ECOLOGICAL ASSESSMENT OF SUBLITTORAL PLANT COMMUNITIES IN THE NORTHERN GULF OF ALASKA

by

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INTRODUCTION

This final report presents the results of our sublittoral baseline investigation, which was initiated in the summer of 1975 in conjunction with the National Marine Fisheries Service intertidal program for the northeastern Gulf of Alaska (NEGOA). Three rocky intertidal stations were selected by NMFS, Auke Bay Biological Laboratory, for inelusion in the NEGOA littoral program, namely: (1) Latouche Point, Latouche Island; (2) Macleod Harbor, Montague Island and (3) Zaikof Bay, Montague Island, in Hinchinbrook Entrance (Figure 1).

The National Marine Fisheries Service established intertidal baseline monitoring sites in each of the previously mentioned locations during 1974-75. The intended purpose of our participation in the program was to expand the biological data acquisition in each location into the shallow sublittoral zone adjacent to the shoreline.

The shallow rocky sublittoral zone in the north Gulf coast - Prince William Sound region is typically dominated by benthic marine plants, therefore the initial effort was directed at identifying the organisms found within these assemblages. The rocky sublittoral zone is defined as the hard or consolidated substratum which lies below MLLW (mean lower low water), or the 0.0' tide elevation on nautical charts. It is for the most part a continuation of the intertidal, for many of the organisms and life history patterns are common to and transcend both zones. Usually there is no distinct break in distributions, and a separation of the two zones is more of a sampling convenience than a reality.

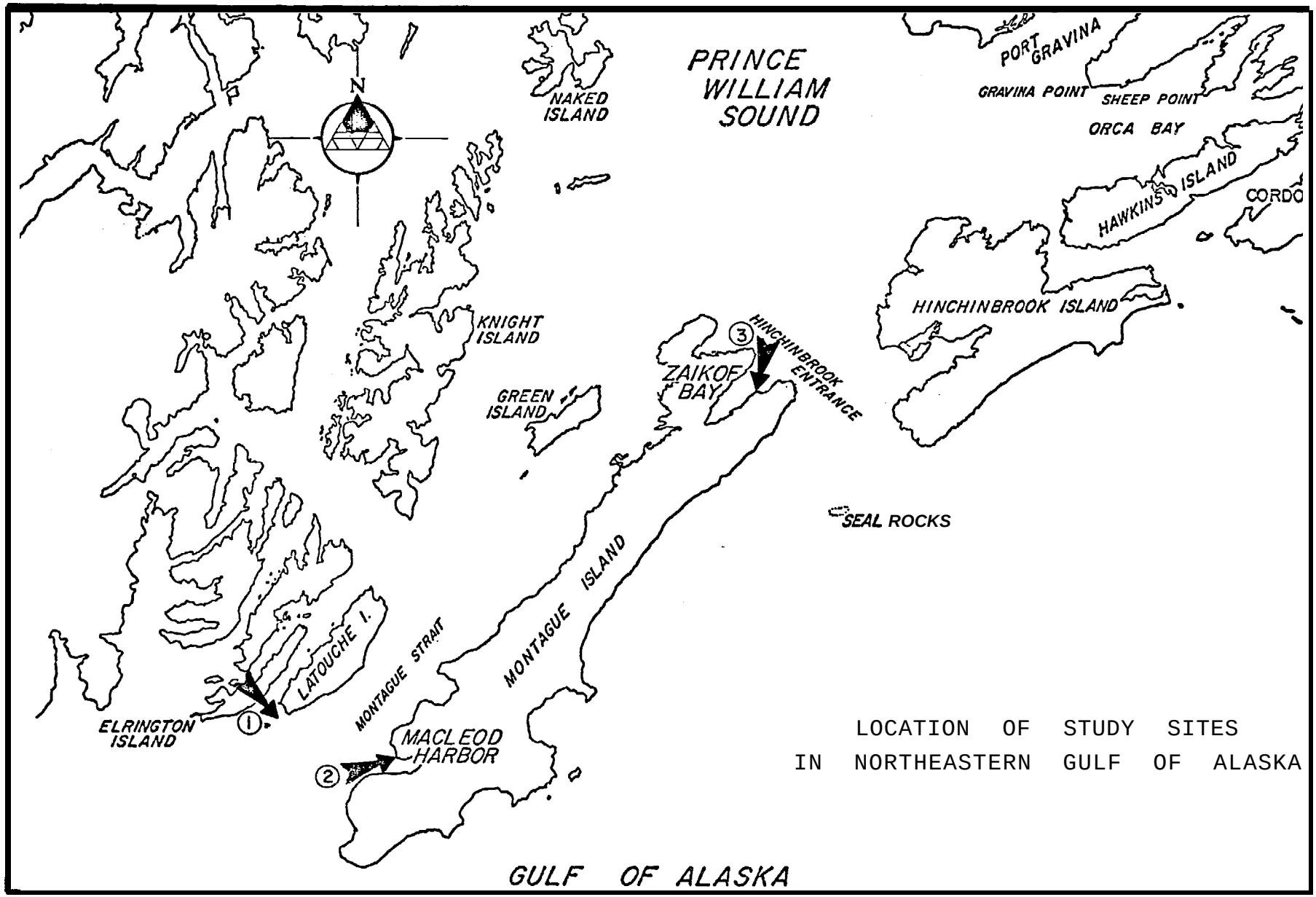


Figure 1. Location of study sites in northeastern Gulf of Alaska.

The solid substratum covers a wide range of geological facies, ranging from patches of gravel and cobbles to extensive reefs composed of exposed bedrock or pavement. Typically, the biota is attached to, or associated with the hard substrate. Because the populations inhabiting various substrata and microhabitat types are frequently different, they require different sampling and study regimes.

The present field study began on July 22, 1975, when diver-biologists associated with Dames & Moore made observations in Zaikof Bay. The nearshore stations were revisited subsequently in mid-September 1975, late November 1975, mid-March 1976 and late June 1976. These observations and sampling periods spanned five seasons from summer 1975 through early summer 1976. Each location was sampled at least three times, and one of the stations (Latouche Point) was visited on five separate occasions.

GENERAL STUDY OBJECTIVES

The purpose of this study was to provide an inventory of the biological resources and ecological composition of three rocky sub-littoral sites in the northeastern Gulf of Alaska. This was accomplished by first making a reconnaissance survey of the study sites in order to make a qualitative assessment of the habitat types present. After this phase, more intensive sampling was conducted at each location.

During this baseline investigation, we attempted to provide a characterization of habitats, biotic assemblages and species composition

that reflected seasonal or temporal differences. The intent was to examine the baseline parameters that would partially serve as a basis for assessment of impacts and provide the background data necessary for designing long-term monitoring studies.

METHODS

Most of the direct observations were made while scuba diving at depths from MLLW to about 30 meters below the sea surface. A total of 52 dives, representing approximately 119 man hours, were spent underwater during this phase of the project. Our normal procedure was to spend between 3 and 4 days working at each site. More casual observations dealing with Wage of the inshore zone by birds and mammals were made either in route to, or while anchored on station. Movement to the OCS study sites and living accommodations while in the field were provided by the M.V. Humdinger, a 36' commercial troller that is equipped for diving and intertidal research.

Numerical information was gathered from specific locations in the subtidal zone. Except when collecting specimens, we tried not to disturb the organisms or their environment. All observations were made during daylight hours.

Because of the multitude of species present within the shallow subtidal zone, we chose to limit our sampling to the more conspicuous or characteristic species in the assemblage. Characteristic or representative important species are: (1) species of obvious numerical (biomass) importance, (2) species that are known to have important

structural roles for furnishing habitat, (3) the competitive dominants or key predators which may be uncommon, but which are considered likely to have important functional roles in the maintenance of the community and (4) species of aesthetic or present-day commercial value.

Several types of quantitative data have been collected about the characteristic species present at each site. Included are estimates of density (number of specimens per meter^2), frequency (spatial distribution), and percent cover (primary and secondary space). Methods of estimating percent cover, or the amount of surface area occupied by a particular taxon or group varied. Usually this information was obtained from replicated 0.25m^2 quadrats. The quadrats were either placed in a haphazard (unbiased) manner, or stratified in such a way that a particular habitat or microhabitat was sampled in the sublittoral zone. The surface or floating seaweed canopies were estimated visually.

Random or haphazard transect bands of various dimensions were also used in each location to estimate density (abundance). The transects were usually run along a specific isobath or depth contour. However, due to physical heterogeneity, some changes in depth and substrate were frequently encountered.

Biomass estimates have been generated for selected species at the study sites as a first step toward estimating consumption rates, and to provide information on temporal variations in population structure at specific sites, Measurements of linear size (length, width, aperture width, etc.) and weight (wet or dry weight of soft tissue) have also been obtained.

In addition to the numerical information derived from the quadrats and transects, species-specific interactions or natural history phenomena involving feeding and reproduction were also recorded. These methods assisted in describing the conditions at each study site and permitted examination of the differences between seasons and locations.

THE MARINE PLANT COMMUNITY

From the high watermark or splash zone of the littoral zone down to a depth of about 30 meters below the sea surface, the rocky habitats in the northern Gulf of Alaska are visually dominated by marine vegetation. The macroscopic seaweeds and seagrasses (macrophytes) form a conspicuous belt along the seashore. However, this band is not continuous, and is occasionally broken or interrupted by conditions in the physical environment that are unfavorable or preclude plant colonization and growth. Some of the marine plants that occur either in shallow waters, or grow along the beachlines are visible at various stages of the tide. There are a few subtidal species that form floating canopies that periodically become visible to even the casual observer. However, most of the vegetative band is below the low tide level, and is therefore unseen by surface observers.

The terms community and assemblage are used freely and often times interchanged throughout this report. The question of whether a community is an organized unit (system), or simply a collection of species with similar biological requirements is unresolved at the'

present time. However, a definition we have been able to work with is simply "a community is a group of species which are often found living together" (Fager, 1963).

The rocky sublittoral waters generally contain the greatest number of seaweed species. Typically this habitat is dominated by the broad-leafed brown algae or kelps which display high standing crop. Frequently, the attached benthic plants form dense stands or beds that are comparable to a meadow or terrestrial forest. In some parts of the North Gulf Coast the vegetative belt is wide and extends approximately 5 to 6 kilometers from shore; in other locations where vertical relief is sharp, the width of the belt is less than a few hundred meters (Rosenthal, unpublished data). Inmost areas, significant development of algal assemblages is limited to the upper 25 meters of the water column.

Marine plant communities are highly productive systems (Dawson, 1966; Mann, 1973), which typically attract or contain numerous animals, many of the species are of commercial or high aesthetic value. Some of the associated species live year-round or complete their life cycle in these habitats, while others, such as the herring or king crab, have a more temporary or transitory occurrence.

Recent studies (review by Mann, 1973) have pointed out the important role of macrophytes in coastal productivity. For example, Mann (1972) estimated the primary production in the seaweed zone in St. Margaret's Bay, Nova Scotia averaged 1750 grams of carbon per square meter per year. This was about three times more than the total phyto-plankton production in the same bay. Additional studies by Westlake

(1963) indicate annual levels of production of seaweeds in northern latitudes between 1,000 to 2,000g $c/m^2/yr$. Since these figures apply only to a narrow zone adjacent to land, the estimates are even more important when evaluating the contribution of the seaweeds to the production of carbon in Prince William Sound, a marine ecosystem dominated by its lengthy, rocky shoreline and extensive macrophyte zone.

The floristic components of sublittoral algal assemblages in southern Alaska have received very little attention until the past decade. Recently, Rosenthal and Barilotti (1973), and Dayton (1975) provided descriptive information on kelp bed ecosystems off the west coast of Chichagof Island, Alexander Archipelago and Amchitka Island in the Aleutian Chain. Additional studies conducted by Rosenthal and Lees (in Dames & Moore, 1976a) in Kachemak Bay; Lees and Rosenthal *(in* Dames & Moore, 1977) on the Outer Kenai Peninsula, and Rosenthal (in Dames & Moore, 1976b) in northeastern Prince William Sound provide lists of species, vegetative profiles and estimates of density and percent cover for the characteristic seaweeds in these general locations.

Johansen (1971) made a relatively complete collection of the macroalgae from the Prince William Sound region. Thirty-three shoreline stations in the Sound were occupied approximately 15 months after the earthquake of March 27, 1964. However, all of the collections and observations were made in the intertidal zone, and no information was obtained from the shallow sublittoral waters adjacent to the shore.

In 1913, the U.S. Department of Agriculture conducted a survey of the kelp beds of Alaska (Cameron, 1915). This investigation

was primarily designed to inventory the location, size, type and estimated yield of existing kelp beds in southern Alaska. The importance of this kind of information to present day research has been in providing historical records of the size and exact location of Alaskan kelp beds. Two of the locations in this present study, namely, Macleod Harbor and the southwest end of Latouche Island, are listed in the kelp bed inventory of western Alaska (Rigg, 1915).

RESULTS

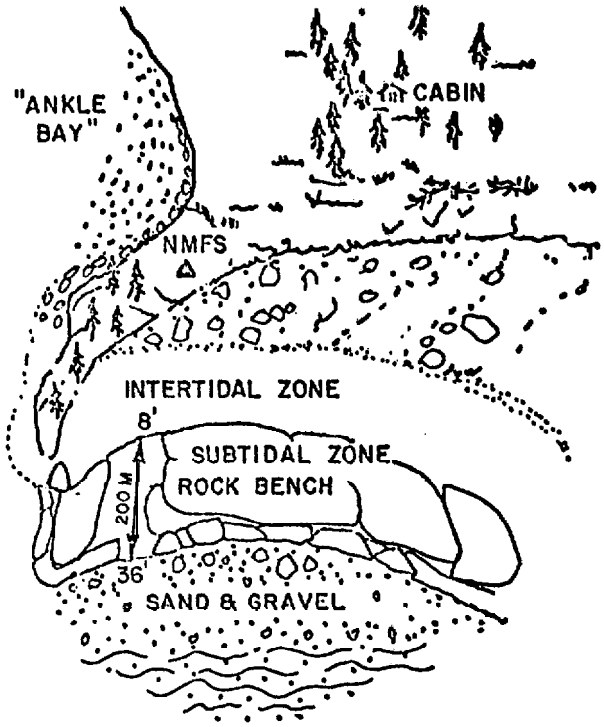
DESCRIPTION OF THE STUDY SITE (LATOUCHE POINT)

Latouche Island is situated on the southwest edge of Prince William Sound. The primary site in this present study was off the extreme southwestern end of the island near a rocky promontory that we have appropriately named Latouche point (Figure 1). The point is strategically situated between Latouche Passage on the north and Montague Strait to the south. Both waterways are major arteries connecting the Sound to the Gulf of Alaska. The entire island underwent dramatic land-level changes during the March 27, 1964 earthquake, resulting in the shoreline being uplifted approximately 10 feet (Plafker, 1969). The present-day shoreline is rocky and moderately wooded with spruce and hemlock. Salt grass (Elymus) is common above the high water mark.

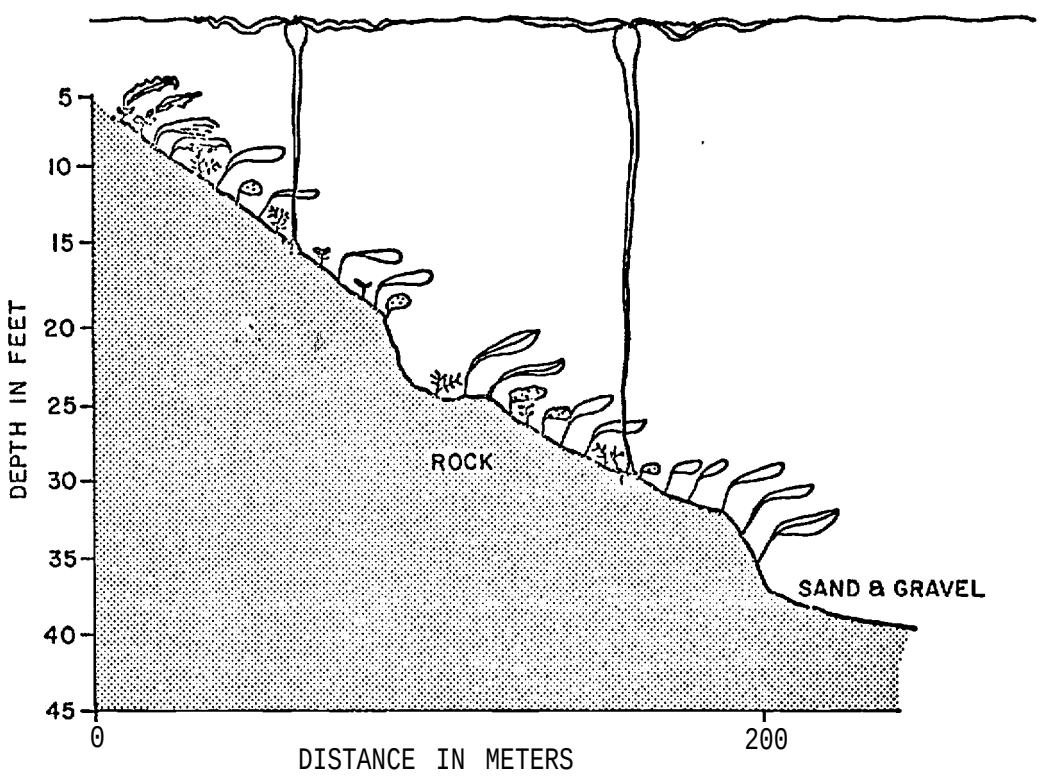
The point is exposed to westerly ocean swells, and a great deal of drift accumulates along the beachline, especially during early fall and spring. Tidal currents are typically moderate to weak in the

lee of the Point. However, further offshore or in Latouche passage where the water mass is not deflected by land, the tidal currents can exceed 2 nautical miles per hour.

The rocky bench that fringes the southwest end of the island projects at least 200 meters horizontally into the shallow sublittoral zone (Figure 2). These measurements were made directly seaward or southwest of the NMFS intertidal transect, from the intertidal-subtidal fringe to a point where the rock and unconsolidated sediments merge. An overall change in water depth from between 9 and 10 meters was recorded between these two ecotones. Surge channels cut through the rock bench and generally run in a perpendicular fashion with respect to the shoreline. Beyond the rockbench the seafloor becomes' somewhat homogeneous, and the bottom is composed mainly of coarse sands, gravel and shell debris. Ripple marks were prominent features of the unconsolidated substrate.



(A)



(8)

Figure 2. Study site (A) and subtidal vegetative canopies (B) at Latouche Point.

BIOLOGICAL SETTING (ALGAL ASSEMBLAGE)

Much of the subtidal study area off Latouche Point was covered by a heavy growth of macroalgae. During summer months a large bed of bull kelp (Nereocystis luetkeana) grew on the shoal area between Latouche Point and Danger Island. The floating portion of the kelp bed was highly visible at slack low tide. Most of the Nereocystis grew on either the reck pavement or boulders. Individual plants were found from the intertidal-subtidal fringe, out to depths in excess of 20 meters. The densest part of the bed was between the 3 and 15 meter depth contour. Densities ranging up to 1.40 individuals/m^2 were observed for mature hull kelp (Tables 1 and 2). The average density during all sample periods was 0.35 plants/m^2. Juvenile Nereocystis were present in the study area during spring and summer; juveniles peaked in the spring and early summer and adult plants peaked in summer and early fall.

The vegetative understory beneath this floating or surface canopy wasmulti-layered,or composed of a number of separate algal canopies. The second canopy level during summer was composed of the annual brown alga Cymathere triplicate. Typically, Cymathere grew on cobbles, gravel and shell debris. It was extremely common in early summer (1976), and densities during the June survey averaged 3.16 plants/m^2 (Table 2). The plants were highly aggregated with a maximum of 11.60/m^2 in the band transects. Some of these plants were 2 to 3 meters in length. The third canopy level was composed of Laminaria

TABLE 1

DENSITY ESTIMATES OF SONE DOMINANT MACROPHYTES AT LATOUCHE POINT
(estimates were derived from band transects of different lengths)

Taxon	9-17-75	9-17-75	11-26-75	11-26-75	11-26-75	n-27-75	3-18-76	3-18-76
Nereocystis luetkeana	3 0. 12/m^2	0	0	0	1 0.06/m^2	14 0. 93/m^2	0	0
Laminaria spp.	116 4. 64/m^2	251 10.04/m^2	84(15)* 6. 60/m^2	74 (61)* 5. 60/m^2	171(61)* 15.47/m^2	Not counted	126 12. 6/m^2	83 8. 30/m^2
Agarum cribrosum	37 1. 48/m^2	49 1. 96/m^2	40 2. 67/m^2	26 1. 73/m^2	25 1. 67/m^2	Not counted	14 1. 40/m^2	4 0. 40/m^2
Pleurophycus gardneri	7 0. 28/m^2	7 0. 28/m^2	0	0	2 0.13\m2	Not counted	16 1. 60/m^2	9 0.90/m^2
Constentinea spp.	Not counted	Not counted	16 1. 07/m^2	24 1. 60/m^2	10 0. 67/m^2	Not counted	Not counted	Not counted
Opuntiella californica	Not counted	Not counted	8 0.53/m3	16 1.07/m^2	34 2. 27/m^2	Not counted	Not counted	Not counted
Ptilota filicina	Not counted	Not counted	17 1. 37/m^2	6 0. 40/m^2	31 2. 07/m^2	Not counted	Not counted	Not counted
Area sampled:	25 x1m	25 x 1m	15 x 1m	15 x 1m	15 x 1m	15 x 1m	10X3.UI	10XI3U
Depth :	12m	12m	12m	14m	7m	7-8m	10m	8m
Substrate type:	Rock	Rock	Rock & Sand	Rock & Sand	Rock	Rock	Rock & Sand	Rock & Gravel

* Number in parenthesis indicates these plants had undergone blade renewal.

TABLE 2

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES
AT LATOUCHE POINT

(Estimates Were Derived from Band Transects of Different Lengths)

Taxon	6-25-76	6-25-76	6-25-76	6-25-76	6-25-76	6-25-76	6-25-76	6-26-76	6-26-76	6-26-76	6-26-76	6-26-76
Nereocystis luetkeana	6 1. 20/m^2	1 0. 20/m^2	3 0. 60/m^2	2 0. 40/m^2	1 0. 20/m^2	1 0. 20/m^2	7 1. 40/m^2	4 0.13/m2	0	3 0. 60/m^2	0	7 0. 23/m^2
Laminaria groenlandica*	27 5. 40/m^2	21 4. 20/m^2	48 9. 60/m^2	0 -	0	0	0	Not counted	19* 3. 80/m^2	20* 4. 00/m^2	29* 5. 80/m^2	Not counted
Laminaria yezoensis	11 2. 20/m2	13 2. 60/m^2	19 3. 80/m^2	28 5. 60/m^2	1 0. 20/m^2	0′	0	Not counted	5 1. 00/m^2	0	2 0. 40/m^2	Not counted
Laminaria dentigera				22 4. 40/m^2	37 7. 40/m^2	44 8. 80/m^2	32 6. 40/m^2	Not counted				Not counted
Agarum cribrosum	10 2. 00/m^2	4 0. 80/m^2	1 0. 20/m^2	5 1. 00/m^2	1 0.2 0/m^2	0	0	Not counted	7 1. 40/m^2	3 0. 60/m^2	8 1. 60/m^2	Not
Pleurophycus gardneri	1 0. 20/m^2	0	0	2 0. 40/m^2	5 1. 00/m^2	24 4. 80/m^2	30 6. 00/m^2	Not counted	0	2 0. 40/m^2	4 0. 80/m^2	Not counted
Cymathere triplicate	1 0. 20/m^2	7 1. 40/m^2	8 1. 60/m^2	10 2. 00/m^2	53 10.60/m^2	0	0	Not counted	0	58 11.60/m^2	21 4.20/m^2	Not counted
Alaria sp.	1 0. 20/m^2	3 0. 60/m^2	3 0. 60/m^2	0	0	4 0.80/m^2	13 2. 60/m^2	Not counted	0	1 0. 20/m^2	0	Not counted
Area sampled:	5x1 m	5x1 m	5x1 m	5x1 m	5x1 m	5x1 m	5x1 m	30x1 m	5x1 m	5x1 m	5x1 m	30x1 m
Depth :	15 m	13.5 m	13.5 m	6 m	5 m	3.5 m	3.5 m	9 m	9 m	9 m	9 m	9 m
Substrate type:	Sand, gravel & cobble	Gravel, cobble & rock	Gravel, sand & rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock

TABLE 3

QUADRAT DATA (0.25m2) FROM LATOUCHE POINT, SUBTIDAL
SEPTEMBER 17, 1975

Taxon	No. 1	No. 2	No. 3
Laminaria spp.	50% (6)	70%	16%
Pleurophycus		20%	
Agarum			40% (1)
Constantinea	20%(7)		20%(4)
Ptilota	P		
Membranoptera	15%		
Foliose, reds, unid.		10%	1%
Encrusting coralline	50%	P	60%
Articulated coralline	5%		20%
Hildenbrandia sp.	2%	5%	
Synoicum	1%		
Musculus vernicosus	P		P
Acmaea mitra	(1)		
? Scrupocellaria			1%
Pagurids	(3)		(2)
Tonicella spp.			(1)
Chelyosoma sp.			(1)
Balanus nubilus			(1)
Depth (meters):	11.0	11.0	11.0
Substrate type:	Boulder & Gravel	Gravel	Boulder & Gravel

TABLE 4

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 26, 1975

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No, 5
Agarum	0	0	40%(2)	o	0
Laminaria spp.	50%(2)(5)*	10%(2)*	5%(2)*	60%(2)	95%(5)(l)*
Ptilota	2%(1)	lo%(l)	o	l%(l)	o
Encrusting coralline	80%	25%	90%	95%	40%
Constantinea	o	1%(1)	o	o	2%(2)
Articulated coralline	20% (8)	o	15%(9)	15%(6)	O
Opuntiella	5%(3)	0	5%(1)	0	5%(2)
Foliose reds, unid.	5%	5%	2%	0	o
Rhynchozoon	5%	1%	o	0	0
Styela	(1)	o	0	0	0
Yellow spatter sponge	3%	0	2%	0	0
Cancer oregonensis	o	(1)	o	0	o
Trichotropis	5%	o	0	0	o
Encrusting sponge	o	1%	2%	0	0
Synoicum	0	5%	2%	1%	0
Pagurids	(1)	o	o	O	0
Serpulidae	(2)	0	(1)	(1)	0
Syconid sponge	(1)	0	o	o	0
Tonicella	(1)	0	0	0	0
Orange globular sponge	o	0	1%	1%	0
White globular sponge	0	0	1%	o	0

Depth (meters): 7.0-8.0
Substrate type: rock bench

* Plants undergoing blade renewal

TABLE 5

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 26, 1975

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Agarum	30% (2)	25%(2)	30% (1)	20% (1)
Laminaria spp.	40%(7)	20%(2)	30%(2)	15%(1)
Ptilota	2% (1)	l%(l)	15% (1)	0
Encrusting coralline	45%	60%	80%	95%
Constantinea	8% (2)	0	0	5% (1)
Articulated coralline	5%(3)	30% (lo)	40% (13)	15% (7)
Opuntiella	0 ,	5%(1)	5%(1)	0
Foliose reds, unid.	5%	2%	0"	0
Musculus vernicosus	(2) ,	(1)	(1)	0
Microporina	1%	5%	5%	0
Synoicum	1%	2%	5%	1%
Pagurids	(7)	(4)	(7)	(3)
Cryptolithodes	0	(1)	0	0
Abietinaria	0	0	1% (1)	0
Lichenopora	0	0	1%	1%
Tricellaria	0	0	2%	1%
Orange globular sponge	(1)	0	0	0
Tonicella	0	0	0	(1)
Encrusting sponge	0	0	(1)	0

Depth (meters): 10.0
Substrate type: Rock bench

TABLE 6

QUADRAT DATA (0.25m²) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 26, 1975

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Agarum	15%	50%(2)	60% (4)	15% (2)
Laminaria SPP.	10% (3)	70%(2)	25% (1)	40% (2)
Ptilota	20% (4)	4%(2)	25% (1)	5%(1)
Encrusting coralline	90%	65%	50%	50%
Constantinea	o	2% (3)	0	0
Articulated coralline	Io%(5)	25%(8)	2%(4)	15% (8)
Opuntiella	o	0	2% (1)	0
Hildenbrandia	0.	0	1%	0
Membranoptera	0	0	0	2%
Foliose reds, unid.	0	2%	1%	0
Musculus vernicosus	0	(3)	(7)	0
Synoicum	1%	1%	0	0
Rhynchozoon	1%	1%	0	0
Tricellaria	2%	2%	3%	5%
Fusitriton	(1)	0	0	0
Strongylocentrotus	o	(1)	0	0
Orthasterias	0	0	0	(1)
Boltenia	0	0	0	(1)
Microporina	0	0	0	1%
Dendrobeania	0	2%	0	4%
Amphissa	0	0	0	(3)
Pagurids	(2)	(2)	(2)	(4)
Yellow spatter sponge	o	0	0	2%

Depth (meters): 12.0
Substrate type: Rock bench

TABLE 7

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 26, 1975

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Agarum	15%	0	10% (1)	0
Laminaria yezoensis	40% (2)	5%	30%(2)	0
Laminaria spp.	40%(2)	0	30%(3)*	40%(3)(3)*
Bossiella	8% (4)	0	0	0
Corallina	5% (4)	5%(1)	1% (1)	8%(5)
Ptilota	1% (1)	1%(1)	1% (1)	1% (1)
Constantine	2% (1)	0	0	0
Foliose reds, unid.	0	2%	2%	3%
Encrusting coralline	80%	80%	75%	90%
Hildenbrandia	0	0	10%	0
Microporina	40%	10%	30%	30%
Syconid sponge	0	0	0	(1)
Musculus vernicosus	(8)	0	0	(8)
Triopha carpenter	0	(1)	0	0
Serpulidae	0	0	(1)	0
Synoicum	1%	1%	1%	0
Tricellaria	1%	1%	1%	0
Dendrobeania	0	0	1%	1%
Pagurids	0	(3)	0	(1)
Heteropora	0	0	0	1%
Diodora	0	0	(1)	0
Calliostoma	0	0	0	(1)
Yellow spatter sponge	0	0	2%	1%

Depth (meters) : 12.0-14.9
Substrate type: Rock bench

* Plants undergoing blade renewal

TABLE 8

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 27, 1975

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Agarum	40%(3)	25% (0)	0	25%(1)	15%
Laminaria yezoensis	0	0	0	20% (1)	30% (2)
Laminaria spp.	10%	40%(3)(1)*	40%(4)	20%	30% (3) (2)*
Laminaria (holdfast)	30%	35%	40%	40%	40%
Hildenbrandia	30%	10%	2%	10%	5%
Bossiella	10% (4)	5% (2)	0	2% (1)	1% (1)
Corallina	0	2%(1)	0	0	15% (4)
Foliose reds, unid.	2%	1%	2%	6%	2%
Ptilota	0	0	0	2%	0
Rhodymenia spp.	0	0	0	0	1% (2)
Microporina	5%	5%	3%	35%	40%
Yellow spatter sponge	3%	0	0	3%	1%
White globular sponge	0	0	0	(1)	0
Dendrobeania	0	0	1%	1%	2%
Rhynchozoon	5%	0	0	0	0
Eudendrium	1% (3)	1% (1)	1% (3)	0	0
Synoicum	1%	0	2%	2%	1%
Serpulidae	0	0	0	(1)	0
Syconid sponge	0	0	0	0	1%
Acmaea mitra	(1)	0	0	0	0
Lichenopora	0	0	1%(2)	2% (1)	0

TABLE 8 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 27, 1975

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Abietinaria	2% (1)	1%(1)	0	1%(1)	2% (2)
Chiton (unid.)	0	(1)	0	0	0
Gravel	25%	50%	80%	25%	20%
Tricellaria	1%	0	0	3%	5%
Balanus ? alaskensis	(1)	0	0	0	0
Musculus vericosus	(1)	0	0	0	(10)
Crossaster	0	0	(1)	0	0
Fusitriton	0	0	(1)	0	0
Trichotropis	0	0	0	(1)	0
Pagurids	0	0	0	0	(1)
Heteropora	0	0	0	(1)	0
Styela	0	0	0	0	(1)
White spatter sponge	0	0	0	1%	0

Depth (meters): 10-12m
Substrate type: boulders, gravel and rock pavement

* Plants undergoing blade renewal

TABLE 9

QUADRAT DATA (0.25m2) FROM LATOUCHE POINT, SUBTIDAL
NOVEMBER 27, 1975

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14
Laminaria groenlandica	(2)	(2)		(1)			(3)		(1)		(2)	(1)	(1)	
Laminaria spp.			(2)		(2)			(4)		(1)			(1)	
Agarum cribrosum	(2) P	(2)	(1) P				(2) P		(1) P	(1)	(2)	(4) P		
Opuntiella														
Constantinea		P	P				P			P	P			
Ralfsia							10%							
Ptilota		P	P				P		10%		P			5%
Odonthalia					5 %									
Foliose red, unid.						10%		P						
Encrusting coralline	60%	70%	50%				75%					50%		
Articulated coralline			7%				2%				15%	4%		
Hildenbrandia			25%				15%		2(3%			40%	20%	
Styela												(1)		
Henricia	(2)						(1)					(2)		
Tonicella		(2)												
Trophonopsis		(1)												
Microporina	2 0%													
Fusitriton														(1)
Depth (meters):	11.5	11.5	11.5	12.0	12.5	12.5	12.0	12.5	12.5	12.5	12.5	12.0	12.5	12.5
Substrate type:	Rock pave-	Rock	Rock	Rock	Gravel	Gravel	Rock	Gravel	Sand-rock	Sand-rock	Rock-gravel	Rock	Rock	Sand-rock

TABLE 10

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
March 16, 1976

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	50%(1)**	40%**	20%**	50%**
Laminaria groenlandica	0	(2)	(1)	(3)
Laminaria (juveniles)	(3)	0	(lo)	0
Agarum	20%(2)	25%(2)	25%	25%(2)
Pleurophycus	0	0	20%(1)	lo%(l)
Encrusting coralline	80%	80%	95%	90%
Ptilota	0	20%(1)	lo%(l)	0
Constantinea	0	15%(3)	2%(1)	0
Rhodymenia	6%	5%	0	2%
Corallina	4%	20%	20%	25%
Bossiella	2%	2%	5%	0
Hildenbrandia	0	2%	0	2%
Ralfsia	0	5%	0	0
Microporina	5%	10%	0	0
Lichenopora	2%	0	0	0
Distaplia	2%	0	0	0
Synoicum	1%	10%	2%	2%
Gray colonial ascidian	1%	2%	1%	0
Orange encrusting sponge	1%	1%	0	0
Tricellaria	0	0	0	1%

TABLE 10 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 16, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Eudendrium	0	0	0	1%
Amphissa	0	(1)	(1)	0
Velutina sp.	0	(1)	0	(1)
Acmaea mitra	0	0	(2)	0
? Rhynchozoon	0	0	0	1%
Pagurids	0	(4)	(1)	(1)
Henricia spp.	0	(1)	0	0
Ophiopholis	0	0	present	0

Depth (meters): 9.0
Substrate type: Rock pavement and boulders

* Total Laminaria cover in quadrat

TABLE 11

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 16, 1977

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
Laminaria groenlandica		(3)	(2)	(3)	(1)	(1)	(2)	(1)				(3)
Laminaria yezoensis				(1)	(1)	(3)						(2)
Laminaria spp.			(3)	(2)		(1)	(6)					(3)
Agarum cribrosum						(2)	(1)		(1)		(1)	
Pleurophycus gardneri		(1)						(4)				
Ralfsia spp.		5%		5%							5%	
Rhodymenia		10%				15%	5%	2%	10%		5%	5%
Delesseria		10%				10%	10%	15%	2%	5%		
Callophyllis								10%				
Constantine		10%	10%	10%	10%	2%				5%	10%	
Membranoptera		10%								20%		
Ptilota		5%		5%		5%	20%	10%		10%	5%	5%
Filamentous brown			10%									
Opuntiella					2%							
Monostroma											2%	
Articulated coralline		5%		3%			15%		10%		2%	
Encrusting coralline		50%	20%	60%		70%	85%	70%	20%	25%	25%	50%
Calliostoma		(1)				(1)						(i)
Acmaea mitra			(1)							(1)		(1)
Tonicella												(1)
Depth (meters):	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0
Substrate type:	Gravel	Rock-Gravel	Rock-Gravel	Rock	Gravel	Gravel-Sand	Rock	Rock	Rock	Rock-Gravel	Rack-Sand	Rock

TABLE 12

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	50%(1)**	80%(8)**	35%**	20%(1)**
Laminaria groenlandica	(1)	0	(3)	0
Laminaria (juveniles)	0	(2)	0	0
Pleurophycus	0	0	25%(3)	20%
Encrusting coralline	40%	50%	30%	50%
Ptilota	1%	2%	5%	2%
Constantine	5%(1)	0	2%(1)	0
Rhodymenia	0	0	0	5%
Corallina	15%	15%	8%	15%
Bossiella	1%	4%	0	0
Ralfsia	2 ′	0′″′	10%	0
Opuntiella	20%	0	0	12%
Delesseria	1%	0	1%	5%
Microporina	5%	2%	2%	1%
Lichenopora	0	1%	1%	0
Synoicum	5%	2%	15%	10%
Gray colonial ascidian	15%	2%	10%	2%
Orange encrusting sponge	2%	0	0	1%
Tricellaria	0	0	0	1%
Orange colonial ascidian	0	0	0	1%
Green colonial ascidian	0	2%	2%	0
Velutina	0	0	0	(1)

TABLE 12 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Serpulidae	0	(1)	(5)	0
Pagurids	0	0	(2)	(5)
Henricia	0	0	(1)	0
Ophiopholis	0	present	present	present
Yellow globose sponge	0	0	0	1%
Lacuna	0	present	present	0
Styela	0	0	(2)	0
Searlesia	0	0	0	(1)
Margaritas	0	0	0	(1)
Trophon	0	0	(2)	0
Placiphorella	(1)	0	0	0
Cancer oregonensis	0	(1)	0	0
Oregonia	0	0	0	(1)

Depth (meters): 8.0-9.0
Substrate type: Rock pavement and boulders

** Total Laminaria cover in quadrat

TABLE 13

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria yezoensis	*40%(2)**	50%(2)	60%
Laminaria groenlandica	(1)	(1)	0
Laminaria (juveniles)	(3)	(2)	(13)
Pleurophycus	lo%(2)	20%(1)	0
Encrusting coralline	40%	70%	50%
Ptilota	2%	10%	0
Constantinea	0	0	2%
Rhodymenia	2%	5%	0
Corallina	2%	15%	4%
Bossiella	0	0	3%
Hildenbrandia	2%	0	0
Opuntiella	10%	20%	5%
Delesseria	2%	2%	0
Microporina	15%	0	4%
Lichenopora	1%	1%	1%
Synoicum	6%	8%	6%
Gray colonial ascidian	15%	8%	30%
Orange encrusting sponge	1%	1%	2%
Abietinaria	0	0	2%
Green colonial ascidian	0	4%	1%
Tonicella	0	(2)	(2)

TABLE 13 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 17, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Pagurids	(2)	(12)	(6)
? Rhynchozoon	0	0	1%
Searlesia	(1)	0	0
Heteropora	1%	0	0
Trophon	0	0	(1)
Entodesma	(1)	0	0

Depth (meters): 7.0-8.0
Substrate type: Rock pavement and boulders

* Total Laminaria cover in quadrat

TABLE 14

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Taxon	Percent Cover (number of individuals) No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	70%**	SO%**	75%(l)**	60%(1)**
Laminaria groenlandica	(2)	(0)	(5)	(2)
Laminaria (juvenile)	0	(2)	0.	0
Pleurophycus	0	25%(1)	0	30%(2)
Agarum	0	25%(1)	lo%(2)	0
Encrusting coralline	60%	50%	80%	45%
Ptilota	25%	0	5%	20%
Constantinea	30%	0	0	8%
Rhodymenia	0′	0	0	2%
Corallina	40%	20%	25%	8%
Bossiella	10%	5%	0	2%
Opuntiella	0 ,	5%	5%	0
Delesseria	0	8 %	1%	1%
Membranoptera	0	0	0	2%
Lichenopora	0	1%	1%	1%
Svnoicum	2%	0	5%	5%
Distaplia	10%	5%	2%	0
Orange encrusting sponge	3%	0	0	1%
Tricellaria	0	1%	1%	1%
Didemnum or Tridídemnum	1%	3%	0	0
Chelyosoma productum	0	0	1%(1)	0

TABLE 14 (cont.)

QUADRAT DATA (0.25m2) FROM LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Lacuna	0	0	0	0
Acmaea mitra	0	(2)	(2)	(1)
Searlesia	(1)	(1)	0	0
Tonicella	0	(3)	(1)	0
Serpulidae	0	0	0	0
Ophiopholis	0	0	0	0
Pagurids	0	(4)	(2)	(2)
Margaritas	0	(2)	0	0

Depth (meters) : 6.0-10.0
Substrate type: Rock bench and boulders

** Total Laminaria cover in quadrat

TABLE 15

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
MARCH 18, 1976

Taxon	Percent Cover (*number* of individuals) No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	25%(l)**	40%(1)**	60%**	5%**
Laminaria groenlandica	0	(1)	(1)	0
Laminaria (juvenile)	0	0	(8)	(4)
Pleurophycus	0	10%(2)	0	15%
Agarum	10%	0	0	0
Encrusting coralline	40%	60%	50%	70%
Ptilota	40%	15%	20%	15%
Constantinea	16%(2)	0	0	5%
Corallina	40%	30%	40%	40%
Bossiella	1%	0	0	1%
Hildenbrandia	1%	0	0	0
Ralfsia	0	5%	0	0
Delesseria	0	0	0	1%
Alaria sp.	0	15%	0	20% (1)
Lichenopora	0	1%	0	0
Synoicum	20%	5%	5%	1%
Distaplia	5%	5%	0	0
Orange encrusting sponge	2%	1%	0	8%
Tricellaria	1%	0	1%	0
? Leucosolenia	0	0	1%	0

TABLE 15 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
March 18, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Yellow encrusting sponge	o	0	2%	o
Acmaea mitra	(1)	0	0	(3)
Searlesia	o	0	0	(2)
Tord.cells	0	0	0	(2)
Serpulidae	0	0	0	present

Depth (meters): 5.0-6.0
Substrate type: Rock bench

** Total Laminaria *cover* in quadrat

TABLE 16

QUADRAT OATA ($0.25m^2$) FROM LATOUCHE POINT, SUBTIDAL
JUNE 25 and 26, 1976

Percent Cover (Number of Individuals)

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	NO. 16
Laminaria yezoensis	5%(1)	5%(1)				5%(1)		65%(4)		40%(3)	75%(2)					10%(1)
Laminaria groenlandica/ dentigera	0	60%	5%(1)		60%(4)	40%(3)	90%(7)								10:	40%(1)
Laminaria saccharina	0			50%(1)												
Laminaria spp.	5Z(10)	2%(3)			2%(2)	5%(10)		8%(5)	2%(3)		lo%(2)		30%(20)	2%(5)		
Pleurophycus	30%(3)					25%(2)	10%(1)			lo%(l)						
Agarum	20%(3)	25%		5%	25%(1)					2%(1)	10%				15%	
Cymathere			50%	15%				25%(4)			15%					
Alaria sp.													5%(1)			
Nereocystis													15%(2)			
Opuntiella	lo%					10%	15%									
Rhodymenia		5%							15%		8%		10%			8%
Constantinea	1OZ(3)									1 0%	15%				10%	15:
Microcladia	5%								22							
Ptilota	5%			2%	5%	1 0%	20%			10%	2%			2%		15:
Pterosiphonia			5%		2%		5%									
Membranoptera				5%						10%	5%					
foliose reds, unid.		5%	1 o%	20%				5%	5%		5%		15%	10%		
Delesseria					2%	5%	2%			13%						
Callophyllis							5%			15%					15%	155
filamentous reds, unid.							15%			5%						
encrusting coralline	60%	10%			50%	70?!	80%	15%		60%	25%	2:	20%	5%		40%
articulated coralline	104				5%	5%	2%									20%
Ralfsia sp.	2%					2%				2%						2%
Odonthalia kamtschatica													15%			
Bossiella sp.	15%					2%				1 o%	10%					
Hildenbrandia sp.	15%															
Desmarestia viridis									2%	5%						
Microporina					60%	22	8%									2%
Heteropora	5%					2%				2%						
Distaplia					30%	15%	1 o%			5%						5%
Syringum	2%				5%	15%	30%								5%	
Dendrobeania murryani	2%															
Musculus vernicosus	P	P	P	P	P	P	P	P	P	P			P	P	P	P
Musculus discors																(1)
Calliostoma						(5)				P						
Searlesia						(1)	(1)									
Acmaea mitra										(1)			P			
Crossaster										(1)	(1)				(1)	
Henricia																(1)
? Leptasterias sp.										(1)						
pagurids							(1)							(1)		
Strongylocentrotus spp.		(1)														(1)
Trichotropis sp.							(1)									
Olivella														(1)		
Tonicella spp.	(1)					(1)	(1)			(2)						(2)
Pycnopodia												(1)				
Depth (meters):	14.5	14.5	12.0	12.0	10.5	5.5	5.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	10.5	10.5
Substrate type:	Rock & gravel	Gravel	Sand, shell and gravel	Sand, shell and gravel	Rock	Rock	Rock	Gravel and shell	Gravel and shell	Gravel and rock	Gravel and rock	Gravel	Gravel and rock	Gravel	Rock & gravel	Rock & gravel

generally lies prostrate on the substratum. Density estimates ranged from 0-2.67/m^2 in the transect bands, however densities up to 16.00/m^2 were recorded for Agarum in the quadrats.

Beneath the brown algal undergrowth was another layer of foliose and peltate reds, comprised of Constantine spp., Opuntiella californica, Ptilota filicina, .? Schizymenia epiphytica and ? Kallymenia oblongifructa. Other ephemeral seaweeds in this red algal guild were Rhodymenia spp.; Delesseria decipiens; Odonthalia kamtschatica; Callophyllis spp.; Membranoptera sp. and Pterosiphonia bipinnata. Crustose and articulated corallines such as Lithothamnion, Bossiella and Corallina, and encrusting layers of Hildenbrandia and Ralfsia formed the final vegetative veneer on the rock substrate.

During summer months the hair-like brown algae Desmarestia aculeata and D. viridis, and a ligulate member of this group, Desmarestia ligulata var. ligulata were scattered around the study area. Typically this genus was found on cobbles, shells and gravel. Both Desmarestia aculeata and D. viridis are perennials, while D. ligulata is reputed to be an annual (Chapman, 1972).

To date, a total of 54 species of macroalgae have been identified from the shallow sublittoral zone off Latouche Point (Table 17). Of these, more are undoubtedly present *in* this location, however only the more conspicuous species were collected 'or included in the species inventory. The coralline algae still need to be properly identified since they are such a difficult group taxonomically.

TABLE 17

LIST OF MACROALGAE COLLECTED AT OCS STUDY SITES
IN THE NORTHEASTERN GULF OF ALASKA

	Latouche Point	Macleod Harbor	Zaikof Bay
CHLOROPHYTA (greens)			
Codium fragile	X		
Enteromorpha ? linza		X	X
Enteromorpha intestinalis			X
Halicystis ovalis	X		
Monostroma ? fuscum	X	X	X
Monostroma sp.	X	X	X
Spongomorpha sp.		X	
Ulva spp.		X	X
PHAEOPHYTA (browns)			
Agarum cribrosum	X	X	X
Alaria fistulosa	X drift		
Alaria ? pylaii	X	X	X
Alaria ? marginata		X	
Chordaria flagelliformis		X	
Costaria costata	X	X	X
Cymathere triplicate	X	X	X
Desmarestia aculeata	X	X	
Desmarestia ligulata var. ligulata	X	X	X
Desmarestia viridis	X	X	X
Fucus distichus	X	X	X
Laminaria groenlandica	X	X	X
Laminaria saccharina	X	X	X
Laminaria dentigera	X		
Laminaria yezoensis	X	X	X
Melanosiphon intestinalis		X	X
Nereocystis luetkeana	X	X	X
Pleurophycus gardneri	X	X	X
Pylaiella ? littoralis		X	X
Ralfsia fungiformis	X	X	X
Ralfsia pacifica	X	X	X
Scytosiphon lomentaria			X
Sphacelaria sp.		X	
RHODOPHYTA (reds)			
Antithamnion sp.			X
Bossiella orbigniana	X	X	X
Bosiella SD.	X	X	
Callophyllis edentata	X	X	X
Callophyllis flabellulata	X	X	X
Callophyllis cristata		X	
Callophyllis ? crenulata	X	X	X
? Clathromorphum circumscriptum	X		
Constantinea simplex	X	X	X
Constantinea subulifera	X	X	X

TABLE 17 (Cont.)

LIST OF MACROALGAE COLLECTED AT OCS STUDY SITES
IN THE NORTHEASTERN GULF OF ALASKA

	Latouche Point	Macleod Harbor	Zai kof Bay
Corallina frondescens	X	X	X
Corallina vancouveriensis	X	X	X
Cryptopleura sp.	X		
? Cryptonemia sp.	X		
Delesseria decipiens	X	X	
Erythrophyllum delesserioides		X	
Gigartina spp.	X	X	X
Halosaccion glandiforme	X	X	X
Hildenbrandia ? occidentalis	X	X	X
Iridea sp.			
? Kallymenia oblongifructa	X	X	X
Lithothamnion sp.	X	X	X
Lithothrix aspergillum	X		X
Membranoptera dimorpha	X	X	X
Membranoptera ? multiramosa	X		
Microcladia borealis	X	X	X
Odonthalia floccosa		X	X
Odonthalia kamtschatica	X	X	X
Opuntiella californica	X	X	X
Phycodrys sp.	X	X	X
Platythamnion sp.			X
? Peyssonelia pacifica	X	X	
Polyneura latissima	X		
Polysiphonia pacifica			X
Polysiphonia sp.	X	X	X
Porphyra spp.	X	X	X
Pterosiphonia bipinnata			X
Ptilota filicina	X	X	X
Ptilota tenuis	X	X	
Rhodoglossum affine		X	
Rhodymenia palmata	X	X	X
Rhodymenia pertusae	X	X	X
Schizymenia spp.	X	X	X
Stenogramme interrupta			X

No. taxa or species = 75

EPIFAUNA AND TROPHIC INTERACTION

Within the three study areas about 211 different taxa of macroinvertebrates (Table 18), and 30 species of inshore fishes (Table 19) were either identified or categorized for future taxonomic verification. Of all groups seen in the seaweed zone, the mollusks were represented by the greatest number of species, and accounted for 36 percent (n=76) of the total macroinvertebrate inventory. Despite this expression of diversity, the molluscan member's of the seaweed community appeared to be only a moderate component of the overall biomass. Based on the information obtained from the quadrats ($0.25m^2$), the attached or sessile fauna such as sea anemones, hydroids, sponges, bryozoans and ascidians were dominants in terms of percent cover and biomass.

The seaweed canopy at Latouche Point provided both food and cover for the animal components of the nearshore system; it also served as living substrate for other plants and animals., For example, some serpulid worms such as Spirorbis spp. and encrusting bryozoans spend the entire life cycle following the initial settling stage attached to seaweeds. Other species such as a tiny mussel Musculus vernicosus covered extensive portions of the shallow sublittoral zone during the summers of 1974, 1975 and 1976. Musculus was most often attached to living marine plants, however it was also found on sedentary animals and solid inorganic substrate. Many of the seaweeds off Latouche Point were almost entirely covered by M. vernicosus, which typically attaches with the foot and byssal threads. It occurred in 26 of 86 quadrats, for

TABLE 18

LIST OF BENTHIC MACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

Porifera (sponges)	Latouche Point	Macleod Harbor	Zaikof Bay
Cliona celata	X	X	X
Halichondria ? panicea		X	X
Esperiopsis spp.	X		
Suberites fiscus		X	X
? Mycale adhaerens		X	X
White globose, unid.	X		X
Yellow spatter, unid.	X	X	X
Red globose, unid.	X	X	
Cnidaria			
Abietinaria spp.			
Sertularella turgita		X	
Anthopleura xanthogrammica	X		
Cribinopsis ? assimilis	X	X	X
Peachia ? parasitics	X		
Telia crassicornis	X	X	X
Tealia spp.	X	X	X
Ptilosarcus gurneyi		X	X
? Stomphia sp.	X		
Metridium senile	X	X	X
Campanularia verticellata	X		X
Hydractinia sp.	X		X
Obelia sp.			X
Grammaria sp.			X
Eudendrium sp.	X		
Gersemia rubiformis	X		
Lafoea sp.		X	X
Haliclystus ? auricula	X	X	X
Cyanea capillata	X	X	X
? Epizoanthus scotinus	X		
Halcampa sp.			X
Nemertea (ribbon worms)			
Unid. species A (orange)			X
Unid. species B (white bands)	X		
Mollusca (mollusks)			
Cryptochiton stelleri	X	X	X
Katharina tunicata	X	X	X

TABLE 18 (Cent.)

LIST OF BENTHIC MACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

Mollusca (mollusks)	Latouche Point	Macleod Harbor	Zaikof Bay
Tonicella lineata	X	X	X
Tonicella insignis	X	X	X
Placiphorella spp.	X	X	X
Mopalia muscosa		X	X
? Ischnochiton mertensii	X	X	X
Mopalia spp.	X	X	X
Puncturella multistriata	X	X	X
Diadora aspera	X	X	X
Crepipatella lingulata	X	X	X
Crepidula nummaria		X	
Cryptobranchia concentric		X	X
Collisella instabilis	X	X	X
Acmaea mitra	X	X	X
Fusitriton oregonensis	X	X	X
Trichotropis cancellata	X	X	X
Trichotropis insignis			X
Margaritas ? pupillus	X	X	X
Calliostoma annulatum	X		
Calliostoma ligature	X	X	X
Velutina rubens	X		
Natica spp.	X	X	X
Lacuna carinata	X	X	X
Olivella baetica	X		
Nassarius mendicus		X	
Ceratostoma nuttallii		X	
Trophon multicostatus	X	X	
Amphissa columbiana	X	X	X
Trophonopsis insignis			X
Searleisa dira	X	X	X
Volutharpa ampullacea			X
Thais ? canaliculata			
Thais lamellosa	X	X	X
Neptunea lirata			X
Turridae, unid.		X	
Trophonopsis lasius			X
Beringinus kenneycotti			X
Aglaja ocelligera		X	
Gastropteron pacificum	X	X	X
Dirona aurantia	X		
Tochuina tetraguetra	X		
Melibe leonina			X
Dendronotus dalli	X		X
Dendronotus spp.		X	
Aeolidia papillosa		X	
Hermissenda crassicornis	X	X	X

TABLE 18 (Cont.)

LIST OF BENTHIC MACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

Mollusca (mollusks)	Latouche Point	Macleod Harbor	Zaikof Bay
Coryphella sp.			x
Triopha carpenter	x	x	
Diaululu sandiegensis	x		
Anisodoris nobilis	x		
Archidoris odneri	x	x	
Cadlina luteomarginata	x	x	
Cadlina sp.	x		
Pododesmus macroschisma	x	x	x
Pecten caurinus		x	
Chlamus spp.	x	x	x
Glycymeris ? subobsoleta		x	
Hiatella arctica	x	x	x
Mytilus edulis	x	x	x
Modiolus modiolus	x	x	
Musculus vernicosus			
Musculus discors	x	x	x
Musculus ? niger			x
Tellina sp.		x	
Clinocardium nuttalli		x	x
Clinocardium ciliatum			x
Thracia trapezoides			x
Lyonsia californica	x	x	x
Prototchaca staminea		x	x
Mya truncata			x
Astarte sp.		x	x
Saxidomus giganteus		x	x
Humilaria kennerlyi	x	x	x
Macoma spp.		x	x
octopus Sp.	x		x
Annelida (segmented worms)			
Onuphis iridescent		x	
Phyllodoce ? groenlandica		x	
Lumbrineris ? similabris		x	
Scoloplos ? acmeceps		x	
Chone ? mollis		x	
Flabelligera infundibularis		x	
Nereis ? pelagica		x	
Phyllodoce sp.		x	
? Sigalion sp.		x	

TABLE 18 (Cont.)

LIST OF BENTHIC MACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

	Latouche Point	Macleod Harbor	Zaikof Bay
Annelida (segmented worms)			
Axiothella rubrocincta		x	
Haploscolops elongatus		x	
Maldanidae, unid.		x	x
pectinaria (Cistenides) Sp .		x	x
Eudistylia vancouveri	x	x	x
Myxicola sp.	x	x	
Spirorbis spp.	x	x	x
Abarenicola sp.		x	
Serpula vermicularis	x	x	x
?" Schizobranchia insignis			x
Sipincula (peanut worms)			
Eubonellia valida			x
Arthropoda (jointed foot)			
Balanus cariosus		x	
Balanus crenatus		x	x
Balanus nubilus	x	x	
Balanus ? rostrotus alaskensis		x	
Cancer magister			x
Cancer oregonensis	x		
Cryptolithodes sitchensis	x		x
Phyllolithodes papillosus			
Hapalogaster mertensii	x		
Rhinolithodes wosnesenskii			x
Placetron wosnesenskii			x
Pagurus ochotensis	x	x	
Pagurus ? beringanus			x
Pagurus stenuensae			x
Elassochirus tenuimanus	x	x	
Elassochirus gilli	x	x	x
Oregonia gracilis	x	x	x
Chionoecetes bairdi			x
Pugettia gracilis	x	x	x
Pugettia ? richii		x	
Hyas lyratus		x	
Telmessus cheiragonus		x	x
Pandalus danae	x	x	x
Pandalus sp.		x	x
Sclerocrangon sp.			x
Eualus spp.		x	x
Heptacarpus spp.	x	x	x

TABLE 18 (Cont.)

LIST OF BENTHIC NACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

Arthropods	Latouche Point	Macleod Harbor	Zaikof Bay
Idotea sp.	X		
Caprella sp.	X	X	X
Gammaridea	X	X	X
Mysidacea	X	X	X
? Discorsopagurus schmitti			X
Echinodermata (spiny skin)			
Ophiopholis aculeata	X	X	X
Ophiura ? sarsii		X	
Leptasterias spp.	X	X	X
Pteraster tesselatus			
Dermasterias imbricata	X	X	X
Henricia leviuscula	X	X	X
Henricia tumida	X		
Orthasterias koehleri	X	X	X
Pisaster ochraceus	X	X"	X
Evasterias troschelii	X	X	X
Pycnopodia helianthoides	X	X	X
Crossaster papposus	X	X	X
Solaster stimpsoni	X	X	X
Solaster dawsoni	X	X	X
Tosiaster acticus	X	X	
Strongylocentrotus droebachiensis	X	X	X
Strongylocentrotus ? pallidus	X	X	
Strongylocentrotus franciscanus	X		
Parastichopus californicus		X	X
Psolus chitonoides	X	X	X
Cucumaria miniata	X	X	X
Bryozoa (moss animals)			
Flustrella ? gigantea			X
Heteropora spp.	X	X	X
? Lichenopora sp.	X	X	X
Disporella sp.		X	X
Microporina borealis	X	X	X
Tricellaria gracilis	X	X	X
Dendrobeania murryana	X	X	X
Hippodiplosia insculpta	X	X	X

TABLE 18 (Cont.)

LIST OF BENTHIC MACROINVERTEBRATES COLLECTED AT THE THREE STUDY SITES IN NORTHEASTERN GULF OF ALASKA (1975-76)

	Latouche Point	Macleod Harbor	Zaikof Bay
Bryozoa			
Membranipora sp.		X	
? Phidolopora pacifica	X	X	X
Costazia sp.	X	X	X
? Myriozoum coarctatum		X	
Crisis sp.	X	X	
Alcyonidium pedunculatum		X	X
Carbasea carbasea			X
Gromia oviformis	X	X	X
Brachiopoda			
Terebratalia transversal	X	X	X
Terebratulina unguicula		X	X
Urochordata			
Styela montereyensis	X		X
Chelyosoma productum	X		X
Corella willmeriana			X
Ascidia paratropa			X
Boltenia villosa	X	X	X
Halocythia igaboja			
Halocynthia aurantium	X		X
Cnemidocarpa finmarkiensis	X	X	
Metandrocarpa taylori	X	X	X
Clauelina sp.	X		
Distaplia occidentals	X	X	X
? Synoicum sp.	X		
Didemnum or Trididemnum	X	X	X

TABLE 19

FISHES OBSERVED IN THE THREE STUDY SITES
DURING 1975-76

COMMON NAME	SCIENTIFIC NAME	LOCATION
Rock greenling	Hexagrammos lagocephalus	L;M;Z
White spotted greenling	Hexagrammos stelleri	M;Z
Kelp greenling	Hexagrammos decagrammus	L;M;Z
Masked greenling ?	Hexagrammos octogrammus	L;M
Lingcod	Ophiodon elongatus	L
Great sculpin	Myoxocephalus polyacanthocephalus	M; Z
Buffalo scuplin	Enophrys bison	M
Blackfin sculpin ?	Malacottus kincaidi	M
Red irish lord	Hemilepidotus hemilepidotus	L;M
Yellow irish lord	Hemilepidotus jordani	L
Northern sculpin ?	Icelinus borealis	L
Grunt sculpin	Rhamphocottus richardsoni	L
Silverspotted scuplin	Blespsias cirrhosus	M
Pacific staghorn sculpin	Leptocottus garmatus	M
Antlered sculpin	Enophrys diceraus	L;M;Z
Sturgeon poacher	Agonus acipenserinus	Z
Pacific spiny lumpsucker	Eumicrotremus orbis	Z
Black rockfish	Sebastes melanops	L;M;Z
Copper rockfish	Sebastes caurinus	L;M
Yellowtail rockfish	Sebastes flavidus	L
Rockfishes, unid. juv.	f: scorpaenidae	L;M;Z
Searcher	Bathymaster signatus	L
Northern ronquil	Ronquilus jordani	L;M;Z
Starry flounder	Platichthys stellatus	M
Yellowfin sole	Limanda aspera	M;Z
Pacific halibut	Hippoglossus stenolepis	L
Snake prickleback	Lumpenus sagitta	M
Prickleback, unid.	f; stichaeidae	L;M;Z
Crescent gunnel	Pholis laeta	L;M;Z
Artic shanny	Stichaeus punctatus	L;M;Z
Pacific tomcod	Microgadus proximus	L;M;Z
Sand lance	Ammodytes hexapterus	L;M;Z
Pink salmon	Oncorhynchus gorbuscha	L

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

which density ranged up to about 2,084 individuals/m^2. From one 0.25m^2 quadrat we removed 521 M. vernicosus that were attached to two elephant-ear kelps (Laminaria groenlandica), each approximately one meter in blade length. Individual Musculus ranged in shell length from 4 to 13mm (Figure 3), however smaller Musculus (<3mm) were also present in the sample, but were not included in the size-frequency histogram. Musculus is a suspension or filter feeder that appears to thrive either in exposed "locations of the northern Gulf, or in ocean entrances that are exposed to rapid water exchange. No doubt, Musculus contributes appreciable amounts of energy to secondary consumers. Major predators of Musculus in this location were sea stars, fin fishes and sea otters. Other probable predators are diving sea ducks such as the harlequin and surf scoter, which frequency raft or roost along the rocky shoreline during late spring and summer.

A number of other species utilize the seaweed resource not only for concealment and sites of attachment, but also as a source of food . For example, the limpet Collisella instabilis has only been *seen* attached to the taller statured understory kelps off Latouche Point. In this case the kelp provides the limpet with both food and cover. One known predator of C. instabilis is the sun star (Pycnopodia helianthoides) which frequently climbs the attached kelps in search of food or potential prey. The limpet seeks refuge from bottom dwelling invertebrates by living on the vegetation suspended above the seafloor.

TABLE 20

CHARACTERISTIC OR REPRESENTATIVE IMPORTANT SPECIES
(RIS) OFF LATOUCHE POINT, SUBTIDAL

Species	Occurrence	Major Taxon	Trophic Category
Agarum cribrosum (P)	A	Brown alga	Producer
Laminaria groenlandica (P)	A	Brown alga	Producer
Laminaria yezoensis (P)	A	Brown alga	Producer
Pleurophycus gardneri (P)	A	Brown alga	Producer
Nereocystis luetkeana (A)	A	Brown alga	Producer
Cymathere triplicate (A)	c	Brown alga	Producer
Constantine spp. (P)	c	Red alga	Producer
Ptilota filicina (?)	c	Red alga	Producer
Opuntiella californica (?)	c	Red alga	Producer
Microporina borealis (?)	c	Bryozoan	Suspension feeder
Encrusting coralline algae (P)	A	Red Alga	Producer
Crossaster papposus (P)	c	Sea star	Predator
Pycnopodia helianthoides (P)	C	Sea star	Predator
Musculus vernicosus (A)	A	Mussel	Suspension feeder
Acmaea mitra (P)	c	Snail	Herbivore
Tonicella spp. (P)	c	Snail	Herbivore
Enhydra lutris (P)	c	Sea otter	Predator
Henricia spp. (p)	c	Sea star	? Suspension feeder
Orthasterias koehleri (P)	c	Sea otter	Predator
Calliostoma ligature (P)	c	Snail	Herbivore
Ophiopholis aculeata (P)	c	Brittle star	Predator
? Distaplia occidentals (P)	c	Ascidian	Suspension feeder
Strongylocentrotus spp. (P)	u	Sea urchin	Herbivore
Dermasterias imbricata (P)	c	Sea star	Predator
Searlesia dira (P)	c	Snail	Predator
Pargurus spp. (P)	A	Hermit crab	Scavenger/Herbivore

Key: (P) = perennial
(A) = annual
A = abundant
c = common
u = uncommon

typically cryptic in behavior and relatively uncommon. Most of the sea urchins were small individuals, and densities for both species combined ranged up to about 4.00/m^2; however, sea urchins occurred in only 3 of 86 quadrats. These data are in agreement with the findings of the transect sampling; densities ranged from 0 to 0.12/m^2 with an average of 0.03/m^2 in 470 square meters of seafloor that was examined during 1975-76 (Table 21).

Grazers of lesser numerical importance were the limpets (Diadora aspera), gumboot chiton (Cryptochiton stelleri), chink shell (Lacuna variegata) and the snai 1 (Margarites spp.). There are numerous other obligatory herbivores that know doubt play key roles in the macrophyte system, i.e. isopods, gammarid amphipods, etc., however no information is available at this time on their distribution or abundance. Most of the crustaceans seem to be highly seasonal in appearance, with peak influx into the inshore zone during spring and summer. Included in the herbivore guild are the facultative consumers which are more catholic in their diet, and as such either browse on marine plants or ingest vegetation incidental to the uptake of animal material. Some of the common members of this group are the hermit crabs, decorator crabs (Oregonia gracilis and Pugettia gracilis) and the leather star (Dermasterias imbricata).

A great percentage of the epibenthic fauna in this area are suspension or filter feeding types. This group of consumers probably

represents the bulk of the biomass off Latouche Point. A few of these species are listed in the characteristic of representative important species category, and numerous others are probably noteworthy of this ranking. The articulated bryozoan (Microporina borealis) covered considerable portions of the rock substrate; percent cover estimates ranged from 0 to 60 percent during this period of time. Microporina appeared to be either an annual species or somewhat ephemeral in abundance and frequency of occurrence. Two predators of Microporina that have been identified to date, are the leather star Dermasterias and the nudibranch Triopha carpenter. The compound ascidian Distaplia sp. and the blood star (Henricia spp.) are both listed as suspension feeders. Both animals are common off Latouche Point, for example, Henricia spp. ranged up to 0.36/m^2, with an average density in the band transects of 0.11/m^2 (Table 21). Distaplia is exquisite in both form and color; it covered between 0 and 30 percent of the rock substratum that was examined during 1975-76.

Seven predators are listed in Table 20. Other important secondary consumers at this location were crustaceans, gastropod, sea anemones, fishes and marine mammals. The sea stars are visual dominants in the shallow waters of the northern Gulf of Alaska. Feeding behavior of sonic common species off the coast of Mashington has been adequately described by Mauzey, Birkeland and Dayton (1968). Since this group has such an important functional role in the rocky sublittoral zone, a great deal of time and energy has been devoted to estimating relative abundance, population size structure and gathering information on the

TABLE 21

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS FROM LATOUCHE POINT

Taxon	9-17-75						
Pycnopodia helianthoides	4 0.16/m^2	5 0.33/m^2	9 0.36/m^2	1 0.04/m^2	°	3 ⊙12/m^2	5 0.20/m^2
Dermasterias imbricata	0	0	1 0.04/m^2	1 0.04/m^2	°	2 °.08/m^2	0
Orthasterias koehleri	1 0.04/m^2	°	2 0.08/m^2	0	⊙	0	3 0.12/m^2
Crossaster papposus	2 0.08/m^2	°	1 0.04/m^2	°	⊙	⊙	1 0.04/m^2
Solaster spp.	1 0.04/m^2	°	0	°	⊙	⊙	○
Henricia spp.	9 0.36/m^2	3 0.20/m^2	0	1 0.04/m^2	0	3 0.12/m^2	6 0.24/m^2
Strongylocentrotus spp.	1 0.04/m^2	0	1 0.04/m^2	0	1 0.04/m^2	0	3 0.12/m^2
Area sampled: Depth:	25 x 1m 12m	15 x 1m 9-11m	25 x 1m 9-11m	25 x 1m 9m	15 x 1m 9m	25 x 1m 9m	25 x 1m 12m

TABLE 21 (Cont.)

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS FROM LATOUCHE POINT

Taxon	11-26-75	11-26-75	11-26-75	3-17-76	3-17-76	6-26-76	6-26-76
Pycnopodia helianthoides	1 0. 06/m^2	1 0. 06/m^2	0	2 0. 02/m^2	11 0. 11/m^2	2 0. 66/m^2	1 0. 20/m^2
Dermasterias imbricata	o	o	1 0. 02/m^2	1 0. 01/m^2	5 0. 05/m^2	1 0. 03/m^2	o
Orthasterias koehleri	1 0. 06/m^2	1 0. 06/m^2	o	3 0.03/m^2	2 0. 02/m^2	5 0. 17/m^2	0
Crossaster papposus	1 0. 06/m^2	2 0. 13/m^2	4 0. 08/m^2	o	1 0. 01/m^2	o	0
Solaster spp.	o	o	o	0	o	0	0
Henricia spp.	2 0. 13/m^2	1 0. 06/m^2	1 0. 02/m^2	0	16 0. 16/m^2	0	1 0. 20/m^2
Strongylocentrotus spp.	1 0. 06/m^2	o	o	0	1 0. 01/m^2	0	o
Area sampled: Depth:	15 x 1m 12m	15 x 1m 12m	25 x 2m 13-14m	50 x 2m 8-11m	50 x 2m 3-8m	30 x 1m 9m	5 x 1m 9m

foraging behavior of some of the common species. Four conspicuous species off Latouche Point were the sun star (Pycnopodia helianthoides); leather star (Dermasterias imbricata); Crossaster papposus and Orthasterias koehleri. Pycnopodia ranged in density from 0 to 0.66/m^2, with an average of 0.17/m^2 (Table 21). Individual sun stars varied in size (radius) from 27 to 185 mm. Hundreds of Pyncopodia were examined for food items; of those feeding 15 were found eating Musculus vernicosus; 3 sea urchin (Strongylocentrotus drobachiensis); 2 Musculus discors; 2 snail (Calliostoma spp.); 3 brittle star (Ophiopholis aculeata; 3 crab (Pugettia gracilis); 2 hermit crab (Pagurus spp.); 2 butter clam (Saxidomus gigantea); 1 snail (Trophonopsis sp.); 1 chiton (Placiphorella sp.); 2 crab (Cancer oregonensis); 1 chiton (Mopalia sp.); and 1 blood star (Henricia sp.).

Orthasterias koehleri is one of the most colorful stars on the reef complex; density estimates ranged from 0 to 0.17/m^2, with an average density of 0.04/m^2 in the band transects (Table 21). Individual Orthasterias ranged in size from 30 to 191 mm; most preyed on mussels (Musculus vernicosus and M. discors; clam (Humilaria kenneryli); rock jingle (Pododesmus macroschisma) and barnacle (Balanus spp.).

The leather star (Dermasterias imbricata) was somewhat less common; density estimates ranged from 0 to 0.08/m^2, and the average was 0.02/m^2. Individual Dermasterias ranged in size from 18 to 180 mm. Dermasterias frequently preyed upon Musculus vernicosus; sea anemone

(Tealia spp.); the clavate ascidian (Synoicum); bryozoa (Microporina borealis); compound ascidians (several species) and red algae.

Another conspicuous sea star in this location was Crossaster papposus. Crossaster is one of the smaller stars in this water, individuals are typically Tess than 50 mm in radius. Frequently it was found on rock and seaweed substrates, and repeatedly it was attached to understory kelps. Density estimates ranged from 0 to 0.13/m^2, with an average of 0.03/m^2. Identifiable prey included Musculus and the serpulid (Spirorbis).

There is sufficient evidence of trophic interaction to present a very qualitative food web for the conspicuous organisms at Latouche Point (Figure 4). The suspected major pathways were from the macrophytes to herbivores such as snails and sea urchins. Organic debris flowed to clams, mussels and bryozoans, and phytoplankton was ingested by clams, mussels and sponges. Linkages from all categories to tertiary consumers such as predators and scavengers are included in the food web.

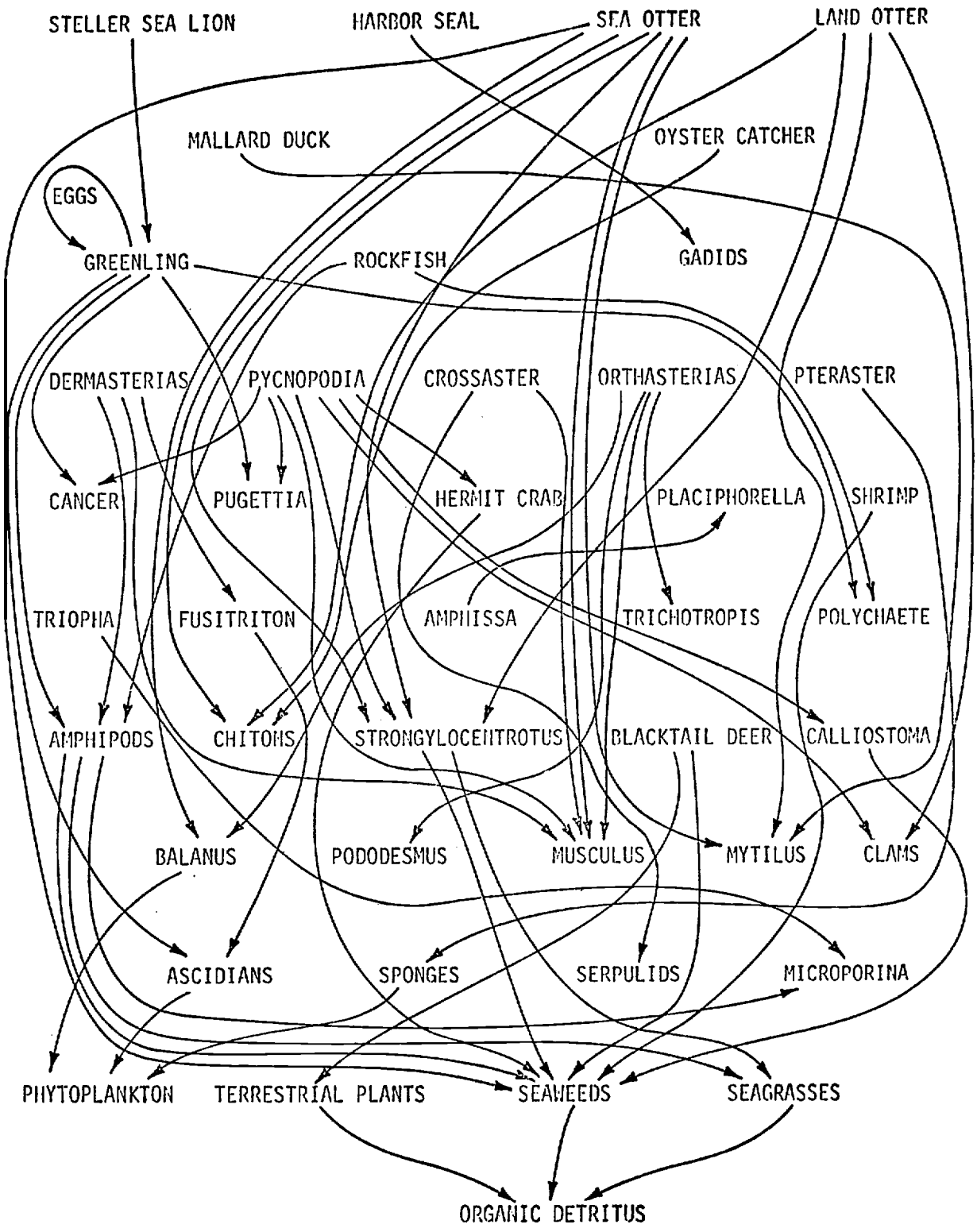
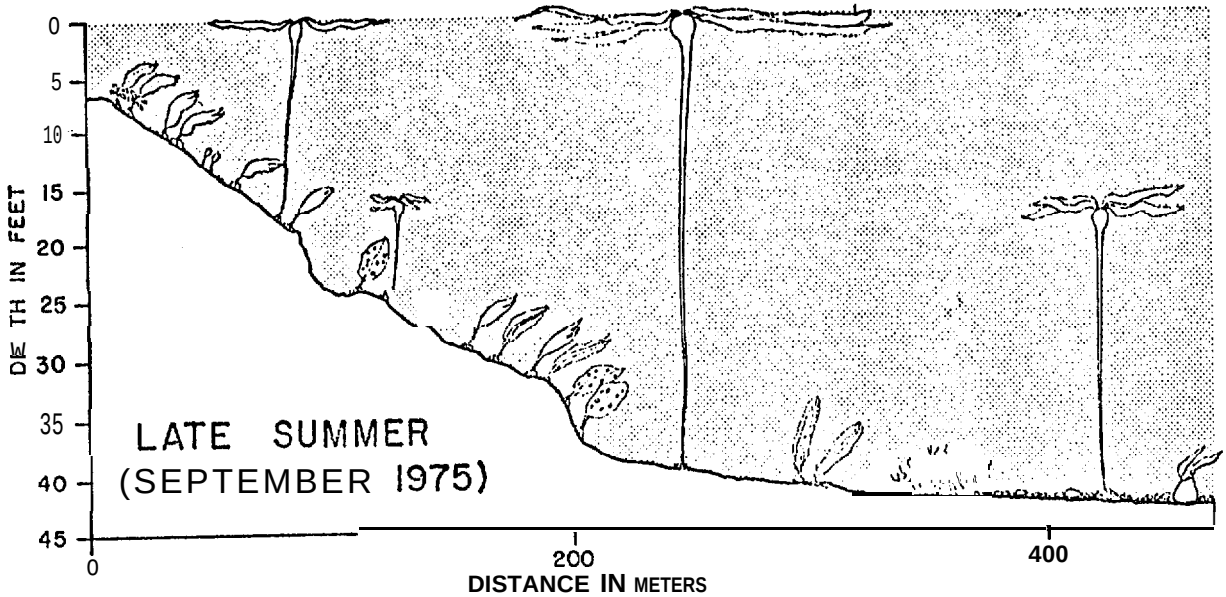


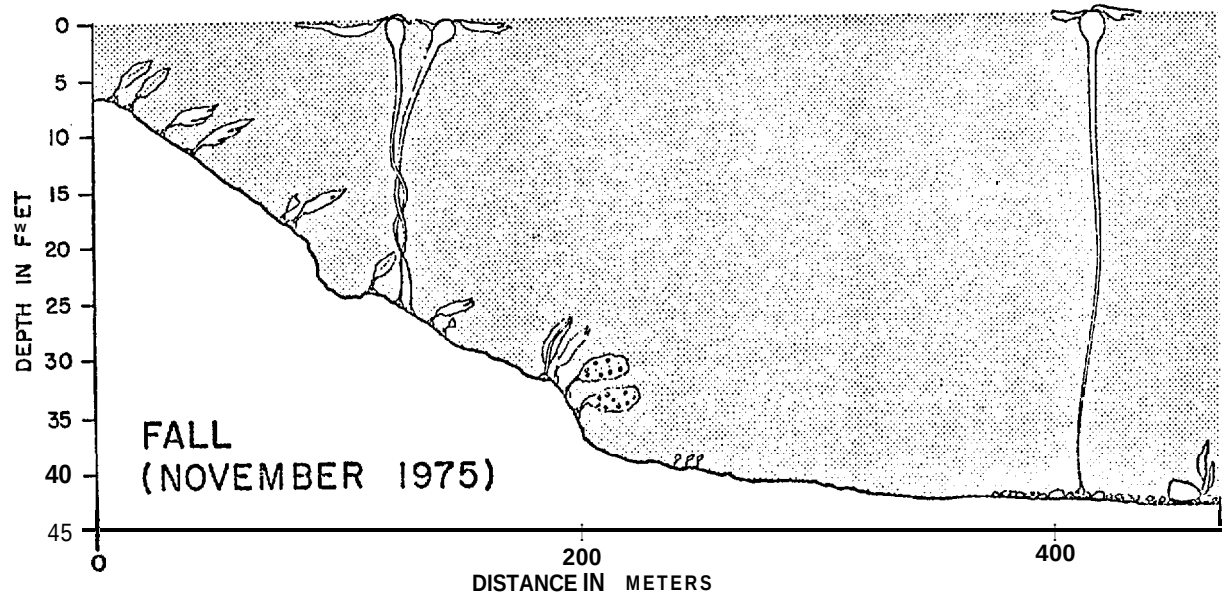
Figure 4. Food web for the rocky sublittoral zone at Latouche Point, Gulf of Alaska.

SEASONAL PATTERNS

The seaweed zone at Latouche Point underwent a marked alteration in appearance with the change of season. One seasonal change that was obvious to even the casual observer was the oscillation in areal cover of the floating portion of the kelp bed. The surface canopy, consisting of bull kelp (Nereocystis), reached peak development and covered considerable areas of the underlying seafloor during the summers of 1974, 1975 and 1976 (Rosenthal, unpublished data). Nereocystis is reputed to be an annual plant, that reaches great size in a single season (Vadas, 1972; Markham, 1969). Most of the growth takes place during the spring and early summer. Fertile plants were observed as early as March, 1976. When bull kelp is mature, zoosporangial sori fall out of the blade and drift to the bottom. Release of zoospores apparently follows soon after. Young sporelings have been observed during early spring, most reached the surface in about 2 to 3 months, and the growth phenology seems to be correlated closely with periods of maximum available light (Vadas, 1972).

During summer, the bull kelp canopy at Latouche Point covered an estimated 50 percent of the underlying seafloor in the central part of the kelp bed (Figures 5 and 6). This same part of the kelp bed was revisited in late November 1975, and at this time the floating canopy was reduced to an estimated 20 percent coverage. Not only was there a reduction in areal cover, but also a heavy attrition of attached plants. Cohorts of adult Nereocystis growing adjacent to one another frequently





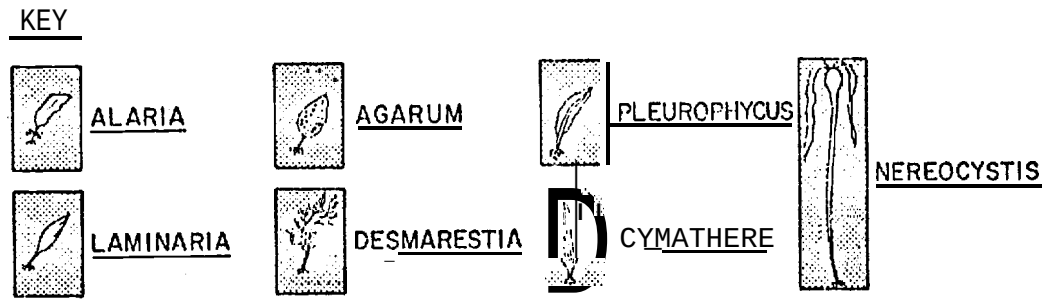


Figure 5. Subtidal vegetative profiles, Latouche Point.

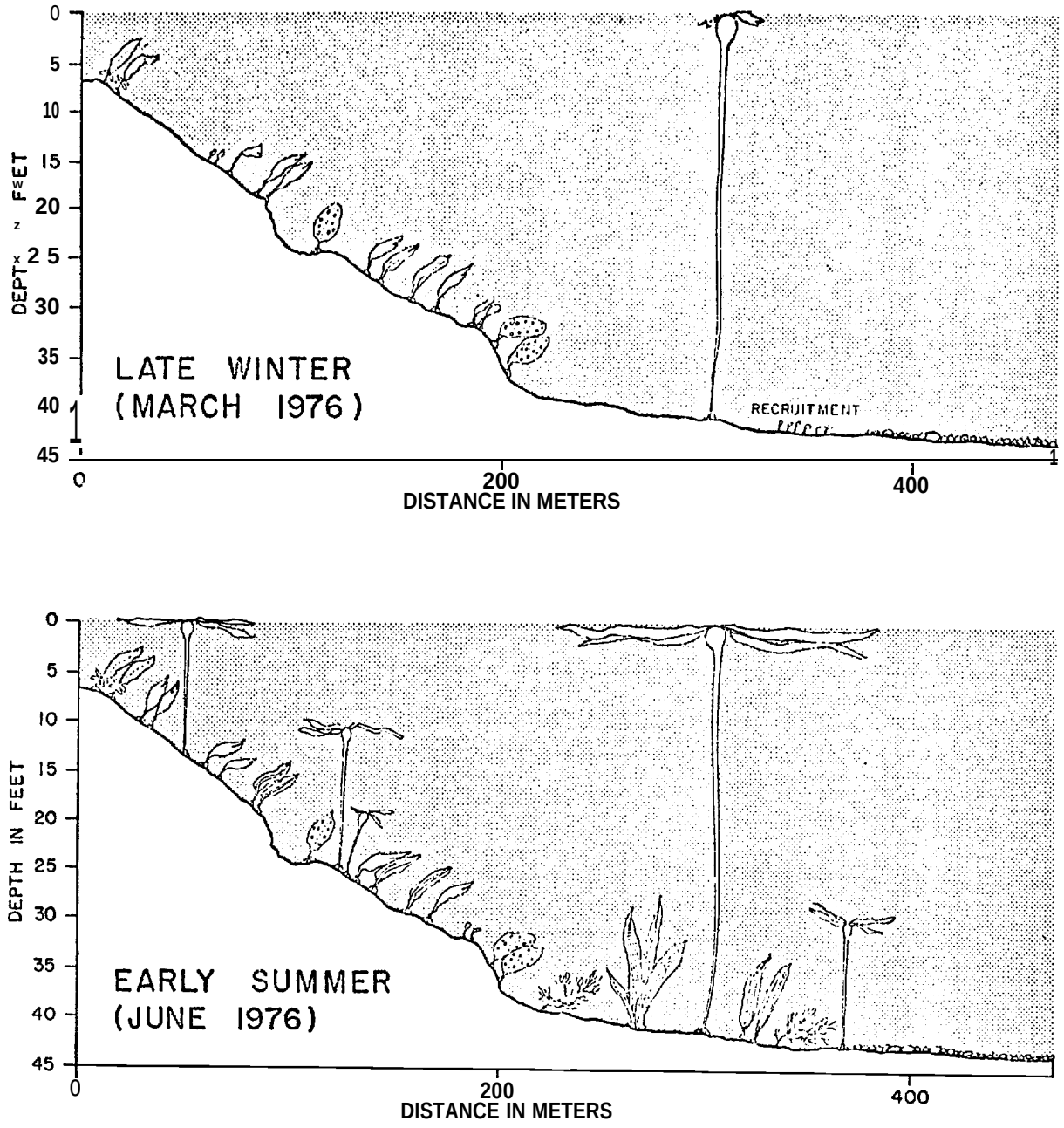


Figure 6. Subtidal vegetative profiles, Latouche Point.

become entangled (Figure 5). Other bull kelp plants that have been detached by storms, substrate dislodgement, and/or grazing, frequently drift through the beds and become entangled with the attached kelps. Mutual entanglement. results, thereby leading to further plant mortality. This same source of kelp mortality was described by Rosenthal, Clarke and Dayton (1974) in the stands of giant kelp (Macrocystis) off the coast of southern California.

Dives were made off Latouche Point during oceanic winter (March 1976); at this time the surface canopy covered less than 5 percent of the seafloor. Attached Nereocystis was still present in this location; however, the blades of most had either eroded away or were reduced in surface area. Since grazing by macroherbivores is of minor importance at this site, the major cause of bull kelp mortality was probably physical detachment and/or old age (senility}: No distinguishable juvenile plants were seen in the area during the March visit, however, by late June 1976 the annual cycle had been renewed, and once again the bull kelp bed was fully developed and supported a heavy surface canopy.

The understory complex or vegetative undergrowth beneath the floating canopy underwent similar change in areal cover and standing crop. The algal understory was typically composed of perennial species such as Laminaria green-landicq-; L. yezoensis; L. saccharin; Agarum cribrosum and Pleurophycus gardneri. Annual or more ephemeral algae such as Cymathere triplicata and Desmarestia ligulata var. ligulata were highly seasonal in appearance; typically these species occurred in the shallow subtidal zone during the summer and disappeared during winter

(Figures 7 and 8). Other fleshy reds, i.e. Delesseria decipiens; Pterosiphonia bipinnata; Rhodymenia spp. ; Membranoptera spp.; and browns Desmarestia viridis and D. aculeata were short-lived (ephemeral) or perennated (died-back) following the growing season.

In contrast to the growth strategies of the annual species, the perennials such as Agarum, Laminaria and Pleurophycus grow rapidly in the winter and early spring. Whereas, most annuals usually appear during late spring and grow rapidly reaching peak development during the summer. Another seasonal phenomena that is typical of the understory canopy is the shedding of fronds by many of the kelp species. Mann (197:3) found that Laminaria and Agarum from eastern Canada completely renewed the tissue of the frond (blade) between one and five times a year. Of the 329 Laminaria spp. examined off Latouche Point during late November 1975, 25 percent (n = 86) had lost or shed a major part of the blade. Only the holdfast, stipe and meristematic growth zone remained of the kelps that were regenerating the blade prior to the active winter growth phase. During the fall when the plants lose their blades a great dean! of drift material is present at this site. The surge channels *or* bathymetric lows in the rocky substrate served as collection points of a great deal of the drift plant material. The process of blade renewal had a significant change in the understory canopy, permitting more available light to reach the seafloor. Kelp germination was apparent during the later winter and spring of 1976.

Seasonal changes in the epifauna were also conspicuous at this location. For example, the mytilid Musculus vernicosus displayed strong

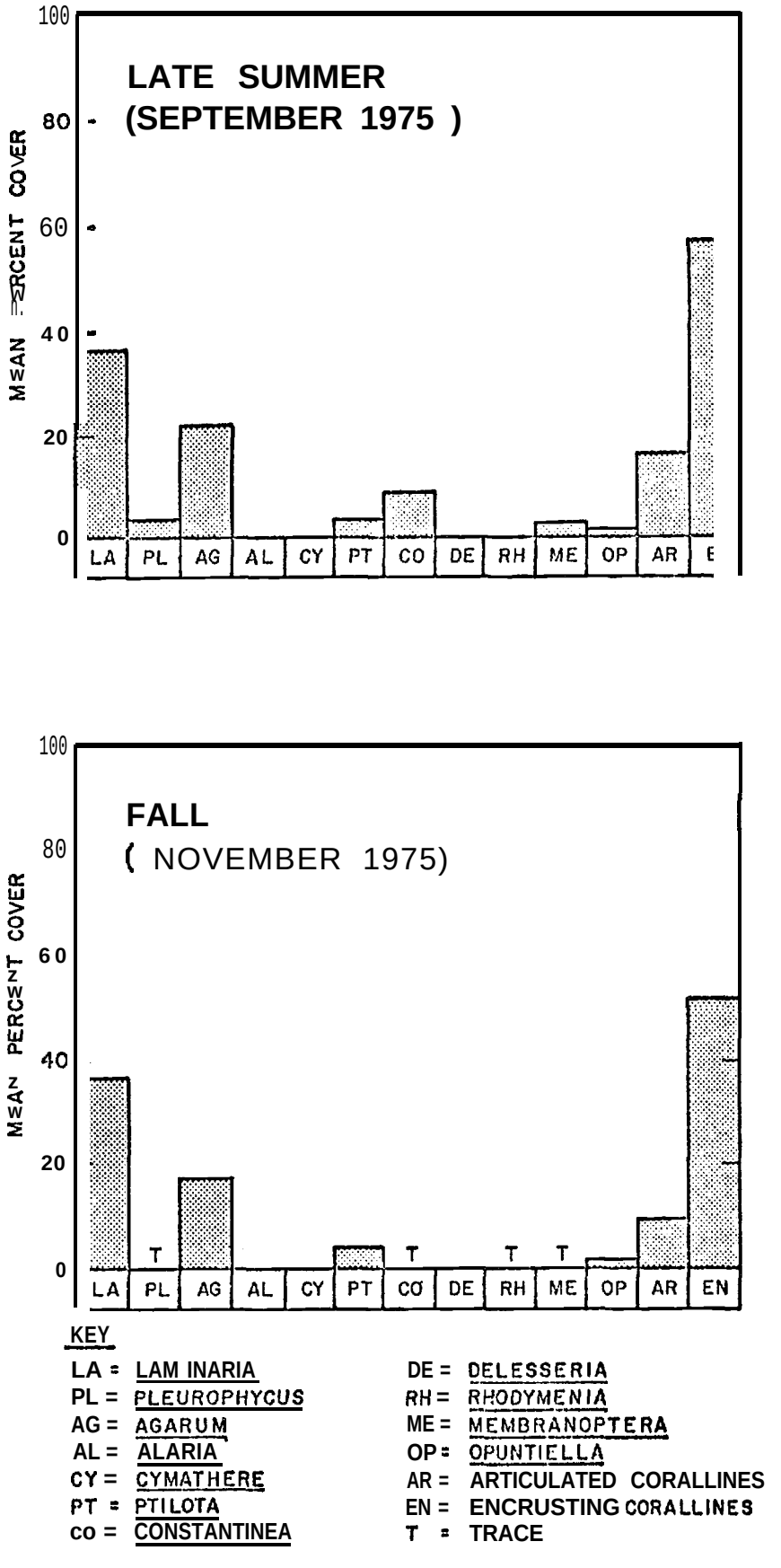


Figure 7. Algal cover at Latouche Point.

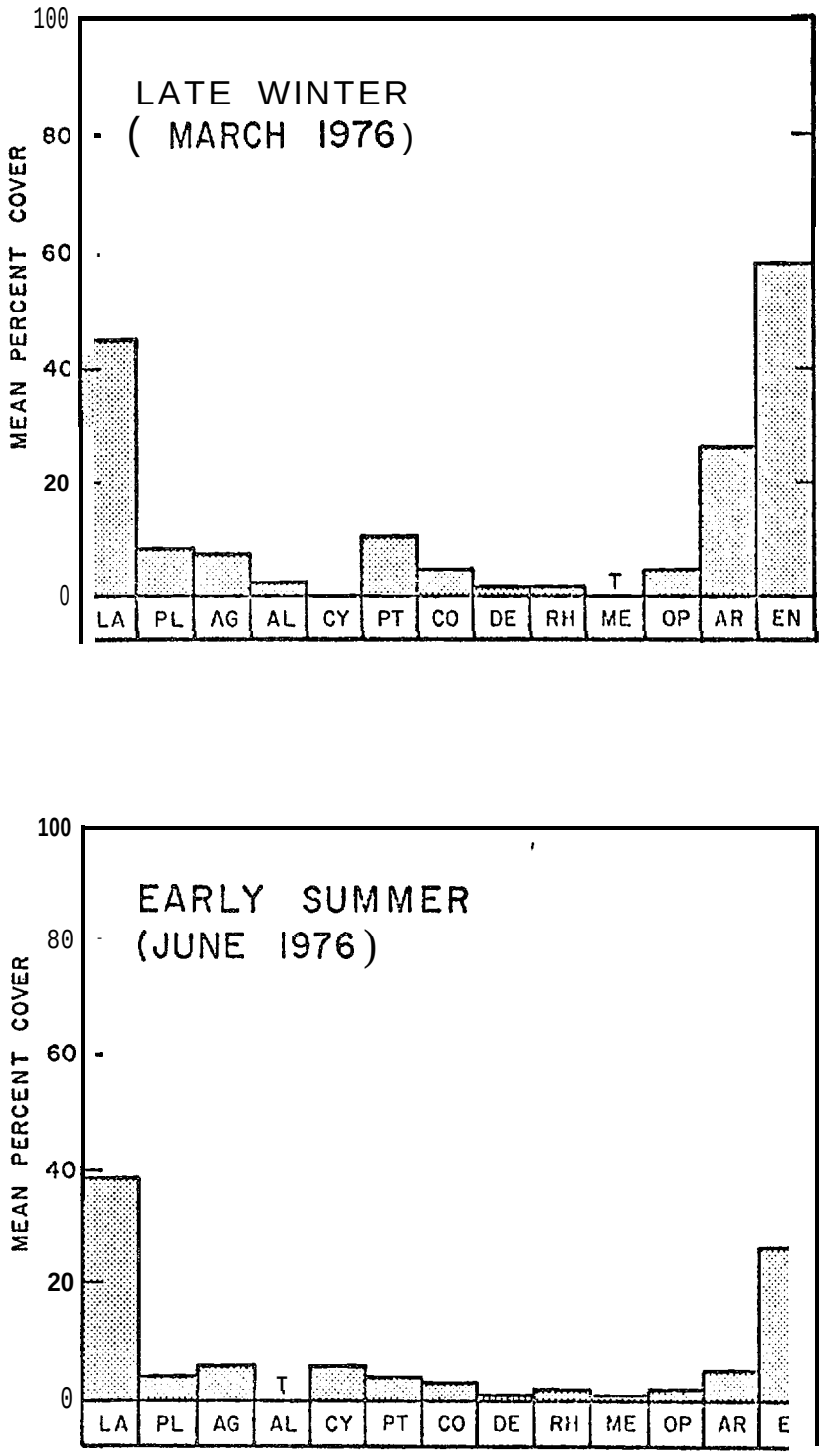


Figure 8. Algal cover at Latouche Point.

seasonal variation in cover and abundance. Since Musculus encrusts large portions of the blades of seaweeds in the lower canopies it is strongly affected by changes in the condition of the marine vegetation. Musculus vernicosus is either annual or hi-annual in terms of life history pattern, most disappeared by winter or early spring. The life history pattern agrees with the recorded longevity of the algal substrates, since the blades of most are continually being removed, and only those mussels that adhere to either the stipes or holdfast portions remain. Possibly because of predation pressures, adult Musculus are rarely successful on the bottom and so decline sharply after fall shedding of the plants, Spring and early summer marked the arrival of the juvenile spat which initially covered the understory seaweeds in such high densities that the bottom had a snow-like appearance. Juveniles were present at each sample period, however, their growth during winter is probably slow, and rapid growth commences concurrently with spring plankton blooms.

Other seasonal patterns were evident in the shallow water zone. For example, the inshore fishes, i.e. rockfish, greenling, flatfish and tomcod etc., which were prominent members of the seaweed assemblages during summer and early fall, tend to either move offshore, or become more secretive in habit. Solitary fishes were common under rock ledges and overhangs, however, schools of fish were not seen in this location until late spring. Even larger vertebrates, such as the ubiquitous sea otter, moved into more protected regions of the Sound; most could be seen either resting or feeding in the embayments and waterways of Elrington, Evans and Latouche Islands.

DESCRIPTION OF THE STUDY SITE (ZAIKOF BAY)

Zaikof Bay is located on the northeast end of Montague island. The mouth of the bay is 2.5 miles wide and is situated on the west side of Hinchinbrook Entrance (Figure 1). The shoreline is heavily wooded with Sitka Spruce and Hemlock; the beach is narrow and rocky. The inner confines of the bay are generally protected from ocean swell; however, at times the surface waters are exposed to storm force winds. The winds generally blow from a southeasterly direction during spring and fall. Local jet stream winds or "williwaws" are known to move through these mountain canyons in excess of 120 mph. For example, during the September (1975) survey we were literally driven from Zaikof Bay by rain and storm force winds in excess of 80 mph.

The NMFS intertidal site is located on a rocky promontory on the south side of the bay. An Alaska Department of Fish & Game stream marker served as a reference point for the sublittoral work. Below the tree line the beach is composed of cobbles and large boulders. The shallow sublittoral zone appears to be a continuum of the exposed portion of the beach. At the intertidal-subtidal fringe the substratum is pavement rock; below this point is a boulder field interspersed with sand and shell material (Figure 9). A fine layer of silt covered most of the solid substratum and marine vegetation during the four seasons of observation. At a depth of approximately 10 to 12m below the sea surface the band of exposed rock stopped and was replaced by sand and silty clay. Shell debris, particularly those of the clams Saxidomus, Mya and Humilaria were common in this location.

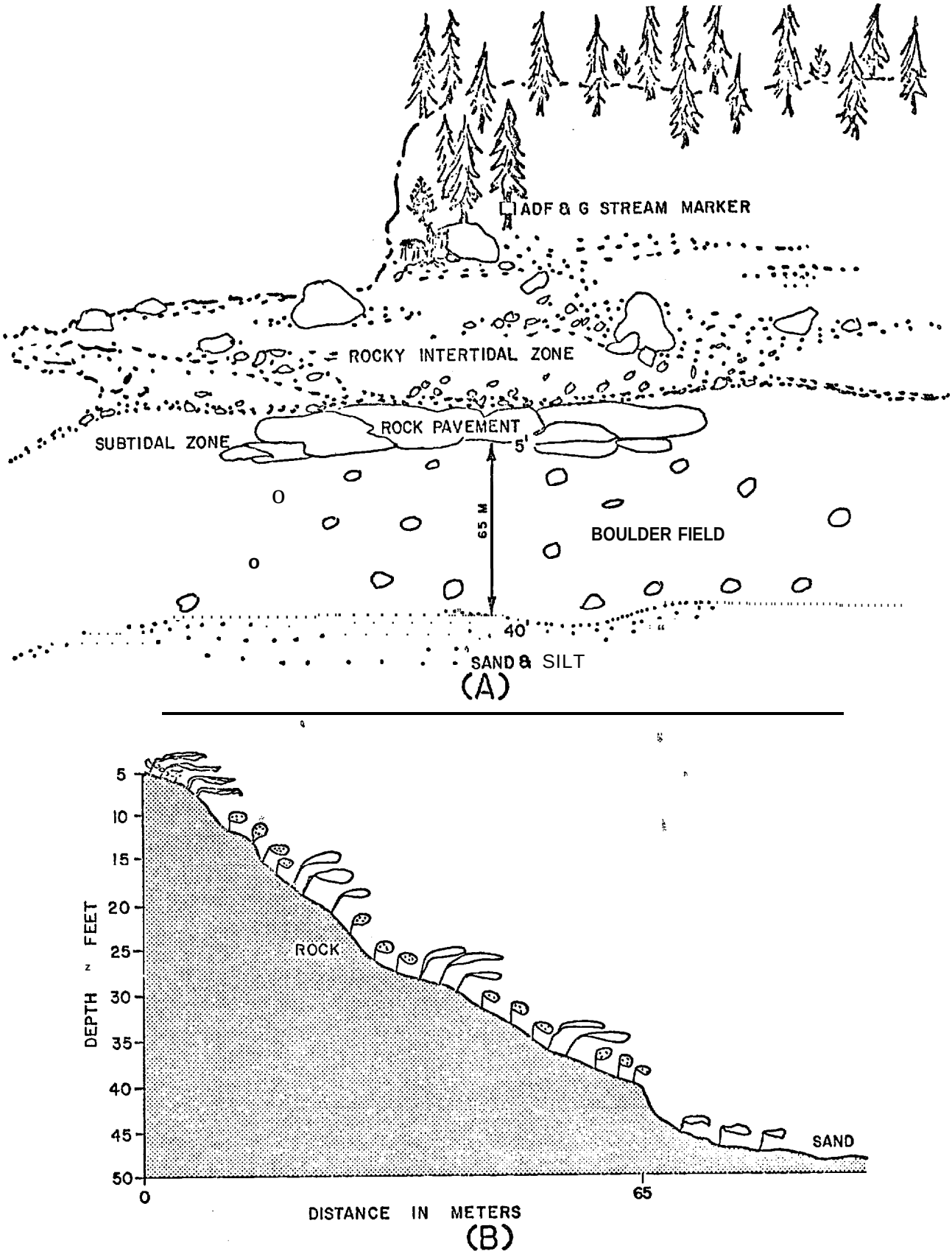


Figure 9. Study site (A) and subtidal vegetative canopies (B) at Zai kof Bay.

BIOLOGICAL SETTING (ALGAL ASSEMBLAGE)

Rockweed (Fucus distichus), formed the most conspicuous algal belt in the high intertidal zone during 1975-76. The brown alga, Alaria ? marginata was common at the MLLW mark, a major break point between the intertidal and shallow subtidal zones. The sublittoral macrophyte band was approximately 65 meters wide in the vicinity of the NMFS station (Figure 9). Most of the macroalgae was confined to the rock pavement or shallow water terrace, and the boulder field that borders the shoreline. However, a few kelp plants were found growing on the soft or unconsolidated substratum. Most of these plants were attached to empty clam shells and/or small stones.

Sieve kelp (Agarum cribrosum) was the numerical dominant in the seaweed zone. Density estimates during three of the sample periods ranged from 2.12/m^2 to 8.20/m^2 in the band transects (Tables 22 and 23); the average density in all transects combined was 4.62/m^2. In 52 quadrats (0.25/m^2) the density ranged from 0 to 28.00/m^2; with an average of 7.77/m^2. Elephant-ear kelp (Laminaria groenlandica) was also abundant in this location; density estimates ranged from 0.20/m^2 to 4.80/m^2 with an average density of 2.48/m2 in the transect bands. These data agree well with the quadrat counts; the range in 41 haphazard casts (0.25/m^2) was 0 to 16.00/m^2, and the mean density was 2.83/m^2 (Tables 24 through 31). Laminaria yezoensis was also present, although relatively uncommon except in the shallow (9.0m) part of the seaweed band. The average density in the belt transects was 0.74/m^2, compared with 1.07/m^2 in the

TABLE 22

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES FROM ZAIKOF BAY
(estimates were derived from band transects of different lengths)

Taxon	11-23-75	11-24-75	3-20-76	3-20-76	3-20-76
Nereocystis leutkeana	0	0	0	0	0
Laminaria groenlandica	/	/	23 2. 30/m2	33 3. 30/m2	14 1. 40/m2
Laminaria yeozoensis	/	/	o	o	12 1. 20/m2
Laminaria SPP.	39 . 78/m2	43 1. 72/m2	0	0	o
Agarum cribrosum	172 3. 44/m2	53 2.12/m2	52 5. 20/m2	59 5. 90/m2	82 8. 20/m2
Pleurophycus gardneri	0	0	o	o	0
Area sampled:	25 x 2m	25 x 1m	10XI.M	10 x 1m	10 X 1m
Depth:	11.0-12.0	12.0-13.0	10.5m	7.5m	4.5m
Substrate Type:	Rock	Rock & Sand	Boulders	Boulders	Boulders & rock pavement

/ = placed under the category of Laminaria spp.

TABLE 23

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES FROM ZAIKOF BAY

(Estimates Were Derived from Band Transects of Different Lengths)

Taxon	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76
Nereocystis luetkeana	0	0	0	0	0	0	0	0	0	0	2 0. 40/m^2
Laminaria groenlandica	3 0. 60/m^2	1 0.2 0/m^2	5 1. 00/m^2	2 0. 40/m^2	19 3. 80/m^2	23 4. 60/m^2	22 4. 40/m^2	16 3. 20/m^2	24 4. 80/m^2	11 2. 20/m^2	Not counted
Laminaria yezoensis	0	0	0	0	0	0	3 0.60/m^2	1 0.20/m2	2 0. 40/m^2	0	Not counted
Agarum cribrosum	11 2. 20/m^2	19 3.8 0/m^2	15 3. 00/m^2	22 4. 40/m^2	24 4. 80/m^2	35 7. 00/m^2	28 5. 60/m^2	29 5. 80/m^2	2 7 5. 40/m^2	12 2. 40/m^2	Not counted
Pleurophycus gardneri	0	0	0	0	1 0. 20/m^2	0	2 0. 40/m^2	4 0. 80/m^2	3 0. 60/m^2	34 6. 80/m^2	Not counted
Area sampled:	5xl m	5xl m	5xl m	5xl m	5xl m	5xl m	5xl m	5xl m	5xl m	5x1 m	5xl m
Depth:	13.5 m	13.5 m	12.0 m	12.0 m	10.5 m	10.5 m	9.0 m	9.0 m	7.6 m	6.1 m	4.6 m
Substrate type:	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Boulders	Rock	Rock	Rock	Boulders	Boulders

TABLE 24

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL
NOVEMBER 23, 1975

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Laminaria spp.	0	5%"	30%(2)	5%	25%(1)
Agarum	20%(1)	o	20%(1)	5%(1)	40%(2)
Constantine	1%(1)	0	0	0	0
Ralfsia	15%	20%	10%	20%	15%
encrusting coralline	80%	60%	90%	80%	80%
Hildenbrandia	0	0	1%	0	1%
Microcladia spp.	0	o "	0	1%	0
Microporina borealis	40%	20%	25%	15%	50%
Didemnum/Tridemnum	1%	1%	1%	5%	1%
pagurids	(2)	(2)	(5)	(1)	(1)
Heteropora sp.	1%	5%	1%	1%	5%
Phidolopora pacifica	1%	1%	1%	1%	5%
Cryptobranchia concentric	'(l)	0	0	0	0
? Rhynchozoon	1%	0	0	0	0
Trichotropis cancellata	0	(1)	0	(1)	0
Crossaster papposus	0	(1)	0	0	0
serpulidae	0	(4)	(2)	(1)	(1)
Crepipatella lingulata	0	(1)	(0)	(1)	0
Acmaea mitra	0	0	(1)	0	0
Flustrella	0	0	2%	35%	0
Pycnopodia helianthoides	0	0	(1)	0	0
Hydroida (unid.)	1%	1%	0	5%	1%
Dendrobeania	0	0	0	1%	0
Thais lamellosa	0	0	0	0	(2)
globular red sponge	(1)	0	(1)	0	0

Location: 100m offshore of NMFS *Transect*
Depth (meters): 10.0-16.0M
Substrate type: rock outcrop

TABLE 25

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL ZONE
NOVEMBER 24, 1975

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria Spp.	30%(5)	40%(4)	20%(2)	Io%(I)
Agarum	40%(2)	Io%(2)	20%(2)	40%(1)
Microcladia spp.	1%	1%	3%	2%
Encrusting coralline	30%	40%	15%	40%
Ralfsia spp.	0	10%	0	o
Hildenbrandia	5%	o	15%	5%
Microporina borealis	5%	10%	2%	2%
Flustrella sp.	5%	5%	5%	o
Distaplia	5%(1)	o	0	0
Pagurids	(5)	(3)	(1)	(1)
Didemnum/Tridídemnum	1%	o	0	o
Dendrobeania	1%	o	0	0
Puncturella multistriata	0	o	0	(1)
Tonicella spp.	(2)	(2)	(1)	(2)
Calliostoma ligatum	(1)	o	0	o
Cancer oregonensis	0	0	0	(1)
Heteropora sp.	0	2%	0	o
Crepipatella lingulata	(1)	o	0	0
Globose red sponge	(2)	0	(3)	0
Colonial ascidian (convoluted)	0	2%	2%	0

Depth (meters): 7.0-8.0

Substrate type: Boulders, cobbles and shell debris

Location: 100m off NMFS transect

TABLE 26

QUADRAT DATA (0.25m2) FROM ZAIKOF BAY, SUBTIDAL ZONE
MARCH 19, 1976

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Laminaria yezoensis	0	25%(3)	0	15%	20%
Laminaria groenlandica	0	o	0	o	o
Laminaria spp.	0	(2)	0	0	(2)
Agarum	90% (6)	15%(7)	80% (5)	50%(2)	25%(7)
Constantine	0	6%	0	o	1%
Ralfsia	5%	o	10%	15%	10%
encrusting coralline	30%	5%	15%	10%	20%
Hildenbrandia	0	o	0	25%	o
Corallina	0	0	0	1%	2%
filamentous reds	6%	4%	5%	2%	10%
Microporina	0	1%	10%	20%	15%
Didemnum/Tridídemnum	1%	o	0	o	1%
pagurids	(6)	(3)	(1)	(2)	(2)
Heteropora	0	o	0	o	2%
Trichotropis	(1)	(1)	(1)	0	o
serpulidae	(2)	(5)	(1)	(2)	(7)
Flustrella	5%	2%	10%	5%	2%
yellow sponge	2%	o	0	o	o
Distaplia	1%	0	5%	0	1%
Margaritas	(1)	0	0	(1)	o

TABLE 26 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL ZONE
MARCH 19, 1976

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Abietinaria	5%	0	0	0	0
Lacuna	present	0	0	0	0
Cancer oregonensis	(1")	0	0	0	0
? Distaplia	2%	0	0	8%	5%
Halocynthia aurantium	(1)	0	0		
Tonicella spp.				(2)	0
Phyllolithodes	0	0	0	0	(1)
Balanus spp.	15%	8%	40%	10%	20%

Location: off NMFS Site
Depth (meters): 6.0-7.0
Substrate type: boulders

TABLE 27

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria yezoensis	4	0	0	0
Laminaria groenlandica	10%	25%	25%(1)	40%(1)
Laminaria spp.	0	0	(2)	(2)
Agarum	60%(4)	0	25%(2)	50%(5)
Constantinea	10%	20%	10%	1%
Ralfsia	40%	40%	10%	25%
encrusting coralline	40%	40%	10%	65%
Corallina	15%	15%	10%	15%
Bossiella	0	2%	0	2%
Ptilota	0	0	20%	20%
Rhodymenia	0	0	0	5%
Microporina	40%	15%	20%	10%
Flustrella	5%	0	0	0
orange globular ascidian	0	0	2%	0
Didemnum/Trid idemnum	0	0	0	1%
Metandrocarpa	0	0	1%	0
pagurids	0	(3)	(3)	(3)
Balanus sp.	0	1%	1%	0
Ophiopholis	present	present	0	0
Tonicella	(1)	0	0	0

TABLE 27 (Cont.)

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Pododesmus	0	0	0	(2)
Amphissa	0	(2)	0	0
Lacuna	present	0	present	present
Searlesia	0	(3)	0	0
Volutharpa ampullacea	0	(1)	0	0
Myxicola	(3)	0	0	0
serpulidae	(9)	(16)	(2)	(3)

Location: off NMFS Transect

Depth (meters): 4.0-5.0

Substrate type: rock pavement

QUADRAT DATA ($0.25m^2$) FROM ZAIKOF BAY, SUBTIDAL ZONE
MARCH 20, 1976

Cover and Composition:

	Percent Cover (number of individuals)				
Taxon	No. 1	No. 2	No. 3	No. 4	No. 5
Laminaria yezoensis	0	0	(1)	0	0
Laminaria groenlandica	25%(3)	0	25%(1)	25%(2)	15%
Laminaria (juveniles)	0	0	0	0	(1)
Agarum	70%(1)	25%	15%(2)	10%	75%(3)
Constantinea	2%	1%	0	0	0
Ralfsia	30%	10%	0	5%	0
encrusting coralline	30%	20%	15%	30%	20%
Hildenbrandia	5%	5%	0	20%	25%
filamentous reds	1%	1%	0	3%	0
Microporina	3%	2%	5%	5%	(3)
pagurids	(2)	0	(4)	(2)	(3)
Heteropora	0	0	0	1%	0
Trichotropis	0	0	(1)	(2)	0
serpulidae	0	10%	0	(1)	0
Flustrella	1%	2%	1%	15%	5%
Distaplia	2%	0	0	0	1%
Margaritas	0	0	0	(1)	(1)
? Archidistoma	0	2%	1%	1%	0
orange globular ascidian	0	0	0	8%	7%
Halocynthia aurantium	(1)	0	0	0	0
Tonicella	(2)	(2)	(1)	(2)	(1)
Musculus discors	(2)	0	0	0	0
Cryptobranchia	present	present	0	present	present
Trichotropis	0	0	(1)	(2)	0
Puncturella	(1)	0	0	0	0
Fusitriton	0	0	(1)	0	0
Trophon	(1)	0	(3)	(1)	0
Ophiopholis	present	0	0	0	0
Strongylocentrotus	0	0	(1)	0	0
Balanus sp.	5%	12%	10%	15%	2%

Location: NMFS Site
Depth: 9-lore
Substratum: Boulder Field

TABLE 29

HAPHAZARD QUADRAT CASTS (O.25m^2)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 1) Depth 10.5m; Sand, Shell Debris & Silt

Taxon	Percent Cover (number of individuals)
Laminaria (juvenile)	(1)
Rhodymenia	2%(2)
diatom scum	80%

(No. 2) Depth 10.5m; Sand & Silt

Taxon	Percent Cover (number of individuals)
Laminaria (juveniles)	(3)
unid. foliose red	(1)
diatom scum	90%
Orthasterias	(1)

(No. 3) Depth 10.5m; Sand & Silt

Taxon	Percent Cover (number of individuals)
diatom scum	80%
shell debris	20%

(No. 4) Depth 10m; Rock & Shell Debris

Taxon	Percent Cover [number of individuals)
Laminaria groenlandica	(1)
Rhodymenia	(1)
Desmarestia	(1)
Unid.filamentous reds	2%

(No. 5) Depth 9m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Constantinea	5%(1)
Callophyllis	10%
Flustrella	5%
Microporina	30%
Evasterias	(1)

TABLE 29 (Cont.)

HAPHAZARD QUADRAT CASTS ($0.25m^2$)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 5) Cont.

Taxon	Percent Cover (number of individuals)
Ischnochiton	(1)
pagurids	(1)
unid. cottid	(1)

(No. 6) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(3)
Callophyllis	2%
encrusting corallines	30%
Microporina	25%
Pycnopodia	(2)

(No. 7) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(5)
Callophyllis	2%
encrusting coral lines	25%
Microporina	30%
Balanus	40%
Calliostoma	(2)

(No. 8) Depth 8.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Callophyllis	2%
Microporina	15%
Bal anus	60%
Heteropora	5%

TABLE 29 (Cont.)

HAPHAZARD QUADRAT CASTS ($0.25m^2$)
FROM IWE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 9) Depth 7.5m; Rock

Taxon	Percent Cover (number of individuals)
Agarum	(1)
Callophyllis	5%
encrusting corallines	15%
Flustrella	5%
Microporina	5%
Balanus	25%
Calliostoma	(1)
Ischnochiton	(1)
Puncturella	(1)

(No. 10) Depth 8m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(2)
Laminaria (juveniles)	(2)
Agarum	(2)
Callophyllis	5%
encrusting corallines	60%
Microporina	10%
Flustrella	2%
Evasterias	(1)
Trichotropis	present

(No. 11) Depth 8m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(1)
Callophyllis	5%
encrusting corallines	40%
Flustrella	5%
Balanus	2%
Trichotropis	(4)

TABLE 29 (Cont.)

HAPHAZARD QUADRAT CASTS ($0.25m^2$)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20, 1976

(No. 12) Depth 6.5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(4)
Agarum	(3)
Callophyllis	2%
encrusting corallines	75%
Microporina	10%
Dendrobeania	2%
Flustrella	5%
Pycnopodia	(1)
Musculus discors	present

(No. 13) Depth 7m; Rock & Shell Debris

Taxon	Percent Cover (number of individuals)
Agarum	(4)
Callophyllis	5%
Microporina	10%
Balanus	20%

(No. 14) Depth 4.5m; Rock & Shell Debris

Taxon	Percent Cover (number of individuals)
Laminaria yezoensis	(1)
Laminaria groenlandica	(4)
Laminaria (juveniles)	(3)
Agarum	(5)
Rhodymenia	2%(1)
Odonthalia	5%
encrusting coral lines	60%
Dendrobeania	2%
Balanus	30%

(No. 15) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(6)

TABLE 29 (Cont.)

HAPHAZARD QUADRAT CASTS ($0.25m^2$)
FROM THE SUBLITTORAL ZONE IN ZAIKOF BAY
MARCH 20 1976

(No. 15) Cont.

Taxon	Percent Cover (number of individuals)
Rhodymenia	5%
Constantinea	(2)
unid. filamentous reds	20%
Hildenbrandia	5%
encrusting corallines	80%

(No. 16) Depth 5m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria groenlandica	(1)
Agarum	(6)
Rhodymenia	5%
Constantine	1%(2)
unid. filamentous reds	20%
Hildenbrandia	5%
encrusting coralline	80%

(No. 17) Depth 3m; Rock

Taxon	Percent Cover (number of individuals)
Laminaria yezoensis	(2)
Agarum	(2)
Rhodymenia	15%
Ptilota	30%
Corallina	5%
encrusting corallines	85%

TABLE 30 & 31

QUADRAT DATA (O. 25 m2) FROM
ZAI KOF BAY , SUBTIDAL ZONE
JUNE 22 and 23, 1976

Percent Cover (Number of Individuals)

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
Laminari a yezoensis	0	0	0	0	0	0	0	0	0	0	0	0
Laminaria groenlandica	0	0	0	0	20%(1)	0	0	0	0	0	80%(4)	30%(1)
Laminaria spp.	0	5%(6)	2%(5)	2%(2)	0	.1%(1)	5%(6)	0	0	5%(10)	2%(15)	2%(4)
Agarum	0	0	0	0	50%(1)	30%(1)	35%	65%(1)	50%	0	15%	50%(2)
Pleurophycus	0	0		0	0	0	0	25%(1)	30%(1)	5%	0	0
Desmarestia viridis	25%	2%	1:%	0	15%	35%	0	5%	0	20%	5%	o
Desmarestia ligulata var. ligulata	0	0	0	5%	0	0	0	0	0	2%	0	0
Ralfsia	P	0	0	0	0	0	0	0	0	P	0	0
encrusting coral l ine	0	0	25%	2%	5%	0	0	60%	60%	0	50%	30%
Hildenbrandia	0	0	0	0			0	0	20%	0	0	0
fi1amentous reds	0	2%	0	2%	1:%	1:%	0	0	5%	0	0	0
Callophyllis	0	o	0	0	0	0	0	0	5%	0	0	0
Microcladia	0	0	0	2%	0	0	2%	2%	0	0	20%	0
Phycodrys	0	0	0	0	0	0	0	0	2%	0	0	5%
Bossiella	0	0	0	0	0	0	0	0	0	0	0	2%
Microporina	0	0	5%	5%	25%	1 0%	25%	25%	60%	25%	20%	0
pagurids	0	(4)	0	(1)	0	(1)	0	0	0	0	(2)	(3)
Trichotropis	0	0	0	0	0	0	0	0	0	0	0	0
serpulidae	0	o	0	0	0	0	0	0	0	0	0	0
Flustrella	0			0	0	0	0	0	0	0	5%	5%
Balanus sp.	30%	1!%	1:%	0	0	0	5%	30%		0	0	0
Didemnum	0	o	0	0	5%		5%	5%	1!%	5%	5%	0
Dendrobeania	0	2%	0	0	0	1;:	0	0	0	10%	10%	10%
foliose reds, unid.	0	0	0	0	0	0	10%	0	0	0	0	0
Abietinaria	5%	0	5%	0	0	2%	0	0	0	0	0	0
Heteropora	2%	0	0	0	0	0	0	0	0	0	0	0
Distaplia	2%	0	0	0	0	0	0	0	0	0	0	0
Tricellaria	0	0	2%	0	0	0		0	0	0	2%	2%
Grammaria sp.	30%	5%	1 0%	5%	25%	15%	1:%	0	0	0	0	0
Hippodiplosia	2%	o	0	0	0	0	2%	0	0	0	0	0
Alcyonidium	0	0	0	0	5%	5%	2%	0	5%	0	0	2%
Hydractinea	P	0	0	0	0	o	0	0	0	0	0	0
Fusitriton	(1)	0	0	0	0	0	0		0	0	0	0
Ishnochiton spp.	(1)	0	0	0	0	0	0	(i')	0	0	0	0
Tonicella spp.	(2)	0	0	0	0	o	0	(1)	0	(1)	0	(1)
Corella	0	0	(1)	0	0	0	0	0	0	0	0	0
Henricia spp.	0	0	0	0	0	(1)	0	(1)	0	0	0	0
Orthasterias	0	0	0	0	0	0	(1)	0	0	0	0	(1)
Musculus ? discors	0	0	0	0	P	o	0	0	0	0	0	0
Pycnopodia	0	0	0	0	(1)	0	0	0	0	0	0	0
Solaster stimpsoni	0	0	0	(1)	0	0	0	0	0	0	0	0
Phi dol opora	0	0	0	0	0	0	0	2%	0	0	0	0
Oi adora	0	0	0	0	0	0	0	0	(1)	0	0	0
Trichotropis	0	0	0	0	0	0	0	0	(1)	0	0	(1)
Acmaea mitra	0	0	0	0	0	0	0	0	0	(1)	0	0
fan bryozoan	0	0	0	2%	5%	0	0	0	0	0	0	0
Depth:	15.5m	15. 5m	13.5m	13.5m	12. an	12. all	12.0m	10.5m	10.5m	9.0m	9.0m	7.5m
Substrata:	Sand, rock & shel l debris	Rock, sand & shel1 debris	Rock, sand & shell debris	Rock, sand & shell debris	Rock & shell debris	Rock	Rock	Rock	Rock	Rock & coarse sand	Rock & sand	Rock

quadrat counts. The third important member of this understory kelp guild was Pleurophycus gardneri. During the first three visits we did not record this species. Despite our oversight, Pleurophycus was obviously present since mature individuals were seen in the shallow regions of the reef complex during the June (1976) survey. The greatest number of Pleurophycus were attached to boulders in the 5-7 meter depth contour. For example, in June (1976) densities ranged from 0 to 6.80/m^2; the average in 10 band transects was 0.88/m^2 (Table 23) compared with an average density of 0.67/m2 in the quadrat counts for the same sample period (Table 31).

The other conspicuous or characteristic macroalgae in this location were the reds: Callophyllis spp., Constantine, Microcladia borealis and Rhodymenia spp. Crustose and articulated coralline algae were typically shallow in distribution and abundance. Drift or detached bull kelp (Nereocystis) was seen along the southern shores of Zaikof Bay, however it was not until June of 1976 that we actually observed attached bull kelp in the study site. Young Nereocystis or juvenile sporophytes grew on the rock substrate within the boulder field; densities averaged 0.14/m^2 during the summer survey (1976).

EPIFAUNA AND TROPHIC INTERACTION

A variety of epifaunal forms were observed in the relatively narrow macrophyte belt below MLLW. Suspension or filter feeders were abundant in this location. Most of these animals occurred along a narrow portion of the shoreline that was dominated by rock pavement and large rocks or boulders. The suspension feeders, along with the macrophyte species flourished from MLLW down to approximately 10 meters below the "0" elevation of the tide. The vertical faces of the rock substrates generally supported the greatest number of organisms. The dominant sessile forms were the bryozoans Microporina borealis, Flustrella gigantea, Heteropora SPP. and Dendrobeania murryani; barnacles Balanus spp., serpulid worms; a nestling mytilid Musculus discors and the ascidians Distaplia ? occidentals, Halocynthia aurantium, and Didemnum or Trididemnum. Hydroids were also common on rock substrata; the genera Abietinaria and Grammaria were particularly common during the June (1976) survey. For example, the tall statured Grammaria was recorded in 7/12 quadrats (.25m^2), with estimates of percent cover ranging between 0 and 30 percent, with an average coverage of 8.3 percent during this summer sample period.

Microherbivores were common on these same rock substrates. A few of the common species are listed in Table 32. Of the three genera, the most abundant and frequently encountered in the vegetative undergrowth was hermit crabs of the genus Pagurus. Hermit crabs occurred in 26/52 quadrats, with maximum densities of 24.0/m^2. The average density

TABLE 32

CHARACTERISTIC OR REPRESENTATIVE IMPORTANT SPECIES
AT ZAIKOF BAY, ROCKY SUBLITTORAL

Species	Occurrence	Major Taxon	Trophic Category
Agarum cribrosum (P)	A	Brown alga	Producer
Laminaria groenlandica (P)	C	Brown alga	Producer
Laminaria yezoensis (P)	C	Brown alga	Producer
Pleurophycus gardneri (P)	C	Brown alga	Producer
Desmarestia viridis (A)	C	Brown alga	Producer
Encrusting coralline (P)	A	Red alga	Producer
Microcladia borealis (?)	C	Red alga	Producer
Constantinea spp. (P)	C	Red alga	Producer
Callophyllis spp. (?)	C	Red alga	Producer
Ralfsia spp. (P)	C	Brown alga	Producer
Microporina borealis (A)	C	Bryozoan	Suspension feeder
Flustrella gigantea (P)	C	Bryozoan	Suspension feeder
Balanus spp. (P)	A	Barnacle	Suspension feeder
Grammaria sp.	c	Hydroid	Suspension feeder
Heteropora sp. (P)	c	Bryozoan	Suspension feeder
Pycnopodia helianthoides (P)	c	Sea star	Predator
Orthasterias koehleri (P)	c	Sea star	Predator
Dermasterias imbricata (P)	c	Sea star	Predator
Crossaster papposus (P)	c	Sea star	Predator
Henricia spp. (P)	c.	Sea star	Suspension feeder/predator
Evasterias troschelii (P)	c	Sea star	Predator
Fusitriton oregonensis (P)	c	Snail	Predator/scavenger
Musculus discors (A)	c	Mussel	Suspension feeder
Tonicella spp. (P)	c	Chiton	Herbivore
Pagurus spp. (P)	A	Hermit crab	Herbivore/S cavenger
Margaritas pupillus	c	Snail	Herbivore
Enhydra lutris (P)	c	Sea otter	Predator

Key: (P) = perennial
(A) = Annual
A = abundant
C = common
u = uncommon

was 5.1/m^2 in all quadrats combined. Members of this genus are reputed to be opportunistic consumers, and some species are known to consume both plant and animal matter. Herbivory was observed on attached macroalgae, particularly along the erroded edges of older blades where bacterial decomposition and tissue breakdown was no doubt great.

Several chitons (Tonicella insignis, T. lineata; Mopalia SPP. and Ishnochiton spp.) and snails (Margaritas pupillus, Calliostoma ligatum, Cryptobranchia spp., Puncturella spp., and Acmaea mitra) were also common in this location. The most common genera was Tonicella, and densities ranged as high as 8.0/m^2. Tonicella spp. occurred in 15 of 52 quadrats (.25m^2). Margarites and Calliostoma both reached densities of 4.0/m^2, and most often were seen on either rock or algal substrates · Most of these mollusks are microherbivores, arid as such feed on the diatom film or algal turf that is generally composed of gametophytes and algal sporelings.

Macroherbivores, such as sea urchins were uncommon in 'this 'location, although a few relatively small individuals were encountered during the quadrat sampling efforts. Most of the green sea urchins (Strongylocentrotus drobachiensis) were less than 30 cm in diameter and were typically cryptic in habit. Densities of S. drobachiensis ranged from 0 to 4.00/m^2, and averaged 0.04/m^2 in the 52 haphazardly placed quadrats. Frequency of occurrence was 1/52 in this same quadrats.

These data are comparable to the transect sampling, for only 1 green sea urchin was encountered during this phase of the field work, and densities ranged from 0 to 0.02/m^2 in the 292 square meters of seafloor that was sampled by band transects (Tables 33 and 34).

There are a number of other herbivores in the inshore system; i.e. amphipods, isopods, fishes etc.; however, no information has been generated from these groups of organisms since their occurrence at Zaikof Bay was more transient or ephemeral over the l-year (1975-76) sample period. Other invertebrate species which utilized the seaweed resource in the bay were Lacuna carinata (snail); Diadora aspera (limpet]; Mopalia spp. (chitons); Pugettia gracilis (decorator crab); Punturella spp. (snail) and Dermasterias imbricata (sea star).

As stated earlier, the sedentary or attached organisms were common on the solid substratum, and most of these species because of restrictions of mobility gather or collect food items that have either fallen or drifted to them in the water column. Most of the detritus that reaches the seafloor probably needs to be reworked further or broken down by bacterial action before it can be assimilated by the macroinvertebrates of the reef. Conspicuous members of this trophic guild included the articulated bryozoan Microporina borealis, which occurred in 40 of 52 quadrats, and covered between 0 and 60 percent of solid substrate. The average coverage over the 1-year period was 12.56 percent (Tables 24-31). Microporina longevity is unknown, although in some locations of the Northern Gulf the colonies appeared to be short-lived. Another

TABLE 33

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT ZAIKOF RAY
(estimates were derived from band transects)

Taxon	11-23-75	11-23-75	11-23-75	11-24-75	11-24-75	03-19-76	03-20-76	03-20-76	03-20-76
Pyncopodia helianthoides	19 0.38/m^2	5 0.25/m^2	12 0.48/m^2	16 0.64/m^2	4 0.18/m^2	11 0.22/m^2	8 0.80/m^2	3 0.30/m^2	9 0.90/m^2
Dermasterias imbricata	2 0.04/m^2	0	1 0.04/m^2	0	0	0	0	0	0
Orthasterias koehleri	3 0.06/m^2	1 0.05/m^2	1 0.04/m^2	0	1 0.05/m^2	5 0.10/m^2	1 0.10/m^2	1 0.10/m^2	0
Crossaster papposus	2 0.04/m^2	2 0.05/m^2	1 0.04/m^2	0	4 0.18/m^2	4 0.08/m^2	1 0.10/m^2	1 0.10/m^2	0
Solaster spp.	1 0.02/m^2	1 0.03/m^2	0	0	1 0.05/m^2	0	0	0	0
Henricia spp.	1 0.02/m^2	3 0.07	4 0.16/m^2	1 0.04/m^2	2 0.09/m^2	5 0.10/m^2	1 0.10/m^2	0	1 0.10/m^2
Evasterias troschelii	3 0.06/m^2	1 0.03/m^2	2 0.08/m^2	2 0.08/m^2	0	7 0.14/m^2	0	2 0.20/m^2	0
Strongylocentrotus Spp.	0	0	0	0	0	1 0.02/m^2	0	0	0
Axes sampled: Depth: Substrate type:	25 x 2m 11-12m Rock	2ox2m 10-11m Rock & Sand	25 x 1m 6-7m Rock	25 x 1m 12-13m Rock & Sand	22 x 1m 7-8m Rock	50 x 1m 7-12m Rock	10 x 1m 10.5m Rock & Sand	10 x 1m 8m	10 x 1m 4.5m Rock

TABLE 34

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS
AT ZAIKOF BAY

(Estimates Were Derived from Band Transects)

Taxon	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	6-22-76	Combined $\bar{x}/m^2$
Pycnopodia helianthoides	2 0.40/m^2	1 0.20/m^2	0	1 0.20/m^2	4 0.80/m^2	0	1 0.20/m^2	3 0.60/m^2	1 0.20/m^2	3 0.60/m^2	0.39
Dermasterias imbricata	0	1 0.20/m^2	0	0	0	0	0	0	0	3 0.60/m^2	0.01
Orthasterias koehleri	0	1 0.20/m^2	2 0.40/m^2	0	1 0.20/m^2	0	1 0.20/m^2	0	1 0.20/m^2	0	0.09
Crossaster papposus	1 0.20/m^2	0	0	0	0	0	0	0	0	0	0.04
Solaster spp.	0	0	0	0	0	0	0	0	0	0	0.01
Henricia spp.	0	0	0	0	1 0.20/m^2	0	1 0.20/m^2	0	2 0.40/m^2	0	0.08
Evasterias troschelii	0	0	0	0	0	0	0	0	0	0	0.03
Strongylocentrotus spp.	0	0	0	0	0	0	0	0	0	0	
Area sampled:	5X1 m	5x1 m	5x1 m	5X1 m	5X1 m	5X1 m	5x1 m	5X1 m	5x1 m	5X1 m	
;...pct, :	13.5 m	13.5 m	12.0 m	12.0 m	10.5 m	10.5 m	9.0 m	9.0 m	7.6 m	6.1 m	
Substrate type:	Rock & sand	Rock & sand	Rock s sand	Rock & sand	Boulders	Boulders	Rock	Rock	Boulders	Boulders	

common bryozoan in this area was Flustrella gigantea, which frequently grew in either mat-like encrustations between boulders or attached to the shell of Fusitriton oregonensis (snail). Estimated coverage of Flustrella ranged between 0 and 35 percent, with an average in all quadrats combined of 2.83 percent. The frequency of occurrence in the shallow water *zone* was 23/52. Based on observations made in Kachemak Bay (ADF&G, 1977), the canopy produced by Flustrella colonies are important habitats or nursery areas for juvenile crabs and shrimps. The colonies appeared to be perennial, and the only predator known to feed upon Flustrella in Prince William Sound is the white dorid nudibranch (Archidoris odhneri).

A third bryozoan, Heteropora spp. formed calcareous, branched colonies that are frequently referred to as coral by the fishermen of the Sound. Heteropora occurred in 10/52 quadrats, with maximum coverage of 5 percent in the haphazardly placed quadrats. Duration of life is unknown, however, judging from the size of some colonies it appeared to be long--lived. Few predators of Heteropora are known from this site, however, one occasional predator is the sun star, Pycnopodia helianthoides (Figure 10), and another known predator from the Northern Gulf is the China rockfish, Sebastes nebulosus, which probably ingests the colonies incidental to eating the brittle star (Ophiopholis aculeata) (Rosenthal, unpublished data).

Balanoid barnacles: Balanus nubilus, B. ?crenatus and B. glandula encrusted substantial portions of the rock substrate beneath

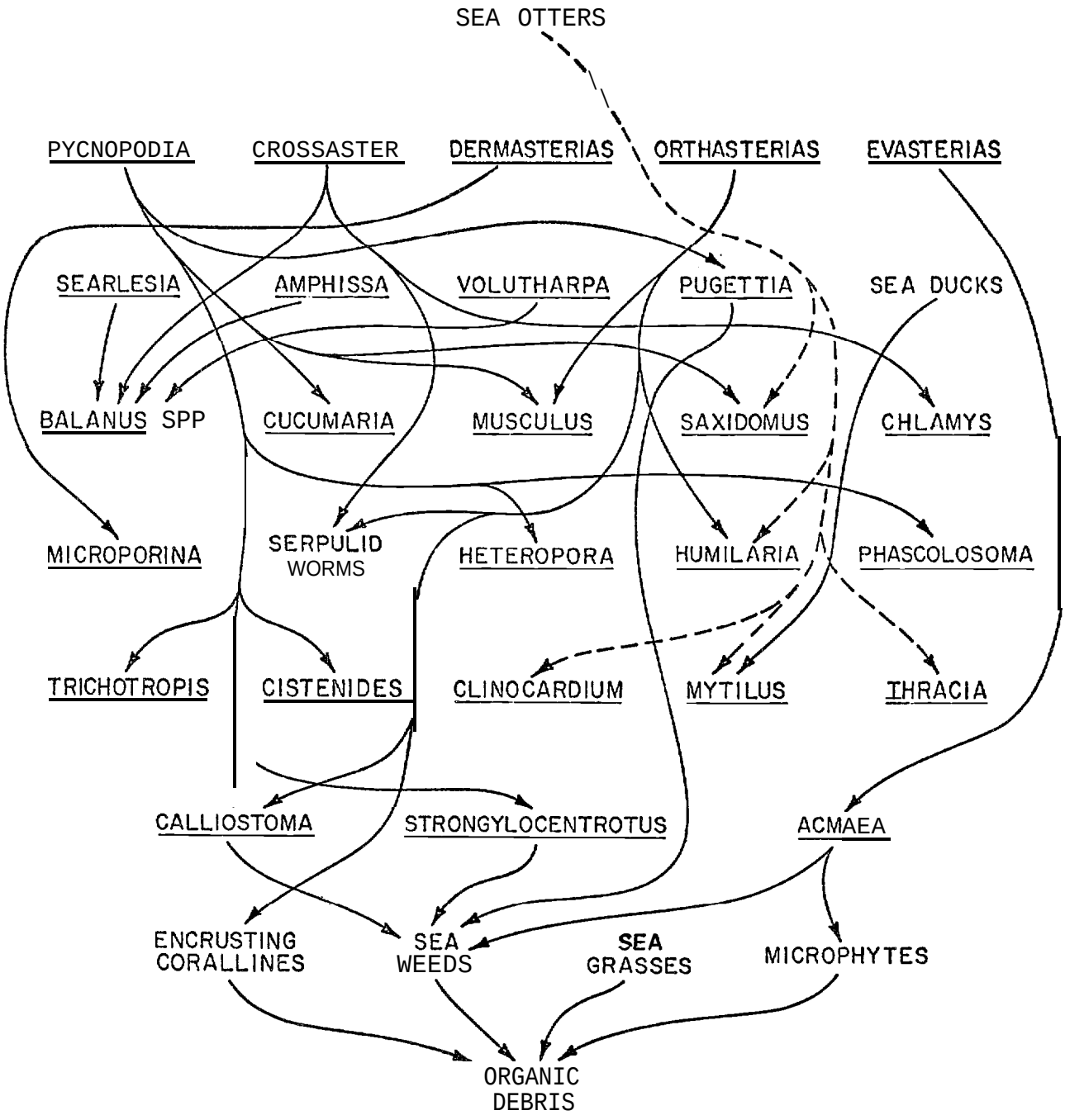


Figure 10. Food web for the conspicuous species in the shallow subl ittoral zone at Zai kof Bay, Montague Island.

the vegetative undergrowth. Estimates of barnacle coverage ranged between 0 and 60 percent, with an average of 7.8 percent in all of the quadrats ($.25m^2$). Barnacles occurred in 23 of 52 quadrats. Some of the predators of Balanus spp. in this location included the snails: Searlesia dira, Amphissa columbiana and Volutharpa ampullacea; the sea stars Crossaster papposus and Orthasterias koehleri.

The mytilid, Musculus discors is another member of the suspension feeding guild. It occupies a considerably different niche than it's congener M.vernicosus, and has adopted a substantially different pattern of life history, Mostlive in byssus nests attached to the vertical faces of rocks, or the holdfast portion o-f kelps. The population at Zaikof Bay contained a large proportion o-f adults (Figure 11), which brood tremendous numbers of eggs within the byssal nests until the juveniles are at least 0.5 mm in shell length. A length-weight regression for the winter population is presented in Figure 12. Shell debris at the base of the reef indicate that Musculuspopulations have been successful in this location during the past few years.

Some of the major predators at Zaikof Bay are listed in Table 32, and of these 6 species are sea stars, 1 is a snail and 1 a sea mamma 1. Other important tertiary consumers in the bay include crabs, shrimps, gastropod, sea anemones, fishes, marine mammals and sea ducks. Sea stars were the visual dominants in this trophic level. The sun star Pycnopodia was the numerical dominant in the 292 square meters of seafloor that was quantitatively sampled by band transects (Tables 33 and

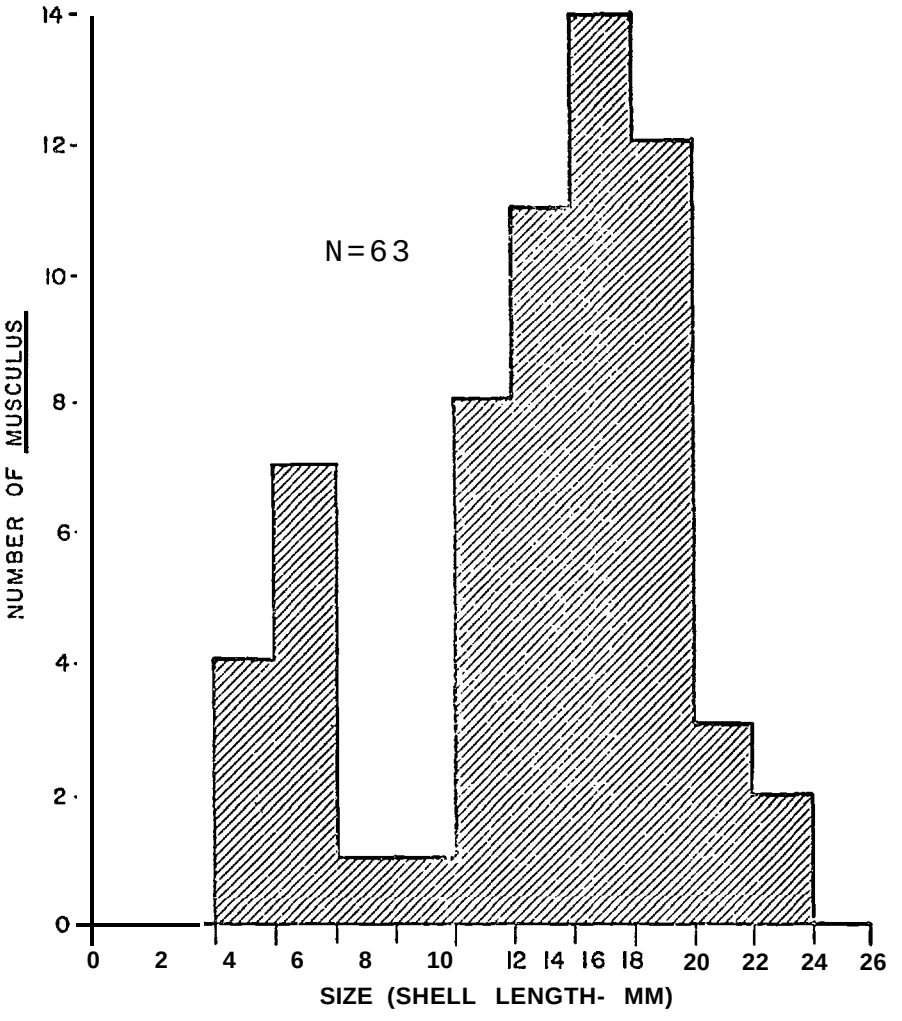


Figure 11. Size frequency histogram for *Musculus discors* collected from the subtidal zone in Zaikof Bay, 20 March 1976.

34). Density estimates ranged between 0 and 0.90 individuals/m^2; average density in all of the combined transects was 0.39/m^2. Pycnopodia is an opportunistic predator, and was observed to prey on a wide variety of species and trophic levels such as: Trichotropis spp. (snail}; Calliostoma ligatum (snail); Musculus spp. (mussel); Saxidomus gigantea [clam); Cucumaria spp. (sea cucumber); Strongylocentrotus drobachiensis (sea urchin); Cistenides (polychaete); Heteropora spp. (bryozoan); Phascolosoma (sipunculid), and Pugettia gracilis (crab).

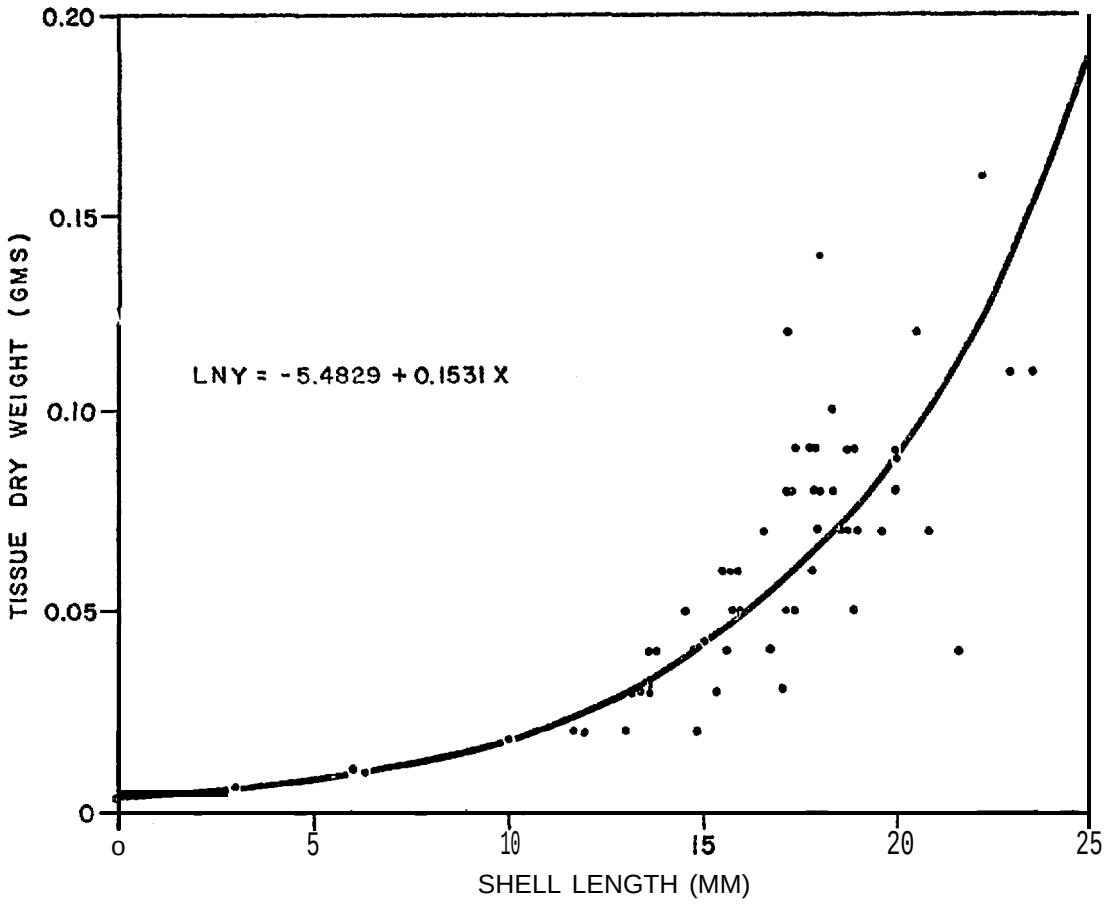


Figure 12. Relationship between shell length and dry tissue weight for *Musculus discors* from Zaikof Bay, 20 March 1976.

The second most abundant sea star was Orthasterias koehleri; density estimates ranged from 0 to 0.20/m^2, with an average of 0.09/m^2 in the band transects. Typically, it preyed on bivalve mollusks such as Musculus discors, Humilaria kennerlyi (clams) and barnacles Balanus spp.

The blood star Henricia spp. was the third most abundant genus in the shallow sublittoral zone. Since individuals were not identified to species, feeding type cannot be identified. However, one of the species present in this location H. leviuscula, is reputed to be a suspension feeder. Mode of feeding in the other species (H.

tumida) is unknown. Densities of Henricia ranged from 0 to 0.40/m^2 with the average density of 0.08/m^2.

Another common sea star was the multi-rayed star Crossaster papposus; estimates of density ranged from 0 to 0.20/m^2, and the average density in all band transects was 0.04/m^2. Individuals were seen eating serpulid worms, balanoid barnacles and a scallop Chlamys ? rubida. Most were seen either on rock substrate, or were attached to taller statured kelps in the algalunderstory.

Two other genera, the mottled star (Evasterias troschelli), and the genus Solaster are listed in Tables 33 and 34. Estimates of Evasterias ranged from 0 to 0.20/m^2, with an average density of 0/03/m^2. Solaster stimpsoni and S. dawsoni are presented under the one genus, and as such ranged from 0 to 0.05/m^2. The mean density in all transects during 1975-76 was 0.01/m^2.

Numerous predators and scavengers were seen in Zaikof Bay, and these included several species of fish, namely rock, whitespotted and kelp greenling, great sculpin, antlered sculpin, irish lord, rockfish, northern ronquil and flounder (Table 31). Although marine birds and mammals were not surveyed, several species of sea duck, i.e. white-winged scoter, barrow's goldeneye, and great scaup (Table 35}, were seen feeding in the shallow waters of the bay. Scoters were seen diving for bay mussels (Mytilus edulis) during the March and June (1976) surveys.

Sea otters are common in Zaikof Bay, with some of the feeding directed at the clams Humilaria, Saxidomus, Clinocardium, Thracia and

TABLE 35

A LIST OF AQUATIC BIRDS AND MAMMALS OBSERVED
AT THE OCS STUDY SITES DURING 1975-76

COMMON NAME	SCIENTIFIC NAME	LOCATION
WATER BIRDS		
Harlequin duck	Histrionics histrionics	L;Z
White-winged scoter	Melanitta deglandi	L;M;Z
Oldsquaw	Clangula hyemalis	M;Z
Mallard duck	Anas platyrhynchos	L
Greater scaup	Aythya marila	M;Z
Barrow's goldeneye	Bucephala islandica	M;Z
Cormorant	Phalacrocorax sp.	L
Black-legged kittiwake	Rissa tridactyla	L
Glaucous-winged gull	Larus glaucescens	L;M;Z
Grebe	Podiceps sp.	M
Common murre	Uris aalge	L
Murrelet	Brachyramphus sp.	L;M;Z
Pigeon guillemot	Cepphus columba	L
Black oyster catcher	Haematopus bachmani	L;M
MAMMALS		
Sea otter	Enhydra lutris	L;M;Z
Land otter	Lutra canadensis	L
Harbor seal	Phoca vitulina	L;M;Z
Steller sea lion	Eumetopias jubata	L;M;Z
Harbor porpoise	Phocoena phocoena	L;M;Z
Killer whale	Orcinus orca	L;Z
Dan porpoise	Phocoenoides dalli	Z
Minke whale	Balaenoptera acutorostrata	L

Location Symbols:

L = Latouche Point
M = Macleod Harbor
Z = Zaikof Bay

bay mussel (M. edulis). Shell debris was moderately abundant on the sandy slope below the boulder field.

SEASONAL PATTERNS

The macrophyte assemblage in the shallow waters cf Zaikof Bay exhibited changes in both alga cover, and number of species present with the movement of time from July, 1975, until June, 1976. The most pronounced change was in the a gal undergrowth, particularly the brown algae or phaerophytes. For example, during the November (1975) survey most of the laminarian kelps had either shed or lost most of the blade material above the meristematic growth region. Drift and/or detached pieces of plants, particularly sieve kelp (Agarum); elephant-ear kelp (Laminaria groenlandica) and l eaves or turions of eel grass (Zostera marina) were prominent on the bottom, particularly on soft substrata below the boulder field. Even leaves of terrestrial origin, such as alder were conspicuous in the shallow subtidal.

One of the seaweeds in the brown algal guild that oscillated in areal cover with the change of seasons was hair-kelp (Desmarestia viridis). Desmarestia viridis was rare in the study area during November, however, by late June, it occurred in 8/12 quadrats, and covered between 0 and 35 percent of the area contained in these .25m^2 quadrats. Average coverage for this same time period was 10 percent (Figure 13). Desmasteria viridis is reputed to be perennial alga (Champan 1974), however, it does undergo a perennation (die back) process during fall, with renewed growth during late winter and early spring. Many of the foliose (leaf-

like), and filamentous varieties of red algae are also highly seasonal in occurrence and physical appearance. Some of these like the filamentous reds Pterosiphonia bipinnata and Polysiphonia pacifica are summer plants, while others such as the peltate red Constantine subulifera apparently persist for a number of years provided the plant remains attached to the seafloor.

Several changes in the epifauna were also evident in this location. For instance, during 1975-76, the hydroids Grammaria sp. and Lafoea varied in abundance (coverage) in a similar fashion as the macroalgae; both hydroids covered up to 30 percent of the available surface area in the .25m^2 quadrats. However, prior to the summer survey both genera were rare or absent in this location. Grammaria and Lafoea both appear to be either annuals or exhibit substantial variation in cover and relative abundance during a year's time.

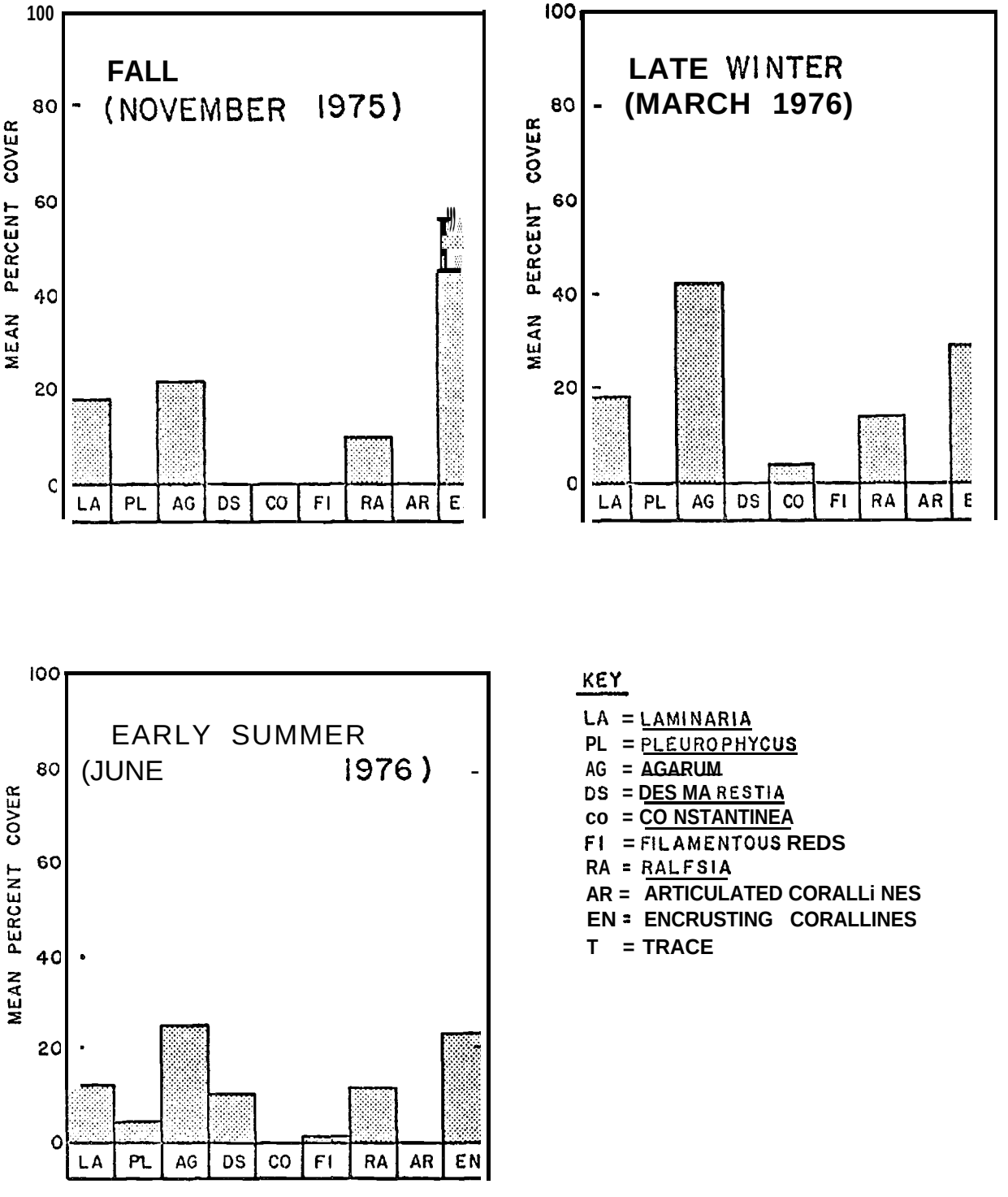


Figure 13. Algal cover at Zaikof Bay.

DESCRIPTION OF THE STUDY SITE (MACLEOD HARBOR)

Macleod Harbor, located on the southwest end of Montague Island (Figure 1) is generally protected from the Gulf of Alaska; however, it does receive some ocean swell and storm surf from Montague Strait. The northern shoreline from the entrance at Point Woodcock to about midway into the harbor is rocky and irregular. The head of the bay is shallow and fed by a large freshwater stream. Fresh water is a prominent feature of the upper part of *the water* column. The southwest coast of Montague Island was raised by as much as 30 feet during the Good Friday Earthquake of 1964 (Plaf ker, 1969). One effect of the quake was to separate the pre-earthquake littoral zone from the post earthquake shoreline.

At present, the shoreline is characterized by a band of sol id substratum compcsed of boulders and cobbles (Figure 14), Steeply sloping rocky cliffs overlook the NMFS intertidal station on the northern shores of Macleod Harbor. Sitka spruce and hemlock grow above the rocky buttress. A number of exposed low profile ridges, extend from shore into the shallow subtidal zone. Between these ridges or fingers of rock are broad surge channels. The sublittoral zone in this part of Macleod Harbor is composed of a narrow band of bedrock approximately 40 to 70m wide. Seaward of the exposed bedrock, at depths ranging between 6 and 9m below the sea surface, the seafloor was comprised of sand, silt and moderate amounts of shell material. The surface of the sand was usually covered by a thin layer of benthic diatoms, and sulfur bacteria spotted numerous areas of the bottom.

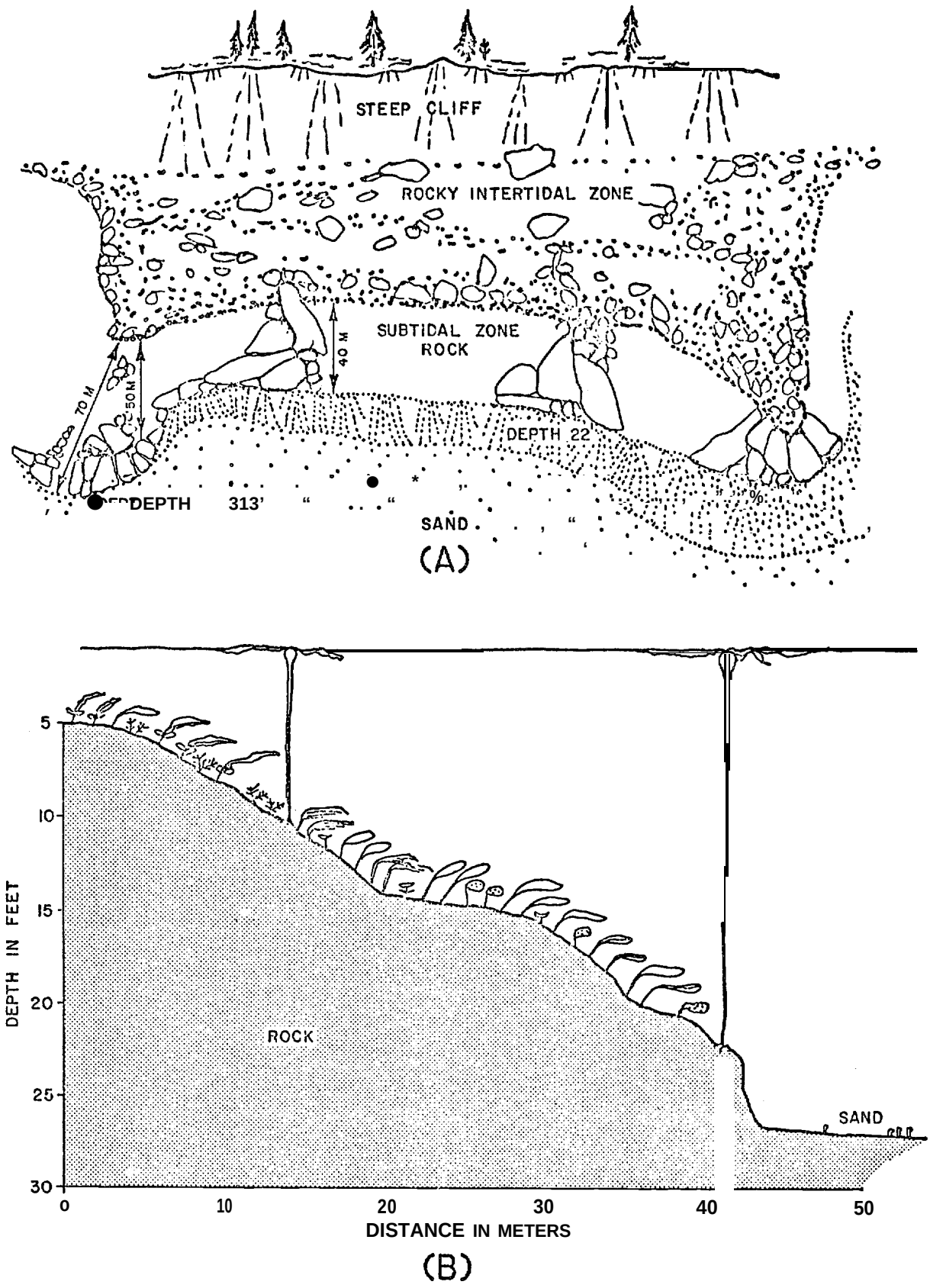


Figure 14. Study site (A) and subtidal vegetative canopies (B) at Macleod Harbor.

BIOLOGICAL SETTING (ALGAL ASSEMBLAGE)

A prominent feature of this location was the fringing bed of bull kelp (Nereocystis luetkeana) that occurred along the northern shoreline. During summer, the bed extended from the rocky promontory midway into the bay to approximately .25 nautical miles beyond Pt. Woodcock. Most of the bull kelp was scattered along the rocky reefs and in only a few locations was the surface canopy moderately heavy. Plants grew from MLLW to approximately 12 meters below the sea surface. Density estimates ranged from 0 to 0.46/m^2, with an average density of 0.07/m^2 (Table 36).

A thin band of rockweed (Fucus distichus) grew on the rock substrate above MLLW. Below the Fucus zone around the intertidal-subtidal fringe was a narrow girdle of Alaria ? tenuifolia. The brown alga, Costaria costata also occurred in the shallow water. Costaria is an annual species, and during March (1976) juvenile sporophytes were common in this location. Along most the rocky shoreline the seaweed belt was 40 to 70 meters wide; the width was largely determined by the availability of the hard or rock substrate. The sublittoral algal association was comprised of several layers or canopy levels. Laminaria groenlandica was the most abundant brown alga in the understory complex (Tables 37-50). Density estimates ranged from 0 to 64.00/m^2, the average density during March 1976 was 14.80/m^2 (Tables 44 to 50). Another congener, L. yezoensis was also common; densities ranged between

TABLE 36

DENSITY ESTIMATES OF SOME DOMINANT MACROPHYTES AT MACLEOD HARBOR
(estimates were derived from band transects of different lengths)

Taxon	9-15-75	9-15-75	9-15-75	3-13-76	3-13-76	3-15-76
Nereocystis luetkeana	0	0	23 0. 46/m²	0	0	0
Laminaria spp.	83 16. 6/m²	71 14. 2/m²	Not counted	42 2. 80/m²	31 3. 10/m²	36 5. 14/m²
Agarum cribrosum	35 7. 0/m²	13 2. 6/m²	Not counted	28 1. 87/m²	30 3. 00/m²	12 1. 71/m²
Pleurophycus gardneri	5 1.0/m²	14 2. 8/m²	Not counted	o	18 1. 80/m²	2 0. 28/m²
Area sampled:	10 x 5 m	10 x 5 m	25 x 2 m	15 x 1m	10 x 1m	7 x 1m
Depth:	7-8m	7-8m	5m	10m	*4.5m*	7.5-8.5m
Substrate type:	Rock & Kelp	Rock & Kelp	Rock	Rock & Sand	Rock	Rock & Sand

TABLE 37

QUADRAT DATA ($0.25m^2$) FROM NACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13
Laminaria spp.	(3)	(2)	(3)	(3)	(1)	(9)		(13)	(7)	(6)	(3)	(1)	(1)
Agarum cribrosum	(2)				(1)						(1)	(1)	(1)
Constantinea						P							
Opuntiella						P	P	10%					
Encrusting coralline			15%			30%	80%	80%	50%				
Microporina	45%	20%		5%	2%		60%	25%		15%	10%	15%	30%
Dendrobeania	5%				2%				2%			2%	
Tricellaria							2%						
Heteropora							5%						
Didemnum/Trididemnum	2%					5%	5%						
Hippodiplosia				P									
Halocynthia aurantium												(2)	
Musculus									P				
Pycnopodia			(1)	(1)	(1)					(1)			
Dermasterias							(1)						
Thais lamellosa						(1)							
Tonicella						(1)							
Halocynthia igaboja						(1)							
Trophonopsis			(1)										
Depth (meters)	9.0	9.0	9.0	9.0	10.0	5.0	3.0	3.0	5.0	10.0	10.0	10.0	13.0
Substrate type:	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock	Rock	Rock	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock & sand

TABLE 38

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Agarum	50%	15% (1)	25% (3)
Laminaria spp.	0	10% (2)	50%(3)
Alaria sp.	0	10%	0
Encrusting coralline	70%	50%	40%
Hildenbrandia	20%	30%	20%
Didemnum/Tridemnum	3%	5%	2%
Yellow spatter sponge	15%	5%	5%
Sertularella	1%	0	2%
? Scrupocellaria	1%	0	Present
Microporina	50%	50%	30%
? Rhynchozoon	5%	1%	2%
Musculus discors	(1)	(1)	0
Tonicella	(3)	(1)	(1)
Serpulidae	(1)	0	0
Trichotropis	(3)	(1)	(1)
Metandrocarpa	0	Present	0
Synoicum	Present	0	Present
Crepipatella	(1)	(1)	(1)

Depth (meters): 10.0
Substrate type: Rock pavement
Location: Rock projection off NMFS station

TABLE 39

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

	Percent Cover (number of individuals)	
Taxon	No. 1	No. 2
Laminaria groenlandica	90%(3)(1)*	100%(13)(4)
Laminaria yezoensis	(2 holdfasts)	5%(2)
Agarum	0	10% (1)
Corallina	2% (1)	0
Encrusting coralline	80%	80%
Foliose reds, unid.	2%	0
Musculus vernicosus	1%	0
Tonicella	(3)	0
Acmaea mitra	(3)	(2)
Dendrobeania	0	3%
Sertularella	0	3%
Microporina	15%	15%
Pycnopodia	(1)	(2)
Pagurids	0	(5)
Cryptobranchia concentric	0	(5)
Synoicum	0	1%
? Rhynchozoon sp.	1%	3%
Crepipatella lingulata	6%	5%
Yellow spatter sponge	1%	1%

Depth (meters): 6.0-7.0
Substrate type: Rock and boulders
Location: 200m S.E. NMFS station

* Plants undergoing blade renewal

TABLE 40

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Laminaria groenlandi ca	4% (25)	15%	50% (6)	90% (3)
Laminaria yezoensis	5% (25)	15% (5)	lo%(3)	0
Laminaria spp.	4% (25)	o	0	0
Cymathere triplicate	0	30% (7)	0	0
Desmarestia viridis	0	20%	0	0
Ptilota	0	o	0	5%(1)
Opuntiella californica	0	0	0	5% (1)
Constantine	0	1%(1)	2% (3)	0
Hildenbrandia sp.	1%	o	0	0
Bossiella	0	0	0	2%
Corallina	0	0	5%	2%
Foliose reds, unid.	1%	1%	2%	5%
Ralfsia	0	0	0	0
Encrusting coralline	70%	5%	40%	20%
Musculus vernicosus	25%	20%	40%	10%
Tonicella	(3)	0	0	0
Acmaea mitra	(4)	0	0	0
Dendrobeania	1%	0	1%	1%
Sertularella	1%	0	0	0
Plumularia sp.	1%	0	0	0
Microporina borealis	0	0	5%	15%

TABLE 40 (Cont.)

QuADRAT DATA (0.25m2) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

	Percent Cover (number of individuals)			
Taxon	No. 1	No. 2	No. 3	No. 4
Serpulidae	10%	0	0	0
Orange encrusting sponge	1%	0	2%	0
Yellow spatter sponge	0	0	5%	2%
Tricellaria sp.	0	0	0	2%
Pycnopodia	(1)	0	(1)	0
Didemnum/Tridídemnum	0	0	0	1%
? Ritterella	0	0	0	1%(1)
Distaplia sp.	0	0	0	2%(1)
Pagurids	0	0	0	0
Balanus ? alaskiensis	0	0	0	(1)
Sand	25%	50%	0	25%

Depth (meters): 5.0
Substrate type: Rock outcrop
Location: 200m S.E. NMFS station

* Plants undergoing blade renewal

TABLE 41

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 29, 1975

	Percent Cover (number of individuals)	
Taxon	No. 1	No. 2
Laminaria groenlandica	40% (4)	20% (4)
Laminaria yezoensis	20% (5)	20% (5)
Cymathere triplicate	5% (2)	0
Constantinea	2% (3)	0
Corallina	5% (2)	0
Foliose reds, unid.	10%	1%
Ralfsia spp.	1%	0
Encrusting coralline	20%	10%
Musculus vernicosus	20%	25%
Tonicella	0	(1)
Dendrobeania	1%	0
Microporina borealis	5%	1%
Yellow spatter sponge	5%	0
Pycnopodia	(1)	0
Pagurids	(3)	0
Distaplia	0	0
White colonial ascidian	1% (1)	0

Depth (meters): 5.0
Substrate type: Rock outcrop
Location: 200m S.E. NMFS station

TABLE 42

Q ADRAT DATA (0.25m^2) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 30, 1975

Taxon	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18	No. 19	No. 20
Laminaria groenlandica	(2)		(1)	(3)	(2)	(5)	(3)		(8)	(5)
Laminaria yezoensis		(1)	(1)							
Laminaria spp.	(3)	(3)		(2)	(8)	(6)	(13)	(1)	(7)	(19)
Agarum cribrosum	(3)		(2)	(1)						
Ralfsia spp.										
Opuntiella	10%		P	P			P			
Constantinea				P						
Hildenbrandia		20%	10%	20%	5%		10%	10%	15%	10%
Microporina	20%	60%	25%	25%	30%	20%	20%	20%	5%	10%
Tricellaria					5%				5%	
Abietinaria										10%
Heteropora	5%									
Encrusting coralline	70%	80%	70%	60%	70%	70%	60%	70%	60%	70%
Dendrobeania		5%								5%
Distaplia sp.			5%							
? Ritterella					2%			2%		
Pycnopodia								(1)		
Tonicella										(1)
Dermasterias						(1)				
Amphissa					(3)					
Calliostoma			(1)	(2)						
Evasterias										
Henricia							(1)			
Algal debris										
Acmaea mitra							(1)			
Depth (meters):	6.0	6.0	6.0	6.0	5.0	5.0	5.0	5.0	3.5	3.5
Substrate type:	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock

TABLE 43

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
NOVEMBER 30, 1975

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
Laminaria groenlandica	(1)	(4)	(2)	(2)	(2)	(2)		(1)		
Laminaria yezoensis										(1)
Laminaria spp.		(1)								(2)
Agarum cribrosum		(1)	(1)			(4]	(4)	(1)		
Ralfsia spp.						P				2%
Opuntiella						P				
Constantinea										
Hildenbrandia						5%			15%	
Microporina	5%	25%	30%	10%		60%	50%	15%	20%	
Tricellaria		2%								20%
Abietinaria										2%
Heteropora									2%	
Encrusting coralline		25%	20%		10%	85%	75%	60%	30%	60%
Dendrobeania										
Distaplia										
? Ritterella			2%							
Pycnopodia										
Tonicella										(1)
Dermasterias										
Amphissa								(1)		
Calliostoma										
? Lichenopora						2%				
Evasterias						(1)				
Henricia							(1)			
Algal debris	50%		5%	5%	15%					
Acmaea mitra										
Depth (meters):	11.0	11.0	11.0	11.0	11.0	7.0	7.0	7.5	7.5	7.5
Substrate type:	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock & sand	Rock	Rock	Rock	Rock

TABLE 44

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 13, 1976

Taxon	Percent Cover (*number* of individuals) No. 1	No. 2	No. 3	No. 4	No. 5
Laminaria groenlandica	40% (13)	50% (16)	90% (6)	40% (12)	60% (7)
Agarum	(1)	(1)	0	25% (2)	0
Encrusting coralline	60%	70%	70%	60%	60%
Corallina	0	0	0	10%	0
Bossiella	0	15%	0	0	10%
Hildenbrandia	Present	Present	30%	20%	0
Opuntiella	0	(2)	0	0	0
Microporina	0	15%	0	1%	0
Distaplia	0	5%	0	0	0
Serpulidae	(2)	0	0	0	0
Tonicella	0	(1)	0	0	0
Musculus vernicosus	Present	Present	Present	Present	Present
Pagurids	0	(2)	0	0	0

Depth (meters): 3.0-5.0
Substrate type: Survey channel with *rock* bedrock

TABLE 45

QUADRAT DATA (0.25m²) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

Taxon	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
Laminaria groenlandica		(1)	(2)	(4)	(3)	(5)		(5)	(3)	(3)	(4)
Laminaria yezoensis			(2)							(11)	(1)
Laminaria spp. (juv.)	(14)	(2)	(5)	(8)	(3)				(10)	(4)	(4)
Agarum cribrosum	(1)	(4)	(8)	(2)	(5)	(1)					(1)
Pleurophycus gardneri	(1)		(2)		(3)				(2)		
Ralfsia spp.			5%			5%					
Costaria costata									(3) juv.		
Nereocystis luetkeana											
Opuntiella		10%	2%		10%	10%					
Rhodymenia spp.						5%				2%	
Delesseria		2%			5%	15%	15%	10%	5%		
Callophyllis			2%		10%						
Hildenbrandia	10%	20%	15%			10%					
Microcladia	2%										
Encrusting coralline	60%	80%	80%	80%	85%	70%		75%	70%	10%	15%
Articulated coralline	5%	2%		15%	10%	5%		10%		10%	
Constantinea	2%								5%		
Tonicella	(1)	(1)	(2)		(1)					(1)	
Acmaea mitra					(1)	(1)					
Pycnopodia	(1)		(1)								
Musculus		P	P	P	P	P			P	P	P
Depth (meters):	8.0	8.0	6.0	6.0	.50	5.0	3.0	3.0	4.0	7.0	7.0
Substrate type:	Rock & sand	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Rock & sand	Rock & sand

TABLE 46

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

Taxon	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18	No. 19	No. 20	No. 21	No. 22
Laminaria groenlandica	(1)	(2)	(1)	(6)	(15)	(5)	(8)	(2)	(1)	(2)	(3)
Laminaria yezoensis	(8)	(1)	(5)		(6)				(1)		(1)
Laminaria spp. (juv.)	(2)	(8)	(10)	(10)	(20)	(10)	(10)	(9)	(25)	(4)	(12)
Agarum cribrosum			(2)	(1)						(2)	
Pleurophycus gardneri											
Ralfsia spp.			5%	2%							
Costaria costata											
Nereocystis luetkeana											(3)
Opuntiella	5%		2%	5%		5%	15%	10%		2%	2%
Rhodymenia spp.	5%	2%				2%				5%	
Delesseria		2%	2%		2%	5%		5%			
Callophyllis											
Hildenbrandia				2%	10%	50%		10%			
Microcladia			5%	2%			20%				
Encrusting coralline	80%	50%	80%		50%	60%		65%	15%	20%	30%
Articulated coralline	5%					10%					
Constantinea		2%									
Tonicella	(1)										
Acmaea mitra	(1)		(1)								
Pycnopodia								(1)		(1)	
Musculus	P	P	P	P	P			P	P	P	P
Depth (meters):	7.0	7.0	6.0	6.0	6.0	5.0	4.0	6.0	5.0	5.0	6.0
Substrate type:	Rock	Rock	Rock	Rock & sand	Rock	Rock	Rock	Rock	Rock & sand	Rock & sand	Rock & sand

TABLE 47

QUADRAT DATA (0.25m2) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria spp.	5%(1)	60%(5)	80%(14)
Costaria (juveniles)	2%(3)	5%(3)	0
Alaria ? marginata	80%(1)	0	0
Constantinea	10% (6)	2%(1)	0
Rhodymenia	20%	5%	2%
Corallina	20%	1%	0
Bossiella	20%	0	0
Encrusting coralline	30%	40%	60%
Membranoptera spp.	0	0	0
Phycodrys sp.	0	5%	10%
Distaplia	0	1%	0
Yellow sponge	0	1%	0
Orange encrusting sponge	0	0	2%
Dendrobeania	0	0	1%
Diatom film	0	50%	50%
Musculus spp.	Present	Present	Present
Tonicella	0	(2)	0

Depth (meters): 3.0-5.0
Substrate type: Rock
Location: Off NMFS transect

TABLE 48

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 14, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria spp.	0	25%(4)	50% (3)
Costaria (juveniles)	5% (1)	5%(1)	0
Alaria ? Marginata	50% (3)	60%(1)	10%
Constantinea	0	15%(3)	0
Rhodymenia	15%	5%	15%
Corallina	1%	40%	0
Bossiella	0	40%	2%
Encrusting coralline	80%	30%	60%
Membranoptera sp.	0	60%	0
Phycodrys sp.	10%	0	10%
Thais canaliculata	0	(1)	(4)
Distaplia	0	1%	1%
Yellow sponge	0	0	2%
Serpulidae	0	0	(1)
Pagurids	0	0	(5)
Orange encrusting sponge	1%	0	0
Dendrobeania	0	0	0
Diatom film	25%	0	25%
Musculus Vernicosus	Present	Present	Present
Tonicella	0	0	(3)

Depth (meters): 3.5-5.0
Substrate type: Rock pavement

TABLE 49

QUADRAT DATA (0.25m^2) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria yezoensis	(5)	(2)	(2)
Laminaria groenlandica	50%(6)**	25%(3)**	25%(1)**
Agarum	5%	0	5%
Rhodymenia	0	1%	1%
Encrusting coralline	60%	30%	50%
Corallina	8%	1%	2%
Bossiella	8%	0	1%
Delesseria	0	0	0
Opuntiella	0	0	0
Hildenbrandia	0	2%	0
Ralfsia	1%	0	0
Distaplia sp.	7%	0	1%
Microporina	0	0	0
Tonicella	(1)	0	(2)
Searlesia	0	(1)	(1)
Pagurids	(6)	(4)	0
Musculus vernicosus	Present	Present	Present
Dendrobeania	0	0	0
Serpulidae	(2)	0	0
Acmaea mitra	0	(1)	0
Crepipatella	Present	0	0
Cryptobranchia	0	Present	Present
Puncturella	(1)	0	0
Pycnopodia	0	0	(1)

Depth (meters): 6.0-8.0
Substrate type: Rock

** Total Laminaria cover in the quadrat

TABLE 50

QUADRAT DATA ($0.25m^2$) FROM MACLEOD HARBOR, SUBTIDAL
MARCH 15, 1976

	Percent Cover (number of individuals)		
Taxon	No. 1	No. 2	No. 3
Laminaria yezoensis	0	(1)	0
Laminaria groenlandica	lo%(3)**	60%(6)**	75%(8)**
Agarum	60%(5)	15%	15%
Rhodymenia	1%	o	2%
Encrusting coralline	75%	60%	50%
Corallina	3%	1%	2%
Bossiella	8%	3%	3%
Delesseria	o	5%(1)	15
Opuntiella	0	5%	10%
Hildenbrandia	0	10%	1%
Ralfsia spp.	0	10%	o
Distaplia	3%	3%	15%
Microporina	o	1%	o
Tonicella	0	(2)	0
Metandrocarpa	0	5%	0
Pagurids	(2)	(lo)	(5)
Musculus	Present	Present	Present
Dendrobeania	1%	1%	2%
Serpulidae	(1)	0	0
Acmaea mitra	o	(2)	(1)
Crepipatella	Present	o	0
Cryptobranchia	o	Present	Present
Lichenopora	0	1%	0
Puncturella	0	0	(1)

Depth (meterS): 6.0
Substrate type: Rock
Location: Off NMFS transect

** Total Laminaria cover in quadrat

0 to 44.00/m^2 and averaged 4.97/m^2 during this same sample period. Another conspicuous species in this assemblage was sieve kelp (Agarum), the average density in 37 quadrats (0.25m^2) during March 1976 was 3.68/m^2. These estimates are in good agreement with the average estimate of 3.24/m^2 that was obtained from the band transects (Table 36). Pleurophycus gardneri was an important member of this brown algal understory; density estimates ranged from 0 to 2.80/m^2 in the band transects, the average density in all of the transects was 1.05/m^2. Density estimates from the 0.25m^2 quadrats averaged 0.86/m^2.

The other conspicuous brown algae in this location were Cymathere triplicate and Desmarestia viridis. Both species were scmIe-what ephemeral in occurrence, and were uncommon except during the summer and fall seasons of the year (Figure 15). Below the kelp canopies were the fleshy, erect reds such as Opuntiella californica, Callophyllis spp., Membranoptera spp., Rhodymenia palmata and R. pertusa, Constantinea and Ptilota filicina. The final vegetative layer in Macleod Harbor included the rock encrusting forms: Corallina spp., Lithothamnium spp., Ralfsia spp., and Hildenbrandia sp.

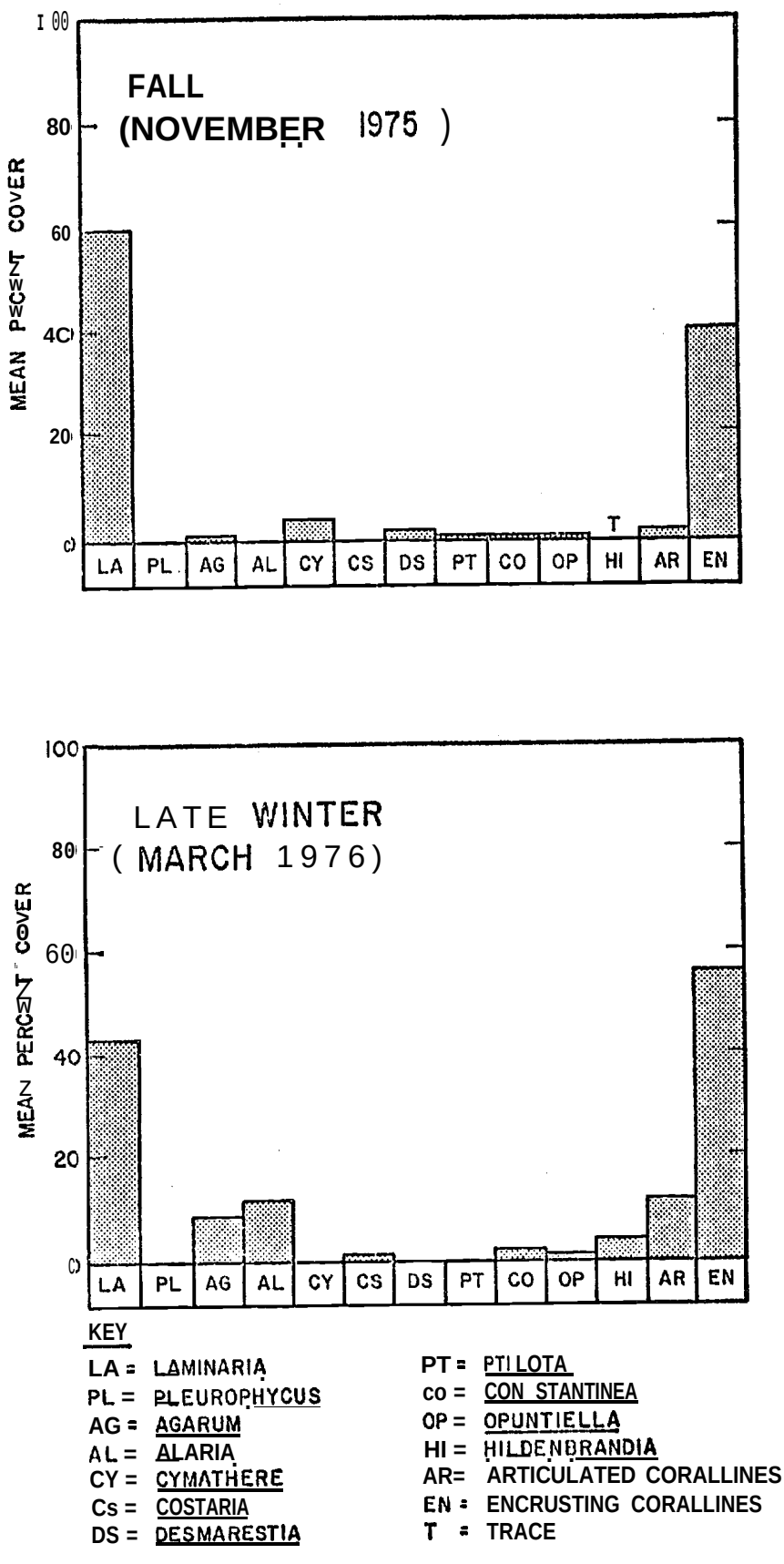


Figure 15. Algal cover at Macleod Harbor.

EPIFAUNA AND TROPHIC INTERACTION

The major rock habitats examined in Macleod Harbor were the (1) rock fingers which extended from shore, (2) surge channels between the rock-like appendages, and the (3) rock/sand interface at the base of the shoreline. The fingers are deeply fissured, with numerous overhanging ledges and shelves. Many large blocks and boulders were located around the base of the steeply sloped platform. Typically, the larger boulders were interspersed with sandy channels and patches of gravel and cobble.

The epifauna was dominated by suspension feeders and species composition was relatively diverse. The suspension feeding assemblage was dominated by the bryozoan Microporina borealis; it occurred in 37 of 71 quadrats (Tables 37-50). Estimates of percent cover ranged from 0 to 60 percent; however, the average coverage was 9.37 percent during the one year sample period.

Other common suspension feeders in this location were the filibranch mussels Musculus discors and M. vernicosus. During the late fall (1975) and winter (1976) surveys heavy sets of juveniles were observed in the shallow subtidal waters; most samples were collected on macrophytes and larger attached macroinvertebrates such as ascidians. Size structures of the population at this time is virtually indistinguishable.

It appeared as though there was little or no growth during the winter months, and this is probably due to the fact that as suspension or Filter feeders the food source, i.e. phytoplankton, was extremely scarce during this time of year. Musculus species were encountered in 41 of 71 quadrats during two observation periods. Estimates of percent cover ranged between 0 and 40 percent. An important predator of this age group of Musculus was the muricid snail Thais canaliculata, many of which were observed feeding on dense populations of juvenile Musculus. Maximum densities of 16.0/m^2 were observed for Thais in this location during the March (1976) survey.

Hydroids and bryozoans *such* as Dendrobeania murryani, Sertularella; Tricellaria and Heteropora spp. were moderately common in this site. Other common suspension feeding forms were the ascidians Halocynthia aurantium; Distaplia sp; Synoicum sp.; ? Ritterella rubra and Didemnum or Trididemnum.

Few herbivores were seen at Macleod Harbor, however, others species were no doubt present, but because of their size and/or behavioral traits were not recorded, or listed in the generalized food web (Figure 16). As previously noted for the other two locations, the sea urchins were relatively small and cryptic in behavior. Most were seen beneath rocks, or were found crawling on the undersises of the leaf-like brown algae. Maximum densities of 0.10/m^2 of S. droebachiensis were recorded in the band transects (Tables 51 and 52).

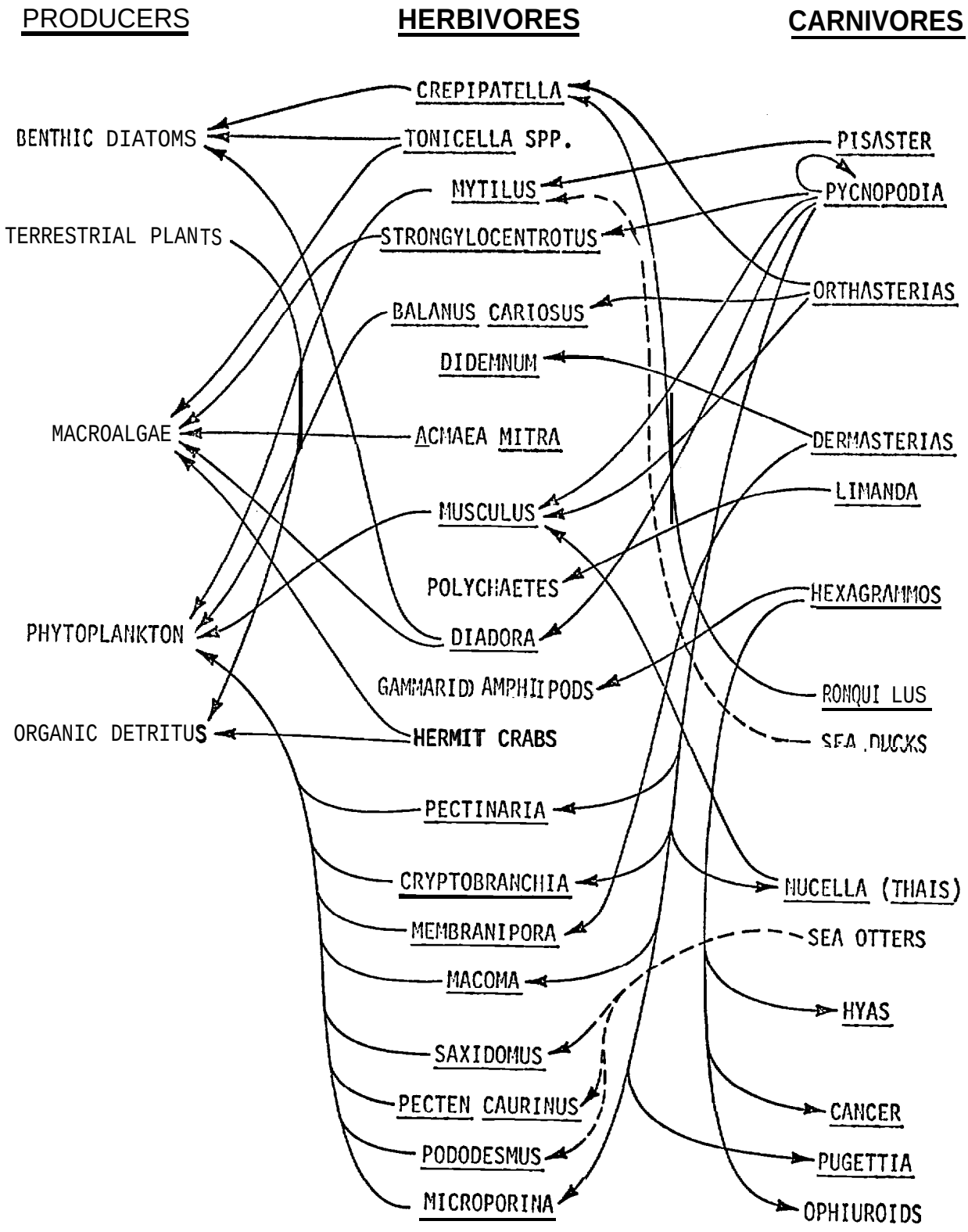


Figure 16. Food web of a sublittoral reef at Macleod Harbor, Montague Island.

TABLE 51

DENSITY ESTIMATES OF SONE COMMON **ECHINODERMS AT** MACLEOD HARBOR

Taxon	9-14-75	9-14-75	9-14-75	9-14-75	9-15-75	9-15-75	9-15-75	9-15-75	9-15-75
Pycnopodia helianthoides	7 0. 14/m^2	3 0. 12/m^2	5 0. 33/m^2	1 0. 06/m^2	1 0. 04/m^2	0	13 0. 26/m^2	6 0. 24/m^2	4 0. 16/m^2
Dermasterias imbricata	0	1 0. 04/m^2	1 0. 06/m^2	0	1 0. 04/m^2	0	2 0. 04/m^2	0	0
Orthasterias koehleri	0	0	1 0. 06/m^2	0	0	0	0	0	0
Crossaster papposus	0	0	0	0	0	0	0	0	0
Henricia spp.	0	0	1 0. 06/m^2	0	0	0	1 0. 02/m^2	0	0
Pisaster ochraceus	0	0	0	0	0	0	0	0	0
Evasterias troschelii	0	0	0	0	0	0	0	0	0
Strongylocentrotus spp.	0	0	0	0	0	1 0.02/m^2	0	0	0
Area sampled:	25 X 2m	25 x 1m	lsxl.in	15 x 1m	25 x 1m	10 x .5m	50 x 1m	25 x 1m	25 x 1m
Depth:	6-7m	12m	8m	5m	12m	7-8m	7-11m	6m	3-5m
Substate type:	Rock & sand	Sand & rock	Rock out-crop	Rock	Sand & rock	Rock & kelp	Rock & sand	Rock & kelp	Rock & kelp

TABLE 52

DENSITY ESTIMATES OF SOME COMMON ECHINODERMS AT MACLEOD HAREOR

Taxon	11-29-75	11-29-75	11-30-75	11-30-75	11-30-75	3-13-76	3-13-76	3-14-76	3-14-76	3-15-76
Pyncopodia helianthoides	18 0. 72/m^2	8 0. 80/m^2	15 0. 38/m^2	4 0. 40/m^2	0	12 0. 80/m^2	1 0. 10/m^2	10 0. 20/m^2	5 0.33/m2	10 0. 20/m^2
Dermasterias imbricata	1 0. 04/m^2	2 0. 20/m^2	2 0. 05/m^2	1 0. 10/m^2	0	0	0	4 0. 08/m^2	1 0. 06/m^2	0
Orthasterias koehleri	0	3 0. 30/m^2	3 0.08/m^2	0	0	0	1 0. 10/m^2	1 0.02/m^2	0	1 0 .02/m^2
Crossaster papposus	0	0	0	0	0	1 0. 06/m^2	0	0	0	0
Henricia spp.	0	1 0. 10/m^2	2 0. 05/m^2	3 0. 30/m^2	0	1 0. 60/m^2	0	1 0. 02/m^2	0	1 0. 02/m^2
Pisaster ochraceus	0	0	0	0	12 1. 2/m^2	0	0	0	0	0
Evasterias troschelii	0	0	1 0.03/m^2	1 0. 10/m^2	0	0	0	0	0	0
Strongylocentrotus spp.	0	0	0	1 0. 10/m^2	0	0	0	0	0	0
Area sampled:	25 x lm	10 x lm	40 x lm	10 x lm	10 x lm	15 x lm	10 x lm	50 x lm	15 x lm	50 x lm
Depth:	6-7m	3-4m	9m	6-7m	1- 2m	10m	5m	2-7m	10IS	3-9m
Substrate type:	Rock & sand	Rock	Rock & sand	Rock	Rock	Rock & sand	Rock	Rock	Rock & sand	Rock

Some of the other conspicuous herbivores are listed in Table 53 of Representative Important Species (RIS). These are the limpet Acmaea rnitra, chitons Tonicella lineata and T. insignis, and the occasional herbivore Dermasterias imbricata (sea star). l-he snail Calliostoma-ligatum, Diadora aspera (limpet), Puncturella spp. (snail), Crepipatella spp. (snail], Lacuna carinata (snail) and hermit crabs of the genus Pagurus werealso common in this location. Most of these are micro-herbivores, and none were sufficiently abundant to influence the flora appreciably.

The most numerous predators in the rock habitat were the sea stars. Eight species of predatory starfish were observed in the study area, and of these the sun star Pycnopodia helianthoides was the most abundant species (Tables 51 and 52). Density estimates ranged from 0 to 0.80/m^2, and averaged 0.28 individuals/m^2 in the 470 square meters of seafloor that was quantitatively sampled during 1975-76. Pycnopodia was observed to feed on Musculus spp.; Diadora aspera; Cryptochiton stelleri (chiton); Thais spp. (snail); Macoma spp. (clam); Microporina (bryozoan); Pectinaria (polychaete worm) and Strongylocentrotus droebachiensis (Figure 16).

The second most common species in this location was the leather star Dermasterias imbricata; density estimates ranged from 0 to 0.20/m^2, and averaged 0.04/m^2 in all of the combined transects. Demasterias preyed on Didemnum (ascidian); Membranipora spp. (bryozoan) and the clavate ascidian Synoicum sp. and macroalgae.

TABLE 53

CHARACTERISTIC OR REPRESENTATIVE IMPORTANT SPECIES
FROM THE SHALLOW SUBLITTORAL ZONE AT MACLEOD HARBOR

Species	Occurrence	Major Taxon	Trophic Category
Agarum cribrosum (P)	A	Brown alga	Producer
Laminaria groenlandica (P)	A	Brown alga	Producer
Laminaria yezoensis (P)	c	Brown alga	Producer
Pleurophycus gardneri (P)	c	Brown alga	Producer
Nereocystis luetkeana (A)	C	Brown alga	Producer
Costaria costata (A)	c	Brown alga	Producer
Opuntiella californica (?)	C	Red alga	Producer
Constantinea spp. (P)	c	Red alga	Producer
Callophyllis spp. (?)	c	Red alga	Producer
Rhodymenia spp. (?)	c	Red alga	Producer
Ralfsia spp. (P)	c	Brown alga	Producer
Hildenbrandia ? occidentals (P)	c	Red alga	Producer
Delesseria decipiens (A)	c	Red alga	Producer
Encrusting coralline (P)	A	Red alga	Producer
Strongylocentrotus spp. (P)	U	Sea urchin	Herbivore
Tonicella spp. (P)	C	Snail	Herbivore
Acmaea mitra (P)	C	Snail	Herbivore
Orthasterias koehleri (P)	C	Sea star	Predator
Pycnopodia helianthoides (P)	C	Sea star	Predator
Dermasterias imbricata (P)	C	Sea star	Predator/Herbivore
Henricia spp. (P)	C	Sea star	Suspension feeder
Fusitriton oregonensis (P)	C	Snail	Predator/Scavenger
Thais canaliculata (P)	C	Snail	Predator
Halocynthia aurantium (P)	C	Ascidian	Suspension feeder
Musculus spp. (A)	C	Mussel	Suspension feeder
Enhydra lutris (P)	C	Sea otter	Predator
Microporina borealis	C	Bryozoan	Suspension feeder

Key: (P) = perennial
(A) = annual
A = abundant
c = common
u = uncommon

The star Orthasterias koehleri was next in abundance; densities of up to 0.03/m^2 were recorded for Orthasterias, however the average of 0.03/m^2 is probably a more realistic estimate of density. Orthasterias was seen eating Balanus cariosus (barnacle), Crepipatella (snail), and the mussels Musculus vernicosus and M. discors.

Another common asteroid was the blood star Henricia spp. The predominant blood star in this area was H. leviuscula, although two other species, H. tumida and H. sanquinolenta, occurred in the same shallow water habitat. Because of taxonomic difficulties inherent in field identifications the numerical data are presented as combined counts. Estimates of density ranged from 0 to 0.60/m^2, with a mean density of 0.06/m^2.

One of the other common sea stars in the littoral zone was the ochre star, Pisaster ochraceus. Pisaster was relatively rare in the rocky subtidal regions of Macleod Harbor, however, around the MLLW mark it was more common. For example, within one 10 x 1m transect we counted ?2 P. Ochracens for a mean density of 1.2/m^2 (Table 52). The only feeding observations that *involved* P. ochraceus during this time period were with the bay mussel, Mytilus edulis.

A number of other secondary and tertiary consumers were observed in Macleod Harbor, notably sea otters, diving ducks, harbor seals and fin fishes. Density estimates of these species were not made at this time; however, in some cases feeding observations were recorded

or *the* occurrence of a particular species present in a certain habitat was noted. A total of31 species of fishes are listed in Table 19; of these the most conspicuous families in the kelp habitat were the greenings (Hexagrammidae), sculpins (Cottidae), ronquils (Bathymasteridae) and righteye flounders (Pleuronectidae). Other fishes such as pricklebacks (Stichaeidae) and gunnels (Pholididae) were seen, but because of their small size and secretive nature could not be counted properly by our sampling methodology.

SOFT BOTTOM AND FAUNAL COMPONENTS

The soft bottom directly seaward o the NMFS intertidal station consisted of fine silty sand, with r· pple marks and large amounts of shell debris. The upper layer of the shell debris was composed heavily of empty Musculus spp. and clam shells. Organic debris of marine and terrestrial origin was moderate, i.e. alder leaves were common on the seafloor during the November (1975) survey. At slightly deeper depths, beyond the rock/sand interface the sand was siltier, and contained low fecal mounds that were produced by tubicolous polychaetes. A dense "layer or film comprised of sessile diatoms covered the surface of the sand during March 1976. Dominant invertebrates observed on the sand were tubicolous polychaetes, the most conspicuous of which was a large maldanid or bamboo worm with a slightly branched, thick walled sandy tube. The estimated density of the maldanid ranged between 0 and 64.0 individual/m^2; the average density in 48 quadrats (.25m^2) was 25.6/m^2. The maldanid bed was best developed at depths of between 5 and 7 meters on a sandy bench west of the shoreline. A less conspicuous,

but possibly larger worm was also common in this habitat; the tube did not extend very far above the sand surface. This species was identified as Onuphis iridescent. Non-tubicolous species of worms were common about 15 cm below the surface of the unconsolidated sediment.

There were a number of species observed in this soft bottom habitat including: Pycnopodia helianthoides (sea star); Crangon sp. (shrimp); Ophuira ? sarsii (brittle star); Olivella baetica (snail); Tellina sp. (bivalve); Chone ? mollis (sabellid worm); Margaritas sp. (snail); Nassarius mendicus (snail); Pagurus ochotensis (hermit crab); unid. hermit crabs; Clinocardium spp. (bivalve); Halcampa sp. (sea anemone); unid. nemertean worm; and Aglaja ocelligera (opisthobranch snail). A few fishes were also common on the softer substrates, notably the yellow fin sole, Limanda aspera; starry flounder, Platichthys stellatus; whitespotted greenling, Hexagrammos stelleri; and pacific tomcod, Microgadus proximus.

DISCUSSION

Seaweeds and their associated microflora are important sources of energy in the coastal ecosystems of the northern Gulf of Alaska. Much of the carbon production in the Gulf is undoubtedly derived from within a narrow band of the shoreline where the marine plant life flourishes. Other forms of organic carbon are pumped into the system from terrestrial sources such as freshwater streams, island meadows, forests, and shallow bays or estuaries. Despite the seaward flow of energy, usually in the

form of detritus, there is a positive feedback to the terrestrial system. Many of the terrestrial life forms, i.e. waterfowl, deer and land otter, utilize the resources of both major environments. One example of this feedback is the foraging behavior of the blacktail deer (Odocoileus columbianus), which utilize seaweed resources of the Prince William Sound Archipelago on a fairly regular, yet seasonal basis. This is especially evident during winter months, when heavy snows push the deer from the high country down to the beaches where they browse on both attached and drift seaweeds. For example, during the March survey (1976) four blacktail deer were sighted in the rocky intertidal zone at Latouche Point, and an equal number were seen browsing at the NMFS intertidal station in Zaikof Bay. Even higher consumer species such as the land otter, Lutra canadensis derive a great deal of energy from the sea by foraging in the shallow subtidal waters of the Sound for clams, mussels, chitons and sea urchins. Undoubtedly, however, considerably more energy flows from terrestrial to estuarine and marine systems than is returned through such pathways as described above.

Many commercially valuable species like Pacific salmon pass through the waters of Zaikof Bay, Macleod Harbor and Latouche Point on their way to and from the spawning streams of Prince William Sound. The major species in these areas are pink and chum salmon. Recently Sibert, Brown, Healey and Kask (1977) described a detritus-based food web that involved juvenile chum salmon from coastal waters of southern British Columbia and it appears that they also use some resource associated with kelp beds during their development. Additionally, schools of juvenile salmon were observed in the seaweed beds off Latouche Point during

August, 1974, and early September, 1976. Usage of these habitats by salmon has been poorly documented in Alaska.

During the 12 months of this study (1975-76), there was a pronounced oscillation in the appearance and areal dimensions of the subtidal vegetative canopies. Concurrent with these subsurface changes was a physical alteration in the size of the floating canopies of bull kelp (Nereocystis 1 uetkeana) that typically grew above the shorter statured species. These pronounced seasonal changes have been interpreted as characteristic for this part of the Gulf of Alaska. Annual brown algae such as Nereocystis, Cymathere triplicata and Costaria costata germinated in early spring and formed dense canopies by mid to late summer. However, most of these same plants were lost by late fall of the same year. Conversely, the perennial kelps, such as Agarum cribrosum, Laminaria spp. and Pleurophycus gardneri persisted year round, and exhibited maximum growth during late winter and early spring. The rapid growth period usually follows a period of tissue shedding or blade loss. One hypothesis to account for the winter growth strategies of these perennial species is that it results from competition with both understory and taller statured annuals such as bull kelp (Nereocystis). The alternation in peak growth and development between different canopy levels would possibly negate some competitive interactions between kelps (Dames & Moore, 1976a). These factors would lead to the creation of more free space, and light penetration in the rocky subtidal zone. All of these factors could contribute to the high plant diversity and high standing crop and plant production exhibited by the seaweeds of the Gulf.

Many of the same parameters that influenced the seaweed populations in the NEGOA study sites also affected the associated invertebrate fauna. The species composition of the epifauna was reasonably constant throughout the year, however patterns of distribution, frequency of occurrence and relative abundance was effected or altered with variations of the calendar year. The variations in distribution, density and size for the mussel (Musculus vernicosus) population at Latouche Point can be used as an example. This small filibranch is a conspicuous member of the seaweed assemblages of the northeastern Gulf. Shell debris at the base of some rocky reefs and previous field observations by Rosenthal (unpublished data} indicate that these populations have thrived in the vicinity of Latouche Point and Danger Island for the past 3 years. Heavy sets of juvenile Musculus or spat were attached to algal substrates during the spring and summers of 1974-76. However, by late November, most of the population was drastically reduced in number, and this is probably due in part to algal shedding and fall storms which periodically remove the mussels along with their attachment sites. Several other epifaunal species exhibited substantial seasonal variations in abundance and coverage of the underlying substrate. Among these were the hydroids Campanularia, Grammaria and Abietinaria, which covered substantial portions of the rocky substrate in Zaikof Bay during spring and summer, but typically were reduced in coverage by late fall leading to the conclusion that annual variations in abundance are part of the life history patterns of these hydroids.

The physical oceanographic conditions in the shallow waters of Zaikof Bay, Macleod Harbor and Latouche Point differ somewhat in terms of

exposure to ocean swell, velocity of tidal currents and transparency of the sea water. Two of the stations (Macleod Harbor and Zaikof Bay) are generally protected from the power of deep sea swells so conspicuous in the Gulf of Alaska. However, the southwest end of Latouche Island does receive moderate wave activity when storm surf breaks over the reef complex between the Point and Danger Island. The second major difference between stations seemed to be in the degree and/or velocity of the tidal currents. Although no measurements were made in conjunction with the biological surveys, strongest currents observed during this study were at the Latouche Point. The third physical parameter which was measured in the field was water transparency or visibility in sea water. Transparency was determined by making either visual observations while submerged, or estimating water transparency with the aid of a standard white secchi disc. Again, the Latouche Point station generally had the clearest water with a maximum secchi disc reading of 13 meters during the March (1976) survey. Latouche Point was typically bathed in an oceanic environment characteristic of exposed outer coast habitats, whereas the other 2 stations were more typical of embayment or fiord systems in Prince William Sound. At Latouche Point the bottom was usually free of silt, and the subtidal plant life formed a lush submarine forest which covered several square kilometers of the reef complex. Whereas in more protected areas such as Zaikof Bay and Macleod Harbor the hard substrate and bottom vegetation were usually dusted with a thin veneer of silt, and the seaweeds were generally restricted to a narrow girdle along the rocky shoreline.

For the most part, the composition of the subtidal algal assemblage was rather similar in all 3 areas, however, in terms of species

composition, frequency and abundance the areas were dissimilar. At all three stations the benthos was dominated by marine plants, with the kelps being visual, numerical and biomass dominants. Recent subtidal surveys in the vicinity of Danger Island have shown algal biomass (wet weight) at between 1,468 and 5,676 grams/m^2 during late summer (Rosenthal, unpublished data). However, these estimates are conservative, and would be much higher if the floating canopies were included.

The underlying invertebrate fauna was dominated by suspension or filter feeders; macroherbivores appeared to be somewhat unimportant on a year-round basis. Tertiary consumers were visually conspicuous with the asteroids appearing to be the most important group in this level of the food chain. However, the importance of finfish, diving birds and marine mammals has not been assessed. For the most part, energy pathways appeared to be basically similar in each of the 3 sites, with the inshore food chain dependent upon a regular flow of plant and animal detritus.

Because circulation appeared to be somewhat restricted in Macleod Harbor and Zaikof Bay, they appear to have a higher probability of prolonged exposure to contaminants drifting on the sea surface than Latouche Point. However, since the latter is strategically situated between two major arteries of Prince William Sound, biological processes are definitely susceptible to man-induced contaminants that would affect species of aesthetic and commercial importance.

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