YAQUINA HEAD ZONATION STUDY PROTECTED AREA

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Introduction:

The objective of our Yaquina Head study was to evaluate the zonation of a well protected area and to compare it with the report made last year of the same general area.

Description of Area:

A diagram of the areas studied this year and last year is presented in Fig. 2. Face 1 is a well protected wall of basalt extending above the HHW level and with an inclination of 60°. Face 2 is relatively vertical to about ten feet where there is a ledge; HHW breaks over this ledge and may cover it.

The faces studied began at approximately +2 f3et, and the area within the protected channel was strewn with rocks and boulders. These factors explain why neither Face 1 nor Face 2 was washed at LLW by waves entering the channel from the S. E. At no time in the tidal cycle would heavy wave action be expected on Face 1; however, Face 2 appears to be exposed to wave activity at tide levels exceeding two feet.

The tide levels for 20 June 67 were found by checking with the tide gauge at the OSU Marine Science Center and recent tide tables. They were: LLW (-1.4 ft.), HLW (2.9 ft.), LHW (6.7 ft.), HHW (9.5 ft.).

Methods:

Our study began at 5:50 AM on 20 June 1967. The zonation of Face 1 was studied intensively and a brief survey was conducted on Face 2.

Using a level and a measuring stick, one foot intervals were marked off on Face 1 with LLW as the datum plane. Six inch square sections were then marked off between successive feet and this surface was scraped and bagged. The identification and counting of the individual animals and fragments of algae was done in the laboratory. All plant-animal numbers were converted to density per square foot and are listed in Table 1. All observed data is recorded in the appendix.

Discussion:

There is a definite zonation present in the study areas as determined both quantitatively and by observation. After assembling our data, differences and similarities between the two areas studied were noted. It should be understood that the rock faces studied this year are not those studied last year. Thus no direct comparison can be made.

Table 4 shows the vertical distribution of the organixms identified. Those organisms reported last year were, in most cases, observed in a lower range this year. It is not known whether this difference is due to wave action on Face 4 causing "smearing." or if it is a result of the slope of Face 1.

On Face 1 and Face 2 there is a complete absence of <u>Strongylocentrotus purpuratus</u> in contrast with its presence on Face 4 last year. This might be evidence for the lack of wave activity in our area.

It was also observed that Pollicipes, Mytilus, and Balanus formed a thick mat on Face 2, but on Face 1 Pollicipes was totally absent and Mytilus and Balanus were sparse and smaller in size. This is believed to be a result of Face 4 having a horizontal ledge and being exposed to heavy wave action at high tide.

In both of our areas sampled (1 and 2) a relatively "bare zone" occurs between approximately 5 and 7 feet. This appears to be a critical level roughly corresponding to LHW (6.7 ft.) and HLW (2.9 ft.). The top of the "bare zone" coincides with LHW, but the discrepancy at the lower edge cannot be explained. This critical level may be correlated with the sudden increase in time of exposure that occurs at certain parts of the tidal cycle or, conversely; with the sudden increase in the duration of submergence.

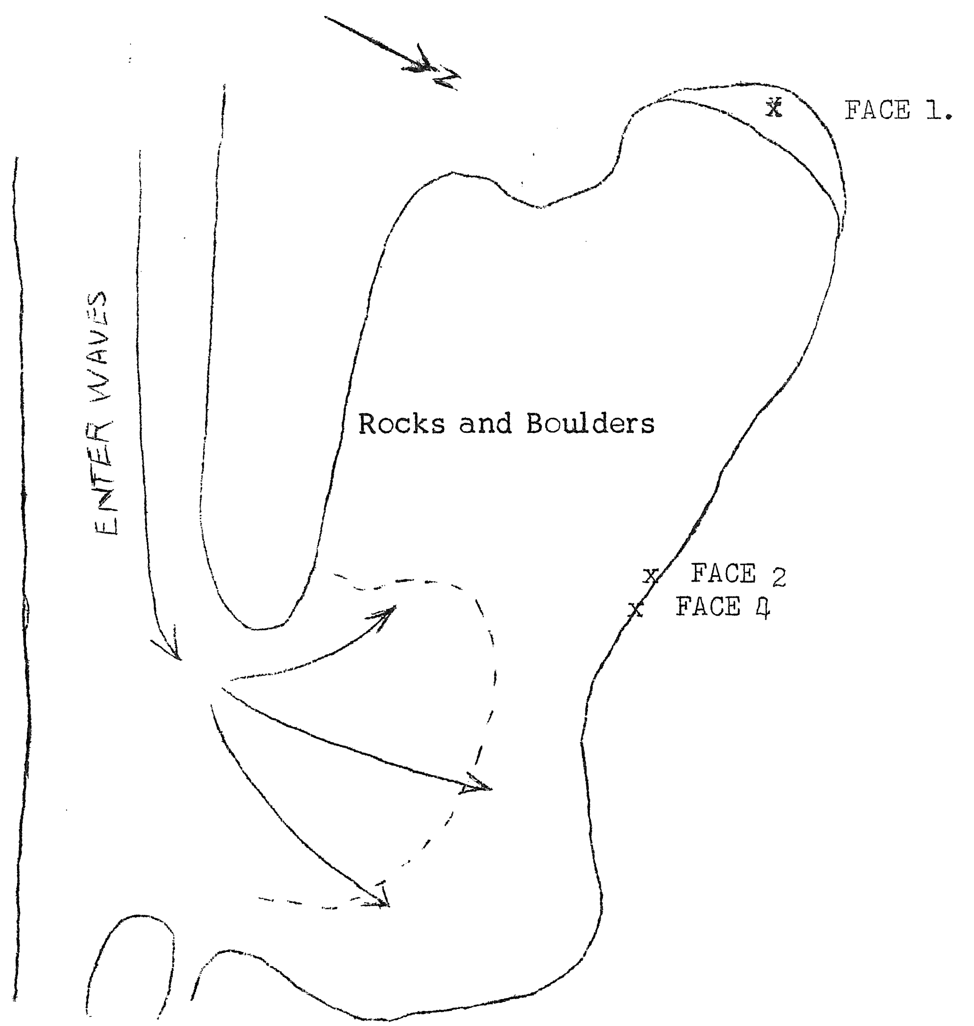

FIGURE 1. Diagrammatic representation of the study area at low tide. Face 1 and 2 are the sites of the present zonation study. Face 4 is the approximate location of the 1966 study.

TABLE 2: Vertical Distribution of the Dominant Organisms of Face 1.

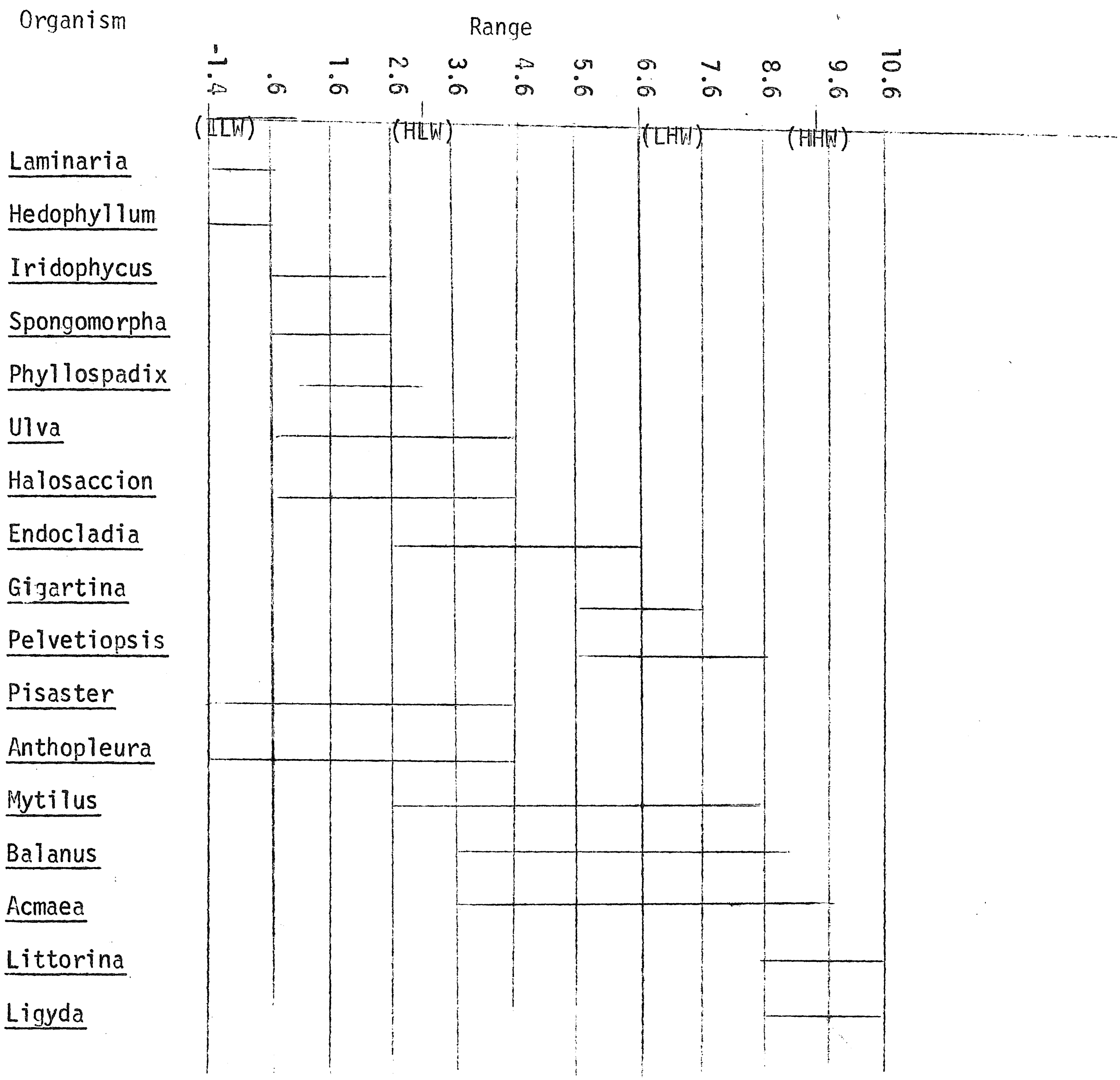

TABLE 4: Comparison of Vertical Distribution

	Organism (Genus)	June 27, 1966 Face 4	June 21, 1966 Face 1
PLANTS	Spongomorpha	2.0 - 4.0 ft.	0.6 - 2.6 ft.
	Iridiophycus	1.0 - 4.0	0.6 - 2.6
	Ulva	4.0 - 5.0	2.6 - 3.6
	Halosaccion	Absent	2.6 - 4.6
	Endocladia	4.0 - 10+	2.6 - 4.6
	Pelvetiopsis	9.0 - 10+	8.0 - 8.6
ANIMALS	Pisaster	1.0 - 4.0 ft.	-1.4 - 4.6 ft.
	Balanus	2.0 - 10+	3.6 - 8.0
	Littorina	4.0 - 10+	8.6 - 10.6
	Strongylocentrotus	1.0 - 4.0	Absent
	Mytilus	6.0 - 10+	2.6 - 7.6

APPENDIX

Table I: Number of Organisms on Face I

Zone	Tide Datum	Group	Fragments (sq. ft.)	Group	Number (sq. ft.)
I	10.6			Littorina	40
				Ligyda	16
				Otocryptops	8
	9.6			Littorina	40
				Ligyda	8
	8.6			Littorina	7
				Ligyda	6
				Acmaea	1
II	7.6	Distinct band of Pelvetiopsis and Littorina			
III	6.6	Pelvetiopsis	1782	Balanus	3000
		Endocladia	336	Tegula	1724
		Gigartina	144	Mytilus	480
				Acmaea	96
				Isopoda	48
				Nemertea	48
IV	5.6	Endocladia	16	Balanus	2880
		Pelvetiopsis	12	Mytilus	1728
				Acmaea	4
	4.6	Ulva	288	Balanus	2880
		Halosaccion	1540	Amphipoda	288
				Acmaea	72
	3.6	Halosaccion	1200	Balanus	68
		Ulva	36	Acmaea	20
		Fucus	32	Mytilus	116
		Gigartina	16	Nemertea	12
		Corallina	4	Amphipoda	10
				Littorina	8
				Polychaeta	4
				Pagurus	4
	2.6	Halosaccion	1300	Nemertea	64
		Ulva	36	Amphiphoda	40
		Pelvetiopsis	4	Mytilus	24
		Substrate of Endocladia		Isopoda	20
	1.6	Same as 0.6 ft.			
	0.6	Spongomorpha	80	Amphipoda	8
		Odonthalia	52		
		Iridophycus	36		
		Ulva	28		
		Halosaccion	12		
		Galliarthron	8		
		Gigartina	8		
V	-1.4	Hedophyllum		Pisaster	
		Laminaria		Anthopleura	

ZONATION STUDY OF SURGE CHANNEL AT YAQUINA HEAD

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Introduction:

On June 20, 1967 we studied a surge channel and wave-cut bench at Yaquina Head, located two miles north of Newport, Oregon. The purpose of the survey was to determine if zonation occurs and, if so, how it compared to Ricketts and Calvin's classic scheme of zonation for the Pacific Coast and to the observations of last year's class (Farrell, et al, 1966) made at the same place.

The area studied was on the southeast-facing slope of a surge channel, approximately 100 feet inshore from its mouth. This surge channel is located on the east side of the base of a large sea stack, Butte Rock. The wall of the channel slopes at approximately 70 degrees to 7-1/2 feet and then breaks to form a wave-cut bench. The substrate is highly irregular basaltic rock. Waves approach the rock from the Northwest. Several rocky ridges break the force of the water before it enters the surge channel. (See map, figure 1)

Material and Methods:

At 6:00 A. M. the first reference mark was made on the face at ebb, -0.8 MLLW. The depth of water in the surge channel was 4 inches. (See figure 2) Using this mark as a zero point, one foot levels were marked off for 9 successive vertical feet. Sampling procedure varied, but generally density counts of the most abundant organisms were taken at each level. Observations were also made of those organisms living to either side of the transect area. Organisms were collected and taken back to the lab for identification.

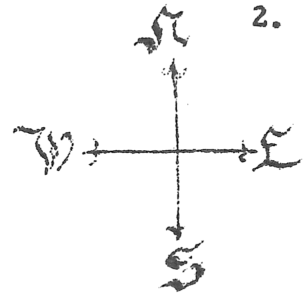
In addition, an area 6 inches square at level 6 was marked off and all the organisms within this area were taken back to the lab for a biomass study.

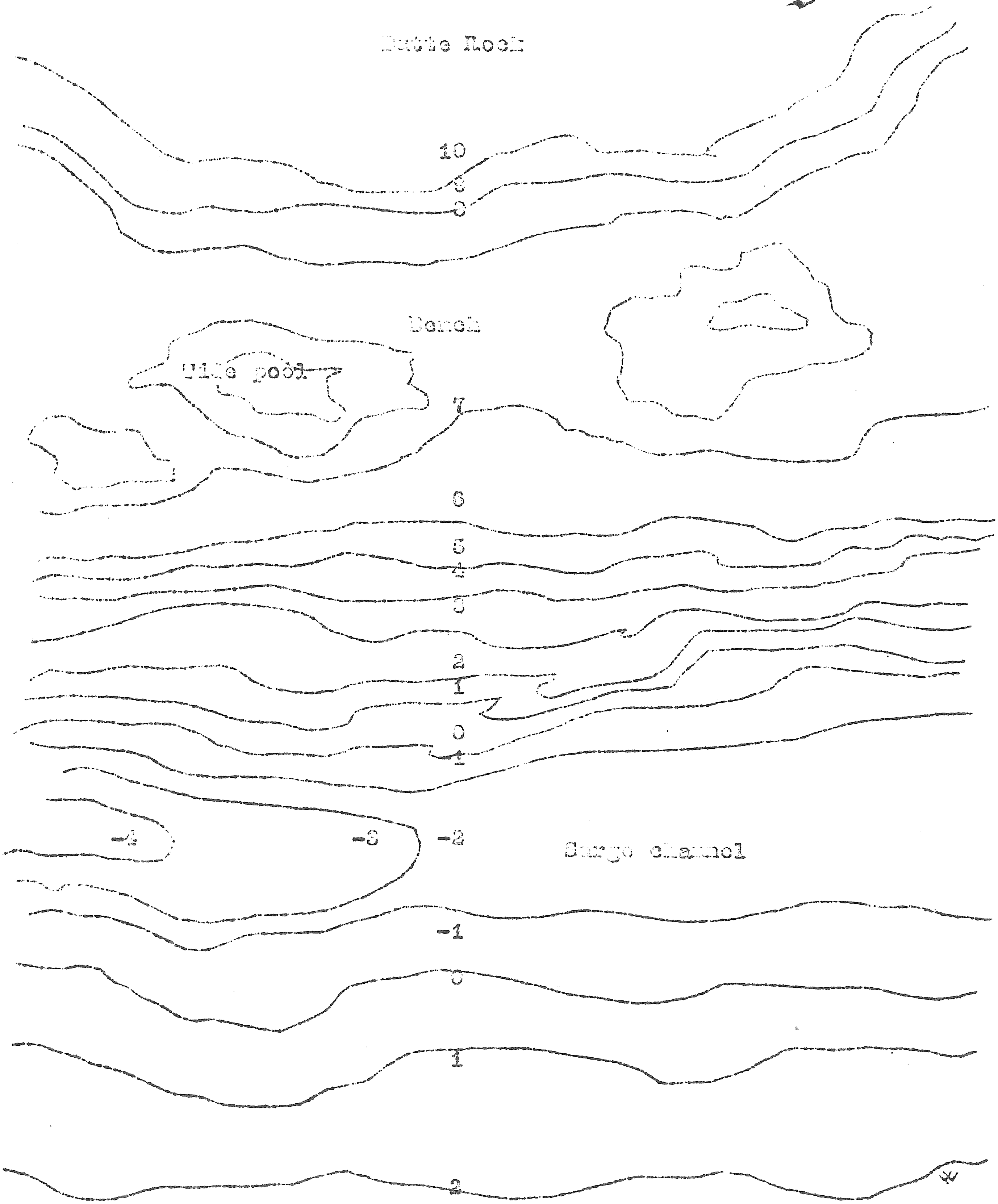
Fig. 2
Conversion chart for tide levels and survey marks

Mark 9	7.4
Mark 8	6.4
Mark 7	5.4
Mark 6	4.4
Mark 5	3.4
Mark 4	2.4
Mark 3	1.4
Mark 2	0.4
	0.0 (mean l.l. water)
Mark 1	-.8
Lowest water level on 20 June 1967	-1.4 water level
Bottom of surge channel	-1.73

FIGURE 1

Note: The contour marks are largely fanciful. The map is intended to give a general idea of the area; it is NOT exact.





Physical description and notes on transect studied:

Level 1 included a crevice. Smaller amounts of algae were found in this crevice than to either side of the transect. As the water rushed in, a greater turbulence was noted in this crevice. This may be the explanation for the paucity of algae.

Level 2 was still in the crevice.

Level 3 was in the upper part of the crevice which, however, now was not markedly different in its biota from the surrounding wall. In this area many of the animals were found under the algae which were in great abundance at this level. The curtain of algae provided a moist, cool microhabitat to which the animals could retreat at low tide.

Level 4 was more gently sloping and almost completely covered by the large brown kelp.

Level 5 included the lower margin of the mussel bed. The size of the mussels ranged from 1/4 to 6 inches in length.

Level 6 was in the mussel bed. A biomass sample was taken at this level.

Level 7 was in the mussel bed. Mitella was more abundant at this level and Balanus reduced in number compared to other levels.

Level 8 extended onto the bench, breaking at about the middle of the foot level.

Level 9 was completely on the bench. Ulva was in abundance and most dense on the exposed rocks. The mussel bed extended onto the bench. A small tide pool was present. The mussels were observed to be smaller and fewer clusters of gooseneck barnacles were seen.

As the slope faced southeast, it would receive a relatively great amount of sun (on clear days) leading to insolation of exposed organisms.

Since the area sampled was a surge channel, it was assumed that the velocity of water passing through the channel would be relatively great, because of the funneling effect.

Organisms observed in sample area

Level 1
Pagurus sp. hermit crab
Leptasterias hexactis 6-armed sea star
Caprellid amphipod
Pycnogonid sea spider
Lithothamnion sp. encrusting coralline alga
St ronglyocentrotus purpuratus purple sea urchin
Balanus glandula acorn barnacle
Anthopleura xanthogrammica great green solitary anemone

Level 2
Petrolisthes cinctipes porcelain crab
Ulva sp. sea lettuce
Odonthalia sp. green alga

Level 2 (cont'd)
Endocladia sp. red alga
Spongomorpha sp. green alga
Cladophora sp. green alga
Hedophyllum sp. brown alga
Microcladia sp. red alga
Katharina tunicata chiton
Acmaea spp. limpet
Thais emarginata short-spired purple
Anthopleura xanthogrammica great green solitary anemone
Strongylocentrotus purpuratus purple sea urchin
Balanus glandula acorn barnacle
Pisaster ochraceus ochre sea-star
Laminarians kelp

Level 3
Leptasterias hexactis 6-armed sea star
Hedophyllum sp. brown alga
Endocladia sp. red alga
Pagurus sp. hermit crab
Balanus glandula acorn barnacle
Anthopleura xanthogrammica great green solitary anemone
Katharina tunicata chiton
Pisaster ochraceus ochre sea star
Acmaea sp. limpet
Ulva sp. sea lettuce
Mopalia sp. chiton

Level 4
Pelvetia sp. brown alga
Iridaea sp. red alga
Endocladia sp. red alga
Sculpin
Petrolisthes cinctipes porcelain crab
Lithothamnion encrusting coralline alga
Acmaea sp. limpet
Pagurus sp. hermit crab
Anthopleura xanthogrammica great green solitary anemone
Balanus glandula acorn barnacle
Katharina tunicata chiton
Mytilus californianus Calif. mussel
Cirolana sp. isopod

Level 5
Balanus glandula acorn barnacle
Mitella polymerus gooseneck barnacle
Anthopleura xanthogrammica great green solitary anemone
Cirolana sp. isopod
Acmaea spp. limpet
Cucumaria lubrica sea cucumber
Ulva sp. sea lettuce
Mytilus californianus Calif. mussel

Level 5 (cont'd)
Endocladia sp. red alga
Mopalia sp. chiton
Petrolisthes cinctipes porcelain crab

Level 6
Mytilus californianus Calif. mussel
Petrolisthes cinctipes porcelain crab
Cirolana sp. isopod
Amphipods
Mitella polymerus gooseneck barnacle
Nereis sp. clam worm
Phascolosoma agassizii sipunculid worm
Thais spp. purple snail
Balanus glandula acorn barnacle

Level 7
Same as level 6

Level 8
Nereis sp. clam worm
Endocladia sp. red alga
Planocera californica flatworm
Pelvetiopsis sp. brown alga
Emplectonema gracile ribbon worm
Hemigrapsus nudus purple shore crab
Mitella polymerus gooseneck barnacle
Littorina scutulata periwinkle
Phascolosoma agassizii sipunculid worm
Petrolisthes cinctipes porcelain crab
Polysiphonia red alga
Cirolana sp. isopod
Ulva sp. sea lettuce
Thais emarginata short-spired purple
Balanus glandula acorn barnacle
Acmaea digitalis limpet
Gigartina sp. red alga
Lissodendoryx noxiosa sponge
Paranemertes peregrina ribbon worm
Mytilus californianus Calif. mussel

Level 9
Cladophora sp. green alga
Nereis sp. ;clam worm
Thais emarginata short-spired purple
Pelvetiopsis sp. brown alga
Endocladia sp. red alga
Emplectonema gracile ribbon worm
Littorina scutulata periwinkle
Rhodomela sp. red alga
Paranemertes peregrina ribbon worm
Acmaea digitalis limpet

Level 9 (cont'd)
Ulva sp. sea lettuce
Balanus glandula acorn barnacle
Mitella polymerus gooseneck barnacle
Mytilus californianus Calif. mussel

Discussion:

Breaking points for the zones we indicate were determined by a comparison of the densities per square foot of the organisms at each vertical foot level. (See figure 5) The division between zones A and B was the level recorded as the start of the Mitella-Mytilus association. The upper limit of zone C was the failing point of Strongylocentrotus purpuratus. Zone B was furthermore the area of the highest density of the kelp Hedophyllum sessile.

As compared to Ricketts' zontaion plan (see figure 4), the area under study showed definite "smearing" of the zones. Zonation was clear but the greatest densities of many of the major organisms in our area (including Mytilus, Mitella, and Thais) were located at consistently higher levels than those which were determined by Ricketts at Pacific Grove. Zone A of our sampling was at the level of Ricketts' zones 1 and 2 but the organisms we found correspond to those of Ricketts' zone 3. One possible factor contributing to this phenomenon is the physical environment of the surge channel. The force of the water passing through the surge channel and striking against the irregularities of the wall would produce spray, wetting the rocks at the higher levels and reducing exposure to heat and air. However, some organisms in our test area were found in their greatest densities at the same levels noted by Ricketts, notably Katherina and kelp. Different organisms were chosen as indicator species in several instances by Ricketts and our team.

Comparison of density/sq. ft.
recorded by teams of 1966 and 1967

	1967	1966
	Zone C	"low"
Anthopleura	10	3.78
Strongylocentrotus	18	8.89
	Zone B	"middle"
Katherina	7	.11
	Zone A	"high"
Acmaea	576	.67

Comparison of the densities/sq. ft. recorded by the two studies was made wherever possible. This year's sampling seemed to show a denser population than that which was observed the year before. The weather conditions, food supply, etc. may have been more favorable this year, thus the denser population.

Data shown for last year's report was taken from a table which was a composite report of 3 different transects, thus is not strictly comparable to our data.

A comparison of the 1966 study of Plot 3 (which was in the same general area that we sampled) with our data reveals that the Mytilus-Mitella association occurred in both studies in the only area of overlap available for comparison, the level from 4.6 to 7.4 feet (see figure 4).

Table 3: Zonation of Face 2.

		10 ft.
Isopods Balanus Pollicipes	Zone 1 (Thick Mat)	HHW 9.5 ft. 9 ft.
Mytilus	Zone II	8 ft.
Isopods Balanus	Zone III	7 ft.
Penitella (Boring Clam)	Zone IV (Relatively Bare Zone)	LHW 6.7 ft. 6 ft.
Acmaea Styela Haloscaaion Ulva Iridophycus Spongomorpha Odonthalia Calliarthron Cladophora Serpula	Zone V (Thick zone of Algae) Base of Rock Race	HLW 3.9 ft. 0.6
Pisaster Anthopleura Hedophyllum	Zone VI Water Level	0
		LLW -1.4 ft.

Figure 4

0	Farrell, Regan, & Haley Yaquina Head, Ore. '66	Ricketts & Calvin Pacific Grove, Calif.	Jones, White & Roth Yquina Head, Ore. '67
9	10.1 Pelvetiopsis Balanus glandula B. cariosus Mitella polymerus Littorina		
8	8.1 Thais, Acmaea, Phascolosoma, Mitella, Petrolisthes, Nereis, Abietinaria, Ligyda, Membranipora, Orchestia, Spirobis Mytilus Halosydna Balanus Fabia Anthopleura Distaplia 4.6		
7		7.5 Acmaea digitalis Littorina planaxis Ligyda	7.4 Mytilus californianus Mitella polymerus Balanus glandula Nereis Cirolana Petrolisthes cinctipes Thais Endocladia Acmaea
6			
5		5 Littorina scutulata Pachygrapsus Tegula funebralis Balanus glandula Pelvetia	
4			
3	MEAN SEA LEVEL		
2		2.5 Thais emarginata Mytilus, Mitella Hemigrapsus nudis Katharina Kelp Iridophycus	2.4 Hedophyllum (kelp) Balanus glandula Pisaster ochraceus Katharina tunicata
1			
0	MEAN LOWER LOW WATER	0.0 Laminarians Phyllospadix hydroids, sponges	.4 Anthopleura xanthogrammica Strongylocentrotus purpuratus Pisaster ochraceus Laminarians -1.4
-1			
-2		-1.6	

Fig. 5

Recorded density of organisms/square ft. at each level

Organisms	Ft. 1	Ft. 2	Ft. 3	Ft. 4	Ft. 5	Ft. 6	Ft. 7	Ft. 8	Ft. 9
Anthopleura	10	15		9	2				
Strongylocentrotus	18	1							
Polychaete in calcareous tube	200								
Balanus glandula	288	2306	4608	7488	4320				
Katharina tunicata			3	4					
Pisaster ochraceus		2	3						
Laminarians		3							
Acmaea sp.			12	576				288	
Hedophyllum			7						
Mytilus				1	1152	744			
Endocladia					20				
Petrolisthes cinctipes				2.	432	420			
Cirolana					1440	360			
Cucumaria lubrica					72				
Mitella polymerus						80			
Nereis						8			
Phascolosoma agassizii						4			
Thais sp.						20			
Pagurus sp.				25					
Mopalia sp.				36					

Biomass Determination
White; Jones

An area of mussel bed 6" square and 4-1/2" deep was removed from the wall of the surge channel at level 6 (approximately three feet from mean lower low water) and taken back to the laboratory. Organisms were counted, weighed wet, dried in an oven, and weighed dry to obtain an approximation of the mass of carbon in a representative area of mussel bed. Numbers of organisms were as follows:

Cirolana and amphipods	90
Petrolisthes cinctipes	105
Mitella polymerus	20
Phascolosoma agassizii	1
Nereis	1
Thais	5
Mytilus californianus	192
Balanus glandula	not counted

Mytilus were weighed wet with shell and barnacles. 10% of these mussels and associated barnacles were then warmed in an oven for 1 hour at 80° C. to cause the animals to gape and drain water from the mantle cavity. Mussels and barnacles were then weighed again.

Next, all the meat of the Mytilus and barnacles (the latter only of individuals over 3/8" diameter) was removed using a scalpel. Meat and shells were weighed separately. The remaining organisms were weighed wet, taking an estimated 10% of copepods, amphipods, crabs, Mitella, and Thais (shelled) but all Nereis and Phascolosoma.

Finally, shells, meat, and remaining organisms were dried in an oven at 90° C. for 14 hours and 20 minutes to remove all moisture and then reweighed.

Results are tabulated below:

All Mytilus, Balanus with shells wet	1872.00 g
10% Mytilus, Balanus with shells wet	187.00 g
10% wet shell and small Balanus	135.00 g
10% dry shell and small Balanus	131.40 g
10% Mytilus and Balanus meat wet	45.00 g
10% Mytilus and Balanus meat dry	11. 05 g
10% Petrolisthes, amphipods, Cirolana, Thais, Mitella wet	10.30 g
10% Petrolisthes, amphipods, Cirolana, Thais, Mitella dry	7.15 g
Nereis, Phascolosoma wet	1.00 g
Nereis, Phascolosoma dry	0.40 g

The following computations were made to determine the biomass of the mussel bed:

10% dry meat Mytilus, Balanus	11.05 g x 10 =	110.5 g
Nereis, Phascolosoma dry		0.4 g
10% dry other organisms	7.15 g x 10 =	71.5 g
		182.4 g in 6" sq.

182.4 g in 6" sq. total weight
x 4
729.6 g/ sq. ft.
x10.76 sq. ft./sq. metre
7850.496 g/ sq. metre

Rounding this figure to one significant decimal, the total weight per sq. metre is 7850.5g. This figure does not include "the ones that got away."

A note on the associations found by collection of all major organisms in the mussel bed: high densities of organisms which would not be found at this level without the protection afforded by the environment of the mussel bed were revealed, especially in the case of Petrolisthes and Cirolana and Phascolosoma.

Summary:

Zonation was observed in the area samples and "smearing" of the zones was noted. Some attempt was made to consider physical factors involved in the distributions noted for the organisms observed. Insoltaion, exposure to air and water currents were considered.

The densities of major animals occuring in the area studied were recorded, and natural breaks in the biota noted. A comparison was made between our data, that reported by last year's study, and that presented by Ricketts and Calvin.

A biomass study was made for an area of mussel bed.

References:

Farrell, Regan, and Haley - "The distribution of Marine Invertebrates near Yaquina Head", (private publication) 1966.

Ricketts and Calvin - Between Pacific Tides, 3rd Edition. Stanford University Press, 1964.