Identification and Distribution of Subtidal and Intertidal Shellfish Populations in Tillamook Bay, Oregon

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EXECUTIVE SUMMARY

An increase in the commercial and recreational harvest of clams in Tillamook Bay, Oregon, coupled with a general lack of knowledge about the bay's ecology, served as the impetus for a shellfish survey undertaken in the summer of 1995. Commercial clam harvest has increased twelve fold since 1978 (Carter et al 1994). Recreational harvest has nearly tripled since 1993, although it is still far below the recreational harvest from the early 1970s (Johnson pers com 1995). The 1995 survey served as a precursor to a more extensive survey to be completed in 1996, and was designed to provide a qualitative assessment of clam distribution in the bay. By identifying those areas of the bay that support relatively dense populations of commercially and recreationally important species of clams, this report will assist in the design of the 1996 survey. It encompassed the northern half of the bay, and provided additional information about substrate type, flora, and fauna in the surveyed areas.

Methods were modeled after Hancock et al (1979) and consisted of identifying 92 sampling stations throughout the northern half of the bay. The 92 stations were selected to provide a variety of substrate type and depth. Two SCUBA divers used a two square foot sampling ring placed randomly at each station to identify an area that was then excavated to a depth of two feet using hand rakes. Clams found within the sampling volume were identified, measured, and in some cases, sent to Oregon Department of Fish and Wildlife (ODFW) for size measurement and age class analysis.

Data collected from this study and from previous studies suggests that the overall abundance of clams in Tillamook Bay has remained relatively stable or increased over the past 20 years. The exception to this observation is with the population and biomass of gaper clams (*Tresus capax*), which has declined substantially since the late 1970s. Densities of the other three commercially and recreationally important clam species appear to have generally increased, and it is appears that biomass has increased nominally. The average size of individual clams has decreased.

The density of clams appears to be linked to the type of substrate, and substrate preference differs between species of clams. A wide variety of flora and fauna, and a prevalence of juvenile finfish and shellfish appear to indicate an ecologically productive estuary. However, natural and human-caused impacts such as sedimentation and agricultural runoff pose a threat to the bay's ability to continue providing food, recreation, and economic benefit to the communities dependent upon the bay. The paper concludes by briefly discussing the current and the future management of the clam resource in Tillamook Bay.

INTRODUCTION

Tillamook Bay supports shellfish populations which provide a valuable resource for recreational, and commercial users. Both maricultured oysters and wild populations of clams support these uses. While all oyster harvest is for commercial purposes, several species of clams are harvested by both commercial and recreational interests. The four major species of harvested clams are the cockle, *Clinocardium nuttalli*, littleneck, *Protothaca staminea*, butter, *Saxidomus giganteus,* and

gaper. These four species are the most important because they are the most sought after by both commercial and recreational interests.

This report focuses on these four species, although the presence of other species is also noted. The bay has traditionally experienced mostly subsistence and recreational harvest, but has recently been subject to increasing commercial harvest, which has caused growing concern among resource users, particularly those in the recreational harvest sector. Figure 1 depicts the commercial harvest from 1978 to 1994. It shows that the total harvest has increased substantially in the past decade, from 2,869 pounds in 1978 to 149,494 pounds in 1994. Cockles make up the vast majority of this increase (Carter et al, 1994).

The ODFW has placed a commercial quota of 90,000 pounds of cockle clams for 1995, which represents approximately 10% of the estimated biomass of market sized clams in areas sampled in past surveys. This quota was implemented in response to growing concerns of recent increases in commercial harvest, but applies only to cockles because this species makes up nearly 90% of the total commercial harvest (Johnson pers com 1995). The strategy behind this management tool is conservative in nature (a 10% harvest level is generally considered a low fisheries quotas), especially since the biomass estimate only applies to a limited, albeit productive, area of the bay (Johnson pers com, 1995). The findings of this study indicate that there is likely a significant, un-surveyed biomass that exists in other parts of the bay. See Figure 2 for the extent of the previously surveyed portion of the bay, but keep in mind that although much of the bay has been surveyed, only a small portion has been used to obtain biomass estimates. The shaded area in Figure 2 shows the portion of the bay for which biomass has been

estimated. This part of the bay is known as Hobsonville Channel. The area known as the Ghost Hole, which mostly corresponds with Hobsonville Channel, represents a large portion of previously surveyed areas, and is off limits to commercial clam harvesting in an attempt to ensure an undisturbed brood population (Johnson pers com 1995). It is not known if this management strategy will be effective, but I believe it will be, due to the reproductive nature of clams. Specifically, larvae of clam species found in Tillamook Bay are free swimming, and are likely to settle far away from the parent. This means that an undisturbed area could potentially provide clam larvae to all other areas of the bay.

Accurate data for recreational harvest of bay clams is more difficult to obtain, because it has not been collected as routinely as commercial harvest data. Nonetheless, the available information indicates that the recreational harvest has dropped significantly since the early 1970s, but has increased in the past few years (ODFW 1985). Table 1 uses data collected by volunteers and compiled by the ODFW to show recreational harvest trends. It is unclear exactly why recreational harvest has diminished. However, one reason may be due to the changes in substrate composition adjacent to the Bay Ocean Peninsula as a result of jetty and dike construction. This area was previously heavily used by recreational clam diggers, but is rarely used now (Gaumer and McCrae, 1990). Another reason for a decrease in recreational harvest is that a bag limit reduction was implemented in the 1970s, from 36 clams to 20. However, this bag limit reduction does not alone account for the decrease in recreational harvest.

The data from different years was not collected using the same methods, and therefore is not directly comparable. Nonetheless, broad comparisons can be inferred. Table 1 indicates that

recreational harvest is currently much lower than in the early 1970s. In 1971, over 60,000 pounds of the four major species were taken from Garibaldi Flat between March 1 and October 31. In the years 1993-1995, the total catch from Garibaldi Flat increased from 8,183 to 21,759 pounds (ODFW unpublished data). Data from Garibaldi Flat is used because this is the focal point of the recreational clam fishery in Tillamook Bay, and it provides the best option for comparison and data collection. Garibaldi Flat is located adjacent to the old Coast Guard pier at the north end of the bay. The recreational catch appears to be increasing, but is still substantially lower then the catches of the early 1970s. Catch per unit effort, measured in number of clams harvested per hour, has increased recently, but clams per trip has remained stable at almost 20 per day, which is the daily limit. This trend indicates that recreational diggers are getting their limits in less time than in the early 1970s (Johnson pers com 1995). Does that mean there are more clams at Garibaldi Flat, or does it mean that recreational clam diggers are becoming more proficient at their hobby? It is a difficult question to answer, especially with the limited amount of data available.

The fundamental resource management question which needs to be addressed is: what level of harvest will ensure the sustainability of bivalves, and therefore the opportunity for both recreational and commercial to harvest equitable shares of the resource? At the root of the issue of sustainable harvest is a general lack of knowledge about just *what* is in the bay, and *how* much there is of it. In addition, who will define equitable shares of the resource? To answer these questions, much more information is required than this study provides. Therefore, this report will not directly address these questions. This report will, however, provide a general picture of the clam distribution in the bay and some data regarding density, biomass, and distribution.

After ODFW completes the 1996 survey, it will be in a better position to make decisions on harvest level and allocation.

The first comprehensive survey of the clam population in Tillamook Bay was conducted by ODFW in 1974-76. Previous to this, there had been some examination of the clam population, however, data is limited and not directly comparable to more recent information. The 1974-76 survey first identified areas of the bay that had clam population densities that could support commercial harvest. The pre-determined density that could support commercial harvest was identified as being greater than five clams per square foot ($54/m^2$). Those areas were then further surveyed to assemble information such as biomass estimates, composition of the populations (age, size, species, etc), and a characterization of the habitat in that area. Surveys in 1984 and 1985 covered the same area, and biomass, population composition, and habitat characteristics were described and estimated. These two surveys provided information on which the current management regime is based. The data, however, is over ten years old, and there is a need for current information, especially in light of the recent increase in commercial activity in the bay. Table 2 summarizes the results of the previous surveys as well as the 1995 study. The findings of the surveys will be addressed later in this report.

In April 1995, the Tillamook Bay National Estuary Project (TBNEP) solicited proposals for challenge grants. The proposals were required to address one or more of the TBNEP's priority problems, one of which was to gain a better understanding of the biota in the bay. I submitted a proposal to complete a shellfish survey, and it was approved in May 1995. The survey served as a precursor to a more extensive survey to be completed in 1996, and was designed to identify

those areas of the bay that supported relatively dense populations of commercially and recreationally important species of clams. The term "relatively dense" is defined as a density that will support either recreational or commercial harvest. This report identified areas of the bay that support any clams, the densities of which ranged from less than $10.8/m^2$ to $129/m^2$. This information will be used to design the 1996 survey by locating areas of abundance, and therefore, those areas that are capable of supporting a commercial or recreational harvest. In addition, the 1995 survey provided information regarding marine invertebrates, fish, plants, and substrate type.

METHODS

The methods for this survey were adopted from Hancock et al (1979), and modified to fit the scope of this project. A total of 92 stations were sampled in the lower bay, which encompasses the area approximately from Bay City to the mouth (see Figure 3). The stations were chosen to provide a broad representation of the many different types of clam habitat in the bay, which is determined by substrate type (sand, mud, shell, rock, etc), depth, current velocity, salinity, and presence of marine plants. In addition, stations were chosen in order to assess parts of the bay that were not surveyed in either the 1974-76 or the 1984-85 surveys. Budget and time constraints precluded surveying more of the bay, hence large areas of the bay were left un-surveyed.

At each station, information was recorded by two SCUBA divers regarding substrate type, the presence of plant life, depth, current velocity, and any other information that seemed applicable. Substrate was classified using the following descriptors: mud, silt, sand, gravel, small rocks, medium rocks, large rocks, and shell. Gravel was assigned an approximate diameter of less than 1/4 inch; small rocks were between 1/4 inch and one inch; medium rocks were greater than one inch and less than three inches; and large rocks were considered to be greater than three inches in diameter. In one case, the term "boulders" was used to describe rocks that were several feet in diameter. Where there was a combination of the substrate materials, each type was noted, although the most prominent type was emphasized. Plant life was characterized as being sparse, moderate, or dense, and the plants were identified when possible. The qualitative descriptors of sparse, moderate, and dense refer respectively to a vegetation cover of less than 10%, 10-50%, and greater than 50%. Depth was recorded from the SCUBA console, although this was used only for the purpose of comparing depth at nearby stations, and cannot be used as an absolute or accurate indicator of depth. Current velocity was also qualitatively noted, but again, it can only be used to provide a general indicator; not as a valid measurement. Raw data is shown in Appendix D.

After observations were completed and recorded at each station, a two square foot ring was placed randomly on the substrate surface. Gaper clam necks were counted, because this species often digs too deep to collect. The area inside the ring was excavated to a depth of two feet using hand rakes, and the clams found within the excavated volume were measured and counted. In many, but not all cases, replicates were completed to provide a more accurate count. Time constraints precluded conducting a greater number of replicates. Occasionally, samples of clams

were sent to the Oregon Department of Fish and Wildlife for analysis of age class, reproductive state, and other applicable factors. These samples were not intended to provide an accurate representative sample, rather, just to give an general indicator of the age and status of the collected clams. Again, the scope of the project precluded collecting more than a few dozen clam samples. Each station was described using available landmarks such as buoys or jetties, and was also logged using a global positioning system (GPS).

DATA AND RESULTS

The locations of the 92 stations in this study are shown in Figure 4. Clams were found to be present at 37 of these sites, at densities ranging from less than $10.8/m^2$ to $129/m^2$. Densities were recorded in terms of square feet, and recalculated to reflect the number per square meter, ($1/ft^2 = 10.8/m^2$). In many cases, densities were recorded as being less than $1/m^2$, resulting in density measurements of less than $10.8/m^2$. As expected, significant concentrations of clams were found primarily in, or adjacent to, major channels in the bay (see Figure 5). This is likely due to the suitable substrate that is common to channel areas, as well as the readily available food supply that is carried through the channels during the incoming and outgoing tides (Simenstad 1983). An exception to this was found with cockle clams, some of which were found in shallow or intertidal areas of sandy substrate. These clams were generally large individuals (greater than 3 inches in diameter) and were often found on the substrate surface, completely exposed. However, they were always found at low densities in these situations.

The most prevalent clam species found was the cockle, of which 115 individuals were counted. Gaper was the second most prevalent (85 individuals), followed by butter (51), littleneck (26), and "other" (5), which included softshell, *Mya arenaria*, baltic, *Macoma balthica*, irus, *Macoma inquinata*, and bentnosed, *Macoma nasuta*. In addition, shells from several species of clams were found. These shells were not included in the count, but were identified in the species list for qualitative information (see Appendix C).

Cockles also appeared in the highest density of any of the species, reaching a maximum density of $129/m^2$. Butter clams were found at a similar maximum density of $123.6/m^2$. The highest densities of both these species were found very close to each other; just west of Hobsonville Point. Littleneck clams were found to have the lowest maximum density of the four major species, at $54/m^2$, while the greatest density of gaper clams was $80.6/m^2$.

It is not reasonable to derive biomass estimates for the entire bay because the sampling methods were not designed to provide such information. The location of sampling stations was subjective, and intended to provide qualitative rather than quantitative information. Nonetheless, given the survey design, we can estimate the biomass and population for the area known as Hobsonville Channel, which is the same area surveyed in the 1974-76 and the 1984-85 surveys, and then compare it to previous biomass and population estimates. To derive biomass and population estimates for 1995, data from those stations that are in Hobsonville Channel was used. Of the 14 stations located in this channel, only eight were usable because the other six were either not in the channel proper, or visibility prohibited sampling. Previous surveys used a minimum of 57 stations.

The average 1995 density for each species was multiplied by the total area of Hobsonville Channel as reported in the previous studies. This provided a number, which was then multiplied by the average weight of each species to obtain a biomass estimate.

There are two problems with this method. First, the area of Hobsonville Channel is reported differently in each of the past surveys. The 1974-76 survey states an area of 460,000/m^2, while the 1985 survey reports an area of 334,884/m^2. Each of these areas will obviously result in different products when multiplied by 1995 densities. Therefore, I used both figures to obtain two separate biomass and population estimates for 1995. Second, the average weight of clams differed between years, which again resulted in differing biomass estimates. The averaged species weight from each survey year was averaged to provide a weight per clam. The average size and weight of clams in Tillamook Bay appeared to decrease between 1974 and 1985, but the 1995 study did not provide average weights due to a lack of representative samples. Therefore average weights from the past studies were used. Because of limited and subjective sampling, these biomass estimates using 1995 data are not as reliable as biomass estimates from previous surveys. The results of biomass and population estimates are summarized in Table 2.

Substrate Preferences

The four major species of clams present in Tillamook Bay share some of the same type of habitat. Specifically, they prefer a sandy substrate mixed with small rocks or gravel. This type of substrate is more stable than sand or mud, and offers a more permanent environment for bivalves. However, individual species of clams do have some differences in their habitat preferences and burrowing

behavior. For example, cockle clams and littleneck clams have short siphons, and tend to burrow very shallow. Gaper clams and butter clams tend to burrow much deeper, presumably because their siphons are longer (up to two feet), and being deeper in the substrate offers more protection from predators. Gapers are sometimes found in muddy areas dominated by eelgrass, while cockles are sometimes found on the substrate surface in sandy intertidal areas where no vegetation occurs (Rudy and Rudy, 1983). See Appendix A for information on individual species.

Species of clams that are not as commercially or recreationally important were often found in shallow or intertidal areas characterized by a muddy, silty substrate. These species include softshell, bentnosed, irus, and baltic. These clams, especially the softshell and bentnosed, are capable of withstanding significantly different conditions than the four major species. Low salinity and anaerobic conditions represent suitable habitat for these clams (Rudy et al 1984). This study's findings concur with literature, as evidenced by the fact that of the five locations where bentnosed, sofshell, or baltic clams were found, three were intertidal mudflats, and the other two were subtidal, but characterized by a silt and mud benthos.

One method to predict the presence or absence of a particular species is to generate correlations with habitat, such that a given type of habitat would be an indicator that a particular species of plant or animal is present. This study does not generate statistical correlations, but a brief examination of the 1995 data provides an idea of the type of substrate that each species of clam prefers. There also appears to be species that indicate the presence or absence of clams.

Figure 6 shows the average density of clams found in five different substrate types. The greatest density of cockles was found in sand/shell/silt substrate, but cockles were found in all types of substrate. Littlenecks were found at the greatest density in rock/sand/shell/silt substrate, and never found in sand only. Gapers showed the highest densities in sand/shell/silt substrate, but, like cockles, were found in all types. Butters were found in the greatest density in rock/sand/shell/silt substrate, and were never found in sand/shell/silt or sand substrate. It appears that although there is some preference of substrate (the highest density for each species was found at a mix of substrate types), it is not a strong association. There may be other contributing factors such as greater food availability and water depth in channel areas.

There did, however, appear to be a negative species indicator of the presence of clams. That is, the presence of burrowing shrimp almost always precluded the presence of clams. The two types of burrowing shrimp in Tillamook Bay are ghost shrimp, *Callianassa californiensis*, and mud shrimp, *Upogebia pugettensis*. Of the 92 total stations, 26 had burrowing shrimp present. Of those 26 points, only three also showed the presence of clams. Further, the density of clams at those three stations was the lowest recorded - less than 10.8 per square meter. This observation is supported by Gaumer (1983).

Eelgrass was found to be another negative species indicator of clam presence. Of 21 stations where eelgrass was present, only five also had clams present. Of those five, only gapers and cockles were found, and always in densities less than $10.8/m^2$. Gaper clams are reported to be found frequently in eelgrass beds (Gaumer, 1990), however, the 1995 survey did not indicate this. (See next section for a discussion of gaper population declines). Additionally, at the five stations where eelgrass and

clams coexisted, the density of eelgrass was low (always less than 50% cover). So, while it seems that there is not an absolute substrate indicator of the presence of clams, there do seem to be inverse species indicators - burrowing shrimp and eelgrass. However, the volume of data collected in this study is probably not sufficient to quantify this inverse relationship.

Changes over Time

The findings of this study regarding density and distribution generally agree with those of Hancock et al (1979). In areas that the 1974-76 study showed as having high densities of clams, we found relatively high densities as well. These area generally correspond with channel areas. Conversely, in areas that were shown to have low densities in 1977, also appear to have relatively low densities. These areas generally are within or near major channels, and are often intertidal and characterized by muddy substrate. There were, however, several areas of the bay that appear to have different numbers of clams now than they did in the past.

Cockle clams were found at three locations that were not identified in the 1974-76 study: Immediately south and east of the rock jetty on Kincheloe Point; northwest of the Three Graces; and in the center of the bay, half way between Hobsonville Point and Kincheloe Point (see Figure 7). Littleneck clams were found to display almost the identical distribution that the species exhibited in 1974-76 (Figure 8). Gaper clams were present at three locations not identified by the 1974-76 study: Immediately south and east of the rock jetty on Kincheloe Point; at the Three Graces; and directly south of the Coast Guard Pier, in the channel (Figure 9). The 1974-76 study

found butter clams present only at Garibaldi Flat, and the intertidal mudflats immediately north of Hobsonville Point. This study found butter clams to be present at several other locations (see Figure 10). The 1974-76 study only identified areas that had greater than $1/ft^2$ density, which may account for some discrepancy between that data and 1995 data. The 1984-85 studies did not address distribution over the entire bay.

Biomass and Population

It is imperative to remember that only eight sampling stations were used to derive biomass and population estimates. That being stated, it will nonetheless be worthwhile to derive biomass and population using the limited amount of 1995 data. Estimates will be derived from the 1996 study, which will utilized many more sampling stations, and will be therefore be more reliable. Table 2 summarizes biomass and population findings from this survey as well as previous surveys for the area of Hobsonville Channel. The method for deriving biomass and population estimates is described earlier in this section. The population estimate for cockle clams is between 10 and 14 million clams, depending upon which total area is used. This number is higher than any of the previous surveys. The littleneck population, between 4 and 5.5 million, is lower than any of the previous surveys. Gaper clam population is significantly lower than the 1984-85 surveys, and drastically lower than the 1974-76 survey. The gaper population estimate of 563,000 to 773,000 is approximately 10% of the 1974-76 estimate of over 7 million. Poor recruitment since 1975 has contributed to this decline, however, the reasons for poor recruitment years are unknown. 1975 was a very strong recruitment year for gaper clams (Gaumer 1990). The 1995 butter clam population

estimate is nearly identical to the 1984-85 survey, but more than double the estimate from 1974-76. The total population estimate for the four major species is between 22.9 and 31.4 million clams, which is similar to the population estimates of previous studies. The 1995 population estimates indicate that while the total population in Hobsonville Channel is either stable or growing, the contribution of each species to the total population appears to be changing. Gaper clam population is down significantly from 20 years ago, while butter clam population is up significantly. Cockle and littleneck clam populations are apparently not changing as noticeably as gaper and butter clams.

Reliability of Data

While the goal of this study was achieved using qualitatively collected data, I recorded some information regarding the reliability of data, which is presented in Figure 11. Time constraints precluded a rigorous statistical analysis of the data, but is may be of use to ODFW in designing the 1996 survey.

Distinct patchiness of species was found within areas that contained multiple species, that is, even though multiple species of clams may have been found in the same area, each individual species tended to occupy its own territory within the area. In addition, a patch, or "bed" of one species of clam will exhibit its own patchiness in that a concentration of individuals may be found with a very

small area (one square foot, for example), while immediately adjacent, there will not be individuals present (Johnson pers com, 1995). Although I did not measure patchiness, it could be done with the 1995 data. It has been previously documented that clams do not display a normal distribution, which creates a challenge for those developing a sampling scheme.

Data on age and size of collected specimens is pending completion by the ODFW.

CONCLUSION

Data from previous surveys appear to indicate a trend toward smaller clams in Tillamook Bay, indicating that clams are being harvested at an earlier age than in previous years. This presents a problem if the age at which clams are being harvested is less than the age at sexual maturity. If the clams are being harvested before reproducing, the population will inevitably decline. At this point, it appears that virtually all clams harvested in Tillamook Bay are harvested well after they have reached sexual maturity. The raw data (Appendix D) shows that the majority of clams sampled were two to four inches in length. Gapers reach maturity at approximately three inches, and littlenecks reach maturity at about one inch (Emmett et al 1991). Butter clams reach maturiy at about one inch in length (Nickerson 1977), and cockles mature at approximately one inch (Gaumer and McCrae, 1990). Observations of recreational and commercial clam harvesters lead me to believe that harvested clams are generally much larger than size at sexual maturity. However, the

trend toward smaller clams indicates that a minimum size requirement may be required in the future.

Significant changes in densities and distribution over time were noted for gapers, butters, and cockles. There are several factors, both human-caused and naturally-occurring, that influence the densities and distribution of clams. In the case of gaper clams, there is documentation that there has poor recruitment since 1975 (Gaumer 1984; Gaumer 1990). In addition, many recreational clam diggers have stated that a large increase in burrowing shrimp populations has negatively affected gaper and cockle clam habitat. This was especially noted for the intertidal area adjacent to Bay Ocean Peninsula, which has been subject to dike construction (following a breach of the peninsula) and jetty construction (Gaumer 1983). This has resulted in accumulation of silt and mud in the area, effectively improving burrowing shrimp habitat, and decreasing clam habitat.

There is great concern by both recreational and commercial harvesters of Tillamook Bay's clams. In fact, a recent petition calling for the cessation of all commercial clam digging in the bay was presented to the ODFW. A hearing in October 1995 resulted in inaction by the ODFW on this petition. In fact, the four major species of clams, as well as softshell clams, were designated as developmental fisheries, meaning that they will likely be opened to commercial harvest in the near future (Griffith 1995). There will probably be quotas on each species, and the fishery will be on a limited entry basis. A major problem with creating viable management strategies is the lack of adequate data about the bivalves in the bay. This is especially true of the recreational harvest sector, which has been poorly surveyed.

This study provides preparatory information for the 1996 survey. It has shown where there are significant densities of clams in the bay, and provided a characterization of habitat, flora, and non-bivalve species. Obviously, an equitable distribution of the total allowable catch is desired by all parties. Hopefully, the survey to be completed in 1996 will develop a comprehensive data set, and allow for confidence in the management of the bay's clam resource. Sampling methods will be employed that minimize subjectivity, and that will provide accurate counts of clams without sacrificing the volume of data collected.

ODFW has gradually become more proactive in the management of the clam resources in Tillamook Bay, as evidenced by a recreational bag limit reduction in the 1970s, and a commercial quota implemented in 1995. The results of the 1996 survey should provide a good basis for management decisions in the near future. The Tillamook Bay clam fishery is unique in that it has been historically subject to very little commercial harvest, but now supports a commercial fishery, and is likely to do so in the future. A review of east coast clam fisheries revealed that most have historically supported a commercial industry, and that management efforts are aimed at increasing abundance through stock enhancement. These programs seem to have met with mixed success. The management regime in Tillamook Bay has focused on maintaining wild populations. Commercial clam fisheries of the west coast have focused mainly on razor and geoduck clams.

Geoduck clams have been heavily exploited in British Columbia since 1976. In 1979, a license limitation program was implemented and an overall quota representing 1% of biomass was

imposed (Harbo 1993). I am not familiar with the biology of the geoduck clam, but it is probably a long-lived species that may not be as fecund as the clams in Tillamook Bay. In that case, a 1% harvest level may be appropriate. However, ODFW should examine this issue, taking into consideration the biology, ecology, and reproductive characteristics of the geoduck. ODFW should question why there is only a 1% harvest level, and if the 10% harvest level of cockles in Tillamook Bay is too high. Again, the results of the 1996 survey will be of great assistance in determining the stability of clam stocks over time.

The most important issues for ODFW to address are the drastic decline in gaper clam abundance, and the trend toward smaller sized clams. At this point, a restriction in recreational harvest of gapers should be considered, at least until the reasons behind the decline have been better identified, and the population has been better estimated. Commercial harvest of gapers should also be restricted, although there has been very little commercial harvest in the past. In addition, methods should be explored to increase the overall size of clams, which has declined. Minimum size requirements may need to be instituted. A valuable data base for ODFW to maintain would be a random sampling of the size of individual clams harvested by both commercial and recreational harvesters. If the size of individuals being harvested is indeed declining, it means one of two things: clams are being harvested at an earlier age than previously; or clams are growing slower than previously. If clams are being harvested at an earlier age, a minimum size requirement would be the most obvious management strategy to employ. However, if the clams are growing slower than they used to, further investigation would be required to determine the reasons behind the decline in growth rate. It could be poor nutrient availability, temperature variations, or an increase in growth-reducing substances in the water of the bay.

The 1996 survey should use the information in this report as a hypothesis. Since the sampling methods used to gather data for this project are qualitative in nature, and estimates of biomass and population are generated using limited data, they cannot be used to base any management decisions on. However, if the 1996 survey reinforces the information collected in this study, it would lend more credibility to the quantitative information presented in this report. In addition, ODFW should use the replicate counts in Figure 11 to determine the optimum number of replicates required to maximize reliability of sampling methods.

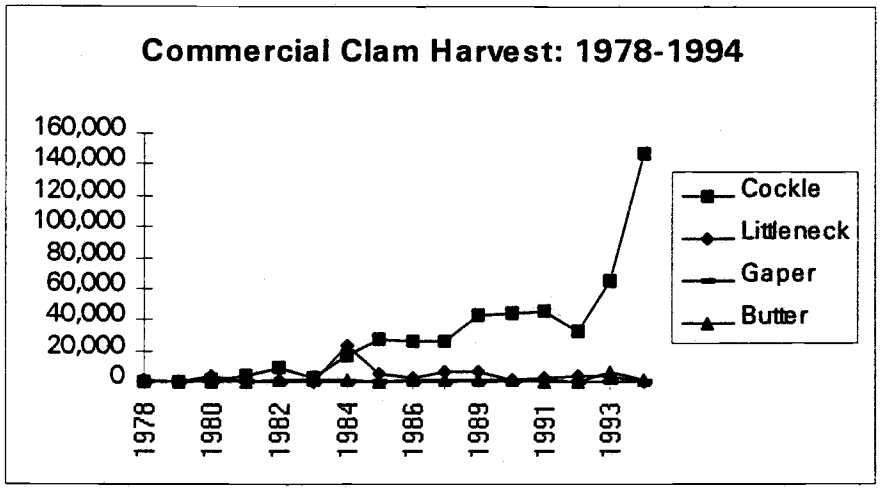

Figure 1: Commercial clam harvest in Tillamook Bay; 1978-1994.

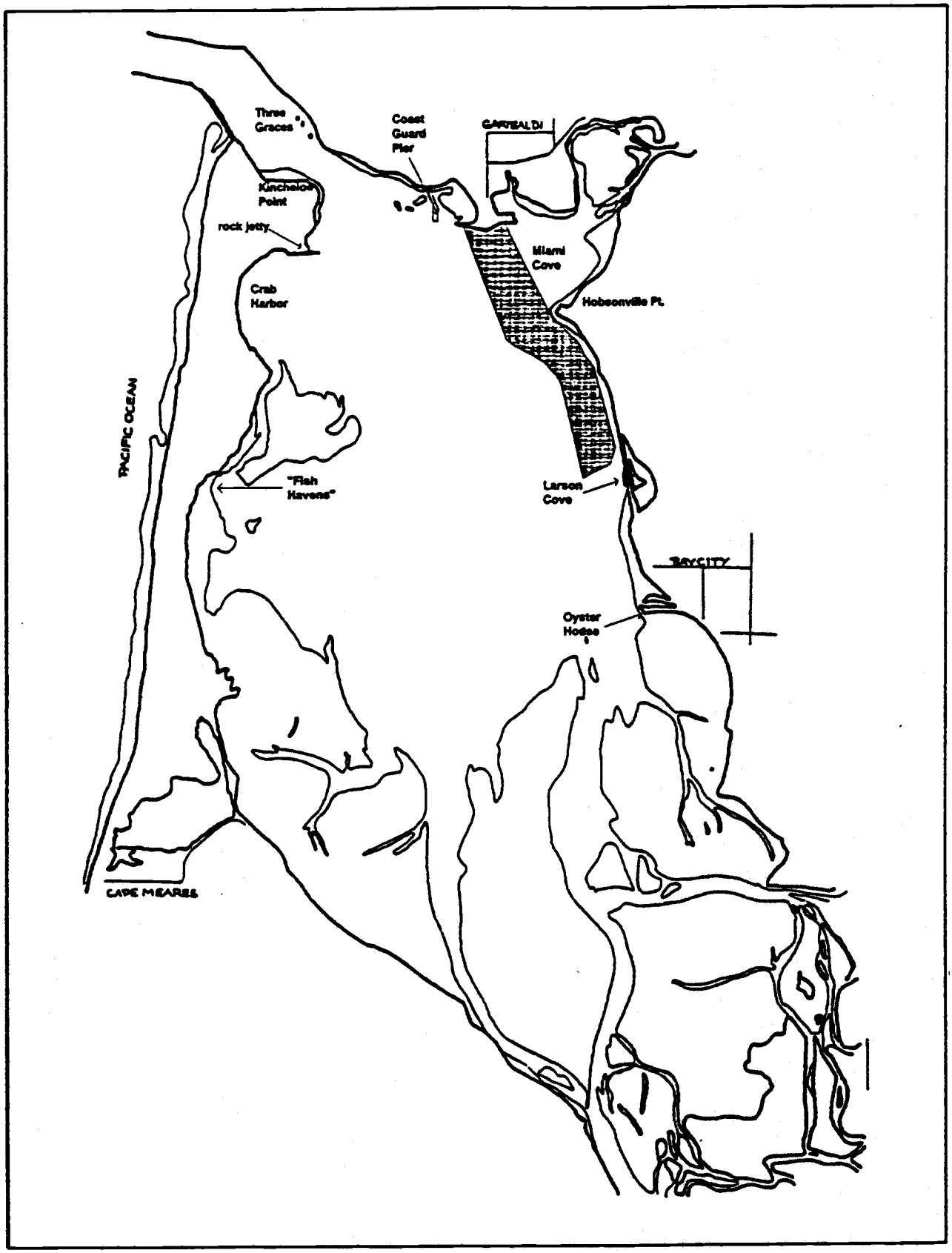

Figure 2: Area surveyed in 1974-76 and 1984-85 to obtain biomass and population estimates. (Base map source: Hancock et al 1979).

Table 1: Recreational harvest from Garibaldi Flat in Tillamook Bay for 1971-71, and 1993-95.

	Pounds harvested- Garibaldi Flat				
	Cockle	LN	Gaper	Butter	Total
1971*	13,523	11,708	14,175	21,344	60,750
*1972***	*N/A*	*N/A*	*N/A*	*N/A*	*101,715*
1993	3,866	462	245	3,610	8,183
1994	6,997	749	204	3,272	11,222
1995	13,567	1,453	395	6,344	21,759

* 1972 estimate includes catch from March 1-October 31.
**1972 estimate includes entire bay (not just Garibaldi Flat).
***In 1971, Garibaldi Flat produces 65% of the total Tillamook Bay recreational catch.

Table 2: Summary of density, population, biomass, and average weight per clam in Hobsonville Channel, Tillamook Bay, Oregon, for four studies: 1974-76, 1984; 1985; and 1995.

Density (clams/m^2)

Species	1974-76	1984	1985	1995
cockle	18.6	21.6	28.0	30.7
littleneck	15.7	28.1	25.8	12.1
gaper	16.4	3.2	4.3	1.7
butter	7.9	19.4	31.2	23.9
Average	14.7	18.1	22.3	17.1

Population

Species	1974-76	1984	1985	*1995A	*1995B
cockle	8,286,000	8,773,900	9,360,000	14,094,400	10,260,837
littleneck	7,191,000	11,082,900	8,640,000	5,570,600	4,055,442
gaper	7,162,000	1,462,300	1,440,000	772,800	562,605
butter	3,620,000	7,850,400	10,440,000	10,971,000	7,986,977
Total	26,259,000	29,169,500	29,880,000	31,408,800	22,865,861

*Note: 1995A calculates the population of clams in Hobsonville Channel using 1995 densities and the stated area from 1974-76.
1995B calculates the population of clams in Hobsonville Channel using the 1995 densities and the stated area from 1985.

Biomass

Species	1974-76	1984	1985	1995A	1995B
cockle	1,756,100	N/A	1,322,700	2,466,520	1,795,646
littleneck	348,400	N/A	N/A	278,530	202,772
gaper	2,447,100	N/A	N/A	262,752	191,286
butter	1,174,800	N/A	2,925,300	3,291,300	2,396,093
Total	5,726,400	N/A	N/A	6,299,102	4,585,797
*Total (cockle+butter)	2,930,900	N/A	4,248,000	5,757,820	4,191,740

Average weight per clam (in pounds)

	1974-76	1985	Average
Cockle	0.21	0.14	0.175
Littleneck	0.05	N/A	0.05
Gaper	0.34	N/A	0.34
Butter	0.32	0.28	0.3
Average	0.22	0.21(cockle + butter)	

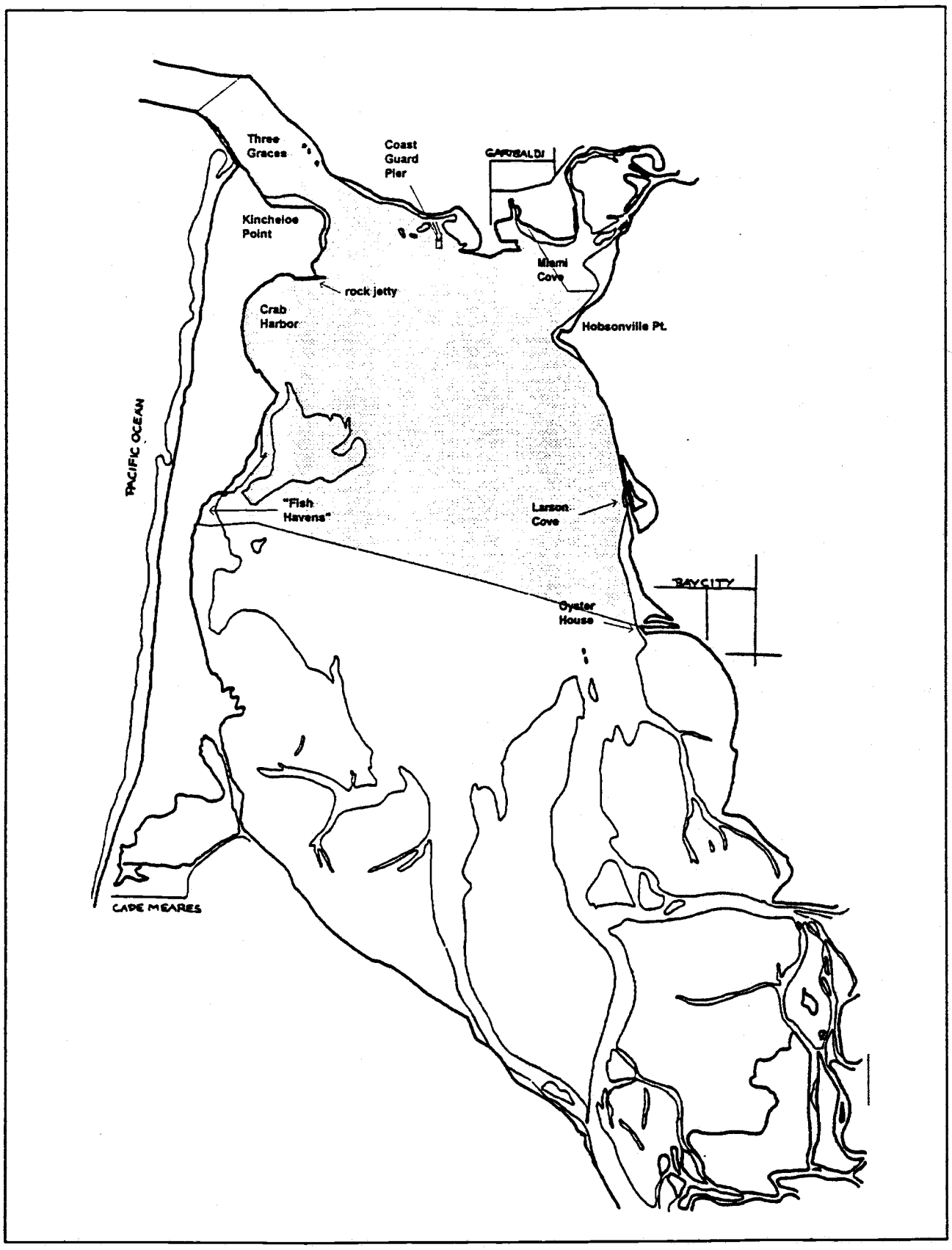

Figure 3: Area encompassed by the 1995 survey (shaded area). (Base map source: Hancock et al 1979).

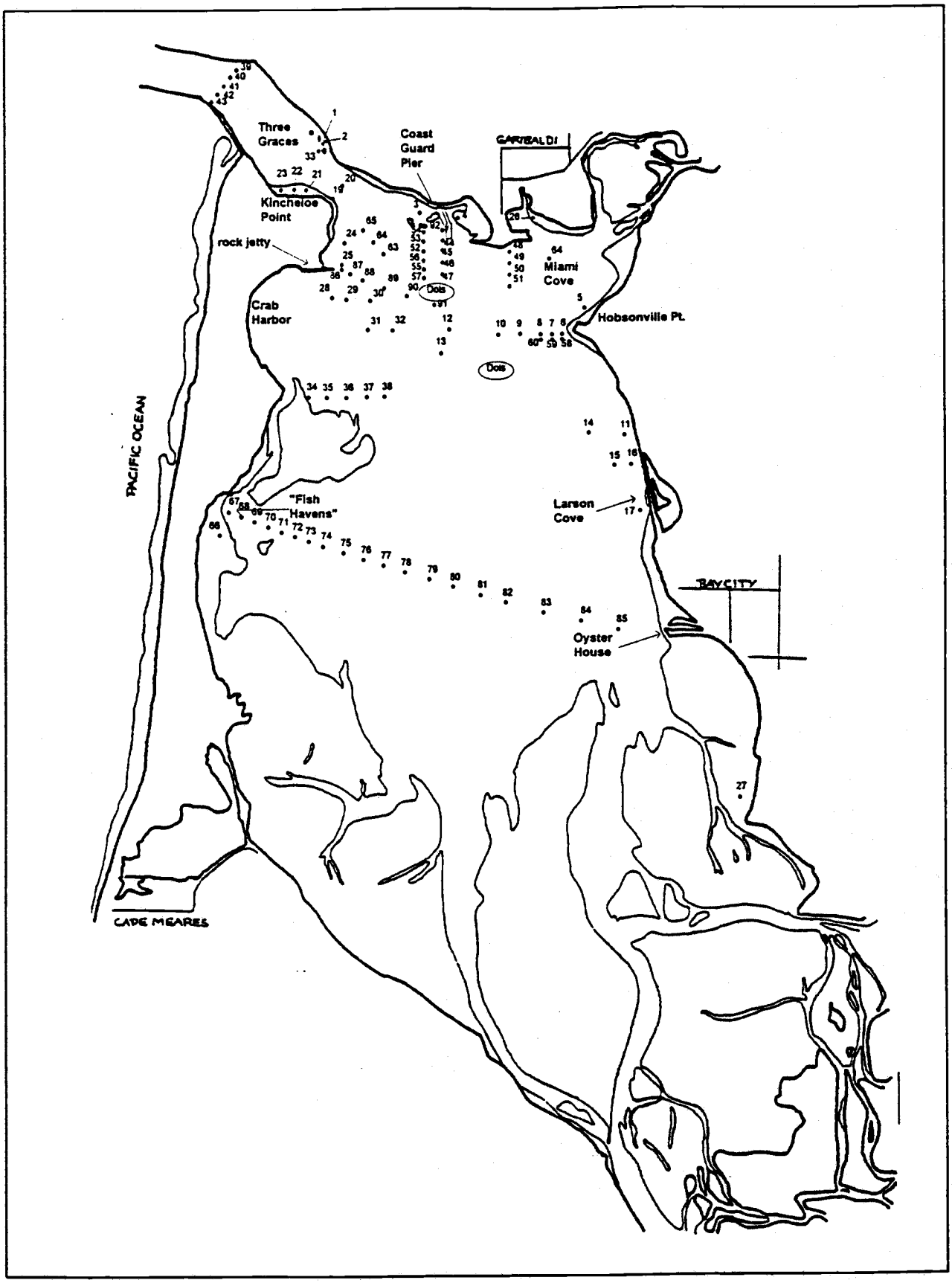

Figure 4: Locations and numbers of 92 stations from the 1995 shellfish survey in Tillamook Bay, OR. (Base map source: Hancock et al 1979).

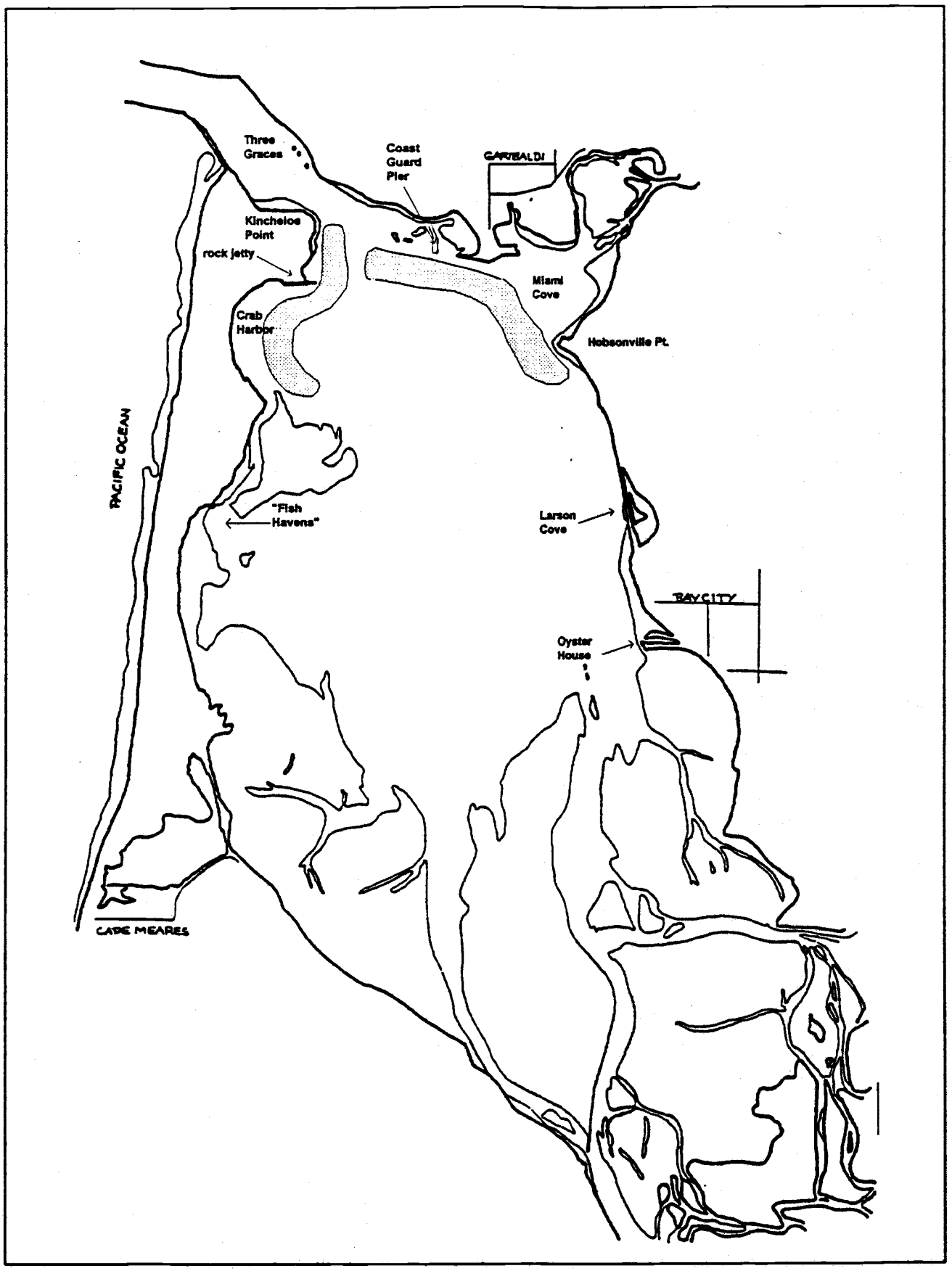

Figure 5: Two major channels of Tillamook Bay, OR (shaded area). Clams tend to be found in or near channels. (Base map source: Hancock et al 1979).

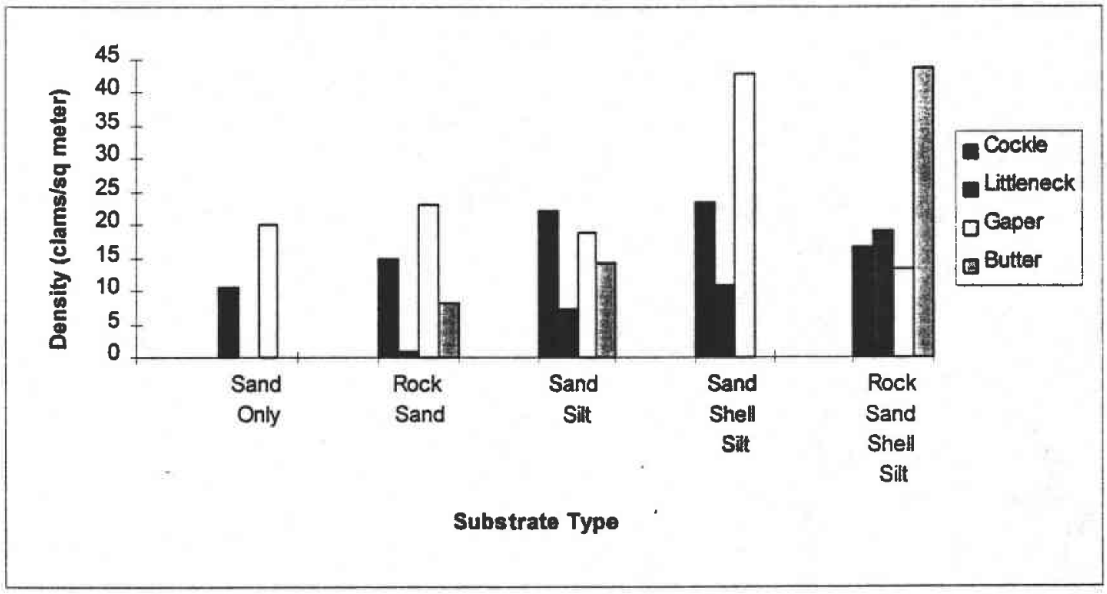

Figure 6: Average densities of the four major clam species in Tillamook Bay in five different substrate types.

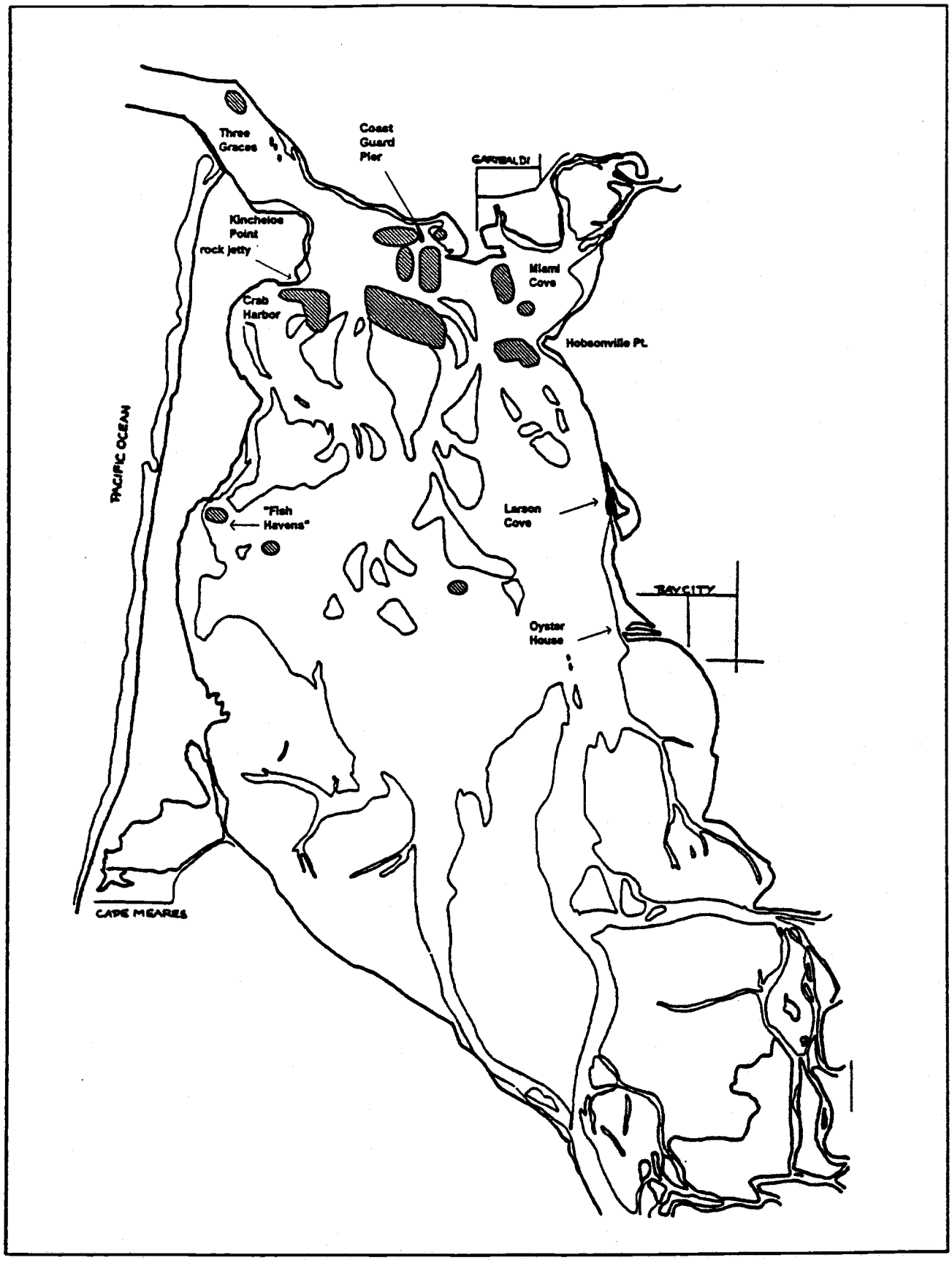

Figure 7: Distribution of cockle clams in Tillamook Bay, OR. Shaded areas represent parts of the bay that had quantifiable numbers of cockles present. (Base map source: Hancock et al 1979).

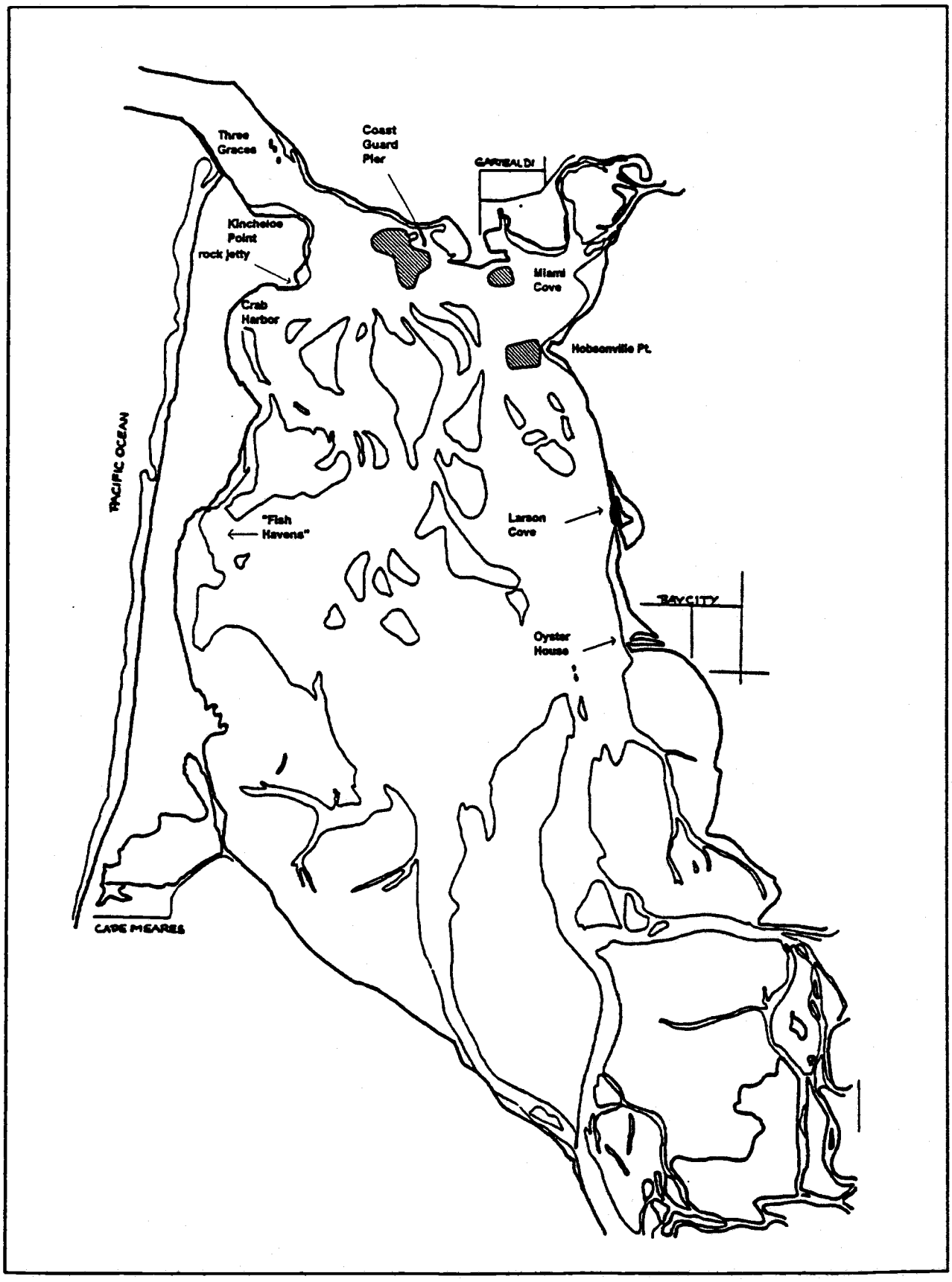

Figure 8: Distribution of littleneck clams in Tillamook Bay, OR. Shaded areas represent parts of the bay that had quantifiable numbers of littlenecks present. (Base map source: Hancock et al 1979).

Figure 9: Distribution of gaper clams in Tillamook Bay, OR. Shaded areas represent parts of the bay that had quantifiable numbers of gapers present. (Base map source: Hancock et al 1979).

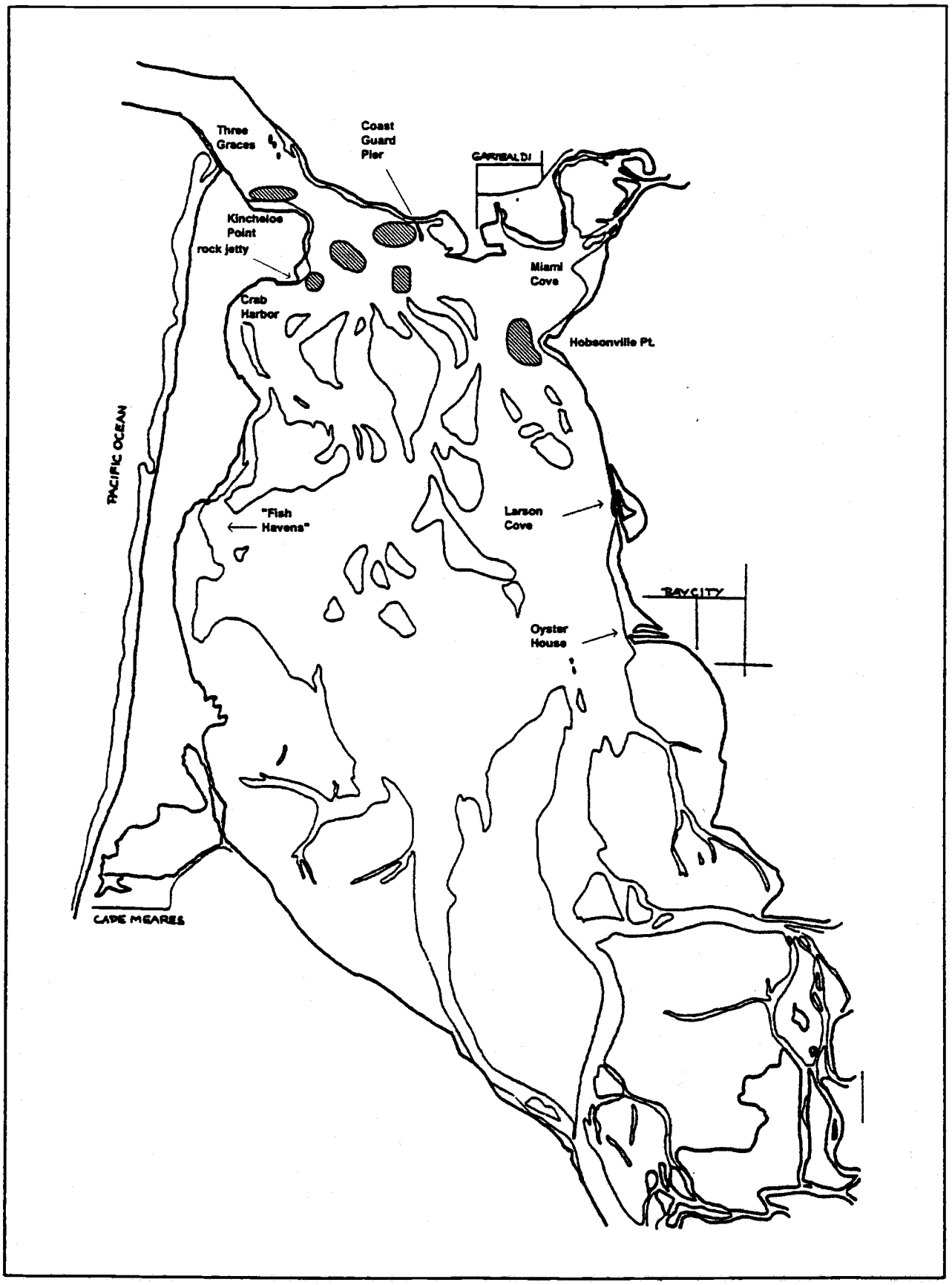

Figure 10: Distribution of butter clams in Tillamook Bay, OR. Shaded areas represent parts of the bay that had quantifiable numbers of butters present. (Base map source: Hancock et al 1979).

Station 52		Number found		
	Cockle	Littleneck	Gaper	Butter
replicate 1	6	0	15	0
replicate 2	0	2	8	0
replicate 3	0	0	7	1
mean	2+/-3.92	0.67+/-1.31	10+/-4.9	0.33+/-0.65
std error	2	0.67	2.5	0.33

Station 62		Number found		
	Cockle	Littleneck	Gaper	Butter
replicate 1	3	0	0	1
replicate 2	5	1	0	0
replicate 3	0	0	0	0
mean	2.67+/-2.85	0.33+/-0.65	0	0.33+/-0.65
std error	1.45	0.33	0	0.33

Station 67		Number found		
	Cockle	Littleneck	Gaper	Butter
replicate 1	0	0	0	0
replicate 2	2	0	0	0
replicate 3	0	0	0	0
mean	0.67+/-1.3	0	0	0
std error	0	0	0	0

Station 68		Number found		
	Cockle	Littleneck	Gaper	Butter
replicate 1	0	0	0	0
replicate 2	0	0	0	0
replicate 3	1	0	0	0
mean	0.33+/-0.46	0	0	0
std error	0.33	0	0	0

Station 92		Number found		
	Cockle	Littleneck	Gaper	Butter
replicate 1	0	0	1	0
replicate 2	2	0	0	0
replicate 3	3	1	0	0
replicate 4	1	0	0	0
replicate 5	2	0	0	0
replicate 6	3	0	0	0
mean	1.83+/-0.94	0.167+/-0.33	0.167+/-0.33	0
std error	0.477	0.167	0.167	0

Figure 11: Replicate counts of clams at five stations in Tillamook Bay, OR.

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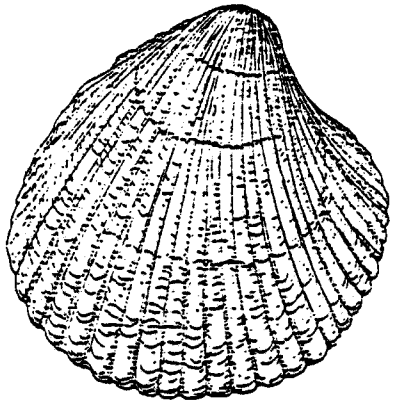
Appendix A - Ecology and Life History



Cockle clam
Clinocardium nuttallii

Description

Size: Up to 100 mm (4 inches).

Shell: Off-white, brown, sometimes mottled. Prominent radial ribs distinguish it from other Tillamook Bay clam species.

Range: Japan, Alaska, NW coast south to San Diego. Habitat: Subtidal and intertidal areas charactrized by coarse sand, gravel. Also found in muddy areas and in eelgrass beds. Prefers high salinity.

Habitat: Sandy, rocky, or muddy substrate. Burrows only to a depth of 6", although sometimes is found on surface of substrate.

Life History

Reproduction: Hemaphroditic; spawns generally in June and July, but spawning time depends on local water temperature and current. Free swimming larvaesettle sublittorally, and move inshore. Maturity attained at two years.

Longevity: Up to 15 years.

Feeding: Suspension feeder. Pumps water through gills, and strains macroalgae and plankton.

Predators: Sea stars, birds, humans. Larvae are preyed upon by other suspension feeders.

Source: Rudy (1983)

Soft-shelled clam
Mya arenaria

Description

Size: Up to 12.5cm (5"). Average 5-10cm (2-4").

Shell: Color white with gray or darker periostracum. Smooth concentric ribs; brittle shell.

Range: Vancouver Island to San Diego. Likely introduced to San Francisco in 1869. Also common on U.S. Atlantic coast and Europe.

Habitat: Tolerates extreme anaerobic and low saline conditions, therefor it often habitates upper reaches of estuaries, where foul mudflats are prevalent.

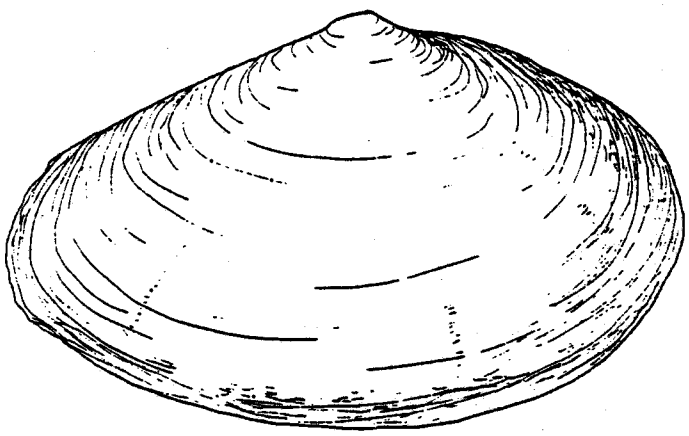
Life History

Reproduction: Separate sexes release eggs and sperm into water column. Spawning occurs twice: spring and fall, although Chesapeake Bay soft-shells spawn continuously from April to October.

Longevity: ?

Feeding: Suspension feeder.

Predators: Birds, humans. Larvae are preyed upon by other suspension feeders.



Source: Rudy (1983)

Bent nosed clam
Macoma nasuta

Description

Size: Up to 7cm (2 3/4"). Average 2.5-5cm (1-2").

Shell: White, chalky shell; black periostracum sometimes visible near lower edge. Distinct bend of shell at posterior end. Smooth, with faint radial lines.

Range: Kodiak, AK to Baja California.

Habitat: Prefers mud, or mud mixed with sand. Often found in eelgrass beds, and in foul areas.

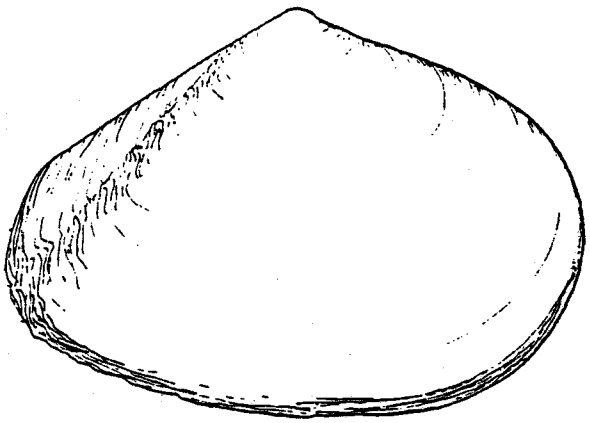
Life History

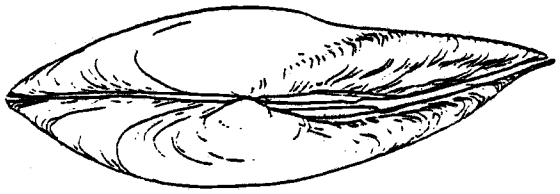
Reproduction: Separate sexes release eggs and sperm into water column in late spring/early summer. Larvae are pelagic, and settle after metamorphosis.

Longevity: ?

Feeding: Filter feeder, but also can consume benthic organic material.

Predators: Crabs, some gastropods.





Source: Rudy (1983)

Baltic clam
Macoma baltica

Description

Size: Up to 45mm (1 3/4"). Average 25-35mm (1-1 3/8").

Shell: Pinkish or rose hue to a chalky white shell. Concentric rings. Ligament is visible on outside of shell.

Range: Circumarctic; south to San Francisco.

Habitat: Mud and sand areas in estuaries and offshore. Tolerant of anaerobic conditions; black, foul mud.

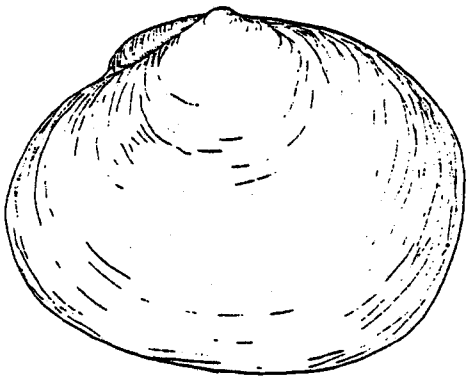
Life History

Reproduction: Planktonic larvae settle after 2-5 weeks. Spawning occurs in Spring. Fall spawning has been observed in England.

Longevity: Unknown.

Feeding: Suspension feeder, but also feeds on benthic microorganisms.

Predators: Birds, especially mudflat feeding birds; fish.



Source: Rudy (1983)

Gaper clam
Tresus capax

Description

Size: Up to 20cm (8"), average 10-13cm (4-5").

Shell: Chalky white, with brown, flaking periostracum. Smooth concentric rings. Prominent gape at posterior end.

Range: Kodiak, AK to San Francisco.

Habitat: Found in subtidal and intertidal mudflats or in soft fine sand. Burrows to a depth of 61cm (24").

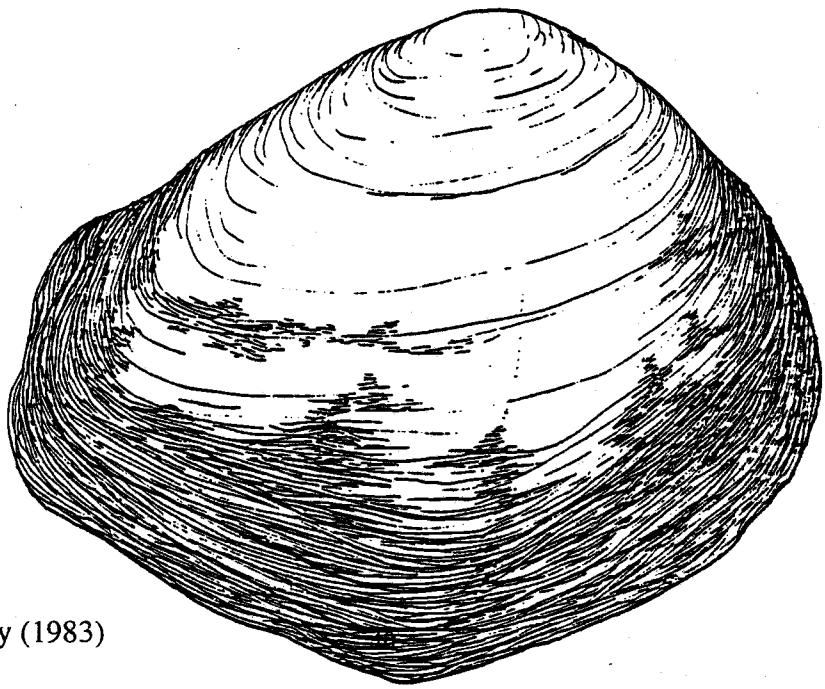
Life History

Reproduction: Dioecious; spawns January-April.

Longevity: ?

Feeding: Suspension feeder.

Predators: Birds, humans, drilling gastropods, sea stars. larvae are fed upon by other suspension feeders.



Source: Rudy (1983)

Littleneck clam

Venerupsis staminea (*V. philippinarium*)

Note: the native littleneck, V. Staminea appears to be the only species of littleneck present in Tillamook Bay, although the Manila littleneck, V. philippinarium, is present in many other northwest estuaries.

Description

Size: Up to 75 mm (3"). Average 25-50 mm (1-2").

Shell: Color whitish, sometimes darker, but always light colored. Shell has both radial and concentric rings, distinguishing it from other Tillamook Bay species.

Range: Aleutian Islands to Socorro Islands, Mexico.

Habitat: Found in coarse sand, often mixed with small rocks. Usually found within 6" of substrate surface. Prefers salinities greater than 30ppt.

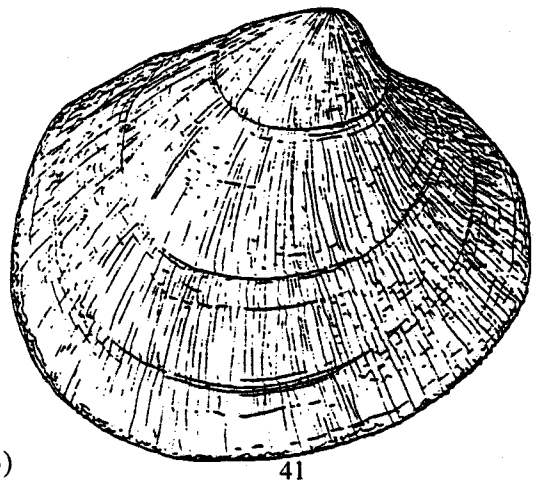
Life History

Reproduction: Separate sexes, although some hemaphrodism occurs. Eggs and sperm released into water column usually in February and March, but depends on water temperature. Maturity at 2 years.

Longevity: Rarely over 10 years.

Feeding: Suspension feeder..

Predators: Birds, humans, drilling gastropods. Larvae are preyed upon by other suspension feeders.



Source: Rudy (1983)

Butter clam
Saxidomus giganteus

Description

Size: Up to 10cm (4"); average 8cm (3").

Shell: Color is whitish, chalky, sometimes dark blue or black. Concentric ribs are close together and irregular in size. Slight gape at posterior end.

Range: Aleutian Islands to Monterey, California.

Habitat: Sand, mud, or mixed with small rocks.

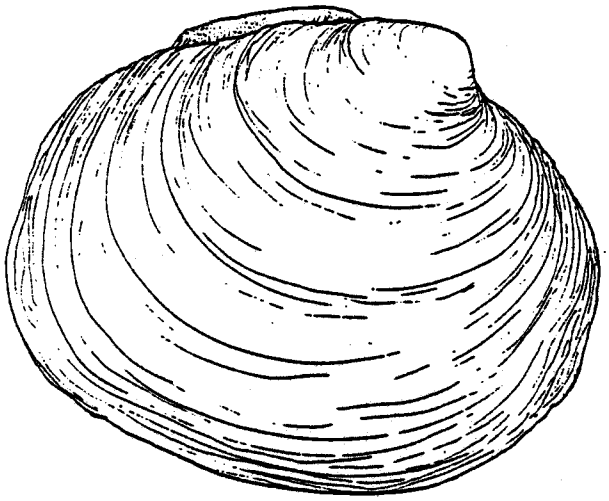
Life History

Reproduction: Pelagic larvae settle after four weeks. Spawning usually June-August, although highly variable. Later in Puget Sound.

Longevity: Up to 20 years.

Feeding: Filter feeder; pumps water through gills and filters out suspended macroalgae and plankton.

Predators: Birds, humans, fishes, drilling gastropods.



Source: Rudy (1983)

Irus Clam
Macoma inquinata

Description

Size: Up to 55mm.

Shell: Whitish; dark periostracum.

Range: Siberia, Aleutian Islands, British Columbia south to Oregon.

Habitat: Prefers soft sand or mud; eelgrass.

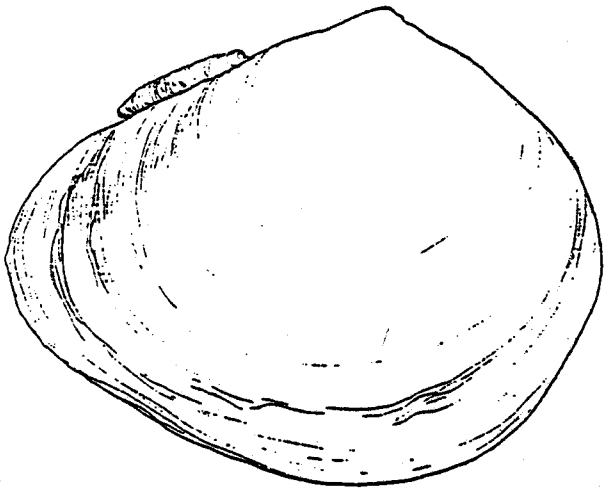
Life History

Reproduction: Separate sexes release egg and sperm into water column; pelagic larvae complete metamorphosis before settling.

Longevity: Unknown.

Feeding: Deposit feeder; cleans surface film of substrate. Feeds primarily on diatoms; other plankton.

Predators: Shorebirds.



Source: Rudy (1983)

Appendix B-

Number and density of the four major species of clams at all stations where any species of clams were present.

Station	Coordinates latitude longitude	Species Cockle number density (#/m^2)	Littleneck number density (#/m^2)	Gaper number density (#/m^2)	Butter number density (#/m^2)
3	45 33 21.5N 123 55 3.2W	1.0 5.4	0.0 0.0	0.0 0.0	1.0 5.4
4	45 33 22.5N 123 55 13.0W	1.0 5.4	0.0 0.0	0.0 0.0	0.0 0.0
6	45 32 47.0N 123 54 31W	24.0 129.0	2.0 10.8	0.0 0.0	5.0 21.5
18	45 33 1.0N 123 54 50W	2.0 10.8	0.0 0.0	0.0 0.0	0.0 0.0
29	45 33 00.0N 123 56 00.0W	2.0 3.6	0.0 0.0	<1 <10.8	0.0 0.0
31	45 32 53.0N 123 55 51.0W	1.0 1.8	0.0 0.0	3.0 5.4	0.0 0.0
32	45 32 54.0N 123 55 41.0W	<1 <10.8	0.0 0.0	0.0 0.0	0.0 0.0
33	45 33 42.0N 123 56 8.0W	<2 <10.8	0.0 0.0	1.5 5.4	0.0 0.0
34	45 32 38.0N 123 56 18.0W	0.0 0.0	0.0 0.0	1 10.8	0.0 0.0
35	45 32 37.0N 123 56 10.0W	1.0 10.8	0.0 0.0	0.0 0.0	0.0 0.0

60	45 32 49.0N	6.0	10.0	0.0	0.0
	123 54 48.0W	35.3	53.8	0.0	0.0
61	45 33 15.0N	7.0	0.0	0.0	2.0
	123 55 50.0W	12.5	0.0	0.0	3.6
62	45 33 12.0N	8.0	1.0	0.0	1.0
	123 55 45.0W	14.3	1.8	0.0	1.8
63	45 33 8.0N	N/A	N/A	N/A	N/A
	123 55 42.0W	N/A	N/A	N/A	N/A
67	45 31 57.0N	2.0	0.0		0.0
	123 56 35	3.6	0.0	10.8	0.0
68	45 31 57	1.0	0.0		0.0
	123 56 30	1.8	0.0	<10.8	0.0
74	45 31 50.5N	0.0	0.0	0.0	0.0
	123 56 3.0W	10.8	0.0	0.0	0.0
80	45 31 38.5N		0.0	0.0	0.0
	123 55 1.0W	<10.8	0.0	0.0	0.0
86	45 33 7.5N	0.0	0.0		
	123 56 4.0W	0.0	0.0	<10.8	<10.8
89	45 33 3.5N		0.0	0.0	0.0
	123 55 45.0W	<10.8	0.0	0.0	0.0
90	45 32 58.0N		0.0	0.0	0.0
	123 55 35.0W	<10.8	0.0	0.0	0.0
91	45 33 57.0N		0.0	0.0	0.0
	123 55 20.0W	<10.8	0.0	0.0	0.0
92	45 33 18.0N	11.0	1.0	1.0	0.0
	123 55 15.0W	9.9	0.9	0.9	0.0

36	45 32 37.0N		0.0	0.0	0.0
	123 56 3.0W	<10.8	0.0	0.0	0.0
38	45 32 37.0N	1.0	0.0		0.0
	123 55 48.0W	10.8	0.0	<10.8	0.0
44	45 33 18.0N	4.0	2.0	15.0	0.0
	123 55 14.0W	21.5	10.8	80.6	0.0
45	45 33 15.0N	7.0	0.0	12.0	0.0
	123 55 13.5W	37.6	0.0	64.5	0.0
46	45 33 12.5N	4.0	0.0	7.0	0.0
	123 55 13.5W	21.5	0.0	37.6	0.0
47	45 33 11.0N	1.0	0.0	9.0	0.0
	123 55 13.5W	5.4	0.0	48.4	0.0
49	45 33 11.0N	1.0	<1	0.0	0.0
	123 30 52.0W	10.8	<10.8	0.0	0.0
50	45 33 9.0N	5.0	0.0	0.0	0.0
	123 30 52.0W	26.9	0.0	0.0	0.0
51	45 33 6.0N		0.0	0.0	0.0
	123 30 52.0W	<2	0.0	0.0	0.0
52	45 33 17.0N	6.0	2.0	27.0	4.0
	123 55 24.0W	10.8	3.6	48.6	7.2
53	45 33 19.0N	5.0	2.0		0.0
	123 55 24.0W	26.9	10.8	<10.8	0.0
58	45 32 49.0N	2.0	2.0	5.0	17.0
	123 54 31.0W	5.4	5.4	13.4	45.7
59	45 32 49.0N	3.0	3.0	0.0	23.0
	123 54 40.0W	16.1	16.1	0.0	123.6

Appendix C-

Species list of clams identified during the 1995 Tillamook Bay survey

Common name	Scientific name
Cockle clam	Clinocardium nuttallii
Littleneck clam	Venerupis staminea
Butter clam	Saxidomus giganteus
Gaper clam	Tresus capax
Softshell clam	Mya arenaria
Baltic clam	Macoma baltica
Irus clam	Macoma irus
Bentnosed clam	Macoma nasuta
Bodega tellin clam	Tellina bodegensis
Jackknife clam	Solen sicarius

Appendix D-

Raw data from 1995 Tillamook Bay shellfish survey

RAW DATA
Intertidal Shellfish Populations in Tillamook
Bay, Oregon
Kerry Griffin

EXPLANATION

Single cap letters indicate direction.
A single, small case "m" means meters.
For example: "50 m S of buoy 19" means 50
meters south of buoy 19.

Lengths of collected clams are given in inches:

Cockles	3	2.5

This means that two cockles were found;
one was 3 inches, one was 2.5 inches.

Dolphins" are the two pair of large wooden pilings in the middle of the bay.
They are marked on the NOAA chart as "dols"

Station 1

Location	Three Graces; just W. of easternmost rock	
	Lat	45 33 42.5
	Lon	123 56 7.0
	UTM	
Description	Sand/gravel, w/ a few larger rocks interspersed	
	Intertidal -3.0 ft. level	
Observation	Multiple flora species on rocks: ulva, iridia, red algae, fucus.	
Findings	None. Shells of gapers, little necks.	
Notes	2 foot square ring; dug 18" down.	

Station 2

Location	6 m N of DP 1 (shoreward)	
	Lat	45 33 44.0
	Lon	123 56 6.0
	UTM	
Description	Sand/gravel, w/ a few larger rocks interspersed	
	Intertidal -0.5 ft. level	
Observation	Multiple flora species on rocks: ulva, iridia, red algae, fucus.	
Findings	None. Shells of gapers, little necks.	
Notes	2 foot square ring; dug 24" down.	

Station 3

Location	Recreational clam bed immediately W of old Coast Guard pier. Sampled at westernmost end of gravel island Lat 45 33 21.5 Lon 123 55 3.2 UTM
Description	Small/medium rocks/gravel/sand. Intertidal -2.5 ft.
Observation	Nearly complete algal cover: ulva, iridium. Moderate density of burrowing shrimp (approx 20/square foot). Shore crabs, dungeness crabs, benthic worms, etc.
Findings	Cockle 2.5" Butter 2.5"
Notes	2 foot square ring; dug 24" down.

Station 4

Location	10 m W of old Coast Guard pier; 50 m from base of pier. Lat 45 33 22.5 Lon 123 55 13.0 UTM
Description	Sand/mud. Intertidal; -1.0 ft.
Observation	Significant shrimp burrow density (>20/sq. ft.) Very soft sediment; little flora; some eelgrass. Few inverts.
Findings	Cockle 2" Unknown 0.5"
Notes	4 x 4" core samples.

Station 5

Location	Immediately N of Hobsonville pt. (Intertidal near Miami Cove) Lat 45 32 56.5 Lon 123 54 23.0 UTM
Description	Very soft mud/sand.
Observation	Dense shrimp burrows.
Findings	None.
Notes	3 x 4" core samples.

Station 6

Location	W of Hobsonville pt.

	Lat 45 32 50.0
	Lon 123 54 31
	UTM
Description	Soft sediment; littered with many clam shells.
Observation	Hermit crabs, juvenile dungeness, moderate vegetation. Dogwinkles with eggs sacs.
Findings	Cockles (all lengths in inches) 3 2 2.5 2.5 2.5 3 3 2.25 2.75 3 2.5 2.25 2 2 1
	Little necks 2 1
	Butter 3.5 1.5 1 1 2
Notes	1 replicate 2 foot square ring

Station 7

Date	14-Jun-95
Location	W of Hobsonville pt; W of DP 6
	Lat 45 32 50.0
	Lon 123 54 40.0
	UTM
Description	Sand; lots of wood particles on surface and in sediment.
Observation	Juvenile flatfish and dung. crabs. Hermit crabs.
Findings	None
Notes	3 replicates 2 ft. square ring, 24" down.

Station 8

Date	14-Jun-95
Location	W of Hobsonville pt; W of DP 7
	Lat 45 32 50.0
	Lon 123 54 48.0
	UTM
Description	Sandy, shallow.
Observation	No flora or fauna observed,
Findings	None
Notes	Visual observation confirmed no shellfish present.

Station 9

Date	14-Jun-95
Location	W of Hobsonville pt; W of DP 8; Approx. 1/3 across bay.
	Lat 45 32 50.0
	Lon 123 54 52.0

	UTM
Description	Sandy, shallow.
Observation	No flora or fauna observed,
Findings	None
Notes	Visual observation confirmed no shellfish present.

Station 10

Date	14-Jun-95
Location	100 m W of DP 9
	Lat 45 32 50.0N
	Lon 123 55 3.0W
	UTM
Description	Sand; shallow (not in channel)
Observation	No flora or fauna.
Findings	None.
Notes	Visual observation; no sampling ring used.

Station 11

Date	14-Jun-95
Location	Ghost Hole 1/2 way between highway pullout and entrance to Larson's Cove; 25 m W of Hwy 101.
	Lat 45 33 23.0N
	Lon 123 54 5.0W
	UTM
Description	Sandy; silty
Observation	Dense eelgrass beds and shrimp burrows (approx 12/sq. foot)
Findings	None.
Notes	3 replicates, 2 sq foot ring

Station 12

Date	15-Jun-95
Location	SW of Hobsonville Pt; in line w/ 2 "dolphins"; in secondary channel located in between the two "dolphins (large wooden pinlings in middle of bay).
	Lat 45 32 51.0N
	Lon 123 55 12.0W
	UTM
Description	Sandy
Observation	Poor visibility. Numerous juvenile dungeness crabs.

Findings	None.
Notes	3 reps, 2sq ft ring.

Station 13

Date	15-Jun-95
Location	SSW of DP 12 approx. 150m; middle of channel.
	Lat 45 32 45.0N
	Lon 123 55 19.0W
	UTM
Description	Sandy; shallow (4 ft. deep at low tide)
Observation	Lots of juv dung crabs, some mature. Shrimp burrows = 5/sq ft.
	Some flora observed.
Findings	None.
Notes	Visual observation.

Station 14

Date	
Location	Intertidal area W of Ghost Hole.
	Lat 45 33 47.0N
	Lon 123 54 20.0W
	UTM
Description	Sandy.
	Intertidal DP.
Observation	Ulva and eelgrass present. Lots of woody debris. Shrimp burrows = 18/sq ft.
Findings	None.
Notes	3 reps 2 sq ft ring.

Station 15

Date	
Location	Ghost Hole; 25 m W of Hwy 101; 150 m E of DP 14
	Lat 45 32 17.0N
	Lon 123 54 8.0W
	UTM
Description	Sandy/muddy sediment.
	Depth = 5 ft (shallow, not in channel).
Observation	Lots of eelgrass; shrimp burrows.
Findings	None.
Notes	2 reps 2 sq ft ring.

Station 16
Date
Location Ghost Hole, 30 m W of DP 15.
Lat 45 32 17.0N
Lon 123 54 12.0W
UTM

Description Rocks, sand, shells.

Observation Visibility was 0 ft.
Findings None- due to lack of visibility
Notes Sediment felt like good clam habitat.

Station 17
Date
Location Ghost Hole. 30 m W of entrance to Larson's Cove.
Lat 45 32 5.0N
Lon 123 54 2.0W
UTM

Description Sand, gravel, woody debris mixed.

Observation Seems like good clam habitat, but vis was 0.
Findings None- poor vis.
Notes

Station 18
Date
Location Approx 350 m S of Buoy 19, in channel.
Lat 45 33 1.0N
Lon 123 54 50W
UTM

Description Sand, shells, gravel.

Observation Lots of juvenile flatfish, dungeness crabs.
Findings Cockles 3 3
Notes 1 rep 2 sq ft ring.

Station 19
Date
Location 25 m SE of buoy 10.
Lat 45 33 27.0N
Lon 123 56 2.0W
UTM

Description	Sandy, with a few larger rocks . Deep hole (approx 30 ft)
Observation	Numerous juv and adult dung crabs; hermit crabs, flatfish, seastars, sponges, anemones, snails, and plant growth on rocks.
Findings	None.
Notes	3 reps 2 sq ft ring. Excellent visibility.

Station 20

Date	
Location	120 N of buoy 10; N of Kincheloe pt, in middle of channel.
	Lat 45 33 32.0N
	Lon 123 55 59.0W
	UTM
Description	Large rocks (=4 ft diameter)
Observation	Numerous seastars, anemones, [urchins], plant growth.
Findings	None
Notes	Very deep, approx 50 ft. Extremely strong, dangerous current!

Station 21

Date	17-Jun-95
Location	NW of buoy 10
	Lat 45 33 29.0N
	Lon 123 56 8.0W
	UTM
Description	Sand, with small rocks (diam <1 inch)
	Intertidal data point
Observation	No plants, a few worms.
Findings	None
Notes	1 rep 2 sq ft ring

Station 22

Date	17-Jun-95
Location	100m SW of DP 21.
	Lat 45 33 28.5N
	Lon 123 56 14.0W
	UTM
Description	Sand, with small rocks
	Intertidal data point.

Observation	Ulva attached to some rocks.
Findings	None.
Notes	1 rep 2 sq ft ring.

Station 23

Date	17-Jun-95
Location	SW of DP 22, at base of jetty.
	Lat 45 33 28.0N
	Lon 123 56 21.0W
	UTM
Description	Sandier than DP 21 and DP 22. Some small rocks.
Observation	
Findings	None.
Notes	1 rep 2 sq ft ring.

Station 24

Date	17-Jun-95
Location	E of Kincheloe pt, 25 m offshore.
	Lat 45 33 14.0N
	Lon 123 55 58.0W
	UTM
Description	Sand and medium sized rocks (diam=2-3 inches)
	Depth approx 25 ft.
Observation	Zero visibility.
Findings	None
Notes	No sampling- poor vis.

Station 25

Date	17-Jun-95
Location	S of DP 24, 50 m E of small rock jetty.
	Lat 45 33 7.5N
	Lon 123 56 2.0W
	UTM
Description	Sand, silt, mud
Observation	Juv dung and juv flatfish
Findings	None.
Notes	1 rep 2 sq ft ring.

Station 26

Date	18-Jun-95
Location	Mudflats adjacent (E) to the entrance of Garibaldi marina.
	Lat 45 33 20.0N
	Lon 123 54 39.0W
	UTM
Description	Muddy, silty, very soft sediment.
Observation	Eelgrass (Approx 25% coverage), burrowing shrimp 90/sq ft. many juvenile clams, species unknown. Length 0.5" - 0.75" Some benthic worms present.
Findings	None.
Notes	

Station 27

Date	18-Jun-95
Location	Mudflats near Bay City.
	Lat 45 30 48.0N
	Lon 123 53 17.0W
	UTM
Description	Very silty, fine sediment approx 12" deep. Below is a dense layer of clay.
Observation	Some eelgrass, fucus.
Findings	Juvenile gapers, softshells, bentnose.
Notes	

Station 28

Date	19-Jun-95
Location	North end of Crab Harbor; 100 yds S of small rock jetty.
	Lat 45 33 3.0N
	Lon 123 56 7.0W
	UTM
Description	Sand, silt.
Observation	Seastars, starfish, juv flatfish, adult and juv dung crabs.
Findings	Cockles, bentnose, gaper necks, evidence of razor clam.
Notes	Visual observation only.

Station 29

Date	19-Jun-95
Location	100 m ESE of DP 28; 150 m S of tip of small rock jetty

	Lat	45 33 00.0N		
	Lon	123 56 00.0W		
	UTM			
Description	Sandy			
Observation	Flatfish (juvs), a few burrowing shrimp, numerous adult and juv dung crabs.			
Findings	Cockles	3.5	3.5	
	Gaper necks observed, density <1/sq ft.			
Notes	3 reps 2 sq ft ring.			

Station 30

Date	19-Jun-95			
Location	100 m E of DP 29			
	Lat	45 33 1.0N		
	Lon	123 55 52.0W		
	UTM			
Description	Sandy			
	Juv flatfish and juv dung crabs; little other life observed.			
Observation	None			
Findings				
Notes				

Station 31

Date	19-Jun-95			
Location	200 m s of DP 30			
	Lat	45 32 53.0N		
	Lon	123 55 51.0W		
	UTM			
Description	Thick mud and sand.			
Observation	Extensive algal growth over mud; a few isolated larger plants.			
	Evidence (shells) of razors and bentnosed clams.			
Findings	Gaper	5	4.5	5
	Cockle	3		
Notes	3 reps 2 sq ft ring.			

Station 32

Date	19-Jun-95			
Location	100 m E of DP 31			
	Lat	45 32 54.0N		
	Lon	123 55 41.0W		
	UTM			

Description Sandy

Observation Adult and juv dung crabs; limited flora.
Findings Cockles: density = less 1/sq ft.
Notes

Station 33
Date 19-Jun-95
Location Three Graces; NW of SE most rock (w/hole through it).
Lat 45 33 42.0N
Lon 123 56 8.0W
UTM

Description Sandy, intermixed with boulders, various sized rocks.

Observation Extensive floral growth of many different species; red rock crabs, dung crabs, several species of fish: greenling, pile perch, striped surf perch, sculpin
Findings Gapers density = 1-2/sq ft.
Cockles density = less than 1/sq ft.
Notes

Station 34
Date 20-Jun-95
Location S end of Crab Harbor.
Lat 45 32 38.0N
Lon 123 56 18.0W
UTM

Description Sandy, with dark, silty sediment underneath.
Shallow- 5 ft.
Observation Eelgrass = 50% cover; dung crabs (mature)
Findings Bentnosed 0.5
Gaper necks; density = 1/sq ft.
Notes 1 rep 2 sq ft ring

Station 35
Date
Location Crab Harbor, 30 m from Bayocean shoreline, near S end of C. H.
Lat 45 32 37.0N
Lon 123 56 10.0W
UTM

Description Sandy

Observation Little vegetation

Findings	Cockles density = 1/sq ft.
Notes	Depth = 7 ft, halfway incoming tide.

Station 36	
Date	
Location	100 m E of DP 35
	Lat 45 32 37.0N
	Lon 123 56 3.0W
	UTM
Description	Sand
Observation	Eelgrass, shrimp burrows = 25,sq ft.
Findings	Cockles, density < 1/sq ft
Notes	DP 36 and DP 37 are directly E of dentral part of peninsula, where mature conifers stand.

Station 37	
Date	
Location	100 m E of DP 36
	Lat 45 32 37.0N
	Lon 123 55 56.0W
	UTM
Description	Sand.
Observation	100% eelgrass cover. Shrimp burrows, 8/sq ft.
Findings	None.
Notes	Depth = 4 ft.

Station 38	
Date	
Location	100 m E of DP 34
	Lat 45 32 37.0N
	Lon 123 55 48.0W
	UTM
Description	Sandy.
Observation	patches of eelgrass, ulva, other algaes; juv flatfish and dung crabs.
Findings	Cockles, density = 1/sq ft.
	Gapers, density < 1/sq ft.
Notes	

Station 39
Date
Location Barview, where jetty angles (near buoy 6).
Lat 45 34 5.0N
Lon 123 56 41.0W
UTM

Description Sandy.

Observation juv dung crabs and flatfish.
Findings None.
Notes This DP begins a transect from this point, south toward the bend in the south jetty.

Station 40
Date
Location 50 m S of 39.
Lat 45 34 3.0N
Lon 123 56 43.0W
UTM

Description Sand, a few small rocks.

Observation Little vegetation; a few dung crabs (juveniles).
Findings None.
Notes

Station 41
Date
Location 50 m S of DP 40
Lat 45 33 59.0N
Lon 123 56 45.0W
UTM

Description Sandy

Observation Little vegetation; a few dung. crabs (juvs)
Findings None.
Notes

Station 42
Date
Location 50 m S of DP 41

	Lat	45 33 57.0N
	Lon	123 56 46.0W
	UTM	
Description	Sandy	
Observation	Little vegetation; a few dung. crabs (juvs)	
Findings	None.	
Notes		

Station 43
Date
Location Immediately adjacent to south jetty, at bend in jetty.

Lat	45 33 54.0N
Lon	123 56 48.0W
UTM	

Description Large jetty boulders, then sandy sediment.

Observation Plentiful plant life, fish, and invertebrates on, and adjacent to jetty.
Findings None
Notes

Station 44
Date
Location Adjacent to, and S of old Coast Guard pier.

Lat	45 33 18.0N
Lon	123 55 14.0W
UTM	

Description Sandy, silty, littered with lots of old clam shells.

Observation Pile perch, surf perch, (anchovies?), flatfish, juv and adult dung crab.
Findings

Gapers	15 necks			
Cockles	1	2	3.5	3.5
Little neck	2	2		

Notes 1 rep 2 sq ft ring.
DP 44-47 are in a transect from old CG pier towards buoy 14

Station 45
Date
Location 50 m S of DP 44 (in channel)

Lat	45 33 15.0N
Lon	123 55 13.5W

	UTM				
Description	Sandy w/ lots of small rocks and shells.				
Observation	crabs, some fish, little flora.				
Findings	Cockles	3	3	3	3
		3	3	3	
	Gapers	12 necks.			
Notes	1 rep 2 sq ft ring.				

Station 46					
Date					
Location	50 m S of DP 45 (in channel)				
	Lat	45 33 12.5N			
	Lon	123 55 13.5W			
	UTM				
Description	Sandy, lots of shells.				
Observation	Crabs, some fish, little flora.				
Findings	Cockles	2.5	3	3	2.5
	Gapers	7 necks			
Notes	1 rep 2 sq ft ring.				

Station 47		
Date		
Location	At buoy 14.	
	Lat	45 33 11.0N
	Lon	123 55 13.5W
	UTM	
Description	Sandy, approaching edge of channel.	
Observation	Few juv dungeness, flatfish.	
Findings	Gapers	9 necks
Notes	Cockles	3

Station 48		
Date	22-Jun-95	
Location	Adjacent to buoy 19.	
	Lat	45 33 13.0N
	Lon	123 30 52.0W
	UTM	
Description	Soft sediment, very silty.	

Observation	Shrimp burrows, 10/sq ft.
Findings	None.
Notes	Poor visibility. This DP begins another transect south from buoy 19 across channel.

Station 49

Date	22-Jun-95	
Location	50 S of DP 48	
	Lat	45 33 11.0N
	Lon	123 30 52.0W
	UTM	
Description	Sandy/silty.	
Observation	Some vegetation, juv dungeness.	
Findings	Cockles	density = 1/sq ft
	littleneck	density = <1/sq ft.
Notes		

Station 50

Date	22-Jun-95				
Location	50 m S of DP 49				
	Lat	45 33 9.0N			
	Lon	123 30 52.0W			
	UTM				
Description	Sandy/silty				
Observation	Some vegetation				
Findings	Cockles	3	3	3.5	4
Notes	1 rep 2 sq ft ring.				

Station 51

Date	22-Jun-95	
Location	50 me S of DP 50.	
	Lat	45 33 6.0N
	Lon	123 30 52.0W
	UTM	
Description	Sandy.	
Observation	Juv flatfish and dung crab, a few adult dungeness.	
Findings	Cockle density < 2/sq ft.	
Notes		

Station 52

Date	23-Jun-95				
Location	6 m N of buoy 13				
	Lat	45 33 17.0N			
	Lon	123 55 24.0W			
	UTM				
Description	Very silty.				
Observation	Lots of shells, some flora, juv and adult dung crab; juv flatfish.				
Findings	Replicate 1	Cockles	2	2	2.5
			2.5	3	3
		Gaper necks = 15			
	Replicate 2	Littlenecks	2	2	
		Gaper necks = 8			
	Replicate 3	Butter	4		
		Gaper necks = 7			
Notes	3 reps 2 sq ft ring.				

Station 53

Date	23-Jun-95			
Location	50 m N of DP 52			
	Lat	45 33 19.0N		
	Lon	123 55 24.0W		
	UTM			
Description	Soft sediment, lots of shells.			
Observation	Juv flatfish and juv dung crabs, some algae			
Findings	cockles	3	3	2.5
		3	2.5	
	Littlenecks	2	1.5	
	gapers	Some necks; density <1/sq ft.		
Notes				

Station 54

Date	23-Jun-95	
Location	50 m N of DP 53	
	Lat	45 33 21.5N
	Lon	123 55 24.0W
	UTM	

Description	Silty, moreso than DP 53
Observation	Fewer shells, more eelgrass (than DP 53)
Findings	None.
Notes	

Station 55	
Date	23-Jun-95
Location	South side of channel, across channel from buoy 13
	Lat 45 33 9.0N
	Lon 123 55 24.0W
	UTM
Description	Sandy.
Observation	juv flatfish and juv dung crabs
Findings	None
Notes	

Station 56	
Date	23-Jun-95
Location	50 m N of DP 55- in channel.
	Lat 45 33 12.5N
	Lon 123 55 24.0W
	UTM
Description	Sandy.
Observation	Juv flatfish and juv dung crabs.
Findings	None.
Notes	

Station 57	
Date	23-Jun-95
Location	50 m S of DP 55
	Lat 45 33 6.0N
	Lon 123 55 24.0W
	UTM
Description	Sandy.
Observation	Some juve flatfish and dung crabs.
Findings	None.
Notes	Visual observation only.

Station 58

Date	29-Jun-95				
Location	W of Hobsonville Pt, approx 35 m				
	Lat	45 32 49.0N			
	Lon	123 54 31.0W			
	UTM				
Description	Sandy, silty sediment, with many clam shells and small rocks.				
Observation	Limited algal growth				
	Numerous small fish and crabs: hermit crabs, juv dung, flatfish, sculpins.				
Findings	Butters	1	2	2.5	3
		3.5	3.5	3.5	3.5
		3.5	3	3	3
		4	4		
	Littleneck	0.5	2		
	Gapers	5 necks observed.			
	Cockles	1	2		
Notes	2 reps 2 sq ft. ring				

Station 59

Date	29-Jun-95				
Location	50 m W of DP 58, in channel.				
	Lat	45 32 49.0N			
	Lon	123 54 40.0W			
	UTM				
Description	Sandy, silty, lots of shells and small rocks.				
Observation	Some flora observed.				
Findings	Butters	3	3	3	3
		3	3	3	3
		3	3.5	3.5	3.5
		3.5	3.5	3.5	3.5
		3.5	4	4	
	Littleneck	1	1.5	2	
	Cockles	2	2	0.75	
Notes	1 rep 2 sq ft ring				

Station 60

Date	29-Jun-95	
Location	50 m W of DP 59	
	Lat	45 32 49.0N

	Lon	123 54 48.0W			
	UTM				
Description	Sandy, silty, lots of shells and small rocks.				
Observation	Darker sediment underneath top layer.				
Findings	Cockles	1.5	1.5	1.5	1.5
		2	0.5		
	Littleneck	2	2	2	1.5
		1.5	1.5	1.5	1.5
		1	1		
Notes	1 rep 2 sq ft ring.				

Station 61

Date	30-Jun-95				
Location	50 m NW of buoy 12, directly in line with buoy10				
	Lat	45 33 15.0N			
	Lon	123 55 50.0W			
	UTM				
Description	Gravel, sand, clam shells.				
Observation	Juv crab, juv flatfish, mature ling cod or greenling, anemones, red rock crab. Unidentified sculpin: 3-4" length, reddish head, white and grey vertical bars on body (5 total), white spots near base of pect fins.				
Findings	Cockle	4	4	4	3
		3	3	3	
	Butter	0.5	0.5		
Notes	3 reps 2 sq ft ring.				

Station 62

Date	30-Jun-95				
Location	At buoy 12 (5 m to the S)				
	Lat	45 33 12.0N			
	Lon	123 55 45.0W			
	UTM				
Description	gravel, sand, small/medium rocks, lots of shells.				
Observation	Same as DP 61				
Findings	Rep 1	Cockles	0.5	0.5	4
		Butters	5		
	Rep 2	Cockles	3	3	4
			4	1.5	

	Littleneck	2
Rep 3	None.	

Notes 3 reps 2 sq ft. ring

Station 63

Date 30-Jun-95

Location 50 m ESE of buoy 12, directly in line sith buoys 10 and 12

Lat 45 33 8.0N

Lon 123 55 42.0W

UTM

Description gravel, sand, some silt, clam shells.

Observation

Findings N/A

Notes Original data lost.

Station 64

Date 12-Jul-95

Location Directly S across channel from Garibaldi marina (50 m S of entrance)

Lat 45 33 13.0N

Lon 123 54 39.0W

UTM

Description Intertidal, muddy, silty, very soft sediment.

Observation Shrimp burrows = 30/sq ft.

Findings Bentnosed 1 adult/sq ft.

Notes 3 reps 2 sq ft ring.

Station 65

Date 13-Jul-95

Location W of buoy 10, in shallow harbor area near base of S jetty.

Lat 45 33 30.0N

Lon 123 56 15.0W

UTM

Description Sandy, moderate amount of flora.

Shallow, approx 4-8 ft.

Observation

Findings Medium sized (3-4") butter clams taken by recreationist subtidally. Clams have dark bluish shells. Density unknown, but likely

Notes to be commercially significant.

Station 66

Date	14-Jul-95
Location	Intertidal mudflat of Bayocean Peninsula, adjacent to dredged area ("Fish Havens" on NOAA chart).
	Lat 45 31 55.0N
	Lon 123 56 49.0W
	UTM
Description	Sandy, little vegetation.
Observation	Shrimp burrows = 81/sq ft.; oyster (C. gigas) cluster present, probably escaped" from nearby longlines.
Findings	Bentnosed 1/sq ft.
Notes	3 reps 2 sq ft ring.

Station 67

Date	14-Jul-95		
Location	Deep hole adjacent to B.O Peninsula, 70 m E of vegetation line.		
	Lat 45 31 57.0N		
	Lon 123 56 35		
	UTM		
Description	Very silty, soft sediment.		
Observation	Flatfish, some oyster cluster < 1/sq ft.		
Findings	Gaper necks		
	Rep 1	None	
	Rep 2	Cockles	3 1
	Rep 3	None	
Notes	# reps 2 sq ft ring. Depth = 25 ft.		
	The next several DPs are on a transect from the deep hole ("Fish Havens") directly toward the oyster house building at Bay City.		

Station 68

Date	14-Jul-95
Location	50 m E of DP 67
	Lat 45 31 57
	Lon 123 56 30
	UTM
Description	This DP is on the slope of the deep hole (DP 67).
	Sandy/silty.
Observation	Flatfish; goby (probably).
	Gaper necks density < 1/sq ft.

Findings	Rep 1	Bentnosed	1.5
	Rep 2	None	
	Rep 3	Cockle	3
Notes	3 reps 2 sq ft. ring.		

Station 69

Date	14-Jul-95	
Location	50 m E of DP 68	
	Lat	45 31 56.0N
	Lon	123 56 24.0W
	UTM	
Description	Muddy, silty.	
	Shallow, approx 4-8 ft.	
Observation	Eelgrass, shrimp burrows present.	
Findings	None	
Notes	Observation only.	

Station 70

Date	14-Jul-95	
Location	50 m E of DP 69	
	Lat	45 31 55.0N
	Lon	123 56 20.0W
	UTM	
Description	Muddy, silty.	
	Shallow, approx 4-8 ft.	
Observation	Eelgrass, shrimp burrows present.	
Findings	None	
Notes	Observation only.	

Station 71

Date	14-Jul-95	
Location	50 m E of DP 70	
	Lat	45 31 53.5N
	Lon	123 56 16.0W
	UTM	
Description	Muddy, silty.	
	Shallow, approx 4-8 ft.	
Observation	Eelgrass, shrimp burrows present.	
Findings	None	
Notes	Observation only.	

Station 72

Date	14-Jul-95
Location	50 m E of DP 71
	Lat 45 31 52.5N
	Lon 123 56 11.0W
	UTM
Description	Muddy, silty.
	Shallow, approx 4-8 ft.
Observation	Eelgrass, shrimp burrows present.
Findings	None
Notes	Observation only.

Station 73

Date	14-Jul-95
Location	50 m E of 72
	Lat 45 31 51.0N
	Lon 123 56 7.0W
	UTM
Description	Muddy, silty.
	Shallow, approx 4-8 ft.
Observation	Eelgrass, shrimp burrows present.
Findings	None
Notes	Observation only.

Station 74

Date	14-Jul-95
Location	50 m E of DP 73
	Lat 45 31 50.5N
	Lon 123 56 3.0W
	UTM
Description	Sandy, strong current, deeper than previous 5 DPs.
Observation	
Findings	Cockles < 1/sq ft.
Notes	Observation only.

Station 75

Date	14-Jul-95
Location	100 m E of DP 74.

	Lat	45 31 49.0N
	Lon	123 55 54.0W
	UTM	
Description	Sandy, still slightly deeper.	
Observation	None.	
Findings	None.	
Notes	Observation only.	

Station 76

Date	14-Jul-95	
Location	100 m E of DP 75	
	Lat	45 31 47.0N
	Lon	123 55 45.5W
	UTM	
Description	Shallower than DPs 74-75. Sandy.	
Observation	Eelgrass, some shrimp burrows (low density).	
Findings	none.	
Notes	Observation only.	

Station 77

Date	14-Jul-95	
Location	130 m E of DP 76.	
	Lat	45 31 44.5N
	Lon	123 55 30.0W
	UTM	
Description	Sandy/silty.	
Observation	Burrowing shrimp, low density.	
Findings	None.	
Notes	Observation only.	

Station 78

Date	14-Jul-95	
Location	100 m E of DP 77	
	Lat	45 31 43.0N
	Lon	123 55 21.0W
	UTM	
Description	Sandy, shallow (5-5 ft at mid-incoming tide).	

Observation	None
Findings	None.
Notes	Observation only.

Station 79

Date	14-Jul-95
Location	100 m E of DP 78; at PVC stake that marks corner of oyster grounds.
	Lat 45 31 40
	Lon 123 55 10
	UTM
Description	Sand, mud.
Observation	Numerous unidentified juv clams.
Findings	None.
Notes	Observation only.

Station 80

Date	14-Jul-95
Location	100 m E of DP 79.
	Lat 45 31 38.5N
	Lon 123 55 1.0W
	UTM
Description	Deeper (12-14 ft at mid-incoming tide).
	Sand, mud
Observation	
Findings	Cockles < 1/sq ft.
Notes	Observation only.

Station 81

Date	14-Jul-95
Location	100 m E of DP 80, approx 2/3 across bay.
	Lat 45 31 37.0N
	Lon 123 54 50.0W
	UTM
Description	Silt, mud.
Observation	Shrimp burrows present.
Findings	None.
Notes	Observation only.

Station 82

Date	14-Jul-95
Location	100 M e of DP 81
	Lat 45 31 34.5N
	Lon 123 54 39.0W
	UTM
Description	Sand/silt.
Observation	Shrimp burrows present.
Findings	Numerous unidentified juv clams. (= 5/sq ft)
Notes	Observation only.

Station 83

Date	14-Jul-95
Location	150 m E of DP 82
	Lat 45 31 31.0N
	Lon 123 54 24.0W
	UTM
Description	Mud, silt
Observation	flatfish, crabs, burrowing shrimp, eelgrass.
Findings	None.
Notes	Observation only.

Station 84

Date	14-Jul-95
Location	150 m E of DP 83
	Lat 45 31 28.0N
	Lon 123 54 12.0W
	UTM
Description	Sandy
Observation	Eelgrass, shrimp burrows present.
Findings	None.
Notes	Observation only.

Station 85

Date	14-Jul-95
Location	150 m E of DP 84; Approx 200 m W of Oyster house at Bay City.
	Lat 45 31 26.5N
	Lon 123 54 00.0W

	UTM
Description	Sandy
Observation	eelgrass, shrimp burrows.
Findings	None.
Notes	Observation only.

Station 86	
Date	14-Jul-95
Location	30 m E of tip of small jetty adjacent to Crab Harbor.
	Lat 45 33 7.5N
	Lon 123 56 4.0W
	UTM
Description	Med size rocks (2" - 5" diameter). Depth= 27 ft. mid-incoming tide.
Observation	Sea anemones, hermit crabs, starfish, dung. crabs, moderat flora.
Findings	Gaper and butter necks density < 1/sq ft.
Notes	3 reps 2 sq ft ring.

Station 87	
Date	14-Jul-95
Location	70 m E of DP 86 (100 me from small jetty)
	Lat 45 33 7.5N
	Lon 123 56 2.0W
	UTM
Description	Sandy; depth = 10-12 ft mid-incoming tide; at edge of slope.
Observation	None.
Findings	None.
Notes	Observation only.

Station 88	
Date	14-Jul-95
Location	50 m E of DP 87 (150 me off jetty)
	Lat 45 33 6.0N
	Lon 123 55 54.0W
	UTM
Description	Sandy; 6-8 ft depth at mid-incoming tide.
Observation	
Findings	None.

Notes Observation only.

Station 89

Date 14-Jul-95

Location 300 m E of jetty; 1/2 way toward NE-most dolphin.

Lat 45 33 3.5N

Lon 123 55 45.0W

UTM

Description Sandy.

Observation No flora; little other life.

Findings Cockles < 1/sq ft.

Notes Observation only.

Station 90

Date 14-Jul-95

Location 2/3 toward dolphin; approx 450 m off jetty.

Lat 45 32 58.0N

Lon 123 55 35.0W

UTM

Description Sandy.

Observation Little life.

Findings A few large (3"-4") cockles; <1/sq ft.

Notes Observation only.

Station 91

Date 14-Jul-95

Location At NW-most dolphin pair.

Lat 45 33 57.0N

Lon 123 55 20.0W

UTM

Description Sandy.

Observation

Findings A few large cockles; <1.sq ft.

Notes Observation only.

Station 92

Date 14-Jul-95

Location

40 m W of old coast guard pier.

Lat	45 33 18.0N
Lon	123 55 15.0W
UTM	

Description

Mix of sand, mud, gravel, wood debris.

Observation

Lots of vegetation, including eelgrass. Broken shells, numerous species of shellfish, fish, and inverts: starfish, flatfish, perch, dungeness crab (mature and juvenile).

Findings

Rep 1	Gaper	(1 ind., size unknown)		
Rep 2	Cockle	3	1	
Rep 3	Cockle	2	3	3
	Littleneck	2		
	Bentnosed	2		
Rep 4	Cockle	3.5		
Rep 5	Cockle	2.5	3	
Rep 6	Cockle	2	2.5	2.5

Notes

6 reps 2 sq ft. ring.