Marine Resource Inventory of Pacific Rim National Park - 1977

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by

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ABSTRACT

Lee, J. C., and N. Bourne. 1978. Marine resource inventory of Pacific Rim National Park - 1977. Fish. Mar. Serv. MS Rep. 1467: 198 p.

The 1977 marine resource study was the 3rd year of a 5-year program designed to provide information on marine organisms and their associated habitats for Park planning, interpretation, and management. Results of fauna and flora and recreational impact studies are discussed under the three Park sections, Long Beach, Broken Group Islands, and West Coast Trail.

Key words: marine park, marine resource inventory, British Columbia.

RÉSUMÉ

Lee, J. C., and N. Bourne. 1978. Marine resource inventory of Pacific Rim National Park - 1977. Fish. Mar. Serv. MS Rep. 1467: 198 p.

L'étude de 1977 sur les ressources marines constituait la troisième année d'un programme quinquennal de collecte d'information sur les organismes marins et leurs habitats aux fins de la planification et de la gestion des parcs et de l'interprétation de la nature. Les résultats des études des incidences sur la faune, la flore et les loisirs sont regroupés pour chacune des trois sections du parc: Long Beach, Broken Group Islands et west Coast Trail.

Mots clés: parc marin, inventaire des ressources marines, Colombie-Britannique.

INTRODUCTION

The marine resources study, begun in 1975 in Pacific Rim National Park (Lee and Bourne 1976) was continued in 1977 on behalf of Parks Canada, Western Region, by Lee and Adkins Ltd. in affiliation with the Pacific Biological Station (Nanaimo), Fisheries and Marine Service, Department of Fisheries and the Environment. The 1977 study was the third year of a 5-yr. program designed to provide information on marine communities for Park planning, interpretation, and management. Investigations were continued in all three sections of the Park. Major emphasis was on obtaining quantitative data to determine yearly and seasonal levels of marine populations within the Park.

In the Long Beach Section, fauna and flora surveys along rocky shores and recreational impact studies were continued; the razor clam (Siliqua patula) study was reduced and surveillance of the littleneck clam (Protothaca staminea) population was discontinued. Both sea mussel (Mytilus californianus) studies, the purple olive snail (Olivella biplicata) and purple starfish (Pisaster ochraceus) studies were continued. Subtidal surveys in this Park section were confined to the northern end of Wickaninnish Bay.

Major emphasis in 1977 was on studies in the Broken Group Islands and the West Coast Trail Sections. Intertidal and subtidal fauna and flora surveys were continued in the Broken Group Islands. The bivalve population study in this section was continued and included an assessment of population structure and recruitment of a clam population at Hand Island.

Intertidal fauna and flora surveys, begun in 1976 along the entire length of the West Coast Trail, were continued in 1977.

Terms of reference for the 1977-1978 resource inventory are given in Appendix 1.

LONG BEACH SECTION

HABITAT TYPES

Habitat types - Intertidal

Sampling procedures were similar to those in 1976 (Lee and Bourne 1977). Only rocky shore studies were continued to further assess seasonal and yearly variations within the marine communities of this habitat. Transects 4, 11, 12b, 13, and 14a were sampled (Fig. 1). Results of fauna and flora studies along rocky shores are discussed under appropriate headings.

Numbers of organisms in a 1 m^2 sample were recorded from each biotic zone along transects. Sponges, bryozoans, compound ascidians, and some polychaete species were recorded as percent coverage within a m^2 area. A 25 x 25 cm grid was used when counting organisms smaller than 2 cm. Algal cover was recorded as percent coverage within a m^2 area.

Exposed habitats

Rocky shores

Fauna and flora studies of exposed rocky shores were continued along a vertical rock face at Green Point (Fig. 1); numbers of organisms recorded are shown in Table 1. The four biotic zones described in the previous year (Lee and Bourne 1977) were used again in 1977.

Zone 1, splash or spray zone

The splash zone is the most sparsely populated area along a rocky shore.

The few plant species observed in this zone were the same as in 1976. The black lichen, Verrucaria sp. had a coverage of 50%/m^2 throughout the year. Prasiola meridionalis, a small green alga found along the top of the rock face, was most abundant in June at 60%/m^2, but by December, it was completely absent.

Collisella digitalis, the dominant limpet in this zone, occurred in much greater densities than in 1976. In April, numbers were as high as 300/m^2 (increase of five times) but gradually decreased to 160/m^2 in December (two times 1976 densities). This increase was probably due to immigration into

the area since all animals were large, i.e., there was no major recruitment. Notoacmea persona and N. scutum were present throughout the year but in much lower numbers than in the previous year. Periwinkles, Littorina sitkana, and L.scutulata were common in this zone. L. sitkana was more abundant in 1977 than in 1976, 4,000/m^2, compared to 130/m^2. L. scutulata occurred in much lower numbers. Numbers of acorn barnacles, Balanus glandula, and Chthamulus dalli, were not significantly different between the 2 years. B. glandula was recorded at mean density of 42,000/m^2 and C. dalli, a much smaller species, at 2,000/m^2.

Zone 2, high intertidal zone

Dominant algae usually associated with Zone 2 on exposed rocky shores are the brown algae, Fucus distichus, and Pelvetiopsis limitata. During the past 2 years Fucus plants were small and sparsely distributed at Green Point with a maximum coverage of 30%/m^2. Pelvetiopsis was more abundant in 1977 with a coverage of 60%/m^2 in June which decreased to 20%/m^2 by December. This seasonal fluctuation in densities was also observed in 1976. Numbers of green algae were low throughout the year in Zone 2 as was observed in 1976. In 1977, a greater number of red algal species were identified but their coverage remained low, less than 5% throughout the year (Table 1).

Several faunal species recorded in Zone 1 were also observed in Zone 2. Numbers of C. digitalis were lower in Zone 2 than 1 as in 1976; density of L. scutulata was similar to that of Zone 1; L. sitkana and C. dalli showed marked increases in numbers (3,200/m^2 and 2,100/m^2, respectively) over 1976 observations. Other species common to both Zones 1 and 2 showed no marked changes in densities between the 2 years. Three other species commonly found in Zone 2, Thais emarginata, T. lamellosa, and B. cariosus occurred at densities similar to those of 1976.

Zone 3, mid-intertidal zone

The characteristic assemblage of the mid-intertidal zone was similar in 1976 and 1977; however, siginficant changes in numbers were recorded for the dominant faunal species.

Growth of Hedophyllum sessile, the dominant alga of this zone, was similar to that observed in 1976. Area of coverage increased throughout the season to a maximum of 60%/m^2 in June and gradually decreased in winter. A larger number of small red algae were identified in this zone than in 1976 but their coverage was low, 5-10%/m^2 (Table 1).

Sea mussels, Mytilus californianus, which occur in extensive beds in this zone, increased from 25,000/m^2 in 1976 to 57,000/m^2 in 1977, due mainly to a greater number of small sea mussels in 1977. Bay mussels, M. edulis, were abundant in the upper part of the mussel bed and their density showed little change in the 2 years. Goose barnacles, Pollicipes polymerus, were more abundant at this site than in 1976. Clumps of adult barnacles were observed as before but there were large areas covered with juveniles. Densities increased from 200/m^2 in 1976 to 2,900/m^2 in 1977.

Abundance of some other fauna in this zone was markedly different from that of 1976 (Lee and Bourne 1977). Limpets C. pelta and N. scutum were again present in moderate numbers. Fewer C. digitalis were observed in 1977 but N. persona was more abundant at 320/m^2. Abundance of two species of Thais was similar to that in 1976.

Numbers of B. nubilus remained the same in the 2 years but B. cariosus showed a slight increase. Two major differences in the fauna were found in 1977; C. dalli, not observed in 1976, was recorded at densities of 4,500/m^2 in 1977 and densities of B. glandula increased from 17,000/m^2 in 1976 to 30,000/m^2.

The population of A. xanthogrammica remained fairly constant throughout the year but were slightly lower than in 1976. A large number of juvenile A. elegantissima were recorded and numbers increased from 400/m^2 in 1976 to 2,400/m^2 in 1977; in December they decreased slightly to 1,300/m^2.

Zone 4, low intertidal zone

Brown and red algae were the dominant algal species in the low intertidal zone. The dominant brown algae continued to be Alaria marginata and Laminaria setchellii but their densities were slightly lower than in 1976. A. marginata remained the more abundant alga even into winter. Densities of a few red algae increased in 1977; Petrocelis sp. and Prionitis sp. increased to 10-15%/m^2 during summer months, but Gigartina exasperata was not as abundant as in 1976. Other algae present in this zone are shown in Table 1.

Few faunal species were observed in this zone and their densities were low (Table 1).

Semi-exposed habitats

Rocky shores

Studies of fauna and flora along semi-exposed rocky shores were continued in 1977. Sample sites were the same as

in 1976 - Box Island (12b), Quisitis Point (14a), and Half Moon Bay (4) (Fig. 1). Numbers of organisms recorded at these sites are shown in Table 1.

Zone 1, splash or spray zone

The black lichen, Verrucaria sp. was the dominant floral species and densities were similar to those of 1976. A larger number of algal species were recorded in the splash zone in 1977. Prasiola meridionalis a small green alga, was recorded only at Quisitis Point at densities as high as 30%/m^2 during the summer months. Another green alga, Enteromorpha intestinalis, occurred in low densities, less than 5%/m^2 at Box Island. A few brown and red algae were recorded in small depressions and tidepools in the splash zone. Coverage provided by these algae was low, 5-10%/m^2 (Table 1).

Dominant faunal species in Zone 1 were again limpets, periwinkles and acorn barnacles. Densities of these organisms showed some marked differences from those in 1976. Numbers of C. digitalis, the most abundant limpet found at these three sites, were similar to those in 1976 except at Half Moon Bay where they increased from 40/m^2 in 1976 to 300/m^2. N. persona and N. scutum were present in low densities throughout the year; C. pelta, not recorded at these sites in 1976, was found in low numbers. L. sitkana, the most numerous periwinkle in Zone 1, showed a slight increase in numbers over 1976; highest density 740/m^2 was observed at Half Moon Bay in December. Numbers of L. scutulata were also higher at each site in 1977; greatest number (700/m^2) was at Half Moon Bay in June. B. glandula was still the dominant acorn barnacle at all sites and densities did not change significantly in the 2 years; a slight reduction in numbers was noted at Half Moon Bay. Numbers of C. dalli increased in 1977 at all three sample sites, but were lower than those of B. glandula.

Zone 2, high intertidal zone

Rockweed, Fucus distichus was the dominant algae in the high intertidal zone. Coverage was slightly less in 1977 at all three sites, but was at least 30% at the height of the growing season. Green and red algae were not common at these sites except for Gigartina sp. at Half Moon Bay where coverage was as high as 40%/m^2 (Table 1).

Numbers of limpets were similar to those in 1976 except for C. digitalis at Quisitis Point and Half Moon Bay where densities increased to as high as 300/m^2. The periwinkle L. sitkana increased in numbers from 150/m^2 in 1976 to as high as 4,800/m^2 at Half Moon Bay. Numbers of acorn barnacles were similar in the 2 years except for C. dalli, which increased

from a few scattered individuals in 1976 to as high as 4,000/m^2 at all sites in June.

Abundance of T. emarginata varied considerably from site to site (80-130/m^2) in 1977. Bay mussels were found in isolated patches except at Half Moon Bay where densities increased to 1,400/m^2. Isolated patches of sea mussels were recorded at Quisitis Point and Half Moon Bay.

Zone 3, mid-intertidal zone

Extensive mussel beds and the brown alga Hedophyllum sessile were the characteristic biota of Zone 3 in semi-exposed areas.

The brown alga H. sessile was dominant at all three sites. Other brown algae (A. marginata and A. nana) and the red alga Halosaccion sessile were common in the mid-intertidal zone. Coverage by these algae was greatest during summer months, and decreased during winter (Table 1). Densities of other red and green algae varied from site to site but were usually less than 10% coverage (Table 1).

Both M. californianus and M. edulis were common except at Box Island. Numbers of acorn barnacles (B. glandula and C. dalli) and goose barnacles Pollicipes polymerus increased significantly in 1977 (Table 1). There was little seasonal variation in numbers of limpets, thaids and acorn barnacles.

Although sea urchins are not common along these rocky shores, a consistent number of purple sea urchins, Strongylocentrotus purpuratus, were observed at Half Moon Bay in both 1976 and 1977. The only anemone that showed a change in density was A. elegantissima which increased significantly at Half Moon Bay to 900/m^2 compared to 275/m^2 in 1976. Other species present in this zone are shown in Table 1.

Zone 4, low intertidal zone

The dominant algal species in the low intertidal zone were similar in 1976 and 1977. As in 1976, these algae are not evenly distributed throughout the semi-exposed area. Phyllospadix scouleri, A. marginata, and Egregia menziesii were most abundant at Box Island. Laminaria setchellii, Lessoniopsis littoralis, and Gigartina exasperata were the dominant algal species at Quisitis Point and Half Moon Bay. Iridaea sp. was common at both Box Island and Half Moon Bay. Highest densities of each alga occurred in summer and decreased by winter (Table 1). Additional algal species that appeared irregularly or in low densities are shown in Table 1.

Faunal species were not abundant in the low intertidal

area. The most noticeable species - sponges, bryozoans, anemones, polychaetes, and barnacles - were found in lower densities than recorded in Zone 3. Species observed and their densities are given in Table 1.

Sheltered habitats

Rocky shores

Biota of sheltered rocky shores was studied along the rocky outcrop of Grice Bay (Fig. 1, Site 11). Numbers of organisms recorded at this site are given in Table 2.

No splash zone (Zone 1) was found at this site.

Zone 2, high intertidal zone

Coverage of F. distichus was more extensive in sheltered areas than in exposed or semi-exposed sites. Highest density was recorded in summer (75%/m^2) and decreased significantly in winter. A few species of green and red algae were recorded in low densities except for the red alga Hildenbrandia sp. which had a coverage of 60%/m^2 in summer months.

Numbers of limpets, periwinkles, and thaids showed little change between 1976 and 1977 (Table 2). Bay mussels, M. edulis, were more abundant (400/m^2) in 1977. As noted in exposed and semi-exposed habitats, numbers of acorn barnacles increased substantially in sheltered areas in 1977. The new barnacle set occurred in densities of 200,000/m^2 while individuals of B. glandula and C. dalli from previous sets were recorded at 7,000/m^2 and 4,000/m^2, respectively. The new set was reduced to 90,000/m^2 by December.

Zone 3, mid-intertidal zone

Bay mussels, acorn barnacles B. glandula, and red algae Halosaccion glandiforme and Endocladia muricata were the dominant species in this zone (Table 2). Densities of these species were similar to those of 1976 except for H. glandiforme which had a much reduced coverage. A larger number of algal species were identified in 1977 in the mid-intertidal zone (Table 2); their densities were low (less than 5%/m^2) except for the green alga Ulva sp. which had a coverage as high as 30%/m^2 in June.

Zone 4, low intertidal zone

Eelgrass Zostera marina was the dominant floral species but coverage was low (30%) even at the height of the growing

season. Algal coverage in the low intertidal area was less in 1977 than in 1976. Algal species present were Ulva sp., Grateloupia doryphora, and Iridaea sp. The brown alga Agarum fimbriatum occurred below the water's edge.

Faunal species were not abundant at this site. Starfish P. ochraceus and Dermasterias imbricata were found in low numbers (less than 1/m^2).

Summary

In 1977, populations of some faunal species increased substantially in exposed, semi-exposed and sheltered rocky shore habitats in the Long Beach Section. A heavy set of acorn barnacles B. glandula and C. dalli was recorded in all three habitats (Fig. 2). The greatest increase was in the sheltered area of Grice Bay.

In exposed and semi-exposed situations there was a high recruitment of periwinkles L. sitkana, goose barnacles P. polymerus, and anemones A. elegantissima. In Zones 1 and 2, a substantial increase in numbers of L. sitkana was recorded from 200/m^2 in 1976 to 48,000/m^2 in 1977. Clumps of adult goose barnacles were observed in Zone 3 as in 1976 but in 1977 there were also large areas covered with juveniles. Larger numbers of juvenile A. elegantissima were recorded in Zone 3 at Green Point and Half Moon Bay (Fig. 3).

Fauna and flora surveys of these habitats will continue in 1978 to further assess seasonal and yearly levels of the marine communities.

Razor clams (Siliqua patula) study

Studies to assess recruitment and subtidal populations were continued in 1977. Beach screening and subtidal sampling was carried out as in previous years (Lee and Bourne 1976, 1977). Adult population assessments, growth rates, and time of spawning studies were discontinued since the major clam population at Long Beach has not changed significantly over a 10-yr period (Bourne and Quayle 1970),and no strong recruitment was found in 1977.

No juvenile razor clams were found at any sample locations (Fig. 4) during the spring or fall sampling periods. Lack of recruitment was also observed in the last 2 years.

Subtidal populations

A new transect was established on either side of

Transect 3 in 1977 (Fig. 5) to expand the number of samples taken. Sampling was carried out monthly from April to July, inclusive.

No shows or siphons were observed along these subtidal transects and only one juvenile clam was found in suction pump samples, which is similar to results in 1976. Results of the razor clam study in 1977 indicate there was little recruitment in either the intertidal or subtidal areas. Beach screening work will be continued to determine strength of the incoming year-classes. Subtidal studies will also contine to further assess recruitment and the significance of this population to the intertidal population.

Sea mussel (M. californianus) study

The sea mussel study to assess re-establishment patterns and recovery time of a denuded mussel bed was continued in 1977. Organisms recolonizing the cleared m^2 plot since July 1975 were monitored in April, July, and October 1977. Numbers of organisms recolonizing the cleared plot are given in Table 3.

Northcraft (1948) and Castenholz (1961, 1967) reported that Ulva and/or Enteromorpha were usually the first macroscopic algae to settle in a cleared area, and this colonization was often followed by sparse settlement of the original organisms forming the mussel beds. Hewatt (1937) observed that barnacles were the major colonizing organisms following the first growth of algae. In 1977, recolonization of the cleared mussel plot at Cox Point had a noticeable algal coverage and a heavy set of barnacles. As in 1976 the dominant algal species were the green alga Ulva sp. and the red algae Endocladia muricata, Gigartina sp., and H. glandiforme. Pterosiphonia bipinnata was found in 1977 but not in 1976. These algae were all more abundant in 1977 than in 1976, but a steady seasonal decrease in algal coverage was observed as in 1976 (Table 3). In contrast with 1976 observations, there was an exceptionally heavy set of barnacles in this area in 1977 which occurred in other habitats. In April, these barnacles were too small to identify to species; by July the species were more easily separated. The most abundant barnacle was B. glandula (1,455,000/m^2), followed by C. dalli (132,500/m^2) and B. cariosus (88,000/m^2). Densities of these barnacles decreased slightly throughout the year. Goose barnacles P. polymerus were also more abundant in April but numbers decreased to a few individuals in October. Numbers of barnacles were higher in this area because there was more available space for settlement than in undisturbed areas. This barnacle settlement was not accompanied by an influx of Thais emarginata, a predator of barnacles. Numbers of Thais remained low throughout the year. Much lower numbers of M. californianus and M. edulis were observed in 1977 than in 1976. This may be due in part to natural mortality

and to the marked increase in algal cover which could obscure small mussels. Numbers of limpets and periwinkles were similar to those of 1976.

Although further recolonization was observed in the m^2 plot, there was little mussel recruitment in 1977. The outline of the m^2 plot is still easily identified after 2 years (Fig. 6).

This study at Cox Point will continue through 1978.

Partial removal of sea mussel (M. californianus) study

The study begun in 1976 to assess the effect of different exploitation rates on sea mussel beds was continued. Sampling techniques were the same as outlined by Lee and Bourne (1977). Two sets of samples were taken at Quisitis Point (Fig. 1; adjacent to Site 14a) - one in July and the other in December (Fig. 7).

Length-frequency distributions are given in Table 4 and Fig. 8. Lengths of the mussels varied from plot to plot but the modes of the largest mussels in most samples continued to range from 50-70 mm.

In July and December the outlines of each sample plot were barely distinguishable from the remainder of the mussel bed. Removal of the surface layer of mussels may have allowed for some movement of adjacent mussels between sampling periods. The plots completely cleared in 1976 remained bare in 1977.

This partial removal study will be continued to determine the long-term effects of prolonged exploitation to the mussel bed.

Purple olive snail (Olivella biplicata) study

Studies to assess intertidal populations and distribution of Olivella on Long Beach were continued in 1977. Sampling procedures and sites (Fig. 9) were the same as in 1976.

Numbers of Olivella observed in monthly quadrat samples are given in Table 5. Intertidal distribution of Olivella was again confined to the northern end of Long Beach, but numbers were much reduced in 1977. Density in May was $0.5/m^2$ which increased to $1/m^2$ in June, and decreased to $0.5/m^2$ in July.

Although density of Olivella from quadrat counts increased only slightly throughout the summer, their range up the intertidal beach increased (Table 6) following the overall

trend observed in 1976. In May, all Olivella occurred in the 60 m intertidal zone closest to low water (a zone three times wider than observed in 1976). In June the width of this zone increased by only 10 m and by July decreased sharply to 20 m. Table 6 also shows the intertidal Olivella population was not homogeneously distributed throughout the sample areas and, in some cases, tended toward a clumped distribution.

It should be noted that surface (quadrat counts) and sub-surface (screening samples) densities were reversed between 1976 and 1977. In 1976 density of Olivella from quadrat counts was as high as $8/m^2$ while in screening samples along a transect for this same period it was $2-3/m^2$. In 1977 density in quadrats was only $1/m^2$ while in screening samples it was as high as $6/m^2$. Combining densities obtained from both sampling techniques shows the overall density of this intertidal population was similar for both years. Both sampling techniques should be used to provide an accurate estimate of numbers of Olivella in the intertidal area.

The subtidal survey of Olivella was continued in 1977. Two new transects were established to a depth of 6 m from shore, between Round and Little Islands (Fig. 9, Sites A and B). (Transect B could not be sampled in May because of weather conditions.)

Numbers of Olivella collected in the suction sampler are given in Table 7. As is the intertidal population, the distribution of subtidal Olivella was not homogeneous. Density of subtidal O. biplicata decreased throughout the summer months from a total number of 92 in April to 12 in July. Numbers of another smaller species, O. baetica, were lower but remained constant throughout the sampling period. Decrease in density of the subtidal population may reflect movement into the intertidal area.

The Olivella study will continue in 1978.

Purple or ochre starfish (Pisaster ochraceus) study

A study begun in 1975 to determine seasonal changes in density of starfish populations at Long Beach was continued in 1977. Starfish were counted monthly from April to July at all three sites (Fig. 1, Sites 2, 12b, and 13). Results are given in Table 8.

In 1977, starfish populations fluctuated more than in 1976 at Box and Grassy Islands. The marked increase in July at these two sites was possibly due to shifting sand which penetrated higher into the sample sites, thus confining Pisaster to smaller areas. Density of Pisaster showed little change from 1976 observations at Green Point. Few sunflower starfish

(*Pycnopodia helianthoides*) were found in 1977.

The starfish study will continue in 1978.

BROKEN GROUP ISLANDS SECTION

HABITAT TYPES

Intertidal and subtidal fauna and flora studies in the Broken Group Islands Section were continued in 1977. Sampling was confined to exposed and semi-exposed rocky shores and to sheltered cobble beaches and rocky shores. Studies of subtidal habitats was limited to one representative sample site for each habitat type identified in 1976. Number of sample sites in both intertidal and subtidal areas was reduced to permit more detailed seasonal sampling. Sampling procedures were similar to those in 1976 (Lee and Bourne 1977).

In both the intertidal and subtidal work numbers of animals in 1-m^2 sample plots were recorded from each biotic zone along transects. Sponges, bryozoans, compound ascidians, and some polychaete species were recorded as percent coverage within a m^2 area. Organisms smaller than 2 cm were counted in 25 x 25 cm subsamples. Algal cover was recorded as percent coverage within a m^2 area.

Habitat types - Intertidal

Exposed habitats

Rocky shores

Fauna and flora of exposed rocky shores were recorded at Wouwer Island (Fig. 10, Site 64), using criteria outlined in the Long Beach Section. Results are given in Table 9 .

Zone 1, splash or spray zone

Organisms observed in this zone were similar to those in Zone 1 of exposed rocky shores, Long Beach Section.

The dominant floral species, black lichen *Verrucaria* sp., had a coverage of 75%/m^2 in summer which decreased to 50%/m^2 in winter. A few green and red algal species were recorded at densities of less than 10% (Table 9).

Limpets, periwinkles, and acorn barnacles were the dominant faunal species in the spray zone in both 1976 and 1977. In 1977, numbers of the periwinkle *L. sitkana* increased from 128/m2 in spring to 700/m^2 in summer. The numbers of the acorn barnacle *B. glandula* followed a similar trend, increasing from 480/m^2 to 800/m^2. Densities of other species varied from season to season (Table 9).

Zone 2, high intertidal zone

Rockweed F. distichus, a characteristic alga of the high intertidal area, was found in low densities (20% coverage) in May but was completely absent in July. Pelvetiopsis limitata, a brown alga usually indicative of exposed rocky shores, was not found at this site. Red algae Gigartina sp. and Petrocelis sp. were the dominant algal species in 1977 and had a maximum coverage of 40 and 30%, respectively, in July. Other algal species present in low densities are given in Table 9.

Limpets (Collisella digitalis, C. pelta, Notoacmea persona, and N. scutum) and periwinkles (L. scutulata and L. sitkana) were more abundant in 1977 than in 1976 and maximum numbers of each species were recorded in July. Numbers of acorn barnacles were much lower than in 1976, especially B. glandula when maximum densities were 52,500/m^2 but only 1,100/m^2 in 1977. Other fauna recorded in this zone are shown in Table 9.

Zone 3, mid-intertidal zone

Algal cover was sparse in the mid-intertidal zone. Coralline red algae Bossiella sp. and Corallina sp. were most abundant (30 and 40% coverage, respectively). H. sessile, usually the dominant brown alga in this zone, had only 5% coverage in both years. No green algae were recorded in this zone. Other red and brown algal species found in low densities are given in Table 9.

M. californianus and P. polymerus remained the dominant fauna. In 1977, numbers of mussels decreased slightly to 1,200/m^2 but the density of P. polymerus increased from 120/m^2 to 2,000/m^2. Limpets (C. digitalis, N. persona, and N. scutum), thaids (Thais canaliculata and T. emarginata), anemone A. xanthogrammica and chiton Katharina tunicata were common in the mid-intertidal zone and their densities varied seasonally (Table 9).

Zone 4, low intertidal zone

Surf grass Phyllospadix scouleri, brown algae Laminaria setchellii and Lessoniopsis littoralis and coralline red algae were the dominant flora in the low intertidal zone. Maximum coverage of these algae was recorded during the summer growing season. Other algae were recorded in low densities throughout the year (Table 9). Although no quantitative samples are available for the winter season, Laminaria and Lessoniopsis plants were reduced to stalks with only tattered remnants of blades in October.

Faunal species were not abundant and are shown in Table 9.

Semi-exposed habitats

Rocky shores

Fauna and flora of semi-exposed rocky shores were studied at Turret Island (Fig. 10, Site 47). Results are shown in Table 9 .

Zone 1, splash or spray zone

Verrucaria sp. was the dominant floral species but coverage was less than in exposed sites. A few algal species were observed in low densities throughout the year (Table 9).

Limpets, periwinkles, and acorn barnacles were the dominant faunal species in 1976 and 1977. Densities of these organisms showed little change throughout the year except for L. sitkana, which increased from 400/m^2 in summer to 4,000/m^2 in fall. This increase was due to recruitment of the 1977 year-class, since most individuals measured 5 mm or greater in height (Sylvia Behrens Yamada, personal communication).

Zone 2, high intertidal zone

Maximum coverage of F. distichus, the dominant algae in the high intertidal zone, decreased from 80%/m^2 in 1976 to 40%/m^2 in 1977. A red alga Hildenbrandia sp., not present at this site in 1976, had a coverage of 60% in the summer but decreased to 5% by October. Other algal species were present in densities less than 10% (Table 9).

Numbers of limpets, periwinkles, and gastropods varied slightly from season to season but were not significantly different from those in 1976. Lower numbers of two acorn barnacle species were recorded in 1977 than in 1976. Numbers of B. cariosus decreased slightly but the density of B. glandula was reduced from 62,500/m^2 in 1976 to 600/m^2. In 1977, there was a seasonal increase in numbers of B. glandula from 600/m^2 to 1,500/m^2 which was still much lower than 1976 densities. The third acorn barnacle species, C. dalli, increased from a few scattered individuals in 1976 to 10,000/m^2 during 1977 but had decreased to 10/m^2 by October. These sharp decreases in barnacle numbers may be due to overcrowding or to predation by Thais emarginata which are known predators of barnacles. These snails were not recorded at this site in 1976 but numbers increased continually in 1977 to 96/m^2 in October. Bay mussels and the anemone A. elegantissima were not recorded in 1976 but both species were abundant in the spring of 1977 then decreased by late fall. Other faunal species present in this zone are given in Table 9 .

Zone 3, mid-intertidal zone

H. sessile, usually the dominant alga of this zone, was recorded in low densities (5%) in 1976 and was completely absent in 1977. The dominant algal species at Turret Island (47) varied with the season. In spring the red algae Corallina sp. and Gastroclonium coulteri each had a coverage of 40%/m^2. By July, coverage of the green alga Codium fragile and red alga Ceramium sp. increased to 50% and 40%, respectively. These two algae were found growing on other algae during the summer. In October, the green alga Ulva sp. was most abundant at 25% coverage. Coverage of Corallina sp. remained at 40% throughout the sampling period. Other algal species recorded throughout the year at low densities are given in Table 9.

Few animals were observed in the mid-intertidal zone at Turret Island. No M. californianus or P. polymerus were recorded at this site. Numbers of B. glandula decreased from 20,000/m^2 in 1976 to 40/m^2 in 1977. No thaids were found. C. dalli was not recorded here in 1976 but in 1977 had a density of 1,000/m^2 which decreased to 700/m^2 in October. Other animals recorded are shown in Table 9.

Zone 4, low intertidal zone

This zone was not sampled in 1976. In 1977 the predominant algae were Macrocystis integrifolia, Gelidium robustum, and Lithothamnion sp., along with surf grass P. scouleri. Maximum coverage of these species were recorded at the peak of the growing season; densities decreased slightly by fall. Additional algal species recorded at this site are given in Table 9.

Gastropods, acorn barnacles, crabs, and starfish were the common fauna in the low intertidal zone. Astraea gibberosa, the largest of the gastropods observed (5 cm in height or greater) was recorded at constant densities (10/m^2) throughout the year; Searlesia dira, the dire whelk, was most abundant in July (128/m^2); Homalopoma lurida a small blue gastropod was recorded at densities of 192/m^2 in spring but decreased to 90/m^2 by fall. Acorn barnacles occurred in low abundance; C. dalli, the dominant barnacle, was recorded at 620/m^2 in May but densities decreased during the year. Hermit crabs Pagurus sp., porcelain crabs Petrolisthes eriomerus and black-clawed crabs Lophopanopeus bellus were common among and under the cobble in this area; their densities varied seasonally (Table 9). Red rock crabs Cancer productus were recorded at this site in densities less than 1/m^2 in May. Patiria miniata was the dominant starfish species; numbers of this species ranged from 5/m^2 to 8/m^2 throughout the year. Less abundant faunal species are given in Table 9.

Sheltered habitats

Cobble beaches

Sheltered cobble beaches were sampled at Hand Island (Fig. 10, Site 43). Fauna and flora recorded at this site are presented in Table 10.

No spray zone (Zone 1) was present.

Zone 2, high intertidal zone

Coverage by F. distichus was sparse in the high intertidal zone in both 1976 and 1977. The green alga Enteromorpha sp. was the dominant species (40% coverage) in spring. During summer months all algae were recorded at densities less than 5%. In October, red algae Cryptosiphonia woodii and Lomentaria hakodatensis provided the dominant floral coverage, 40% and 10% respectively. Other algae present in low densities are shown in Table 10.

Limpets, periwinkles, acorn barnacles, and shore crabs were common in the high intertidal zone in both years. Numbers of limpets (Collisella digitalis, C. pelta, Notoacmea persona and N. scutum) varied seasonally (0-200/m^2). Both periwinkles L. scutulata and L. sitkana were more abundant in 1977; highest densities of each species were 500/m^2 in July. Numbers of acorn barnacles varied considerably between the 2 years. Density of B. glandula decreased from 26,000/m^2 in 1976 to 5,400/m^2 in the spring of 1977; during 1977 numbers of this species doubled to 10,000/m^2. Density of B. cariosus followed the same trend but in lower numbers. C. dalli, found in low numbers in 1976, was abundant in the summer of 1977 but decreased from 7,500/m^2 to 200/m^2 by October. Increase in numbers of acorn barnacles in 1977 was due to recruitment similar to that observed in the Long Beach Section. Numbers of shore crabs Hemigrapsus nudus and H. oregonensis and hermit crabs Pagurus sp. varied seasonally (Table 10). Bay mussels, not recorded in this zone in 1976, were present in scattered clumps throughout the zone (500/m^2).

Zone 3, mid-intertidal zone

Flora in the mid-intertidal zone was similar in both years. Eelgrass Zostera marina was dominant (90% coverage) throughout the year. The brown alga Leathesia difformis, found growing on other algae, was the most abundant algal species but occurred in low densities, 20% coverage. Other algae present in densities less than 10% are given in Table 10.

The gastropod Searlesia dira and crabs Lophopanopeus bellus and Petrolisthes eriomerus were common in both years.

Density of acorn barnacles followed the trend observed in Zone 2. Highest densities of B. glandula and B. cariosus were 2,000/m^2 and 2,500/m^2, respectively. Other fauna observed in this zone are given in Table 10.

Zone 4, low intertidal zone

This zone was not sampled at Hand Island in 1976.

In 1977, red algae Gigartina sp., Rhodomela larix, Hildenbrandia sp., and Lithothamnion sp. were the dominant flora in the low intertidal zone. Other algal species are given in Table 10.

Conspicuous faunal species observed throughout 1977 were Astraea gibberosa, bat star Patiria miniata, hermit crabs Pagurus sp., and the crab Lophopanopeus bellus. Other crabs P. eriomerus and Pugettia sp., common among the cobble and algae, were recorded at varying densities throughout the year. C. dalli, the dominant acorn barnacle, was recorded at densities of 10,000/m^2 in May which decreased to 5,400/m^2 by fall.

Rocky shores

Fauna and flora of sheltered rocky shores were studied at Keith Island (5) and Nettle Island (24) (Fig. 10). Biota recorded at these sites are given in Table 10.

Zone 1, splash or spray zone

This zone was not observed in 1976.

The spray zone at these sites was sparsely populated in 1977. Verrucaria sp. covered 50-70% of the rock face. Densities of limpets (C. pelta, N. persona, and N. scutum) and gastropod Tegula funebralis varied throughout the year but were generally in low abundance (Table 10). Numbers of periwinkles varied between the two sample sites; generally both species L. scutulata and L. sitkana were abundant in May and densities decreased steadily throughout the year (Table 10).

Zone 2, high intertidal zone

Flora observed in the high intertidal zone was similar in both years. F. distichus provided a coverage of up to 80%. Other algae were recorded at densities less than 10%.

A larger number of limpets were observed in 1977 than in 1976; density of each species varied seasonally (0-250/m^2).

Periwinkles, L. scutulata and L. sitkana, were more abundant in 1977, as high as 1,000/m^2 and 2,600/m^2, respectively. Densities of acorn barnacles differed in the 2 years; B. cariosus, observed in low numbers (240/m^2) in 1976, was more abundant in the spring of 1977 at 3,500/m^2 but decreased gradually throughout 1977. Numbers of B. glandula decreased from 36,000/m^2 in 1976 to 10,000/m^2 in 1977. C. dalli, present in low numbers (375/m^2) in 1976, was recorded at 120,000/m^2 at Nettle Island in 1977. This heavy set decreased to 250/m^2 by October as a result of overcrowding and predation. M. edulis, not recorded in 1976, was present in 1977 at densities of 500/m^2. At Nettle Island, there was a seasonal increase of this species from 500/m^2 to 2,500/m^2. These mussels were small and found mainly in cracks and crevices under the dense growth of Fucus. Shore crabs H. nudus and H. oregonensis, hermit crabs Pagurus sp. and porcelain crabs Petrolisthes cinctipes were common in both years; densities varied from season to season in 1977.

Zone 3, mid-intertidal zone

Of the dominant floral species observed in 1976, only L. difformis had a similar coverage in 1977. All other species (Sargassum muticum, Halosaccion glandiforme, and Rhodomela larix) had much lower densities in 1977. In 1977, Ulva sp. was the most abundant alga in the mid-intertidal zone (highest coverage was 60%). Other algae present are given in Table 10.

In 1977 faunal species indicative of sheltered areas (A. gibberosa and P. miniata) were recorded at varying densities throughout the year. Numbers of acorn barnacles were higher in 1977 than in 1976; densities reflect the heavy set in summer followed by a significant decrease in fall as observed in Zone 2. Other fauna observed in this zone are presented in Table 10.

Zone 4, low intertidal zone

This zone was not sampled in 1976.

The most common algal species observed were Leathesia difformis, Macrocystis integrifolia, Gastroclonium coulteri, and Gelidium robustum; densities varied from season to season.

Gastropods, acorn barnacles, and crabs were common in this zone. Amphissa columbiana and Homalopoma lurida were the most abundant gastropods; densities were as high as 1,000/m^2 and 1,500/m^2, respectively, in May and decreased throughout the year. Numbers of acorn barnacles in the low intertidal zone were lower than in Zones 2 and 3, but continue to reflect a heavy set in spring and a gradual decrease throughout the year (Table 10). Shore crabs H. oregonensis, hermit crabs Pagurus sp., and porcelain crabs Petrolisthes eriomerus were generally most

abundant in spring and numbers decreased throughout the year. Other fauna are presented in Table 10.

Summary

Increases in faunal populations in the Broken Group Islands were not as marked as in the Long Beach Section.

Numbers of acorn barnacles were generally lower in 1977 than in 1976; but some recruitment occurred in 1977. The greatest increase was in the sheltered area of Nettle Island where C. dalli increased from 375/m^2 in 1976 to 120,000/m^2 in 1977. In exposed areas, goose barnacles P. polymerus increased in number from 120/m^2 to 2,000/m^2. Recruitment was not as heavy as in the Long Beach Section.

In exposed and semi-exposed areas there was a large increase in numbers of the periwinkle L. sitkana. This increase reflects recruitment of the 1977 year-class.

Fauna and flora surveys of these habitats will continue in 1978 to further assess differences in seasonal and yearly abundance.

Habitat types - Subtidal

In 1977, ecological subtidal investigations were continued with emphasis on detailed quantitative studies.

Sampling procedures were similar to those used in 1976. One representative site from each subtidal habitat type identified in 1976 was sampled seasonally. The number of m^2 quadrats in each biotic zone was increased from one to five to obtain more accurate estimates of subtidal fauna and flora communities. Densities of fauna and flora were recorded as mean number per m^2. Sponges, hydroids, polychaetes, bryozoans, ascidians, and algal cover were recorded as percent coverage per m^2.

Each transect was perpendicular to the shore and extended from the intertidal area seaward to a subtidal depth of 12 m where possible, or on gently sloping shores, to a distance of 100 m from shore. Biotic zones of each transect were defined by depth and width of the zone and by the presence and/or absence of dominant organisms. Depth was the distance below the water's surface at zero tide level; width was the distance from the lower edge of the previous zone seaward to the lower subtidal limit.

Exposed habitats

Rocky shores

Exposed rocky shores were identified as the most distinct and common subtidal habitat type in the Broken Group Islands. Fauna and flora studies in this habitat type were continued at Elbow Islets (Fig. 11, Site 46).

Zone 1

Depth and width of the first subtidal zone adjacent to the intertidal area were similar in 1976 and 1977 (3 m and 5 m, respectively).

Red and brown algae were the characteristic flora of this zone in both years. Lithothamnion sp. had a mean coverage of 57%, range 10% to 90%. Coverage of the brown alga Desmarestia ligulata decreased from 95% in 1976 to a mean coverage of 21% in 1977. The brown algae Alaria marginata, Laminaria setchellii, Costaria costata, and Nereocystis luetkeana were not abundant in either year in this zone and had a patchy distribution, less than 10% in 1977 (Table 11). No quantitative counts were made in this zone in July. Observations indicated no marked change in algal coverage since May except that N. luetkeana plants were larger.

Faunal densities showed some changes in the 2 years. The encrusting polychaete Dodecaceria fewkesi, recorded at less than 5% coverage in 1976, had a coverage of 10-50% in 1977. Fauna, present in moderate numbers in 1977 but not recorded in this zone in 1976, were the white cap limpet, Acmaea mitra and the leafy hornmouth, Ceratostoma foliata (both $5/m^2$), and the dusky turban, Tegula pulligo ($2/m^2$). Low numbers ($1/m^2$ or less) of British Columbia abalone, Haliotus kamtschatkana, and red sea urchin, Strongylocentrotus franciscanus, were recorded in this zone in 1977. Several species of starfish were found in low densities in both years. Density of sponges, ascidians, and bryozoans was similar in both years (Table 11).

Zone 2

The second zone extended from 3 m to 12 m in depth and was 25 m wide in both years. The substrate was a combination of bedrock and boulders. This zone was characterized by a sparsity of algae and a moderate number of red sea urchins.

Lithothamnion sp. had a coverage ranging from 10-90%. The red alga Hildenbrandia sp. and brown alga Ralfsia sp. were recorded only in 1977 at low densities (15% and 8% coverage). A few green, brown, and other red algae were recorded in low numbers, less than 5% coverage (Table 11).

Cup coral Balanophyllia elegans, recorded in low numbers in 1976, decreased slightly in density in 1977 from a mean of 200/m^2 to 87/m^2 by July. Brooding anemone Epiactus prolifera occurred in slightly higher densities in 1977 (3/m^2) than in 1976. Encrusting polychaete D. fewkesi was more abundant in this zone than in the first zone and had a maximum coverage of 55% by July 1977. The chiton Tonicella sp., limpet A. mitra and British Columbia abalone H. kamtschatkana, recorded in low densities in 1976, were observed in slightly higher numbers in 1977, 10/m^2, 3/m^2, and 2/m^2, respectively. Numbers of abalone decreased to less than 1/m^2 by July. Sponges, bryozoans, and ascidians remained at about the same level of abundance in both years, 5% coverage. Numbers of red sea urchins, S. franciscanus were similar (4/m^2) in both years. Starfish species similar to those observed in Zone 1, were recorded in low numbers in this zone in both years.

Semi-exposed habitats

Gravel and shell shores with isolated boulders

Subtidal studies of fauna and flora in this habitat type were continued in a long shallow bay at Clarke Island (Fig. 11, Site 22).

Zone 1

The depth of the first subtidal zone was similar in both years, 3 m; the width of the zone increased from 20 m in 1976 to 30 m in 1977.

There was a general increase in number of species and coverage of algae in Zone 1. In 1976, a brown alga bed, Macrocystis integrifolia, was located primarily in Zone 2 but in 1977 it had moved shoreward and had a maximum mean coverage of 72% in Zone 1 in May. Coverage of red algae Gelidium robustum and Hildenbrandia sp. and coralline red algae (Bossiella sp., Calliarthron sp., and Corallina sp.) was slightly greater in 1977 than in 1976. At the height of the growing season Hildenbrandia was the most abundant species, 16% coverage. Red alga Lithothamnion sp. increased in coverage from less than 5% in 1976 to a mean of 69% in May 1977, then decreased to a mean of 47% in July. Few green algae were recorded in this zone (Table 12).

Dominant fauna in this zone were cup coral B. elegans (13/m^2 in May 1977 only), encrusting polychaete D. fewkesi (maximum mean coverage 12% in May 1977), limpet A. mitra (3/m^2), and the gastropods A. gibberosa (8/m^2), and Tegula pulligo (5/m^2). Sea cucumbers Cucumaria miniata, anemones Tealia coriacea, and T. crassicornis, and several species of starfish were recorded at densities of 1/m^2 or less in both years.

Zone 2

Depth of the second subtidal zone in this shallow bay was the same as the first, 3 m. The width decreased from 50 m in 1976 to 30 m in 1977. Substrate was predominantly sand, and fauna and flora were sparse. Few green, brown, and red algal species were observed and coverage was less than 5% in both years. The predominant bed of M. integrifolia observed in 1976 had disappeared from this zone in 1977. Most conspicuous faunal species were unidentified polychaetes in parchment tubes (5% coverage), moon snail, Polinices lewisii, and Dire whelk Searlesia dira (both less than $1/m^2$), and the bat star Patiria miniata (maximum numbers $4/m^2$ in July 1977).

Cobble, boulder, and rock shores

Subtidal studies of this habitat type were continued at Gibraltar Island (Fig. 11, Site 7).

Zone 1

Depth of the first subtidal zone was similar in both years (4 m); width of the zone ranged from 3 to 10 m.

Red algae were the dominant floral species in this zone. G. robustum had a maximum mean coverage of 30% in July 1977. Corallina sp., Hildenbrandia sp., and Lithothamnion sp. had maximum mean coverages at the height of the growing season of 12, 26, and 11%, respectively. Few green and brown algal species were recorded in this zone (Table 13). The green alga Ulva sp. and the brown alga Scytosiphon lomentaria occurred in low densities (5% coverage or less) in the uppermost region of Zone 1; these species extended seaward from the adjacent Ulva-dominated intertidal zone.

A few faunal species were more abundant in 1977 than in 1976. The chiton Tonicella sp. and red turban snail A. gibberosa increased in numbers from less than $1/m^2$ in 1976 to $3/m^2$ and $6/m^2$, respectively. Numbers of sea cucumbers C. miniata increased from $6/m^2$ in 1976 to a maximum mean density of $13/m^2$ in 1977. Unidentified species of bryozoans increased from less than 5% coverage in 1976 to 50% in 1977. The polychaete Serpula vermicularis had densities of less than 5% in both years. Species present in densities of $1/m^2$ or less in both years were white-cap limpets A. mitra, giant cucumber Parastichopus californicus, and several species of starfish.

Zone 2

The zones identified as 2 and 3 in 1976 were combined in 1977 because no distinct differences were observed in the fauna and flora. Zostera marina, the dominant floral species of Zone 2

in 1976, was not observed in 1977; the brown algae Agarum fimbriatum and Eisenia arborea, the dominant flora of Zone 3 in 1976, were abundant in 1977 throughout the area encompassed by both zones. The substrate of cobble and shell extended from 4 to 12 m depth, and was 12 m in width in 1977.

The dominant flora in both years were two species of brown algae: A. fimbriatum and E. arborea. Coverage by A. fimbriatum ranged from 40% to 90% per sample at the height of the growing season while E. arborea occurred in lower densities ranging from 1% to 20% coverage. Other brown and red algae were recorded at densities less than 10% coverage (Table 13). No green algae were observed in this zone.

Faunal species were not abundant in this zone in either year. The burrowing anemone Pachycerianthus fimbriatus, chiton Tonicella sp., limpet A. mitra, red turban snail A. gibberosa, giant cucumber P. californicus and several species of starfish occurred in densities of $1/m^2$ or less. Coverage by unidentified bryozoans was less than 5% in both years.

Zone 3

The third zone (fourth zone in 1976) extended below the 12 m depth for an undetermined distance in both years. Substrate was predominantly mud with a few small cobbles.

No flora were observed in 1976. Unidentified loose red algae were the dominant flora, by July 1977, 65% coverage. A few other red algal species were recorded at low densities (Table 13); A. fimbriatum, the only brown alga recorded, had a low mean coverage of 2% in July. No green algae were present.

Burrowing anemone P. fimbriatus was the dominant faunal species in both years; densities were similar, $2/m^2$. Hydroids, polychaetes, chitons, and giant cucumbers were recorded at densities less than $1/m^2$ in both years (Table 13).

Rocky shores

Fauna and flora of semi-exposed rocky shores were studied at Hand Island (Fig. 11, Site 12) in both years.

Zone 1

Depth and width of Zone 1 were similar in both years, 4.5 m and 175 m, respectively. Biota was sparse along the extensive flat bedrock of this zone in 1976 and 1977.

Red algae were the dominant floral species. Coverage by G. robustum increased from 30% in 1976 to a mean maximum of 88% in May 1977. Red alga Calliarthron sp. and Hildenbrandia sp., not

recorded in this zone in 1976, had coverages of 6% and 13%, respectively, in 1977; coverage by Lithothamnion sp. was similar in both years, 5%. No green algae and few brown algae were recorded in either year (Table 14).

The dominant faunal species in both years was the red turban snail A. gibberosa. Numbers ranged from 8 to 45/m^2. Densities of other faunal species were similar in the 2 years. Polychaetes and bryozoans were recorded at less than 5% coverage. Numbers of giant cucumbers P. californicus, white cap limpets A. mitra, red rock crabs, C. productus, and several species of starfish remained at less than 1/m^2.

Zone 2

In 1977, a second zone, composed of bedrock, boulder, cobble, gravel, and shell, was delineated below Zone 1. Zone 2 extended from 4.5 to 6 m in depth and was 30 m wide. Biota was sparse in this zone.

M. integrifolia, the only brown alga recorded, was the dominant floral species. Coverage of this alga was greatest in May (mean 82%) but decreased slightly to 60% in July. Lithothamnion sp. had a maximum mean coverage of 32% in May. Other red algae G. robustum, Hildenbrandia sp., Bossiella sp., and Calliarthron sp. were recorded at densities less than 5%. No green algae were found in this zone.

The dominant faunal species A. gibberosa and dusky turban snail, T. pulligo, were observed mainly on Macrocystis plants. Numbers of A. gibberosa were similar throughout the year (mean 15/m^2) while density of T. pulligo varied from mean 19/m^2 in May to mean 2/m^2 in July. Giant cucumber P. californicus and British Columbia abalone H. kamtschatkana were present in densities less than 1/m^2.

Sheltered habitats

Sand and mud flats

Subtidal studies of this habitat were continued at Jaques Island (Fig. 11, Site 5).

Zone 1

Depth and width of the first zone were similar in both years, 6 m and 150 m. Substrate was mud, shell, and gravel.

Eelgrass, Z. marina, was the dominant floral species in 1976 and 1977 but coverage decreased from 95% in 1976 to a maximum mean of 48% in July 1977. A small epiphytic red alga Smithora naiadum was found on Zostera in low densities (less than 5%) in both years. Few green, brown, or red algae were recorded in either year (Table 15).

Fauna was not abundant at this site; numbers showed little change in the 2 years. Burrowing anemone P. fimbriatus, red turban snail A. gibberosa, moon snail P. lewisii, red rock crab C. productus, and several species of starfish had densities less than 1/m^2. A polychaete Spirorbis sp. was found on Zostera in densities less than 5% in both years (Table 15).

Zone 2

Zone 2 extended from a depth of 6 m to an undetermined depth and width. Substrate was predominantly mud with a few scattered cobbles. A rock reef extending along the mud was not sampled in 1977.

The brown alga L. saccharina, not present in 1976, had a patchy distribution in 1977; maximum mean coverage was 39% in July. D. aculeata, another brown alga not recorded in 1976, had a mean coverage of 18% in May 1977 but decreased to less than 1% by July. Coverage of other brown algae and several species of red algae was less than 5% (Table 15). No green algae were recorded.

Fauna was sparse in the second zone and numbers were similar in both years. Density of polychaetes and compound ascidians remained low (less than 5%). Burrowing anemone P. fimbriatus increased in numbers from zero in 1976 to 2/m^2 in May 1977 then decreased to less than 1/m^2 in July. Pisaster brevispinus, the only starfish recorded in this zone in 1977, occurred at densities less than 1/m^2.

Sand, mud, gravel, and shell slopes

Fauna and flora studies of this habitat were continued at Turtle Island (Fig. 11, Site 1).

Zone 1

Depth and width of Zone 1 were similar in 1976 and 1977, 3 m and 15 m, Substrate was mud, shell, and gravel in both years. Biota in this zone was sparse in both years.

Eelgrass Z. marina had a coverage of 90% in 1976 but was restricted to the upper part of Zone 1 in 1977. Few algae were recorded in either year (Table 16).

The dominant faunal species were horse clam Tresus capax and bat star Patiria miniata. Horse clams were present in low numbers in both years. Numbers of bat stars increased from less than 1/m^2 in 1976 to 4/m^2 in May 1977, then decreased to 2/m^2 by July. Fauna recorded at low densities in both years were the burrowing anemone and several species of starfish (Table 16).

Zone 2

In both years, depth of the second zone extended from 3 to 6 m and width ranged from 6 to 50 m over the area sampled. Substrate remained as a mixture of cobble and mud. Fauna and flora were not abundant in either year.

Brown alga L. saccharina, not recorded in this zone in 1976, had a maximum mean coverage of 51% by July. A few other brown algae were recorded at densities less than 5%; no green or red algae were observed.

Dominant fauna in both years were the burrowing anemone P. fimbriatus, red rock crab C. productus, and starfish P. brevispinus and Pycnopodia helianthoides; densities were less than $1/m^2$.

Zone 3

Depth of Zone 3 extended from 6 to 12 m; width ranged from 12 to 50 m. Substrate was predominantly cobble and mud with some boulders.

The brown alga L. saccharina, recorded at 100% coverage in 1976, was present at only 3% coverage in 1977. Brown algae A. fimbriatum and E. arborea were the dominant species in 1977. Mean coverage of A. fimbriatum was 54% in May but decreased to 28% by July; E. arborea had a maximum mean coverage of 25% in July. Corallina sp. and Lithothamnion sp., the dominant red algal species, had maximum mean coverage of 16% and 20%, respectively.

Sponges, polychaetes, bryozoans, chitons, and ascidians, found in cobbles, occurred in low numbers (less than 5%) in both years (Table 16). Numbers of sea cucumbers and starfish remained at less than $1/m^2$. Numbers of P. fimbriatus in Zone 3 decreased from $4/m^2$ in 1976 to zero in 1977.

Zone 4

Zone 4 was not sampled in 1976. Substrate was predominantly mud with a few small cobbles, and continued from the lower limit of Zone 3 to an undetermined depth and distance.

The only floral species recorded in this zone were a few red algae - Gracilariopsis sjoestedtii, Rhodoptilum plumosum, and unidentified species. Total coverage was less than 5%.

The dominant fauna in Zone 4 was an unidentified polychaete (narrow parchment tubes that protruded from the mud approximately 1 cm) that covered 90% of the mud substrate. A few hydroids and bryozoans (less than 5% coverage), burrowing anemones and jingle shells Pododesmus macroschisma (less than $1/m^2$) were the other fauna recorded in this zone.

Summary

Changes in subtidal populations were not as marked as those in the intertidal zone. Seasonal variations in the growth and density of algae were the most significant differences in the subtidal populations. Changes in the faunal populations are attributed to immigration.

Fauna and flora surveys of these habitats will be continued in 1978 to assess further seasonal and yearly fluctuations.

Bivalve population study

Studies of bivalve populations in the Broken Group Islands were continued in 1977 to provide additional information for management policies. Previous studies showed that populations of the commonly utilized species, littleneck *Protothaca staminea*, butter *Saxidomus giganteus*, and Manila clams *Venerupis japonica* and Pacific oysters *Crassostrea gigas*, were not extensive in the Broken Group Islands.

A study was begun at Hand Island to determine the clam population size and structure (Fig. 12, Site 4). This site was selected because 1976 sampling indicated it was one of the nine locations with a moderate bivalve population. Total area of the clam bed was approximately 7,000 m^2. Three m^2 plots were dug in the sand-shell-cobble bar between the two islets at the north-eastern end of Hand Island. Numbers of all bivalves and shell lengths of littleneck and butter clams were measured to the nearest mm. Length measurements were grouped into 5 mm size classes.

Littleneck and butter clams were the dominant bivalve species at Hand Island, mean 147/m^2 and 65/m^2 respectively. Soft-shell *Mya arenaria* and bent-nose clams *Macoma nasuta* had densities of 12/m^2 or less. No Manila clams were found in these plots, but they occur at densities of 20/m^2 and greater in an adjacent beach (Lee and Bourne 1977).

At densities recorded, the population size of the two common species was estimated at about 1 million littleneck and 455,000 butter clams in the 7,000 m^2 beach.

Length frequency distribution of littleneck clams shows two modes: the largest at 15-19 mm and the smaller at 40-44 mm (Fig. 14). Clams of the 15-19 mm modal size are 1-2 yr olds and show good recruitment occurred in 1975; those in the 40-44 mm modal size are 4-5 yr olds. Clams larger than this modal size show there has been an accumulation of older year classes in the population.

The present littleneck clam population could support moderate exploitation. Immediate digging would remove the

older clams which would be replaced by smaller clams in the population. Further exploitation would depend on survival of smaller clams and future recruitment.

The length frequency distribution of butter clams shows a population skewed towards larger individuals. This size distribution is common in many clam populations in British Columbia. The population structure shows an accumulation of older clams. Minor recruitment occurred in 1975 since a small number of clams 20-35 mm shell length were found.

The butter clam population could support modest exploitation, but once the larger clams were removed there would be few small clams to replace them. Future digging would be at low levels until major recruitment occurred and clams grew sufficiently to enter the fishery.

Bivalve population studies will be carried out on clam beaches in the Broken Group Islands in 1978 to obtain an estimate of exploitable clam resources in this area.

WEST COAST TRAIL SECTION

HABITAT TYPES

Habitat types - Intertidal

In 1977, fauna and flora studies were continued in exposed and semi-exposed habitats along the West Coast Trail during two 7-day periods in June and August.

Study sites (Fig.14) and sampling procedures were similar to those in 1976 (Lee and Bourne 1977). Numbers of organisms observed in one m^2 samples were recorded for each biotic zone along a transect. A subsample, 25 x 25 cm, was taken to record numbers of organisms less than 2 cm long. Algal coverage was recorded as percent cover.

Exposed habitats

Gravel and cobble beaches

Small exposed gravel and cobble beaches were sampled at Camper Bay (2) and Cullite Cove (3) (Fig.14). Marine life on these beaches was sparse in both 1976 and 1977 (Table 17); virtually no organisms were found at Cullite Cove in 1977.

Although no apparent zonation was observed in 1976, two algal zones were recorded at Camper Bay in 1977. The main portion of the beach was dominated by a green alga Spongomorpha sp., while at the water's edge the brown algae A. marginata and Cymathere triplicata were abundant amongst the cover of Spongomorpha sp. Algal cover at this site was twice that of 1976 (Table 17).

Acorn barnacles were the dominant faunal species in both years. B. glandula increased in density from 1,600/m^2 in 1976 to 5,000/m^2 in 1977; B. cariosus decreased from 500/m^2 in 1976 to 75/m^2 in 1977. Other fauna present but not common at this site are given in Table 17.

Rocky shores

Sample sites along exposed sandstone benches were 4, 5, 7, 8, 13-15 (Fig.14) and results of sampling fauna and flora are presented in Table 18.

Zone 1, splash or spray zone

This zone was not evident along sandstone benches in either year.

Zone 2, high intertidal zone

In both years the dominant algae along the flat surface of the benches were rockweed F. distichus and red algae Rhodomela larix and Gigartina sp. Fucus was present at each site but varied seasonally from site to site (5-75%/m^2); at Sites 5 and 7 coverage decreased throughout the year but at other sites coverage increased (Table 18). P. limitata was present in 1976 but not in 1977. Other algae present at densities less than 10% are given in Table 18.

The dominant fauna in the high intertidal area were periwinkles, limpets, and acorn barnacles. Numbers of L. scutulata were similar in 1976 and 1977, but those of L. sitkana increased from 1,000/m^2 in 1976 to 3,000/m^2 in 1977. At Site 7, there was a maximum density of 10,000/m^2 in 1977 which was reduced to 1,000/m^2 by August. This increase was again due to recruitment of the 1977 year-class because the majority of periwinkles were greater than 5 mm in height. Numbers of limpets (C. digitalis, C. pelta, N. persona and N. scutum) varied from season to season but were similar in both years. Three species of acorn barnacles were recorded in varying densities along sandstone benches. Numbers of B. cariosus and C. dalli were similar in 1976 and 1977; densities of B. glandula generally decreased from 15,000/m^2 in 1976 to 4,000/m^2 in 1977.

As in the Long Beach Section, numbers of the anemone A. elegantissima increased in the crevices and tidepools along sandstone benches; increases varied from site to site. Numbers decreased slightly as the year progressed.

Zone 3, mid-intertidal zone

The brown alga H. sessile was the dominant alga in Zone 3 at all sample sites. Coverage was similar in both years and showed little seasonal variation throughout 1977. Coralline red algae (Bossiella sp., Calliarthron sp., and Corallina sp.) occurred more frequently in Zone 3 and coverage was slightly higher in 1977 than in 1976. Other algae present are given in Table 18.

Sea mussels M. californianus, goose barnacles P. polymerus, and purple urchins S. purpuratus were the characteristic fauna in the mid-intertidal area. Sea mussels occurred in depressions and small cracks, usually a single layer deep, in similar densities, 2,500/m^2, in both years. These mussels were not found in clearly demarcated areas as in the Long Beach or Broken Group Islands Sections. Goose barnacles occurred in widely scattered clumps in depressions and crevices; numbers increased slightly from 1976 to 1977. Acorn barnacles also showed a slight increase in total numbers in the 2-year period. Purple urchins occurred in tidepools along the benches and showed little change in densities between 1976 and 1977.

Zone 4, low intertidal zone

The low intertidal zone could not be sampled in August at Sites 14 and 15.

Brown algae A. marginata, Egregia menziesii, and Postelsia palmaeformis and red algae Gigartina spp., Iridaea sp., Rhodoglossum affine and coralline red algae were the characteristic flora of Zone 4 in both years (Table 18).

Faunal species were not abundant in this zone. M. californianus and P. polymerus occurred in isolated clumps in 1976 and were not observed in 1977. Numbers of these two species may have decreased due in part to predation or to slumping of overburden areas.

Semi-exposed habitats

Boulder beaches

Fauna and flora of semi-exposed boulder beaches were studied at Thrasher Cove (1) (Fig.14). Results are given in Table 19.

Zone 1, splash or spray zone

A splash zone, 10 m in width, was observed along the rocky outcrop behind the boulder beach at this site in 1977. Marine life was sparse. The black lichen Verrucaria sp. was the only floral species found. Numbers of periwinkles L. scutulata and L. sitkana remained fairly constant, 40/m^2 and 200/m^2, respectively. B. glandula, the only acorn barnacle species observed, showed a slight increase in density from 1,000/m^2 in June to 1,500/m^2 in August.

Zone 2, high intertidal zone

Rockweed, F. distichus, was the dominant alga in the high intertidal zone in 1976 and 1977. Coverage decreased slightly throughout 1977. Red algae Rhodomela larix and H. glandiforme were also common in this zone. Other algae present are shown in Table 19.

Fauna in this zone was similar to semi-exposed rocky shores in the Broken Group Islands. Numbers of limpets (C. digitalis, C. pelta, N. persona and N. scutum) varied seasonally but were similar to those observed in 1976. Numbers of periwinkles L. scutulata showed little change between the 2 years; density of L. sitkana increased from 640/m^2 in 1976 to 2,300/m^2 in June 1977 and decreased slightly to 1,900/m^2 in August. Low numbers of thaids were recorded in both years. In 1977, densities

of the three acorn barnacles showed a seasonal increase which reflects the barnacle set observed in the area; however, numbers were generally lower than in 1976 (Table 19).

Zone 3, mid-intertidal zone

Coverage by surf grass, Phyllospadix scouleri, was greater in 1977 than in 1976 and increased from less than 5% in 1976 to 50% by August 1977.

H. sessile was the dominant algal species in 1976 and 1977. Coverage of this species decreased in 1977 from 40% in June to 10% in August. Other algae recorded in low densities are given in Table 19.

Numbers of mussels showed marked changes between the 2 years. Density of M. californianus decreased from 2,700/m^2 in 1976 to 200/m^2 in 1977. This may be due to a combination of natural mortality, predation, and slumping of overburden areas. M. edulis increased in numbers from 320/m^2 in 1976 to 2,000/m^2 in 1977, which probably reflects recruitment of the 1975 and 1976 year-classes. Numbers of B. cariosus increased from 160/m^2 in 1976 to 1,200/m^2 in August 1977; B. glandula, not recorded at this site in 1976, showed a maximum density of 7,500/m^2 in June 1977. Numbers of limpets (C. digitalis, C. pelta, N. persona and N. scutum) varied seasonally (Table 19).

Zone 4, low intertidal zone

Surf grass P. scouleri, not observed in this zone in 1976, was the dominant floral species in the low intertidal zone in 1977, 60% coverage. This marked increase may be due in part to an expanded distribution of plants from Zone 3 and to an exceptional growing season during the spring of 1977. A. marginata was the most abundant algal species in both years. These two species decreased slightly throughout 1977. Other alga present in densities less than 5% are given in Table 19.

Few faunal species were recorded in the low intertidal zone in both years (Table 19).

Summary

In 1977, several changes in faunal and floral populations of exposed and semi-exposed rocky shores were noted in the West Coast Trail Section.

The only substantial change in floral populations was the increase in coverage of Phyllospadix scouleri at Thrasher Cove. In faunal populations, significant recruitment of the periwinkle L. sitkana, anemone A. elegantissima, and acorn

barnacles occurred in 1977 as in the Long Beach and Broken Group Islands Sections.

In exposed and semi-exposed areas, populations of sea mussels M. californianus and goose barnacles P. polymerus showed slight decreases in numbers probably due to natural mortality, predation and slumping of overburden areas. Recruitment of P. polymerus observed in other Park sections was completely absent in the West Coast Trail Section. An increased density of bay mussels M. edulis was observed in semi-exposed habitats as in sheltered areas in the Broken Group Islands.

Several faunal populations remained stable in the 2 years. Numbers of limpets (C. digitalis, C. pelta, N. persona, and N. scutum) varied from season to season but were similar in both years. Purple sea urchins, S. purpuratus, occurred in tidepools along the sandstone benches and showed little change in densities.

Surveys of these habitats will continue in 1978 to further assess seasonal and yearly levels of faunal and floral communities.

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REFERENCES

Bourne, N., and D. B. Quayle. MS 1970. Breeding and growth of razor clams in British Columbia. Fish. Res. Board Can. Tech. Rep. 232: 42 p.

Castenholz, R. W. 1961. The effect of grazing on marine littoral diatom populations. Ecology 42: 783-794.

Castenholz, R. W. 1967. Stability and stresses in intertidal populations, In Olson, T. A., and F. J. Burgess (ed.). Part 2. Dynamics of the littoral marine community. Pollution and Marine Ecology. Interscience Publishers, John Wiley and Sons, Inc., New York.

Hewatt, W. G. 1937. Ecological studies on selected marine intertidal communities of Monterey Bay, California. Amer. Midland Nat. 18: 161-206.

Lee, J. C., and N. Bourne. MS 1976. Marine resource inventory of Pacific Rim National Park. Fish Res. Board Can. MS Rep. 1389: 236 p.

Lee, J. C., and N. Bourne. MS 1977. Marine resource inventory of Pacific Rim National Park - 1976. Fish. Mar. Serv. MS Rep. 1436: 375 p.

Northcraft, R. D. 1948. Marine algal colonization on the Monterey Peninsula, California. Am. J. Botany 35: 396-404.

Table 1. Seasonal observations of fauna and flora in exposed and semi-exposed rocky shores, Long Beach Section (1977). (Multiply No./m^2 of *B. glandula* and *M. californianus* by 100; *L. sitkana*, *C. dalli*, *M. edulis*, *A. elegantissima* and *P. polymerus* by 10)

Table 1

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 1	6 m			5 m			10 m			4 m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA												
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia												
Collisella digitalis	300	253	160	70	55	60	80	60	62	368	256	90
C. pelta	0	0	0	15	12	26	0	3	14	0	160	64
Littorina scutulata	50	98	60	23	43	56	150	160	120	0	700	320
L. sitkana	440	400	320	204	324	216	200	160	210	0	200	740
Notoacmea persona	12	3	1	16	2	14	30	3	23	48	21	41
N. scutum	0	1	1	0	1	0	0	3	1	0	48	14
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia												
Balanus glandula	430	428	400	410	650	570	700	650	630	240	260	200
Chthamalus dalli	200	210	190	0	100	87	250	300	270	310	300	290
Subclass Malacostraca												
Ligia palisii	0	0	0	0	0	0	0	0	0	0	160	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 1	6m			5m			10m			4m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA												
Lichens												
Verrucaria sp.	50	50	50	45	60	50	50	50	50	60	80	60
PHYLUM Chlorophyta												
Enteromorpha intestinalis	0	0	0	0	<5	0	0	0	0	0	0	0
Prasiola meridionalis	15	60	0	0	0	0	10	30	10	0	0	0
PHYLUM Phaeophyta												
Ralfsia sp.	0	0	0	0	0	0	0	0	0	0	<5	<5
PHYLUM Rhodophyta												
Hildenbrandia sp.	0	0	<5	0	0	0	<5	10	<5	0	10	10
Porphyra sp.	0	0	0	0	0	0	<5	<5	0	10	<1	0
Rhodomela larix (in tidepools)	0	0	<5	0	0	0	0	<5	0	0	10	<5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 2	2m			3m			3m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA												
PHYLUM Mollusca Class Gastropoda Subclass Opisthobranchia												
Onchidella borealis	0	0	0	0	0	5	0	0	0	0	50	0
Subclass Prosobranchia												
Collisella digitalis	30	27	40	42	80	50	72	368	89	80	160	73
C. pelta	120	100	97	0	0	0	10	16	0	41	16	1
Littorina scutulata	100	95	87	105	90	72	150	320	220	32	160	79
L. sitkana	320	340	290	200	175	120	290	224	160	272	480	320
Notoacmea persona	0	4	13	14	2	8	3	19	14	9	12	16
N. scutum	80	36	1	0	1	3	16	4	10	3	0	1
Thais emarginata	0	112	98	0	0	14	120	130	97	80	64	32
T. lamellosa	0	3	1	1	0	0	3	1	<1	0	<1	0
Class Bivalvia												
Mytilus edulis	0	0	0	10	7.5	8.0	0	0	0	120	144	100
M. californianus	0	0	0	0	0	0	200	304	190	80	96	73

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 2	2m			3m			3m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia												
Balanus cariosus	350	425	300	195	150	140	410	340	390	290	300	270
B. glandula	420	460	400	610	700	550	550	700	650	820	400	390
Chthamalus dalli	200	230	190	100	400	200	220	400	370	400	450	390
Pollicipes polymerus	0	0	0	0	0	0	0	0	0	0	500	270
Subclass Malacostraca												
Hemigrapsus nudus	0	0	0	0	0	0	0	0	0	0	<1	0
FLORA												
PHYLUM Chlorophyta												
Cladophora sp.	0	0	0	0	<1	0	0	<5	0	<5	10	<5
Spongomorpha sp.	<5	<5	<5	5	<1	0	0	0	0	<5	5	<5
Ulva sp.	0	<5	<5	<5	<1	0	0	<5	<5	0	5	<5
PHYLUM Phaeophyta												
Fucus distichus	10	30	10	20	40	10	<5	10	10	60	60	10
Pelvetiopsis limitata	10	60	20	0	0	0	10	10	10	0	5	<5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 2	2m			3m			3m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA cont'd												
PHYLUM Phaeophyta cont'd												
Ralfsia sp.	0	<5	<5	0	5	5	0	0	0	0	<5	<5
PHYLUM Rhodophyta												
Calliathamnion pikeanum	0	0	0	0	0	0	10	10	5	<5	<5	<5
Endocladia muricata	10	10	<5	0	0	0	<5	10	5	<5	10	10
Gigartina sp.	0	<5	<5	<5	<5	<5	<5	<5	<5	0	40	10
Microcladia borealis	0	0	0	0	0	0	0	0	0	0	<5	0
Odonthalia floccosa	0	<5	<5	0	0	0	0	0	0	0	0	0
Petrocelis sp.	<5	<5	<5	0	0	0	0	<5	<5	10	5	5
Porphyra sp.	0	0	0	0	0	0	<5	<5	<5	0	0	0
Pterosiphonia bipinnata	0	<5	<5	0	0	0	<5	<5	<5	0	<5	<5
Rhodomela larix	<5	<5	<5	0	0	0	0	<5	<5	0	<5	<5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA												
PHYLUM Porifera												
Haliclona permollis	0	0	0	5	<5	<5	5	5	5	<5	<5	<5
Ophlitaspongia pennata	0	<5	<5	10	10	10	<5	<5	<5	<5	<5	<5
unidentified species	0	<5	<5	<5	<5	<5	0	<5	<5	25	<5	<5
PHYLUM Cnidaria												
Class Anthozoa												
Order Actiniaria												
Anthopleura elegantissima	240	148	130	75	160	150	240	470	320	131	992	870
A. xanthogrammica	16	2	2	8	8	8	10	2	3	12	10	10
Metridium senile	0	0	0	10	7	7	0	0	0	<1	<1	<5
Class Hydrozoa												
unidentified species	0	<5	<5	0	0	0	0	0	0	0	<5	<5
PHYLUM Annelida												
Class Polychaeta												
Eudistylia vancouveri	<5	<5	<5	<5	<5	<5	0	0	0	5	5	5
Serpula vermicularis	5	5	5	10	10	10	<5	<5	<5	<5	<5	<5
Spirorbis sp.	0	0	<5	0	0	0	0	0	0	0	<5	<5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Nemertea												
unidentified species	0	0	<1	0	0	0	<1	<1	<1	<1	<1	<1
PHYLUM Mollusca Class Amphineura												
Cryptochiton stelleri	0	0	0	0	0	0	0	<1	0	0	<1	0
Katharina tunicata	0	4	3	7	16	10	3	8	4	8	3	5
Mopalia spp.	0	3	1	0	0	0	0	<1	<1	<1	3	0
Tonicella lineata	0	0	0	0	<1	0	0	80	0	0	10	0
Class Gastropoda Subclass Opisthobranchia												
Aeolidida papillosa	0	0	0	0	0	0	0	0	0	0	<1	0
Archidoris montereyensis	0	<1	0	<1	0	0	0	0	0	<1	<1	0
Dirona albolineata	0	0	0	0	0	0	0	0	0	0	0	0
Hermissenda crassicornis	0	0	0	0	0	0	0	0	0	0	0	0
Rostanga pulchra	0	0	0	<1	<1	0	0	0	0	0	0	0
Subclass Prosobranchia												
Ceratostoma foliata	0	0	0	0	0	0	0	0	0	<1	<1	0
Calliostoma ligatum	0	0	0	0	0	0	0	0	0	1	<1	0
Collisella digitalis	0	41	0	1	16	3	240	70	17	14	320	82

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia cont'd												
C. pelta	96	32	0	20	16	10	0	192	20	128	160	72
C. strigatella	0	0	0	0	0	0	0	0	0	0	240	0
Crepidula adunca	0	0	0	0	0	0	0	0	0	0	48	0
Diodora aspera	0	0	0	0	0	0	<1	<1	0	0	<1	0
Littorina scutulata	0	0	0	0	0	4	10	0	0	0	43	0
Notoacmea persona	224	224	160	0	0	0	50	46	48	256	220	218
N. scutum	32	30	63	1	3	4	10	16	20	14	3	1
Scarlesia dira	0	0	0	0	0	0	0	0	0	48	160	51
Tegula funebralis	0	0	0	0	0	0	10	16	20	0	0	0
Thais emarginata	64	240	136	0	0	14	48	48	21	320	48	40
T. lamellosa	0	64	3	3	1	0	5	0	1	2	1	<1
Class Bivalvia												
Mytilus californianus	512	640	480	.25	.27	.26	160	152	150	928	950	870
M. edulis	110	100	100	120	117	112	150	170	152	240	220	190
Pododesmus macroschisma	0	0	0	0	0	0	0	0	0	0	0	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia												
Balanus caricsus	600	575	520	250	300	270	200	600	570	400	500	480
B. glandula	130	300	280	100	150	142	250	241	240	480	400	390
B. nubilus	2	3	3	2	2	2	0	0	0	8	10	6
Chthamulus dalli	50	45	40	0	30	28	40	260	200	480	500	380
Pollicipes polymerus	240	350	280	0	0	0	528	30	28	32	32	30
Subclass Malacostraca Order Decapoda												
Hemigrapsus nudus	4	1	0	0	0	0	0	0	0	0	0	0
H. oregonensis	0	0	0	0	0	0	0	0	0	0	0	0
Lophopanopeus bellus	0	0	0	0	0	0	0	0	0	0	<1	0
Oedignathus inermis	0	0	0	<1	<1	<1	<1	3	<1	<1	7	3
Pagurus sp.	20	12	14	0	<1	3	11	8	14	5	10	11
Pugettia gracilis	0	<1	0	0	0	<1	<1	<1	<1	<1	<1	<1
Order Amphipoda												
Idothea wosnesensleii	0	3	<1	0	<1	<1	<1	<1	<1	<1	9	<1
unidentified species	0	+	+	0	+	+	+	+	+	+	+	+

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Bryozoa												
Dendrobaenia lichenoides	5	5	5	5	5	5	5	5	5	5	5	5
Frustrellidra corniculta	5	5	5	10	10	10	<5	<5	<5	<5	<5	<5
unidentified species	<5	<5	<5	10	10	10	5	5	5	5	5	5
PHYLUM Echinodermata Class Asteroidea												
Dermasterias imbricata	0	<1	0	<1	0	0	0	<1	0	<1	<1	0
Evasterias troschellii	0	<1	0	0	0	0	<1	<1	0	<1	0	0
Henricia leviuscula	0	0	<1	0	0	0	0	0	0	2	<1	0
Leptasterias hexactis	0	64	30	0	0	<1	0	32	14	0	3	0
Pisaster ochraceus	4	8	3	4	3	4	2	6	4	7	3	3
Pycnopodia helianthoides	0	0	0	<1	0	<1	0	0	0	0	<1	<1
Class Echinoidea												
Strongylocentrotus purpuratus	1	1	0	0	0	0	0	0	0	41	40	36
S. franciscanus	<1	0	0	0	0	0	0	0	0	1	0	1
Class Holothuroidea												
Cucumaria miniata	0	0	0	0	<1	0	0	0	<1	3	3	4
Eupentacta pseudoquinquesemita	0	0	0	0	0	0	0	0	0	<1	<1	<1

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Chordata Subphylum Urochordata Class Ascidiacea												
Clavelina huntsmani	0	0	0	0	0	0	<1	<1	<1	<1	<1	<1
Styela montereyensis	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
unidentified species	5	5	5	15	10	10	5	5	5	<5	5	5
Subphylum Craniata Class Osteichthys												
Clinocottus sp. OR Oligocottus sp.	3	20	10	0	0	0	14	17	13	3	7	4
FLORA												
PHYLUM Spermatophyta												
Phyllospadix scouleri	10	5	5	0	0	0	10	10	10	<5	10	<5
PHYLUM Chlorophyta												
Cladophora sp.	0	0	0	10	15	<5	<5	<5	<5	<5	<5	0
Codium fragile	0	0	0	0	0	0	0	0	0	<5	<5	<5
Spongomorpha sp.	0	<5	<5	0	5	<5	<5	<5	<5	<5	<5	<5
Ulva sp.	<5	<5	<5	20	5	5	<5	<5	<5	<5	<5	<5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA cont'd												
PHYLUM Phaeophyta												
Alaria marginata	<5	<5	<5	0	0	0	5	10	<5	5	10	<5
A. nana	0	0	0	0	0	0	0	0	0	10	20	5
Egregria menziesii	<5	<5	<5	10	5	5	0	<5	<5	<5	<5	<5
Fucus distichus	0	0	0	<5	<5	<5	0	0	0	0	0	0
Hedophyllum sessile	10	50	10	<5	60	20	60	60	30	40	60	20
Leathesia difformis	10	10	<5	5	5	<5	0	<5	<5	0	<5	<5
Ralfsia sp.	0	<5	<5	0	<1	<1	0	<5	<5	0	<5	<5
PHYLUM Rhodophyta												
Bossiella sp.	0	0	0	0	0	0	<5	<5	<5	<5	<5	<5
Calliarthron sp.	0	<5	<5	0	0	0	<5	<5	<5	<5	<5	<5
Calliathamnion pikeanum	0	0	0	0	<1	<1	<5	5	<5	<5	<5	<5
Corallina sp.	<5	<5	<5	0	0	0	10	10	5	<5	<5	<5
Dilsea edulis	0	<5	0	0	0	0	0	<5	0	0	<5	0
Endocladia muricata	10	<5	<5	<5	<1	<1	<5	5	<5	10	10	10
Gigartina exasperata	0	0	0	0	0	0	10	20	5	0	<5	0
Gigartina sp.	<5	<5	<5	0	5	5	0	<5	<5	<5	<5	<5
Halosaccion glandiforme	5	5	5	<5	20	10	<5	<5	<5	<5	<5	<5
Hildenbrandia sp.	0	<5	<5	0	20	10	<5	<5	<5	10	<5	<5
Hymenina sp.	0	0	0	0	0	0	0	0	0	0	<5	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 3	5m			5m			3m			14m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA cont'd												
PHYLUM Rhodophyta cont'd												
Iridaea sp.	<5	<5	<5	<5	<1	<1	<5	<5	<1	20	10	<1
Laurencia spectabilis	0	0	0	0	<5	0	0	0	0	0	0	0
Lithothamnion sp.	0	0	0	0	5	<5	<5	10	5	5	10	5
Microcladia borealis	0	10	5	0	<1	<1	0	10	<5	<5	10	5
M. coulteri	0	0	0	0	0	0	0	5	0	<5	50	<5
Odonthalia floccosa	0	5	5	<5	<5	<5	5	5	5	10	<5	<5
Petrocelis sp.	5	5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Plocamium sp.	0	0	0	0	0	0	0	<5	0	0	<5	0
Porphyra sp.	<5	<5	0	<5	5	0	5	5	0	5	5	0
Prionitis sp.	<5	20	<5	0	0	0	10	10	5	<5	<5	<5
Rhodomela larix	0	0	0	15	5	<5	<5	5	5	10	<5	<5
Rhodoglossum affine	0	0	0	0	0	0	10	20	10	<5	10	<5
Schizymenia pacifica	0	0	0	0	0	0	0	0	0	0	<5	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA												
PHYLUM Porifera												
Haliclona permollis	<5	<5	<5	5	<1	<1	5	5	5	5	5	5
Ophlitaspongia pennata	5	5	<5	5	5	5	5	5	5	5	5	5
unidentified species	<5	<5	<5	<5	<5	<5	5	<5	<5	10	<5	<5
PHYLUM Cnidaria												
Class Anthozoa												
Order Actiniaria												
Anthopleura elegantissima	100	87	80	28	50	48	40	87	63	0	0	0
A. xanthogrammica	30	63	50	2	5	3	0	3	1	10	10	6
Epiactus prolifera	0	0	0	0	0	0	0	<1	0	0	<1	<1
Tealia coriacea	0	0	0	0	0	0	<1	<1	<1	<1	<1	<1
T. crassicornis	0	0	0	<1	<1	<1	<1	<1	<1	0	0	0
Class Hydrozoa												
unidentified species	<5	<5	<5	0	0	0	<5	<5	<5	0	<5	<5
PHYLUM Annelida												
Class Polychaeta												
Serpula vermicularis	0	0	0	10	10	10	5	<5	<5	10	5	5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Mollusca Class Amphineura												
Cryptochiton stelleri	0	0	0	0	0	0	0	<1	0	0	0	0
Katharina tunicata	0	1	0	0	2	0	1	5	<1	3	6	<1
Mopalia sp.	<1	2	1	0	0	0	1	0	0	<1	<1	0
Tonicella lineata	0	3	0	<1	<1	0	3	80	14	2	7	3
Class Gastropoda Subclass Opisthobranchia												
Archidoris montereyensis	0	<1	0	<1	0	0	0	<1	0	0	<1	0
Triopha carpenteri	0	0	0	0	0	0	0	0	0	0	0	0
Subclass Prosobranchia												
Acmaea mitra	0	0	0	0	0	0	0	0	0	<1	0	0
Ceratostoma foliata	0	0	0	0	0	<1	0	0	0	<1	0	0
Crepidula adunca	0	0	0	0	0	0	0	16	0	0	0	0
Megatobennus bimaculatus	0	0	0	0	0	0	0	0	0	<1	0	0
Notoacmea persona	0	0	0	10	6	0	0	160	0	0	0	0
N. scutum	0	0	0	0	0	0	0	48	14	0	0	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Arthropoda												
Class Crustacea												
Subclass Cirripedia												
Balanus nubilus	4	4	4	1	1	1	<1	<1	<1	6	4	4
Chthamalus dalli	0	20	14	0	0	0	27	40	37	0	0	0
Pollicipes polymerus	15	14	14	0	0	0	5	8	6	0	0	0
Subclass Malacostraca												
Order Decapoda												
Pagurus sp.	5	4	1	0	0	0	14	80	3	10	3	0
Order Isopoda												
unidentified species	+	+	+	+	+	+	+	+	+	+	+	+
PHYLUM Bryozoa												
Frustrellidra corniculata	0	0	0	5	5	5	0	0	0	10	10	10
unidentified species	10	10	10	15	10	10	<5	<5	<5	<5	<5	<5
PHYLUM Echinodermata												
Class Asteroidea												
Dermasterias imbricata	<1	<1	<1	0	0	0	<1	0	0	<1	0	0
Leptasterias sp.	0	16	3	0	0	0	42	64	21	14	36	12

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FAUNA cont'd												
PHYLUM Echinodermata Class Asteroidea cont'd												
Pisaster ochraceus	<1	<1	<1	0	<1	0	0	<1	<1	3	<1	<1
Pycnopodia helianthoides	0	0	0	<1	0	0	0	<1	0	0	0	0
Solaster dawsoni	0	0	0	0	0	<1	0	0	0	0	0	0
Class Echinoidea												
Strongylocentrotus purpuratus	0	0	0	0	0	0	0	0	0	0	14	2
PHYLUM Chordata Subphylum Urochordata Class Ascidiacea												
Styela montereyensis	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
unidentified compound ascidians	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	<1
unidentified simple ascidians	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	<1
FLORA												
PHYLUM Spermatophyta												
Phyllospadix scouleri	10	10	5	40	60	20	20	40	10	20	10	5

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA cont'd												
PHYLUM Chlorophyta												
Codium setchellii	0	0	0	0	0	0	0	<5	0	0	0	0
Ulva sp.	0	5	0	0	5	0	0	5	0	0	5	0
PHYLUM Phaeophyta												
Alaria marginata	10	25	5	10	20	5	5	10	<5	0	0	0
Dermasteria sp.	<5	<5	<5	0	0	0	5	25	<5	0	0	0
Egregia menziesii	<5	<5	<5	15	10	5	<5	<5	<5	10	10	<5
Laminaria setchellii	5	10	<5	0	0	0	<5	10	<5	10	10	<5
Lessoniopsis littoralis	0	0	0	0	0	0	20	20	<5	50	60	15
Nereocystis leutkeana	0	<5	<5	0	0	0	<5	<5	<5	5	5	5
Postelsia palmaeformis	0	0	0	0	0	0	0	0	0	0	0	0
Ralfsia sp.	0	0	0	0	0	0	0	<5	<5	0	0	0
PHYLUM Rhodophyta												
Bossiella sp.	<5	<5	<5	<1	<1	<1	<5	<5	<5	<5	<5	<5
Calliarthron sp.	<5	<5	<5	0	0	0	<5	10	5	<5	<5	<5
Constantinea simplex	0	0	0	0	0	0	<5	<5	<5	<5	5	<5
Corallina sp.	<5	<5	<5	<1	<1	<1	40	10	5	<5	<5	<5
Dilsea edulis	0	0	0	0	0	0	0	0	0	0	10	0

Table 1 cont'd

Location	Green Pt. (13)			Box Is. (12b)			Quisitis Pt. (14a)			Half Moon Bay (4)		
Zone 4	2m			2m			1m			2m		
Date	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.	Apr.	Jun.	Dec.
FLORA cont'd												
PHYLUM Rhodophyta cont'd												
Gigartina exasperata	<5	10	<5	0	0	0	40	20	20	30	30	15
Gigartina sp.	5	<5	<5	0	5	5	5	20	10	<5	<5	<5
Gymnogongrus sp.	5	5	5	0	0	0	0	<5	<5	0	<5	<5
Hildenbrandia sp.	0	0	0	0	0	0	0	<5	<5	<5	<5	<5
Iridaea sp.	0	0	0	10	5	5	<5	<5	<5	15	10	5
Lithothamnion sp.	<5	<5	<5	0	<1	<1	10	10	5	<5	10	<5
Microcladia borealis	0	0	0	0	0	0	0	<5	0	<5	<5	0
Micronema sp. (on Phyllospadix)	<5	<5	0	10	10	0	0	40	0	10	10	0
Petrocelis sp.	10	15	10	0	0	0	0	0	0	0	0	0
Polyneura latissima	0	0	0	0	0	0	0	0	0	0	<5	0
Porphyra sp.	0	<5	0	0	0	0	0	<5	0	0	<5	0
Prionitis sp.	10	10	5	0	0	0	0	<5	<5	<5	<5	<5
Rhodoglossum affine	0	0	0	0	0	0	0	0	0	10	20	10

Table 2. Seasonal observations of fauna and flora on sheltered rocky shores, Grice Bay (11), Long Beach Section (1977). (No./m^2)

Table 2

ZONE 2 Width - 3m	April	June	Dec.
FAUNA			
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia			
Collisella digitalis	32	40	25
C. pelta	16	32	20
Littorina scutulata	16	160	140
L. sitkana	160	640	580
Notoacmea persona	112	0	42
N. scutum	0	64	12
Thais lamellosa	<1	<1	<1
Class Bivalvia			
Mytilus edulis	120	400	420
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia			
Balanus glandula	6700	*7000	6900
Chthamulus dalli	2100	4000	3000
Subclass Malacostraca			
Hemigrapsus oregonensis	112	64	50

(*new barnacle set = 200,000/m^2)

Table 2 cont'd

ZONE 2 Width - 3m	April	June	Dec.
FLORA			
PHYLUM Chlorophyta			
Cladophora sp.	0	<5	<5
Ulva sp.	<5	<5	<5
PHYLUM Phaeophyta			
Fucus distichus	40	75	30
PHYLUM Rhodophyta			
Gigartina sp.	0	<5	<5
Hildenbrandia sp.	60	60	40

Table 2 cont'd

ZONE 3 Width - 2m	April	June	Dec.
FAUNA			
PHYLUM Mollusca Class Bivalvia			
Mytilus edulis	320	350	340
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia			
Balanus glandula	1300	1300	1200
Subclass Malacostraca			
Hemigrapsus oregonensis	12	48	32
Pagurus sp.	20	30	14
FLORA			
PHYLUM Chlorophyta			
Enteromorpha sp.	0	<5	<5
Spongomorpha sp.	<5	<5	<5
Ulva sp.	<5	30	10
PHYLUM Phaeophyta			
Leathesia difformis	<1	<5	<1
PHYLUM Rhodophyta			
Endocladia muricata	35	35	25
Gigartina sp.	<5	<5	<5
Halosaccion glandiforme	20	20	10
Prionitis sp.	<5	<5	<5

Table 2 cont'd

ZONE 4 Width - 3m	April	June	Dec.
FAUNA			
PHYLUM Echinodermata			
Dermasterias imbricata	<1	<1	<1
Pisaster ochraceus	0	<1	<1
FLORA			
PHYLUM Spermatophyta			
Zostera marina	25	30	30
PHYLUM Chlorophyta			
Ulva sp.	<5	<5	<5
PHYLUM Phaeophyta			
Agarum fimbriatum	* we	we	we
PHYLUM Rhodophyta			
Grateloupia doryphora	<5	10	<5
Iridaea sp.	<5	10	<5

*we = water's edge

Table 3. Number of organisms re-colonizing cleared one m^2 plot of mussel bed, Cox Point (1977).

Table 3

Species	April	July	Oct.
PHYLUM Cnidaria Class Anthozoa Order Actiniaria			
Anthopleura elegantissima	0	3	4
A. xanthogrammica	3	3	0
PHYLUM Annelida Class Polychaeta			
Nereis vexillosa	0	0	0
Polychaetes	0	0	0
PHYLUM Nemertea			
Nemerteans	+	+	+
PHYLUM Platyhelminthes Class Turbellaria			
Flatworms	0	0	0
PHYLUM Sipuncula Family Phascolosomatidae			
Phascolosoma agassizii	0	0	0
PHYLUM Echinodermata Class Holothuroidea			
Cucumaria pseudocurata	0	0	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia			
Balanus cariosus	+	* 88	* 76.5
B. glandula		*1455	*1448
Chthamalus dalli		* 132.5	* 116.5
Pollicipes polymerus	26	5	5

*(multiply by 1,000)

Table 3 cont'd

Species	April	July	Oct.
Subclass Malacostraca Order Decapoda Suborder Reptantia Section Brachyura			
Hemigrapsus nudus	0	0	0
H. oregonensis	0	0	0
Section Anomura			
Pagurus sp.	0	0	0
Petrolisthes eriomerus	0	0	0
Order Amphipoda			
Amphipods	0	0	0
Order Isopoda			
Isopods	0	0	0
PHYLUM Mollusca Class Amphineura			
Cyanoplax dentiens &			
Tonicella sp.	0	0	0
Mopalia sp.	0	0	0
Class Gastropoda Subclass Prosobranchia			
Collisella digitalis	258	229	177
C. pelta	34	19	11
C. strigatella	0	0	0
Lacuna marmorata	0	0	0
Littorina scutulata	41	96	77
L. sitkana	482	656	455
Notoacmea persona	294	371	320
N. scutum	101	15	25
Tegula brunnea	0	0	0
T. funebralis	0	0	0

Table 3 cont'd

Species	April	July	Oct.
Class Gastropoda Subclass Prosobranchia cont'd			
Thais canaliculata &			
T. emarginata	126	85	95
T. lamellosa	0	0	0
Class Gastropoda Subclass Opisthobranchia			
Onchidella borealis	0	0	0
Class Bivalvia			
Hiatella arctica	0	0	0
Mytilus californianus &			
M. edulis ≥1.0 cm	25	0	0
<1.0 cm	260	195	187
Petricola sp.	0	0	0
Protothaca staminea ≥1.0 cm	0	0	0
<1.0 cm	0	0	0
PHYLUM Chlorophyta			
Cladophora sp.	0	0	0
Spongomorpha sp.	0	6	3
Ulva sp.	8	48	16
PHYLUM Phaeophyta			
Fucus sp.	0	0	0
Leathesia difformis	0	0	0
Ralfsia sp.	0	9	9

Table 3 cont'd

Species	April	July	Oct.
PHYLUM Rhodophyta			
Endocladia muricata	15	31	21
Gigartina sp.	16	77	65
Halosaccion glandiforme	13	57	44
Hildenbrandia sp.	0	1	1
Microcladia borealis	0	3	3
Petrocelis sp.	8	1	1
Porphyra sp.	0	0	0
Prionitis sp.	0	0	0
Pterosiphonia bipinnata	10	50	25

Table 4. Total and monthly length frequency distributions of sea mussels removed from plots at Quisitis Point, Long Beach Section (1977). (Measurements in 10 mm size classes)

Location	A - 20			B - 20		
Date	July	Dec.	Total	July	Dec.	Total
Size class						
40.0 - 49.9	5	1	6	3	2	5
50.0 - 59.9	8	9	17	8	10	18
60.0 - 69.9	4	7	11	8	5	13
70.0 - 79.9	3	2	5	1	2	3
80.0 - 89.9	0	1	1	0	1	1
90.0 - 99.9	0	0	0	0	0	0
100.0 - 109.9	0	0	0	0	0	0
Total	20	20	40	20	20	40

Location	A - 40			B - 40		
Date	July	Dec.	Total	July	Dec.	Total
Size class						
30.0 - 39.9	3	0	3	1	0	1
40.0 - 49.9	9	6	15	1	2	3
50.0 - 59.9	17	21	38	8	10	18
60.0 - 69.9	6	8	14	15	21	36
70.0 - 79.9	4	5	9	10	7	17
80.0 - 89.9	1	0	1	5	0	5
90.0 - 99.9	0	0	0	0	0	0
100.0 - 109.9	0	0	0	0	0	0
Total	40	40	80	40	40	80

Table 4 cont'd

Location	A - 60			B - 60		
Date	July	Dec.	Total	July	Dec.	Total
Size class						
40.0 - 49.9	0	2	2	2	1	3
50.0 - 59.9	18	15	33	18	11	29
60.0 - 69.9	27	29	56	23	18	41
70.0 - 79.9	10	11	21	14	24	38
80.0 - 89.9	4	2	6	3	3	6
90.0 - 99.9	1	1	2	0	3	3
100.0 - 109.9	0	0	0	0	0	0
Total	60	60	120	60	60	120

Location	A - 80			B - 80		
Date	July	Dec.	Total	July	Dec.	Total
Size class						
30.0 - 39.9	6	4	10	11	20	31
40.0 - 49.9	10	6	16	39	46	85
50.0 - 59.9	39	46	85	23	11	34
60.0 - 69.9	23	21	44	6	3	9
70.0 - 79.9	2	2	4	1	0	1
80.0 - 89.9	0	1	1	0	0	0
90.0 - 99.9	0	0	0	0	0	0
100.0 - 109.9	0	0	0	0	0	0
Total	80	80	160	80	80	160

Table 4 cont'd

Location	A - 100			B - 100		
Date	July	Dec.	Total	July	Dec.	Total
Size class						
30.0 - 39.9	1	1	2	4	5	9
40.0 - 49.9	2	1	3	48	47	95
50.0 - 59.9	25	31	56	43	35	78
60.0 - 69.9	37	42	79	3	10	13
70.0 - 79.9	18	17	35	1	2	3
80.0 - 89.9	10	3	13	1	1	2
90.0 - 99.9	5	3	8	0	0	0
100.0 - 109.9	2	2	4	0	0	0
110.0 - 119.9	0	0	0	0	0	0
Total	100	100	200	100	100	200

Table 5. Number of Clivella biplicata observed in 10 quadrats, each 3 x 3 m, Long Beach Section (1977).

Location	4				5			
Date	May	June	July	Sept.	May	June	July	Sept.
Sample No.								
1	3	10	3	-	1	12	1	-
2	6	13	2	-	2	11	0	-
3	4	9	4	-	1	10	0	-
4	2	7	0	-	5	14	1	-
5	1	12	1	-	7	7	0	-
6	1	11	0	-	3	7	2	-
7	3	6	2	-	8	8	11	-
8	1	10	4	-	2	4	21	-
9	2	14	1	-	8	10	7	-
10	4	11	3	-	5	11	2	-
Total	27	103	20	-	42	94	45	-
Mean	2.7	10.3	2.0	-	4.2	9.4	4.5	-
No./m^2	0.30	1.14	0.20	-	0.47	1.04	0.50	-

Table 6. Number of *Olivella biplicata* collected at 5 m intervals along a transect between Round and Little Islands (1977). (No./m^2)

Date		May	June	July	Sept.
Sample(m)					
water's edge	0 a	12	3	0	-
	b	12	0	0	-
	5 a	0	4	4	-
	b	0	4	56	-
	10 a	0	0	12	-
	b	8	0	4	-
	15 a	0	0	8	-
	b	4	0	0	-
	20 a	12	4	8	-
	b	4	8	4	-
	25 a	3	0	0	-
	b	24	0	0	-
	30 a	0	4	0	-
	b	0	0	0	-
	35 a	4	16	0	-
	b	4	0	0	-
	40 a	4	0	-	-
	b	0	0	-	-
	45 a	4	4	-	-
	b	0	0	-	-
	50 a	4	8	-	-
	b	0	0	-	-
	55 a	0	0	-	-
	b	0	4	-	-
	60 a	4	12	-	-
	b	0	8	-	-
	65 a	0	4	-	-
	b	0	8	-	-
	70 a	0	8	-	-
	b	0	0*	-	-*
Mean/m^2		3.60	3.06	6.00	

*(plus two consecutive sets of samples with no *Olivella*)

Table 7. Number of Olivella biplicata and O. baetica collected at 10m intervals along two subtidal transects between Round and Little Islands, Long Beach Section (1977). (No./m^2)

APRIL	Depth (m)		O. biplicata		O. baetica	
Sample	Transect		Transect		Transect	
No.	A	B	A	B	A	B
1	4.5	6.0	0	6	0	0
2	↓	↓	2	10	0	0
3	↓	↓	2	2	0	0
4	↓	↓	2	6	0	0
5	3.0	↓	2	12	0	2
6	2.5	↓	2	10	0	0
7	↓	3.0	0	4	0	4
8	↓	↓	0	26	0	10
9	↓	↓	0	0	0	0
10	↓	↓	2	0	0	0
11	1.8	1.8	0	4	0	0
Total No.			12	80	0	16

MAY						
1	4.5	-	0	-	2	-
2	↓	-	2	-	0	-
3	↓	-	2	-	0	-
4	↓	-	8	-	2	-
5	↓	-	4	-	4	-
6	3.0	-	0	-	0	-
7	↓	-	4	-	4	-
8	↓	-	-	-	-	-
9	↓	-	2	-	0	-
10	↓	-	6	-	2	-
11	2.5	-	4	-	2	-
Total No.			32	-	16	-

Table 7 cont'd

JUNE	Depth (m)		O. biplicata		O. baetica	
Sample	Transect		Transect		Transect	
No.	A	B	A	B	A	B
1	6.0	6.0	0	2	2	0
2	↓	↓	0	0	0	0
3	↓	↓	4	2	0	2
4	↓	↓	0	0	0	0
5	3.0	↓	2	0	2	0
6	2.5	3.0	2	0	0	0
7	↓	↓	2	0	2	0
8	↓	↓	0	0	0	0
9	↓	↓	0	2	0	0
10	↓	↓	0	0	0	0
11	1.8	1.8	4	0	0	0
Total No.			14	6	6	2

JULY						
1	6.0	6.0	0	0	8	0
2	↓	↓	0	0	4	0
3	↓	↓	0	2	0	0
4	↓	↓	0	0	0	0
5	↓	↓	0	2	0	0
6	3.0	3.0	0	0	2	0
7	↓	↓	4	0	2	0
8	↓	↓	0	0	0	0
9	↓	↓	0	4	0	0
10	↓	↓	0	0	0	0
11	1.8	1.8	0	0	0	0
Total No.			4	8	16	0

Table 8. Number of starfish recorded from three sample sites, Long Beach Section (1977).

Sample Site	Box Island			Grassy Island			Green Point	
Species	Pisaster		Pycno.	Pisaster		Pycno.	Pisaster	
	Total No.	No/m^2	Total No.	Total No.	No/m^2	Total No.	Total No.	No/m^2
April	71	4.1	1	111	6.4	0	30	2.2
May	31	1.8	1	60	3.5	1	23	1.7
June	60	3.4	0	66	3.8	1	32	2.4
July	74	4.2	6	106	6.1	0	18	1.3

Table 9 . Seasonal observations of fauna and flora recorded at exposed and semi-exposed rocky shores, Broken Group Islands (1977). (No./m^2)

Table 9

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 1						
FAUNA						
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia						
Collisella digitalis	96	80	-	20	48	32
Littorina scutulata	32	30	-	0	0	48
L. sitkana	123	700	-	320	480	4200
Notoacmea persona	48	0	-	0	0	0
N. scutum	0	0	-	0	3	1
Thais emarginata	0	0	-	<1	0	64
Class Bivalvia						
Mytilus edulis	0	0	-	100	80	90
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia						
Balanus glandula	480	800	-	90	112	100
FLORA						
Lichens Verrucaria sp.	50	75	50	20	20	20
PHYLUM Chlorophyta						
Cladophora sp.	<5	<5	-	0	0	0
Enteromorpha intestinalis	10	10	-	<5	<5	<5
Prasiola meridionalis	0	0	-	0	0	0
Ulva sp.	5	5	-	0	0	0
PHYLUM Phaeophyta						
Fucus distichus	0	0	-	0	<5	0
Scytosiphon lomentaria	0	0	-	<5	<5	<5

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 1 cont'd						
FLORA cont'd						
PHYLUM Rhodophyta						
Hildenbrandia sp.	0	10	-	<5	<5	<5
ZONE 2						
FAUNA						
PHYLUM Cnidaria Class Anthozoa Order Actinaria						
Anthopleura elegantissima	0	0	-	224	224	48
A. xanthogrammica	0	0	-	2	5	0
PHYLUM Annelida Class Polychaeta						
Spirorbis sp.	0	0	-	<5	<5	<5
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia						
Collisella digitalis	160	528	-	0	0	1
C. pelta	0	320	-	48	48	16
Littorina scutulata	0	160	-	0	0	48
L. sitkana	80	800	-	200	400	160
Onchidella borealis	0	0	-	<1	32	16
Notoacmea persona	0	16	-	0	32	0
N. scutum	0	25	-	112	80	0
Tegula funebralis	0	0	-	96	80	48
Thais emarginata	0	0	-	0	16	96
Searlesia dira	0	0	-	32	16	0

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 2 cont'd						
FAUNA cont'd						
PHYLUM Mollusca cont'd Class Bivalvia						
Mytilus californianus	320	224	-	0	0	0
M. edulis	0	0	-	2,880	2,800	160
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia						
Balanus cariosus	10	400	-	40	48	250
B. glandula	160	1,100	-	700	600	1,500
Chthamulus dalli	30	300	-	10,000	10,000	10
Subclass Malacostraca Order Decapoda						
Hemigrapus nudus	0	0	-	1	16	96
Pagurus sp.	0	0	-	10	16	16
Petrolisthes cinctipes	0	0	-	240	320	400
PHYLUM Bryozoa						
unidentified species	0	0	-	<5	<5	<5
PHYLUM Echinodermata Class Asteroidea						
Dermasterias imbricata	0	0	-	1	<1	0
Pisaster ochraceus	0	0	-	<1	3	0
PHYLUM Chordata Subphylum Craniata Class Osteichthys						
Clinocottus sp. OR Oligocottus sp.	0	0	-	5	10	10

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 2 cont'd						
FLORA						
PHYLUM Chlorophyta						
Cladophora sp.	<5	<5	-	5	5	5
Enteromorpha intestinalis	0	0	-	<5	<5	<5
Ulva sp.	0	0	-	10	5	<5
PHYLUM Phaeophyta						
Fucus distichus	20	0	-	40	40	40
Leathesia difformis	0	0	-	<5	<5	-
Ralfsia sp.	0	10	-	<5	<5	5
PHYLUM Rhodophyta						
Endocladia muricata	<5	5	-	5	5	5
Hildenbrandia sp.	<5	<5	-	60	60	5
Gigartina sp.	10	40	-	<5	<5	<5
Petrocelis sp.	10	30	-	<5	5	<5
Porphyra sp.	5	5	-	0	0	0
Prionitis sp.	0	0	-	0	5	5
Pterosiphonia bipinnata	<5	<5	-	0	0	0

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 3						
FAUNA						
PHYLUM Porifera						
Haliclona permollis	<5	<5	-	0	0	0
unidentified species	5	5	-	0	0	0
PHYLUM Cnidaria						
Anthopleura xanthogrammica	14	12	-	1	1	0
PHYLUM Annelida Class Polychaeta						
Serpula vermicularis	0	0	-	5	5	5
Spirorbis sp.	0	0	-	<5	<5	<5
PHYLUM Mollusca Class Amphineura						
Katharina tunicata	0	7	-	0	0	0
Class Gastropoda Subclass Prosobranchia						
Amphissa columbiana	0	0	-	0	48	0
Ceratostoma foliata	0	0	-	3	<1	0
Collisella pelta	192	160	-	0	0	0
Homalopoma lurida	0	0	-	0	80	0
Notoacmea persona	0	48	-	0	16	0
N. scutum	0	112	-	0	48	0
Thais canaliculata	32	0	-	0	0	0
T. emarginata	0	96	-	0	0	0
Class Bivalvia						
Mytilus californianus	1,200	1,200	-	0	0	0

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd						
FAUNA cont'd						
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia						
Balanus cariosus	192	400	-	50	64	40
B. glandula	200	480	-	40	40	30
Chthamulus dalli	0	80	-	1,000	900	700
Pollicipes polymerus	2,080	1,360	-	0	0	0
Subclass Malacostraca Order Decapoda						
Pagurus sp.	0	0	-	70	256	160
PHYLUM Bryozoa						
unidentified species	0	0	-	<5	10	10
PHYLUM Echinodermata Class Asteroidea						
Dermasterias imbricata	0	0	-	0	<1	1
Patiria miniata	0	0	-	<1	<1	<1
Pisaster ochraceus	<1	<1	-	0	0	1
Pycnopodia helianthoides	0	0	-	0	0	<1
FLORA						
PHYLUM Chlorophyta						
Cladophora sp.	0	0	-	0	<5	<5
Codium fragile	0	0	-	20	50	10
Enteromorpha intestinalis	0	0	-	<5	<5	<5
Spongomorpha sp.	0	0	-	<5	<5	<5
Ulva sp.	0	0	-	10	10	25

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd						
FLORA cont'd						
PHYLUM Phaeophyta						
Alaria nana	<5	10	-	0	0	0
Hedophyllum sessile	<5	5	-	0	0	0
Laminaria setchellii	<5	<5	-	0	0	0
Leathesia difformis	0	0	-	10	20	<5
Lessoniopsis littoralis	<5	0	-	0	0	0
Ralfsia sp.	0	0	-	0	<5	<5
PHYLUM Rhodophyta						
Bossiella sp.	20	30	-	0	0	0
Calliarthron sp.	20	40	-	0	0	0
Ceramium sp.	0	0	-	15	40	<5
Corallina sp.	20	10	-	40	40	5
Cryptosiphonia woodii	0	0	-	10	10	10
Endocladia muricata	<5	<5	-	0	0	0
Gastroclonium coulteri	0	0	-	40	20	10
Gigartina spp.	<5	<5	-	<5	10	<5
Halosaccion glandiforme	0	0	-	<5	<5	<5
Hildenbrandia sp.	0	10	-	<5	10	<5
Iridaea sp.	0	<5	-	0	0	0
Microcladia borealis	<5	10	-	0	0	0
Lithothamnion sp.	15	20	-	<5	<5	<5
Polysiphonia sp.	0	<5	-	0	0	0
Porphyra sp.	0	10	-	0	0	0
Pterosiphonia bipinnata	0	<5	-	0	0	0
Rhodomela larix	0	0	-	<5	10	<5
Schizymenia pacifica	0	<5	-	0	0	0

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 4						
FAUNA						
PHYLUM Porifera						
unidentified species	<5	5	-	0	0	0
PHYLUM Cnidaria Class Anthozoa Order Actiniaria						
Anthopleura xanthogrammica	14	7	-	0	0	0
Tealia coriacea	0	0	-	<1	<1	<1
PHYLUM Annelida Class Polychaeta						
Serpula vermicularis	0	0	-	<5	<5	<5
Spirorbis sp.	0	0	-	<5	<5	<5
PHYLUM Mollusca Class Amphineura						
Katharina tunicata	3	6	-	0	0	0
Mopalia spp.	0	0	-	0	16	0
Tonicella sp.	1	112	-	0	0	0
Class Gastropoda Subclass Prosobranchia						
Acmaea mitra	0	16	-	0	0	0
Astraea gibberosa	0	0	-	10	9	10
Bittium sp.	0	0	-	0	80	0
Ceratostoma foliata	0	0	-	<1	4	2
Homalopoma lurida	0	0	-	192	160	90
Searlesia dira	0	0	-	96	128	24
Vermetus compactus	0	5	-	10	10	5

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd						
FAUNA cont'd						
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia						
Balanus cariosus	0	0	-	40	16	200
B. glandula	0	0	-	100	48	50
B. nubilus	<1	2	-	0	0	0
Chthamulus dalli	0	0	-	620	590	400
Subclass Malacostraca Order Decapoda Suborder Reptantia Section Anomura						
Pagurus sp.	0	0	-	400	320	48
Petrolisthes eriomerus	0	0	-	192	224	48
Section Brachyura						
Cancer productus	0	0	-	<1	0	0
Lophopanopeus bellus	0	0	-	192	144	80
Pugettia sp.	0	0	-	3	2	3
PHYLUM Bryozoa						
unidentified species	0	0	-	<5	<5	<5
PHYLUM Echinodermata Class Asteroidea						
Dermasterias imbricata	0	0	-	<1	<1	<1
Evasterias troschelii	0	0	-	0	<1	<1
Leptasterias hexactis	0	64	-	0	0	0
Patiria miniata	0	0	-	5	8	6
Pisaster ochraceus	5	2	-	0	0	0
Pycnopodia helianthoides	0	0	-	<1	0	<1

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd						
FAUNA cont'd						
PHYLUM Echinodermata						
Class Echinoidea						
Strongylocentrotus purpuratus	7	25	-	0	0	0
Class Holothuroidea						
Cucumaria miniata	0	0	-	6	8	5
Parastichopus californicus	0	0	-	<1	<1	0
Class Ophiuroidea						
unidentified species of brittle stars	0	0	-	16	16	10
PHYLUM Chordata						
Subphylum Urochordata						
Class Ascidiacea						
unidentified species	0	5	-	0	0	0
FLORA						
PHYLUM Spermatophyta						
Phyllospadix scouleri	30	40	-	70	70	50
Zostera marina	0	0	-	0	0	25
PHYLUM Chlorophyta						
Codium fragile	0	0	-	<5	10	20
Ulva sp.	0	0	-	<5	10	5

Table 9 cont'd

Exposure	Exposed			Semi-exposed		
Sample site	Wouwer Is. (64)			Turret Is. (47)		
Date	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd						
FLORA cont'd						
PHYLUM Phaeophyta						
Colpomenia sp.	0	0	-	0	<1	<1
Hedophyllum sessile	<5	<5	-	0	0	0
Laminaria setchellii	5	30	-	0	0	0
Leathesia difformis	0	0	-	<5	5	<1
Lessoniopsis littoralis	40	30	-	0	0	0
Macrocystis integrifolia	0	0	-	50	50	20
Ralfsia sp.	<5	<5	-	0	<5	<5
PHYLUM Rhodophyta						
Bossiella sp.	10	40	-	0	0	0
Calliarthron sp.	10	40	-	0	0	0
Ceramium sp.	0	0	-	0	10	0
Constantinea simplex	0	10	-	0	0	0
Corallina sp.	10	10	-	<5	5	5
Cryptosiphonia woodii	0	0	-	<5	10	<5
Dilsea californica	<5	10	-	0	0	0
Erthrophyllum delesserioides	30	20	-	0	0	0
Gastroclonium coulteri	0	0	-	0	10	10
Gelidium robustum	0	0	-	25	60	40
Gigartina sp.	0	0	-	<5	20	<1
Hildenbrandia sp.	0	10	-	15	25	<5
Hymenina sp.	0	10	-	0	0	0
Iridaea sp.	0	<5	-	0	0	0
Lithothamnion sp.	5	20	-	60	80	5
Microcladia borealis	<5	<5	-	0	0	0
Petrocelis sp.	<5	<5	-	0	0	0
Prionitis sp.	<5	<5	-	0	0	0
Ptilota sp.	10	0	-	0	0	0
Schizymenia pacifica	0	<5	-	0	0	0

Table 10. Seasonal observations of fauna and flora recorded at sheltered cobble beaches and rocky shores, Broken Group Islands (1977). (Multiply No./m^2 of *Balanus cariosus*, *B. glandula* and *Chthamulus dalli* by 100.)

Table 10

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 1									
FAUNA									
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia									
Collisella pelta	0	0	0	0	16	0	0	0	0
Littorina scutulata	0	0	0	2100	1000	100	600	160	100
L. sitkana	0	0	0	1300	160	160	3000	480	200
Notoacmea persona	0	0	0	64	80	0	0	0	16
N. scutum	0	0	0	0	48	0	0	0	0
Tegula funebralis	0	0	0	48	0	16	0	0	0
FLORA									
Lichens									
Verrucaria sp.	0	0	0	60	70	60	50	50	50
ZONE 2									
FAUNA									
PHYLUM Annelida Class Polychaeta									
Serpula vermicularis	<1	0	0	0	0	0	0	0	0
Spirorbis sp.	<1	<1	<1	0	0	0	0	<5	0
PHYLUM Mollusca Class Amphineura									
Mopalia spp.	0	<1	<1	0	0	0	0	0	0
Tonicella sp.	<1	0	0	0	0	0	0	0	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 2 cont'd									
FAUNA cont'd									
PHYLUM Mollusca cont'd Class Gastropoda Subclass Opisthobranchia									
Archidoris montereyensis	<1	0	0	0	0	0	0	0	0
Subclass Prosobranchia									
Collisella digitalis	80	0	64	256	48	80	0	48	16
C. pelta	192	80	0	0	16	16	1	0	16
Littorina scutulata	90	500	64	1000	1200	48	800	450	300
L. sitkana	150	500	160	1600	320	240	2600	320	400
Notoacmea persona	96	0	0	64	16	0	0	32	32
N. scutum	0	16	48	80	80	0	96	48	48
Searlesia dira	48	40	16	24	24	16	48	32	0
Thais emarginata	0	0	0	0	48	16	16	0	32
T. lamellosa	16	0	0	0	0	0	0	0	0
Tegula funebralis	0	1	16	160	80	160	0	0	64
Class Bivalvia									
Crassostrea gigas	<1	<1	<1	0	0	0	0	0	0
Hiatella arctica	16	32	32	0	0	0	0	0	0
Mytilus edulis	560	550	320	432	320	112	500	2500	1500
Pododesmus macroschisma	16	32	28	0	0	0	0	0	0
Prototnaca staminea	25	25	25	0	0	0	0	0	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia									
Balanus cariosus	0.7	32	30	15	12	10	35	3	1.9
B. glandula	54	20	100	100	50	25	50	80	40
Chthamulus dalli	75	5	2	14	48	30	1200	4	2.5

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is. (24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 2 cont'd									
FAUNA cont'd									
PHYLUM Arthropoda cont'd Subclass Malacostraca Order Isopoda									
Gnorimosphaeroma sp.	256	200	90	0	0	0	0	0	0
unidentified species	0	0	0	0	320	200	0	0	0
Order Amphipoda									
unidentified species	324	340	300	0	250	200	0	0	0
Order Decapoda									
Cancer productus	0	<1	0	0	0	0	0	0	0
Hemigrapsus nudus	0	0	0	0	128	160	0	16	0
H. oregonensis	0	20	0	48	80	160	0	0	0
Lophopanopeus bellus	0	25	0	0	0	0	0	0	0
Pagurus sp.	320	0	0	0	90	112	0	48	48
Petrolisthes cinctipes	160	130	90	0	40	80	0	0	0
PHYLUM Echinodermata Class Asteroidea									
Evasterias troschelli	0	0	0	0	0	0	<1	0	0
Patiria miniata	<1	0	0	0	0	0	0	0	0
Pisaster ochraceus	<1	<1	0	0	0	0	0	0	0
FLORA									
PHYLUM Chlorophyta									
Cladophora sp.	0	0	0	10	10	20	0	0	0
Enteromorpha sp.	30	0	0	0	0	0	<5	<5	<5
Ulva sp.	<5	<5	<5	<5	<5	<5	<5	<5	<5

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 2 cont'd									
FLORA cont'd									
PHYLUM Phaeophyta									
Fucus distichus	<5	<1	<1	75	75	50	75	80	50
Leathesia difformis	<5	<1	0	<5	0	0	<5	<5	0
Scytosiphon lomentaria	0	0	0	0	0	0	<5	0	0
PHYLUM Rhodophyta									
Ceramium sp.	0	<5	<5	0	0	0	0	0	0
Cryptosiphonia woodii	0	0	40	0	0	5	0	0	0
Endocladia muricata	5	5	5	0	0	0	0	0	0
Gastroclonium coulteri	0	<1	0	0	0	0	0	0	0
Gelidium robustum	0	<1	0	0	0	0	0	0	0
Gigartina sp.	<5	<5	<5	0	<5	<5	0	0	0
Gloiopeltus furcata	0	0	0	<5	0	0	0	0	0
Gracilaria sjoestedii	0	1	0	0	0	0	0	0	0
Halosaccion glandiforme	<5	0	0	0	0	0	0	0	0
Hildenbrandia sp.	0	<5	0	<5	10	5	<5	10	<5
Lomentaria hakodatensis	0	0	10	0	0	0	0	0	0
Neoagardhiella baileyi	0	<5	<5	0	0	0	0	0	0
Ralfsia sp.	0	0	0	0	<5	0	0	<5	<5

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 3									
FAUNA									
PHYLUM Porifera									
Haliclona permollis	0	0	0	<1	<5	<5	0	0	0
unidentified species	0	0	0	0	0	<5	0	0	0
PHYLUM Cnidaria Class Anthozoa Order Actinaria									
Tealia coriacea	<1	<1	<1	0	0	0	0	0	0
PHYLUM Annelida Class Polychaeta									
Serpula vermicularis	<1	<1	<5	10	5	<5	0	0	0
Spirorbis sp.	0	0	5	10	10	20	0	10	0
PHYLUM Mollusca Class Amphineura									
Mopalia lignosa	0	0	<1	<1	0	0	0	0	0
Tonicella sp.	0	0	0	0	0	0	<1	0	16
Class Gastropoda Subclass Prosobranchia									
Astraea gibberosa	0	0	0	0	5	1	0	0	0
Bittium sp.	0	<1	16	300	16	0	0	0	0
Collisella digitalis	0	0	0	0	32	0	48	0	0
C. pelta	48	0	0	16	0	0	480	0	0
Crepipatella lingulata	0	0	32	0	0	48	0	0	0
Homolapoma lurida	0	0	0	1700	500	500	0	0	0
Lirularia succincta	0	0	0	0	0	16	0	0	0
Notoacmea persona	0	0	48	16	32	0	0	0	32
N. scutum	0	<1	16	0	48	0	0	48	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd									
FAUNA cont'd									
PHYLUM Mollusca Subclass Prosobranchia cont'd									
Ocenebra interfossa	0	0	0	0	16	<1	0	0	0
Searlesia dira	48	<1	16	136	80	80	16	16	0
Tegula funebralis	0	0	0	0	160	48	0	0	0
Thais emarginata	0	0	0	80	0	0	0	0	0
Vermetus compactus	0	<1	10	5	5	5	0	0	0
Class Bivalvia									
Hiatella arctica	0	0	0	0	0	<1	0	0	0
Kellia laperousi	0	0	0	0	0	16	0	0	0
Mytilus edulis	0	0	0	160	150	160	2500	2000	2000
Pododesmus macroschisma	352	100	90	0	16	80	0	0	0
PHYLUM Sipuncula									
Phascolosoma agassizii	16	16	16	16	16	16	0	0	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia									
Balanus cariosus	3	25	10	3	100	20	6	10	15
B. glandula	0.7	16	20	120	500	40	25	40	20
Chthamulus dalli	0.5	1	1	23	25	15	6	5	3
Subclass Malacostraca Order Isopoda									
unidentified species	0	0	0	200	300	250	0	0	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd									
FAUNA cont'd									
PHYLUM Arthropoda Class Crustacea Subclass Malacostraca cont'd Order Amphipoda									
unidentified species	0	0	0	200	300	150	50	0	0
Order Decapoda									
Cancer productus	0	0	<1	0	0	0	0	0	0
Hemigrapsus nudus	0	0	0	0	0	0	0	0	90
H. oregonensis	0	0	0	200	144	0	0	0	0
Lophopanopeus bellus	160	0	0	0	0	0	0	0	0
Pagurus sp.	0	<1	0	240	192	96	0	48	0
Petrolisthes eriomerus	160	80	16	160	48	16	0	0	0
PHYLUM Bryozoa									
unidentified species	0	<1	<5	10	0	0	0	0	0
PHYLUM Echinodermata Class Asteroidea									
Dermasterias imbricata	0	0	<1	<1	1	<1	<1	<1	0
Evasterias troschelli	0	0	0	0	0	0	0	<1	0
Leptasterias hexactis	0	0	0	0	64	64	0	0	0
Orthasterias koehleri	0	0	0	<1	<1	0	0	0	0
Patiria miniata	<1	<1	<1	2	2	2	0	0	0
Pisaster ochraceus	0	<1	<1	0	2	<1	0	0	<1
Pycnopodia helianthoides	0	0	0	0	0	<1	0	0	0
Solaster dawsoni	0	0	0	<1	<1	0	0	0	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd									
FAUNA cont'd									
PHYLUM Chordata Subphylum Craniata Class Osteichthys									
blenny	0	0	0	0	0	0	<1	<1	<1
FLORA									
PHYLUM Spermatophyta									
Zostera marina	90	90	90	0	0	0	0	0	0
PHYLUM Chlorophyta									
Cladophora sp.	0	0	0	0	<5	0	<5	<5	<5
Codium fragile	0	0	0	<5	<5	<5	0	0	0
Enteromorpha sp.	0	<5	<5	<5	40	<5	<5	<5	40
Rhizoclonium riparium	0	0	<5	0	0	0	0	0	0
Spongomorpha sp.	<5	<5	0	<5	0	0	0	0	0
Ulva sp.	<1	<5	<5	50	30	<5	60	40	10
PHYLUM Phaeophyta									
Colpomenia sinuosa	0	0	0	0	0	<5	0	0	<5
Fucus distichus	0	0	<5	<1	10	0	<5	<5	20
Leathesia difformis	<1	20	<5	<5	10	<5	<5	40	<5
Sargassum muticum	0	0	0	0	0	0	<5	0	0
Scytosiphon lomentaria	<1	0	0	<5	0	0	0	0	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 3 cont'd									
FLORA cont'd									
PHYLUM Rhodophyta									
Corallina sp.	0	0	0	<5	40	<5	5	<5	0
Cryptosiphonia woodii	<1	<1	10	0	<5	0	10	5	<5
Endocladia muricata	0	0	0	0	0	5	0	0	<5
Gastroclonium coulteri	0	0	<5	0	<5	0	15	<5	0
Gelidium robustum	0	10	<5	<5	<5	0	0	<5	0
Gigartina sp.	<5	5	<5	50	<5	<5	<5	10	<5
Halosaccion glandiforme	<1	<1	0	5	<5	0	<5	<5	0
Hildenbrandia sp.	0	5	0	0	10	<5	<5	10	<5
Lithothamnion sp.	40	5	5	5	10	<5	<5	<5	<5
Petrocelis sp.	0	0	0	0	0	0	<5	<5	<5
Pterosiphonia bipinnata	0	0	0	<5	<5	<5	0	0	0
Ralfsia sp.	0	0	5	0	0	0	0	<5	<5
Rhodomela larix	0	<5	<5	<5	0	0	<5	10	5
Smithora sp.	50	0	0	0	0	0	0	0	0
ZONE 4									
FAUNA									
PHYLUM Cnidaria Class Anthozoa Order Actinaria									
Tealia coriacea	0	0	0	0	<1	0	0	0	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd									
FAUNA cont'd									
PHYLUM Annelida Class Polychaeta									
Serpula vermicularis	<1	<1	5	5	5	5	<1	<1	<5
Spirorbis sp.	5	5	10	5	<5	<5	<5	<5	20
PHYLUM Mollusca Class Amphineura									
Mopalia sp.	0	<1	<1	0	0	0	<1	3	2
Tonicella lineata	0	0	<1	0	0	0	0	0	0
Class Gastropoda Subclass Opisthobranchia									
Diaulula sandiegensis	0	0	0	0	0	0	0	<1	0
Subclass Prosobranchia									
Acmaea mitra	0	0	0	<1	0	0	0	0	0
Amphissa columbiana	0	0	0	1000	900	350	96	48	48
Astraea gibberosa	10	8	7	20	17	6	0	0	0
Bittium eschrichtii	0	0	16	0	16	0	0	0	0
Ceratostoma foliata	0	0	0	<1	0	0	0	0	0
Crepipatella lingulata	0	0	32	0	0	0	0	0	32
Homalopoma lurida	0	0	0	1500	160	160	0	0	0
Notoacmea scutum	0	0	0	0	0	0	0	0	48
Ocenebra interfossa	0	<1	16	0	32	0	0	0	0
Searlesia dira	<1	<1	<1	0	16	16	16	48	16
Tegula funebralis	0	0	0	0	0	0	0	112	0
Thais emarginata	0	0	0	80	0	0	0	0	0
Vermetus compactus	<1	<1	20	<5	20	<5	5	5	10

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd									
FAUNA cont'd									
PHYLUM Mollusca cont'd Class Bivalvia									
Hiatella arctica	0	0	0	0	0	0	48	0	0
Pododesmus macroschisma	96	80	90	0	0	0	0	0	0
PHYLUM Sipuncula									
Phascolosoma agassizii	16	16	16	0	0	0	0	0	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia									
Balanus cariosus	0	2	15	0	3	5	0	20	20
B. glandula	0.7	4	2	0.7	8	7	0	40	25
Chthamulus dalli	100	90	54	0	0	0	2	9	10
Subclass Malacostraca Order Decapoda									
Cancer sp.	0	0	0	<1	0	0	0	0	0
Hemigrapsus oregonensis	0	0	0	0	0	0	160	48	0
Lophopanopeus bellus	80	72	0	0	0	0	0	0	0
Pagurus sp.	96	16	0	320	90	0	240	48	32
Petrolisthes eriomerus	0	200	16	80	112	0	80	48	16
Pugettia sp.	48	0	0	<1	0	0	16	<1	0
PHYLUM Bryozoa									
unidentified species	<5	5	<5	5	5	0	5	20	15

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd									
FAUNA cont'd									
PHYLUM Echinodermata Class Asteroidea									
Dermasterias imbricata	0	<1	0	<1	<1	0	0	1	1
Evasterias troschellii	0	0	<1	<1	<1	0	0	0	0
Orthasterias koehleri	<1	<1	<1	<1	<1	<1	0	0	0
Patiria miniata	11	5	6	10	14	8	7	4	7
Pisaster brevispinus	<1	0	0	0	0	<1	0	0	0
P. ochraceus	<1	<1	<1	<1	0	0	0	0	0
Pycnopodia helianthoides	0	0	0	0	<1	<1	0	<1	<1
Class Echinoidea									
Strongylocentrotus droebachiensis	0	0	0	<1	0	0	0	0	0
Class Holothuroidea									
Cucumaria miniata	1	1	5	6	4	3	0	4	3
Parastichopus californicus	0	0	0	0	<1	0	0	<1	0
PHYLUM Chordata Subphylum Craniata Class Osteichthys									
blenny	0	1	0	1	16	0	0	0	0
Clinocottus sp. OR									
Oligocottus sp.	0	0	0	0	16	0	0	16	0

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is.(24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 4									
FLORA									
PHYLUM Chlorophyta									
Bryopsis plumosa	0	0	0	<1	0	0	0	0	0
Cladophora sp.	0	<1	0	0	0	0	0	<5	0
Enteromorpha sp.	<5	<5	0	0	0	0	0	<5	0
Spongomorpha sp.	<5	0	0	0	0	0	<5	0	0
Ulva sp.	<5	<5	<5	<1	<5	<5	<5	<5	10
Urospora urothrix	0	0	0	0	0	0	0	10	0
PHYLUM Phaeophyta									
Colpomenia sinuosa	0	0	0	0	0	0	0	0	<5
Leathesia difformis	<5	0	0	0	10	0	0	60	0
Macrocystis integrifolia	0	0	0	50	50	50	20	30	20
Sargassum muticum	<1	<1	<5	<1	0	0	<5	<5	<5
Scytosiphon lomentaria	0	0	0	<1	0	0	<5	0	0
PHYLUM Rhodophyta									
Ahnfeltia plicata	<5	0	0	0	0	0	0	0	0
Corallina sp.	0	0	0	5	<5	<5	<5	<5	<5
Cryptosiphonia woodii	5	0	0	0	0	0	0	0	0
Gastroclonium coulteri	10	0	0	0	0	0	<5	20	5
Gelidium robustum	<5	10	<5	30	30	<5	0	<5	<5
Gigartina exasperata	0	0	0	0	0	0	10	10	0
Gigartina sp.	30	10	0	0	0	0	<5	<5	10
Halosaccion glandiforme	<5	0	0	0	0	0	0	0	0
Hildenbrandia sp.	10	10	10	10	10	10	<5	10	<5
Lithothamnion sp.	10	30	30	30	30	<5	<5	10	5

Table 10 cont'd

Exposure	Sheltered								
Substrate	Cobble			Rock					
Sample site	Hand Is. (43)			Keith Is. (5)			Nettle Is. (24)		
Date	May	July	Oct.	May	July	Oct.	May	July	Oct.
ZONE 4 cont'd									
FLORA cont'd									
PHYLUM Rhodophyta cont'd									
Neoagarhiella baileyi	0	0	0	0	0	0	5	0	0
Ralfsia sp.	0	5	0	0	10	10	0	0	<5
Rhodomela larix	30	0	0	0	0	0	0	10	<5

Table 11. Seasonal observations of fauna and flora recorded at a subtidal exposed rocky habitat, Elbow Islets (46), Broken Group Islands (1977).

Table 11

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA				
PHYLUM Porifera				
Sponges (unidentified species)	0	-	0	0.2
PHYLUM Cnidaria Class Hydrozoa				
hydroids (unidentified species)	4.2	-	0.2	2.2
Class Scyphozoa				
Stauromedusa	0	-	2	0.6
Class Anthozoa				
Balanophyllia elegans	0	-	244	87
Epiactis prolifera	0.8	-	0.2	2.6
Metridium senile	0.8	-	0.2	0.6
Tealia lofotensis	0.2	-	0	0
T. crassicornis	0	-	0.2	0
PHYLUM Annelida Class Polychaeta				
Dodecaceria fewkesi	20	-	30	55
Eudistylia vancouveri	1.6	-	0	0
Serpula vermicularis	1.6	-	0.4	0.8
PHYLUM Mollusca Class Amphineura				
Placiphorella velata	0.2	-	0	0
Tonicella sp.	6.8	-	9.4	10.4

Table 11 cont'd

Species	Zone 1 May	Zone 1 July	Zone 2 May	Zone 2 July
FAUNA cont'd				
PHYLUM Mollusca cont'd Class Gastropoda Subclass Prosobranchia				
Acmaea mitra	5.4	-	2.6	2.6
Amphissa columbiana	0	-	1.2	0.2
Astraea gibberosa	0.2	-	0.2	0.4
Calliostoma ligatum	2.0	-	3.4	1.6
Ceratostoma foliata	4.6	-	0	0.2
Diodora aspera	0	-	0.6	0.4
Haliotis kamtschatkana	1.2	-	2.4	0.4
Homalopoma sp.	0	-	0	1.6
Notoacmea scutum	0	-	0	0.2
Tegula pulligo	1.8	-	0.2	0.4
Subclass Opisthobranchia				
Hermissenda crassicornis	0.8	-	1	0.8
Class Bivalvia				
Hinnites giganteus	0	-	0	0.2
PHYLUM Arthropoda Class Crustacea Subclass Malacostraca Order Decapoda Suborder Reptantia Section Anomura				
Pagurus sp.	0.2	-	0.8	0.6
Cryptolithodes sitchensis	0.2	-	0	0
PHYLUM Ectoprocta				
bryozoans (unidentified species)	1	-	0.8	5.2

Table 11 cont'd

Species	Zone 1 May	Zone 1 July	Zone 2 May	Zone 2 July
FAUNA cont'd				
PHYLUM Echinodermata Class Holothuroidea				
Eupentacta quinquesemita	0	-	0.2	1
Class Ophiuroidea				
Ophiopholis sp.	0	-	0	0.2
Class Asteroidea				
Dermasterias imbricata	1	-	0	0.2
Henricia leviuscula	0.4	-	0.2	0.2
Orthasterias koehleri	0.4	-	0	0.2
Pycnopodia helianthoides	0.2	-	0.2	0.2
Solaster stimpsoni	0	-	0	0.2
Class Echinoidea				
Strongylocentrotus droebachiensis	0.4	-	0	0
S. franciscanus	0.4	-	2	3.6
PHYLUM Chordata Subphylum Urochordata				
Metandrocarpa taylori	0	-	2.2	0.2
Styela montereyensis	0.4	-	0	0.2
Compound ascidians (unidentified species)	1.6	-	4.4	0.6
Subphylum Craniata Class Osteichthyes				
Jordania zanope	0	-	0.2	2

Table 11 cont'd

Species	Zone 1 May	Zone 1 July	Zone 2 May	Zone 2 July
FLORA				
PHYLUM Chlorophyta				
Codium setchellii	0	-	3	0.2
Halicystus ovalis	0	-	1	0.6
PHYLUM Phaeophyta				
Alaria marginata	9	-	0	0
Costaria costata	1	-	0	0
Desmarestia ligulata	21	-	0.2	0
Laminaria setchellii	8	-	0	0
Nereocystis luetkeana	7	-	0	0
Ralfsia sp.	0	-	6.5	8
PHYLUM Rhodophyta				
Bossiella sp.	0	-	2.4	0.2
Calliarthron sp.	1	-	0	0.2
Corallina sp.	1	-	0	0
Fauchea sp.	0	-	0.2	0.2
Hildenbrandia sp.	0	-	15	15
Lithothamnion spp.	57	-	46	77
Opuntiella californicus	1	-	0.6	0
Polysiphonia sp.	3	-	0	0.2
unidentified red algae	1	-	0	0.4

Table 12. Seasonal observations of fauna and flora recorded at subtidal semi-exposed gravel and shell shores with isolated boulders, Clarke Island (22), Broken Group Islands (1977).

Table 12

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA				
PHYLUM Cnidaria Class Hydrozoa				
hydroids (unidentified species)	0.4	0.4	0	0
Class Anthozoa				
Balanophyllia elegans	13	0	0	0
Tealia coriacea	0.2	0	0	0
T. crassicornis	0	0.2	0	0
PHYLUM Annelida Class Polychaeta				
Dodecaceria fewkesi	12	0.4	0	0
Serpula vermicularis	0.8	0.6	0	0
Spirorbis sp.	0.2	0	0	0
unidentified polychaetes	0	0	1	5
PHYLUM Mollusca Class Amphineura				
Tonicella sp.	2	0	0	0
Class Gastropoda Subclass Prosobranchia				
Acmaea mitra	3.4	1.2	0	0
Astraea gibberosa	5.2	8	0	0
Calliostoma ligatum	0.4	0	0	0
Ceratostoma foliata	0.4	0	0	0
Crepidula adunca	0	0.6	0	0
Diodora aspera	0.4	0	0	0
Haliotis kamtschatkana	0.2	0.2	0	0
Polinices lewisii	0	0	0	0.2
Searlesia dira	0	0	0	0.2
Tegula pulligo	4.8	2.8	0	0
Vermetus sp.	0.2	0	0	0

Table 12 cont'd

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA cont'd				
PHYLUM Mollusca cont'd				
Class Gastropoda				
Subclass Opisthobranchia				
Archidoris montereyensis	0.4	0	0	0
Diaulula sandiegensis	0.4	0	0	0
Class Bivalvia				
Pododesmus macroschisma	0.2	0	0	0
PHYLUM Arthropoda				
Class Crustacea				
Subclass Malacostraca				
Order Decapoda				
Suborder Reptantia				
Section Anomura				
Pagurus sp.	0.8	3	0.2	0
Scyra acuifrons	2.6	1	0	0
Section Brachyura				
Cancer productus	0	0.2	0	0
C. oregonensis	0	0.2	0	0
PHYLUM Ectoprocta				
bryozoans	0.6	0.8	0	0
PHYLUM Echinodermata				
Class Holothuroidea				
Cucumaria miniata	1.4	1.4	0	0
Eupentacta quinquesemita	0.2	0	0	0
Parastichopus californicus	0	0.2	0	0
Class Ophiuroidea				
Ophiopholis sp.	0	0.2	0	0

Table 12 cont'd

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA cont'd				
PHYLUM Echinodermata cont'd Class Asteroidea				
Henricia leviuscula	0.2	0	0	0
Patiria miniata	0.2	0.2	2.2	4.4
Pycnopodia helianthoides	0	0.2	0	0
PHYLUM Chordata Subphylum Urochordata				
Boltenia villosa	0.2	0	0	0
Compound ascidians	0.6	1	0	0
Subphylum Craniata Class Osteichthyes				
sculpin (unidentified species)	0.2	0.4	0	0
FLORA				
PHYLUM Chlorophyta				
Enteromorpha sp.	0	0	0.2	0
Ulva sp.	0.2	0	0.8	0
PHYLUM Phaeophyta				
Macrocystis integrifolia	72	34	0	0
Neoagardhiella baileyi	0	0	0.4	1
Ralfsia sp.	8.4	9	0	0

Table 12 cont'd

Species	Zone 1		Zone 2	
	May	July	May	July
FLORA cont'd				
PHYLUM Rhodophyta				
Bossiella sp.	6.2	10	0	0
Calliarthron sp.	2	4.2	0	0
Corallina sp.	3.2	7.2	0	0
Gelidium robustum	5.2	14.2	0	0
Hildenbrandia sp.	6.2	16	0	0
Lithothamnion spp.	69	47	0	0
Polysiphonia spp.	0	0	0	0.2
epiphytic red algae	0	0	0	0.2

Table 13. Seasonal observations of fauna and flora recorded at subtidal cobble, boulder and rock shores, Gibraltar Island (7), Broken Group Islands (1977).

Table 13

Species	Zone 1		Zone 2		Zone 3	
	May	July	May	July	May	July
FAUNA						
PHYLUM Cnidaria Class Hydrozoa						
hydroids (unidentified species)	0	0	0.6	0	2.2	1.4
Class Anthozoa						
Pachycerianthus fimbriatus	0	0	0.2	0.2	2	1.6
PHYLUM Annelida Class Polychaeta						
Serpula vermicularis	1.8	3.2	1	0.4	0	1
Spirorbis sp.	+	0.6	0.8	0	0	1
PHYLUM Mollusca Class Amphineura						
Lepidozona sp.	0	0.2	0	0.2	0	0
Tonicella sp.	3.4	0	1.2	0.4	0.2	0
Class Gastropoda Subclass Prosobranchia						
Acmaea mitra	1	0	0.4	0.6	0	0
Astraea gibberosa	6.2	1.8	1	0.2	0	0
Calliostoma ligatum	0	1	0	0	0	0
Ceratostoma foliata	0	0.2	0.2	0	0	0
Diodora aspera	0.8	0	0	0	0	0
Homalopoma luridum	0	0	0	2.6	0	0
Margarites pupillus	0.6	0	0	0	0	0
Tegula pulligo	0.2	0.2	2	0.4	0	0
Vermetus sp.	1	1.4	0	0	0	0
Subclass Opisthobranchia						
Cadlina luteomarginata	0	0	0.2	0	0	0
Diaulula sandiegensis	0	0.4	0	0	0	0
Hermissenda crassicornis	0	0	0	0.2	0	0
Triopha carpenteri	0	0	0	0.2	0	0

Table 13 cont'd

Species	Zone 1		Zone 2		Zone 3	
	May	July	May	July	May	July
FAUNA cont'd						
PHYLUM Mollusca cont'd Class Bivalvia						
Hiatella arctica	0.2	0	0	0	0	0
Hinnites giganteus	0.2	0	0	0	0	0
Pododesmus macroschisma	0	0	5.4	0.2	0	0.2
PHYLUM Sipuncula						
Phascolosoma agassizii	0	0.2	0	0	0	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia						
Balanus glandula	2.2	0	0	0	0	0
Subclass Malacostraca Order Decapoda Suborder Reptantia Section Anomura						
Pagurus sp.	0.2	1.4	0.4	0.2	0	0
Petrolisthes sp.	0.8	0	0	0	0	0
Scyra acutifrons	0	1.3	0	0	0	0
Section Brachyura						
Cancer productus	0	0.2	0	0	0	0
PHYLUM Ectoprocta						
bryozoans	50	50	2.8	2.6	0	0.2
PHYLUM Echinodermata Class Holothuroidea						
Cucumaria miniata	12.8	2.6	0	0	0	0
Parastichopus californicus	0.2	0.6	0.4	0.4	0.4	0.2

Table 13 cont'd

Species	Zone 1		Zone 2		Zone 3	
	May	July	May	July	May	July
FAUNA cont'd						
PHYLUM Echinodermata cont'd Class Ophiuroidea						
Ophiopholis sp.	1.6	0	0.2	0	0	0
Class Asteroidea						
Dermasterias imbricata	0.6	0.4	0	0	0	0
Evasterias troschelii	0	0	0.2	0	0	0
Henricia leviuscula	0	0	0	0.2	0	0
Orthasterias koehleri	0.2	0.2	0.2	0	0	0
Pisaster brevispinus	0	0	0.4	0.2	0	0
Pycnopodia helianthoides	0.2	0.4	0	0.2	0	0
Solaster stimpsoni	0	0.2	0	0	0	0
Stylasterias forreri	0	0	0	0	0.2	0
PHYLUM Chordata Subphylum Urochordata						
Ascidia paratropa	0	0	0	0	0.2	0.2
Clavelina huntsmani	0.2	0.6	0	0	0	0
Pyura haustor	0.4	0	0.2	0	0	0
Subphylum Craniata Class Osteichthyes						
Coryphopterus nicholsi	0.4	0.8	0	0.4	0	0
blenny (unidentified species)	0	0	0.2	0	0	0
sculpin (unidentified species)	0.4	0	0	0	0	0

Table 13 cont'd

Species	Zone 1		Zone 2		Zone 3	
	May	July	May	July	May	July
FLORA						
PHYLUM Chlorophyta						
Bryopsis plumosa	0.4	0	0	0	0	0
Cladophora sp.	0	0.2	0	0	0	0
Ulva sp.	4.4	0	0	0	0	0
PHYLUM Phaeophyta						
Agarum fimbriatum	0	0.2	24	63	0	2.2
Colpomenia sinuosa	0.4	0	0	0	0	0
Desmarestia viridis	0	0.4	0	0.2	0	0
Eisenia arborea	1	0.2	10.2	6	0	0
Haplogloia andersoni	0	0.2	0	0	0	0
Leathesia difformis	0	3	0	0	0	0
Macrocystis integrifolia	0	9	0	0	0	0
Ralfsia sp.	5	5	0	0	0	0
Sargassum muticum	0.2	0.4	0.2	0	0	0
Scytosiphon lomentaria	2.4	0	0	0	0	0
PHYLUM Rhodophyta						
Botryocladia pseudodichotoma	0	0	0	0.2	0	0.2
Corallina sp.	12.2	13	0	0	0	0
Gelidium robustum	14.2	30	0	0	0	0
Gigartina sp.	0	0	0	0.2	0	0.2
Hildenbrandia spp.	10	11	0	2.2	0	0
Laurencia spectabilis	0	0	0.2	0	0	0
Lithothamnion sp.	22	26	9.2	16.5	0.8	1.2
Rhodoptilum plumosum	0	0.2	0	0.2	0	0
unidentified red algae	0	0.2	0	7	5.4	65

Table 14. Seasonal observations of fauna and flora recorded at a subtidal semi-exposed rocky habitat, Hand Island (12), Broken Group Islands (1977).

Table 14

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA				
PHYLUM Cnidaria Class Anthozoa				
Balanophyllia elegans	0	0	0.2	0
PHYLUM Annelida Class Polychaeta				
Dodecaceria fewkesi	0	0	0.2	0
Serpula vermicularis	0	0.4	0	0.2
Spirorbis sp.	0.8	0.6	0	0
PHYLUM Mollusca Class Amphineura				
Tonicella sp.	0.4	0.4	0.6	0
Class Gastropoda Subclass Prosobranchia				
Acmaea mitra	2.6	0.8	1	2.4
Astraea gibberosa	29.6	33.8	14.9	12.2
Ceratostoma foliata	0	0	0.2	0
Haliotis kamtschatkana	0	0	0.2	0
Homalopoma luridum	0.6	0	0	0.4
Notoacmea scutum	0	0.4	0	1
Tegula pulligo	0	0	19.2	1.6
Vermetus sp.	0.2	0.6	0	2
Subclass Opisthobranchia				
Diaulula sandiegensis	0.2	0	0	0
Class Bivalvia				
Chlamys sp.	0.2	0	0	0
Pododesmus macroschisma	0.4	0	0	0

Table 14 cont'd

Species	Zone 1 May	Zone 1 July	Zone 2 May	Zone 2 July
FAUNA cont'd				
PHYLUM Arthropoda Class Crustacea Subclass Malacostraca Order Decapoda Suborder Reptantia Section Anomura				
Pagurus sp.	0.4	0.8	0	0.2
Petrolisthes sp.	0.4	0.2	0	0
Scyra acutifrons	0	0	0	0.2
Section Brachyura				
Cancer productus	0.2	0	0	0
C. oregonensis	0	0	0.8	0
PHYLUM Ectoprocta				
bryozoans (unidentified species)	2.8	0.4	0	0.2
PHYLUM Echinodermata Class Holothuroidea				
Parastichopus californicus	1	0.8	0.8	0.2
Class Asteroidea				
Patiria miniata	0	0.2	0	0
Solaster stimpsoni	0.2	0	0	0
PHYLUM Chordata Subphylum Urochordata				
Boltenia villosa	0	0	0.2	0
Metandrocarpa taylori	0	0	1.2	0
Pyura haustor	0	0.2	0	0

Table 14 cont'd

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA cont'd				
PHYLUM Chordata cont'd Subphylum Craniata Class Osteichthyes				
sculpin (unidentified species)	0	0.2	0	0.2
FLORA				
PHYLUM Phaeophyta				
Leathesia difformis	0	0.2	0	0
Macrocystis integrifolia	0	0	82	60
Ralfsia sp.	5	5	2	5
PHYLUM Rhodophyta				
Bossiella sp.	0	0	0	0.2
Calliarthron sp.	6	0.4	1	0
Gelidium robustum	88	48	0.6	6
Hildenbrandia sp.	8.5	13	0.6	1.2
Lithothamnion sp.	3.2	5	32.2	24

Table 15. Seasonal observations of fauna and flora recorded at a subtidal sheltered sand and mud flats, Jaques Island (5), Broken Group Islands (1977).

Table 15

Species	Zone 1 May	Zone 1 July	Zone 2 May	Zone 2 July
FAUNA				
PHYLUM Cnidaria				
Class Anthozoa				
Pachycerianthus fimbriatus	0.6	0.2	2.4	0.2
PHYLUM Annelida				
Class Polychaeta				
Spirorbis sp.	1	0	0	0.4
unidentified polychaetes	0	0	0.8	0
PHYLUM Mollusca				
Class Gastropoda				
Subclass Prosobranchia				
Astraea gibberosa	0.2	0	0	0
Polinices lewisii	0.2	0	0	0
Subclass Opisthobranchia				
Dendronotus sp.	0	0	0.2	0
Diaulula sandiegensis	0	0	0.2	0
Class Bivalvia				
Panope generosa	0	0	0	0.4
Tresus capax	0	0.4	0	0
PHYLUM Arthropoda				
Class Crustacea				
Subclass Malacostraca				
Order Decapoda				
Suborder Reptantia				
Section Brachyura				
Cancer productus	0.2	0	0	0

Table 15 cont'd

Species	Zone 1		Zone 2	
	May	July	May	July
FAUNA cont'd				
PHYLUM Echinodermata Class Asteroidea				
Patiria miniata	1	0.2	0	0
Pisaster brevispinus	0	0	0	0.2
Pycnopodia helianthoides	0.2	0	0	0
PHYLUM Chordata Subphylum Urochordata				
Compound ascidians	0	0	0.8	0
FLORA				
PHYLUM Spermatophyta				
Zostera marina	54	43	0	0
PHYLUM Phaeophyta				
Costaria costata	0	0	0	1
Laminaria saccharina	0	0	26.2	39
Desmarestia aculeata	0	0	17.9	0.2
PHYLUM Rhodophyta				
Ceramium sp.	0	0.4	0	0.6
Gracilaria verrucosa	0	0	0.2	0
Griffithsia pacifica	0	0	0	0.6
Lithothamnion sp.	0	0	0.4	0
Rhodoptilum plumosum	0	0	0.6	0
Smithora naiadium	1	0	0	0
unidentified epiphytic reds	0	0	0.4	0

Table 16. Seasonal observations of fauna and flora recorded at a subtidal sheltered sand, mud, gravel and shell habitat, Turtle Island (1), Broken Group Islands (1977).

Table 15

Species	Zone 1		Zone 2		Zone 3		Zone 4	
	May	July	May	July	May	July	May	July
FAUNA								
PHYLUM Porifera								
sponges (unidentified species)	0	0	0	0	0	0.4	0	0
PHYLUM Cnidaria Class Hydrozoa								
hydroids (unidentified species)	0	0	0	0	0	0	0.4	0
Class Anthozoa								
Pachycerianthus fimbriatus	0.4	0	0.2	0.4	0	0	1.2	0
PHYLUM Annelida Class Polychaeta								
Serpula vermicularis	0	0	0	0	0.8	1	0	0
Spirorbis sp.	0	0	0	0	0.4	0.6	0	0
unidentified polychaetes	0	0	0	0	0	0	90	90
PHYLUM Mollusca Class Amphineura								
Tonicella sp.	0	0	0	0	1.2	0.6	0	0

Table 16 cont'd

Species	Zone 1		Zone 2		Zone 3		Zone 4	
	May	July	May	July	May	July	May	July
FAUNA cont'd								
PHYLUM Mollusca cont'd								
Class Gastropoda								
Subclass Prosobranchia								
Margarites pupillus	0	0	0	0	0.2	0	0	0
Tegula pulligo	0	0	0	0	0	0.2	0	0
Vermetus sp.	0	0	0	0	0.2	0.6	0	0
Subclass Opisthobranchia								
Archidoris odhneri	0	0	0	0	0.2	0	0	0
Cadlina luteomarginata	0	0	0	0	0	0.2	0	0
Diaulula sandiegensis	0	0	0	0	0	0.2	0	0
Class Bivalvia								
Pododesmus macroschisma	0	0	0	0	7.6	2.2	0	0.2
Tresus capax	2.4	0.2	0	0	0	0	0	0
PHYLUM Arthropoda								
Class Crustacea								
Subclass Cirripedia								
Balanus glandula	0.2	1.2	0	0	2.2	4.2	0	0
Subclass Malacostraca								
Order Decapoda								
Suborder Reptantia								
Section Brachyura								
Cancer productus	0	0	0	0.2	0	0	0	0

Table 16 cont'd

Species	Zone 1		Zone 2		Zone 3		Zone 4	
	May	July	May	July	May	July	May	July
FAUNA cont'd								
PHYLUM Ectoprocta								
bryozoans (unidentified species)	0	0	0	0	1	0.6	0	0.2
PHYLUM Echinodermata Class Holothuroidea								
Eupentacta quinquesemita	0	0	0	0	1	0.2	0	0
Parastichopus californicus	0	0	0	0	0	0.2	0	0
Psolus chitonoides	0	0	0	0	0.2	0	0	0
Class Ophiuroidea								
Ophiopholis sp.	0	0	0	0	0	0.2	0	0
Class Asteroidea								
Dermasterias imbricata	0.2	0	0	0	0	0.2	0	0
Evasterias troschelii	0.4	0	0	0	0	0	0	0
Orthasterias koehleri	0	0	0.2	0	0	0	0	0
Patiria miniata	4.4	2.2	0	0	0	0	0	0
Pisaster brevispinus	0.2	0.2	0.2	0.2	0	0	0	0
Pteraster tesselatus	0	0	0	0	0.2	0	0	0
Pycnopodia helianthoides	0	0	0.2	0.4	0	0	0	0

Table 16 cont'd

Species	Zone 1		Zone 2		Zone 3		Zone 4	
	May	July	May	July	May	July	May	July
FAUNA cont'd								
PHYLUM Chordata Subphylum Urochordata								
Boltenia villosa	0	0	0	0	0.8	0	0	0
Chelyosoma producta	0	0	0	0	0.2	0	0	0
Clavelina huntsmani	0	0	0	0	0.4	2.4	0	0
Corella willmeriana	0	0	0	0	0	0.2	0	0
Metandrocarpa taylori	0	0	0	0	5.2	3	0	0
compound ascidians (unidentified species)	0	0	0	0	0.4	0.6	0	0
Subphylum Craniata Class Osteichthyes								
Coryphopterus nicholsi	0	0.4	0	0	0.2	0	0	0
sanddab	0	0	0	0	0.2	0	0	0
FLORA								
PHYLUM Chlorophyta								
Cladophora sp.	0	0	0	0	0	8	0	0
Enteromorpha sp.	0	0.4	0	0	0	0	0	0

Table 16 cont'd

Species	Zone 1		Zone 2		Zone 3		Zone 4	
	May	July	May	July	May	July	May	July
FLORA cont'd								
PHYLUM Phaeophyta								
Agarum fimbriatum	0	0	0	0	54	28	0	0
Desmarestia viridis	0	0	0.2	0.2	0	0.2	0	0
Eisenia arborea	0	0	0	0	4.2	25	0	0
Haplogloia andersoni	0	0	0	0	0	0.2	0	0
Laminaria saccharina	0	0	23	51	0	3	0	0
Neoagardhiella baileyi	5	0.4	0.2	0	0	0	0	0
Sargassum muticum	0	0	0.2	0	0	0.2	0	0
PHYLUM Rhodophyta								
Botryocladia pseudodichotoma	0	0	0	0	1	0	0	0
Ceramium sp.	0	0.2	0	0	0	0.2	0	0
Corallina sp.	0	0	0	0	0.2	16	0	0
Hildenbrandia sp.	0	0	0	0	4	6	0	0
Gelidium robustum	0	0	0	0	0	1	0	0
Gigartina sp.	0	0	0	0	0	2	0	0
Gracilariopsis sjoestedtii	0	0	0	0	0	0	0	1
Griffithsia pacifica	0	0	0	0	0.2	0.2	0	0
Laurencia spectabilis	0	0	0	0	3.4	0	0	0
Lithothamnion spp.	0	0	0	0	8.2	20	0	0
Polysiphonia sp.	0	0	0	0	0	1	0	0
Rhodoptilum plumosum	0	0	0	0	2.2	0	0	1
unidentified red algae	0	0.4	0	0	+	2.2	0.2	2.2

Table 17. Fauna and flora observed on exposed gravel and cobble beaches, West Coast Trail Section (1977). (No./m^2)

Table 17

Site	2	3
ZONE 1		
FAUNA		
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia		
Notoacmea persona	32	0
Class Bivalvia		
Mytilus edulis	100	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia		
Balanus cariosus	75	0
B. glandula	5,000	0
Subclass Malacostraca Order Isopoda		
Exosphaeroma sp.	200	0
FLORA		
PHYLUM Chlorophyta		
Spongomorpha sp.	40	0
Ulva sp.	<5	0
PHYLUM Rhodophyta		
Gigartina sp.	5	0
Porphyra sp.	5	0

Table 17 cont'd

Site	2	3
ZONE 2		
FAUNA		
PHYLUM Mollusca Class Bivalvia		
Mytilus edulis	75	0
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia		
Balanus cariosus	75	0
Subclass Malacostraca Order Amphipoda		
unidentified species	200	0
FLORA		
PHYLUM Chlorophyta		
Spongomorpha sp.	50	0
Ulva sp.	<5	0
PHYLUM Phaeophyta		
Alaria marginata	60	0
Cymathere triplicata	10	0
PHYLUM Rhodophyta		
Hildenbrandia sp.	20	0

Table 18. Seasonal observations of fauna and flora recorded at exposed rocky shores, West Coast Trail Section (1977).

(Multiply No./m^2 of *Littorina scutulata*, *L. sitkana*, *Mytilus californianus*, *Balanus cariosus*, *B. glandula*, *Chthamulus dalli* and *Pollicipes polymerus* by 100.)

Table 18

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 2														
FAUNA														
PHYLUM Cnidaria														
Class Anthozoa														
Order Actinaria														
Anthopleura elegantissima	400	-	0	0	400	100	0	0	224	160	112	20	160	112
A. xanthogrammica	0	-	0	0	2	1	1	1	1	1	3	3	1	3
PHYLUM Mollusca														
Class Amphineura														
Mopalia sp.	0	-	0	0	<1	0	0	0	0	0	0	0	0	0
Class Gastropoda														
Order Prosobranchia														
Ceratostoma foliata	0	-	<1	<1	0	0	0	0	0	0	0	0	0	0
Collisella digitalis	240	-	0	112	336	200	368	0	224	160	112	48	320	0
C. pelta	32	-	96	64	48	100	16	100	0	0	0	0	112	240
Littorina scutulata	0.4	-	4	3.6	20	1	13	3	3	3.2	4	3.2	4	3.2
L. sitkana	7.4	-	32	30	100	10	31	31	24	13	22	13	26	5.6
Notoacmea persona	0	-	112	96	254	0	256	0	0	160	0	0	240	160
N. scutum	48	-	0	0	192	0	0	80	16	80	48	0	48	0
Tegula funebralis	0	-	0	0	0	0	48	0	32	400	48	16	0	0
Thais emarginata	0	-	160	112	0	0	0	100	0	0	0	0	0	112

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 2 cont'd														
FAUNA cont'd														
PHYLUM Mollusca cont'd Class Bivalvia														
Mytilus californianus	0	-	50	45	0	0	8	5	3	3.2	0.8	0.8	0.5	2.4
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia														
Balanus cariosus	1	-	3	2.5	3	0.7	10	10	4	5	1	1.6	0.7	3
B. glandula	15	-	65	50	42	32	40	10	40	40	50	60	0.5	20
Chthamulus dalli	10	-	20	15	50	1	40	50	10	15	9	10	4	25
Subclass Malacostraca Order Decapoda														
Hemigrapsus nudus	48	-	3	16	192	0	48	0	32	32	16	0	0	0
H. oregonensis	0	-	0	0	256	0	0	0	0	16	0	0	0	0
Pagurus sp.	0	-	0	32	0	0	192	0	160	400	112	0	0	0
PHYLUM Chordata Subphylum Craniata														
tidepool sculpins (cottidae)	0	-	0	0	10	0	0	0	6	10	8	10	0	50

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 2 cont'd														
FLORA														
PHYLUM Spermatophyta														
Phyllospadix scouleri	0	-	5	5	0	0	5	<5	<5	0	<5	5	<5	10
PHYLUM Chlorophyta														
Cladophora sp.	0	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10
Enteromorpha sp.	0	-	0	0	0	0	0	0	0	0	5	5	30	10
Prasiola meridionalis	0	-	0	0	<5	30	0	0	0	0	0	0	0	0
Ulva sp.	20	-	5	5	<5	<5	<5	<5	0	0	<5	<5	0	0
PHYLUM Phaeophyta														
Fucus distichus	20	-	20	5	10	5	50	70	10	30	30	75	60	75
Ralfsia sp.	0	-	<5	<5	0	0	5	5	<5	<5	<5	<5	<5	<5
Scytosiphon lomentaria	0	-	0	0	0	0	0	0	0	0	0	0	10	5
Soranthera ulvoidea	0	-	0	0	10	5	0	0	<5	<5	10	5	10	5
PHYLUM Rhodophyta														
Endocladia muricata	0	-	<5	<5	20	20	<5	5	<5	<5	5	<5	5	10
Gigartina sp.	10	-	<5	<5	<5	20	<5	<5	<5	5	<5	5	10	<5
Petrocelis sp.	<5	-	<5	<5	0	0	<5	0	<5	<5	<5	<5	<5	<5
Porphyra sp.	0	-	<5	0	<5	<5	0	<5	0	0	0	0	0	0
Rhodomela larix	50	-	0	0	40	10	0	0	5	5	5	5	25	<5

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3														
FAUNA														
PHYLUM Porifera														
Haliclona permollis	0	-	<5	<5	<5	<5	<5	<5	0	0	0	0	0	0
unidentified species	5	-	0	0	0	0	<5	<5	<5	<5	5	<5	<5	<5
PHYLUM Cnidaria														
Class Anthozoa														
Order Actinaria														
Anthopleura elegantissima	512	-	400	300	100	100	20	20	80	75	112	100	112	160
A. xanthogrammica	3	-	2	<1	3	<1	4	1	<1	<1	<1	2	<1	<1
Tealia coriacea	0	-	<1	<1	0	<1	0	0	<1	<1	0	0	0	0
PHYLUM Nemertea														
unidentified species	2	-	0	0	0	0	2	0	0	0	0	0	0	0
PHYLUM Annelida														
Serpula vermicularis	0	-	<5	<5	0	0	<5	<5	0	0	0	0	<1	<1

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3 cont'd														
FAUNA cont'd														
PHYLUM Mollusca Class Amphineura														
Cryptochiton stelleri	0	-	0	0	0	0	<1	<1	0	0	0	0	0	0
Katharina tunicata	2	-	5	4	0	<1	5	1	<1	1	<1	<1	0	<1
Mopalia sp.	0	-	<1	<1	0	<1	0	0	0	0	0	0	0	<1
Tonicella sp.	<1	-	<1	<1	0	0	<1	0	<1	1	<1	<1	<1	0
Class Gastropoda Subclass Opistobranchia														
Archidoris montereyensis	2	-	<1	0	0	0	0	<1	0	0	0	0	0	0
Subclass Prosobranchia														
Acmaea mitra	0	-	<1	<1	<1	<1	0	<1	2	<1	<1	<1	0	0
Calliostoma ligatum	0	-	4	3	0	0	0	1	0	0	0	0	0	0
Collisella digitalis	160	-	320	0	0	0	0	500	0	160	0	0	0	80
C. pelta	240	-	48	64	64	0	48	0	64	80	16	48	496	160
Diodora aspera	<1	-	<1	<1	0	0	0	<1	0	<1	0	0	0	0
Littorina scutulata	6	-	0.5	0.5	0	0	0	0.6	0	0	0	0	11	0
L. sitkana	15	-	4	3.2	0	0	0	1	0	0	0	0	0	0
Notoacmea persona	640	-	80	48	160	0	352	16	0	16	16	16	192	0
N. scutum	80	-	0	16	0	16	32	160	48	16	64	160	0	160
Searlesia dira	0	-	16	16	0	16	0	16	64	0	48	80	0	0
Tegula funebralis	0	-	64	0	0	0	0	0	320	400	432	16	80	16
Thais emarginata	96	-	0	32	320	0	160	<1	48	48	32	48	352	0

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3 cont'd														
FAUNA cont'd														
PHYLUM Mollusca Class Gastropoda cont'd Subclass Plumonata														
Onchidella borealis	3	-	0	0	0	0	0	0	0	0	0	160	0	0
Class Bivalvia														
Mytilus californianus	8	-	24	20	11	10	11	10	24	6	23	8	36	30
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia														
Balanus cariosus	3.5	-	1	0.2	4	3	20	1	1	5	4	0.6	12	10
B. glandula	85	-	22	20	60	40	52	30	10	40	60	40	375	10
Chthamulus dalli	41	-	50	20	13	10	75	60	50	20	45	5	30	10
Pollicipes polymerus	17	-	0	0	24	20	19	10	0	0	10	13	1	1
Subclass Malacostraca Order Decapoda														
Cancer oregonensis	0	-	0	0	0	0	0	0	0	0	0	<1	0	0
Oedignathus inermis	3	-	0	0	0	0	0	0	0	<1	0	16	0	0
Pagurus sp.	0	-	160	64	0	0	0	16	0	0	0	160	208	240

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3 cont'd														
FAUNA cont'd														
PHYLUM Echinodermata														
Class Asteroidea														
Henricia leviuscula	0	-	<1	<1	0	0	<1	<1	0	<1	0	0	0	0
Leptasterias hexactis	0	-	0	0	0	0	0	0	0	<1	0	0	0	0
Pisaster ochraceus	0	-	<1	<1	0	0	<1	1	4	2	2	3	<1	0
Pycnopodia helianthoides	0	-	0	0	0	0	<1	0	0	0	0	0	0	0
Class Echinoidea														
Strongylocentrotus droebachiensis	0	-	<1	0	0	0	0	0	0	<1	0	0	0	0
S. franciscanus	0	-	<1	0	0	0	0	0	0	<1	0	0	0	0
S. purpuratus	40	-	65	45	45	45	25	30	40	49	50	50	50	40
PHYLUM Chordata														
Subphylum Craniata														
tidepool sculpins (cottidae)	4	-	10	6	0	0	6	0	10	50	5	10	3	0

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3 cont'd														
FLORA														
PHYLUM Spermatophyta														
Phyllospadix scouleri	20	-	<5	<5	0	0	<5	10	0	0	0	0	0	10
PHYLUM Chlorophyta														
Cladophora sp.	<5	-	0	0	0	0	0	0	0	0	0	0	0	<5
Codium fragile	0	-	<5	<5	0	<5	<5	<5	<5	<5	<5	<5	0	0
Spongomorpha sp.	0	-	<5	0	0	<5	<5	<5	<5	0	<5	0	0	0
Ulva sp.	0	-	<5	<5	0	0	<5	<5	5	<5	<5	<5	<5	<5
PHYLUM Phaeophyta														
Alaria marginata	0	-	0	0	0	0	0	0	0	0	0	0	10	5
A. nana	5	-	0	0	0	0	0	0	0	0	0	0	0	0
Egregia menziessii	0	-	0	<5	0	<5	<5	5	<5	<5	<5	<5	10	10
Hedophyllum sessile	60	-	60	60	50	40	75	50	20	80	40	75	10	60
Leathesia difformis	0	-	<5	<5	<5	<5	0	<5	0	0	0	0	<5	0
Postelsia palmaeformis	10	-	0	0	0	0	0	0	0	0	10	10	0	0

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 3 cont'd														
FLORA cont'd														
PHYLUM Rhodophyta														
Bossiella sp.	10	-	5	5	5	5	5	10	5	5	5	5	10	10
Calliarthron sp.	10	-	5	5	5	5	5	5	5	5	<5	<5	10	5
Callithamnion pikeanum	0	-	<5	<5	0	0	0	0	0	0	0	0	0	0
Corallina sp.	10	-	5	5	5	80	5	5	5	10	10	10	10	10
Endocladia muricata	10	-	5	5	5	5	<5	<5	5	<5	5	5	20	10
Desmarestia ligulata	0	-	0	0	0	0	<5	<5	0	0	0	0	0	0
Gigartina sp.	5	-	0	0	0	<5	0	20	<5	<5	5	5	<5	5
Halosaccion glandiforme	0	-	<5	<5	0	0	<5	<5	<5	<5	<5	5	<5	<5
Iridaea sp.	0	-	0	<5	0	0	<5	<5	<5	<5	<5	<5	60	5
Lithothamnion sp.	10	-	5	5	5	5	5	5	10	<5	15	10	<5	<5
Microcladia borealis	0	-	5	5	0	10	5	5	0	0	0	0	<5	<5
Odonthalia floccosa	0	-	<5	<5	0	0	0	5	40	<5	20	10	20	10
Petrocelis sp.	<5	-	<5	0	0	0	0	0	0	0	0	0	0	5
Porphyra sp.	0	-	0	<5	0	0	0	5	0	0	0	0	0	<5
Prionitis sp.	<5	-	<5	<5	0	<5	0	0	<5	<5	<5	<5	0	0
Pterosiphonia bipinnata	<5	-	<5	<5	0	0	0	0	0	<5	0	0	0	0
Rhodoglossum affine	<5	-	<5	<5	0	0	<5	<5	0	0	0	0	0	0
Rhodomela larix	<5	-	10	5	0	0	<5	5	<5	<5	<5	<5	<5	<5

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 4														
FAUNA														
PHYLUM Porifera														
unidentified species	10	-	0	0	0	0	15	10	<5	<5	5	-	<5	-
PHYLUM Mollusca Class Amphineura														
Cryptochiton stelleri	0	-	0	0	0	0	0	0	<1	0	<1	-	0	-
Katharina tunicata	2	-	0	0	0	0	0	0	0	0	0	-	0	-
Tonicella sp.	0	-	0	0	0	0	0	0	<1	0	<1	-	0	-
Class Gastropoda Subclass Prosobranchia														
Acmaea mitra	<1	-	0	0	0	0	0	0	3	0	3	-	3	-
Calliostoma ligatum	0	-	0	0	0	0	0	0	0	0	0	-	<1	-
Diodora aspera	0	-	0	0	0	0	0	0	<1	0	0	-	0	-
Notoacmea persona	0	-	0	0	0	0	0	0	16	0	12	-	0	-
N. scutum	160	-	0	0	0	0	0	0	0	0	0	-	0	-
Searlesia dira	0	-	0	0	0	0	0	0	0	0	0	-	<1	-
PHYLUM Echinodermata Class Asteroidea														
Henricia leviuscula	<1	-	0	0	0	0	0	0	<1	0	0	-	0	-
Pisaster ochraceus	<1	-	0	0	0	<1	0	0	0	0	0	-	0	-
Pycnopodia helianthoides	0	-	0	0	0	0	0	0	<1	0	0	-	0	-

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 4 cont'd														
FAUNA cont'd														
PHYLUM Echinodermata Class Echinoidea														
Strongylocentrotus franciscanus	<1	-	0	0	0	0	0	0	<1	0	<1	-	0	-
S. purpuratus	45	-	0	0	9	10	0	0	65	50	40	-	50	-
FLORA														
PHYLUM Spermatophyta														
Phyllospadix scouleri	0	-	40	40	30	25	20	10	5	5	5	-	30	-
PHYLUM Phaeophyta														
Alaria marginata	0	-	5	5	0	0	0	0	30	25	50	-	0	-
Costaria costata	0	-	0	0	0	0	0	0	50	25	0	-	0	-
Egregia menziessii	0	-	5	10	0	0	0	0	0	0	0	-	0	-
Laminaria setchellii	40	-	40	40	40	40	40	20	30	25	30	-	40	-
Lessoniopsis littoralis	10	-	0	0	20	20	0	0	0	0	0	-	<5	-
Nereocystis luetkeana	0	-	10	10	10	10	0	0	40	40	0	-	0	-
Postelsia palmaeformis	0	-	0	0	5	5	0	0	0	0	0	-	0	-

Table 18 cont'd

Sample Site	4		5		7		8		13		14		15	
Date	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug	Jun	Aug
ZONE 4 cont'd														
FLORA cont'd														
PHYLUM Rhodophyta														
Bossiella sp.	10	-	10	10	5	5	5	5	0	0	0	-	15	-
Calliarthron sp.	10	-	10	10	5	<5	5	<5	0	0	0	-	15	-
Corallina sp.	10	-	10	10	5	15	5	10	0	0	0	-	5	-
Constantinea simplex	0	-	0	0	0	0	0	0	<5	<5	<5	-	<5	-
Erythrophyllum delesserioides	5	-	0	0	0	0	0	0	0	0	0	-	0	-
Iridaea sp.	0	-	<5	<5	0	0	<5	<5	0	0	0	-	<5	-
Lithothamnion sp.	<5	-	5	5	5	5	5	<5	20	10	20	-	<5	-
Opuntiella californica	0	-	0	0	0	0	<5	<5	<5	<5	<5	-	0	-
Microcladia coulteri	20	-	5	5	0	0	0	0	<5	<5	<5	-	0	-
Petrocelis sp.	0	-	0	0	0	0	<5	<5	0	0	0	-	0	-
Rhodoglossum affine	20	-	5	5	5	<5	5	<5	<5	<5	<5	-	40	-

Table 19. Seasonal observations of fauna and flora on semi-exposed boulder beaches, Thrasher Cove, West Coast Trail Section (1977). (No./m^2)

Table 19

Species	June	Aug.
ZONE 1		
FAUNA		
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia		
Littorina scutulata	48	32
L. sitkana	208	250
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia		
Balanus glandula	1,000	1,500
FLORA		
Lichens		
Verrucaria sp.	80	80
ZONE 2		
FAUNA		
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia		
Collisella digitalis	208	196
C. pelta	48	32
Littorina scutulata	100	90
L. sitkana	2,300	1,900
Notoacmea persona	48	0
N. scutum	16	32
Thais emarginata	0	16
T. lamellosa	0	6

Table 19 cont'd

Species	June	Aug.
ZONE 2 cont'd		
FAUNA cont'd		
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia		
Balanus cariosus	75	1,200
B. glandula	4,200	5,200
Chthamulus dalli	400	1,000
Subclass Malacostraca Order Decapoda		
Hemigrapsus nudus	160	112
Pagurus sp.	0	16
Order Isopoda		
unidentified species	368	250
PHYLUM Chordata Subphylum Craniata		
tidepool sculpins (cottidae)	10	5
FLORA		
PHYLUM Phaeophyta		
Fucus distichus	60	30
Leathesia difformis	<5	<5
PHYLUM Rhodophyta		
Halosaccion glandiforme	10	5
Gigartina sp.	<5	<5
Microcladia borealis	<5	0
Petrocelis sp.	<5	<5
Porphyra sp.	<5	0
Rhodomela larix	10	5

Table 19 cont'd

Species	June	Aug.
ZONE 3		
FAUNA		
PHYLUM Cnidaria Class Anthozoa Order Actiniaria		
unidentified species	1	1
PHYLUM Nemertea		
unidentified species	10	5
PHYLUM Mollusca Class Gastropoda Subclass Prosobranchia		
Collisella digitalis	160	0
C. pelta	0	32
Lacuna sp.	0	16
Notoacmea persona	48	0
N. scutum	0	16
Thais emarginata	16	0
T. lamellosa	12	10
Class Bivalvia		
Mytilus californianus	160	200
M. edulis	2,000	1,900
PHYLUM Arthropoda Class Crustacea Subclass Cirripedia		
Balanus cariosus	900	1,200
B. glandula	7,500	7,000
Subclass Malacostraca Order Decapoda		
Pagurus sp.	160	16

Table 19 cont'd

Species	June	Aug.
ZONE 3 cont'd		
FAUNA cont'd		
PHYLUM Arthropoda Class Crustacea Subclass Malacostraca Order Isopoda		
Exosphaeroma sp.	0	16
Idotea sp.	0	36
PHYLUM Bryozoa		
unidentified species	5	5
FLORA		
PHYLUM Spermatophyta		
Phyllospadix scouleri	20	50
PHYLUM Chlorophyta		
Spongomorpha sp.	<5	0
Ulva sp.	<5	5
PHYLUM Phaeophyta		
Fucus distichus	0	<5
Hedophyllum sessile	40	10
Leathesia difformis	0	<5
PHYLUM Rhodophyta		
Dilsea californica	0	<5
Halosaccion glandiforme	<5	10
Hildenbrandia sp.	<5	<5
Iridaea sp.	<5	0
Odonthalia floccosa	0	<5

Table 19 cont'd

Species	June	Aug.
ZONE 3 cont'd		
FLORA cont'd		
PHYLUM Rhodophyta cont'd		
Petrocelis sp.	<5	<5
Prionitis sp.	<5	<5
Ralfsia sp.	<5	<5
Rhodomela larix	<5	<5
ZONE 4		
FAUNA		
PHYLUM Porifera		
unidentified species	5	5
PHYLUM Annelida Class Polychaeta		
Eudistylia vancouveri	5	5
PHYLUM Mollusca Class Amphineura		
Katharina tunicata	4	1
Mopalia spp.	<1	<1
Class Gastropoda Subclass Prosobranchia		
Collisella pelta	16	3
Diodora aspera	<1	<1
Class Bivalvia		
Tresus sp.	4	4

Table 19 cont'd

Species	June	Aug.
ZONE 4 cont'd		
FAUNA cont'd		
PHYLUM Arthropoda		
Class Crustacea		
Subclass Cirripedia		
Balanus cariosus	112	500
B. glandula	2,200	3,500
Subclass Malacostraca		
Order Isopoda		
Idotea sp.	96	16
Order Decapoda		
Pagurus sp.	240	112
PHYLUM Echinodermata		
Class Holothuroidea		
Parastichopus californicus	<1	0
FLORA		
PHYLUM Spermatophyta		
Phyllospadix scouleri	60	50
PHYLUM Phaeophyta		
Alaria marginata	30	10
PHYLUM Rhodophyta		
Ahnfeltia plicata	<5	<5
Farlowia mollis	0	<5
Gigartina sp.	<5	<5
Iridaea sp.	<5	0

Table 19 cont'd

Species	June	Aug.
ZONE 4 cont'd		
FLORA cont'd		
PHYLUM Rhodophyta cont'd		
Lithothamnion sp.	5	<5
Microcladia borealis	<5	<5
Odonthalia floccosa	<5	<5
Petrocelis sp.	<5	<5
Prionitis sp.	<5	<5
Ptilota sp.	0	<5
Rhodoglossum affine	<5	<5

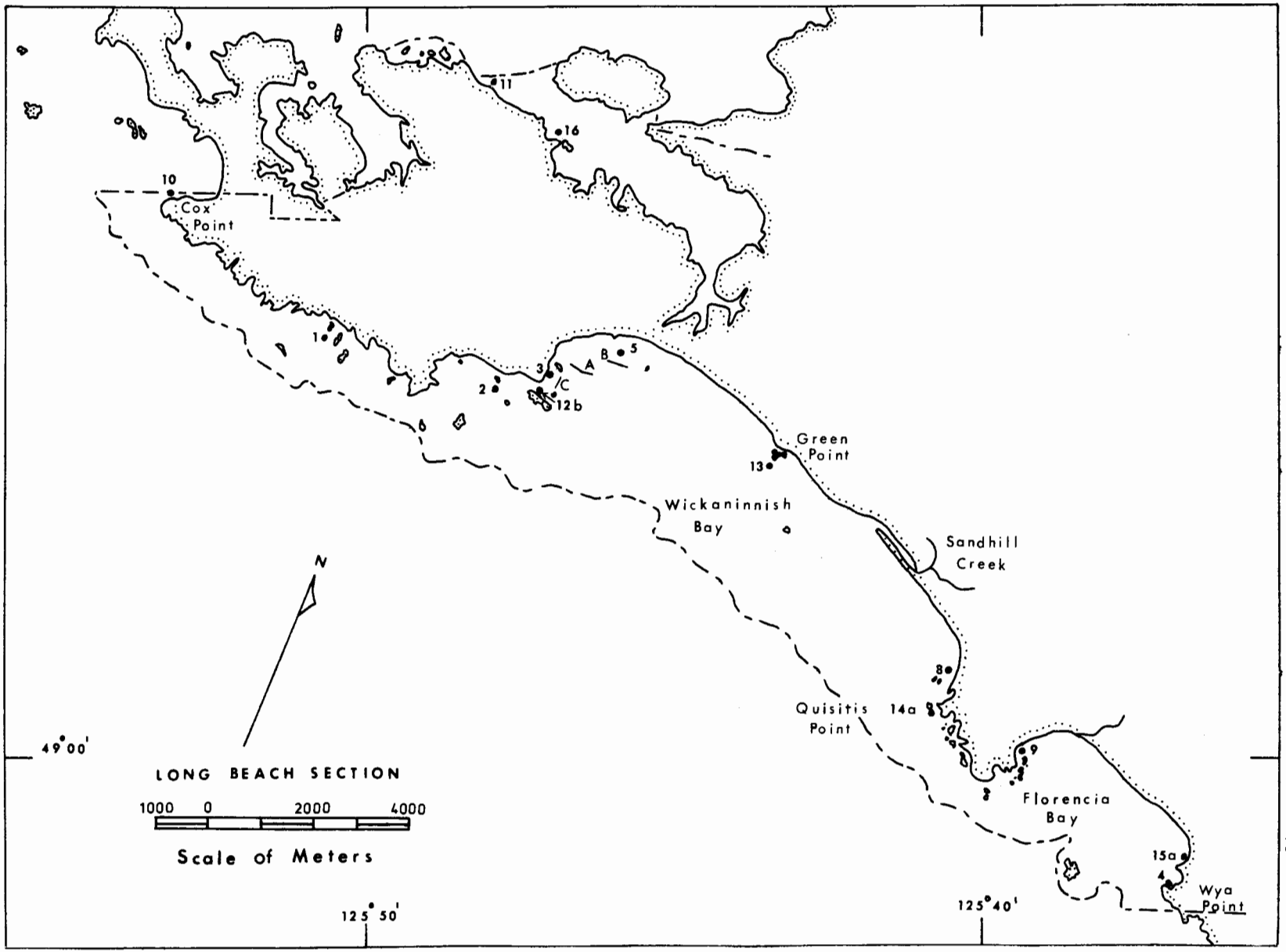

Figure 1. Location of intertidal fauna and flora survey sites, Long Beach Section (1977).

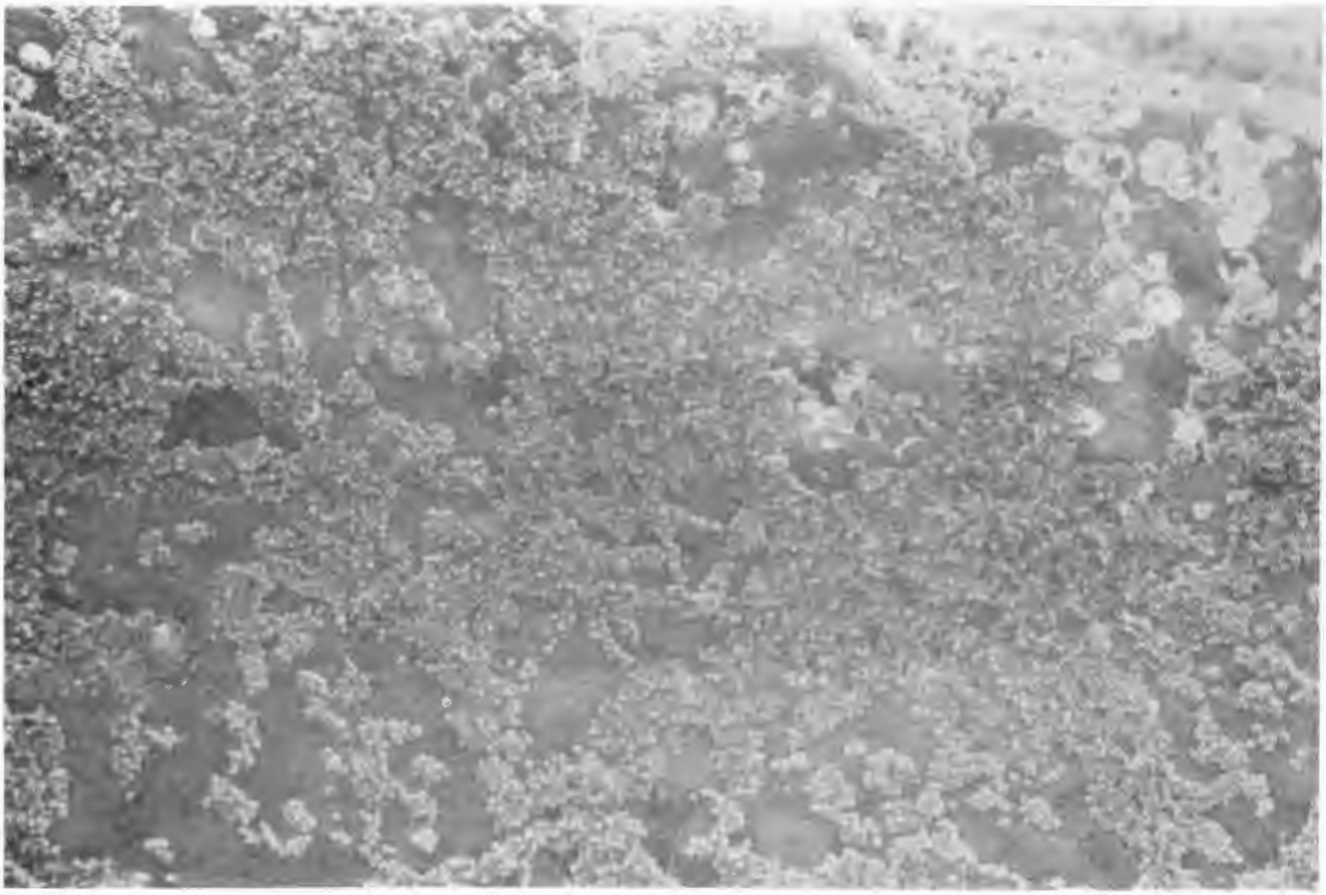

Figure 2. Heavy set of acorn barnacles, Cox Point, Long Beach Section (1977). (Area: 35 cm x 25 cm)

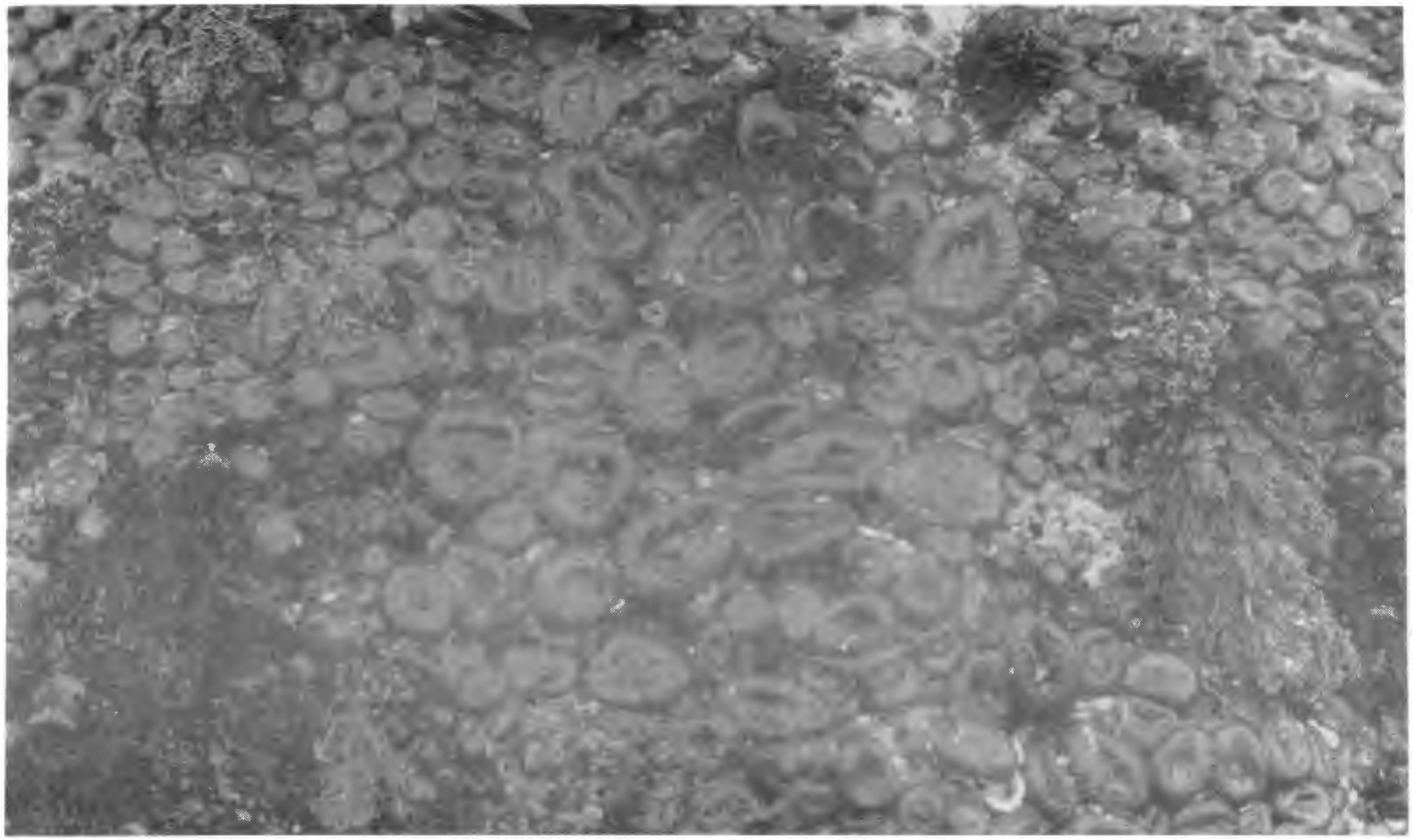

Figure 3. Recruitment of anemones Anthopleura elegantissima, Half Moon Bay, Long Beach Section (1977). (Area: 40 cm x 25 cm)

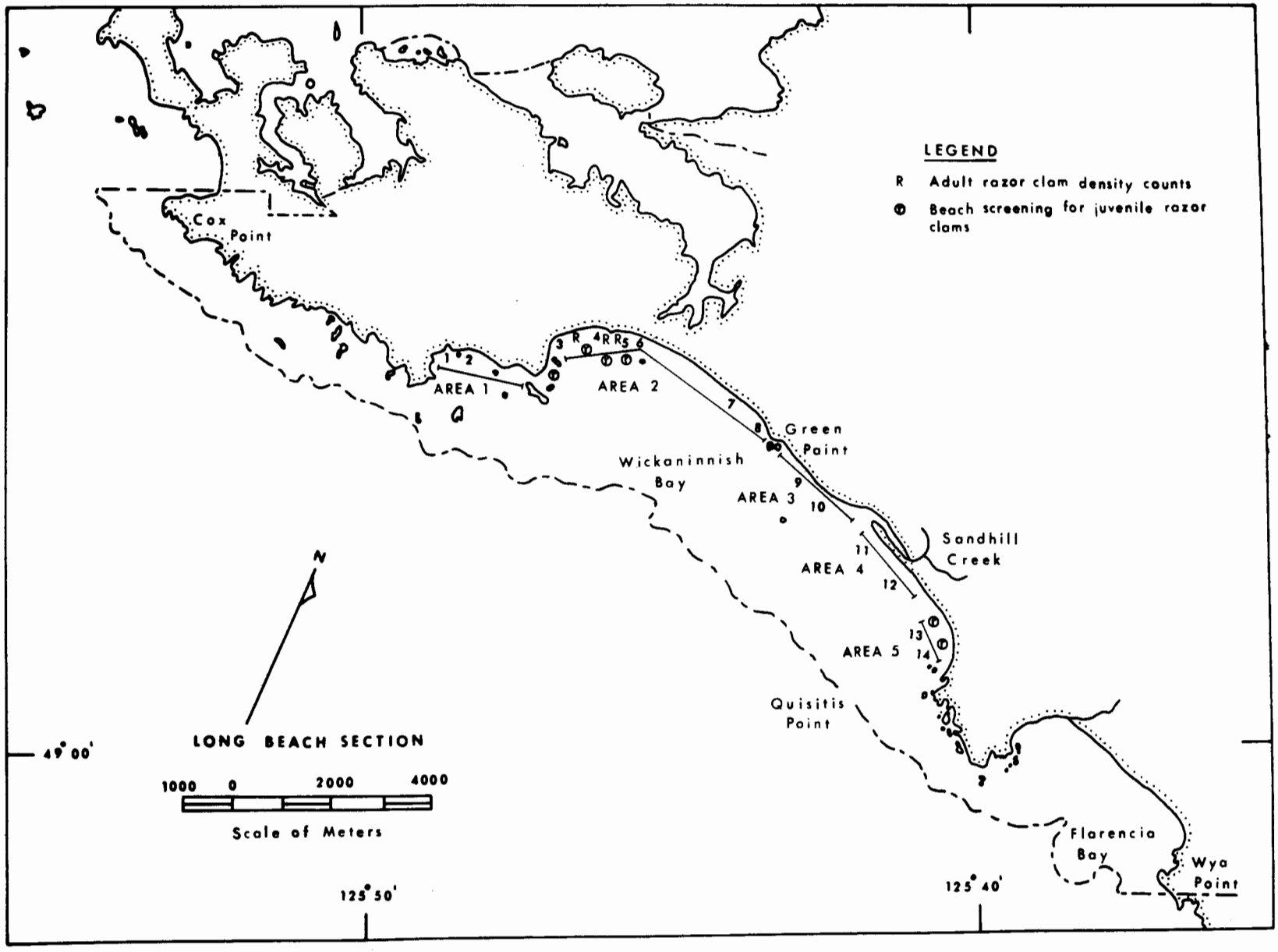

Figure 4. Locations of juvenile razor clam sampling, Long Beach Section (1977).

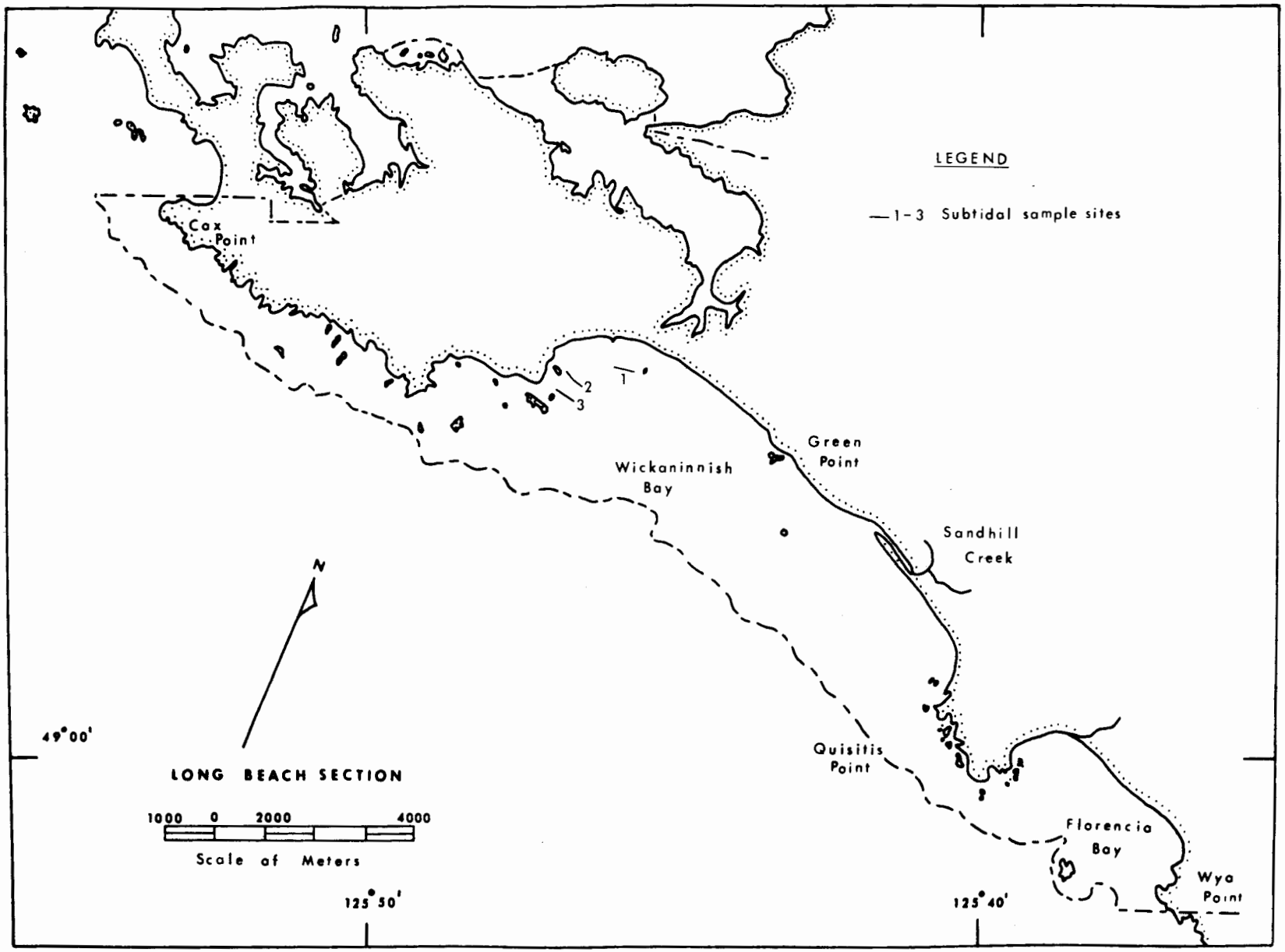

Figure 5. Locations of subtidal razor clam sample sites, Long Beach Section (1977).

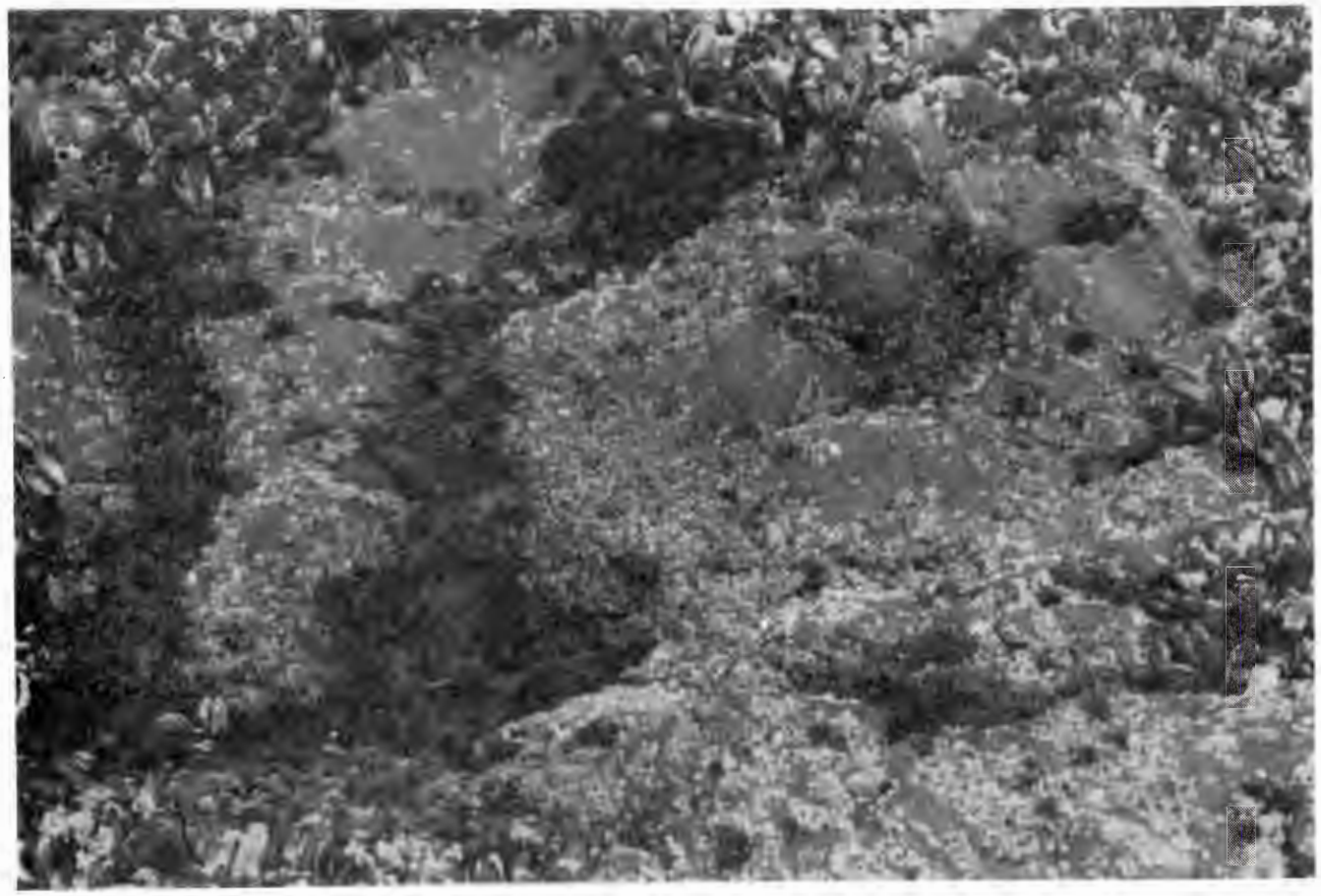

Figure 6. Re-colonization of a cleared one m^2 plot at Cox Point, Long Beach Section (July 1977).

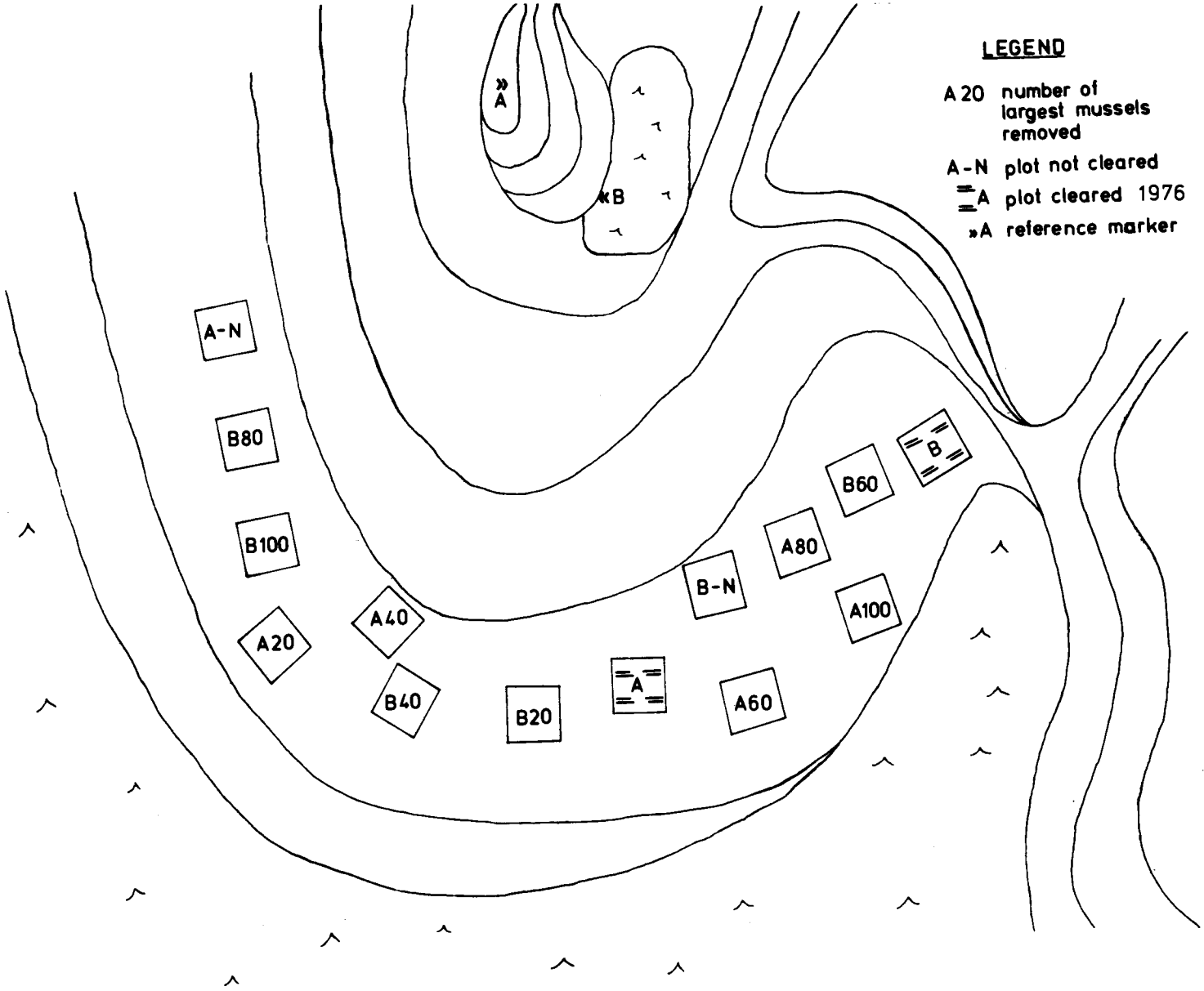

Figure 7. Schematic diagram of sea mussel partial removal plots at Quisitis Point, Long Beach Section (1977).

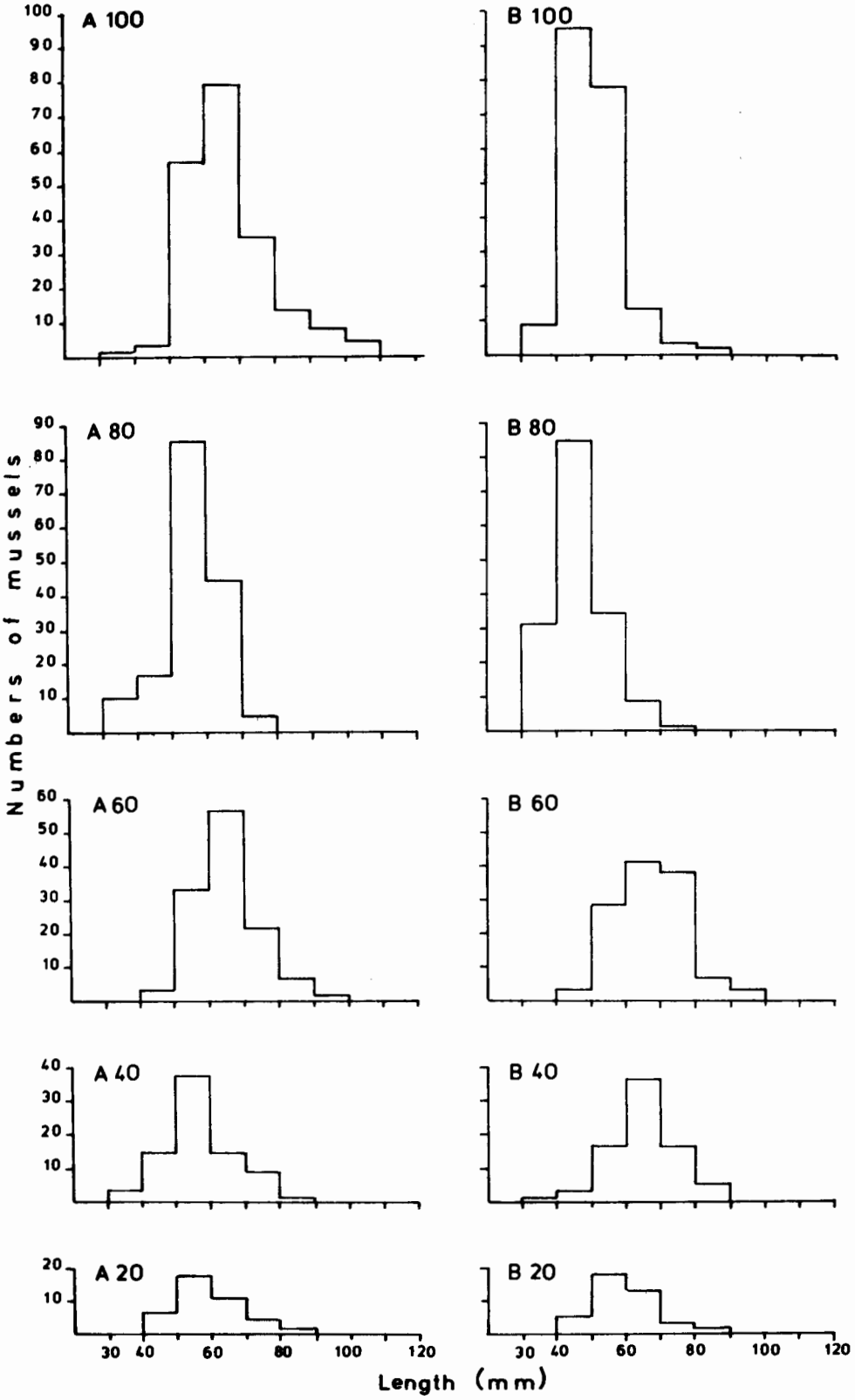

Figure 8. Total length frequency distribution of sea mussels removed from plots at Quisitis Point, Long Beach Section (1977). (Measurements grouped into 10 mm size classes.)

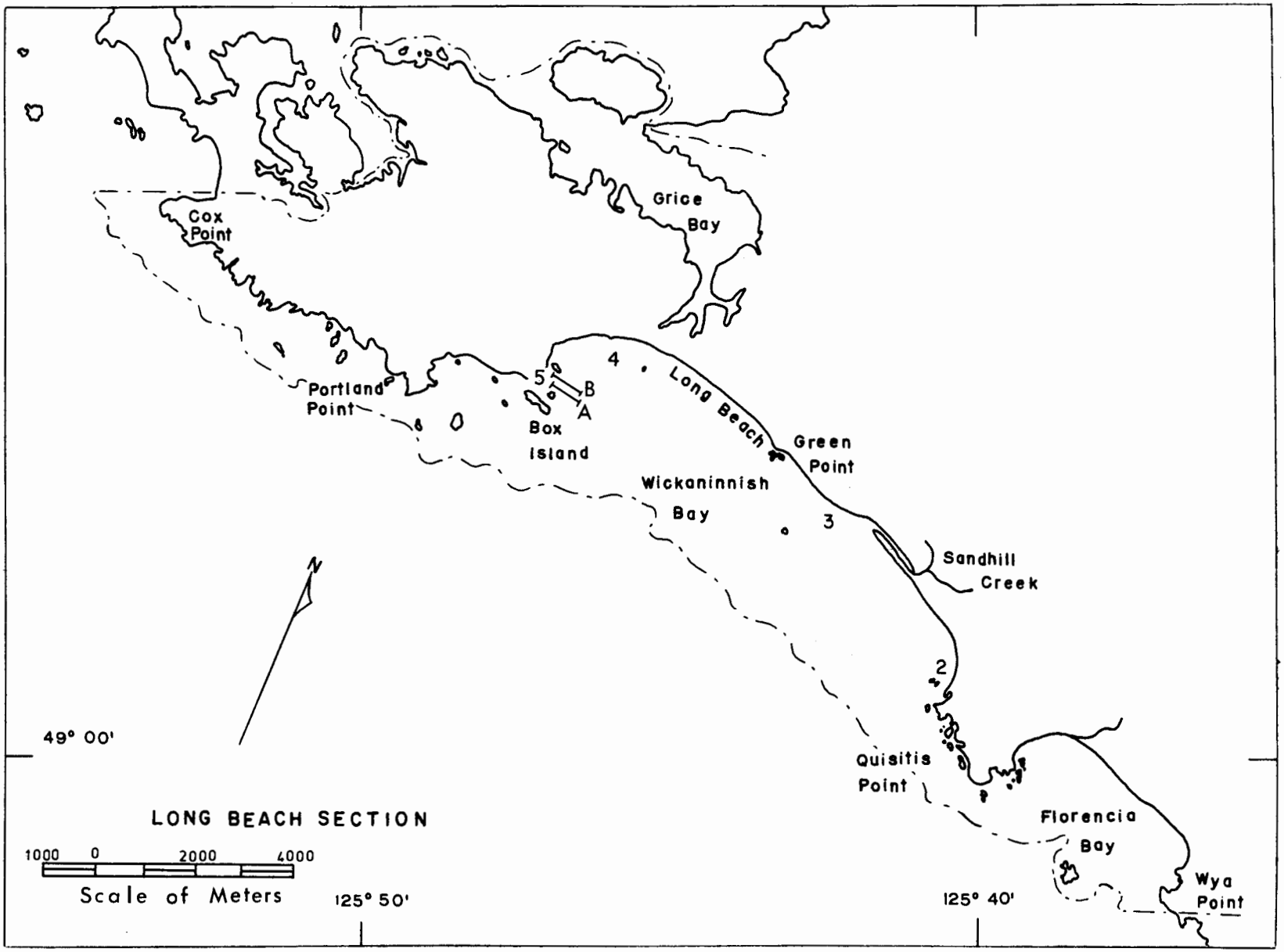

Figure 9. Locations sampled to determine density of Olivella, Long Beach Section (1977).

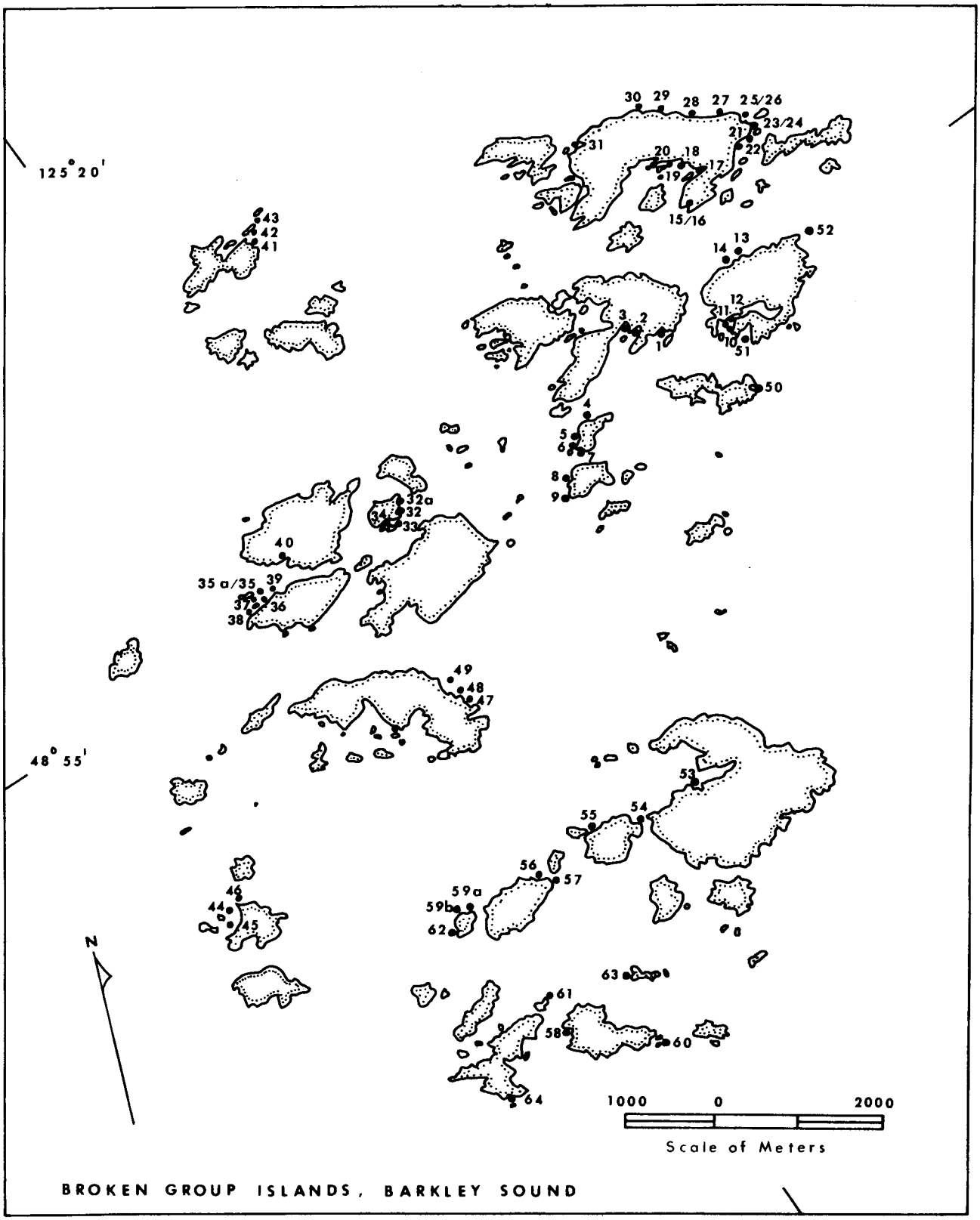

Figure 10. Location of intertidal fauna and flora survey sites, Broken Group Islands Section (1977).

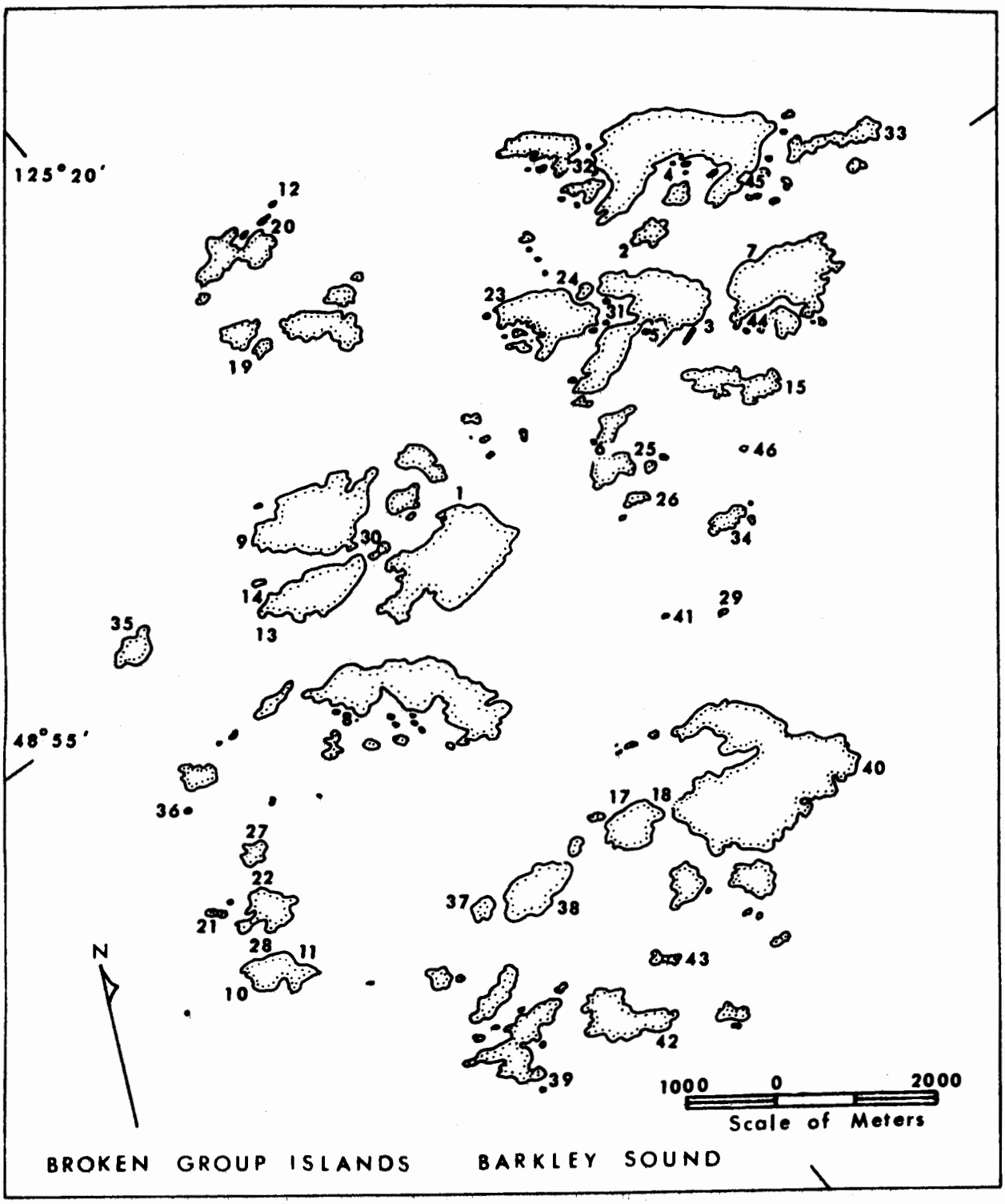

Figure 11. Location of subtidal fauna and flora survey sites, Broken Group Islands Section (1977).

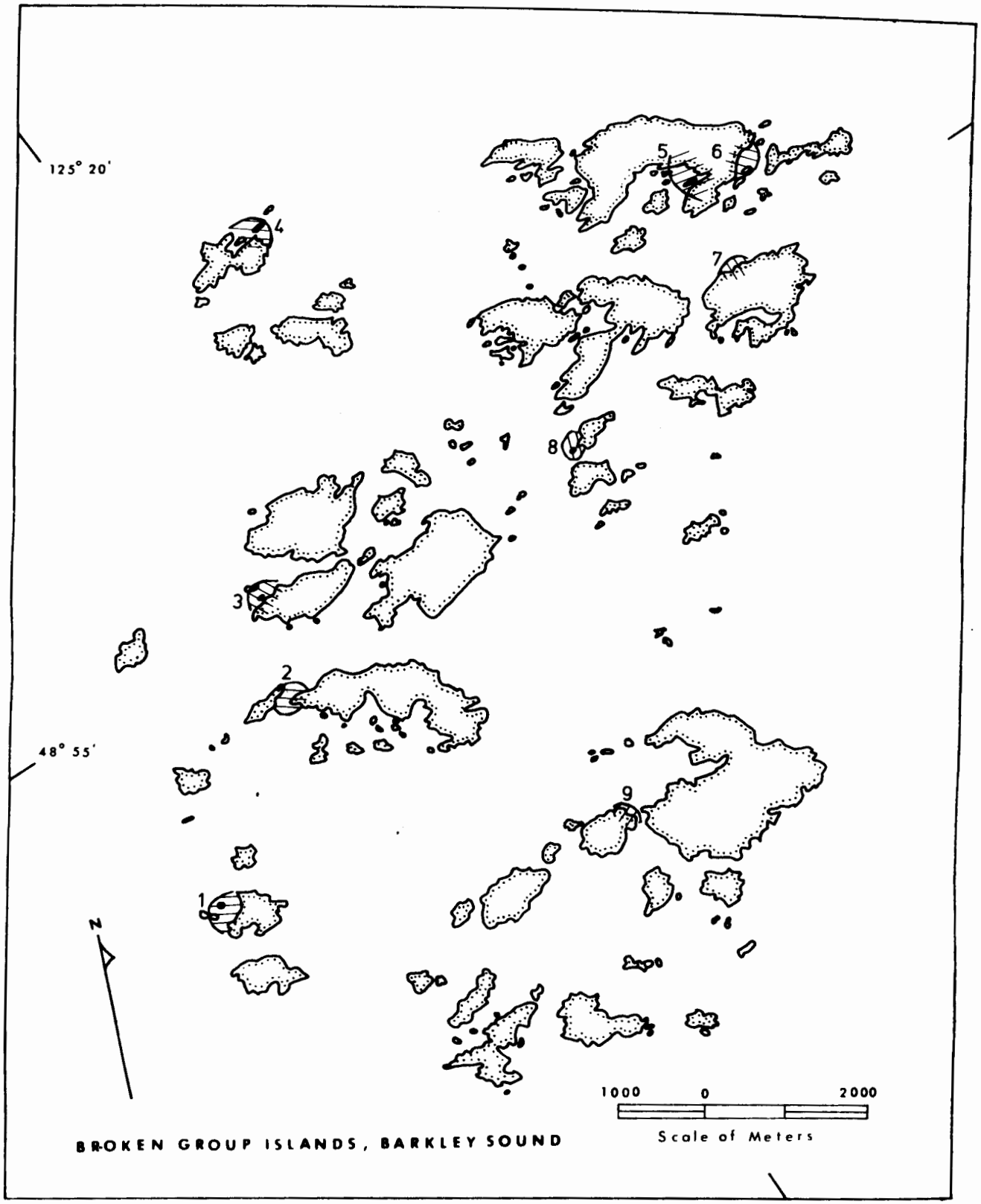

Figure 12. Sites of major bivalve populations, Broken Group Islands Section (1977).

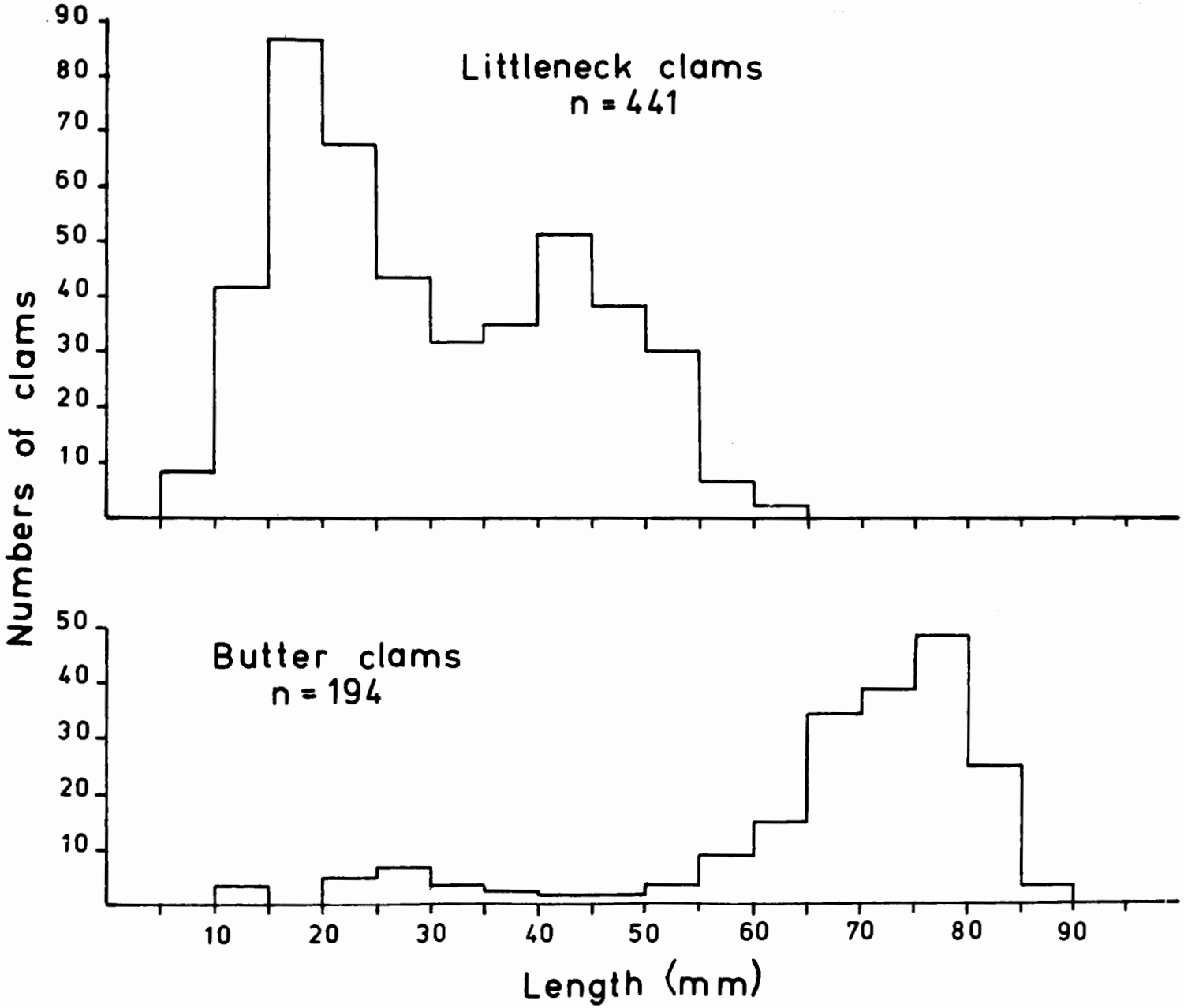

Figure 13. Length frequency distribution of total number of littleneck and butter clams in three m^2 plots, Hand Island, Broken Group Islands: Section (1977).

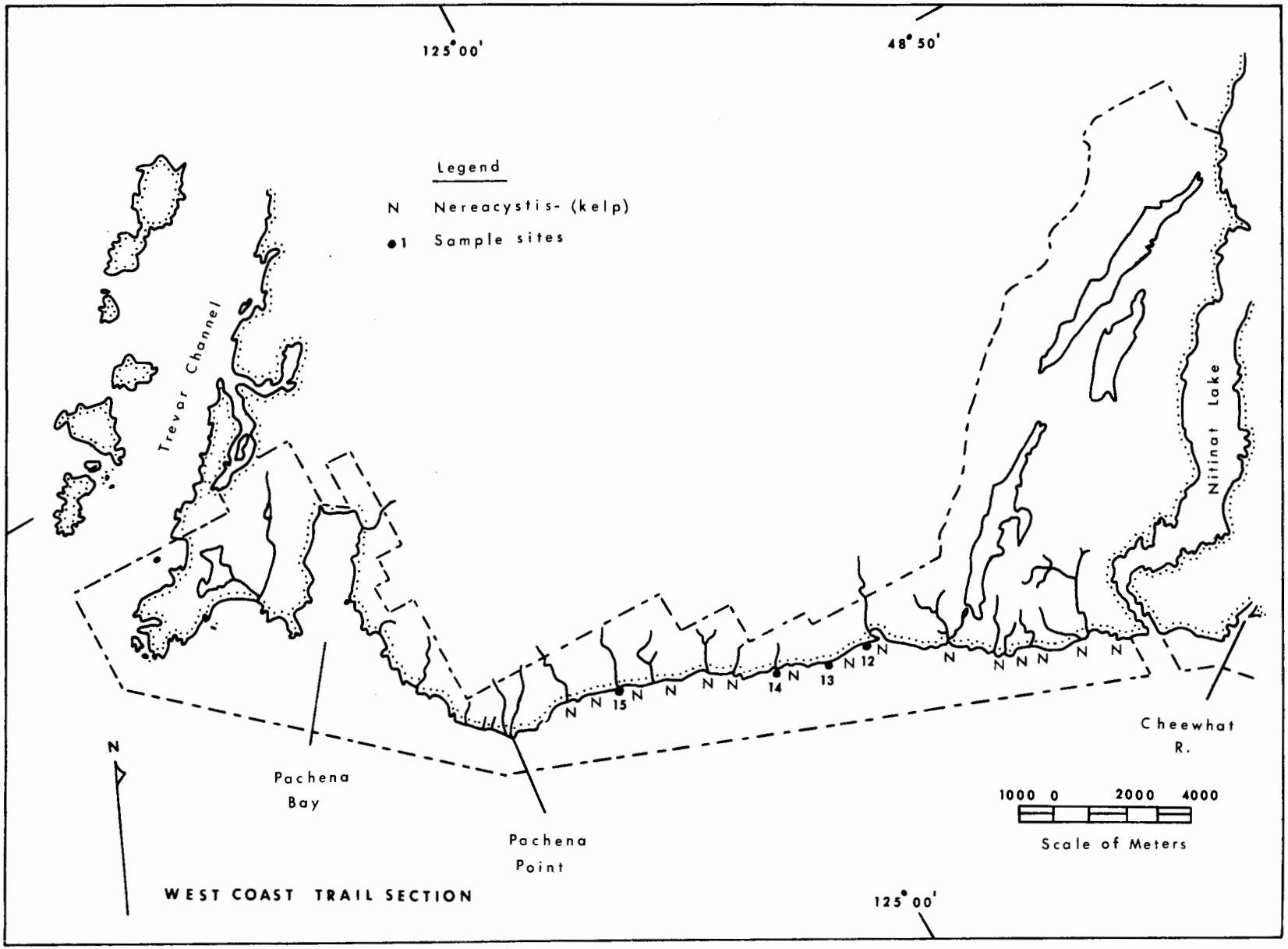

Figure 14. Location of intertidal fauna and flora survey sites, West Coast Trail Section (1977). (Pachena Bay to Cheewhat River.)

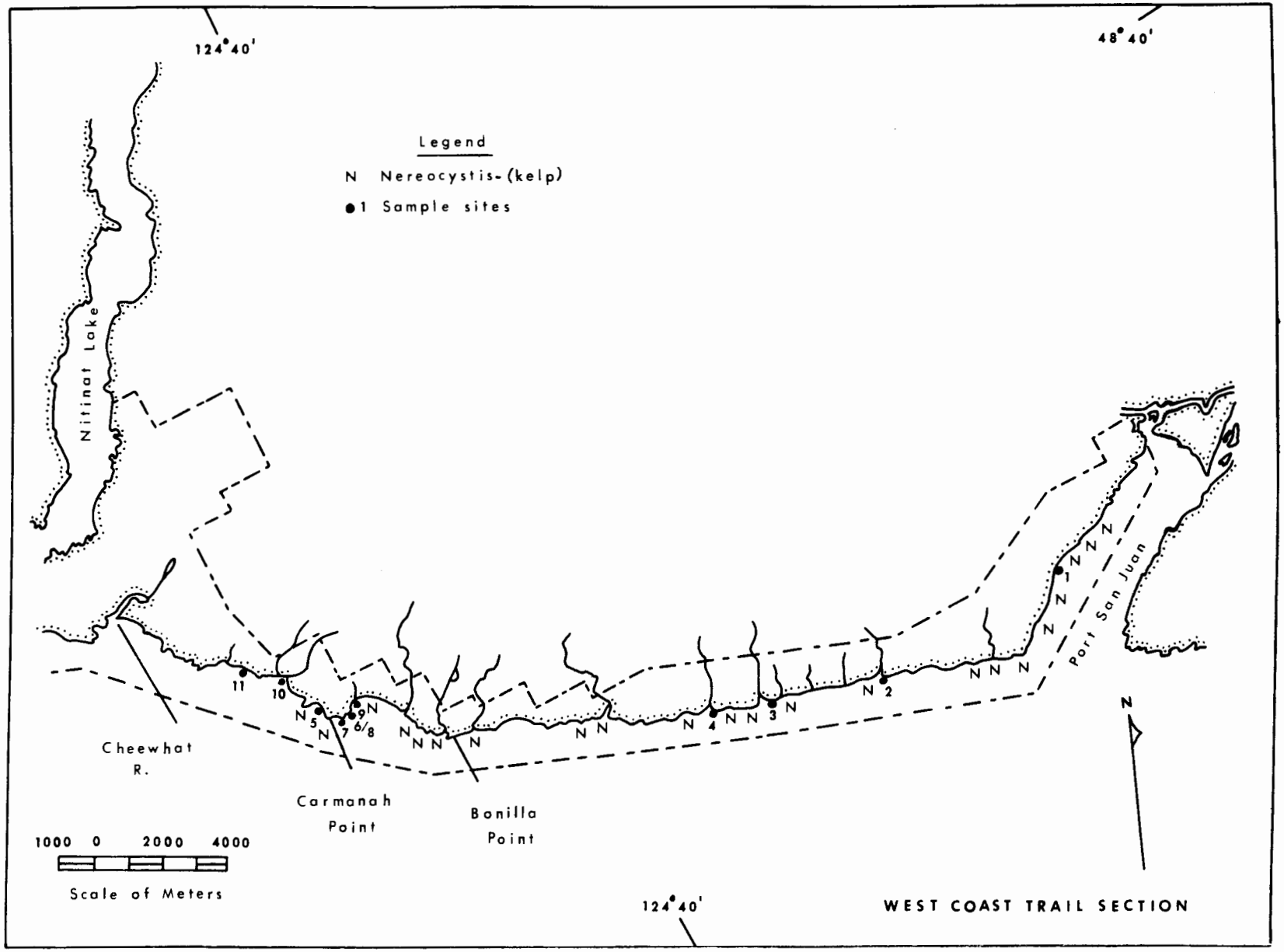

Figure 14. Continued
(Cheewhat River to Port San Juan.)

APPENDIX 1

Terms of Reference

PARKS CANADA
TERMS OF REFERENCE
FOR
MARINE RESOURCE INVENTORY
IN
PACIFIC RIM NATIONAL PARK
APRIL 20, 1977

INTRODUCTION

The following terms of reference were initially prepared by Miss J. Charlene Lee and Dr. N. Bourne, Fisheries and Marine Services (February, 1975) and subsequently modified as follows:

- March 1975: by C. Zinkan (Parks Canada), to satisfy Parks Canada format requirements.
- February 18, 1976: by C. Zinkan, to update the terms of reference as agreed at a review meeting in the Park, February 11, 1976.
- March 31, 1977: by P. Benson and L. McIntosh, to update the terms of reference as agreed at a review meeting in the Park, March 9, 1977, and to accommodate a change in contract responsibility from Fisheries and Marine Services, D.O.E. to Lee & Adkins Ltd., Biomarine Consultants.

Commencing the 3rd year (1977-1978), the Pacific Biological Station will no longer be administering this project. The contract will now be written

directly between Lee & Adkins Ltd., Biomarine Consultants and Parks Canada, and the latter will assume contract administration. The intent of these terms of reference remains unchanged from those developed when the project was initially envisaged. The principal researcher (J.C.Lee), principal advisor (N.Bourne), and the privileges offered by the Pacific Biological Station (consultation, lab facilities, publication) will also remain. The continuing interest of the Station in this project and their offer of assistance to ensure that the project requirements are adequately met are recognized as essential by all.

1. Purpose

The principal aim of this project is to undertake a biophysical resource inventory of the marine flora and fauna of the Pacific Rim National Park. The study will include:

1) a qualitative assessment of the marine flora and fauna within the Park borders;
2) a quantitative assessment of these organisms;
3) a description of their habitat type;
4) an evaluation of the effect of recreational pressure and human encroachment.

This information is required to ensure effective Park planning, interpretation and management and is an integral part of the Resource Inventory program for Pacific Rim National Park.

2. Project Area

Studies will be undertaken concurrently in all three phases of Pacific Rim National Park. In the initial year emphasis will be placed on the Long Beach Section because:

1) easy access;

2) acute recreation pressure;

3) relatively few habitat types are present in this area. Studies will be initiated in all three phases of the Park during the first year and emphasis will increase in Phases 2 and 3 after the initial year.

The boundaries of the study area will extend from the high-tide to subtidal depth of 18m (≅10 fathoms, ≅60 ft.).

3. Project Requirements

Major emphasis in the studies will be on the invertebrate populations within the Park. However, attention will also be given to the fish populations.

Because the lower limit of the photosynthetic zone and of most diving is 15m (≅50 ft.), data requirements for depths greater than 15m will be extrapolated from sampling etc. done at shallower depths where possible.

More specifically but without limiting the generality of the foregoing, the project requirements include:

3.1 Update of Fisheries Research Board of Canada Manuscript Report No. 1276; Marine Bibliographical and Review

Study of Pacific Rim National Park. This report was undertaken under contract to Parks Canada in 1973. Specifically information concerning species habitat lists and references acquired after 1973 shall be gathered and the status of all work listed under "Current Research Projects" in MS Rept. No. 1276 in addition to other recent projects and data collections shall be ascertained and documented.

3.2 Studies will be undertaken concurrently in all three phases of the Park under the following general schedule.

3.2.1 Baseline Studies

From systematic and distributional studies qualitative data will be gathered to:

(i) Correct and broaden information on habitat types, zonation and species lists.

(ii) Determine areas of uniqueness (e.g., habitat types and/or species populations).

(iii) Establish control and recreational pressure study sites for each habitat type.

3.2.2 Long-Term Studies

Ecology and community structures will be continuously studied seasonally and yearly in intertidal and subtidal (where possible) areas using transect and random sampling procedures. Quantitative data obtained will be required to:

(i) Determine populations of marine organisms and monitor fluctuations in these populations.

(ii) Assess adult populations and recruitment of marine organisms particularly in areas where recreational pressure is greatest, i.e., are populations in danger of being seriously depleted?

(iii) Determine if any populations will require further protection.

(iv) Identify potential locations for intertidal and subtidal trails where collection of specimens is permitted and where collection is not permitted.

(v) Determine recruitment and mortality rates and whether bag limits are needed for species which will be taken in the recreational fisheries: clams, fish, oysters, abalone, etc.

3.3 Description of Habitat Types

The marine ecological parameters and habitat types within the project area will be identified, mapped and described. The descriptive format shall allow easy comparison of one habitat type to another. All criteria used in habitat identification shall be defined.

3.4 Sampling will be confined primarily to the period March to December. During the remainder of the time, samples will be identified, data analyzed and reports prepared. A tentative sampling schedule is outlined on the following pages.

4. Submission Requirements

Yearly reports, similar to Manuscript Report No. 1276, will be submitted. A final report at the end of the 5-year study which will summarize all work will also be prepared.

The annual report will include all results of work outlined in Section 3. Future submission requirements will be based on review of the annual report. The annual reports will be submitted in twenty-five (25) copies.

5. Project Cost

The total cost of work for the 1977/78 contract year shall be $29,000.00. Payments will be made as follows:

5.1 Upon receipt of a firm outline of proposed field work for the 1977/78 field season, on or before May 1, 1977; the sum of $12,200.00

5.2 Upon the receipt of a progress report which may be an oral presentation at the Park; on field activities during the 1977/78 season on or before Aug. 1, 1977; the sum of $ 8,700.00

5.3 Upon receipt of a written progress report on or before December 1, 1977; the sum of $ 4,000.00

5.4 Upon receipt of the final report for 1977/78 on or before March 31, 1978; the sum of $ 4,100.00

6. Completion Schedule

At present the project is planned to be conducted over a 5-year period, 1975/76-1979/80 inclusive.

7. Material Supply

The contractor shall provide all material and equipment required for the completion of the study with the exception of:

7.1 Chronaflex base maps, transparencies, and/or paper prints of the area at a scale of 1:12,500, 1:25,000 and 1:50,000 for final mapping.

7.2 For the field season 1976/77 to 1979/80 inclusive Parks Canada will make available 1 zodiac boat (Grand rapid III) with 20 hp motor and a smaller 7 hp backup motor. Parks Canada will also attempt to provide cabin facilities in the Broken Islands Group, Jaques Island, and will encourage staff assistance in diving when staff time permits.

7.3 For the field season 1977/78 Parks Canada (P.R.N.P.) will provide 1 VHF radio (GE model) and charger with alkaline battery.

APPENDIX A

SPECIAL CONDITIONS

1. The contractor shall be;

   Lee & Adkins Ltd.,
   Biomarine Consultants

2. The principal researcher shall be:

   (Miss) J. Charlene Lee

3. The contract supervisor shall be the Resource Studies Manager, Parks Canada Calgary.

4. All reports shall be sent to:

   Director
   Western Region
   Parks Canada
   Department of Indian and Northern Affairs
   134 - 11 Avenue S.E.
   Calgary, Alberta
   T2G 0X5

   Attention: Resource Studies Manager

5. The field supervisor shall be the Superintendent, P.R.N.P. Park, or his designate.

6. The contractor agrees not to transfer the responsibility to a third party without the consent of the Department.

7. The contract price includes all expenses which may be recovered by the contractor from Parks Canada in connection with the work.

8. The contractor shall supply all equipment and materials required for the study, except where otherwise specifically noted in this contract, and shall provide all necessary assistance and pay all incidental expenses.

9. The final report will be professionally adequate in

content, presentation and terminology, and of a quality such that it could, at the discretion of the Director, Parks Canada, be published.

The reports paid for under this contract are the property of the Government of Canada.

9.1 In this section,

a) "copyright work" means any work in which a copyright may subsist, produced in or as a result of performing the contract.

b) "publication" or "publish" do not include disclosure to an academic supervisor or appraiser for the sole purpose of academic evaluation.

9.2 Copyright in any copyright work vests in Her Majesty but in any publication of such work by or on behalf of Her Majesty the contribution of the contractor and of the author shall be acknowledged.

9.3 The contractor and the author each shall have a royalty free non-exclusive licence to publish or have published any copyright work in the course of the normal dissemination of knowledge in the subject field, but they shall not publish or have published any copyright work during the performance of the contract or for a period of three months thereafter without the prior written consent of the Minister.

9.4 Any copyright work published by or on behalf of the contractor or the author shall acknowledge that the

work was performed under contract with Her Majesty unless the Minister gives notice to the contrary.

9.5 The copyright and all proprietory rights of ownership or use of any and all slides, photographs - positives and/or negatives - sketches or other illustrations made, or taken by the contractor in any way related to the work to be performed under this contract shall belong to Her Majesty the Queen in right of Canada.

10. Collection of specimens will be strictly limited to those specified or made necessary by the terms of the contract. The contractor and his designated assistants shall comply with the following requirements when collecting specimens under the contract agreement.

10.1 Carry the collecting permit supplied by Parks Canada at all times when engaged in collecting activities or when in possession of specimens and present it upon request of Parks Canada staff or R.C.M.P. officers;

10.2 Obtain any permits that may be required by other agencies relating to collection of certain species or types of specimens;

10.3 Obtain specific authorization from the Director, National and Historic Parks Branch, before collecting specimens of species considered to be rare or endangered in Canada.

10.4 Refrain from collecting specimens where such action may hazard the status of the species in the Park or

when an individual is associated with a next or with young;

10.5 Refrain from collecting specimens in the Park when the intent of the contract can be met by collection of taxonomically comparable specimens from areas adjacent to the Park;

10.6 Comply with conditions specified on the permit.

11. The contractor shall be allowed access to reports in the Research and Resource Inventory collection which pertain to the project and, where necessary, may be provided access to pertinent information from Branch files. Such material is located at Branch Headquarters, Regional Office, and Park Offices and shall be utilized at these places.

12. The contractor shall inform the field supervisor in advance of plans for field work in the Park and shall make arrangements so that the field supervisor is kept informed of progress.

13. At the start of the field work in the Park (each season), the contractor or an authorized representative shall meet with the field supervisor and such Park staff as he designates to review his plans for the season.

14. Prior to leaving the Park (for the season), the contractor or a designated representative shall meet with the field supervisor to review progress and inform him of any important results to date.

15. Interim progress reports shall be submitted in one (1) copy only, both maps and text. The original of the final annual reports including original illustrative material (e.g. negatives) will be deposited at the Pacific Biological Station.

16. The contractor shall maintain a close liaison with the Resource Studies Manager, Western Regional Office, and shall arrange for the work to be reviewed at critical points in the project.

17. Upon completion of each year's final report, the contractor should be prepared to give a seminar on the research to provide all interested Park personnel with a better understanding of the results, purpose, and methodology of this study.

18. If requested, the contractor shall incorporate into the field party one Park Warden, designated by the Field Supervisor, and shall instruct the Park Warden in any techniques on methodologies which might be required to supplement or update the marine resource inventory data. Warden involvement will be encouraged, but due to manpower limitations it may be restricted by previous scheduling or emergency operations.