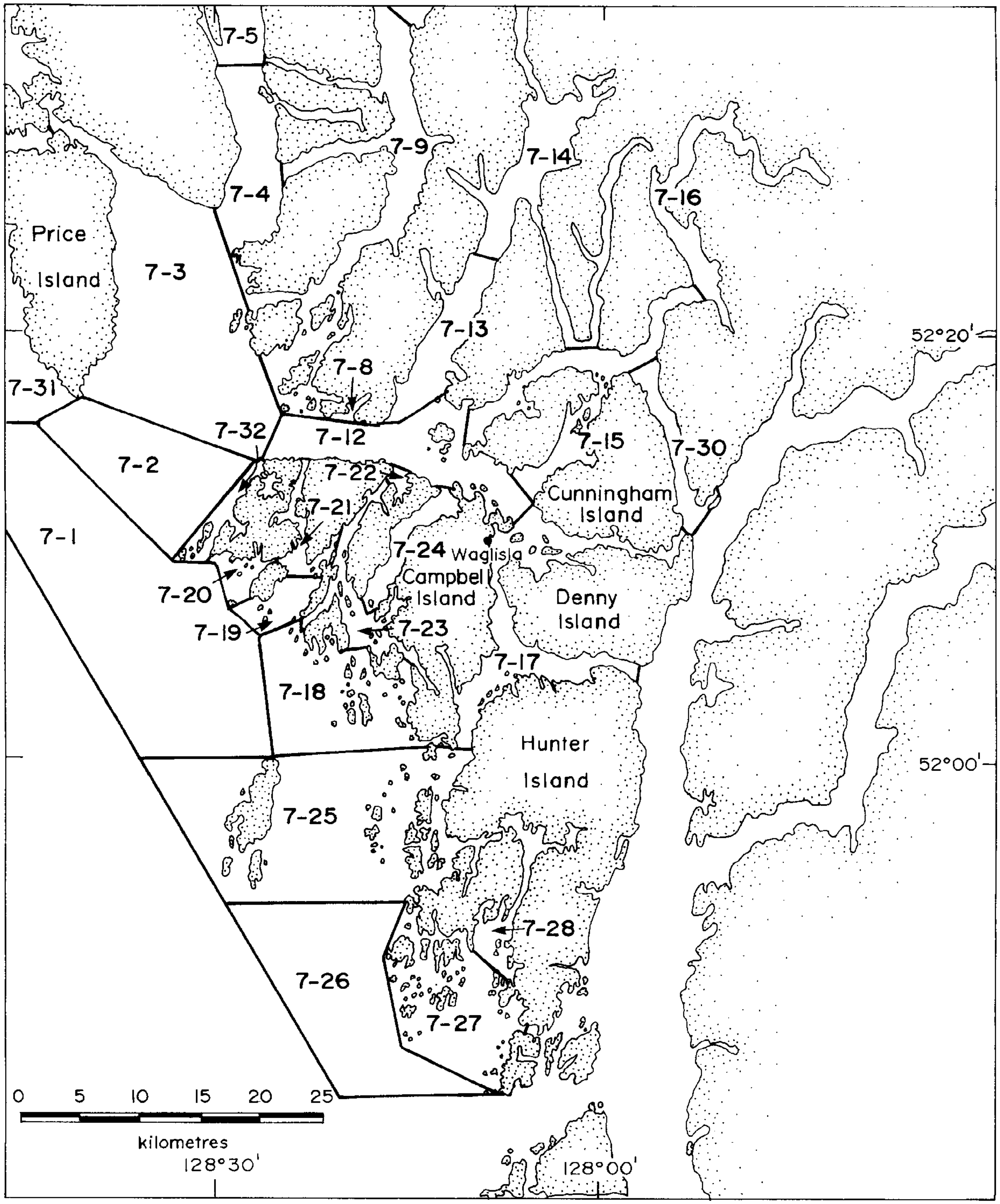


Figure 3. Pacific Fisheries Management Subarea boundaries in the portion of PFMA 7 opened to the Area 7 clam fishery.

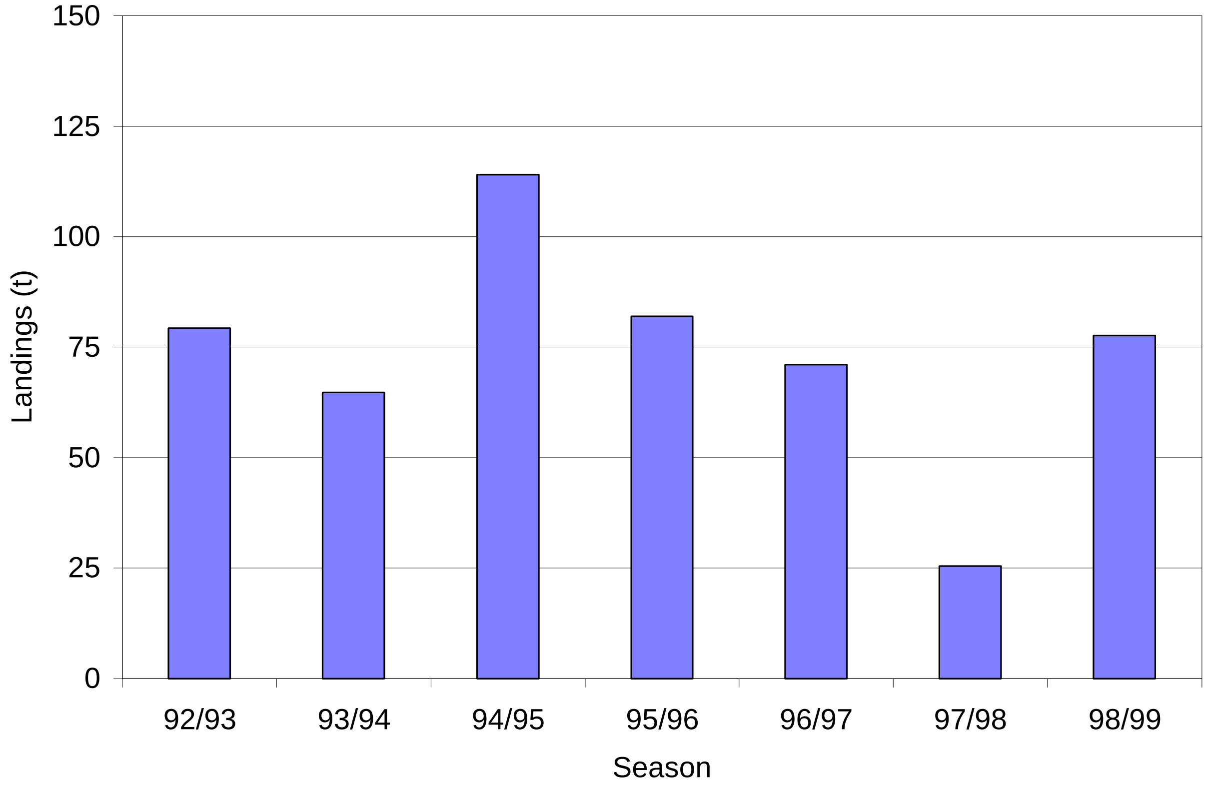


Figure 4. Landings (t) of Manila clams by season from the Area 7 commercial clam fishery.

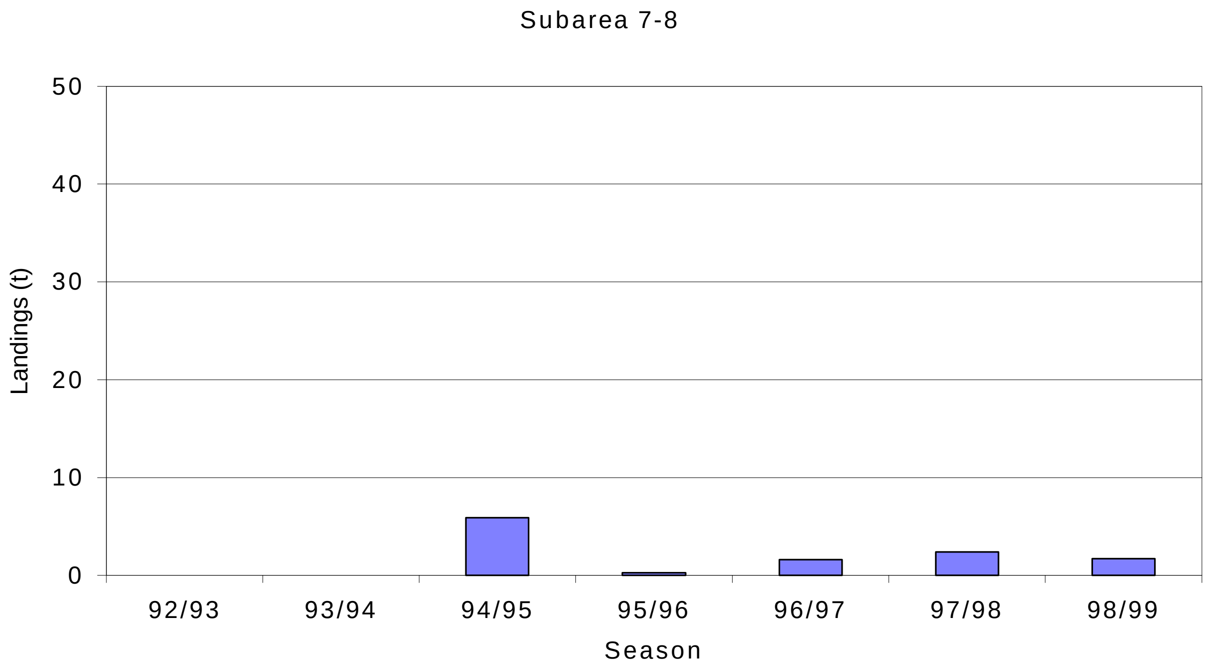


Figure 5. Landings (t) of Manila clams from PFMA 7-8/7-9 (Berry Inlet/Reid Passage) by season.

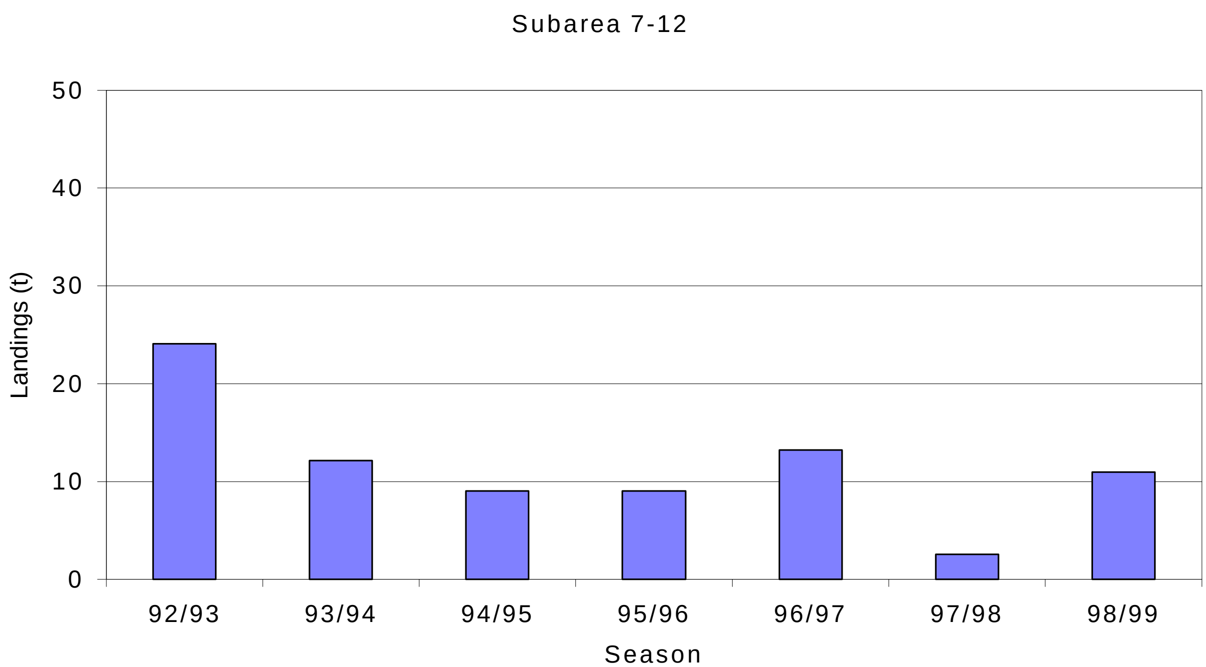


Figure 6. Landings (t) of Manila clams from PFMA 7-12 (Seaforth Channel) by season.

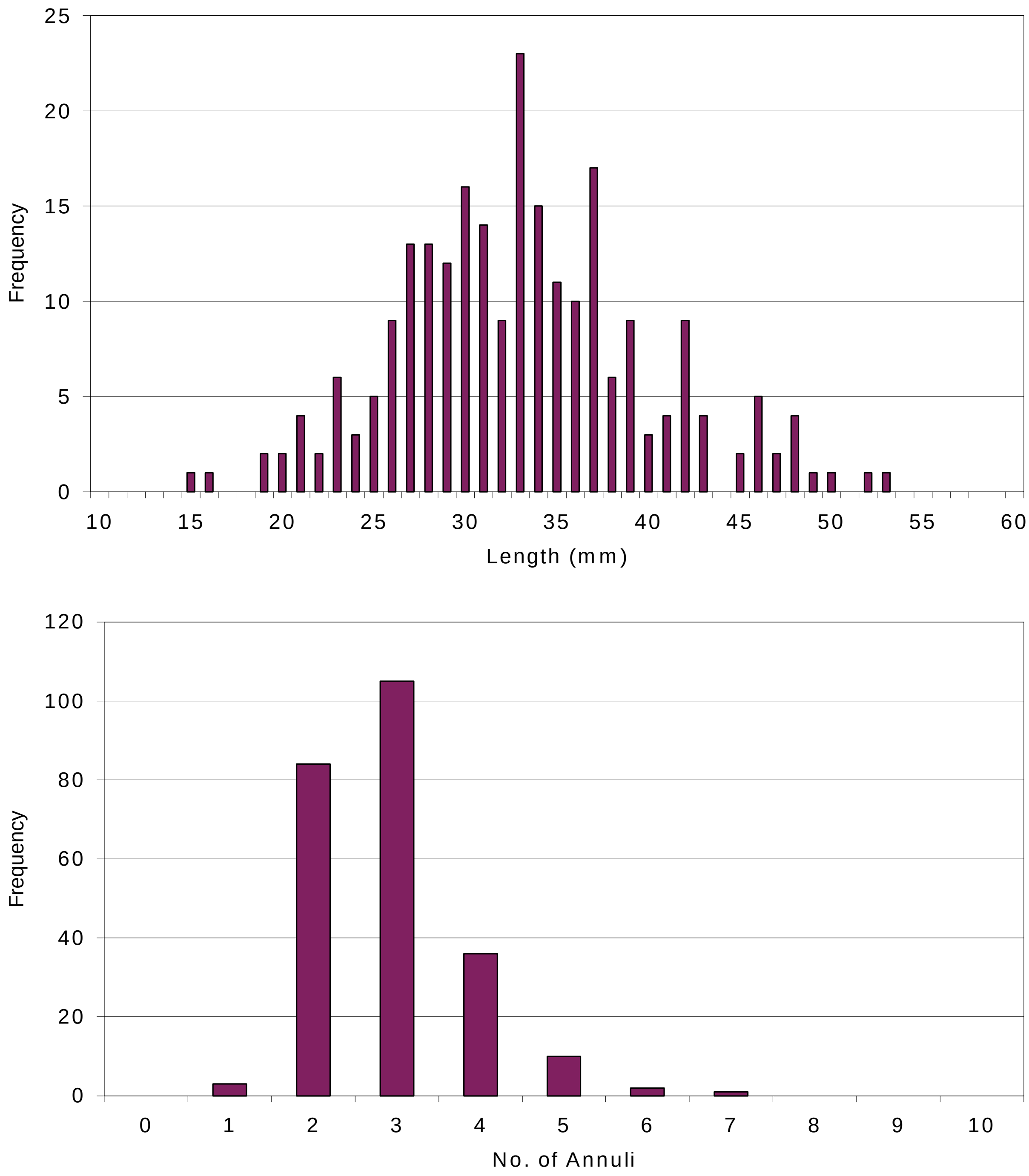


Figure 7. Length and age frequency distributions of Manila clams from Bachelor Bay Beach 1, August 1999.

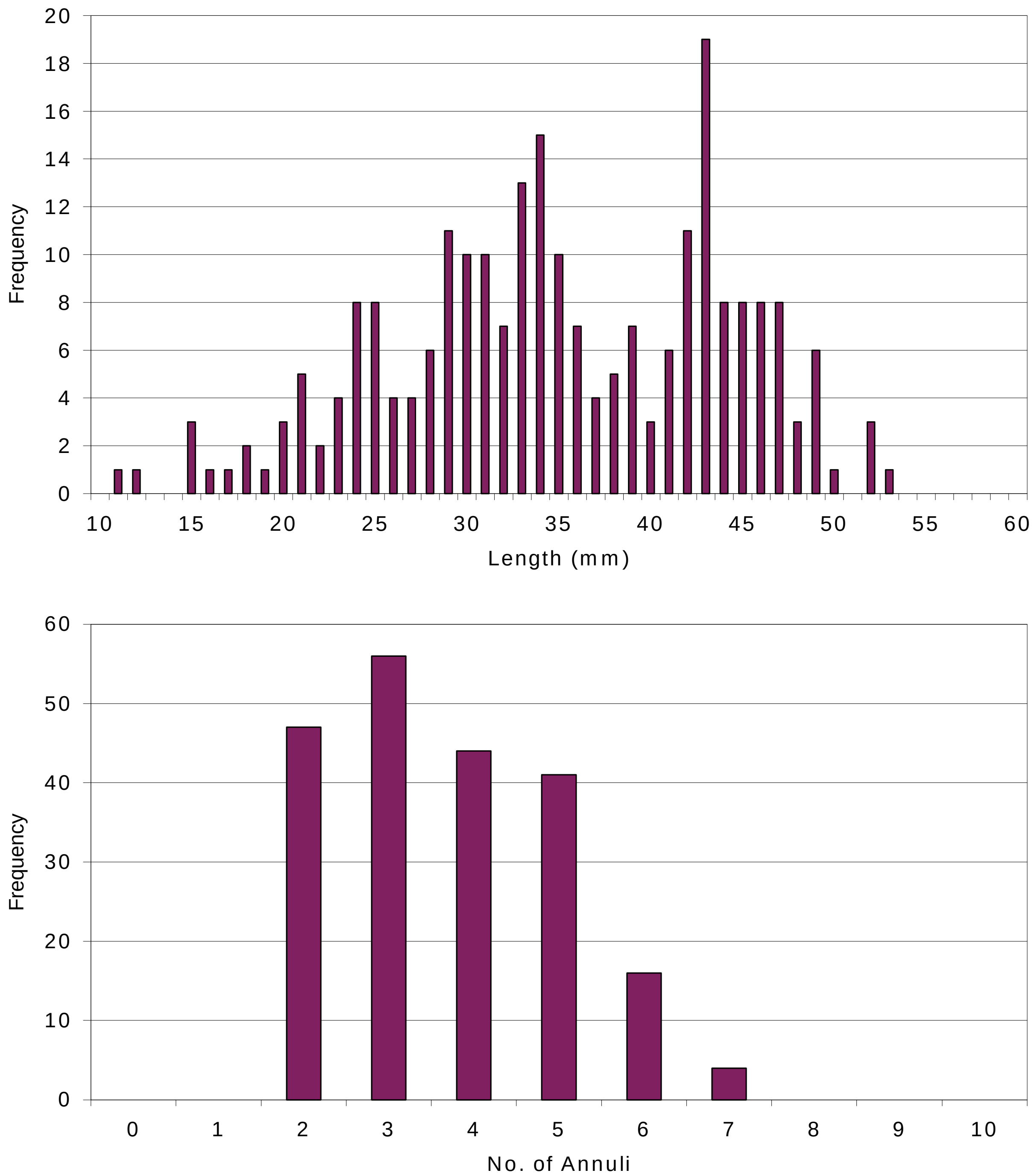
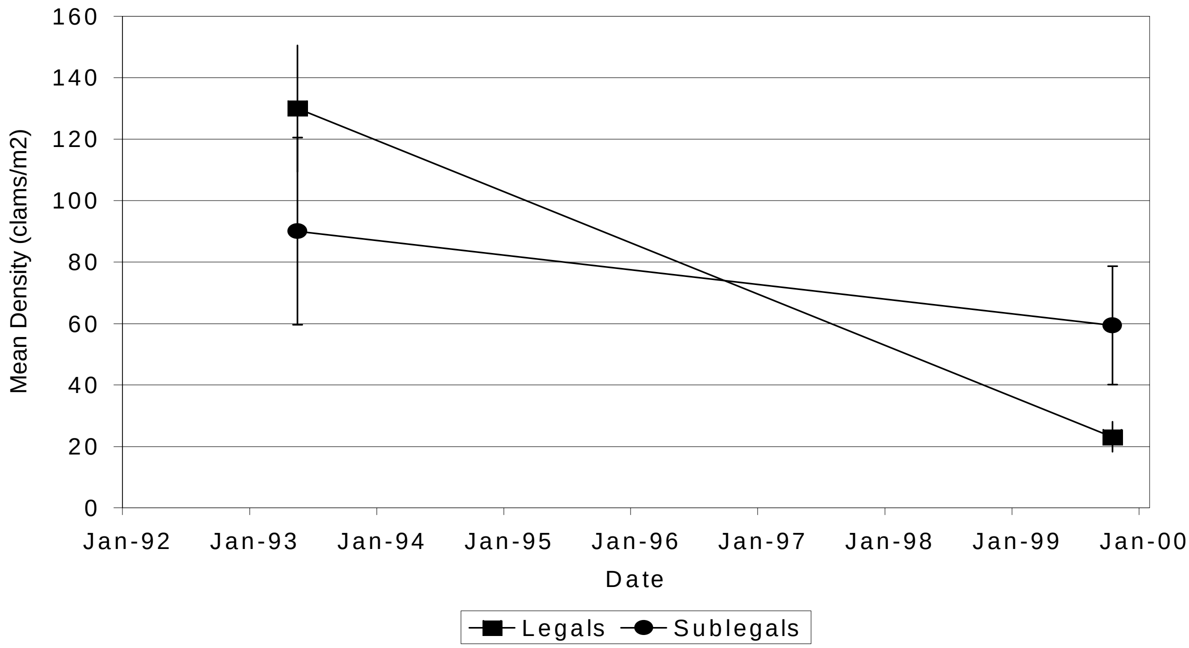


Figure 8. Length and age frequency distributions of Manila clams from Odin Cove, August 1999.



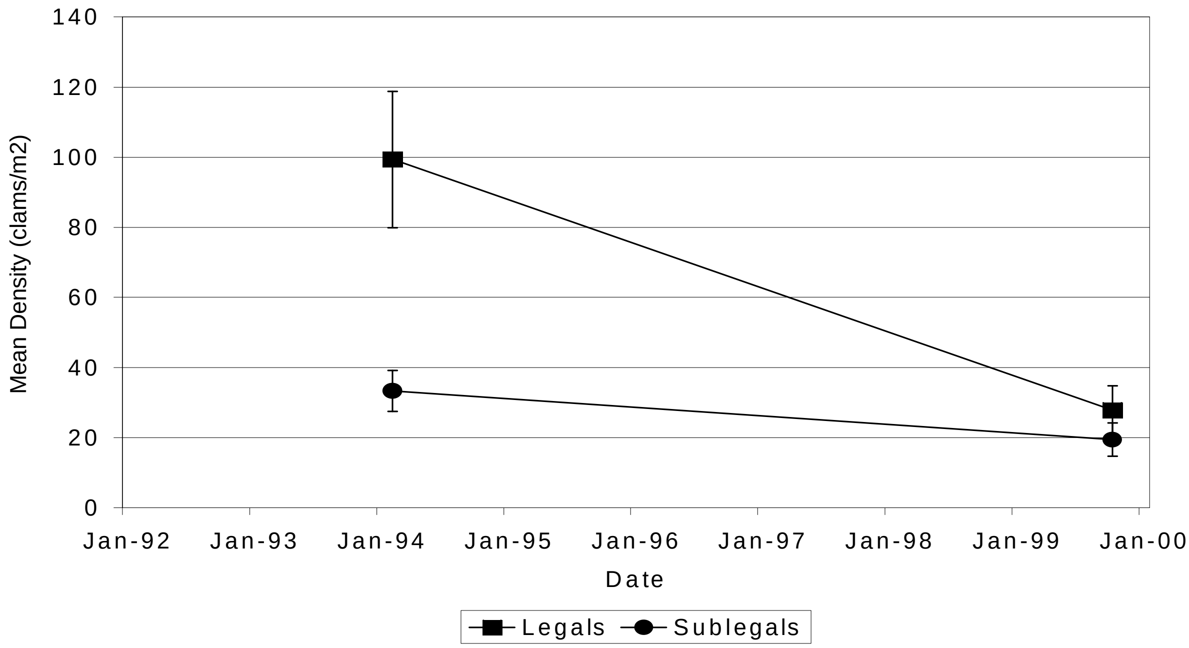


Figure 9. Time series of Manila clam mean densities by size class from HFP surveys at Bachelor Bay 1 (upper panel) and Odin Cove (lower panel), 1992-99. Error bars are ±1 SE.

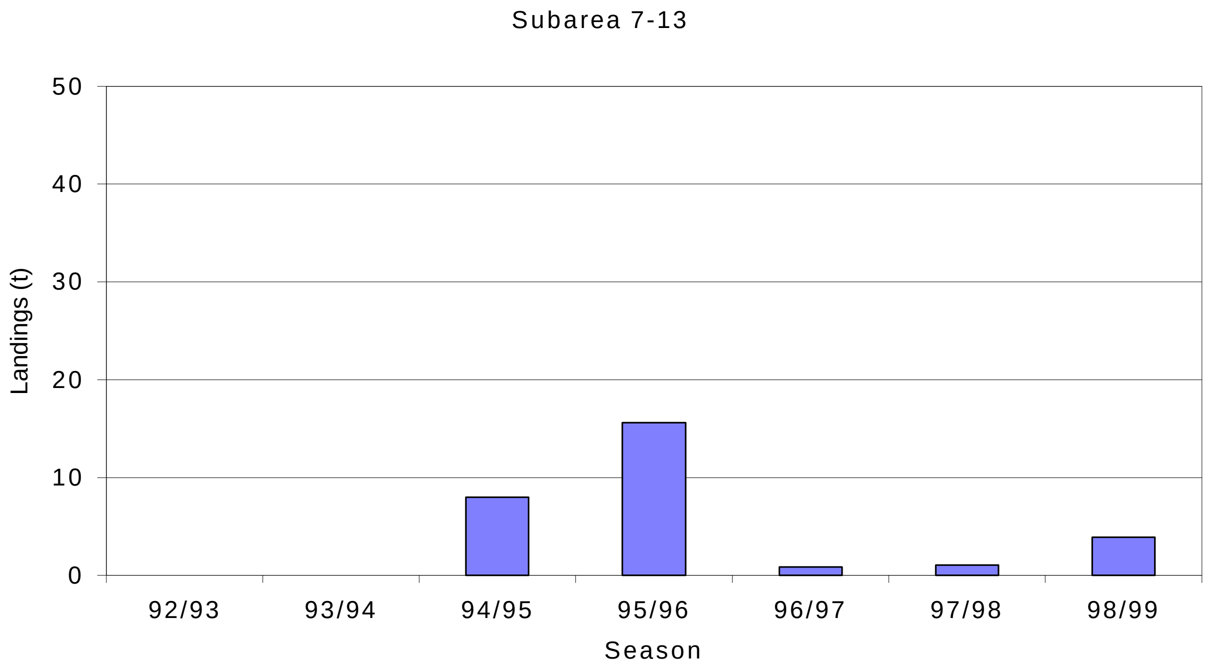


Figure 10. Landings (t) of Manila clams from PFMA 7-13 (Spiller Channel) by season.

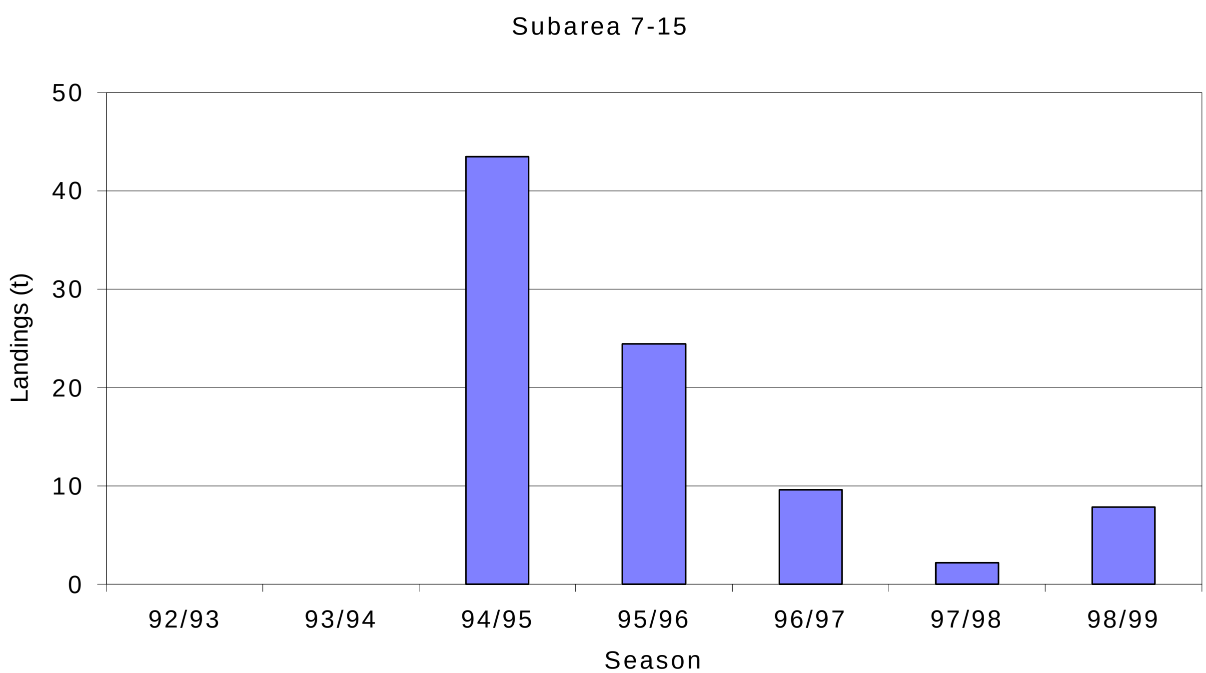


Figure 11. Landings (t) of Manila clams from PFMA 7-15 (Return Channel/Troup Passage) by season.

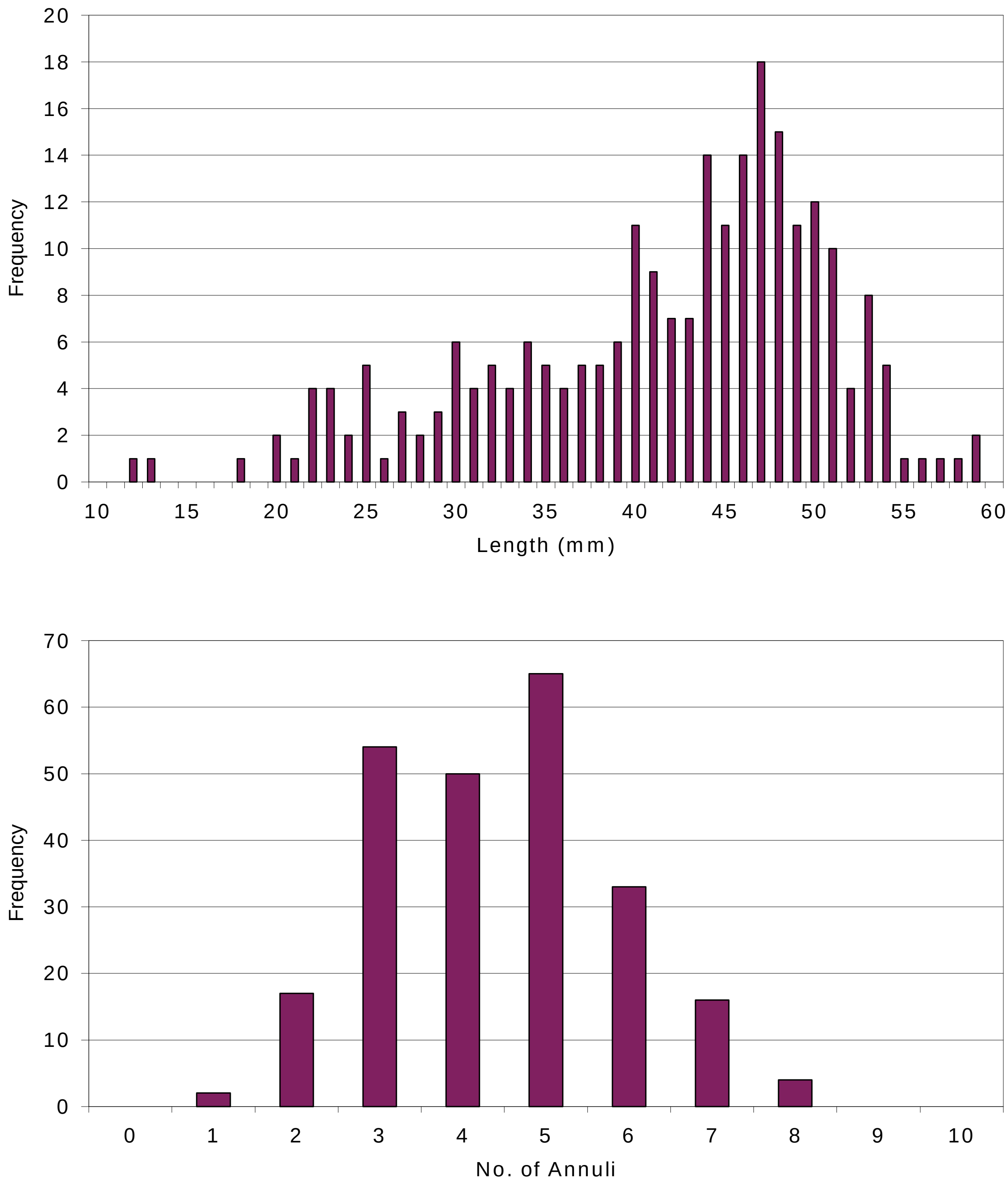


Figure 12. Length and age frequency distributions of Manila clams from Troup Passage Beach 1, August 1999.

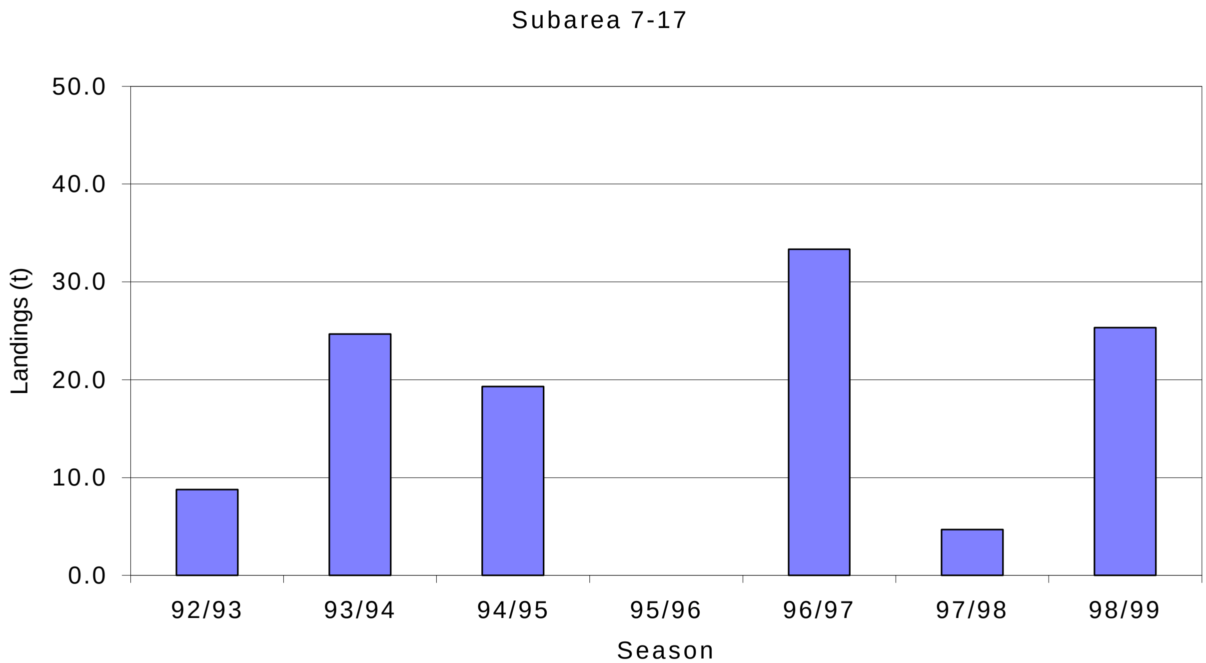


Figure 13. Landings (t) of Manila clams from PFMA 7-17 (Lama Passage/Gunboat Passage/ Hunter Channel) by season.

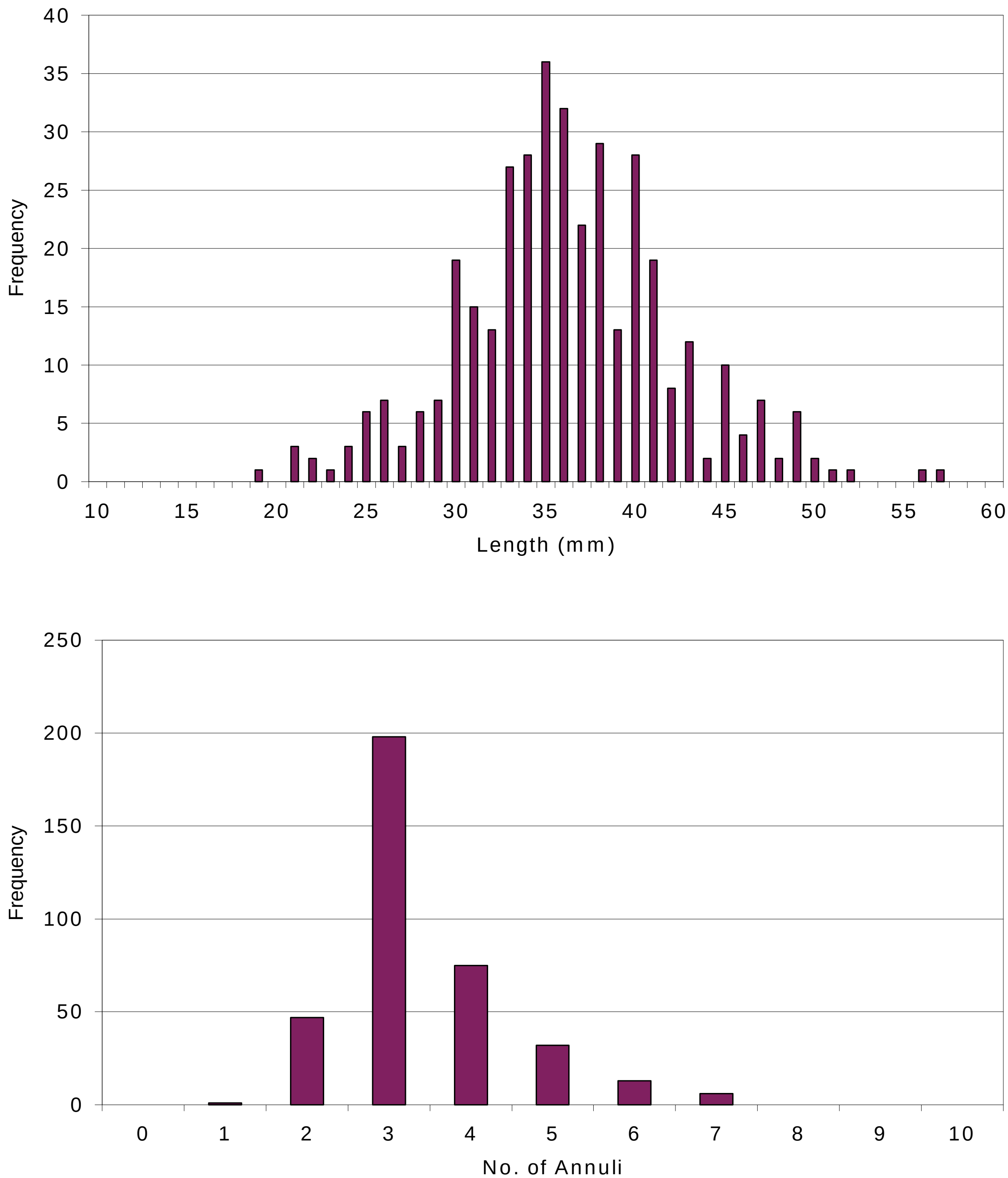
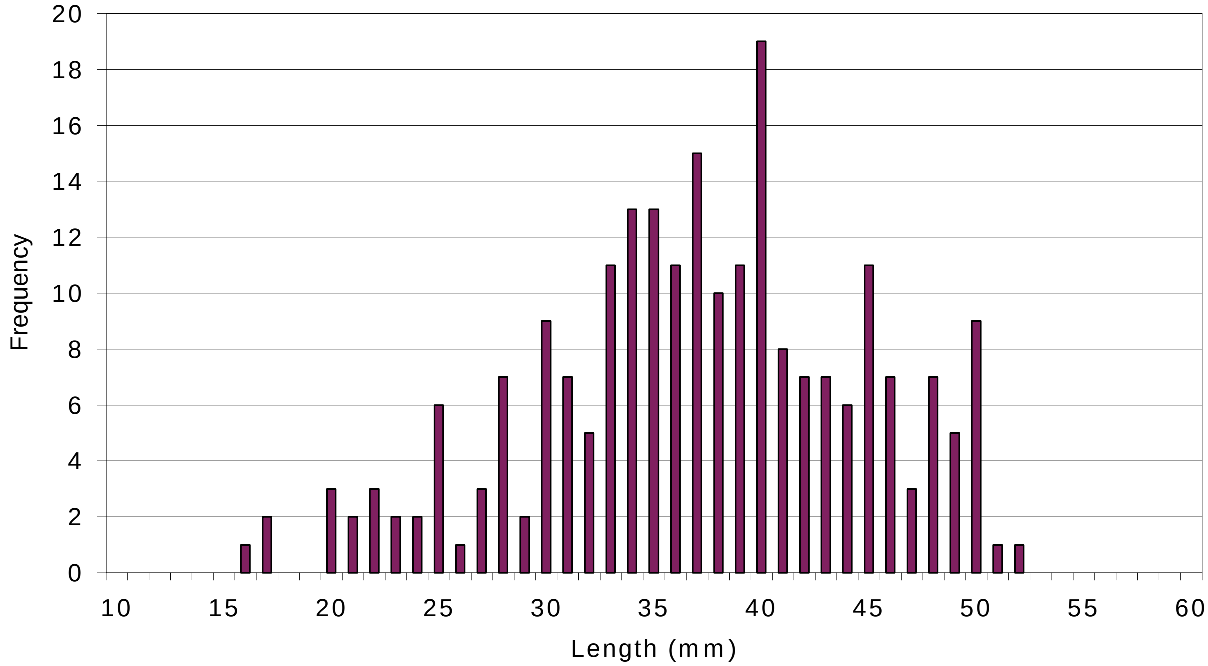


Figure 14. Length and age frequency distributions of Manila clams from Kakushdish Harbour Beach 1, August 1999.



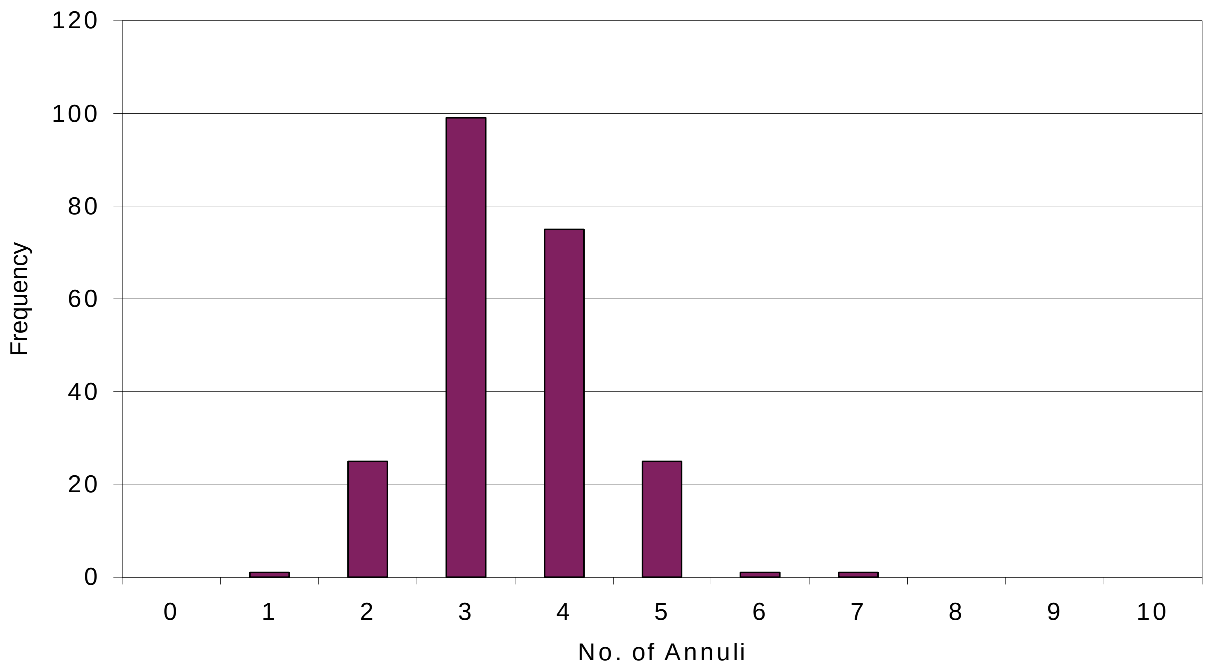


Figure 15. Length and age frequency distributions of Manila clams from Kakushdish Harbour Beach 2, August 1999.

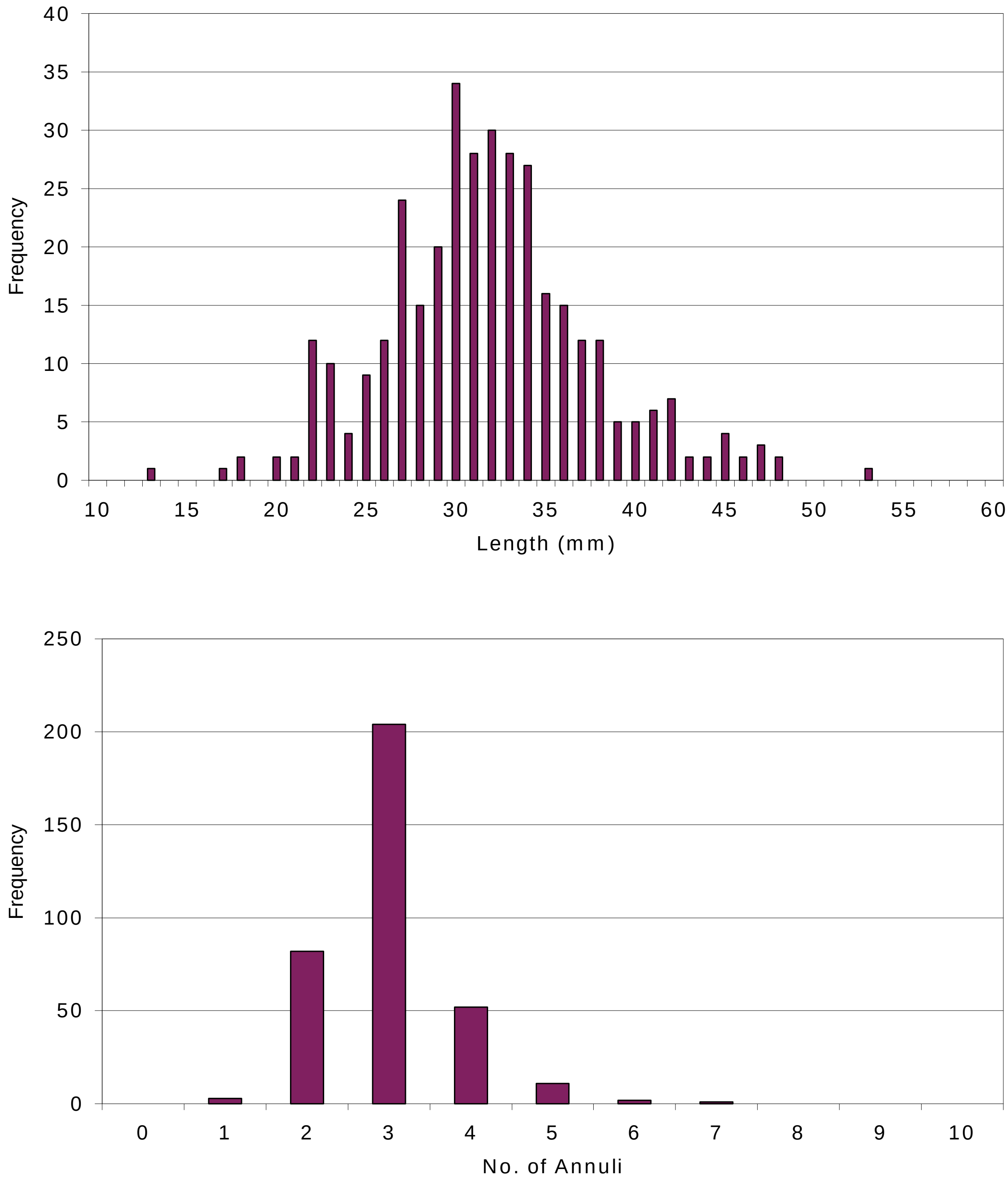
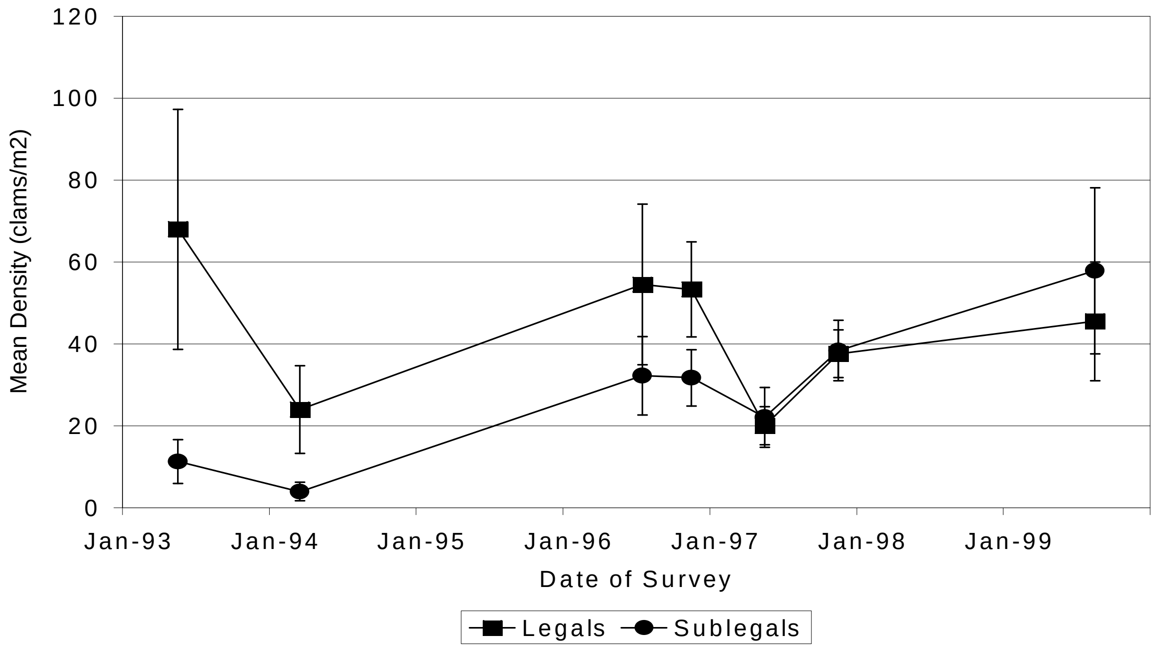


Figure 16. Length and age frequency distributions of Manila clams from Rainbow Island, August 1999.



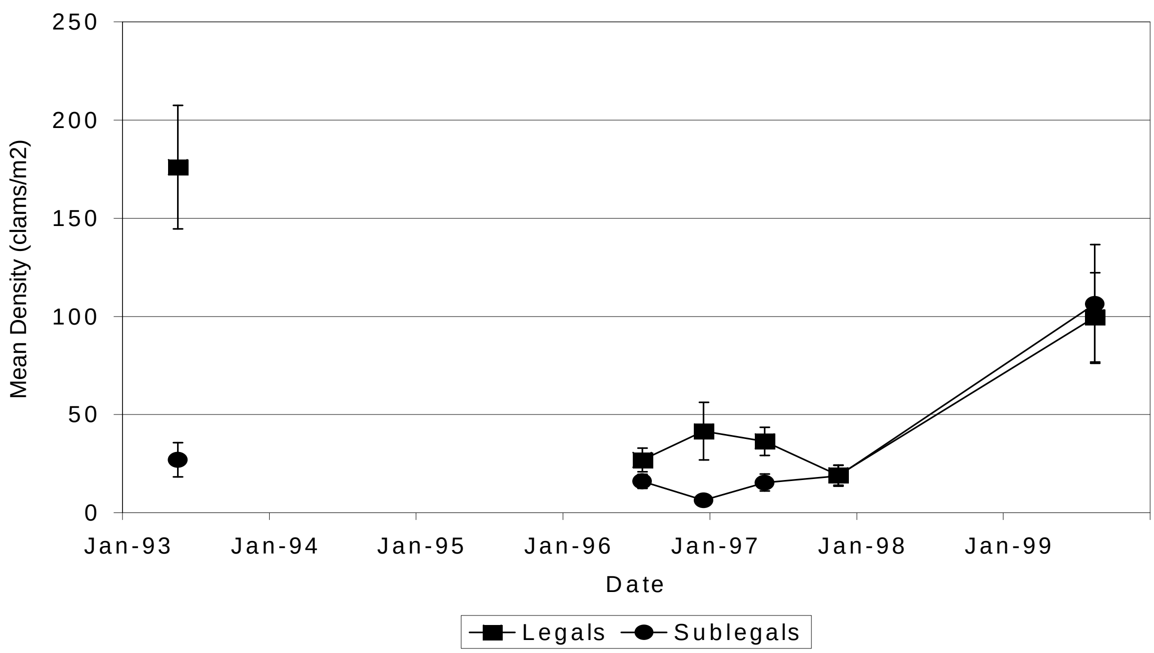


Figure 17. Time series of Manila clam mean density by size class, Kakushdish Harbour 1 (upper panel) and Kakushdish Harbour 2 (lower panel) from HFP surveys, 1992-99. Error bars are ± 1 SE.

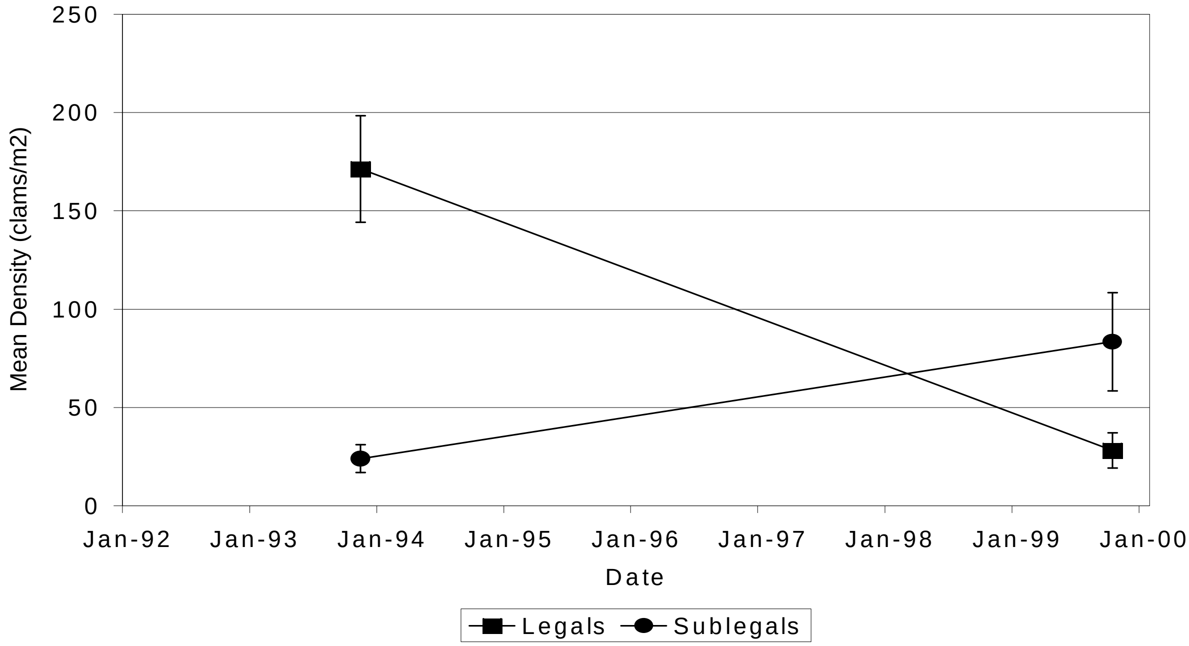


Figure 18. Time series of Manila clam mean densities by size class from HFP surveys at Rainbow Island 3, 1992-99. Error bars are ± 1 SE.

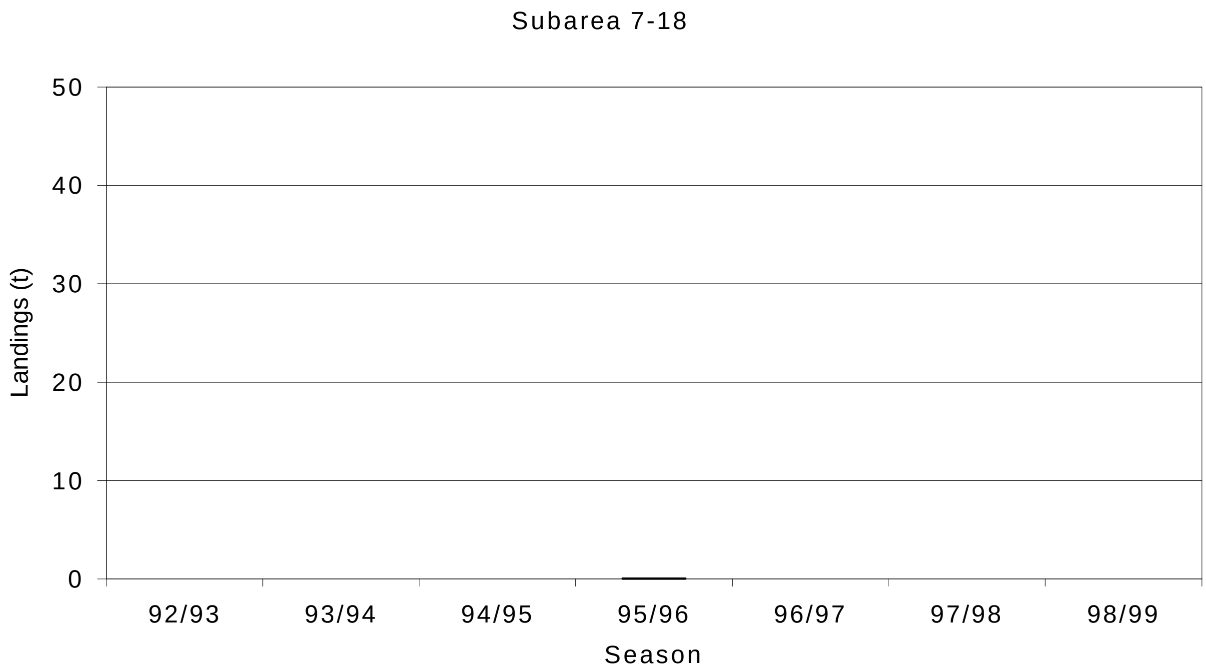


Figure 19. Landings (t) of Manila clams from PFMA 7-18 (Tribal Group) by season.

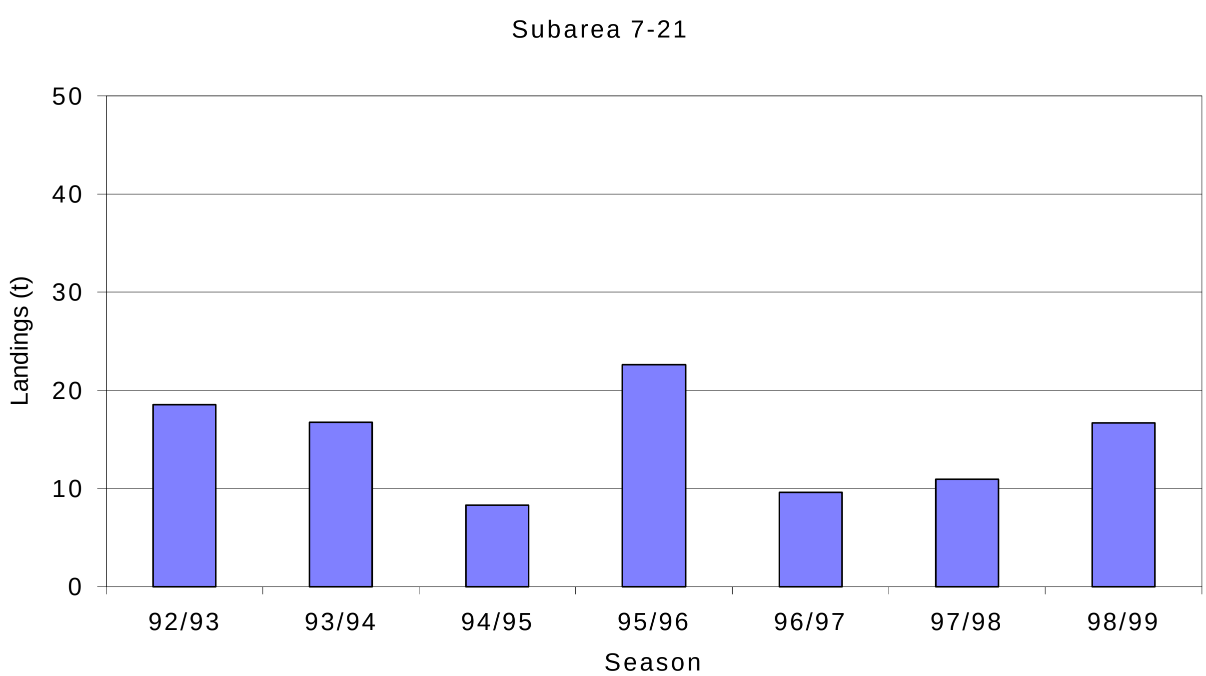


Figure 20. Landings (t) of Manila clams from PFMA 7-21 (Gale Passage) by season.

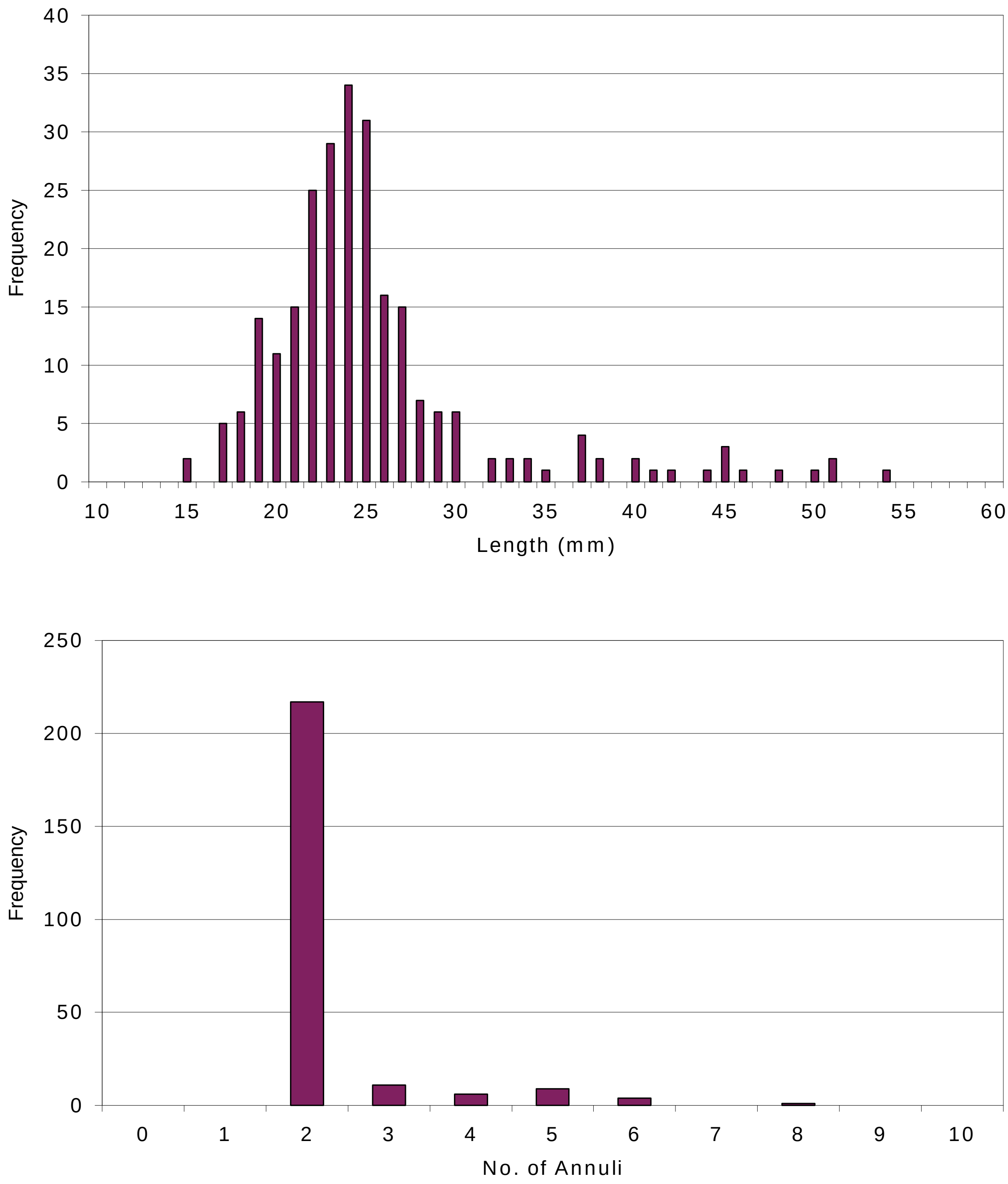


Figure 21. Length and age frequency distributions of Manila clams from Gale Passage Beach 1, August 1999.

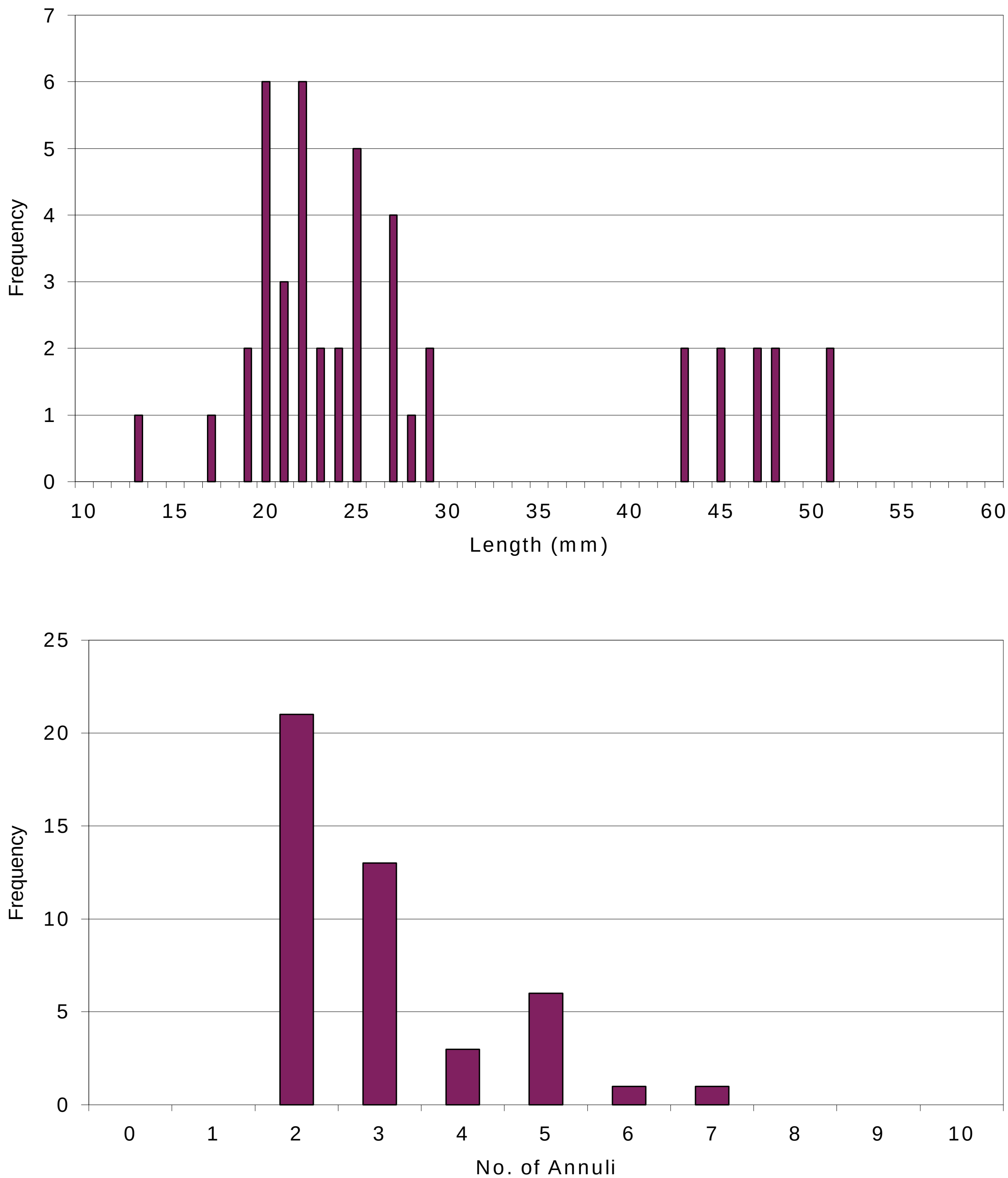


Figure 22. Length and age frequency distributions of Manila clams from Gale Creek, August 1999.

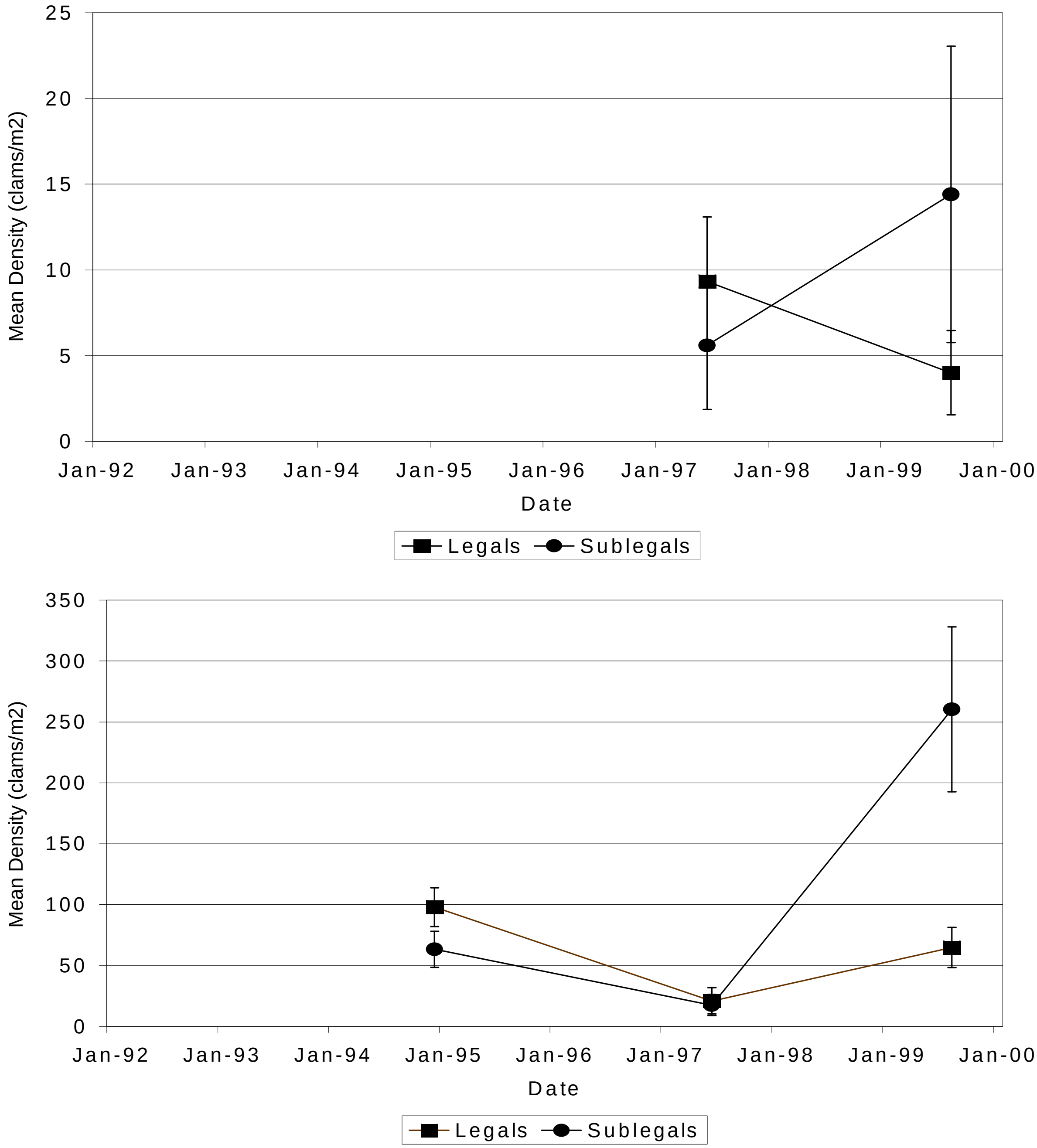


Figure 23. Time series of Manila clam mean density by size class from HFP surveys at Gale Creek (upper panel) and Gale Passage 2 (lower panel), 1992-99. Error bars are ± 1 SE.

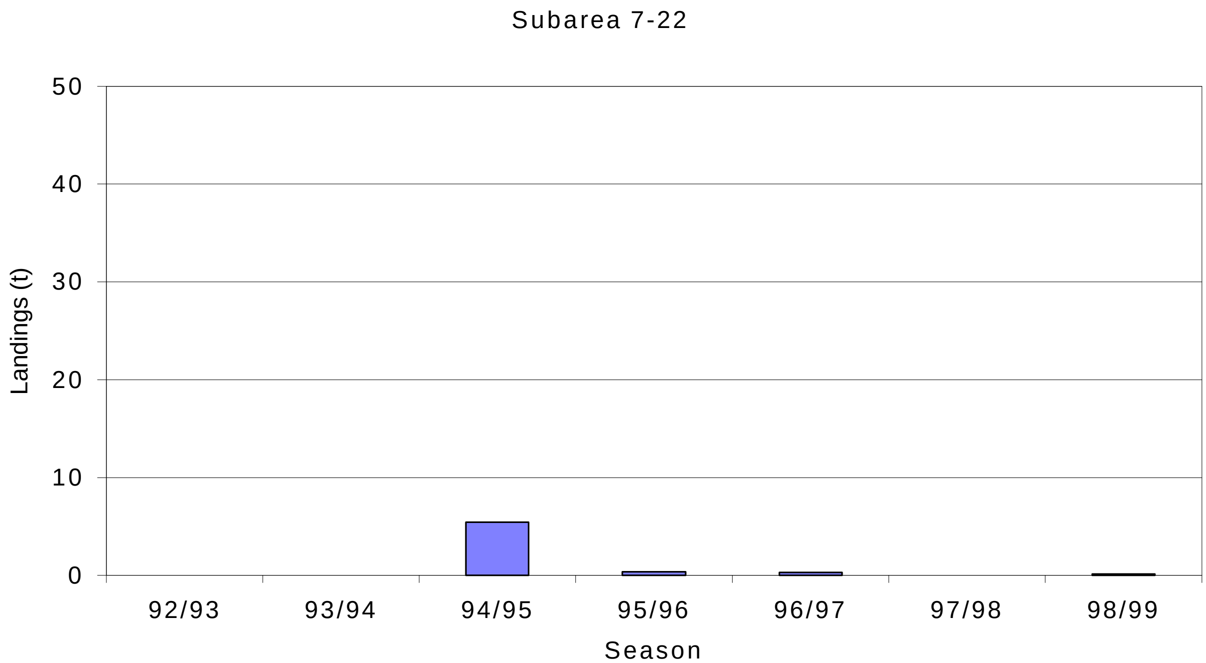


Figure 24. Landings (t) of Manila clams from PFMA 7-22 (Dundivan Inlet) by season.

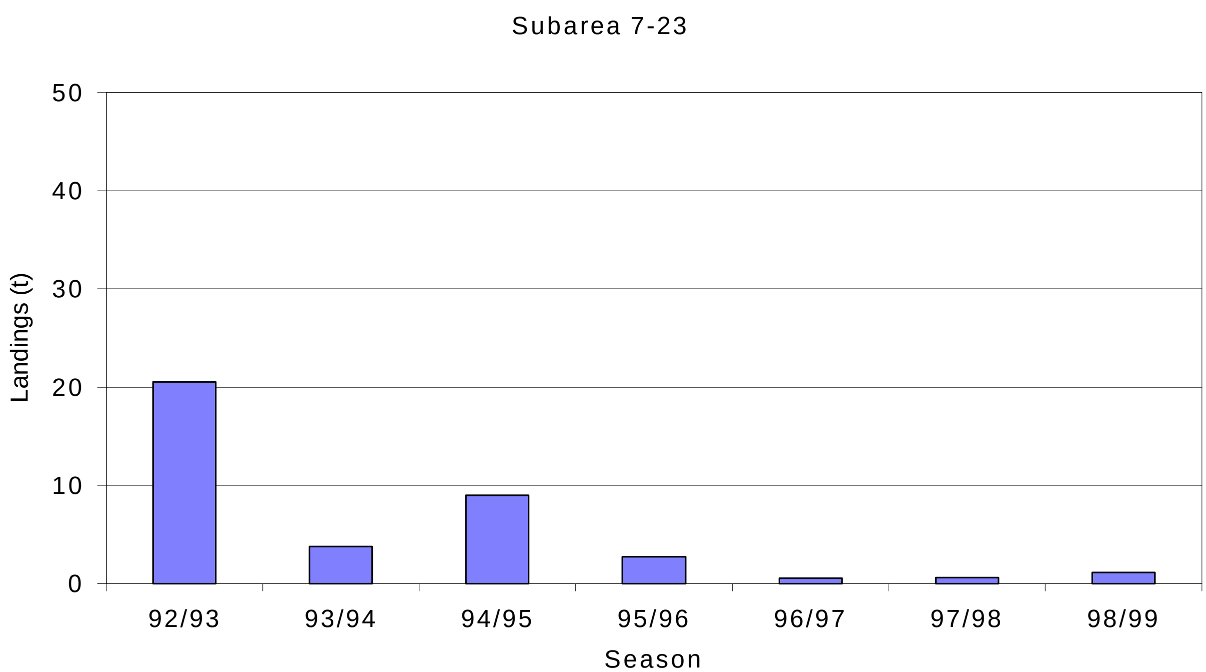


Figure 25. Landings (t) of Manila clams from PFMA 7-23 (Joassa Channel/Louise Channel) by season.

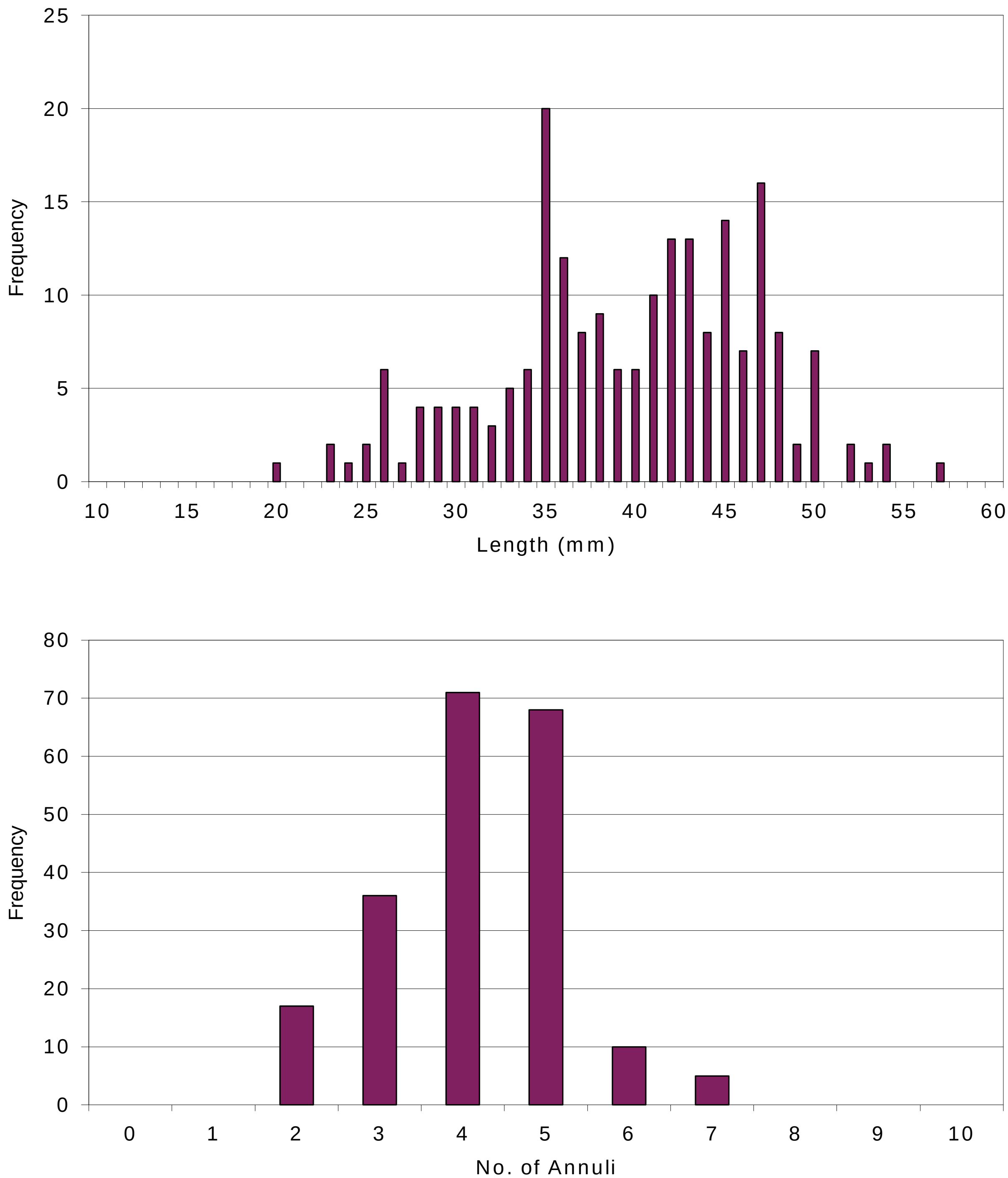


Figure 26. Length and age frequency distributions of Manila clams from Joassa Channel, August 1999.

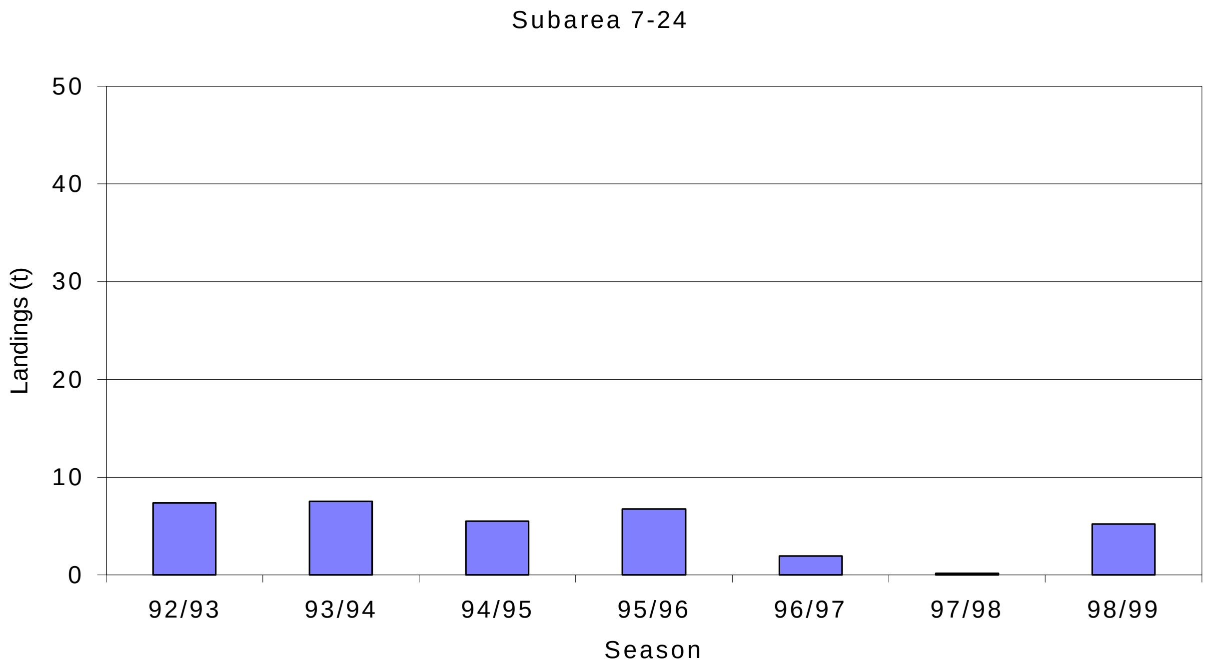
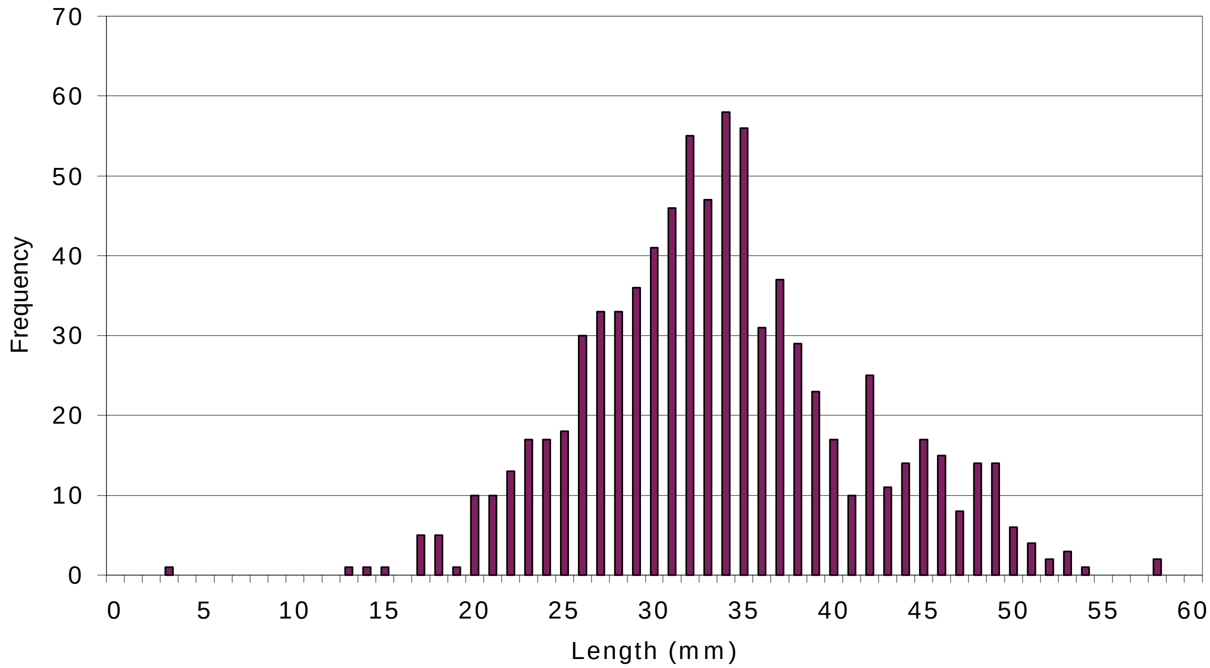


Figure 27. Landings (t) of Manila clams from PFMA 7-24 (Raymond Passage) by season.



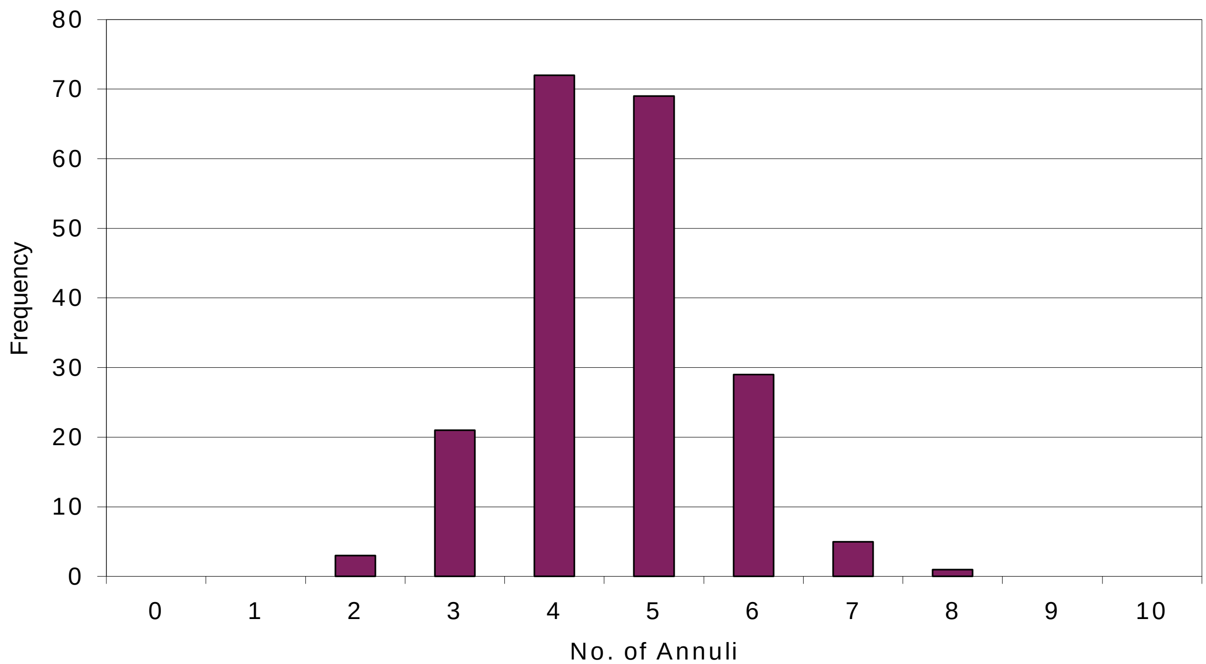


Figure 28. Length and age frequency distributions of Manila clams from Raymond Passage, August 1999.

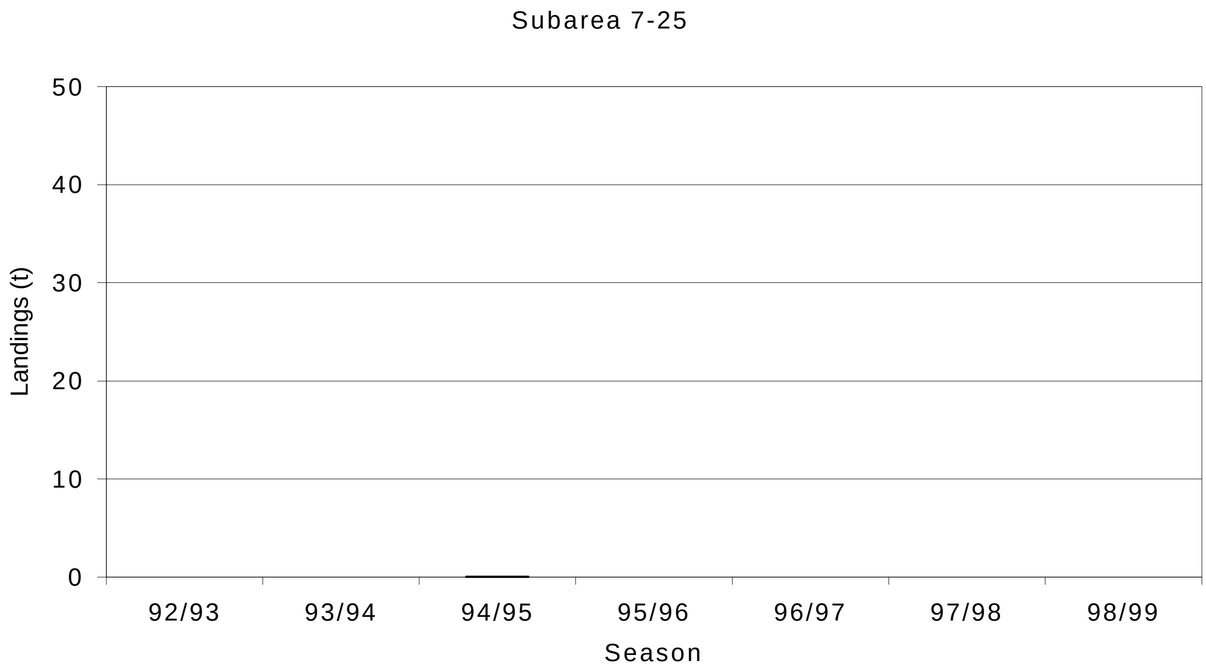


Figure 29. Landings (t) of Manila clams from PFMA 7-25 (Queen Sound) by season.

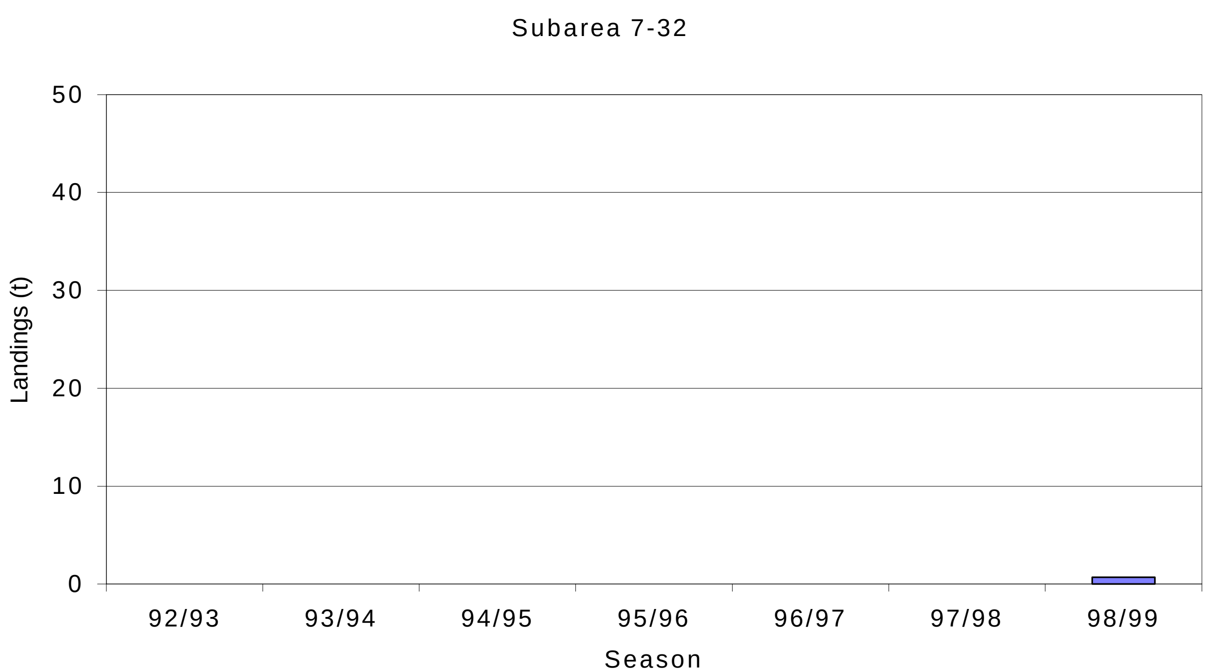
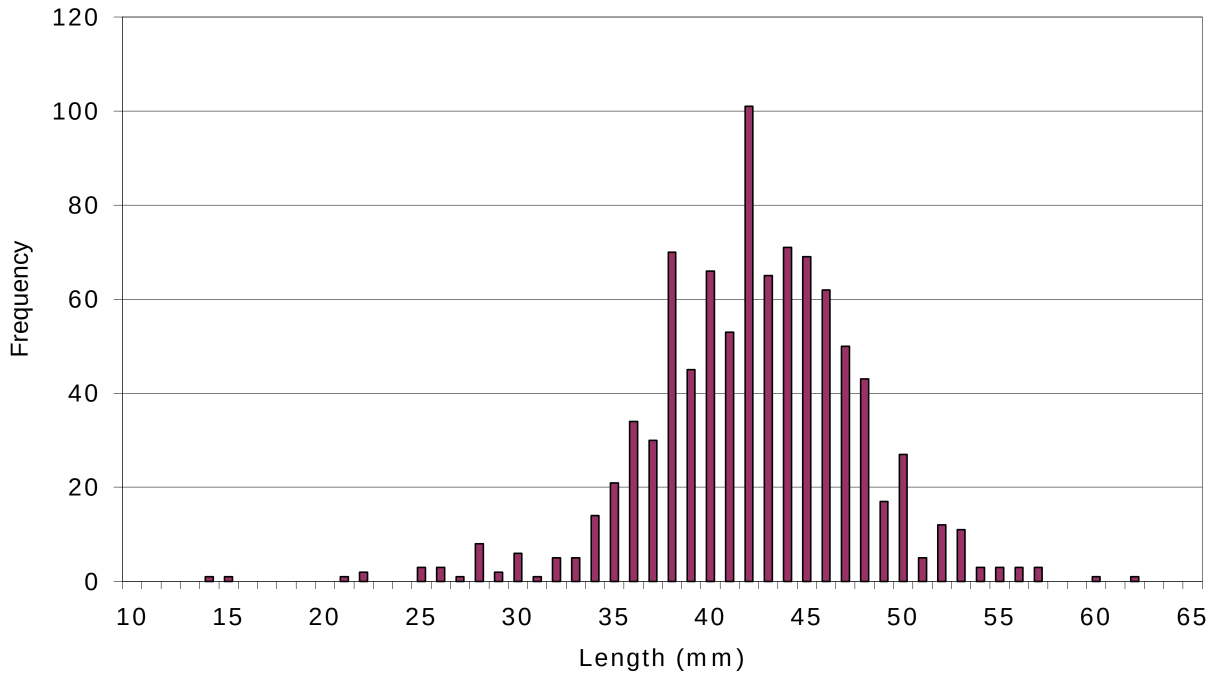


Figure 30. Landings (t) of Manila clams from PFMA 7-32 (St. John Harbour) by season.



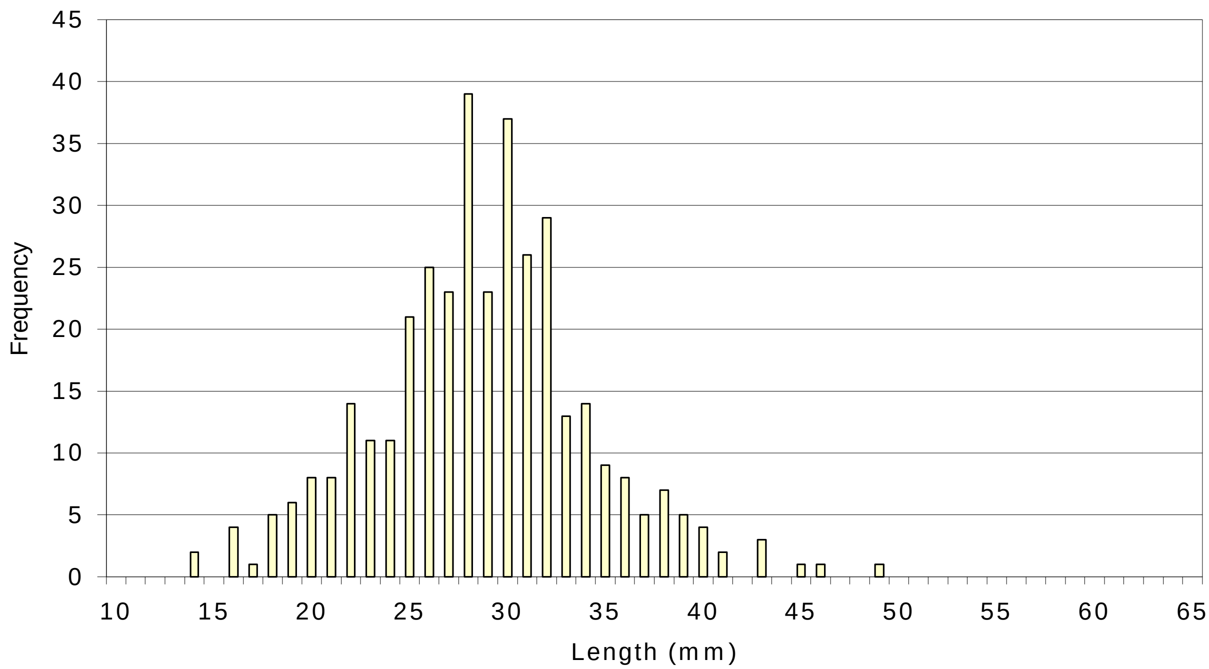


Figure 31. Length frequency distributions of Manila (upper panel) and littleneck clams (lower panel) from an HFP survey at Defeat Point, November 10, 1993.