

# **South Winchelsea Island and West Ballenas Island Habitat Survey**

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SOUTH WINCHELSEA ISLAND AND WEST BALLENAS ISLAND  
HABITAT SURVEY

by

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## ABSTRACT

MacDougall, L.A. 1999. South Winchelsea Island and West Ballenas Island habitat survey. Can. Manuscr. Rep. Fish. Aquat. Sci. 2480: 27p.

This survey describes the marine foreshore habitat of South Winchelsea Island, and West Ballenas Island. Physical and biological characteristics of the backshore, intertidal and subtidal zones were assessed from a boat and by SCUBA diving in September, 1998.

South Winchelsea Island has a more homogenous foreshore than West Ballenas Island. Algal, invertebrate and fish species are similar for each island; however, there are greater differences between transects on West Ballenas Island than there are on South Winchelsea Island. Similar studies conducted in nearby areas recorded greater numbers of fish than were recorded from this study. Limited algal cover, time of year, and restricted sample size may have contributed to the low fish count.

Further studies of the area are required, and the described transect sites should be surveyed again in different seasons.

## RÉSUMÉ

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La présent étude décrit l'habitat marin de la zone littorale de l'île South Winchelsea et de l'île West Ballenas. Les caractéristiques physiques et biologiques de l'arrière-plage et des zones intertidale et infratidale ont été évaluées à partir d'un bateau et par plongée autonome en septembre 1998.

La zone littorale de l'île South Winchelsea est plus homogène que celle de South Ballenas. On observe les mêmes espèces d'algues, d'invertébrés et de poissons dans les deux îles; toutefois, les différences sont plus importantes entre les transects de l'île West Ballenas que ceux de l'île South Winchelsea. Des études similaires menées dans des zones avoisinantes ont révélé un plus grand nombre de poissons que celui enregistré dans le cadre la présente étude. Le petit nombre de poissons peut être attribuable à une couverture algale limitée, à la période de l'année et à la petite taille de l'échantillon.

D'autres études de la zone sont nécessaires, et les sites de transects décrits doivent être de nouveau étudiés à différentes saisons.



## INTRODUCTION

South Winchelsea Island is located about 5 km north-east of Schooner Cove Marina, near Nanoose Bay, Vancouver Island. South Winchelsea Island is an example of Garry oak savannah, with little or no freshwater introduction to the marine environment. Vegetation includes grasses, Garry oak, Douglas fir, pine, as well as several endangered and vulnerable plant species (The Land Conservancy of British Columbia [TLC], 1998). Grey Rock, like South Winchelsea Island, has creviced bedrock cliffs with little vegetation. However, Grey Rock is not as large or as high above sea level as South Winchelsea Island, and does not have a level high backshore with vegetation. Some small grasses grow above the high water mark, but the vegetation is very scarce. Intertidal and subtidal habitats on South Winchelsea Island and Grey Rock consist primarily of bedrock – either a bedrock platform or cliff of varying steepness – with gravel or sandy areas present below the bedrock on most transects.

West Ballenas Island is located about 8 km north-west of Schooner Cove Marina. It is larger than South Winchelsea Island, and has beach areas, small sheltered coves, rocky outcroppings and high bedrock cliffs. The backshore consists of shrubs, deciduous and coniferous trees, grasses and other plant species. Intertidal and subtidal areas are variable, including sheltered, flat pebble beaches, exposed steep bedrock cliffs, and boulders in high current.

The Winchelsea and Ballenas islands are part of the Ballenas/Winchelsea Archipelago, a group of 19 islands on the west side of the central Strait of Georgia (Figure 1). Prevailing winds in the Strait of Georgia are typically from the north-west in the summer, and the south-east in the winter (Thomson, 1981). The strait has mainly locally generated wave action, because of its' separation from the rest of the Pacific, making it "like an inland sea remote from the ocean" (Stephenson and Stephenson, 1961). This area is characterised by moderately strong tidal streams, influence from Fraser River runoff, and residual currents (Thomson, 1981). The average surface circulation in the Strait of Georgia in the Winchelsea/Ballenas area is counter-clockwise, with the current moving south-east on the west side of the strait, and north-west on the east side of the strait (Thomson, 1981).

The Strait of Georgia is one of many fishery closure sites in British Columbia. According to R. J. Beamish (unpublished), commercial fisheries for lingcod were closed in 1990, and restrictions on fishing season, retention size and daily limits have recently been increased on recreational fishing for lingcod and rockfish. Beamish notes that stocks of lingcod have been noticeably declining since the late 1970s, and states that the management measures adopted over the past decade have not rebuilt lingcod stocks to levels that appeared sustainable in the past. Beamish calls the collapse of lingcod stocks in the Strait of Georgia one of [the] tragic legacies of our intervention into marine ecosystems.

The Pacific Marine Heritage Legacy (1996) suggests that the Ballenas/Winchelsea Archipelago is a “unique and rather remarkable area within the context of the high level of development on the east coast of Vancouver Island”. They have suggested that the archipelago has had little invasion by exotic species, and has not been grazed by cattle or deer. In addition, all but three islands in the archipelago are currently under some kind of protection. Only West Ballenas Island (44.5 ha), Gerald Island (11.3 ha), and Mistaken Island are privately owned and unprotected. South Winchelsea Island (10.4 ha) was recently purchased by The Land Conservancy of British Columbia (TLC), a non-governmental organization dedicated to the protection of biodiversity in British Columbia.

Previous studies in the area include surveys of the terrestrial habitat on South Winchelsea Island by The Land Conservancy of British Columbia (Turner, pers. comm.). In addition, background information including sport and commercial fishing data, number of seal and sea lion haulouts, and shellfish harvest data has been compiled for the area (Beamish, unpublished). Evaluations of fish habitat (Russell and Morrison, 1985), and fish assemblages (Richards et al., 1985), have been conducted at sites with similar physical characteristics, and can provide a foundation for comparison. However, there is little baseline data available describing the intertidal or subtidal habitats of the Winchelsea or Ballenas islands in particular (Russell, pers. comm.).

The Habitat and Enhancement Branch of Fisheries and Oceans Canada, Coastal B.C. South, is currently attempting to obtain information about the marine environment in this area. Qualitative habitat surveys were conducted from September 16 to September 24, 1998 on South Winchelsea and West Ballenas islands, to provide some baseline information. This report summarises the surveys, and describes the general habitat types and species assemblages found at various survey locations.

## METHODS

A total of 13 sites were sampled on four inspections between September 16 and September 24, 1998 (Table 1)(Figure 2). Six sites were sampled on South Winchelsea Island, one survey was conducted circumnavigating Grey Rock, and six sites were sampled on West Ballenas Island. Sites were chosen to represent the different types of physical characteristics observed on each island.

At each site, a 50 m transect line was set perpendicular to the immediate coastline, on a compass bearing recorded by one diver. The transect lines were 10 cm braided nylon, marked at 10 m intervals and weighted with seine lead. Two divers swam each the transect line, one with a video camera (Sony Tr 81 Hi8), recording the area to 1 m on either side of the transect, the other recording fish, algal and invertebrate counts on a slate. Algae was identified to genus, fish and invertebrate species were identified to species where possible. Divers swam the entire 50 m transect, or to a depth of 20 m, whichever occurred first. Divers would made note of the maximum depth, and the depth at the end of the 50 m transect. Unknown algal species were collected for identification at a later date.

At the Grey Rock site, immediately south of South Winchelsea Island, the above method was altered to allow divers to swim completely around the islet, at depths from 0-20 m. No 50 m transect was used. Divers swam approximately 100 m around Grey Rock, and the data gathered from this site was included in the South Winchelsea Island data.

While the first and second divers were underwater, videotaping and recording fish, algal and invertebrate counts, the third diver/boat tender made notes based on observations of the intertidal and backshore areas, and photographed the survey area. This information was then used to create site descriptions.

The videotapes and diver observation records were reviewed at South Coast office of Fisheries and Oceans Canada. These were used to create general depth profiles, and a table of habitat characteristics for each transect (Table 2). The videotapes were then archived with Rob Russel of the Habitat and Enhancement Branch, Fisheries and Oceans Canada.

## RESULTS

### SOUTH WINCHELSEA ISLAND AND GREY ROCK

#### Physical Characteristics

The backshore and intertidal areas of South Winchelsea Island and Grey Rock are mainly rocky shorelines. Bedrock substrate, mostly with deep crevices, was observed from above the high water line to over 8 m below chart datum. Often there were large boulders associated with the bedrock, and gravel, sand or mud substrates were found at greater depths.

The grade of slope is variable around South Winchelsea Island. Some areas, such as the north west area surveyed for transect 1, and the north east area surveyed for transect 6, are very gradual slopes, remaining relatively shallow. In contrast, the area surveyed for transect 2, on the west side of the island, transect 4, in the south east corner, and the Grey Rock transect, are relatively steep slopes to 15-20 m depth, levelling off to a flat sandy or bedrock substrate.

The rocky shoreline on the east side of the island is broken up by two small beaches with sandy/pebbly substrate. The beaches are somewhat sheltered by bedrock outcroppings forming small bays, and the substrate slopes gradually in these areas.

#### Biological Characteristics

**Vegetation:** Typical intertidal and subtidal vegetation patterns found on South Winchelsea are shown in Figure 3 a and 3 b. Figure 3 b is also a typical vegetation profile for Grey Rock. *Ulva* sp. was the most common algal species found, occurring at

Grey Rock and every site sampled on South Winchelsea island, often growing along the entire length of the transect. Encrusting red algae was very common, also occurring along entire transects.

*Pelvetiopsis* sp. was also common, but was only found from 4 m to 0 m above chart datum, along each transect. *Microcladia* sp. was noted on the sheltered, west side of the island, but was not recorded on the east side of the island. *Laminaria* sp. and *Agarum* sp. were recorded at Grey Rock and various sites on the east and west sides of the island, but neither was found in great density at any site.

*Enteromorpha* sp., *Sargassum* sp., *Fucus* sp., *Gigartina* sp., *Prionitis* sp., *Gastroclonium* sp., and *Callophyllis* sp. were recorded in patches on various transects. These plants were usually very small, or, as was the case with *Gigartina* sp., were bleached and torn.

**Invertebrates:** The transects surveyed on the east side on South Winchelsea Island averaged more species of invertebrates than the transects surveyed on the west side of the island. Sea urchins (*Stronglyocentrotus* sp.) were abundant at Grey Rock and on four of six transects surveyed at South Winchelsea. Sea urchins were not found at transect 1 or transect 3. A sea urchin "feed line" was evident on transects 4, 5 and 6.

Bryozoans were abundant at all sites, growing on rocks, boulders, or fronds of algae.

Sea stars were common at all sites, but usually not found in large numbers. *Pisaster ochraceus*, the ochre star, was found in the largest numbers, usually from 2 m below to 2 m above chart datum. *Pisaster brevispinus*, the short-spined star, and *Pycnopodia helianthoides*, the sunflower star, were also very common, found in depths of more than 5 m below chart datum. Other types of sea stars included the blood star, *Henricia leviuscula*, and the bat star, *Asterina miniata*.

The kelp crab, *Pugettia producta* was recorded on transects 1, 4 and 6, and seemed to be most plentiful where there was a fairly dense covering of algae, such as the *Ulva* covering transect 1. In contrast, the sea cucumber *Parastichopus californicus* was most often associated with areas of scarce algal growth, such as the sea urchin feed lines on transects 5 and 6. Both kelp crabs and sea cucumbers were recorded from Grey Rock. Kelp crabs were found near the surface in algal growth, while sea cucumbers were found near the end of the transect, in deeper water (13-16 m below chart datum).

Other invertebrates that were often encountered included chitins, tunicates, anemones, limpets, whelks and snails. Usually these were present, but not abundant.

Transects with sandy/muddy substrate usually showed signs of clams: shells, siphon holes, or siphons were evident on the surface of the substrate.

**Fish:** At sites surveyed on South Winchelsea Island and Grey rock, the most abundant fish species was *Coryphopterus nicolsi*, the blackeyed goby. This species

was found on all transects, and was usually more abundant than any other fish species found. Blackeyed gobies seemed to be most prevalent in areas with sparse algal growth, and were always found on or hovering just above the substrate.

Kelp greenlings, *Hexagrammos decagrammus*, were found on all transects except 2 and 3. Usually 2-5 kelp greenlings were spotted per transect, darting rapidly to algal cover or crevices.

Sculpins (family Cottidae) were found on all but the fifth transect. Usually 1-5 sculpins were spotted per transect, near the substrate. Sculpins were not identified to species.

Other fish included striped perch (*Embiotica lateralis*), and copper rockfish (*Sebastes caurinus*). Striped perch were usually found in small schools of 2-8 fish, and were only recorded from transects 4-7. Copper rockfish were usually found alone, with one or two recorded per transect, and were found on transects 3, 4, 6 and 7.

In total, a maximum of 6 species of fish were identified, and less than 20 sculpins were recorded, but not identified to species.

## **WEST BALLENAS ISLAND**

### **Physical Characteristics**

West Ballenas Island appears to have a more varied backshore and intertidal than South Winchelsea island. In addition, West Ballenas Island has had more human influence, including a government lighthouse and associated buildings, and an orchard (Turner, pers. comm.).

The backshore and intertidal on the sheltered, south east side of the island is mainly steep bedrock, with one small cove and pebbly beach. Vegetation is limited on the steep rock slopes, and the cliffs level off about 5-10 m above the high water mark. The bedrock in the backshore and intertidal continues subtidally, often as relatively flat platforms separated by steep descents to the next platform. Sand and gravel substrates are prevalent below 10 m depth.

The east side of the island is mainly exposed to prevailing winds, and consists of high steep cliff faces, rising 20-25 m above the high water mark. This side has mostly bare, jagged rock cliffs, with some small coves and rocky outcroppings. The sharp sloping bedrock continues to about 10 m below chart datum, where the substrate changes to a sandy, flat bottom.

The north and north-west sides of the island are more gradually sloping than the east side of the island, and terrestrial vegetation grows closer to the high water mark. Sheltered coves and flat sandy beaches separate the rocky cliffs on the north and north-west sides of the island. The subtidal substrate is usually consistent with that found in the intertidal, and has a gradual slope.

## **Biological Characteristics**

**Vegetation:** Typical intertidal and subtidal vegetation patterns for West Ballenas Island are shown in Figures 4 a, 4 b, and 4 c.

*Pelvetiopsis* sp. was the most common algae recorded for the West Ballenas samples. It was found at all of the transects, attached to rocks and growing in crevices, usually from 3.5 m to 0 m above chart datum. Encrusting algae was also very common, growing on rocks and shells, and could be found along the entire length of the transect.

*Ulva* sp. was less common than at South Winchelsea Island. *Ulva* sp. was found on the more sheltered transects (1, 2, 3, and 13), growing in patches along the length of the transect, or to the urchin feed lines.

*Laminaria* sp. was found at all transects except 12, at depths greater than 2 m below chart datum, and often had bryozoans growing on its fronds. *Laminaria* sp. was dense on transect 10, near the end of the transect, from depths of 4 m to 6 m below chart datum.

*Enteromorpha* sp. was common on transects 9, 10, and 12, in dense patches throughout the transects.

Other algae included *Prionitis* sp., *Microcladia* sp., *Fucus* sp., *Gigartina* sp., *Sargassum* sp., and *Gastroclonium* sp. Algal growth on most transects was patchy and discontinuous, often interrupted by sea urchin feed lines, or steep rocky slopes. Most *Gigartina* sp. was found torn and bleached, and *Sargassum* plants were very small.

Transect 11, on the steep, sheer rocky east side of the island, had the least amount of algal growth. Transect 12, a high-current area, had fairly dense coverings of *Enteromorpha* sp. and *Pelvetiopsis* sp., and the algal growth was very short.

**Invertebrates:** The greatest number of invertebrate species was recorded at transect 11. Nudibranchs, sea cucumbers, sea urchins, tube worms and chitins were dispersed throughout the length of the transect. Other invertebrates were found in certain zones, either by depth or by substrate. For example, ochre sea stars (*Pisaster ochraceus*) were found from 1 m above to 1 m below chart datum, while shortspined sea stars (*Pisaster brevispinus*) were generally found near the deepest parts of the transect, (7-12 m below chart datum). Sea pens (*Ptilosarcus gurneyi*) and tube dwelling anemones (*Pachycerianthus fimbriatus*) were found in the sandy substrate below the bedrock cliff at 10-15 m below chart datum. Barnacles and small mussels were found in the high intertidal zone (2-5 m above chart datum), on the high relief rocky areas.

Bryozoans were common on all transects, growing on rocky substrate, fronds of algae, or on invertebrate shells.

Ochre sea stars were found on all transects, in the low intertidal or high subtidal zones, in rock crevices or on or under boulders. Sunflower stars were recorded on transects 8, 9 and 11, associated with bedrock or sandy substrates, but usually in flat areas. Shortspined sea stars were recorded on transects 11 and 13, in the lower subtidal areas, often associated with flat sandy/shell substrate.

Nudibranchs were quite common, in small numbers, and did not seem to be associated with any particular kind of substrate or algal assemblage. Nudibranchs were not recorded in the high current (transect 12) or flat, sheltered, and sparsely vegetated (transect 13) areas.

Other invertebrates found in rocky areas often included small barnacles and mussels, blood stars, sea urchins, tunicates, and bat stars. Invertebrates associated with sandy or muddy areas included clams, tube dwelling anemones, and sea pens.

**Fish:** Transect 11 had ten species of fish, more than any other transect. These included kelp greenling, painted greenling (*Oxylebius pictus*), kelp, striped, and pile perch (*Racochilus vacca*), copper and china rockfish (*Sebastes nebulosis*), and sculpins. Almost all of the recorded fish were located on or near the steep rocky cliff, 6 m to 10 m below chart datum.

Transect 13 had the fewest fish species of all transects--only blackeyed gobies and kelp greenling were recorded here.

Blackeyed gobies were abundant on sheltered and exposed transects, in rocky and sandy substrates. More than 15 gobies were recorded per transect, on transects 8-12. However, there were fewer than 10 blackeyed gobies recorded from the flat sheltered transect 13.

Schools of striped perch and pile perch were fairly common. Striped perch were found in schools of 15-20 fish on all transects except 13, pile perch were found on transects 9-12, in schools of 15-30 fish.

Small numbers of kelp greenling (1-3 per transect), were recorded on all but transect 9.

Lingcod (*Ophiodon elongatus*) were present for the majority of transects, but in small numbers. For example, one lingcod was recorded at each of the sheltered transects (8-10), and on the steep exposed transect 11. No lingcod were found on transect 12 or 13.

Fish such as cabezon (*Scorpaenichthys marmoratus*), painted greenling, shiner perch (*Cyamtogaster aggregata*), china rockfish and copper rockfish, were encountered rarely, and in very small numbers.

## DISCUSSION

### SOUTH WINCHELSEA ISLAND AND GREY ROCK

Algal assemblages were similar for most transects on South Winchelsea Island and Grey Rock, possibly due to the relative similarity of physical characteristics around the island. There was no eelgrass, and large kelps such as *Laminaria* sp. and *Agarum* sp. were rare.

Invertebrate assemblages were more varied than algal assemblages, and may be indicative of the type of substrate found on various transects, as well as the relative exposure of each transect. Invertebrate assemblages seemed to be more diverse on the east, more exposed side of South Winchelsea Island. Due to wind and wave patterns identified in the Introduction, the east side of South Winchelsea Island is the most exposed to winter winds and wave action. The west side is sheltered by North Winchelsea, and nearby Ada islands, minimising the effects of wind and waves.

### WEST BALLENAS ISLAND

As noted previously, there is greater diversity in physical characteristics of the backshore, intertidal and subtidal habitats on West Ballenas Island than exists on South Winchelsea Island.

Differences between West Ballenas Island and South Winchelsea Island may primarily be a result of the increased heterogeneity on West Ballenas Island. Invertebrate and algal species found at West Ballenas Island were similar to those found at South Winchelsea Island. However, there appears to be greater variance between transects, with respect to species diversity. This may be due to increased diversity of habitat types available on West Ballenas Island.

Fish species abundance also appeared to be more variable at West Ballenas Island. Number of species ranged from a minimum of 2 species to a maximum of 9. Generally there were 5-8 species of fish recorded per transect. The number of kelp greenlings, blackeyed gobies, and copper rockfish observed on West Ballenas was similar to South Winchelsea Island. Shiner perch, pile perch, and painted greenling were more prevalent than they were on South Winchelsea Island, although their numbers were still low. The total number of species recorded from South Winchelsea Island, Grey Rock, and Ballenas Island was in this study was 9, excluding unidentified sculpins. Catch data identifies twenty species of fish from the Winchelsea/Ballenas area (BC Catch Statistics, 1996).

### FISH

A SCUBA survey by Richards et al. in 1985 in the Strait of Georgia described a more varied species assemblage, with 5 or more species of rockfish, greenlings, perch or lingcod at each site. The sites were similar to South Winchelsea Island and West



Ballenas Island in habitat characteristics, and general location. Sites included: Texada Island, on steep bedrock walls, protected bays, and terraced bedrock and boulders; Bjerre Shoal, with boulders and gravel on a sand base; and Secret Cove, a site with broken rock forming a shallow reef. These sites were sampled from July to October, 1984, similar to the season in which our study was conducted. However, Richards et al. (1985) described greater numbers of copper rockfish, lingcod, kelp greenlings, painted greenlings, and striped and pile perch, than were found during our study.

Quillback rockfish were prominent in the survey by Richards et al. (1985), while no quillback rockfish were observed in our study. Richards et al. (1985) used 50 m transects as well, but had depths from 9-13 m and 14-18 m. Quillback rockfish tend to remain in deeper waters than copper rockfish (Richards et al., 1985; Richards, 1987). Our study may have excluded areas where quillback rockfish are more common, as most transects were less than 12 m deep.

Yamanaka and Richards (1993) suggest that current lingcod stocks in the Strait of Georgia are depressed. The numbers of lingcod recorded on this survey may support this statement. However, Williams (1989) suggests that female lingcod move offshore to deeper water prior to spawning, which does not begin until January. This may have been a contributing factor to the low numbers of lingcod recorded on this survey.

Observed lingcod were relatively small: less than 40 cm in length, which is similar to results from Richards et al. (1987). The size range of recorded lingcod was therefore well below the required 65 cm catch limit size (BC Sport Fishing Guide, 1998).

Holbrook et al. (1990) observed that giant kelp (*Macrocystis* sp.) had an effect on density of certain reef fishes. For example, they found that giant kelp had a positive effect on pile perch, and a negative effect on striped perch. They concluded that "the availability of appropriate settlement or nursery areas, such as provided by giant kelp, can have a substantial effect on the occurrence and strength of larval recruitment" (p. 108), and that the giant kelp can affect the densities of adult reef fish populations as well.

The low numbers of fish recorded in the Winchelsea and Ballenas surveys may be in part due to a shortage of appropriate algal cover. Our results suggest that the availability of large laminarian kelps is limited on Winchelsea and Ballenas Islands. In contrast, *Pelvetiopsis* sp. is commonly found in the intertidal zones on South Winchelsea Island, and West Ballenas Island. This type of algae can provide fish with a source of food, but its availability as shelter or as a nursery area is limited by its restricted growth zone (Russell and Morrison, 1985).

## SEASONAL VARIATION

Murray and Horn (1989) discuss the seasonal variation of macrophyte populations on a rocky habitat off California. In their study, they found there was correlation between overall cover and seasonal patterns. They concluded that a seasonal maxima in standing stocks occurred during late spring through summer or early fall, and a seasonal minima occurred during winter – generally the period of greatest environmental disturbance.

Our results indicated that some species of intertidal, fleshy algae, such as *Gigartina* sp., were exhibiting signs of stress, including bleached or torn fronds. Seawater temperature has been suggested as a seasonal influence on seaweed populations (Murray and Horn, 1989), and observed damage in our study may have been as a result of prolonged high summer temperatures. Murray and Horn (1989) also cited a study by Cubit (1984) indicating that algal cover in the Oregon intertidal was greater in cooler, wetter winter months than in warm, dry summer months.

Further study at these sites, during late fall, winter and spring seasons would be beneficial, to determine if there are differences in algal populations by season.

## ACCURACY

Richards et al. (1985) chose a line transect of variable width, to allow recorders to cover as large an area as possible, as fish abundance was relatively low. They suggested that a fixed width may be more suitable in areas with high cryptic fish abundance, to allow a more thorough search of crevices. In our case, fish abundance was very low, and a variable width for the transect may have been more suitable for our study, allowing a conversion from total fish to density of fish.

Thompson and Mapstone (1987) suggested that errors in visual surveys are usually related to the visibility of organisms and the technique of the observer. They indicated that errors related to organism visibility result in underestimation of population densities, while observer errors are roughly random, affecting the precision, but not the bias, of estimates. Thus, our results likely underestimate the population densities, due to sample size, observer experience and visibility of organisms. Establishing specific rules by which fish are counted, and increasing familiarity with the sites may help to limit observer related error (Thompson and Mapstone, 1987).

## RECOMMENDATIONS

The physical and biological characteristics of the mainly rocky habitat of South Winchelsea Island and West Ballenas Island are similar to characteristics described by Richards et al. (1985), Russell and Morrison (1985), Murray and Horn (1989), and Stephenson and Stephenson (1961). However, species richness and diversity appeared to be lower at our study site than at nearby sites studied by Russell and Morrison (1985) and Richards et al. (1985). It is not clear if the Winchelsea/Ballenas

area is a less productive area than the other study sites, or if the lower species diversity is a result of our restricted sample size. Increasing the number of transects, or the number of times each transect is sampled, would reduce the uncertainty of our study.

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Table 1. Locations of sites sampled during the 1998 dive survey.

Site No.	Description
1.	Northwest tip of South Winchelsea islet, smooth rocky foreshore, transect set on bearing of 235°. Jagged bedrock, algae in low intertidal and subtidal, trees, shrubs, and grasses in high backshore.
2.	West side of South Winchelsea, off the red and white marker, transect set on bearing of 210°. Very steep bedrock with crevices, little vegetation on cliffs, trees, shrubs, and grasses in high backshore.
3.	West side of South Winchelsea, in small bay, transect set on bearing of 140°. Gradual grassy slope to the water, trees and shrubs in high backshore.
4.	South-east tip of South Winchelsea, parallel to rock outcropping and part of seal haul-out, transect set on bearing of 75°. Moderate slope, little vegetation in intertidal, trees, shrubs, and grasses about 3 m above shoreline.
5.	East side of South Winchelsea, in semi-sheltered rocky bay, transect set on bearing of 30°. Steep slope, boulders and bedrock platforms, trees, shrubs, and grasses in backshore.
6.	Northeast tip of South Winchelsea, in small gravel and rock bay, parallel and close to rock wall, transect set on bearing of 360°. Gradual to moderate slope, bedrock becoming gravel and sand in subtidal. Little vegetation in high intertidal, grasses in backshore.
7.	Grey Rock, southeast of South Winchelsea. Divers surveyed to a depth of 20 m around the perimeter of Grey Rock. Low rock outcropping south of South Winchelsea Island. Algae in low intertidal, grasses in backshore.
8.	West side of West Ballenas Island, in small natural bay bordered by steep rock on north side, and lower mounds of rock on south side, transect set at mouth of bay, on bearing of 330°. Gradual slope, rock and gravel beach, driftwood, trees, grasses, and shrubs in backshore.
9.	Between West and East Ballenas Islands, small rocky islet chain joining the two, on the east (sheltered) side of the islet. Steep slope, little vegetation in intertidal, mosses and grasses in backshore.

10. West side of West Ballenas Island, off rocky point, transect set on bearing of 120°. Steep bedrock in platforms, algae in low intertidal, trees, shrubs, and grasses in high backshore.
  11. Southeast tip of West Ballenas Island, exposed, off steep, high rocky cliff, transect set on bearing of 45°. Little algal growth in intertidal. Trees, shrubs in high backshore, about 10 m above shoreline.
  12. Northeast tip of West Ballenas Island, exposed, high current rocky shore, transect set from shore in front of cable-marker sign, on bearing of 245°. Boulders, gradual slope, algal growth in intertidal, trees and shrubs about 15 m back from shoreline.
  13. East side of West Ballenas Island, semi-sheltered gently sloping pebble beach, transect set on bearing of 330°. Tall grasses and shrubs 2-5 m from shore, trees more than 5 m from shore, little algal growth in intertidal.
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Table 2. Habitat characteristics of sites sampled during the 1998 dive survey.

Site	Length (m)	Zone	Physical characteristics	Biological characteristics
1. northwest tip of South Winchelsea	50	backshore	sheltered, bedrock cliffs, crevices, relatively steep incline	little vegetation on cliffs; arbutus, Garry oak, pine, Douglas fir, grasses, blackberry at top of cliffs on level.
		intertidal zone	bedrock with crevices, large boulders	small barnacles, <u>Fucus</u> , <u>Pelvetiopsis</u> .
		subtidal zone	gradually sloping bedrock/boulders, some areas of fine sediment covering bedrock.	thick covering of <u>Ulva</u> , patches of <u>Laminaria</u> , <u>Agarum</u> , kelp crabs, <u>Pisaster ochraceus</u> , <u>Pycnopodia</u> , blackeyed gobies, kelp greenling
2. west side of South Winchelsea	30	backshore	very steep moderately sheltered bedrock cliffs with deep crevices	some small barnacles on incline; grasses, arbutus, Garry oak, Doug fir, pine and blackberries at top of cliffs.
		intertidal zone	deeply creviced, steep bedrock cliffs	small barnacles, small mussels
		subtidal zone	steep creviced bedrock, levelled to sandy bottom at 20 m.	sparse algal growth; some <u>Ulva</u> , <u>Pelvetiopsis</u> , <u>Microcladia</u> and <u>Prionitis</u> sea urchins, sea cucumbers, <u>Pycnopodia</u> blackeyed gobies abundant, sculpins
3. west side of South Winchelsea	50	backshore	40° slope, sandy sediment and grassy covered.	grasses, with pine, arbutus, and Garry oak at top of incline.
		intertidal zone	large riprap material, almost flat (very gradual slope)	<u>Pelvetiopsis</u> , <u>Ulva</u> , small barnacles
		subtidal zone	soft fine mud, scattered with shells	<u>Ulva</u> , <u>Agarum</u> , <u>Microcladia</u> , <u>Gigartina</u> tunicates, <u>Pisaster</u> , tube dwelling anemones, clams, sea cucumbers, sculpins, blackeyed gobies, copper rockfish.
4. southeast tip of South Winchelsea	50	backshore	rocky cliffs, 50° slope, deep crevices	little vegetation on cliffs; grasses and pine, arbutus, Garry oak at top of incline.
		intertidal zone	bedrock with deep crevices, large boulders, rocky outcroppings.	<u>Ulva</u> , <u>Enteromorpha</u> , <u>Pelvetiopsis</u> seal haul out; small barnacles,
		subtidal zone	smooth bedrock, deep crevices, sandy/shell bottom at mid transect, then more bedrock: semi exposed site.	algae for first 3-5 m depth, then urchins— <u>Ulva</u> , <u>Laminaria</u> , <u>Gastroclonium</u> , encrusting algae kelp crabs, <u>Pisaster ochraceus</u> and <u>P. brevispinus</u> , bat star, sea anemones, whelks, limpets, abalone, sea urchins copper rockfish, striped perch, kelp greenling, sculpins, blackeyed gobies.

Table 2 (cont'd).

Site	Length (m)	Zone	Physical characteristics	Biological characteristics
5. east side of South Winchelsea	50	backshore	Rocky beach, to bedrock cliffs in semi sheltered bay.	Little vegetation. on cliffs, grasses and pine, arbutus, Garry oak at top of incline.
		intertidal zone subtidal zone	Large boulders, gravel, bedrock, gradual slope. smooth bedrock, with crevices	<u>Ulva</u> , <u>Pelvetiopsis</u> , encrusting algae, small barnacles. <u>Ulva</u> and <u>Laminaria</u> dominant, some <u>Gigartina</u> , <u>Porphyra</u> , and encrusting red and coralline algae. sea urchins dominant near end of transect, sea cucumbers, snails, tunicates, chitins, <u>Pycnopodia</u> , striped perch, blackeyed gobies abundant, kelp greenlings.
6. east side of South Winchelsea	50	backshore	Uneven large boulders and small cobble bay area, gradual slope.	encrusting algae, <u>Enteromorpha</u> .
		intertidal zone subtidal zone	Bedrock, large boulders, relatively flat grade. Bedrock, crevices, small rocks, some sandy substrate, gently sloping.	<u>Pelvetiopsis</u> , <u>Ulva</u> . snails, barnacles. <u>Ulva</u> , some <u>Gigartina</u> , <u>Agarum</u> , and <u>Laminaria</u> . sea urchin feed line at 6 m depth, kelp crabs, sea cucumbers, snails, chitins, <u>Pycnopodia</u> , blood star, <u>Pisaster brevispinus</u> , anemones, red rock crab. striped perch, kelp greenling, blackeyed gobies, sculpin, copper rockfish.
7. Grey Rock		backshore	fairly steep jagged bedrock	little vegetation—some moss, lichen only
		intertidal zone subtidal zone	bedrock some bedrock, levelling off to sandy/muddy flat bottom on s-e side of island, gravel/boulder flat bottom on n-w side, at ~17 m.	<u>Pelvetiopsis</u> small barnacles, mussels <u>Ulva</u> , <u>Enteromorpha</u> , encrusting algae, <u>Laminaria</u> kelp crabs, clams, anemones, sea pens lingcod, blackeyed gobie, kelp greenling,
8. west side of West Ballenas	50	backshore	steep vertical rock on north side of small natural bay, lower mounds of rock on south side of bay.	grasses and shrubs on south side of bay, no vegetation on steep rock on north side, pine and arbutus trees at top of cliffs.
		intertidal zone subtidal zone	Boulders, basketball-sized rocks, and pebble/sand beach, gradual slope. Gradually sloping bedrock with deep crevices.	<u>Pelvetiopsis</u> , barnacles, small mussels  <u>Ulva</u> patches throughout, <u>Laminaria</u> , <u>Prionitis</u> , <u>Mastocarpus</u> , <u>Pelvetiopsis</u> . <u>Pycnopodia</u> , <u>Pisaster ochraceus</u> , sea cucumber, nudibranchs, sea urchins. lingcod, kelp greenling, copper rockfish, striped perch, shiner perch, blackeyed gobies.

Table 2 (cont'd).

Site	Length (m)	Zone	Physical characteristics	Biological characteristics
9. south side of islet chain between East and West Ballenas	50	backshore	jagged steep bedrock, deep crevices, no loose sediment.	little vegetation: some mosses, lichens and grasses.
		intertidal zone	Steep bedrock and bedrock platform.	<u>Pelvetiopsis</u> , <u>Enteromorpha</u> , barnacles, small mussels,
		subtidal zone	Platforms of bedrock separated by steep vertical drops, substrate changing to smaller cobble at 8 m below chart datum.	<u>Pelvetiopsis</u> , <u>Laminaria</u> , <u>Prionitis</u> , <u>Ulva</u> , encrusting algae. <u>Pisaster ochraceus</u> , Pycnopodia, sponges, nudibranchs, painted greenling, lingcod, pile/striped perch schools, copper rockfish, Cabezon, blackeyed gobies.
10. west side of West Ballenas	50	backshore	steep bedrock, levels out ~15 m above high water mark.	Grasses ~10 m above high water mark, arbutus, pine, poplar, shrubs on level.
		intertidal zone	steep rocky in high intertidal, levels to bedrock platform	<u>Ulva</u> , <u>Enteromorpha</u> barnacles, mussels
		subtidal zone	Steep, large bedrock with crevices to 4 m below chart datum, sloping gradually to large boulders then to gravel. Max depth 8 m.	<u>Callophyllis</u> , <u>Gigartina</u> , <u>Gastroclonium</u> for 1st 6 m, patches of <u>Ulva</u> and <u>Laminaria</u> throughout, <u>Laminaria</u> becoming dense near transect end. blood, leather stars, <u>Pisaster</u> , sea cucumbers, sea urchins, nudibranchs. kelp greenling, copper rockfish, striped/pile perch schools, lingcod, sculpins.
11. southeast tip of West Ballenas	50	backshore	steep bedrock cliff ~20 m vertical, levelled off at top	no vegetation on cliff face, arbutus, Garry oak, grasses, pine on level.
		intertidal zone	steep cliff, some platforms of jagged bedrock and indentations.	<u>Pelvetiopsis</u> barnacles
		subtidal zone	steep drop-off to 12 m, large bedrock platforms with deep crevices, at 12 m levelled to sand and shell substrate.	<u>Pelvetiopsis</u> , <u>Microcladia</u> sparsely growing in crevices, some <u>Laminaria</u> , encrusting algae. sea urchins dominant at 12 m, anemones, sea pens, nudibranchs, sea cucumbers, tube worms, chitins, <u>Pycnopodia</u> , <u>Pisaster</u> . fish all near the steep area: striped/kelp perch schools, copper rockfish, painted greenling, sculpin, blackeyed gobies, kelp greenling, lingcod, china rockfish.

Table 2 (cont'd).

Site	Length (m)	Zone	Physical characteristics	Biological characteristics
12. east side of West Ballenas	50	backshore	Uneven substrate—partly cobble beach, smooth, deeply creviced bedrock, large boulders.	grasses shrubs, arbutus and pine.
		intertidal zone	Large boulders, some gravel substrate.	<u>Pelvetiopsis</u> dominant, some filamentous brown algae. barnacles.
		subtidal zone	gradually sloping, sand/pebble bottom with large boulders. Swift current.	Pile/striped perch schools. <u>Pelvetiopsis</u> , <u>Ulva</u> , encrusting red and filamentous brown algae. anemones, <u>Pisaster</u> , chitins, kelp crabs. kelp greenling, blackeyed gobies.
13. east side of West Ballenas	50	backshore	semi sheltered gently sloping pebble beach, surrounded by low bedrock walls.	Tall grasses and blackberries in lower backshore, pine, arbutus, poplar trees in higher backshore.
		intertidal zone	flat pebble beach with bedrock on east and west of beach.	<u>Pelvetiopsis</u> , some <u>Ulva</u> .
		subtidal zone	flat shallow pebble and sandy substrate, some shells near end of transect.	<u>Ulva</u> , <u>Gigartina</u> , <u>Laminaria</u> patches. tube dwelling anemones, <u>Pisaster</u> , clams. blackeyed gobies, kelp greenling.

Table 3a. Record of fish and algae observed on each transect during the 1998 dive survey.

max																									
Transect	location d(m)	BG	CR	SN	LC	KG	PG	DV	CY	SP	CZ	SC	AG	CA	CO	PE	GI	ME	MI	PR	UL	LA	EA	PO	SA
160901	w. win	8	>10	0	0	2	0	0	0	0	0	3	a	0	0	l	0	l	0	a	a	0	a	0	0
160902	w. win	16	>10	0	0	0	0	0	0	0	0	>5	l	0	0	l	0	0	l	l	l	a	a	0	0
160903	w. win	8	15	3	0	0	0	0	0	0	0	>5	l	0	0	a	l	0	l	l	l	a	l	0	0
220904	e. win	9.5	>30	1	0	0	3	0	0	2	0	1	0	0	0	l	0	0	0	0	l	l	a	0	l
220905	e. win	7.5	>35	0	0	0	5	0	0	5	0	0	0	0	0	0	l	0	0	0	a	a	f	l	0
220906	e. win	7.5	>15	2	0	0	6	0	0	2	0	4	0	0	0	l	l	0	0	0	a	f	f	0	0
220907	g. rock	16.5	0	2	2	2	0	0	0	>30	0	0	0	0	0	f	l	0	0	0	f	l	0	f	0
230908	w. blns	6.8	>10	1	0	1	2	0	0	>10	>20	0	0	0	0	l	0	0	0	f	l	l	f	0	0
230909	w. blns	10	>20	7	0	1	0	1	>20	0	>20	1	0	0	0	l	0	0	0	l	l	a	0	0	
230910	w. blns	6.5	>10	3	0	1	3	0	>20	0	>20	0	6	0	l	0	f	l	0	0	a	l	f	0	l
240911	e. blns	11.5	>20	2	2	1	2	1	>20	0	>20	0	3	0	0	a	0	0	l	0	0	l	a	0	0
240912	e. blns	6.5	>10	0	0	0	1	0	>20	0	>20	0	0	0	0	a	0	0	l	0	0	0	a	0	0
240913	e. blns	8.5	<10	0	0	0	3	0	0	0	0	0	0	0	0	l	l	0	0	0	l	f	f	0	0

Legend:

Location:

w. win = west side of South Winchelsea Island

e. win = east side of South Winchelsea Island

w. blns = west side of West Ballenas Island

e. blns = east side of West Ballenas Island

g. rock = Grey Rock

max d(m):

maximum depth (in meters)

Fish:

BG=blackeyed gobie CR=copper rockfish SN=china rockfish LC=lingcod KG=kelp greenling

PG=painted greenling DV=pile perch CY=shiner perch SP=striped perch CZ=cabezon SC=sculpin

Algae:

AG=agarum CA=callophyllis CO=codium PE=pelvetiopsis GI=gigartina ME=membranoptera MI=microcladia

PR=prionitis UL=ulva LA=laminaria EA=encrusting algae PO=porphyra SA=sargassum

Abundance:

a=abundant, l=less abundant, f=few

Table 3b. Record of invertebrates recorded on each transect during the 1998 dive survey.

Transect	location	substr.	CL	PI	PY	PC	TA	MU	BA	LI	WA	SU	ST	BR	KC	AB	AM	PB	AN	WH	SN	CH	PG	PP	HL	NU
160901	w. win	2	6	7	0	3	3	2	0	0	>50	0	0	0	a	1	0	0	0	0	0	0	0	0	0	0
160902	w. win	2	5		0	6	3	5	0	>50	>50	0	2	<30	0	a	0	0	0	0	0	0	0	0	0	0
160903	w. win	3	8	7	10	2	5	5	<30	>50	>50	0	0	0	1	a	0	0	0	0	0	0	0	0	0	0
220904	e. win	2	6	7	0	5	3	0	0	0	0	<30	0	>50	0	a	10	4	4	3	10	<30	0	0	0	0
220905	e. win	3	5	2	0	0	4	3	0	0	>50	0	0	>30	4	a	0	0	0	0	0	<30	0	0	0	0
220906	e. win	3	4	6	0	10	2	6	0	0	0	0	0	<30	0	1	6	0	0	0	12	0	0	0	0	0
220907	g. rock	3	2	7	0	0	0	6	0	>50	>50	0	6	<30	0	0	0	0	0	0	0	0	6	0	0	0
230908	w. blns	2		0	7	4	8	0	0	0	0	<30	0	a	0	0	0	0	0	0	0	0	0	0	4	6
230909	w. blns	2	3	4	0	8	5	0	0	>50	0	0	0	a	0	0	0	0	0	0	0	0	3	3	0	4
230910	w. blns	2	3	5	0	9	0	12	0	<50	0	0	<30	0	1	0	0	6	0	0	0	0	0	0	3	4
240911	e. blns	2	6	7	0	14	4	11	>20	0	<50	0	0	>30	0	1	0	0	4	0	0	9	3	0	0	12
240912	e. blns	3	2	5	0	6	0	0	0	0	0	<30	5	1	0	0	0	0	0	9	0	14	0	0	0	0
240913	e. blns	5	6	2	>20	8	0	0	>20	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0

Legend:

Location:

w. win = west side of South Winchelsea Island      e. win = east side of South Winchelsea Island

w. blns = west side of West Ballenas Island      e. blns = east side of West Ballenas Island

g. rock = Grey Rock

Substrate:

1=smooth bedrock    2=creviced bedrock    3=boulders    4=cobble    5=gravel    6=sand    7=shell    8=mud

Invertebrates:

CL=clam (unident.) PI=pisaster PY=pyncnopodia PC=sea cucumber TA=tube dwelling anem.

MU=mussel BA=barnacle LI=limpets BT=black turban RT=red turban WA=white plumed anem SU=sea urchin

BR=bryozoan KC=kelp crab AB=abalone AM=bat star PB=short spined star AN=sea anemone WH=whelk SN=snail

CH=chitin ST=solitary tunicate PG=sea pen PP=sponge HL=blood star NU=nudibranchs

Abundance:

a=abundant, l=less abundant, f=few

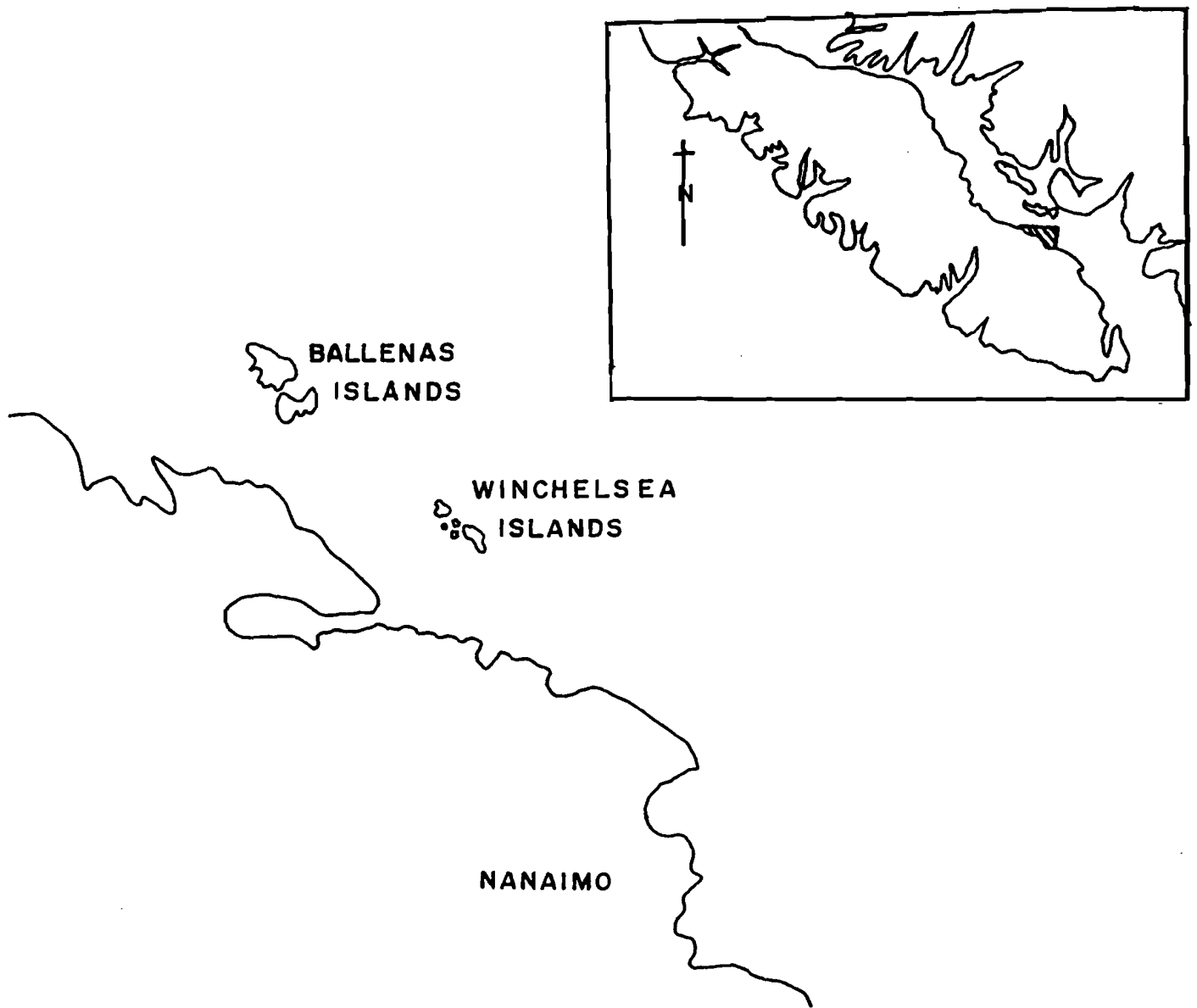


Fig. 1. Winchelsea/Ballenas study area (general location is marked by shaded box in the Vancouver Island map).

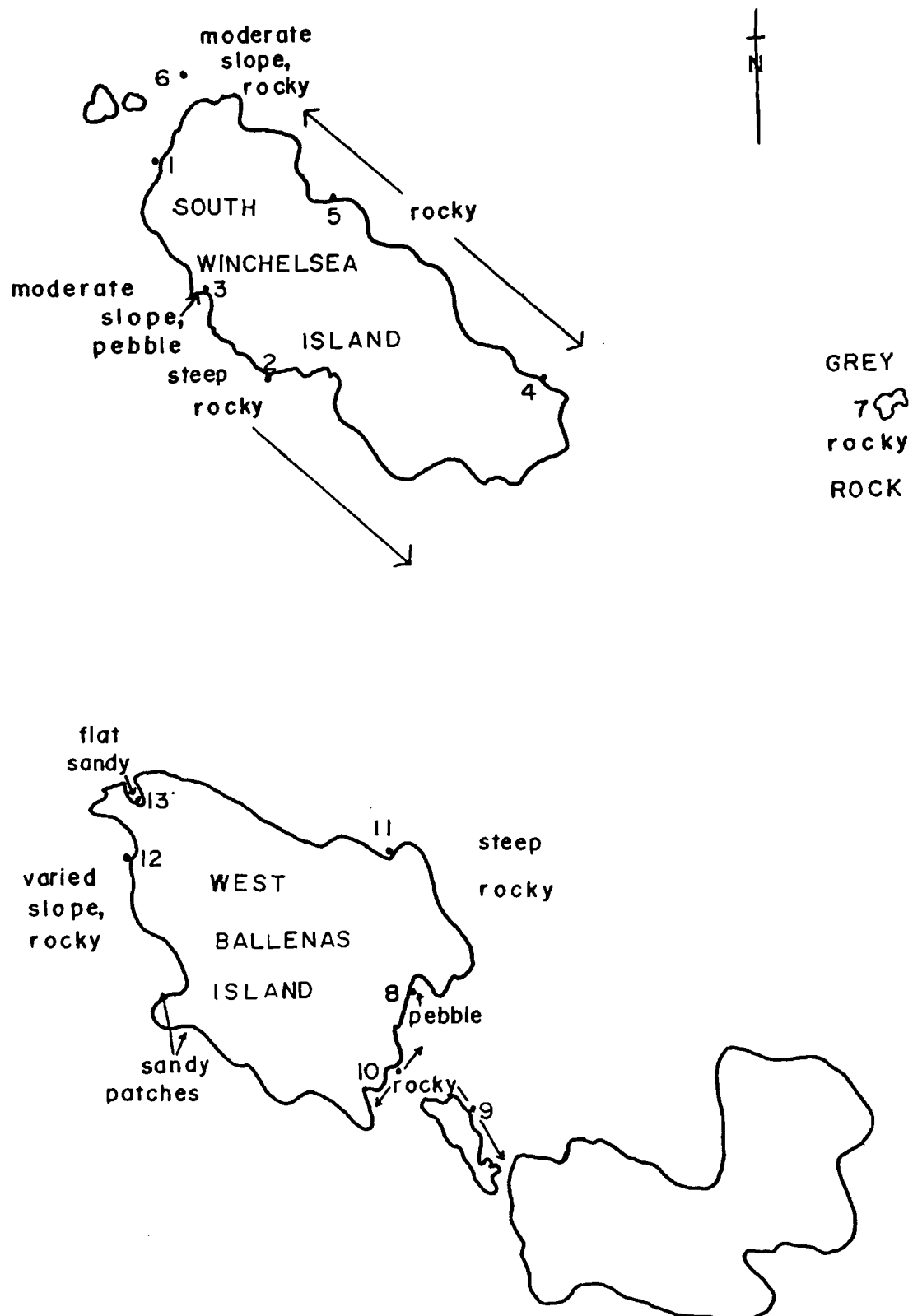


Fig. 2. Winchelsea/Ballenas transect locations



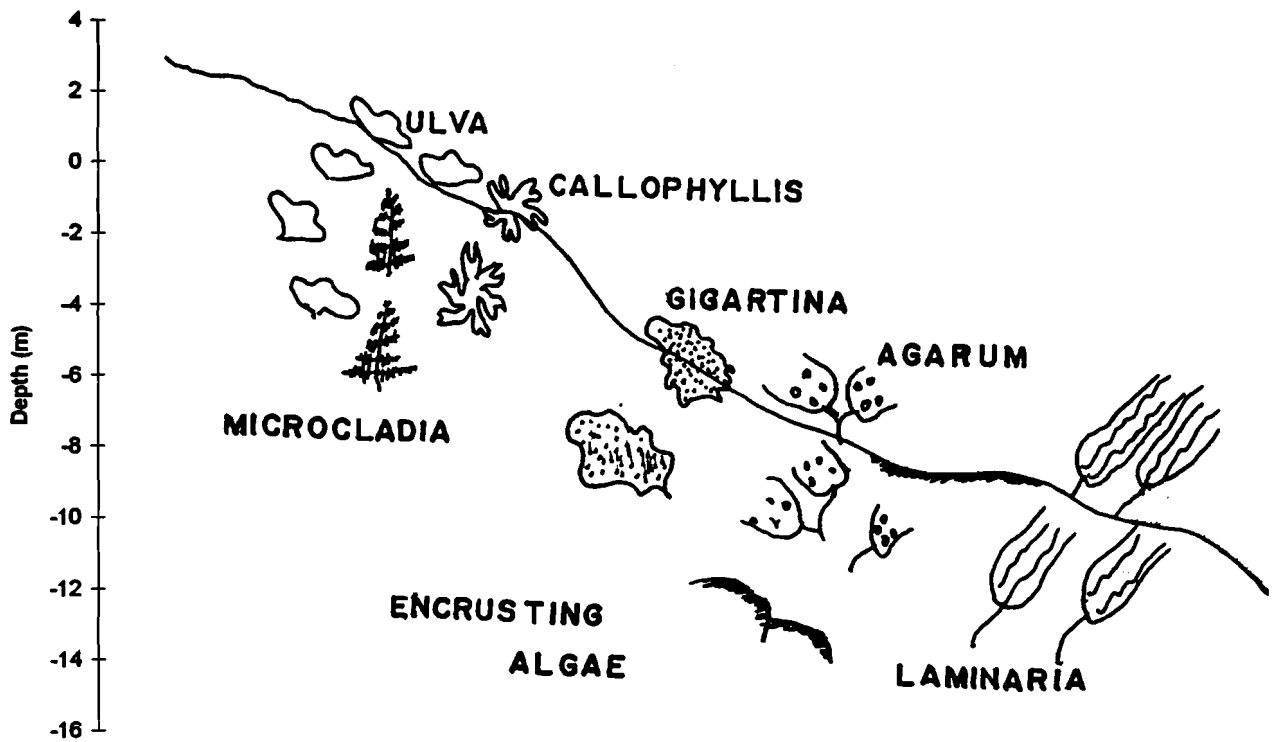


Fig. 3a. Marine foreshore vegetation profile, South Winchelsea Island: sheltered transects.

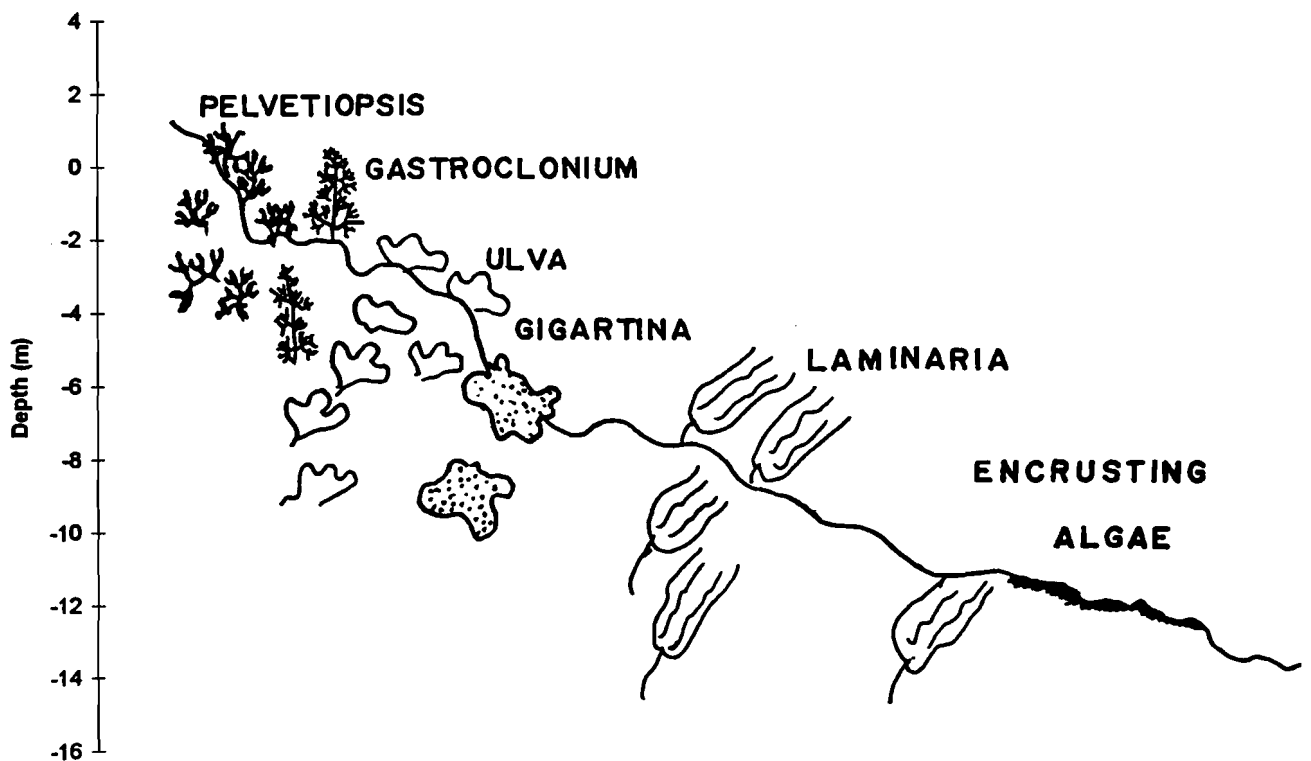


Fig. 3b. Marine foreshore vegetation profile, South Winchelsea Island: exposed transects.

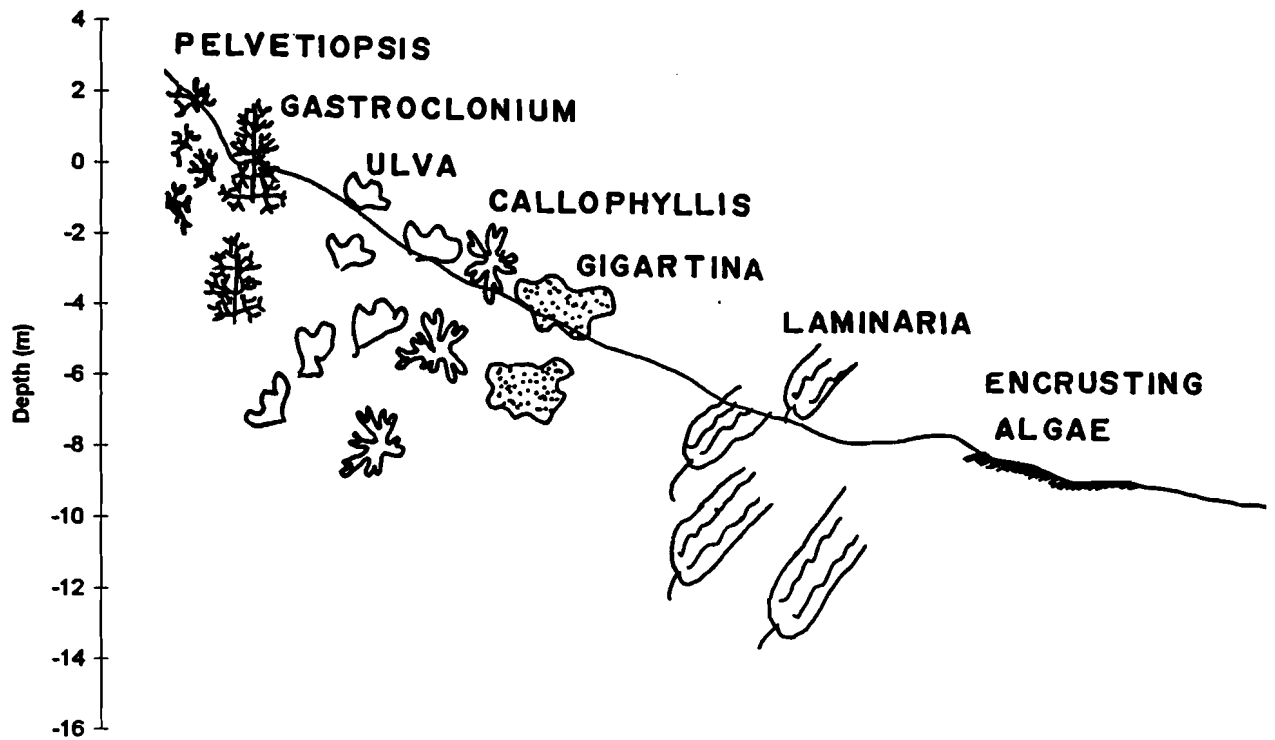


Fig. 4a. Marine foreshore vegetation profile, West Ballenas Island: sheltered transects.

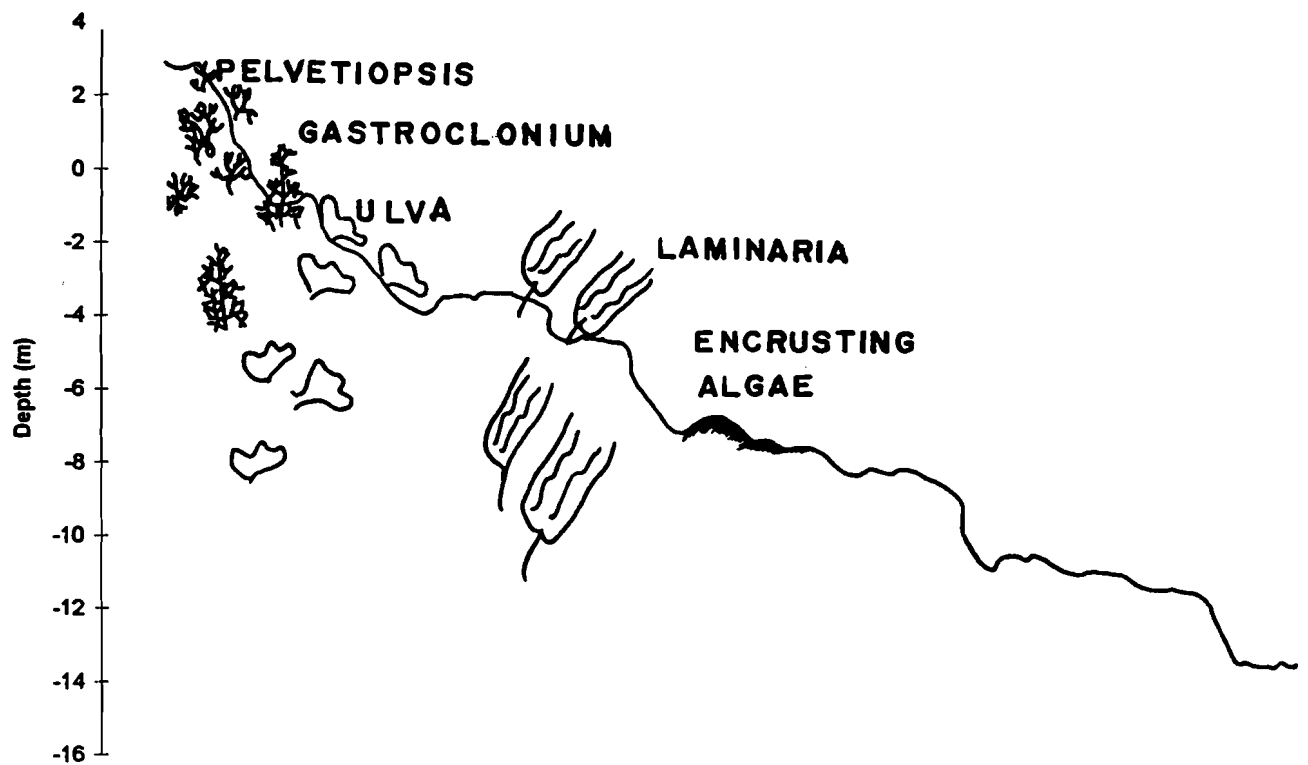


Fig. 4b. Marine foreshore vegetation profile, West Ballenas Island: exposed transects.

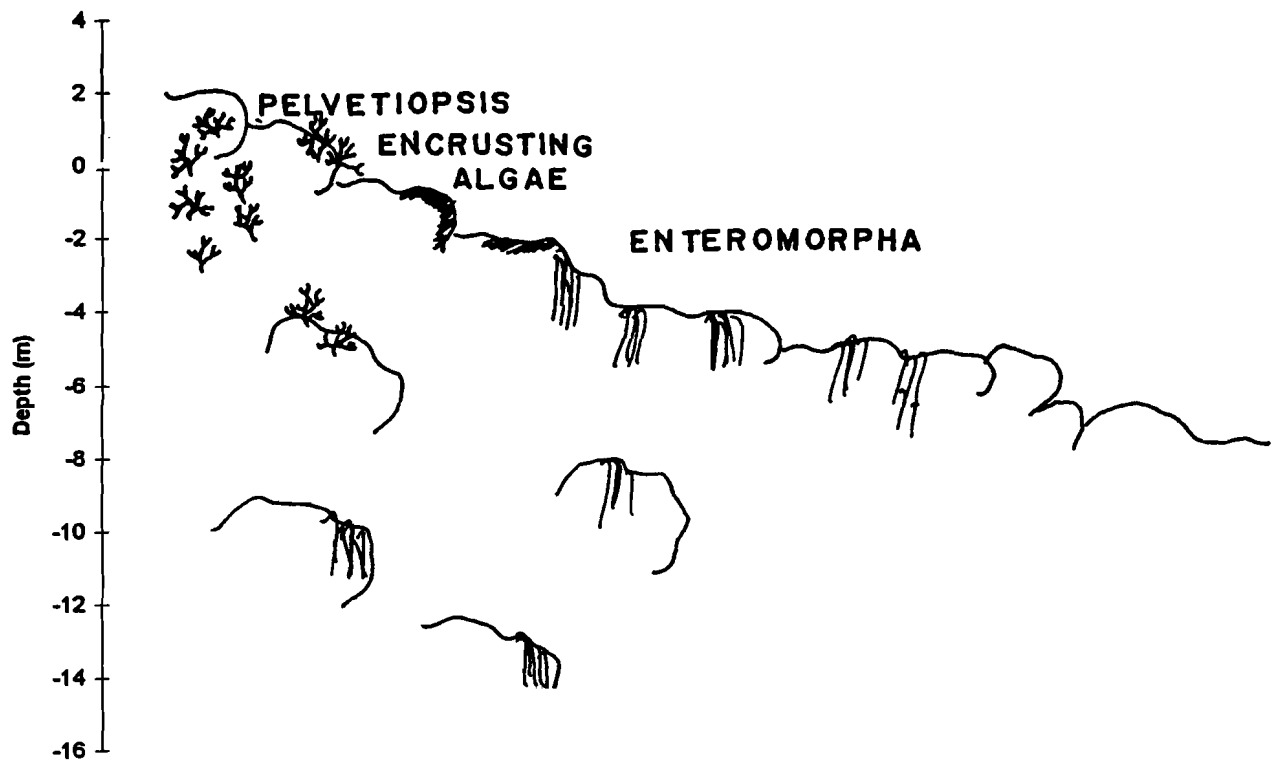


Fig. 4c. Marine foreshore vegetation profile, West Ballenas Island: high current transect.