

INTERTIDAL TRANSECT STUDIES OF NORTHERN MONTEREY BAY

First Quarterly Report

October-December 1971

Submitted to: Association of the Monterey Bay Area Governments

Attn: Mr. Leslie L. Doolittle

Principle Investigators: Dr. William T. Doyle and
Dr. John S. Pearse

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In accordance with a contract dated 10/22/71 between the Association of the Monterey Bay Area Governments (AMBAG) and the University of California, Santa Cruz, (UCSC), two permanent intertidal transects with 14 permanent meter-square quadrats were established on the north shore of Monterey Bay during November, 1971. One transect (6 quadrats) was placed on the shore near the Santa Cruz Sanitation outfall, while the second (8 quadrats) was placed near the Eastcliff Sanitation District outfall at Soquel Point (Pleasure Point). Animals and plants within the quadrats were listed, their abundance estimated, and representative specimens collected for a reference collection maintained at UCSC. Additional species of animals and plants in the areas of the transects were collected for the reference collection. These collections will serve as a base-line for comparative studies which can follow the magnitude and direction of future changes in these areas.

The majority of the work in this study was done by five undergraduate students taking the UCSC course Biology 190A, Proseminar: Intertidal Organisms. These students are: Ms. Michele Jauregui and Mr. Jack Liebster (plants) and Ms. Debra Brewer, Mr. Andrew Oesterle and Ms. Linda O'Kelley (animals). Dr. John Pearse accompanied the students on all of the field trips, and aided in the identification of the animals. Dr. Isabella Abbott (Hopkins Marine Station) visited both study areas with the students and aided in the identification of all plant vouchers.

Teams of other students in Biology 190A established similar intertidal transects along the open ocean coast north of Santa Cruz at Davenport Landing, Scott's Creek, Año Nuevo Cove, Año Nuevo Point, Franklin Point and the north and south shores of Pigeon Point. This work is being supported by a National Oceanic and Atmospheric Agency Sea Grant to UCSC. The AMBAG and Sea Grant programs are coordinated to provide comparable information, and a full report will be made in the fall of 1972 after completion of the year provided for these studies.

This report gives the location of the transects and quadrats and a preliminary floristic and faunistic analysis of the AMBAG part of the program as it now stands. Species identification and the accompanying analysis should not be considered final; identification will be completed and confirmed, and the analyses refined, as the work proceeds in 1972.

MATERIALS AND METHODS

The study areas were selected after preliminary visits were made during the low tide cycles in October, 1971. All sampling was done during the November, 1971, low tides. At each site a nail was driven into the rock of the high intertidal and a measured line

laid perpendicular to the shore extending seaward to sea level during a tide exceeding ~~minus~~ one foot. Profiles were made of the transect using a taut line, a line-level, and a meter stick, with the zero mean low tide level, estimated from tide tables, used as the reference point. Mr. Jerry Weber, a UCSC graduate student in earth sciences, has begun to place stainless steel rods along the transect lines in cement-filled holes drilled in the rocks. The position of these rods will be carefully surveyed so that the transect lines can be accurately relocated. The rods will also aid in determining long-term erosion rates along the transects and, therefore, along this coastal section in general.

Quadrat sites were selected along the transect lines to represent "typical" high, mid and low zones as judged by tide level and floral and faunal composition. The quadrats were chosen to include mainly horizontal rocky surfaces without tide pools or channels. Nails were driven into the rock at two opposite corners of the meter-square wooden quadrat frames to aid in relocation. The meter-square frames were laced with monofilament line to form a grid pattern of 100 10-centimeter squares. All species of exposed macroscopic plants and animals within each meter-square quadrat were identified, and vouchers of each collected outside the quadrat for the reference collection. Plant specimens were pressed and dried for storage in the herbarium while animal specimens were preserved in alcohol. All individuals of large plants and animals with the meter-square quadrat were counted and their position with the square noted on grid maps. The quantity of plants and animals which formed patches or solid cover were estimated by counting the number of 10-centimeter squares which contained these forms. Small or inconspicuous species, whose abundances were difficult to quantitate, were simply noted to be present. After the meter-square quadrats were thoroughly examined, the area around the quadrat was searched for additional species so that the species list for each area could be as complete as possible. These additional species included those under rocks and within shallow tide pools, and representative specimens were collected for the reference collection. As the species lists were compiled, each area was re-visited, and the absence of particular species in each area was either confirmed or corrected.

Ektochrome slides were taken of the transect area and of each of the quadrats during the November visits. These slides will be kept with the plant and animal reference collections and field notes at UCSC for future use and as an aid in relocating the quadrats.

LOCATION AND DESCRIPTION OF THE TRANSECT AREAS

The locations of the two transects are shown in Figure 1. The Santa Cruz transect is located on the third rocky point jutting out from the shore west of the Santa Cruz sewage discharge line.

The sewage outfall is about 1500 feet seaward (southeast) of the transect area in about 40 feet depth. The transect area is at the base of the cement stairs leading from West Cliff Drive down the cliff to the shore, and is just west of the Almar Avenue-De La Costa Avenue junction with West Cliff Drive, and directly across the street from 1212 West Cliff Drive.

A sketch of the Santa Cruz transect area, and a profile of the transect, is shown in Figure 2. The rocky point is bordered on both sides by sand-filled channels. The transect, which covers most of the length of the point, is 70 feet long and drops toward the sea in a series of small plateaus. The "high zone," at about the plus 4.5 foot tide level, extends from the origin of the transect line to about 24 feet, and includes quadrats at 3 and 15 feet on the transect line. The "mid zone," at about the plus 2.5 foot tide level, extends only from about 24 to 42 feet on the transect line, and includes quadrats at 30 and 36 feet on the transect line. The "low zone," at about the zero foot tide level, extends from about 42 to 70 feet on the transect line where the rocky point drops to subtidal depths, and includes quadrats at the 48 and 59 foot points from the origin of the transect line. It can be seen from Figure 2 that the high, mid and low zones of the Santa Cruz transect line form rather discrete areas with respect to tidal height.

The Soquel Point (Pleasure Point) transect runs nearly parallel to the East Cliff sewage line which is about 300 feet to the southwest and discharges intertidally about one foot below mean low tide level. The incoming waves sweep the discharged wastes over the transect area, particularly the lower part of the line. About 50 feet northeast of the origin of the transect a storm drain discharges. The transect line begins on a rocky point below the cliff across from the 33rd Avenue-East Cliff Drive junction, and extends seaward toward the stacks of the Pacific Gas & Electric power plant at Moss Landing.

The Soquel Point transect area and profile are shown in Figure 3. The intertidal at Soquel Point is much more extensive and horizontal than at the Santa Cruz transect area. The Soquel Point transect was about 340 feet long, and most of it covered a flat area between zero and minus one foot tide level. Although largely flat, the intertidal is cut with numerous channels and ridges. A small rocky point, jutting out 28 feet from a cave at the base of the cliff, and at about plus 4 feet above mean low tide, was designated as the "high zone." This rocky point is similar to the high zone at the Santa Cruz transect both with respect to tidal height and substrata. There was no area at Soquel Point that was comparable to the mid-zone at the Santa Cruz area; the rocky point abruptly dropped down to nearly the zero tide level. From 28 feet to about 50 feet on the transect line, the area was sand or smooth rock scoured by sand. The "low zone" at Soquel Point, most comparable to that at the Santa Cruz area, was at about zero tide level

and extended from 50 to 250 feet on the transect line where it reached a large water-filled channel. Seaward of the channel was a rocky platform, about minus one-foot tide level, which was designated a "low-low zone"; this extended from about 290 to 340 feet along the transect line. There was no comparable low-low zone at the Santa Cruz area. The low-low zone was most obviously affected by the sewage discharged from the East Cliff plant. The quadrats along the Soquel Point transect line were located at high: 3 and 15 feet, low: 57, 148 and 201 feet, and low-low: 293, 322, 332 feet from the origin of the line.

SPECIES LISTS AND ANALYSES

Plant and animal lists for the Santa Cruz and Soquel Point transects are given in Tables 1 and 2, and preliminary analyses of these data are given in Tables 3 and 4, and Figures 4, 5 and 6.

Plants. The upper zones of both sites were most similar with Enteromorpha and Ulva being the most conspicuous genera. Gladophora grew in small clumps throughout the upper zones. Of the twenty-one species of plants found in the high zone, twelve were common to both sites with five found only at the Santa Cruz transect and four found only at the Soquel Point transect.

The flora of the mid zone at Santa Cruz contained 21 species; there was no comparable mid zone at the Soquel Point transect. The most ubiquitous species of the mid zone at the Santa Cruz transect was Odonthalia floccosa. The plants were quite short, but covered extensive areas of rock surface. Both Cladophora trichotoma and Enteromorpha linza were also found in large quantities. Most other species were sparsely represented with corallines being confined mainly to tide pools.

The floral populations of the low zones of the two transect areas were widely divergent. Of the forty-two species present in the low zones, only five were found at both sites. The low zone at the Santa Cruz transect was not characterized by a single dominant species. There was a large patch of Phyllospadix in the lower part of the low zone with a variety of small red algae growing under it. Also visually dominant were numerous specimens of Laminaria sinclarii on the seaward edge of the rocky point, a large stand of Rhodomela larix, and diverse populations near small tide pools.

At Soquel Point the most visually dominant species in the upper region of the low zone were Phyllospadix scouleri and Gracillaria verrucosa, both of which were surrounded by large quantities of sand. Few other species were found in the unstable sand of the upper region of the low zone, and only three species were found in the 57 foot quadrat. Epiphytes on Phyllospadix included Smithora naiadum and Enteromorpha linza, both of which

were quite sparse and found mainly in the upper region of the low zone. In the middle region of the low zone, there were numerous specimens of Cystoseira osmundacea and Egregia laevigata, while at the lower end of the low zone, Corallina officinales was beginning to be the visually predominant species.

There was no region at Santa Cruz comparable to the low-low zone at Soquel Point. This region at Soquel Point was almost completely covered with a dense mat of Corallina officinales and was similar in overall appearance to the sewage-affected regions around the Pacific Grove and Carmel intertidal sewage outfalls. There was also a fair number of stunted specimens of Laminaria setchelli and Cystoseira osmundaceae, and puckered specimens of Gigartina corymbifera, G. volans, Iridaea cordata var. splendens, and I. flaccida so characteristic of the Pacific Grove and Carmel outfall regions.

Of considerable interest is the occurrence or predominance of different species of the same genus at the two sites. Thus, the Santa Cruz site with Egregia menziesii, Laminaria sinclarii, Macrocystis pyrifera, Corallina vancouverensis and Prionitis lanceolata can be contrasted with the Soquel Point site with E. laevigata, L. setchelli, M. integrifolia, C. officinales and P. andersonii. It will be of special interest to see if and how these species pairs change in the two areas as the discharge of sewage changes.

Animals. The animals found in the transects have not been as well identified as the plants, and the listing given in Table 2 should be considered preliminary. However, the animal data have been worked up enough to be useful, and there are similar trends between the animal and plant data. Of the 80 species of animals found at the two transect areas, only 25 were found at both areas. As with the plants, the relative similarity between the two areas decreases from the high to the low zones.

The high zones had in common 10 of the total of 19 species. Mytilus californianus, with a few M. edulis, covered large areas at both sites, and Acmaea pelta, A. digitalis, and A. scabra were scattered between clusters of Balanus glandula and Chthamalus dalli.

The visually dominant animal in the mid zone at Santa Cruz was Phragmatopoma californica, and this species and Mytilus californianus covered most available rock surface. In depressions between rocky shelves and ridges were small, aggregated Anthopleura elegantissima, with up to 30 individuals per 10-cm. square.

As with the plants, the animal populations of the low zones in the two areas were widely divergent and only 11 of the

60 species found were common to both areas. The dominant animals in the low zone at Soquel Point were small snails, mainly Lacuna(?) which occurred on Phyllospadix, Iridaea and Ulva, and Mitrella which occurred in the sand and under the coralline algae. Less numerous, but widely scattered throughout the sand areas of the low zone at Soquel Point was Cirriiformia spirabanchia. Phragmatopoma californica and Mytilus californianus dominated the upper part of the low zone at Santa Cruz, while, as with the plants, the lower part of the low zone at Santa Cruz could not be characterized by dominant species. Also, co-with the plants, few kinds of animals were found in the upper regions of the low zone, and only two species were found in the 57-foot quadrat. At least seven species of sponges were found in crevices in the low zone at Santa Cruz, while none were found anywhere at Soquel Point. It is likely that sewage at Soquel Point adversely affected the sponge populations.

Relatively few animal species were found in the low-low zone at Soquel Point, the main species being the small snails Lacuna(?) on Ulva and Cryptopleura and Mitrella under the coralline algae. Large, solitary specimens of Anthopleura elegatissima were relatively numerous in small pools in the low-low zone, but curiously, no specimens of A. xanthogrammica were found.

Preliminary analysis. Although thorough analysis of these data must wait for more definitive species identification and additional field work, several interesting trends can be seen in the preliminary analyses shown in Tables 3 and 4, and in Figures 4, 5 and 6. The numbers of plant and animal species in each zone at both the Santa Cruz and Soquel Point areas seem similar (Fig. 4). At the Santa Cruz site, the number of both plant and animal species increases from the high zone to the low zone; this might be expected as more species should be able to survive in the areas least frequently exposed. Such a trend in numbers of species is not so evident at the Soquel Point site; there is little increase in number of plant species from the high to the low-low zone, and nearly half the number of animal species in the low-low zone as compared to the low zone. The depression in increase of species with lower tidal zones is likely due to adverse conditions from the sewage discharge, and as mentioned above, the low-low zone shows similar affects from the sewage discharge as has been seen at the Pacific Grove and Carmel sewage outfalls. These trends in species numbers are also shown in the number of species found in m² quadrats in each area (Fig. 5; the 57-foot quadrat data are not included in these calculations because they are so low). It will be especially interesting to see if these patterns of species abundance change after discharge from the East Cliff sewage plant is terminated. It will be equally interesting to see if the species abundance pattern at the Santa Cruz site changes when the sewage discharge there is increased.

The percent of the total species found in an area which occurs in an average m^2 quadrat reflects both species diversity and homogeneity of habitat. This percent is similar (between 35 and 50%) for the plants collected in all areas, and probably reflects similar homogeneity of habitat and probably diversity in all the areas. The percent is relatively high for animals in the high and mid zones and the flat rocky surfaces in these areas are similar. The low percent for the animals taken in the low zone quadrats probably reflects the numerous crevices and pools in the low zones outside the quadrats where additional species were found. However, the low percent in the low-low zone at Soquel Point probably reflects a low species diversity more than habitat heterogeneity. Again, it will be of interest to see how this percent changes when sewage discharge is terminated at Soquel Point.

Figure 6. Percent of total species found in average m² quadrat.

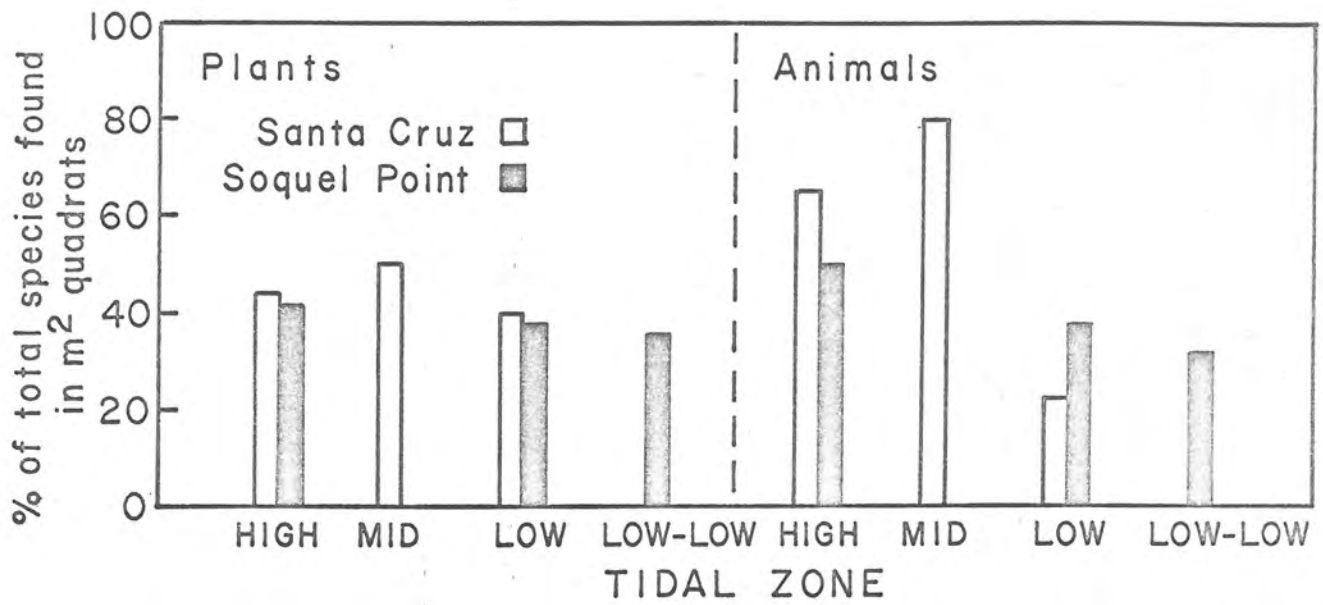


TABLE 1. Plants found at the Santa Cruz (Almar Avenue) and Soquel Point (Pleasure Point) transect sites in November, 1971. Symbols are: No. = no. of plants found in m² quadrat; (no.) = no. of 10-cm squares in m² quadrat with species; x = present in m² quadrat; (x) = present in area but not found in m² quadrat; - = not found in area; * = voucher collected.

Species	Soquel (Pleasure) Point									Santa Cruz (Almar Avenue)					
	High			Low			Low-Low			High	Mid		Low		
Quadrat:	3'	15'	57'	148'	201'	293'	322'	332'	3'	15'	30'	36'	48'	59'	
DARK GREEN BALLS	(x)	-	-	-	-	-	-	-	x	-	-	-	-	-	
<u>GREENS</u>															
> Bryopsis															
corticulans ¹	(x)	-	-	-	-	-	-	-	-	-	-	-	(48)	-	
> Chaetomorpha aerea	(1)	-	-	-	-	-	-	-	(13)	-	-	-	-	-	
> Cladophora															
trichotoma	(40)	(7)	-	-	-	-	-	-	(13)	-	(24)	(39)	(x)	-	
> Enteromorpha															
intestinalis	(x)	-	-	-	-	-	-	-	6	2	-	-	-	-	
> E. linza	(100)	(100)	(x)	(x)	-	-	-	-	6	20	64	-	-	-	
> Ulva expansa	-	-	-	-	-	(74)	(25)	-	-	-	-	-	-	-	
> U. lobata	1	-	(x)	(5)	(26)	-	-	-	x	-	-	28	-	-	
> U. rigida	-	-	-	-	-	-	-	-	-	-	-	-	(x)	-	
<u>BROWNS</u>															
> Cystoseira															
osmundacea	-	-	-	(*)	(*)	-	1	(x)	-	-	-	-	-	-	
> Ectocarpus pygmaeus	-	-	-	-	-	-	(x)	-	-	-	-	-	-	-	
> Egregia laevigata	-	-	-	(x)	-	-	-	-	-	-	-	-	-	-	
> E. menziesii	-	-	-	-	-	-	-	-	-	-	-	-	(x)	-	
> Laminaria															
groenlandica ²	-	-	-	-	-	-	-	(x)	-	-	-	-	(x)	-	
> L. setchellii	-	-	-	-	-	-	(x)	-	-	-	-	-	(x)	-	
> L. sinclarii	-	-	-	-	-	-	-	-	-	-	-	-	(x)	-	
> Macrocystis															
integrifolia	-	-	-	1	-	-	-	-	-	-	-	-	-	-	
> M. pyriferia	-	-	-	-	-	-	-	-	-	-	-	-	(x)	-	
> Pelvetia															
fastigiata ³	-	-	-	-	-	-	-	-	(x)	-	-	-	-	-	

Table 1 (cont.)

Species	Soquel (Pleasure) Point									Santa Cruz (Almar Avenue)					
	Locality:			Tidal level:			Tidal level:			High		Mid		Low	
	Quadrat:	High	Low	Low-Low	High	Mid	Low	High	Mid	Low	High	Mid	Low		
	3'	15'	57'	148'	201'	293'	322'	332'	3'	15'	30'	36'	48'	59'	
<i>Iridaea cordata</i>															
var. <i>cordata</i>	-	-	-	1	6	-	-	-	-	-	(x)	-	-	-	
<i>I. cordata</i>															
var. <i>splendens</i>	-	-	-	-	-	-	(x)	-	-	-	(x)	-	-	-	
<i>I. flaccida</i>	(x)	-	-	-	-	-	1	-	-	-	1	2	14	-	
<i>I. heterocarpum</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
<i>Laurencia</i>															
<i>spectabilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	24	-	
<i>Leathesia difformis</i>	-	-	-	-	-	-	-	-	-	-	(x)	-	-	-	
<i>Odonthalia floccosa</i>	-	-	-	-	-	-	-	-	-	2	(51)	(34)	-	-	
<i>Peyssonelia</i> sp. (on <i>T. brunne</i>)	-	-	-	-	-	x	-	-	-	-	-	-	-	-	
<i>Petrospongium</i> sp.	-	-	-	-	-	-	-	-	(12)	(10)	(18)	(79)	-	-	
<i>Pleonosporium</i>															
<i>dasyoides</i>	-	-	-	-	-	-	(x)	-	-	-	-	-	-	-	
<i>Plocamium pacificum</i>	-	-	-	-	-	-	(x)	-	-	-	-	-	-	x	
<i>Polyneura latissima</i>	-	-	-	-	-	-	(x)	-	-	-	-	-	-	-	
<i>Polysiphonia</i>															
<i>paniculata</i>	x	-	-	-	-	-	-	-	-	4	-	(x)	(x)	-	
<i>Porphyra perforata</i>	2	(x)	-	-	-	-	-	-	-	-	-	x	1	-	
<i>Prionitis</i>															
<i>andersonii</i>	-	-	-	-	(x)	1	-	1	-	-	-	-	-	-	
<i>P. lanceolata</i>	-	-	-	-	(x)	-	-	-	(x)	2	5	(31)	-	-	
<i>Pterosiphonia</i>															
<i>bipinnata</i>	-	-	-	-	-	-	(x)	-	-	-	-	-	-	-	
<i>P. dendroidea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	(x)	
<i>Ptilota filicina</i> ⁴	-	-	-	-	-	-	(x)	-	-	-	-	-	-	x	
<i>Rhodoglossum affine</i>	-	-	-	-	-	-	-	-	-	-	(x)	-	(x)	-	
<i>Rhodomela larix</i>	-	-	-	-	-	-	-	-	-	-	-	-	20	-	
<i>Smithora naiadum</i>	-	-	x	-	-	-	-	-	-	-	-	-	x	x	
FLOWERS															
<i>Phyllospadix</i>															
<i>torreyi</i> ⁵	-	-	(30)	(43)	(15)	-	(6)	-	-	-	-	-	x	x	

Table 1 (cont'd)

Footnotes:

- (1) The Bryopsis corticulans found in the high zone at Soquel (Pleasure) Point was submerged in a tidal pool.
- (2) Laminaria groenlandica was found growing submerged in channels on a shale-rock substrate.
- (3) Both Pelvetia fastigiata and Pelvetiopsis limitata were found growing on a large rock platform adjacent to the transect site's rock platform.
- (4) Cryptopleura violacea, Polyneura latissima and Ptilota filicina were all found on the west side of the sewage line.
- (5) A patch of Phyllospadix scouleri was also found on the west side of the sewage line.

Species	Locality:	Soquel (Pleasure) Point								Santa Cruz (Almar Avenue)					
	Tidal Level:	High		Low			Low-Low			High		Mid		Low	
	Quadrat:	3'	15'	57'	148'	201'	293'	322'	332'	3'	15'	30'	36'	48'	59'
ANNELIDA (Cont'd)															
Thelepus sp.		--	--	--	--	--	--	--	--	--	--	--	--	--	(X)
ARTHROPODA															
(6) { Chthamalus dalli		(X)	--	--	1	--	--	--	--	X	(95) } X	X	X	X	1
{ Balanus glandula		(48)	(49)	--	--	--	--	--	--	X	X	X	X	X	--
{ B. tintinnabulum		--	--	--	--	--	--	--	--	--	--	--	--	--	1
(7) Pollicipes polymerus		(X)	--	--	--	--	--	--	--	--	--	4	7	--	3
Idotea spp.		--	--	--	--	(X)	--	--	--	--	--	--	--	--	--
Ligia occidentalis		(X)	--	--	--	--	--	--	--	--	--	--	--	--	--
Cancer jordani (?)		--	--	--	--	1	--	--	--	--	--	--	--	--	--
Pachygrapsus crassipes		(X)	--	--	--	--	--	--	--	--	--	--	--	--	--
Pugettia producta		--	--	--	1	--	--	--	--	--	--	--	--	--	--
P. gracilius		--	--	--	--	1	--	--	--	--	--	--	--	--	--
(8) { Pagurus hirsutiussculus		--	--	--	(X)	--	4	--	1	--	--	--	--	--	(X)
{ Pagurus samuelis		--	--	--	--	--	--	(X)	--	--	--	--	--	--	--
{ Pycnogonum stearnsi		--	--	--	--	--	--	--	--	--	--	--	--	--	(X)
MOLLUSCA															
Nuttalina californica		--	--	--	--	--	--	--	--	--	--	1	--	--	--
Mopalia muscosa		(X)	(X)	--	--	--	--	--	--	--	--	2	1	--	2
Mopalia ciliata		(X)	--	--	--	--	--	--	--	--	--	(X)	--	--	(X)
Cyanoplax sp.		--	--	--	--	--	--	--	--	--	--	--	--	--	(X)
(9) Hinnites multirugosus		--	--	--	--	--	--	(X)	--	--	--	--	--	--	--
(10) Platydon cancellatus		--	--	--	--	--	--	--	--	--	--	--	--	--	(X)
Saxicava sp.		--	--	--	--	--	--	(X)	--	--	--	--	--	--	(X)
(11) { Mytilus edulis		(7)	(53)	--	--	--	--	--	--	(X)	(10)	(X)	(X)	(24)	--
{ M. californianus		(3)	(23)	--	--	--	--	--	--	(X)	(2)	(60)	(77)	1	--
(12) Acmaea pelta		11	X	--	--	(X)	--	--	--	13	X	X	X	1	--
A. digitalis		6	17	--	--	--	--	--	--	7	X	X	X	--	--
A. scabra		3	26	--	--	--	--	--	--	6	X	X	X	--	--
A. scutum		--	--	--	--	--	--	--	1	--	--	--	--	--	--

Species	Locality:	Soquel (Pleasure) Point							Santa Cruz (Almar Avenue)						
	Tidal Level:	High		Low		Low-Low			High		Mid		Low		
	Quadrat:	3'	15'	57'	148'	201'	293'	322'	332'	3'	15'	30'	36'	48'	59'
MOLLUSCA (Cont'd)															
(13) <i>A. asimi</i>		--	--	--	X	X	3	--	--	--	--	--	--	--	--
(14) <i>A. instabilis</i>		--	--	--	--	--	--	--	1	--	--	--	--	--	--
(15) <i>A. inessa</i>		--	--	--	--	--	--	1	--	--	--	--	--	--	--
<i>Acmaea paleacea</i> (?)		--	--	--	--	--	--	(X)	--	--	--	--	--	--	--
(16) <i>Crepidula adunca</i>		--	--	--	(X)	--	X	(X)	(X)	--	--	--	--	--	--
(17) <i>Crepidula</i> sp.		--	--	--	--	1	--	--	--	--	--	--	--	--	--
(18) <i>Lacuna</i> (?)		--	+	X ^P	X	I-U X	U X	X	C X	--	--	--	--	X	X
<i>Littorina scutulata</i>		X	X	--	--	--	--	--	--	(74)	X	X	X	--	--
<i>L. planaxis</i>			(X)	--	--	--	--	--	--	--	--	--	--	--	--
<i>Tegula funebris</i>		--	--	--	--	5	1	--	--	(X)	--	12	--	--	--
<i>T. brunnea</i>		--	--	--	--	--	--	(X)	--	--	--	--	--	--	--
<i>T. monterejii</i>		--	--	--	--	--	--	(X)	--	--	--	--	--	--	--
<i>Thais emarginata</i>		--	--	--	1	(X)	--	--	1	(X)	9	X	(X)	--	--
(19) <i>Mitrella</i> sp.		--	--	--	X	X	X	X	X	--	--	--	--	--	--
<i>Epitonium</i> sp.		--	--	--	(X)	--	--	--	--	--	--	--	--	--	--
<i>Olivella biplicata</i>		--	--	--	--	--	--	--	--	--	--	--	--	(X)	--
<i>Hermisseuda crassicornis</i>		--	--	--	1	--	--	--	--	--	--	--	--	--	--
<i>Archidoris montereyensis</i>		--	--	--	--	--	--	--	--	--	--	--	--	(X)	--
ECHINODERMATA															
<i>Patiria miniata</i>		--	--	--	(X)	--	--	--	--	--	--	--	--	--	--
<i>Pisaster ochraceus</i>		--	--	--	(X)	--	--	(X)	--	--	(X)	--	--	(X)	--
<i>Pisaster brevispinus</i>		--	--	--	(X)	--	--	--	--	--	--	--	--	(X)	--
(20) <i>Strogyloceutrotus purpuratus</i>		--	--	--	1	X	--	--	--	--	--	--	--	--	--
<i>Cucumaria</i> sp.		--	--	--	--	1	--	--	--	--	--	--	--	--	--
CHORDATA															
<i>Sytela montereyensis</i>		--	--	--	(X)	--	--	--	--	--	--	--	--	--	--
<i>Ascidia ceratoides</i>		--	--	--	(X)	--	--	--	--	--	--	--	--	--	--
<i>Amaroucium</i> sp.		--	--	--	--	--	--	--	--	--	--	--	--	(X)	--

TABLE 2
Footnotes

- (1) Santa Cruz - Mid & low zones: dense, approximately 30 individuals per 10 cm. square
- (2) Found in crevices and rocky ledges
- (3) Soquel Point - very sparse
Santa Cruz - abundant in mid and low zones
- (4) Abundant, found mostly in shallow pools
- (5) Found in Rhodomella
- (6) Soquel Point - mostly in clusters
Santa Cruz - High - in dense patches
Mid - at 30' most dead, scars only
Low - relatively few barnacles present
- (7) Soquel Point - abundant on west side of high zone platform
- (8) Commonly in Tegula shells
- (9) Found in lower pool, not cemented down
- (10) In shallow pools
- (11) Soquel Point - mostly on east side of high zone rock platform
Santa Cruz - few Mytilus edulis, many M. californianus
- (12) Abundant; size, color patterns varied
- (13) Found on Tegula
- (14) On Cystoseira
- (15) On Laminaria
- (16) On Tegula
- (17) In Olivella
- (18) Very small, black snails, numerous. Found on Phyllospadix, (P); Iridea, (I); Ulva, (U); and Cryptopleura, (C).
- (19) Abundant in sand and under coralline algae
- (20) Found juveniles only; under ledges

TABLE 3
Analysis of Plant Data

<u>Number of Species</u>	<u>Total</u>	<u>Tidal Zone</u>			
		<u>High</u>	<u>Mid</u>	<u>Low</u>	<u>Low-Low</u>
Total in both areas	69	21	(21)	44	(25)
Total at Santa Cruz	48	17	21	30	--
Total at Soquel Point	49	16	--	19	25
Only at Santa Cruz	20	5	21	25	--
Only at Soquel Point	21	4	--	14	25
Common to both areas	28	12	--	5	--
% common to both areas	41	57	--	11	--
In each m ² quadrat, Santa Cruz		7,7	9,12	15,9	--
mean per m ² , Santa Cruz		7	10.5	12	--
% total in m ² quadrats, Santa Cruz*		44	50	40	--
In each m ² quadrat, Soquel Point		9,5	--	(3),7,7	9,9,7
mean per m ² , Soquel Point		7	--	7	8.7
% total in m ² quadrats, Soquel Point*		41	--	37	35

* $\frac{\text{mean no. of species per m}^2}{\text{total no. of species in zone}} \times 100$

PEARSE

INTERTIDAL TRANSECT STUDIES OF NORTHERN MONTEREY BAY

Second Quarterly Report

January - March 1972

Submitted to: Association of the Monterey Bay Area Governments

Attn: Mr. Leslie L. Doolittle

Principle Investigators: Dr. William T. Doyle and Dr. John S. Pearse

April 12, 1972

This report summarizes the work done and data collected during the second quarter of the 10/22/71 dated contract between the Association of the Monterey Bay Area Governments and the University of California, Santa Cruz. The two transects established during the previous quarter, near the Santa Cruz City Sanitation outfall (near Almar Street) and near the Eastcliff Sanitation District outfall (east Soquel Point), were visited in January and February, and the species in the quadrats and in the general area were recorded. In addition, three new transects were established: (1) on UCSC's intertidal reef at Natural Bridges, (2) on the west side of Santa Cruz Point, and (3) on the east side of Santa Cruz Point. These five transect areas extend from relatively polluted bay regions westward to relatively open ocean unpolluted regions (Natural Bridges) and should show well the condition of intertidal life in the area of the City of Santa Cruz.

The majority of the work reported here was done by eight undergraduate students taking the UCSC course Biology 190A, Proseminar: Intertidal Organisms. Michele Jauregui and George Landreth (plants), Debra Brewer, Jack Liebster and Linda O'Kelley (animals), and Alex Woronovich (area surveys) worked at the Soquel Point, Almar Street and Natural Bridges sites, while Craig Graffin (animals) and Katie Thickstun (plants) worked on the east and west sides of Santa Cruz Point. Dr. John Pearse accompanied the students on the field trips and aided in the identification of the animals. Dr. Isabella Abbott (Hopkins Marine Station) aided in the identification of plant vouchers.

Teams of other students in Biology 190A worked the intertidal transects established in the Fall of 1971 on the open ocean coast north of Santa Cruz. Mr. Jerry Weber, a UCSC graduate student in Earth Sciences, continued placing stainless steel rods along our transect lines for permanent reference points, including the five in the Santa Cruz city area; he has now placed over 50 rods. In addition, quantitative estimates of the standing crop of algae in quarter-meter square quadrats were made along the whole study region, including the Almar Street and Soquel Point transect areas. These studies will be continued quarterly, and will be included in the final report to be made in the Fall of 1972.

This interim report gives the locations and descriptions of the transects at Natural Bridges, and the east and west sides of Santa Cruz Point, a listing of the plants and animals found at all five areas studied in the region of Santa Cruz, and a preliminary, continuing analysis of these data. These listings and analyses should be considered current working information, and they should not be taken as final.

PROCEDURES

Procedures were the same as reported in the First Quarterly Report. Quantitative counts of plants and animals in the quadrats established in October, 1971, at Soquel Point and Almar Street were made during the low tide cycles of January, 1972. General surveys of the areas were continued

during the low tide cycles of February 1972. Quantitative quadrats were not established at the Natural Bridges and two Santa Cruz Point sites and general surveys, enumerating the species present, were done at these areas. Vouchers of animal and plant specimens, and Ectachrome slides of all the areas, were taken as described in the First Quarterly Report.

LOCATION AND DESCRIPTION OF THE TRANSECT AREAS

The location of the five transect areas are shown in Figure 1. The Almar Street and Soquel Point transect areas were described in the First Quarterly Report. The Natural Bridges site was located on the western most reef of the UCSC preserve just east of the western boundary of the Boise-Cascade trailer complex. A sketch of the area is shown in Figure 2 and a profile in Figure 3. The site is on a gently sloping rock shelf extending 190 feet from the cliff base to the low water line. The west side of the reef is bounded by a sand inlet and the east side is delineated by a distinct crevice.

The Natural Bridges reef was nearly completely bare from the base of the cliff out to about 60 feet where a stainless steel rod was placed. Between about 60 and 100 feet from the base of the cliff the reef was covered by typical high zone organisms, particularly green algae. A dense mussle bed formed a band between about 100 and 140 feet from the cliff; below the mussels was a dense band of Phyllospadix. Large clusters of Egregia menziesii and Laminaria sinclairii occurred at the lower "corners" of the reef. This gently sloping reef showed the clearest example of typical intertidal zonation of any of the Santa Cruz City region study sites.

The sites on the east and west side of Santa Cruz Point were the most heterogeneous of the Santa Cruz City region sites. A sketch of the east Santa Cruz Point transect area and a profile of the transect line are shown in Figures 4 and 5, respectively. The entire sandy-rocky beach area is quite large, approximately 375 feet by 175 feet, and it provides a popular haven for sightseers, tourists, explorers, surfers, clamdiggers, biologists, and other curious people. Consequently, this area is constantly undergoing major changes in substrate conditions and perhaps in the densities of life forms in the middle and lower tidal zones; clamdiggers uproot and overturn rocks and dig new channels; inquisitive youngsters collect starfish; clumsy tourists and surfers trample on delicate algal and animal forms. Quadrats could not be placed on such small and altered surfaces.

The transect line gradually slopes downward some 162 feet seaward (at a compass bearing of 110 degrees) through the middle of this area. Distinguishing between tidal zones proved difficult - some characteristic species of certain zones, for example, were found in unusual places. The "high zone" extends from 0 feet to about 50 feet and is characterized by large, immovable rocks and some sand. The "middle zone" is short, contains some pools but mostly rock and some sand, and lies between 50 feet and 65 feet. The "low zone" extends from 65 feet to about 165 feet and is mostly made up of loose, movable rocks and a little sand.

The west Santa Cruz Point transect area is shown in Figure 6, and the profile of the transect line can be seen in Figure 7. The transect line aims toward the open sea at a compass bearing of 190 degrees. In contrast to the large and fairly protected Santa Cruz point east area, the Santa Cruz Point west transect location is small and can be found at the end of a rocky point exposed to the open ocean. Thus, wave action can be expected to have more of an effect over substrate conditions and the life forms. Substantial differences in sand levels, in fact, were noted just to either side of the transect line; sand gradually began to build up in January and February so that many rocks were completely covered, but by early March, the sand had eroded away to about the same level as in mid-January.

Human impact (trampling, exploring, collecting) was probably only a minor factor in determining the environmental conditions in this area. Poor access to the area, large immovable rocks, and the almost total absence of sand on the transect line itself all combined to keep the area relatively unchanged throughout the study period. It must also be noted that surfers and clamdiggers were never sighted anywhere near the area. Quadrat sites, however, still could not be established because of the absence of enough suitable, meter-square, flat surfaces.

The heavy wave action and the small intertidal area made it nearly impossible to precisely distinguish between tidal zones. The "high zone" is located on the cliff face and extends from 0 feet to approximately 10 feet (plus 12 vertical feet up the cliff). The "middle zone" stretches from about 10 feet to about 30 feet. The "low zone" extends from about 30 feet to the end of the transect line at roughly 60 feet.

SPECIES LISTS AND ANALYSES

The animals and plants found at the four different sites are given in Tables 1 and 2. About 50 species of animals and 40 species of plants were recorded at Soquel Point, Santa Cruz Point-West and Almar Street, indicating that on the basis of a species count alone, these areas are quite similar. Santa Cruz Point-East had a markedly higher number of animals (66) and plants (55) than those other areas; this is somewhat surprising considering the disturbed nature of the area with unstable boulders, shifting sand and heavy human use. However, the Santa Cruz Point-East area is quite extensive, with a wide low zone, which may permit more species to occur there.

The Natural Bridges area had the largest number of animals (76) and the lowest number of plants (20). Not only is this area an extensive reef, but it is also more typical of the open ocean coast. Many animals found at Natural Bridges were also found in the Davenport and Año Nuevo-Pigeon Point areas but not elsewhere in the Santa Cruz City area. These animals included the black abalone Haliotis cracherodii, the tubeworm Salmacina sp., the tidepool shrimp Spirontocaris sp., the crabs Petrolisthes cinctipes and Pachycheles pubescens, and the green tunicate Perophora annectens, as well as the alga Analipus japonica. The low number of algae found at Natural Bridges is probably due to incomplete collecting, and more time will be spent in this area during the Spring Quarter.

The Soquel Point region, with the widest low intertidal reef system of any of the areas, had less species than might be expected. Moreover, some animals such as sponges, the anenome Anthopleura xanthogrammica, nemerteaus and most tunicates, are conspicuously absent at the Soquel Point site. Their absence may be the result of adverse effects of sewage, or may reflect natural conditions of the bay. Several species, such as the small Mitrella sp., the crab Pugettia producta, and the algae Cystoseira osmundacea, Agardhiella tenera, Gracillaria spp., Grateloupia doryphora and Prionitis andersonii, have only been found within the bay at Soquel Point and, for some, Santa Cruz Point-East. Moreover, as noted in the First Quarterly Report, several species pairs of algae change in the Santa Cruz Point region, Egregia laevigata, Corallina chilensis and Prionitis lyallii were found at the Santa Cruz Point and Soquel Point sites while Egregia menziesii, Corallina vancouverensis and Prionitis lanceolata were found at the Santa Cruz Point, Almar Street and Natural Bridges sites. These observations support the notion that the Santa Cruz Point region somehow delineates the open coast and Monterey Bay environments.

Area comparisons, in terms of percent species in common in any two areas, are given in Table 3. The two sides of Santa Cruz Point had the highest percent of species in common, but this was only 46%. Natural Bridges had between 39 and 45% of the species found at the other sites while Soquel Point had between 36 and 39% of the species found at the other sites. Curiously, the two areas with the least number of species in common (34%) were Santa Cruz Point-East and Almar Street.

As shown in Table 4, the largest proportion of animal and plant species were found only at a single locality. Most of these single records are of species which are relatively uncommon in the intertidal, and it is anticipated that many will eventually be found at some of the other sites. However, with further search, additional single records will probably be recorded also, so the proportion of records from only one area will likely remain about the same. For this reason, the number of species found in common between any two areas will likely remain similar to those shown in Table 3.

Santa Cruz Point-East had the highest number of species recorded from only one site (Table 5), emphasizing, perhaps, some unique features of the area. The high total number of species found in the Santa Cruz Point-East area (Tables 1 & 2) is therefore probably not the result of an "overlapping" of bay and open ocean species. The high number of animals found only at Natural Bridges, on the other hand, probably is the result of open coastal species extending eastward toward the Bay, and perhaps also reflect the preserve status of this area.

Table 6 compares the total number of species found in the Fall and Winter surveys at Soquel Point and Almar Street. Although the total number of animals and plants found in both areas was similar in the Fall and Winter, only about 50-60% of the species found at each site were the same in both seasons. Species found in the Fall were recorded in the Winter, while species recorded in the Winter were not found in the Fall. Most of the animals recorded in the Fall at either place, were recorded again in the Winter at at least one of the areas in the Winter, so actual seasonal changes seems unlikely for most animal species. Table 7 compares the animals and plants found at Soquel Point and Almar Street in the Fall and Winter in the same m² quadrats. Again, although the total number of species recorded was similar in both seasons at both areas, only about 50-70% of the species were the same in the two

seasons. This does suggest considerable change, although it is not clear if the change is seasonal in nature, or merely reflects the inadequacy of our early survey methods. Analyses of changes of individual species may be more revealing, and will be done after more seasons have been sampled.

These analyses, comparing species found in different areas and different seasons, point out some of the problems of establishing base line data. Data from one area can not be easily applied to another area, even areas close to each other as the Santa Cruz Point-West and Almar Street areas with only about 36% of the animals being the same in the two areas. Records made at the exact same areas in different seasons only have about 50-70% of the same species, which may reflect seasonal changes, team changes or imprecision of this type of monitoring program. Continuing surveys in these same areas over the next 18 months should reveal more about seasonal and area variability, as well as variability in the methods themselves.

TABLE 1

ANIMALS RECORDED IN JANUARY - MARCH 1972

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
PORIFERA					
<i>Aplysilla graciolis</i>	==	==	L	ML	ML
<i>Cliona celata</i>	--	L	--	ML	M
<i>Craniella arb</i>	--	L	--	--	--
<i>Esperiopsis originalis</i>	--	--	--	ML	M
<i>Haliclona permolis</i>	--	HML	HML	L	ML
<i>Lissodendoryx noxiosa</i>	--	--	L	--	--
<i>Ophlitaspongia pennata</i>	--	HML	ML	--	--
<i>Rhabdoderrella nuttingi</i>	--	ML	--	--	ML
CNIDARIA					
<i>Abietenaria sp.</i>	LL	--	--	L	--
<i>Aglaophenia sp.</i>	--	--	M	L	ML
<i>Sertularia sp.</i>	--	L	--	L	--
<i>Anthopleura artemesia</i>	L*LL*	ML	HML	--	M
<i>A. elegantissima</i>	HL*LL*	HML	HML	H*M*L*	HML
<i>A. xanthogrammica</i>	--	HML	HML	ML*	HML
<i>Epiactis prolifera</i>	L	ML	ML	--	M
<i>Tealia lofotensis</i>	--	L	--	--	--
PLATYHELMINTHES					
<i>Notoplana sp.</i>	LL	H	--	--	M
NEMERTEA					
<i>Emplectonema gracile</i>	--	H	--	L	--
<i>Paranemertes peregrina</i>	--	HM	H	L	--
White nemertean	--	--	--	L	L
SIPUNCULOIDEA					
<i>Dendrostomum pyroides</i>	--	M	--	--	--
<i>Phascolosoma agasizii</i>	--	--	--	--	M
ANNELIDA					
<i>Cirriformia luxuriosa</i>	--	--	--	HM*	HM
<i>C. spirabranca</i>	L*	--	--	H	M
<i>Dodecaeria sp.</i>	--	--	--	L*	M
<i>Stylaroides papillata</i>	L*	--	--	--	--
<i>Neries vexillosa</i>	--	--	--	--	M
Sm. green nereid	--	M	--	--	--
<i>Halosydna brevisetosa</i>	--	--	--	--	M
<i>Phragmatopoma californica</i>	L*LL*	HML	HML	M*L*	HML
<i>Eudistylia polymorpha</i>	--	--	H	--	--
<i>Salmacina sp.</i>	--	--	--	--	M
<i>Serpula sp.</i>	--	HML	H	--	L
Spionid	H*L	--	--	H*	--
<i>Trypanosyllis adamanteus</i>	--	H	--	--	--
<i>Amacea sp.</i>	--	--	--	--	L
<i>Thelepus sp.</i>	--	--	--	--	M

TABLE 1 (Page 2)

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
MOLLUSCA					
Cyanoplax sp.	L	--	L	--	--
Mopalia ciliata	L	--	--	M	ML
M. hindsi	--	L	L	--	--
M. mucosa	HL LL	HM	HM	M*L*	HML
Nuttalina californica	H	H	HM	HM*L*	HM
Tonicella lineata	--	HL	--	--	L
Mytilus californianus	H*	HM	HM	HM*L*	HML
M. edulis	H*LL	HM	HM	HM*L*	HML
Platydon cancellatus	H	--	--	L	M
Saxicava pholadis	HLL	HML	HML	M*	ML
Lucina sp.	--	--	--	L	--
Haliotis cracherodii	--	--	--	--	M
Acmaea asmi	L*LL	H	--	H	H
A. digitalis	H*LL*	H	HM	H*M*L*	HM
A. fenestrata	--	--	M	--	--
A. inessa	--	ML	HM	L	ML
A. limatula	--	--	M	--	--
A. paleacea	L*	HML	L	--	M
A. pelta	H*L	HML	HML	H*M*L*	HM
A. persona	H	--	HL	--	M
A. scabra	H*LLL	H	H	H*M*	HM
A.t. scutum	LL*	H	ML	--	--
Lottia gigantea	--	--	H	--	H
Crepidula adunca	L*LL	L	--	--	--
Cardita carpenteri	--	L	--	--	--
Calliostoma canaliculatum	--	H	--	--	--
C. costatum	--	L	--	--	--
Tegula brunnea	L*LL	ML	--	--	H
T. funebris	L*LL	HML	HML	HM*L*	HM
Littorina planaxis	--	H	H	H*	H
L. scutulata	H*	H	H	H*M*	H
Lacuna sp.	L*LL*	HML	ML	M*L*	M
Mitrella sp.	L*LL*	H	--	--	--
Olivella biplicata	L	--	--	--	--
Acanthina spirata	L*	--	--	L	M
Thais canaliculata	--	--	--	ML	--
T. emarginata	L*LL	HML	HM	HM*L*	HM
Mohnia sp.(?)	LL	--	--	--	--
Aeolidia papillosa	--	--	--	M*	--
Archidoris montereyensis	--	--	--	M	--
Dialula sandiegensis	--	M	--	--	M
Hermissendra crassicornis	LL	--	--	--	--
Oncidiella sp.	--	M	--	--	H
Trimusculus reticulatus	--	--	--	M	M

TABLE 1 (Page 3)

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
ARTHROPODA					
Balanus glandula	H*L*LL*	HML	HML	H*M*L*	HML
Chthamalus sp.	H*L*LL	HML	HML	H*M*L*	HML
Pollicipes polymerus	H	H	HM	M*L*	HML
Tetraclita squamosa	--	H	--	--	M
Tigriopus californica	--	--	--	--	H
Cirolana harfordi	L	--	--	--	--
Idothea fewski	--	--	--	L*	--
I. montereyensis	--	--	L	--	--
I. stenops	--	L	L	--	M
I. urotoma	--	--	--	M	--
Ligia sp.	--	H	H	--	HM
Gammarids	--	ML	ML	L*	M
Spirontocaris sp.	--	--	--	--	M
Cancer antennarius	LLL	--	--	--	M
Pachygrapsus crassipes	H	HM	HM	ML	M
Pugettia gracilis	L*	--	--	--	M
P. producta	LLL	L	--	--	--
Pachycheles pubescens	--	--	--	--	L
Petrolisthes cinctipes	--	--	--	--	M
Pagurus graniosomanus	L	--	--	--	--
P. hirsutiusculus	L*LL	HML	HML	--	H
Pycnogonum stearnsi	--	--	H	--	--
red mites	H	HM	--	--	H
collembolans	--	--	--	--	H
BRYOZOA					
Barentsia sp.	--	--	--	--	L
Bugula sp.	L*	L	--	--	--
Membranipora tuberculata	--	ML	--	--	--
Tricellaria occidentalis	L	--	--	--	--
ECHINODERMATA					
Patiria miniata	--	ML	--	--	--
Pisaster brevispinus	--	HML	--	--	--
P. ochraceus	LLL	HML	HML	ML*	HML
Pycnopodia helianthoides	--	L	--	--	--
Strongylocentrotus purpuratus	LLL	--	H	L	M
CHORDATA					
Amaroucium californicum	--	--	--	ML	ML
Diplosoma pizoni	--	L	--	--	--
Distaplia occidentalis	--	ML	--	--	L

TABLE 1 (Page 4)

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
<i>Eudistoma psammion</i>	--	ML	ML	L	ML
<i>Euherdmania claviformis</i>	--	L	L	--	--
<i>Perophora annectens</i>	--	--	--	--	L
<i>Pyura haustor</i>	--	--	--	--	L
<i>Styela montereyensis</i>	--	L	L	L	--
<i>S. tunicata</i>	--	--	--	--	L
Total species (123)	50	66	50	52	76
Total found in quadrats	27 (54%)	--	--	26 (50%)	--

TABLE 2

PLANTS RECORDED IN JANUARY - FEBRUARY 1972

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
CHLOROPHYTA					
<i>Bryopsis corticulans</i>	L*	ML	--	--	--
<i>Chaetomorpha aerea</i>	--	--	--	H*	--
<i>Cladophora oviodea</i>	--	HML	--	--	--
<i>Cladophora trichotoma</i>	H*	H	HM	H*M*	HM
<i>Codium setchellii</i>	--	--	M	--	--
<i>Enteromorpha compressa</i>	--	H	M	--	--
<i>E. intestinalis</i>	H*	--	--	H*M*L*	H
<i>E. linza</i>	--	--	--	ML	--
<i>Rhizoclonium riparum</i>	HL*LL*	--	--	--	--
<i>Ulva taeniata</i>	M	HM	--	H*	--
<i>Ulva</i> spp. ¹	H*	HML	HML	M*L*	HM
PHAEOPHYTA					
<i>Alaria marginata</i>	--	L	--	--	--
<i>Analipus japonica</i>	--	--	--	--	M
<i>Cystoseira osmundacea</i>	L*LL**	L	--	--	--
<i>Ectocarpus pygmaeus</i>	LL**	--	--	M*	--
<i>Egregia laevigata</i>	L	HML	L	--	--
<i>E. menziesii</i>	--	ML	L	L	L
<i>Laminaria groenlandica</i>	LL	--	--	--	--
<i>L. setchellii</i>	LL*	--	--	--	--
<i>L. sinclairii</i>	--	ML	L	L	L
<i>Macrocystis integrifolia</i>	L*	--	--	--	L
<i>M. pyrifera</i>	--	ML	L	--	--
<i>Pelvetia fastigata</i>	--	--	--	H	--
<i>Pelvetiopsis limitata</i>	--	--	--	H	--
<i>Petrospongium rugosum</i>	--	--	--	--	HM
<i>Phaeostrophion irregulare</i>	--	HM	--	--	--
<i>Ralfsia pacifica</i>	LL*	--	HM	H*M*L*	HM
<i>Scytosiphon dotyi</i>	H*	H	HM	H*	--
RHODOPHYTA					
<i>Acrochaetium porphyrae</i>	--	H	--	--	--
<i>Agardhiella tenera</i>	L	--	--	--	--
<i>Bossiella</i> sp. ²	L	HML	HML	--	M
<i>Botryoglossum farlowianum</i>	--	L	--	--	--
<i>Calliarthron</i> sp.	--	M	--	--	--
<i>Callithamnionpikaenum</i>	--	H	--	L	--
<i>Centroceras clavulatum</i>	--	--	--	M	--
<i>Ceramium eatonium</i>	--	M	HM	M	--
<i>Corallina chilensis</i>	L*LL*	HM	HML	--	--
<i>C. vancouveriensis</i>	--	--	M	M*L*	M
<i>Cryptopleura</i> sp. ³	L*LL*	H	--	L*	--
<i>Cumagloia andersonii</i>	H*	--	--	H*	--

TABLE 2 (Page 2)

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
<i>Farlowia mollis</i>	L*	L	--	L	L
<i>Gastroclonium coulteri</i>	L*	ML	HML	--	--
<i>Gelidium coulteri</i>	--	H	HM	ML	--
<i>G. purpurescens</i>	--	HML	L	L	--
<i>G. robustum</i>	--	--	--	L	--
<i>Gelidicolax microphaerica</i>					
	--	--	H	--	--
<i>Gigartina agardhii</i>	--	H	--	--	--
<i>G. boryi</i>	--	M	--	--	--
<i>G. californica</i>	L	--	--	--	--
<i>G. canaliculata</i>	--	H	HML	L	--
<i>G. harveyana</i>	LL	--	--	--	--
<i>G. leptorhynchus</i>	--	H	--	--	--
<i>G. papillata</i>	--	H	HML	HL	ML
<i>G. volans</i>	--	ML	--	--	--
<i>Gracilaria sjoestidii</i>	--	M	--	--	--
<i>G. verrucosa</i>	L	--	--	--	--
<i>G. doryphora</i> **	L*LL*	LM	--	--	--
<i>Gymnongongrus linearis</i>	--	HM	--	--	--
<i>Halosaccion glandiforme</i>	--	ML	--	--	L
<i>Iridaea c. cordata</i>	L	M	--	--	--
<i>I. c. splendens</i>	LL	HML	L	M*L*	--
<i>I. flaccida</i>	L*	HM	HML	--	--
<i>Laurencia spectabilis</i>	--	HM	--	L	--
<i>Lithothamnion sp.</i>	LL*	--	--	--	--
<i>Microcladia borealis</i>	--	--	M	--	--
<i>M. coulteri</i>	L	L	--	--	--
<i>Odonthalia floccosa</i>	--	--	--	M*L*	--
<i>Petrocelis sp.</i>	--	HM	HM	--	--
<i>Peysoneilia sp.</i>	LL*	--	--	--	--
<i>Plocamium pacificum</i>	L	ML	L	L*	L
<i>Plocamiocolax pulvinata</i>	--	--	--	--	L
<i>Polysiphonia hendryi</i>	--	ML	H	--	--
<i>P. paniculata</i>	--	ML	--	--	--
<i>Porphyra lanceolata</i>	L	--	H	H	--
<i>P. perforata</i>	H*L	H	ML	H*M*	M
<i>Prionitis andersonii</i>	LL	--	--	--	--
<i>P. lanceolata</i>	--	HML	L	M*L*	ML
<i>P. linearis</i>	--	L	--	--	--
<i>P. lyallii</i>	L*	HM	ML	--	--
<i>Pterosiphonia bipinata</i>	--	--	--	HL	--
<i>P. dendroidea</i>	L	L	HM	L*	--
<i>Ptilota filicina</i>	--	--	--	L	--
<i>P. hypnoides</i>	L*	--	--	--	--
<i>Rhodoglossum americanum</i>	L	--	--	--	--
<i>Rhodomela tarix</i>	--	HM	ML	L*	--
<i>Smithora naiadum</i>	L	L	L	L*	L

***Grateloupia doryphora*

TABLE 2 (Page 3)

Symbols: H = high; M = mid; L = low; LL = low-low (Soquel only); * = found in m² quadrats.

	Soquel Point	Santa Cruz Point-East	Santa Cruz Point-West	Almar Street	Natural Bridges
ANGIOSPERMAE					
<i>Phyllospadix torreyi</i>	L*	L	ML	L*	L
Total species (89)	41	55	39	38	20
Total found in quadrats	23(56%)	--	--	20(53%)	--

Plant footnotes:

¹Includes *U. expansa* and *U. rigida* at Santa Cruz Point-East and *U. lobata* at Santa Cruz Point-West; these species were not distinguished in the winter surveys at Soquel Point, Almar Street or Natural Bridges, but *U. expansa* and *U. lobata* were recorded at Soquel Point and *U. lobata* and *U. rigida* were recorded at Almar Street in the fall survey.

²Includes *B. corymbifera* and *B. dichotoma* at Santa Cruz Point East and West and *B. plumosa* at Santa Cruz Point-West; these species were not distinguished at Soquel Point, Almar Street or Natural Bridges in the winter surveys, but *B. dichotoma* and *B. plumosa* were recorded at Soquel Point and Almar Street in the fall survey.

³*C. violacea* only at Santa Cruz Point-East; the species were not distinguished at Soquel Point or Almar Street in the winter surveys, but *C. lobulifera* and *C. violacea* were recorded at Soquel Point and *C. brevis* was recorded at Almar Street in the fall survey.

TABLE 3
 Area Comparison
 Animals

<u>Compared areas</u>	<u>Total No. of Species in the two areas</u>	<u>No. of species in common</u>	<u>% of species in common</u>
Santa Cruz Point-East: Santa Cruz Point-West	80	37	46%
Natural Bridges: Santa Cruz Point-East	100	44	45%
Natural Bridges: Almar Street	87	39	45%
Natural Bridges: Santa Cruz Point-West	89	37	42%
Santa Cruz Point-West: Almar Street	72	28	40%
Soquel Point: Natural Bridges	90	35	39%
Soquel Point: Santa Cruz Point-West	73	27	37%
Soquel Point: Almar Street	77	28	36%
Soquel Point: Santa Cruz Point-East	86	31	36%
Santa Cruz Point-East: Almar Street	89	30	34%

TABLE 4

NUMBER OF SPECIES FOUND IN DIFFERENT AREAS

<u>Total Species</u>	<u>Plants*</u>	<u>Animals</u>
In all five areas	6 (7%)	19 (15%)
In only four areas	9 (10%)	12 (9%)
In only three areas	14 (16%)	18 (15%)
In only two areas	14 (16%)	27 (22%)
In only one area	43 (50%)	48 (39%)
	<u>86</u>	<u>123</u>

*Not including species of Ulva, Bossiella and Cryptopleura

TABLE 5

NUMBER OF SPECIES FOUND IN ONLY ONE AREA

<u>Site</u>	<u>Plants</u>	<u>Animals</u>
Soquel Point	10	6
Santa Cruz Point-East	15	13
Santa Cruz Point-West	3	6
Almar Street	9	6
Natural Bridges	3	16

TABLE 6
 FALL-WINTER COMPARISON
 SOQUEL POINT-ALMAR STREET
 TOTAL SPECIES

Animals

	<u>Total Found</u>	<u>Total in Fall</u>	<u>Total in Winter</u>	<u>Total Found in Both Seasons</u>
Total Found	99	80	77	86 (97%)
Total at Soquel Point	68	54	53	35 (51%)
Total at Almar Street	64	45	52	31 (48%)
Total found in both areas	34 (35%)	25 (31%)	28 (36%)	20 (59%) (21%)

Plants

Total Found	78	69	62	53 (68%)
Total at Soquel Point	61	49	41	31 (51%)
Total at Almar Street	53	48	38	30 (57%)
Total found in both areas	42 (54%)	28 (41%)	17 (28%)	11 (26%) (21%)

TABLE 7
 FALL-WINTER COMPARISON
 SOQUEL POINT-ALMAR STREET
 SPECIES FOUND IN QUADRATS*

	<u>Animals</u>			
	<u>Total Found</u>	<u>Total in Fall</u>	<u>Total in Winter</u>	<u>Total Found in Both Seasons</u>
Total Found	51	39	42	28 (55%)
Total at Soquel Point	38	31	28	19 (50%)
Total at Almar Street	26	20	27	18 (69%)
Total found in both areas	15 (29%)	14 (36%)	13 (31%)	5 (33%) (18%)

	<u>Plants</u>			
Total Found	49	37	35	20 (41%)
Total at Soquel Point	32	23	24	17 (53%)
Total at Almar Street	33	28	20	19 (58%)
Total found in both areas	24 (49%)	14 (38%)	11 (31%)	8 (33%) (40%)

*7 m² quadrats at Soquel Point (the 57' quadrat excluded); 6 m² quadrats at Almar Street

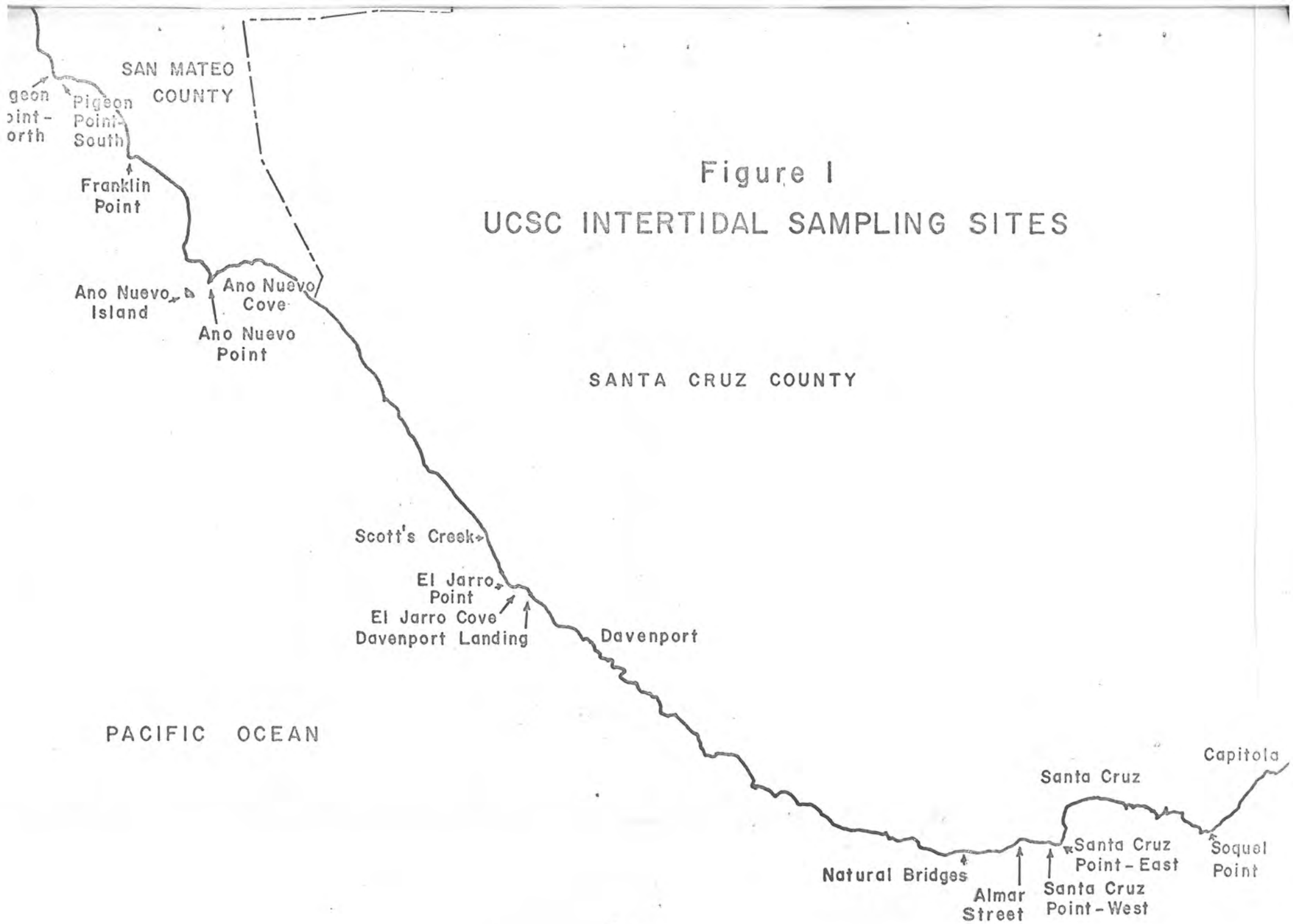


Figure 1
UCSC INTERTIDAL SAMPLING SITES

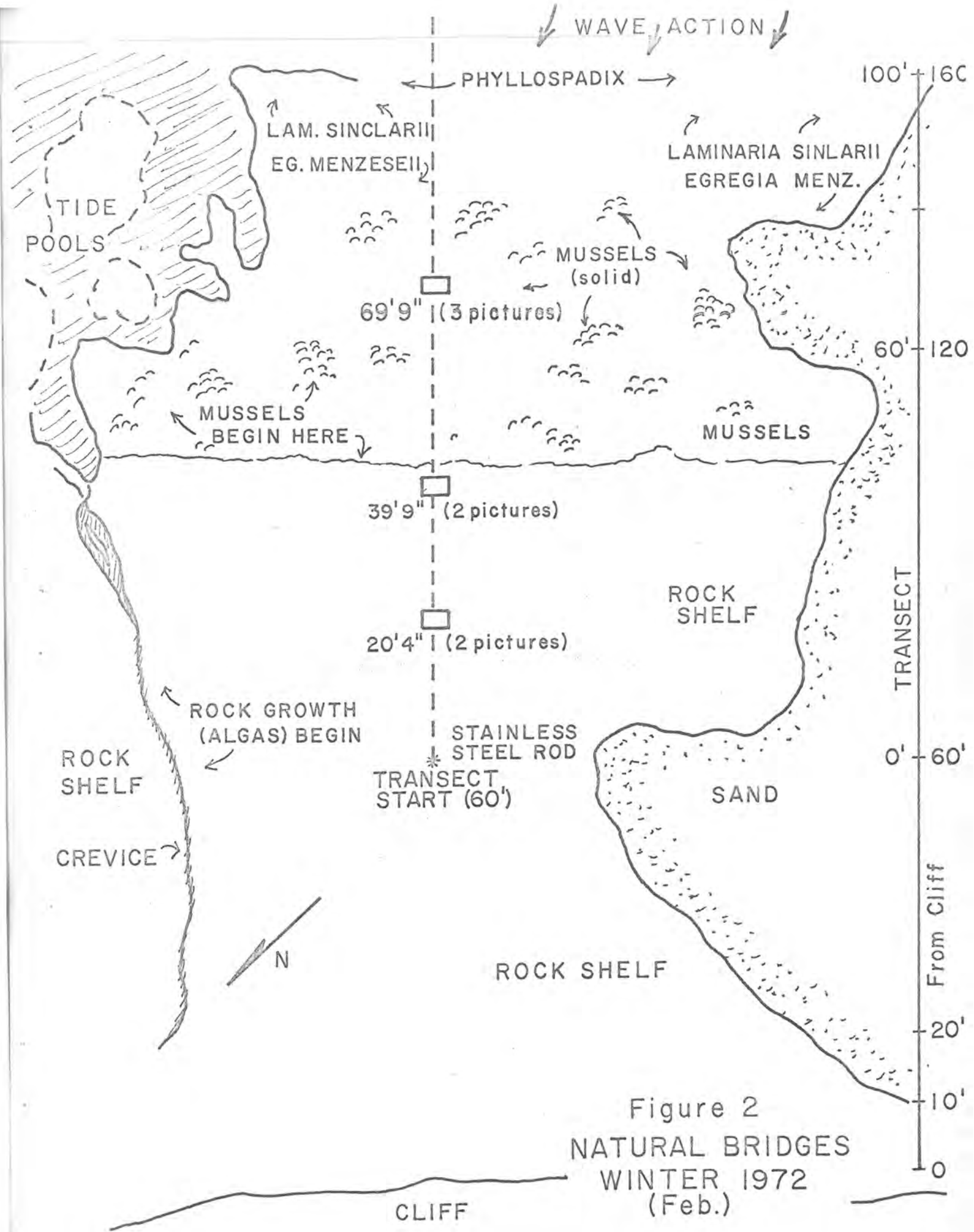
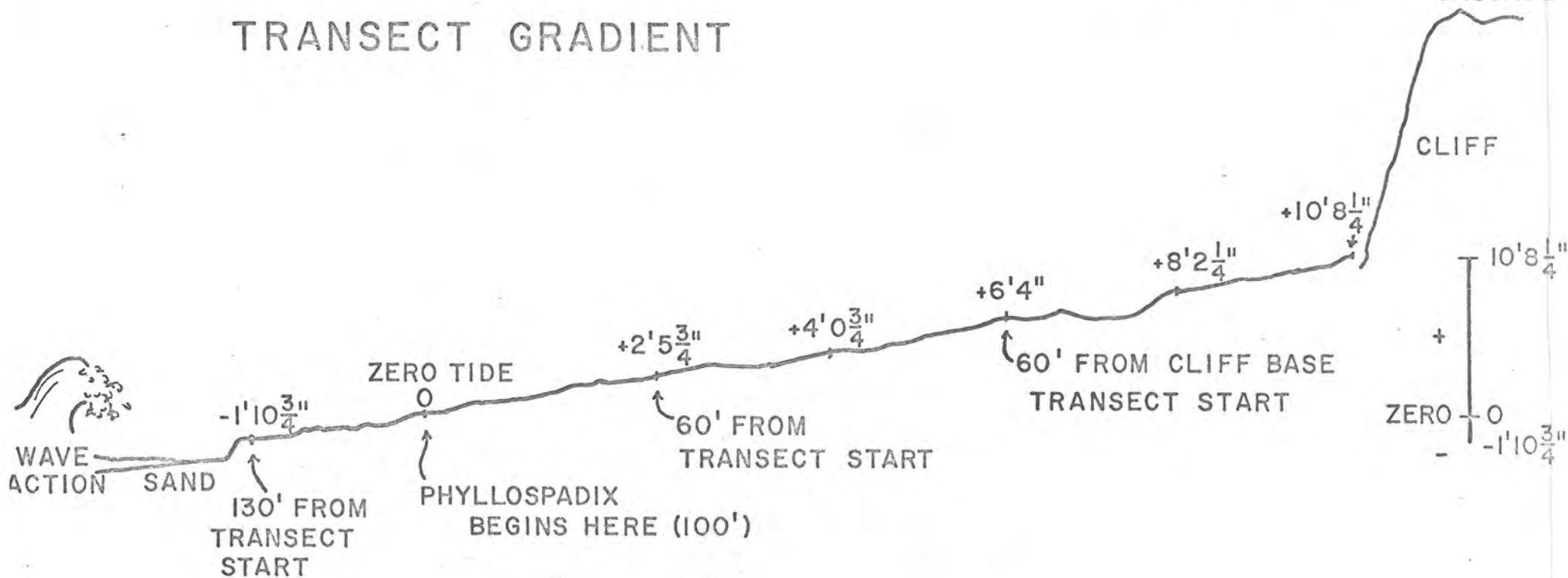


Figure 3
 NATURAL BRIDGES
 TRANSECT GRADIENT

WINTER 1972

BOISE
 CASCADE



12'7" = DEPTH FROM CLIFF BASE
 TO TRANSECT END

ALL MEASUREMENTS ARE ACCURATE
 TO + 1" DEPENDING ON WHETHER THE
 SCALE WAS IN A CREVICE OR NOT

Figure 4
EAST TRANSECT

SCALE IN FEET
0 20 40 60



MONTEREY BAY

↑ 110° (Toward Moss Landing
P.G. & E. power plant stacks)

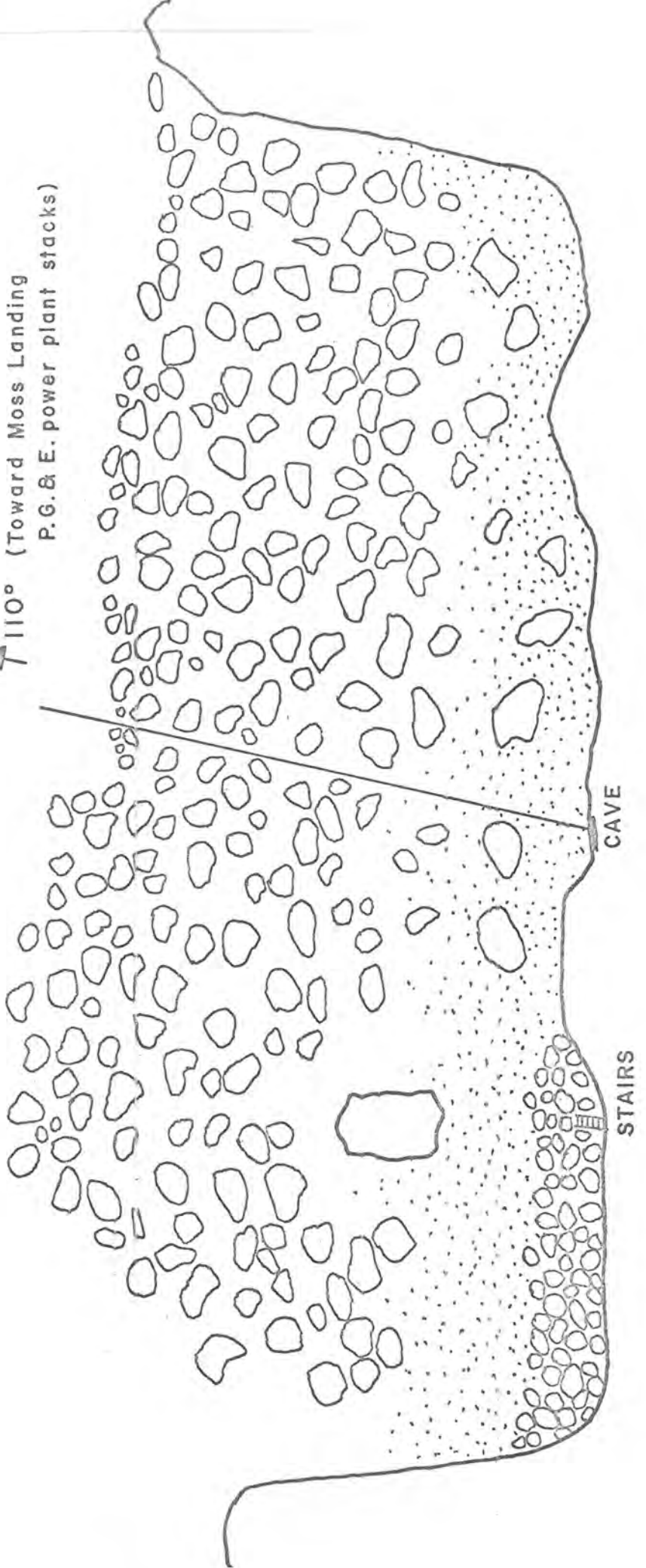


Figure 5

EAST TRANSECT PROFILE

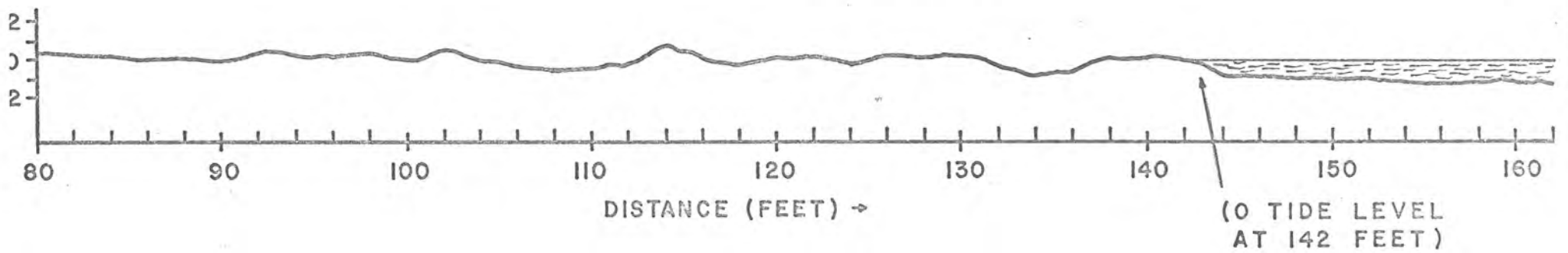
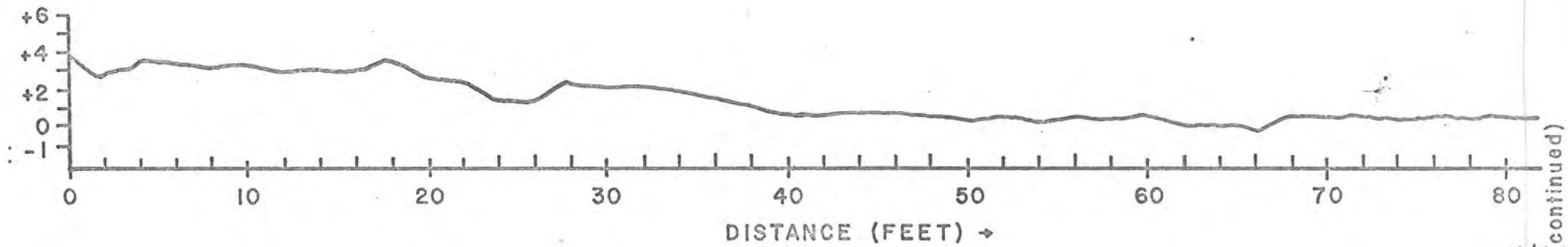
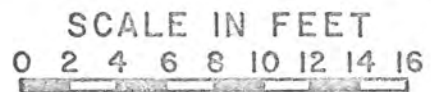
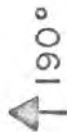


Figure 6
WEST TRANSECT

SCALE IN FEET
0 20 40 60 80



OPEN SEA

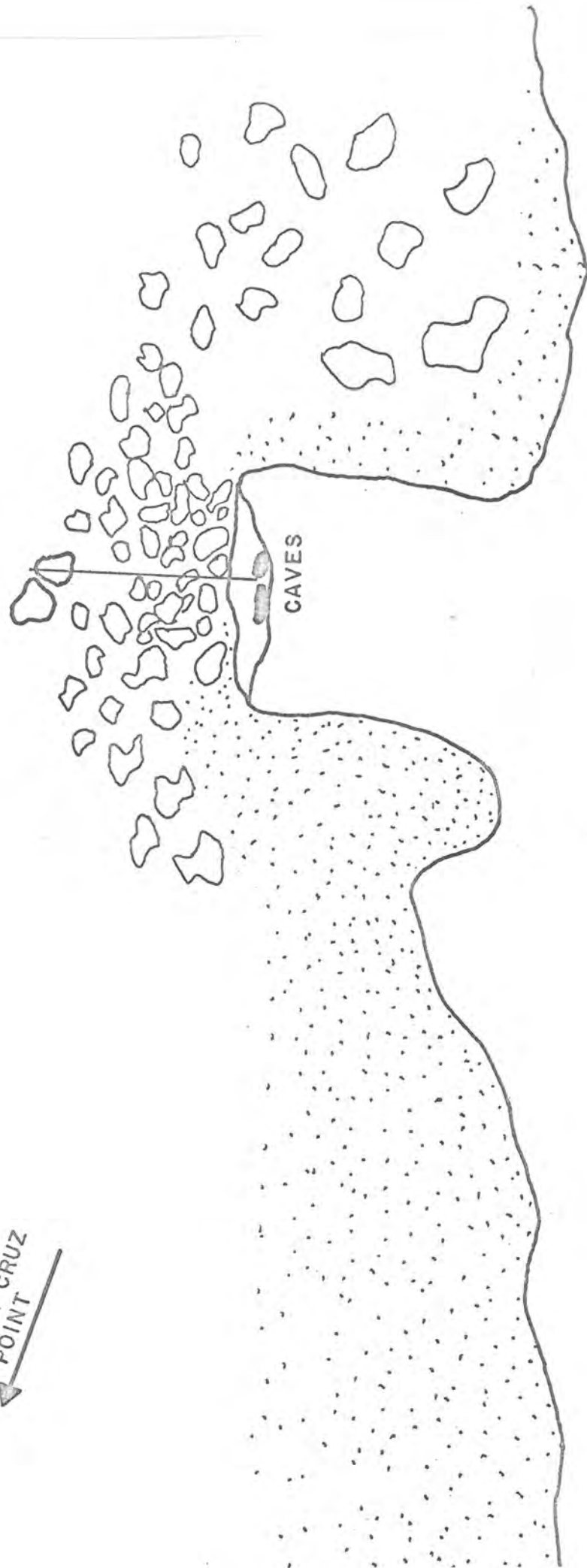
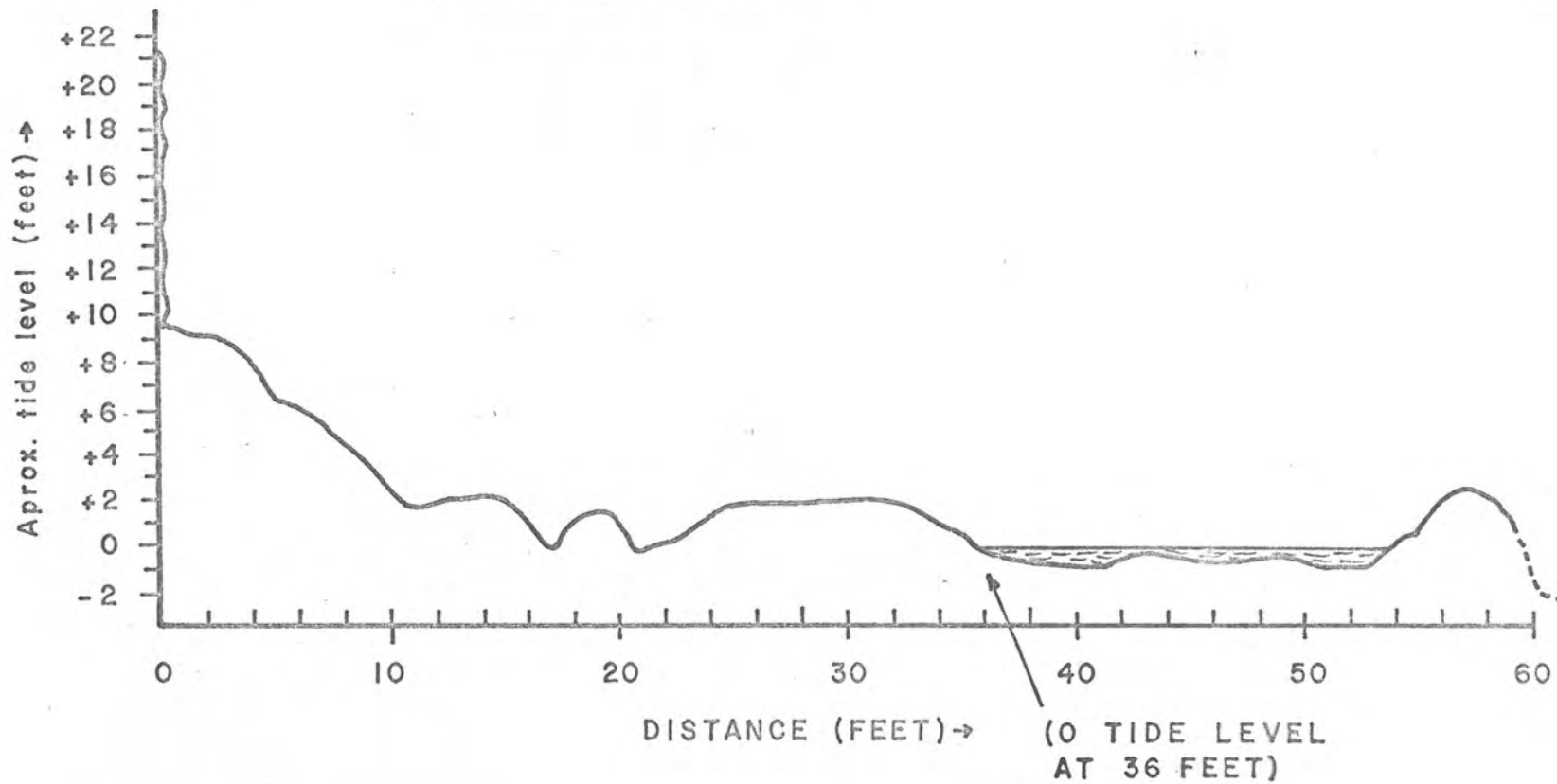


Figure 7
WEST TRANSECT PROFILE

SCALE IN FEET
0 2 4 6 8 10 12 14 16



INTERTIDAL TRANSECT STUDIES OF NORTHERN MONTEREY BAY

Third Quarterly Report

April - June 1972

Submitted to: Association of the Monterey Bay Area Governments

Attn: Mr. Leslie L. Doolittle

Principle Investigators: Dr. William T. Doyle and Dr. John S. Pearse

July 25, 1972

This is the third quarterly report for the 10/22/71 dated contract between the Association of the Monterey Bay Area Governments and the University of California, Santa Cruz. The five transect areas established in the region of the City of Santa Cruz during the first and second quarters were all re-visited in April and May, and the species in the quadrats and in the general area were recorded. In addition, the transects established on the open ocean coast north of Santa Cruz, as indicated in Figure 1 of the Second Quarterly Report, were re-studied in April and May. A new transect, on the open coast of Monterey County, near Lucia, was established in June 1972; this area is far removed from the San Francisco and Monterey Bay regions, and may be useful in distinguishing widespread biotic changes from more localized changes.

During the summer of 1972 we have engaged four undergraduate students, and two graduate students to thoroughly check our voucher specimens and records for correct identification and recording. Mr. James T. Carlton of the California Academy of Sciences has agreed to aid in the identification of the animals, while Dr. Isabella Abbott continues to aid in the identification of the plants.

This interim report lists in Tables 1 and 2, the species recorded at the five sites in the region of Santa Cruz City with respect to tidal zone and season. The species are listed by taxonomic grouping and arranged to show possible distributional patterns. For many groups, there are more species at Soquel Point than elsewhere; this may be due to the more extensive and wider low intertidal at Soquel Point than elsewhere. Only the Porifera (sponges) and Tunicata (sea squirts) show an obvious pattern of distribution, with an increase in number of species occurring from Soquel Point to Natural Bridges. Both of these groups are filter feeding animals and they may be especially sensitive to water conditions.

The obviously polluted area in the Soquel Point transect (the "low-low" of the first and second quarterly reports) is kept distinct and the species found there are marked with an asterisk. Although the stunted and deformed plants indicate that the area is affected by the nearby East Cliff sewage discharge, numerous species were still found in this area.

A more thorough analysis of our species listing, as well as analyses of our quantitative data, will be given in the final report to be completed in the Fall of 1972. That report will include the data collected from our other study areas, and hopefully will indicate more clearly similarities and differences among the different study areas.

TABLE 1

ANIMALS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
PROTOZOA						
<i>Gromia oviformis</i>	L	--	--	--	--	S
PORIFERA						
<i>Cliona celata</i>	ML	--	WS	S	W	W
<i>Haliclona permolis</i>	HML	--	WS	WS	W	WS
<i>Haliclona</i> sp.	HML	--	W	W	FWS	WS
<i>Ophlitaspongia pennata</i>	HML	--	WS	WS	--	S
<i>Rhabdodermella nuttinga</i>	ML	--	WS	S	--	WS
<i>Aplysilla graciolis</i>	L	--	--	WS	FWS	WS
<i>Lissodendoryx noxiosa</i>	L	--	--	WS	F	S
<i>Leucosolenia eleanor</i>	L	--	--	S	--	S
<i>Esperiopsis originalis</i>	ML	--	--	--	F	S
<i>Choanites subera</i>	ML	S	--	--	F	S
<i>Adocia gellindea</i>	L	--	S	--	F	S
<i>Craniella arb</i>	L	--	W	--	--	--
<i>Leuconia heathi</i>	L	--	--	--	S	--
<i>Acarus erithacus</i>	L	--	--	--	--	S
<i>Halichondria panicea</i>	ML	--	--	--	--	S
Total (15)		1	7	8	9	13
CNIDARIA						
<i>Abietenaria</i> spp.	LP	WS*	S	S	WS	S
<i>Aglaophenia</i> sp.	MLP	S*	S	WS	FWS	WS
<i>Anthopleura elegantissima</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Anthopleura artemesia</i>	HMLP	FWS*	WS	WS	--	WS
<i>Epiactis prolifera</i>	MLP	FWS*	WS	W	--	WS
<i>Anthopleura xanthogrammica</i>	HML	--	WS	WS	FWS	WS
<i>Sertularia</i> sp.	L	--	WS	S	W	--
<i>Tealia lofotensis</i>	L	--	W	--	--	--
<i>Plumularia</i> sp.	L	--	--	--	F	--
Total (9)		5	8	7	6	6
PLATYHELMINTHES						
<i>Notoplana</i> sp.	HMP	WS*	W	--	--	WS
NEMERTINEA						
<i>Paranemertes peregrina</i>	HML	S	WS	WS	FWS	S
<i>Emplectonema grocile</i>	HML	--	W	--	WS	S
White unidentified	ML	S	--	--	WS	WS
<i>Cerebratulus californiensis</i>	L	S	--	--	--	--
Total (4)		3	2	1	3	3
SIPUNCULOIDEA						
<i>Dendrostomum pyroides</i>	HML	S	WS	S	--	--
<i>Phascolosoma agassizii</i>	MLP	S*	--	--	--	W
<i>Dendrostomum dyscritum</i>	L	S	--	--	--	--
Total (3)		3	1	1	0	1

TABLE 1 (page 2)

ANIMALS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
ANNELIDA						
<i>Phragmatopoma californica</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Serpula</i> sp.	HML	FS	WS	WS	S	WS
<i>Cirriformia spirabranhia</i>	HML	FWS	S	--	FW	WS
<i>Nereis</i> spp.	ML	F	W	--	WS	--
Spionidae	H	WS	--	--	WS	--
<i>Halosydna brevisetosa</i>	ML	S	--	--	--	W
<i>Nainereis dendritica</i>	L	S	--	--	--	S
<i>Arabella semimaculata</i>	L	S	--	--	--	--
<i>Arctonë</i> sp.	L	S	--	--	--	--
<i>Harmothoë</i> sp.	L	S	--	--	--	--
<i>Hemipodus borealis</i>	L	S	--	--	--	--
<i>Lumbrinereis zonata</i>	L	S	--	--	--	--
<i>Hydroides</i> sp.	L	S	--	--	--	--
<i>Nereis grubei</i>	L	F	--	--	--	--
<i>Platynereis agassizii</i>	LP	FWS*	--	--	--	--
<i>Stylarioides papillata</i>	LL	W	--	--	--	--
<i>Eteone pacifica</i>	L	--	S	--	--	--
<i>Trypanosyllis adamanteus</i>	H	--	W	--	--	--
<i>Eudistylia polymorpha</i>	HM	--	--	WS	--	S
<i>Cirriformia luxuriosa</i>	HM	--	--	--	FWS	WS
<i>Dodecaceria</i> sp.	ML	--	--	--	W	WS
<i>Thelepus crispus</i>	L	--	--	--	F	WS
<i>Amaea occidentalis</i>	L	--	--	--	--	W
<i>Salmacina</i> sp.	L	--	--	--	--	WS
<i>Nereis vexillosa</i>	M	--	--	--	--	W
Total (25)		16	6	3	8	12
MOLLUSCA AMPHINEURA						
<i>Mopalia mucosa</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Nuttalina californica</i>	HML	WS	WS	WS	FWS	WS
<i>Cyanoplax dentiens</i>	ML	WS	S	WS	--	--
<i>Mopalia hindsii</i>	MLP	S*	WS	WS	--	S
<i>Mopalia lignosa</i>	L	S	--	--	--	--
<i>Mopalia ciliata</i>	MLP	FWS*	--	--	FW	WS
<i>Tonicella lineata</i>	HL	--	WS	--	--	W
<i>Chaetopleura gemma</i>	L	--	--	--	--	S
Total (8)		6	5	4	3	6
MOLLUSCA PELYCEPODA						
<i>Mytilus edulis</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Mytilus californianus</i>	HML	FWS	WS	WS	FWS	WS
<i>Hiatella arctica</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Platydon cancellatus</i>	HML	W	--	--	WS	S
<i>Protothaca staminea</i>	L	S	--	--	--	S
<i>Glans carpenteri</i>	L	S	--	--	--	--
<i>Pholadidea penita</i>	L	S	--	--	--	--
<i>Petricola denticulata</i>	H	S	--	--	--	--
<i>Hinnites multirugosus</i>	P	F*	--	--	--	--

TABLE 1 (page 3)

ANIMALS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
MOLLUSCA PELYCEPODA (Cont'd)						
"Lucina" sp. (?)	L	--	--	--	W	--
Total (10)		9	3	3	5	5
MOLLUSCA GASTROPODA (limpets)						
Collisella digitalis	HMLP	FWS*	WS	WS	FWS	WS
Notoacmea inessa	HML	FS	WS	WS	WS	WS
Notoacmea paleacea	HML	FWS	WS	WS	S	WS
Collisella pelta	HMLP	FWS*	WS	WS	FWS	WS
Collisella scabra	HMLP	FWS*	WS	WS	FWS	WS
Notoacmea scutum	HMLP	FWS*	WS	WS	S	S
Collisella asmi	HMLP	FWS*	WS	--	WS	WS
Notoacmea instabilis	P	F*	--	--	--	--
Crepidula adunca	LP	FWS*	WS	--	--	--
Notoacmea persona	HML	W	--	WS	--	W
Lottia gigantea	HM	--	S	WS	--	WS
Notoacmea fenestrata	M	--	--	W	--	--
Collisella limatula	M	--	--	W	S	--
Trimusculus reticulatus	M	--	--	--	WS	WS
Megatebennus bimaculatus	M	--	--	--	--	S
Total (15)		10	9	10	9	11
MOLLUSCA GASTROPODA (snails)						
Lacuna sp.	HMLP	FWS*	WS	WS	FWS	WS
Littorina planaxis	H	FS	WS	WS	W	WS
Littorina scutulata	HM	FWS	WS	WS	FWS	WS
Tegula funebris	HMLP	FWS*	WS	WS	FWS	WS
Thais emarginata	HMLP	FWS*	WS	WS	FWS	WS
Mitrella sp.	HLP	FWS	WS	--	--	WS
Tegula brunnea	HMLP	FWS*	WS	S	--	S
Acanthina spirata	ML	WS	--	--	W	WS
Olivella biplicata	L	FWS	--	--	--	--
Amphissa sp.	HP	WS*	--	--	--	--
Epitonium sp.	HL	FS	--	--	--	--
Tegula montereyi	HL	FS	--	--	--	--
Cardita carpenteri	L	--	W	--	--	--
Calliostoma canaliculatum	H	--	W	--	--	--
Calliostoma ligatum	L	--	W	--	--	--
Thais canaliculata	ML	--	--	--	W	--
Haliotis cracherodii	ML	--	--	--	--	W
Total (17)		12	10	6	7	9
MOLLUSCA GASTROPODA (slugs)						
Hermisenda crassicornis	P	FW*	--	--	--	--
Dialula sandiegensis	ML	--	W	S	--	WS
Oncidiella sp.	HM	--	W	--	--	WS
Coryphella tritineata	L	--	S	--	--	S
Aeolida papillosa	M	--	--	--	W	S
Archidoris montereyensis	M	--	--	--	FW	S
Total (6)		1	3	1	2	5

TABLE 1 (page 4)

ANIMALS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
ARTHROPODA CIRRIPIEDIA						
Balanus glandula	HMLP	FWS*	WS	WS	FWS	WS
Chthamalus sp.	HMLP	FWS*	WS	WS	FWS	WS
Pollicipes polymerus	HML	FWS	WS	WS	FWS	WS
Tetraclita squamosa	HML	--	WS	--	S	WS
Balanus crenatus	L	S	--	--	--	S
Balanus tintinnabulum	L	--	--	--	F	--
Balanus improvisus	L	--	--	--	--	S
Total (7)		4	4	3	5	6
ARTHROPODA PERICARIDA						
Idothea stenops	ML	S	WS	WS	S	S
Idothea montereyensis	ML	S	S	WS	S	WS
Ligia occidentalis	H	FS	WS	WS	--	WS
Gammarids (spp.)	HML	--?	WS	WS	W	WS
Cirolana harfordi	HLP	WS *	--	--	--	--
"Dynamene" dilatata	L	S	--	--	--	--
Porcellio scaber	H	S	--	--	--	S
Neosphaeroma oregonensis	H	--	--	--	S	--
Idothea fewski	L	--	--	--	W	--
Idothea wosnesenskii	M	--	--	--	S	S
Tecticeps convexus	M	--	--	--	S	--
Ligia pallasii	H	--	--	--	--	S
Total (13)		6	4	4	8	7
ARTHROPODA EUCARIDA						
Pachygrapsus crassipes	HML	FWS	WS	WS	WS	WS
Pagurus hirsutiusculus	HMLP	FWS *	WS	WS	--	W
Pugettia producta	LP	FWS *	WS	S	--	--
Pagurus samuelis	MLP	F *	S	S	--	--
Cancer antennarius	MLP	WS *	--	S	--	WS
Pugettia gracilis	L	FW	--	--	F	WS
Spirontocaris sp.	L	S	S	--	--	--
Cancer jordani	L	F	--	--	--	--
Pagurus granosimanus	L	W	--	--	--	--
Pachycheles pubescens	ML	--	--	--	--	WS
Petrolisthes cinctipes	M	--	--	--	--	WS
Total (11)		9	5	5	2	6
ARTHROPODA (Miscellaneous)						
Red mites	HM	WS	WS	--	--	WS
Pycnogonum stearnsi	HL	--	--	W	F	--
Trigiopus californica	H	--	--	--	--	WS
Collembolans	H	--	--	--	--	WS
Total (4)		1	1	1	1	3

TABLE 1 (page 5)

ANIMALS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
BRYOZOA (Very incomplete)						
Bugula sp.	L	W	WS	--	--	--
Membranipora tuberculata	ML	--	WS	S	--	--
Eurystomella bilabiata	L	--	S	--	--	--
Rock encrusting	L	--	S	S	--	--
Algae encrusting	L	--	S	--	--	--
Tricillaria occidentalis	L	W	--	--	--	S
Barentsia sp.	L	--	--	--	--	WS
Total (7)		2	5	2	--	2
ECHINODERMATA						
Pisaster ochraceus	HMLP	FWS *	WS	WS	FWS	WS
Pisaster brevispinus	HML	F	WS	--	F	S
Strongylocentrotus purpuratus	HMLP	WS *	--	W	W	WS
Patiria miniata	ML	F	W	--	--	--
Cucumaria sp.	L	F	W	--	--	--
Henricia leviuscula	L	F	--	--	--	--
Ophiothrix spiculata	L	S	--	--	--	--
Pycnopodia helianthoides	L	--	W	--	--	--
Total (8)		7	4	2	3	3
CHORDATA TUNICATA						
Ascidia ceratodes	L	F	--	--	--	--
Diplosoma pizoni	L	W	WS	--	--	--
Styela montereyensis	L	F	WS	WS	W	S
Amaroucium californicum	ML	--	S	S	W	WS
Eudistoma psammion	ML	--	WS	WS	FWS	WS
Clavulina huntsmani	L	--	S	S	--	S
Distaplia occidentalis	ML	--	WS	S	--	WS
Euherdmania claviformis	L	--	WS	W	--	S
Cystodytes lobatus	L	--	S?	--	--	S
Perophora annectons	L	--	--	--	--	WS
Pyura haustor	L	--	--	--	--	WS
Styela tunicata	L	--	--	--	--	W
Total (12)		3	8	6	3	10
VERTEBRATA (Incomplete)						
Clinocottus sp.	HML	--?	S	S	--	X?
Rimicola eigenmanni	L	F	--	--	--	--
Epigeichthys atro-purpureus	L	--	S	--	--	--
Total (3)		1	2	1	0	1?
Total Species (179)		92	88	69	75	111

TABLE 2

PLANTS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
CHLOROPHYTA						
Bryopsis corticulans	HMLP	FWS*	WS	S	FS	S
Cladophora trichotoma	HML	FWS	W	W	FWS	WS
Enteromorpha compressa	HMLP	S	W	WS	S	S
Ulva linza	HMLP	FWS*	S	S	FWS	WS
Ulva rigida	HML	FS	S	S	FS	S
Cladophora ovidea	HML	S	WS	--	S	S
Enteromorpha intestinalis	HMLP	FWS*	S	--	FWS	WS
Rhizoclonium riparium	HMLP	W*	S	S	S	--
Ulva lobata	HML	FWS	S	--	FS	WS
Chaetomorpha aerea	HM	F	--	S	FWS	--
Ulva expansa	MLP	FWS*	S	--	--	W
Ulva taeniata	HMLP	WS*	WS	--	W	--
Enteromorpha clathrata	HP	S*	--	--	S	--
Cladophora stimsonii	H	--	--	--	--	S
Collinsiella tuberculata	H	--	--	--	S	--
Enteromorpha prolifera	H	--	--	--	S	--
Monostroma zostericola	L	S	--	--	--	--
Codium setchellii	M	--	--	W	--	--
Spongomorpha coalita	M	--	S	--	--	--
Ulva californica	M	--	--	--	W	--
Total (20)		14	12	8	15	10
PHAEOPHYTA						
Laminaria sinclairii	MLP	S*	WS	W	FWS	WS
Scytosiphon dotyi	HMP	FWS*	W	WS	FWS	WS
Egregia menziesii	ML	--	W	W	FWS	WS
Laminaria setchellii	LP	FWS*	S	--	FWS	S
Petrospongium rugosum	HM	S	--	S	FS	WS
Phaeostrophion irregulare	HML	S	WS	--	S	S
Analipus japonica	HML	--	--	S	S	WS
Cystoseira osmundacea	LP	FWS	WS	--	--	S
Ectocarpus sp.	MLP	FWS*	--	--	FWS	S
Egregia laevigata	HMLP	FWS*	WS	WS	--	--
subsp. borealis						
Macrocystis pyrifera	ML	--	W	W	F	--
Ralfsia pacifica	HMLP	FWS*	--	--	FWS	WS
Laminaria groenlandica	LP	FW*	--	--	F	--
Leathesia difformis	HML	S	--	--	FS	--
Macrocystis integrifolia	LP	FWS*	--	--	--	W
Pelvetia fastigiata	H	--	--	--	FWS	WS
Pelvetiopsis limitata	H	--	--	--	FWS	S
Petalonia debilis	HM	F	--	--	F	--
Pterygophora californica	LP	S*	--	--	--	S
Scytosiphon lomentaria	HM	--	--	--	S	WS
Alaria marginata	L	--	W	--	--	--
Haplogloeia andersonii	HML	--	--	--	--	S
Petalonia fascia	HM	--	--	--	S	--
Total (23)		14	9	7	17	16

TABLE 2 (page 2)

PLANTS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
RHODOPHYTA						
<i>Bossiella chilensis</i>	MLP	S*	S	S	S	S
<i>Corallina vancouverensis</i>	HML	S	S	WS	FWS	WS
<i>Gastroclonium coulteri</i>	HMLP	FWS*	WS	WS	FS	S
<i>Gelidium coulteri</i>	HMLP	FS*	WS	WS	FWS	WS
<i>Gelidium purpurascens</i>	HMLP	S*	W	WS	FWS	S
<i>Gigartina canaliculata</i>	HML	S	WS	WS	FWS	S
<i>Gigartina papillata</i>	HMLP	FS*	WS	WS	FWS	WS
<i>Iridaea splendens</i>	HMLP	FWS*	WS	WS	FWS	WS
<i>Iridaea flaccida</i>	HMLP	FWS*	WS	WS	FS	WS
<i>Plocamium coccineum</i> v. <i>pacificum</i>	MLP	FWS*	WS	WS	FW	WS
<i>Polysiphonia paniculata</i>	HML	FS	WS	S	FS	S
<i>Porphyra lanceolata</i>	HL	WS	S	WS	WS	S
<i>Porphyra perforata</i>	HML	FWS	WS	WS	FWS	WS
<i>Prionitis andersonii</i>	MLP	FWS*	S	S	S	S
<i>Prionitis lanceolata</i>	HML	FS	WS	WS	FWS	WS
<i>Pterosiphonia dendroidea</i>	HML	WS	WS	WS	FWS	S
<i>Smithora naiadum</i>	LP	FWS*	W	WS	FWS	WS
<i>Bossiella orbigniana</i>	HMLP	FWS*	--	S	F	S
<i>Bossiella plumosa</i>	ML	FS	--	S	F	WS
<i>Ceramium eatonium</i>	HM	--	W	W	WS	S
<i>Corallina chilensis</i>	HMLP	FWS*	WS	W	FWS	--
<i>Farlowia mollis</i>	HML	W	W	--	WS	WS
<i>Laurencia spectabilis</i>	HML	S	WS	--	FWS	S
<i>Polysiphonia hendryi</i>	HML	--	W	W	S	S
<i>Polysiphonia pacifica</i>	ML	S	S	S	--	S
<i>Prionitis lyallii</i>	HML	W	W	W	W	--
<i>Rhodomela larix</i>	HML	--	WS	WS	FWS	S
<i>Bossiella californica</i>	LP	S*	--	--	S	S
<i>Centroceros clavulatum</i>	HM	--	S	--	WS	S
<i>Cryptopleura corallinara</i>	MLP	S*	--	--	S	S
<i>Cryptopleura lobulifera</i>	MLP	FW*	--	--	FS	S
<i>Cryptopleura violacea</i>	MLP	FS*	--	--	S	S
<i>Cumagloia andersonii</i>	HM	FWS	--	S	FWS	--
<i>Gigartina agardhii</i>	HMLP	S*	WS	--	W	--
<i>Gracilaria verrucosa</i>	HML	FWS	WS	--	S	--
<i>Grateloupia doryphora</i>	MLP	FWS*	W	--	--	S
<i>Iridaea heterocarpum</i>	HML	--	S	--	FS	S
<i>Microcladia borealis</i>	HML	--	--	WS	S	S
<i>Prionitis linearis</i>	L	--	W	S	S	--
<i>Pterosiphonia bipinnata</i>	HMLP	FS*	--	--	WS	S
<i>Rhodoglossum affine</i>	HMLP	S*	--	--	F	S
<i>Schizymenia pacifica</i>	LP	S*	--	--	S	S
<i>Acrochaetium porphyrae</i>	HM	--	W	--	F	--
<i>Agardhiella tenera</i>	L	WS	--	--	--	S

TABLE 2 (page 3)

PLANTS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

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PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
RHODOPHYTA (Cont'd)						
<i>Botryoglossum farlowianum</i>	L	F	W	--	--	--
<i>Calliarthron cheilosporioides</i>	ML	--	W	--	--	W
<i>Callithamnion pikeanum</i>	HL	--	W	--	W	--
<i>Cryptosiphonea woodii</i>	HL	S	--	--	--	S
<i>Gigartina volans</i>	MLP	FS*	WS	--	--	--
<i>Gymnogongrus leptophyllus</i>	L	WS	S	--	--	--
<i>Gymnogongrus linearis</i>	HML	--	WS	S	--	--
<i>Halosaccion glandiforme</i>	ML	--	W	--	--	WS
<i>Hymenena flabelligera</i>	ML	F	--	--	--	S
<i>Laurencia splendens</i>	L	S	S	--	--	--
<i>Melobesia mediocris</i>	MLP	WS*	--	--	S	S
<i>Microcladia coulteri</i>	L	W	--	--	--	--
<i>Odonthalia floccosa</i>	HML	--	--	--	FWS	WS
<i>Peyssonella</i> sp.	LP	FWS*	--	--	S	--
<i>Porphyrella gardneri</i>	L	--	--	--	S	S
<i>Ptilota filicina</i>	LP	FS*	--	--	F	--
<i>Ahnfeltia gigartenoides</i>	L	S	--	--	--	--
<i>Ahnfeltia plicata</i>	P	S*	--	--	--	--
<i>Anisocladella pacifica</i>	M	--	--	--	--	S
<i>Callophyllis flabellulata</i>	P	S*	--	--	--	--
<i>Chondria nidifica</i>	H	F	--	--	--	--
<i>Endocladia muricata</i>	HML	--	--	--	--	WS
<i>Farlowia compressa</i>	L	--	--	--	--	S
<i>Farlowia conferta</i>	H	--	--	--	--	S
<i>Gelidium pusillum</i>	H	F	--	--	--	--
<i>Gelidium robustum</i>	L	--	--	--	FWS	--
<i>Gelidicolax microphaerica</i>	H	--	--	W	--	--
<i>Gigartina boryi</i>	HM	--	WS	--	--	--
<i>Gigartina californica</i>	L	WS	--	--	--	--
<i>Gigartina corymbifera</i>	P	F*	--	--	--	--
<i>Gigartina harveyana</i>	LP	FWS*	--	--	--	--
<i>Gigartina leptorhynchos</i>	H	--	WS	--	--	--
<i>Gigartina spinosa</i>	P	S*	--	--	--	--
<i>Halymenia schizymenioides</i>	L	--	--	--	--	S
<i>Pikea californica</i>	P	S*	--	--	--	--
<i>Pleonosporium dasyoides</i>	P	F*	--	--	--	--
<i>Plocamocolax pulvinata</i>	L	--	--	--	--	W
<i>Polyneura latissima</i>	LP	FS*	--	--	--	--
<i>Polysiphonia villium</i>	H	--	--	--	S	--
<i>Porphyra smithii</i>	L	--	--	--	--	S
<i>Ptilota hypnoides</i>	L	W	--	--	--	--
<i>Rhodoglossum americanum</i>	L	W	--	--	--	--
<i>Rhodoglossum roseum</i>	L	S	--	--	--	--
Total (88)		61	41	30	49	51

TABLE 2 (page 4)

PLANTS RECORDED BETWEEN NOVEMBER 1971 AND MAY 1972

(Symbols: F = fall; W = winter; S = spring; * = in polluted area at Soquel Point)

PHYLUM	TIDAL ZONE	SOQUEL POINT	SANTA CRUZ POINT-EAST	SANTA CRUZ POINT-WEST	ALMAR STREET	NATURAL BRIDGES
Genus Species	HMLP	FWS	WS	WS	FWS	WS
ANGIOSPERMS						
Phyllospadix torreyi	MLP	FWS*	WS	WS	FWS	WS
Phyllospadix scouleri	P	F*	--	--	--	--
Total (2)		2	1	1	1	1
CYANOPHYTA						
Blue green - unid.	H	FS	--	--	F	--
Oscillatoria sp.	H	--	--	--	S	--
Total (2)		1	0	0	2	0
Total Species (135)		92	63	46	84	78

INTERTIDAL TRANSECT STUDIES OF NORTHERN MONTEREY BAY

Fourth Quarterly Report

June - September 1972

Submitted to: Mr. Donald A. Scott
Oceanographic Services, Inc.

Mr. Leslie L. Doolittle
Association of the Monterey Bay Area Governments

Principle Investigators: Dr. William T. Doyle and
Dr. John S. Pearse
University of California, Santa Cruz

This is the fourth and final quarterly report for the contract dated 10/22/71 between the Association of the Monterey Bay Area Governments (AMBAG) and the University of California, Santa Cruz (UCSC). Two intertidal transects were established in the vicinity of the city of Santa Cruz in the Fall of 1971, one at Soquel Point (Pleasure Point) near the East Cliff Sanitation District discharge, and a second near Almar Street inshore from the City of Santa Cruz Sanitation District discharge. These transects were re-examined in the Winter, Spring and Summer of 1972. Three additional transects were established in the Winter of 1972, one on each side of Santa Cruz Point (Lighthouse Point) and a third on the UCSC Marine Reserve adjacent to the Natural Bridges State Park. This report gives the data accumulated from these five intertidal transects.

In addition to these five intertidal transects, a Sea Grant to the University of California from the U.S. Department of Commerce supported the establishment in the Fall of 1971 of seven other permanent intertidal transects north of the City of Santa Cruz; these are located at: Davenport Landing, Scotts Creek, Año Nuevo Cove, Año Nuevo Point, Franklin Point, Pigeon Point South and Pigeon Point North. These were all revisited in the Winter and Spring, 1972, and except for Franklin Point, the Summer of 1972. Continued Sea Grant support will allow these plus the transects in the Santa Cruz area to be re-examined on a quarterly basis through the Summer of 1973. A final intertidal transect was established south of Monterey Bay, at Mill Creek near Lucia, in June, 1972. Final analyses of all these transects will be given at the end of 1973 after two full year's of study. The present report should be considered an interim report and part of an ongoing study.

This study was made possible by the financial support of AMBAG and Sea Grant. Judith Hanson and Kathryn Truscott, graduate students in biology, were supported in part by these contracts to help coordinate this work. Much of the work was done by UCSC graduate and undergraduate students taking the course Biology 190A Proseminar: Intertidal Organisms. During the 1971-1972 academic year, a total of 63 students participated in this course. Financial support from the Janss Foundation made it possible to hire 11 of these students to aid in the summer sampling. The following students worked at the localities in the vicinity of the City of Santa Cruz: Mike Acosta, Denise Allen, Beth Brewer, Debra Brewer, Michele Jauregui, George Landreth, Jack Liebster, Ellen Losee, Ann Nachreimer, Harry Nervino, Andy Oesterle, Linda O'Kelley, Shelley

Smith, and Alex Woronovich. During the Summer of 1972 four students, Craig Graffith and Deborah Meyer (animals), and Julie Packard and Pat Merrill (plants) went through all our voucher specimens and cumulative data to check their validity and consistency of identification.

Three senior theses developed from this work in 1972. Craig Graffith set up the transect areas on the two sides of Santa Cruz Point and did the first animal listing of these areas in the Winter of 1972. Andrew Oesterle did a study of the growth rate of the alga Laminaria setchellii at Soquel Point, Natural Bridges and Davenport Landing. Robert Anderson did a similar comparative study of the animals living in the holdfasts of this alga.

TRANSECT LOCATIONS AND DESCRIPTIONS

The transects at Soquel Point and Almar Street were established in the Fall of 1971 and were described in the First Quarterly Report. Those on the east and west sides of Santa Cruz Point and at Natural Bridges were established in the Winter and were described in the Second Quarterly Report. The position of these five areas with respect to the other study areas on the Santa Cruz and San Mateo County coast is given in Figure 1, taken from the Third Quarterly Report.

The five study areas in the vicinity of the City of Santa Cruz are each quite distinct and different from each other. They range from the more or less exposed ocean conditions at Natural Bridges eastward to the more protected conditions of northern Monterey Bay at Soquel Point. Almar Street, Santa Cruz Point-West and Santa Cruz Point-East are more intermediate with respect to ocean-bay exposure.

The substrate at each is the soft Santa Cruz Mudstone Formation, but the topography and extent of the platforms are different. The transect profiles are shown in Figure 2. The platform at Natural Bridges has a long gentle slope grading from a diffuse high zone down to a diffuse low zone. The mid zone is characterized by a dense mussel bed. The Almar Street area is much more abrupt and the three zones are more or less separated as distinct steps. The Santa Cruz Point-West area is very irregular; the high zone is a near-vertical cliff while the low contains large boulders, outcroppings and pools; the mid zone is indistinct. The Santa Cruz Point-East area (Steamer's Lane) is wide, very gently sloping, and most similar to the Natural Bridges area. However, the low, and much of the mid zone consists of unstable boulders making it virtually

impossible to mark off permanent quadrats. Moreover, much of this area is periodically covered with sand. The nearly horizontal low zone platform at Soquel is extensive, and much is covered with sand. There is essentially no mid zone except on vertical faces and under-cuts

All of the study areas are influenced by human activity. Each one is visited by large numbers of people. The Natural Bridges area is used particularly heavily for educational field trips from schools and colleges. The Santa Cruz Point-East and Soquel Point areas are used a great deal by surfers and clammers.

The Soquel Point area is influenced by the intertidal East Cliff Sanitation discharge some 300' south west of the transect. The outer portion of the transect area is particularly influenced and is designated herein as "polluted". This polluted area is visibly evident from the adjacent cliffs of East Cliff Drive and extends from the discharge point along the outer edge of the platform, about 50-100' wide, at least 1,000' to the north east. Surf-grass (Phyllospadix) is much reduced in the polluted zone and in its place are reddish coralline algae (Corallina) so the affected zone has a reddish-brown tinge. Other evidence of the pollution can also be noted: the incoming tide waters are often scummy and have a strong chlorine disinfectant odor; many of the fleshy red algae (esp. Iridea and Gigartina) are grossly deformed, and the richness of plant and animal species seems reduced by 1/3 to 1/2 (see below). In anticipation of the cessation of the discharge within the next few years, we have made particular effort to characterize this polluted area during the past year.

METHODS

As described in the earlier reports, single transect lines were laid perpendicular to the shore from the high to the low zones of each area. Stainless steel rods were cemented with resin compound into holes drilled in the rock; these rods serve as permanent reference points.

An area 100 feet or less on each side of the transect line was thoroughly searched each quarter for species of plants and animals. Representative specimens were collected of each species, preserved, identified, and stored as part of a permanent reference collection. Plants were identified with the use of G. M. Smith, "Marine Algae of the Monterey Peninsula", 2nd edition, with the 1966 Supplement by G. J. Hollenberg and I. A. Abbott. Dr. I. A. Abbott (Hopkins Marine Station) also checked and identified many of our specimens. The animals were identified following S. F. Light et al., "Intertidal

Invertebrates of the Central California Coast", (1954), with the addition of many unpublished chapters of the new revision supplied by J. T. Carlton. Mr. Carlton (California Academy of Sciences) also checked and identified some of our gastropods and barnacles. Ms. Nancy Collogne aided in the sponge identifications.

In addition to the qualitative enumeration of plants and animals in each area, 2 to 3 m² quadrats were established in each tidal zone along the transect lines at Soquel Point and Almar Street (Fall, 1971) and at Natural Bridges (Spring, 1972) (see Fig. 2). The quadrats were chosen with reference to the permanent stainless steel pins, and once each quarter, the animal and plant species within these quadrats were enumerated. The density of some of these species also was estimated either by direct count of individuals or percent cover estimates. These are not random samples (they were chosen as being "typical" of each area) nor do they represent enough replicates to be used for statistical comparison between areas. Rather, they were established to follow seasonal changes in representative quadrats at each area.

RESULTS

A total of 140 species of plants and 191 taxonomic units of animals were recorded from the five transect areas described above in the vicinity of the City of Santa Cruz. These taxa are listed by group in Tables 1 and 2, with the most widespread species of each group listed first. Most species were not found at every locality nor for every season at the same locality; many of the species were found only once or a few times. This probably reflects 1) team inconsistencies from quarter to quarter, 2) the fact that many of the species are not very common, and 3) differences between the areas.

As shown in Figure 2, one of the main physical differences between the areas is the breadth of the platform. Figure 3 plots the number of species against the breadth of the different areas. A relationship between breadth and the number of species in the high and mid zone seems to exist; this relationship will be further examined during the following year when we have more data from our other stations. Little or no relationship exists between species number and breadth of the low zone. It is also noteworthy that the relatively low number of species found in the polluted low zone at Soquel Point does not seem to be related to the breadth of this zone.

Figure 4 shows the relationship between the total number of species of animals with the total number of species of plants at each area. The number of plants and animal species was nearly the same in the quadrats while there were decidedly more animals than plants in the general surveys of the complete intertidal platform areas. The quadrats were placed on flat surfaces while the general surveys included looking into crevices, under mussels and rocks, in holdfasts, and in other places favorable for cryptic animals. The Almar Street area had the least amount of irregularities and the plant:animal ratio was nearly balanced.

The total number of plant and animal species recorded at each tidal area are compared in Figure 5. A step-wise increase in number of species, from high to low, is evident for the numbers found in the general surveys for all areas except Soquel Point and Santa Cruz Point-East (plants only). The low zone at Santa Cruz Point-East consists mainly of sand and boulders. Clammers continually overturn the boulders, which may account for there being less plants in the low than the mid zone there. Moreover, as shown in Figure 2, the mid and low zones at Santa Cruz Point-East are particularly indistinct.

The relatively high number of animals found in the mid zone at Natural Bridges (Fig. 5) probably reflects the dense mussel bed of the area which harbored many cryptic species. Proportionately less animal species were counted in the quadrats of the area; animals hiding deep in the mussel beds were not sought in the quadrats. Conversely, proportionately more animals and plants were found in the quadrats of the mid zone of Almar Street which was more uniform than at the other areas, and did not have many mussels.

There was no mid zone at the Soquel Point area, but a relatively large number of plants and animals were found in the low zone (Fig. 5). These large numbers may be due in part to the extensive width of the low zone (Figs. 2 and 3). The polluted zone at Soquel Point, however, had a reduction of some third to half the number of plant and animal species found in the adjacent low zone in both the general area and the quadrats.

The number of animal and plant species found each quarter in the quadrats are shown in Figure 6. No distinct seasonal trend was found at any site except perhaps for the plants in the low zone at Soquel Point. Another full year's observation is needed before we can begin to assess possible seasonal changes in total number of species present. Moreover, analysis of changes within

individual species may show some seasonal change. It is again noteworthy that the number of plant and animal species in the polluted zone at Soquel Point was consistently lower than the number in the adjacent low zone.

Figure 7 compares the number of species of animals found in only 1, 2, 3, 4 or all the areas of the five study areas. When the animals from all tidal zones are considered together, Santa Cruz Point-East and West, Almar Street and Natural Bridges show similar patterns; most species found at any of these areas were found at several or more of the other areas. At Soquel Point, however, nearly a third of the species found were only found there. The distinctness of Soquel Point is more evident when only the species in the low zone are considered: nearly half of all the animals found were unique. In contrast, most of the species found in the adjacent visually polluted zone were found at one or more other areas. This suggests that while many unique Bay species may occur in the low zone at Soquel Point, when polluted by the sewage discharge, these species tend to disappear and more widespread species remain.

In the foregoing account all animal and plant species are considered together. Such grouping may obscure differences, especially among the animals, because in some groups, e.g., the annelids, species identification is difficult. Moreover, comparable collections are difficult to obtain of species which need to be collected by breaking up rocks, e.g., annelids and pelecypods. In Figure 8, species numbers of eight different animal groups are compared among the low zones of the study areas. Most species in these groups live on or under (but not in rocks) rocks and were collected in comparable ways. The species in each group show somewhat different trends with respect to area, and little in the way of a consistent trend can yet be seen. Arthropods (mainly crabs) and gastropods were particularly numerous at Soquel Point, while more sponges were found on the open coast than within the bay. For all groups, except the chidarians, there were considerably fewer species in the polluted zone at Soquel Point than in the adjacent low zone. Sponges and tunicates, which as filter feeders are perhaps particularly sensitive to water quality, were entirely absent in the polluted zone of Soquel Point.

DISCUSSION AND SUMMARY

The main purpose of this study was to establish a base line of the intertidal animal and plant species in the vicinity of the City of Santa Cruz. These data are to be used for later comparative studies. We have shown that while

many species are found in the different areas, each area has a distinct species composition. It would be unsound, therefore, to use studies in one area for a baseline for another area; an area can only be compared with itself. Although we did not detect striking seasonal change, more work needs to be done to clarify this variable and the "normal" variation which may be expected with time.

We attempted to determine whether the open ocean coast could be delineated from the Northern Monterey Bay coast. While the Soquel Point area in the Bay contained many species not found elsewhere, there was not a sharp demarcation between the Bay and the open ocean. Over half the species found at Soquel Point were also found at Natural Bridges. Moreover, the Santa Cruz Point and Almar Street sites seemed intermediate in species composition between Soquel Point and Natural Bridges. We therefore do not believe the "bay" and "ocean" can be well separated on a biological basis.

There are, however, several species pairs which may demark conditions in the Bay from the open ocean. In particular the two species of the alga Egregia seem to be divided on bay versus ocean conditions. E. menziesii is characteristic of open coast conditions and was found at Almar Street and Natural Bridges, while E. laevigata, which is found in more protected areas, was found at Santa Cruz Point and Soquel Point. The two species of the isopod, Ligia also are of interest; L. pallasii occurs from Canada to Santa Cruz Point, while L. occidentalis occurs from Soquel Point to Baja California.

We also attempted to characterize the visually polluted area at Soquel Point both to see what sort of organisms live in such sewage polluted areas and to be able to follow changes that occur after the discharge is stopped. The polluted area has a paucity of surf grass which is abundant in adjacent areas, and has a conspicuous cover of coralline algae (mainly Corallina chilensis). Sponges and tunicates are completely lacking and are perhaps especially sensitive to water quality. Since these animals feed on suspended particles in water, they should do well in sewage enriched water; they are probably adversely affected by the chlorine disinfectant. There was also a reduction of the numbers of species of most other groups; generally 1/3 to 1/2 the number of species found in adjacent areas that were not as obviously affected. To further document these suspected pollution effects, we are supporting two senior thesis studies which are establishing other transects at Soquel Point further from the discharge point.

This study has required a large amount of time and would have been very costly without the student help. A more feasible method to continue such monitoring programs on a long term basis needs to be developed. We did not find any "indicator" species which could be used for monitoring. What we are beginning to develop is the selection of "indicator" groups. Such groups need a sufficient diversity of species so that a change in species numbers can be detected. Moreover, they need to be able to be consistently sampled and reliably identified to be used in an on-going monitoring program. From among the animals, perhaps sponges, gastropods and tunicates can be used to monitor rocky intertidal platforms, and we will try to develop methods to do this in the coming year.

TABLE 1. Intertidal plants found between October 1971 and August 1972 in the vicinity of the City of Santa Cruz. H = high zone, M = mid zone, L = low zone, P = polluted; F = Fall, W = Winter, S = Spring, Z = Summer, Underline indicates in quadrat.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges			Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML			HLP	HML	HML	HML	HML
CHLOROPHYTA							CHLOROPHYTA cont.						
<i>Bryopsis corticulans</i>	F	H-P			--L		<i>Ulva rigida</i>	F	---			-ML	
	W	-L-	-ML	---	---	---		W	---	HML	---	---	---
	S	-L-	--L	--L	--L	--L		S	H--	-M-	-ML	-M-	-ML
	Z	H--	--L	--L	-ML	-ML		Z	-	---	---	---	-ML
<i>Cladophora ovoidea</i>	F	---			---		<i>Rhizoclonium riparium</i>	F	---			---	
	W	---	HML	-M-	---	---		W	H--	---	---	---	---
	S	-L-	--L	---	-ML	HML		S	---	-M-	H--	H--	---
	Z	H	HML	--L	HML	HML		Z		H--	---	M	
<i>Cladophora trichotoma</i>	F	H--			HML		<i>Chaetomorpha aerea</i>	F	H--			H--	
	W	H--	H--	HM-	HM-	HM-		W	---	---	---	H--	---
	S	H--	H--	H--	HML	HM-		S	---	---	-M-	H--	---
	Z	H--	H--	H--	HML	HML		Z	HL-	---	-M-	HM-	---
<i>Enteromorpha compressa</i>	F	---			---		<i>Ulva expansa</i>	F	--P			---	
	W	---	H--	-M-	---	---		W	-LP	-ML	---	---	-M-
	S	HL-	---	-ML	-M-	H--		S	-LP	--L	---	---	---
	Z	H	---	---				Z	-LP	---	---	---	-
<i>Enteromorpha intestinalis</i>	F	H--			H--		<i>Enteromorpha clathrata</i>	F	---			---	
	W	---	---	H--	H-L	H--		W	---	---	---	---	---
	S	H--	H--	---	H-L	HM-		S	H-L	---	---	H--	---
	Z	H	-M-	--L				Z	---	---	---	---	---
<i>Ulva linza</i>	F	HLP			HM-		<i>Ulva taeniata</i>	F	---			---	
	W	H--	---	---	HM-	-M-		W	-L-	HM-	---	---	---
	S	HL-	HML	HML	HM-	H--		S	-L-	-ML	---	---	---
	Z	-L-	H-L	H--	HML	H-L		Z	-L-	-ML	---	---	---
<i>Ulva lobata</i>	F	HL			HML		<i>Cladophora stimposonii</i>	F	---			---	
	W	-L-	---	H-L	---	-ML		W	---	---	---	---	---
	S	-L-	HML	---	-ML	-ML		S	---	---	---	---	H--
	Z	-	-ML	---	-ML	L		Z	---	---	---	---	---

CHLOROPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
<i>Collinsiella tuberculata</i>	F	---			---	
	W	---			---	
	S	---			H--	
	Z					
<i>Codium setchellii</i>	F	---			---	
	W	---		-M-	---	
	S	---			---	
	Z	---			---	
<i>Enteromorpha prolifera</i>	F	---			---	
	W	---			---	
	S	---			H--	
	Z					
<i>Monostroma zostericola</i>	F	---			---	
	W	---			---	
	S	-L-			---	
	Z				---	
<i>Spongomorpha coalita</i>	F	---			---	
	W	---			---	
	S	---	-M-		---	
	Z		-ML		---	
<i>Ulva californica</i>	F	---			---	
	W	---			-M-	
	S	---			---	
	Z	---			---	
CHLOROPHYTA TOTAL (20)		14	12	11	14	10

PHAEOPHYTA

Ectocarpus sp.

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	--P			-M-	
W	-LP			-M-	---
S	--P			--L	--L
Z	-LP	-M-	--L	--L	--L

Laminaria setchellii

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	-LP			--L	
W	-LP	---	---	--L	---
S	-LP	--L	--L	--L	--L
Z	-LP	--L	--L	---	--L

Laminaria sinclairii

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	---			--L	
W	---	-ML	--L	--L	--L
S	-L-	--L	--L	--L	--L
Z	---	--L	--L	--L	--L

Phaeostrophion irregulare

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	---			---	
W	---	HM-	---	---	--L
S	-L-	--L	---	-ML	-ML
Z	---	-M-	H-L	--L	-ML

Scytosiphon dotyi

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	H--			HM-	
W	H--	H--	HM-	H--	H--
S	HL-	---	H--	HML	HML
Z	H--	H--	H--	HM-	HM-

Tarspots

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	H--			H-L	
W	--P	HM-	HM-	HML	HML
S	HL-	---	H-L	HML	HML
Z	HL	HM	-ML	HML	HML

Analipus japonica

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	---			---	
W	---	---	---	---	-M-
S	---	---	-M-	--L	H-L
Z	---	-M-	--L	-ML	HM-

Scytosiphon lomentaria

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	---			---	
W	---	---	---	---	H--
S	---	---	---	HM-	-M-
Z	H--	H--	---	-M-	HM-

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
PHAEOPHYTA cont.						
<i>Cystoseira osmundacea</i>	F	--P				
	W	-LP	--L	---	---	---
	S	-LP	--L	---	---	--L
	Z	-LP	--L	---	---	--L
<i>Egregia laevigata</i>	F	-LP				
	W	-LP	HML	--L	---	---
	S	-LP	--L	--L	---	---
	Z	-LP	-ML	-ML	---	---
<i>Leathesia difformis</i>	F	---			---	---
	W	---	---	---	---	---
	S	HL-	---	---	HM-	---
	Z	---	---	---	---	H--
<i>Macrocystis pyrifera</i>	F	---			--L	
	W	---	-ML	--L	---	---
	S	---	---	---	---	---
	Z	---	---	---	--L	---
<i>Petalonia debilis</i>	F	H--			HM-	
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	-M-	H--
<i>Pterygophora californica</i>	F	---			---	
	W	---	--L	---	---	---
	S	--P	--L	---	---	--L
	Z	---	--L	---	---	--L
<i>Egregia menziesii</i>	F	---			-ML	
	W	---	---	---	--L	--L
	S	---	---	---	-ML	-ML
	Z	---	---	---	-ML	-ML
<i>Laminaria groenlandica</i>	F	--P			---	
	W	--P	---	---	--L	---
	S	---	---	---	---	---
	Z	---	---	---	---	---

PHAEOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
PHAEOPHYTA cont.						
<i>Macrocystis integrifolia</i>	F	-L-			---	
	W	-L-	---	---	---	--L
	S	-L-	---	---	---	---
	Z	-L-	---	---	---	--L
<i>Pelvetia fastigiata</i>	F	---			H--	
	W	---	---	---	H--	H--
	S	---	---	---	H--	H--
	Z	---	---	---	H--	H--
<i>Pelvetiopsis limitata</i>	F	---			H--	
	W	---	---	---	H--	---
	S	---	---	---	H--	H--
	Z	---	---	---	H--	H--
<i>Hapalogloia andersonii</i>	F	---			---	
	W	---	---	---	---	---
	S	---	---	---	---	HML
	Z	---	---	---	---	---
<i>Petalonia fascia</i>	F	---			---	
	W	---	---	---	---	---
	S	---	---	---	HM-	---
	Z	---	---	---	---	---
PHAEOPHYTA						
TOTAL (21)		14	12	9	16	17

RHODOPHYTA

<i>Bossiella chiloensis</i>	F	---			---	
	W	---	--L	H--	---	---
	S	-LP	--L	-M-	-M-	-M-
	Z	---	--L	--L	-	---
<i>Bossiella orbigniana</i>	F	-LP			H-L	
	W	-L-	HML	-ML	---	---
	S	-LP	---	--L	---	-M-
	Z	---	---	---	---	---

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
<i>Bossiella plumosa</i>	F	-L-			-M-	
	W	---	---	-M-	---	--L
	S	-L-	---	--L	---	-L
	Z		ML	ML		
<i>Corallina vancouveriensis</i>	F	---			-ML	
	W	---	---	-M-	-ML	-ML
	S	-L-	H--	-ML	-ML	-ML
	Z	---	HML	---	-ML	-ML
<i>Cryptopleura violacea</i>	F	--P				
	W	---				
	S	-LP	---	--L	-M-	-ML
	Z	-L	-M-	--L	-ML	-L
<i>Cumagloia andersonii</i>	F	H--			H--	
	W	H--	---	---	H--	---
	S	H--	---	H--	HM-	---
	Z	H--	HM-	H--	HM-	HM-
<i>Gastroclonium coulteri</i>	F	--P			-ML	
	W	-L-	-ML	HML	---	---
	S	-LP	--L	-ML	HML	HML
	Z	-LP	-ML	-ML	-ML	-ML
<i>Gelidium coulteri</i>	F	--P			-ML	
	W	---	H--	HM-	-ML	HML
	S	H--	H--	HM-	HML	HML
	Z	H--	HM-	HML	HML	HML
<i>Gelidium purpurascens</i>	F	---			--L	
	W	---	HML	-ML	--L	---
	S	--P	---	--L	--L	--L
	Z	---	---	---	--L	---
<i>Gigartina canaliculata</i>	F	---			-ML	
	W	---	H--	HML	--L	-M-
	S	-L-	H--	-ML	HML	H-L
	Z	-L-	-M-	-ML	-ML	-ML

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
<i>Gigartina papillata</i>	F	H--			HML	
	W	---	H--	HML	HML	-ML
	S	H-P	HML	-ML	HML	HML
	Z	H--	HML	-ML	HML	HML
<i>Iridaea flaccida</i>	F	H-P			-ML	
	W	-LP	HM-	HM-	---	-M-
	S	HML	H--	HM-	HML	HML
	Z	H--	HM-	HM-	-ML	HML
<i>Iridaea splendens</i>	F	-LP			-ML	
	W	-L-	HML	-ML	-ML	--L
	S	-LP	-ML	--L	--L	--L
	Z	-LP	-ML	-ML	--L	--L
<i>Melobesia mediocris</i>	F	---			---	
	W	-LP	---	---	---	---
	S	--P	---	---	--L	-ML
	Z	---	-M-	--L	---	--L
<i>Plocamium coccineum</i> var <i>pacificum</i>	F	--P			--L	
	W	-L-	-ML	-ML	--L	--L
	S	-LP	--L	--L	--L	-ML
	Z	---	--L	--L	--L	-ML
<i>Polysiphonia paniculata</i>	F	H--			HML	
	W	---	-ML	---	---	---
	S	-L-	--L	--L	H-L	-ML
	Z	HL-	-ML	-ML		
<i>Porphyra lanceolata</i>	F	---			---	
	W	-L-	---	H-L	H--	---
	S	H--	---	--L	H-L	H-L
	Z	---	---	-M-	-M-	---
<i>Porphyra perforata</i>	F	H--			-ML	
	W	HL-	H--	-ML	HM-	-M-
	S	HL-	HM-	HML	HML	HML
	Z	H--	HML	-ML	HML	HML

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
<i>Prionitis andersonii</i>	F	<u>-LP</u>			---	
	W	<u>-P</u>	---	---	---	---
	S	<u>-LP</u>	--L	--L	--L	--L
	Z	<u>-LP</u>	-ML	--L	--L	---
<i>Prionitis lanceolata</i>	F	-L-			HML	
	W	---	HML	--L	HML	-ML
	S	-L-	--L	--L	--L	-ML
	Z	<u>-LP</u>	--L	---	<u>-ML</u>	HML
<i>Petrospongium rugosum</i>	F	---			HM-	
	W	---	---	---	---	-ML
	S	H--	H--	H--	<u>-ML</u>	HM-
	Z		H--	H--	<u>-M-</u>	HM-
<i>Pterosiphonia dendroidea</i>	F	---			--L	
	W	<u>-L-</u>	--L	HM-	--L	---
	S	<u>-L-</u>	--L	--L	--L	<u>-ML</u>
	Z	<u>HM-</u>	--L	--L	--L	HML
<i>Smithora naiadum</i>	F	<u>-LP</u>			--L	
	W	<u>-L-</u>	--L	-ML	--L	--L
	S	-LP	--	--L	--L	--L
	Z	<u>-L-</u>	--L	--L	--L	--L
<i>Ceramium eatonium</i>	F	---			---	
	W	---	---	HM-	-M-	---
	S	---	---	---	HM-	<u>HM-</u>
	Z	H--	---	-ML	<u>-ML</u>	<u>HM-</u>
<i>Corallina chilensis</i>	F	<u>-LP</u>			-M-	
	W	<u>-LP</u>	-ML	HML	--L	---
	S	<u>-LP</u>	--L	---	<u>-ML</u>	---
	Z	<u>-LP</u>	---	---	HML	---
<i>Cryptopleura lobulifera</i>	F	-LP			--L	
	W	<u>-ML</u>	---	---	---	---
	S	---	---	-M-	--L	<u>-ML</u>
	Z	---	---	--L	<u>-ML</u>	<u>-ML</u>

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML
<i>Gigartina agardhii</i>	F	---			---	
	W	---	H--	---	H--	---
	S	<u>-P</u>	HM-	---	---	---
	Z	---	---	-M-	-M-	---
<i>Gigartina volans</i>	F	--P			---	
	W	---	-ML	---	---	---
	S	-L-	--L	---	---	---
	Z	---	-ML	--L	--L	---
<i>Gracilaria verrucosa</i>	F	<u>-L-</u>			---	
	W	<u>-L-</u>	H--	---	---	---
	S	<u>-L-</u>	--L	---	H--	---
	Z	<u>-L-</u>	-ML	---	HM-	-M-
<i>Grateloupia doryphora</i>	F	<u>-L-</u>			---	
	W	<u>-LP</u>	--L	---	---	---
	S	<u>-L-</u>	---	---	---	--L
	Z	<u>-L-</u>	--L	---	--L	<u>-ML</u>
<i>Laurencia spectabilis</i>	F	---			--L	
	W	---	HM-	---	--L	---
	S	<u>-L-</u>	-M-	---	--L	<u>-ML</u>
	Z	---	---	---	--L	<u>-ML</u>
<i>Microcladia borealis</i>	F	---			---	
	W	---	---	H--	---	--L
	S	---	---	HML	-M-	<u>HM-</u>
	Z	---	-ML	-ML	-ML	<u>HML</u>
<i>Pterosiphonia bipinnata</i>	F	--P			---	
	W	---	---	---	H-L	---
	S	<u>-L-</u>	---	---	HML	HML
	Z	<u>-L-</u>	---	--L	HML	<u>HM-</u>
<i>Polysiphonia pacifica</i>	F	---			---	
	W	---	---	---	---	---
	S	-L-	-ML	-M-	---	--L
	Z	---	---	---	---	---

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML		HLP	HML	HML	HML	HML
<i>Porphyrella gardneri</i>	F	---			---		<i>Gymnogongrus leptophyllus</i>	F	---			
	W	---	---	---	---	---		W	-L-	---	---	---
	S	---	---	---	--L	--L		S	-L-	--L	---	---
	Z	---	-M-	--L	--L	--L		Z	-L-	-ML	--L	---
<i>Prionitis lyallii</i>	F	---			---		<i>Hymenena flabelligera</i>	F	-L-			
	W	-L-	HM-	-ML	--L	---		W	---	---	---	---
	S	---	---	---	---	---		S	---	---	---	---
	Z	---	-M-	---	--L	---		Z	---	---	--L	--L
<i>Rhodomela larix</i>	F	---			--L		<i>Iridaea heterocarpum</i>	F	---			-M-
	W	---	HM-	-ML	--L	H--		W	---	---	---	--L
	S	---	-ML	--L	--L	H-L		S	---	--L	---	HM-
	Z	---	-ML	-ML	-ML	-M-		Z	---	--L	---	-M-
<i>Agardhiella tenera</i>	F	---			---		<i>Laurencia splendens</i>	F	---			
	W	-L-	---	---	---	---		W	---	---	---	---
	S	-L-	---	---	---	--L		S	-L-	--L	---	---
	Z	-L-	-ML	---	---	-M-		Z	-L-	-M-	--L	---
<i>Bossiella californica</i>	F	---			---		<i>Microcladia coulteri</i>	F	---			
	W	---	---	---	--L	---		W	-L-	---	---	---
	S	-LP	---	---	-ML	--L		S	-L-	---	---	---
	Z							Z	---	---	-M-	--L
<i>Centroceros clavulatum</i>	F	---			---		<i>Prionitis linearis</i>	F	---			
	W	---	---	---	-M-	---		W	---	--L	---	---
	S	---	-M-	---	HML	H--		S	---	---	--L	--L
	Z		-ML	---				Z	---	---	---	--L
<i>Cryptopleura corallinara</i>	F	---			---		<i>Polysiphonia hendryi</i>	F	---			
	W	---	---	---	---	---		W	---	---	H--	---
	S	-LP	---	---	--L	-M-		S	---	---	---	-ML
	Z	-P	---	---	--L	---		Z	---	---	HM-	---
<i>Farlowia mollis</i>	F	---			---		<i>Rhodoglossum affine</i>	F	---			-ML
	W	---	---	---	-ML	--L		W	---	---	---	---
	S	---	---	---	HML	HML		S	--P	---	---	H--
	Z	---	-ML	---	-ML	HML		Z	---	---	---	---

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges			Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges	
		HLP	HML	HML	HML	HML			HLP	HML	HML	HML	HML	
<i>Schizymenia pacifica</i>	F	---			---		<i>Gigartina harveyana</i>	F	-L-			---		
	W	---			---			W	--P					
	S	-LP			-L	-L		S	-L-	-ML				
	Z	-L			-L	-ML		Z	-L-	-ML				
<i>Acrochaetium porphyrae</i>	F	---			-M-		<i>Gigartina leptorhynchos</i>	F	---			---		
	W	---	H--					W	---	H--				
	S	---						S	---	H--				
	Z	---						Z	---					H--
<i>Botryoglossum farlowianum</i>	F	-L-					<i>Gymnogongrus linearus</i>	F	---			---		
	W	---	--L					W	---	HM-	-M-			
	S	---						S	---	--L	--L			
	Z	---						Z	---	-M-	--L			
<i>Callithamnion pikeanum</i>	F	---					<i>Halosaccion glandiforme</i>	F	---			---		
	W	---	H--		--L			W	---	HML				--L
	S	---						S	---					--L
	Z	---						Z	---	-M-				HML
<i>Cryptosiphonia woodii</i>	F	---					<i>Odonthalia floccosa</i>	F	---				HM-	
	W	---						W	---				-ML	HML
	S	-L-				H-L		S	---				HM-	H--
	Z	---				H-		Z	---				H--	HM-
<i>Farlowia compressa</i>	F	---	--				<i>Peyssonelia sp.</i>	F	--P			---		
	W	---	--L					W	--P					
	S	---				--L		S	-LP			--L		
	Z	---						Z	-L-					
<i>Gelidium robustum</i>	F	---			--L		<i>Polyneura latissima</i>	F	--P			---		
	W	---			--L			W	---					
	S	---			--L	--L		S	-L-					
	Z	---			--L	--L		Z	-L-					--L
<i>Gigartina californica</i>	F	---					<i>Ptilota filicina</i>	F	--P			--L		
	W	---						W	---			--L		
	S	-L-		-M-				S	-L-					
	Z	---						Z	---					

Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Point	Natural Bridges
HLP	HML	HML	HML	HML

RHODOPHYTA cont.

<i>Rhodoglossum americanum</i>	F ---			---	
	W -L-	---	---	---	---
	S ---	---	---	---	---
	Z -L-	HML	---	---	---
<i>Ahnfeltia gigartinoides</i>	F ---			---	
	W ---	---	---	---	---
	S -L-	---	---	---	---
	Z ---	---	---	---	---
<i>Ahnfeltia plicata</i>	F ---			---	
	W ---	---	---	---	---
	S --P	---	---	---	---
	Z -L-	---	---	---	---
<i>Anisocladella pacifica</i>	F ---			---	
	W ---	---	---	---	---
	S ---	---	---	---	-M-
	Z ---	---	---	---	---
<i>Callophyllis flabellulata</i>	F ---			---	
	W ---	---	---	---	---
	S --P	---	---	---	---
	Z ---	---	---	---	---
<i>Chondria nidifica</i>	F <u>H</u> --			---	
	W ---	---	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Endocladia muricata</i>	F ---			---	
	W ---	---	---	---	-M-
	S ---	---	---	---	<u>HML</u>
	Z ---	---	---	---	<u>HM-</u>
<i>Farlowia conferta</i>	F ---			---	
	W ---	---	---	---	---
	S ---	---	---	---	<u>H</u> --
	Z ---	---	---	---	---

Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
HLP	HML	HML	HML	HML

<i>Gelidium pusillum</i>	F <u>H</u> --			---	
	W ---	---	---	---	---
	S ---	---	---	---	---
	Z <u>H</u> --	---	---	---	---
<i>Gelidicolax microphaerica</i>	F ---			---	
	W ---	---	H--	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Gigartina boryi</i>	F ---			---	
	W ---	-M-	---	---	---
	S ---	H--	---	---	---
	Z ---	---	---	---	---
<i>Gigartina corymbifera</i>	F --P			---	
	W ---	---	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Gigartina spinosa</i>	F ---			---	
	W ---	---	---	---	---
	S --P	---	---	---	---
	Z -L-	---	---	---	---
<i>Gratyloupia californica</i>	F ---			---	
	W ---	-M-	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Gymnogongrus platyphyllus</i>	F ---			---	
	W ---	-M-	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Halymenia schizymenioides</i>	F ---			---	
	W ---	---	---	---	---
	S ---	---	---	---	--L
	Z ---	---	---	---	---

RHODOPHYTA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges			Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML			HLP	HML	HML	HML	HML
<i>Hapalogloia andersonii</i>	F	---			---		<i>Porphyra smithii</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	---	---	---	---	<u>HML</u>		S	---	---	---	---	---
	Z	---	---	---	---	---		Z	---	---	---	---	---
<i>Microcladia californica</i>	F	---			---		<i>Pterochondria woodii</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	---	---	---	---	---		S	---	---	---	---	---
	Z	---	---	---	---	---		Z	---	---	---	---	---
<i>Nemalion elminthoides</i>	F	---			---		<i>Pterosiphonia baileyii</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	---	---	---	---	---		S	---	---	---	---	---
	Z	---	H--	---	---	---		Z	---	--L	---	---	---
<i>Phycodrys setchellii</i>	F	---			---		<i>Ptilota hypnoides</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	---	---	---	---	---		S	---	---	---	---	---
	Z	---	---	---	---	---		Z	---	---	---	---	---
<i>Pikea californica</i>	F	---			---		<i>Rhodoglossum roseum</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	--P	---	---	---	---		S	---	---	---	---	---
	Z	---	---	---	---	---		Z	---	---	---	---	---
<i>Platythamnion sp.</i>	F	---			---		<i>Rhodomenia californica</i>	F	---			---	
	W	---	---	---	---	---		W	---	---	---	---	---
	S	---	---	---	---	---		S	---	---	---	---	---
	Z	---	H--	---	---	---		Z	---	---	---	---	---
<i>Pleonosporium dasyoides</i>	F	--P			---		RHODOPHYTA TOTAL (96)						
	W	---	---	---	---	---			62	56	43	54	61
	S	---	---	---	---	---							
	Z	---	---	---	---	---							
<i>Polysiphonia villium</i>	F	---			---								
	W	---	---	---	---	---							
	S	---	---	---	H--	---							
	Z	---	---	---	---	---							

ANGIOSPERMS

Phyllospadix torreyi

HLP	Soquel Point
HML	Santa Cruz Point East
HML	Santa Cruz Point West
HML	Almar Street
HML	Natural Bridges

F	-LP
W	-LP
S	-LP
Z	-LP
	-ML
	-L
	-L
	-L
	-L
	-ML
	-ML
	-L

Phyllospadix scouleri

F	--P
W	---
S	---
Z	---

ANGIOSPERMS
TOTAL (2)

2
1
1
2
1

TOTAL (140)

92
81
64
86
89

TABLE 2. Intertidal animals found between October 1971 and August 1972 in the vicinity of the City of Santa Cruz. H = high zone, M = mid zone, L = low zone, P = polluted; F = fall, W = winter, S = spring, Z = summer; underline indicates in quadrats.

		Soquel	Santa Cruz	Santa Cruz	Almar	Natural		Soquel	Santa Cruz	Santa Cruz	Almar	Natural
		Point	Point	Point	Street	Bridges		Point	Point	Point	Street	Bridges
		HLP	HML	HML	HML	HML		HLP	HML	HML	HML	HML
ORIFERA												
Suberites sp.	F	---			--L		<i>Adocia gellindra</i>	F	---			--L
	W	---	--L	---	-ML	--L		W	---	---	---	---
	S	-L-	---	---	---	-ML		S	---	---	---	---
	Z	---	--L	---	---	---		Z	---	---	---	---
Cliona celata	F	---			---		<i>Carmia macginitiei</i>	F	---			--L
	W	---	--L	---	-ML	-M-		W	---	---	---	---
	S	---	--L	--L	-L	--L		S	---	---	---	--L
	Z	---	---	--L	---	---		Z	---	---	---	---
Haliclona permolis	F	---			---		<i>Esperiopsis originalis</i>	F	---			--L
	W	---	HML	HML	---	-ML		W	---	---	---	-M-
	S	---	-ML	HML	---	-ML		S	---	---	---	---
	Z	---	-ML	HML	--L	-M-		Z	---	---	---	---
Aplysilla glacialis	F	---			---		<i>Halichondria panicea</i>	F	---			---
	W	---	---	--L	-ML	-ML		W	---	---	---	--L
	S	---	---	--L	--L	-ML		S	---	---	---	--L
	Z	---	---	--L	--L	---		Z	---	---	---	---
Scypha sp. (?)	F	---			---		<i>Haliclona</i> sp.	F	---			--L
	W	---	---	---	-ML	---		W	---	---	---	--L
	S	---	---	--L	---	--L		S	---	---	---	--L
	Z	---	---	--L	---	---		Z	---	---	---	--L
Rhabdodermella nuttingi	F	---			---		<i>Lissodendoryx noxiosa</i>	F	---			---
	W	---	-ML	---	---	-M-		W	---	---	--L	---
	S	---	--L	--L	---	--L		S	---	---	--L	---
	Z	---	--L	--L	---	---		Z	---	---	---	---
Ophlitaspongia pennata	F	---			---		<i>Acarnus erithacus</i>	F	---			---
	W	---	HML	-ML	---	---		W	---	---	---	--L
	S	---	-ML	--L	---	--L		S	---	---	---	---
	Z	---	--L	--L	---	---		Z	---	---	---	---

PORIFERA cont.

Zygherpe hyalodernia

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
F	---			---	
W	---	---	---	---	---
S	---	---	---	---	---
Z	---	---	--L	---	---

PORIFERA
TOTAL (15)

1 5 9 11 12

CNIDARIA

Aglaopheria sp.

F	---			--L	
W	---	---	-M-	--L	-ML
S	H-P	--L	--L	--L	-ML
Z	---	--L	---	---	---

Anthopleura elegantissima

F	<u>HLP</u>			<u>HML</u>	
W	<u>HLP</u>	HM-	H--	<u>HML</u>	<u>HML</u>
S	<u>HLP</u>	HML	HML	<u>HML</u>	<u>HML</u>
Z	<u>HLP</u>	HML	HML	<u>HML</u>	<u>HML</u>

Anthopleura xanthogrammica

F	---			-ML	
W	---	HML	HML	-ML	HML
S	---	-ML	-ML	<u>HML</u>	<u>HML</u>
Z	-L-	HM-	---	-ML	<u>HM-</u>

Abietinaria amphora

F	---			---	
W	--P	--L	---	---	---
S	--P	--L	--L	---	--L
Z	---	---	-ML	---	---

Anthopleura artemisia

F	<u>-LP</u>			---	
W	<u>-LP</u>	-ML	HML	---	-M-
S	<u>-LP</u>	-ML	-ML	---	--L
Z	<u>-LP</u>	--L	--L	---	--L

Epiactis prolifera

F	-L-			---	
W	-L-	-ML	-ML	---	-M-
S	<u>-LP</u>	--L	---	---	-M-
Z	---	--L	---	---	-M-

Sertularella turgida

F	---			---	
W	---	---	---	--L	---
S	---	--L	---	--L	--L
Z	---	---	---	---	---

CNIDARIA cont.

Sertularia furcata

F	---			---	
W	---	--L	---	---	---
S	---	--L	--L	---	---
Z	---	--L	---	---	---

Campanularia volubilis

F	---			---	
W	---	---	---	---	---
S	---	---	---	---	--L
Z	---	---	---	---	---

Plumularia sp.

F	---			--L	
W	---	---	---	---	---
S	---	---	---	---	---
Z	---	---	---	---	---

Tealia lofotensis

F	---			---	
W	---	--L	---	---	---
S	---	---	---	---	---
Z	---	---	---	---	---

CNIDARIA
TOTAL (11)

6 9 7 5 8

PLATYHELMINTES

Polyclads (several species)

F	---			---	
W	--P	H--	---	---	-M-
S	HL-	---	---	---	---
Z	---	---	---	---	---

PLATYHELMINTES
TOTAL ("1")

1 1 0 0 1

NEMERTEA

Paranemertes peregrina

F	---			-M-	
W	---	HM-	H--	--L	---
S	H--	-M-	HM-	-M-	-ML
Z	H--	-M-	-M-	-M-	---

Amphiporus imparispinosus

F	---			---	
W	---	---	---	--L	--L
S	---	---	---	-M-	-ML
Z	---	--L	--L	-ML	<u>H-L</u>

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
		HLP	HML	HML	HML	HML		HLP	HML	HML	HML	HML
NEMERTEA												
Emplectonema gracile	F	---			---	---						
	W	---	H--	---	-M-	---						
	S	---	---	---	--L	--L						-M-
	Z	---	---	---	---	<u>HM-</u>						-M-
Cerebratulis californiensis	F	---			---	---						
	W	---	---	---	---	---						
	S	-L-	---	---	---	---						
	Z	---	---	---	---	---						
NEMERTEA TOTAL (4)		2	3	2	3	3						
SIPUNCULOIDEA												
Phascolosoma agassizii	F	---			---	---						
	W	---	---	---	---	--L						
	S	-LP	---	---	-M-	---						
	Z	---	---	---	H--	---						
Themiste sp.	F	---			---	---						
	W	---	-M-	---	---	---						
	S	---	--L	--L	---	---						
	Z	---	---	---	---	---						
Themiste dyscritum	F	---			---	---						
	W	---	---	---	---	---						
	S	-L-	---	---	---	---						
	Z	<u>-L-</u>	---	---	---	---						
SIPUNCULOIDEA TOTAL (3)		2	1	1	1	1						
ANNELIDA (Polychaeta)												
Phragmatopoma californica	F	-L-			-ML	---						
	W	-LP	HML	HML	-ML	HML						
	S	-LP	HML	HML	-ML	<u>HML</u>						
	Z	<u>-L-</u>	-ML	-ML	-ML	<u>-ML</u>						
Girriformia spirabanchia	F	-L-			---	---						
	W	<u>-L-</u>	---	---	H--	-M-						
	S	-L-	-M-	---	---	-M-						
	Z	<u>-L-</u>	---	---	---	-M-						
ANNELIDA cont.												
Nereidae (several unid. species)	F	<u>-L-</u>			---	---						
	W	---	---	---	---	---						-M-
	S	-LP	-M-	---	---	---						-M-
	Z	---	---	---	---	<u>-ML</u>						---
Serpulidae (several unid. species)	F	<u>-L-</u>			---	---						
	W	---	---	-M-	---	---						
	S	-LP	---	---	---	-M-						-ML
	Z	---	---	---	---	---						---
Halosydna brevisetosa	F	---			---	---						
	W	---	---	---	---	---						-M-
	S	-L-	---	---	---	---						---
	Z	---	---	--L	---	---						---
Serpula vermicularis	F	---			---	---						
	W	---	HML	H--	---	--L						
	S	---	HML	-ML	---	---						
	Z	---	-ML	HML	---	---						
Terebellidae (prob. sev. spp.)	F	---			---	--L						
	W	---	---	---	---	---						-ML
	S	-L-	---	---	---	-M-						-M-
	Z	---	---	---	---	<u>-M-</u>						---
Bocardia proboscidea	F	<u>H--</u>			---	<u>H--</u>						
	W	<u>HL-</u>	---	---	---	<u>H--</u>						---
	S	<u>H--</u>	---	---	---	<u>H--</u>						---
	Z	<u>H--</u>	---	---	---	<u>H--</u>						---
Cirriformia luxuriosa	F	---			---	<u>HM-</u>						
	W	---	---	---	---	<u>HM-</u>						HM-
	S	---	---	---	---	<u>HM-</u>						<u>HM-</u>
	Z	---	---	---	---	<u>HM-</u>						<u>HM-</u>
Dodecaceria sp.	F	---			---	---						
	W	---	---	---	---	--L						-M-
	S	---	---	---	---	--L						-M-
	Z	---	---	---	---	<u>-L-</u>						-M-
Eupomatus gracilis	F	---			---	---						
	W	---	---	H--	---	---						
	S	-L-	---	---	---	---						
	Z	---	---	---	---	---						

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
ARTHROPODA cont.		HLP	HML	HML	HML	HML	ARTHROPODA cont.	HLP	HML	HML	HML	HML
Balanus crenatus	F	---			---		Ligia pallasii	F	---		---	
	W	---			---			W	---	H--	H--	H--
	S	-L-			---			S	---	H--	H--	H--
	Z	---			---	--L		Z	---	H--	H--	H--
Balanus cariosus	F	---			---		Porcellio scaber americanus	F	---		---	
	W	---			---			W	---		---	
	S	---			---	HML		S	H--		---	H--
	Z	---			---	--L		Z	---		---	---
Balanus nubilis	F	---			---		Armadillium vulgare	F	---		---	
	W	---			---			W	---		---	
	S	---			---			S	---		---	
	Z	---		--L	---			Z	---		---	H--
ARTHROPODA (barnacles)							Cirolana harfordi	F	---		---	
TOTAL (7)		4	4	4	4	6		W	-L-	---	---	---
								S	HLP	---	---	---
								Z	---	---	---	---
ARTHROPODA (amphipods)							"Dynamene" dilatata	F	---		---	
Gammarids (several spp.)	F	---			---			W	-L-	---	---	---
	W	---	-ML	-ML	--L	-M-		S	-L-	---	---	---
	S	M--	-ML	-ML	HML	H-L		Z	---	---	---	---
	Z	H--	-ML	-ML	HM-	H-L	Gnoidenaspaeroma oregonensis	F	---		---	
ARTHROPODA (amphipods)								W	---		---	
TOTAL ("1")		1	1	1	1	1		S	---		H--	---
								Z	---		-M-	---
ARTHROPODA (isopods)							Idothea urotoma	F	---		---	
Idothea stenops	F	---			---			W	---	---	---	---
	W	---	--L	--L	---	---		S	---	---	---	---
	S	---	--L	-ML	--L	--L		Z	---	---	-M-	---
	Z	---	--L	--L	--L	--L	Ligia occidentalis	F	H--		---	
Idothea montereyensis	F	---			---			W	---	---	---	---
	W	---		--L	---	---		S	H--	---	---	---
	S	-L-	--L	--L	---	---		Z	H--	---	---	---
	Z	---	--L	--L	---	---	Tecticeps convexus	F	---		---	
Idothea vosnesenskii	F	-L-			---			W	---		---	---
	W	---			-ML	-M-		S	---		--L	---
	S	-LP			-ML	-ML		Z	---		---	---
	Z	---			-ML	---	ARTHROPODA (isopods)					
							TOTAL (12)					

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
ARTHROPODA (decapods)		HLP	HML	HML	HML	HML
Crabs						
<i>Pachygrapsus crassipes</i>	F	H--			---	
	W	H--	HM-	HM-	-ML	-M-
	S	H--	HM-	HM-	H--	HML
	Z	H--	HM-	HM-	-M-	-M-
<i>Pagurus hirsutiusculus</i>	F	-LP			---	
	W	-LP	HML	HML	---	HM-
	S	-LP	-ML	-ML	---	-L
	Z	-LP	-ML	-ML	-ML	HM-
<i>Pugettia producta</i>	F	-L-			--L	
	W	-LP	--L	---	---	-M-
	S	LP	--L	--L	---	-ML
	Z	-P	--L	--L	-L	---
<i>Cancer antennarius</i>	F	---			---	
	W	-LP	---	---	---	-M-
	S	-L-	---	--L	---	-ML
	Z	-L-	---	---	--L	---
<i>Pagurus samuelis</i>	F	-LP			---	
	W	---	---	---	---	---
	S	---	-ML	-ML	---	---
	Z	---	---	---	---	---
<i>Pachycheiles rudis</i>	F	---			---	
	W	---	---	---	---	--L
	S	---	---	---	-L	-L
	Z	---	---	---	---	---
<i>Pagurus granosimanus</i>	F	---			---	
	W	-L-	---	---	---	---
	S	---	---	---	---	---
	Z	-L-	--L	---	---	---
<i>Cancer anthonyi</i>	F	---			---	
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	-L-	---	---	---	---
<i>Cancer jordani</i>	F	-L-			---	
	W	---	---	---	---	---
	S	---	---	---	---	---

ARTHROPODA cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
<i>Emerita analoga</i>	F	---			---	
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	-L-	---	---	---	---
<i>Petrolisthes cinctipes</i>	F	---			---	
	W	---	---	---	---	-M-
	S	---	---	---	---	-M-
	Z	---	---	---	---	-M-
ARTHROPODS (decapods) Crabs						
TOTAL (11)		9	5	5	5	6
ARTHROPODA (decapods)						
Shrimp						
<i>Spirontocaris sp.</i>	F	---			---	
	W	---	---	---	---	-M-
	S	-L-	---	---	---	---
	Z	---	---	---	---	---
<i>Spirontocaris picta</i>	F	---			---	
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	---	-M-
<i>Spirontocaris taylori</i>	F	---			---	
	W	---	---	---	---	---
	S	---	--L	---	---	---
	Z	---	---	---	---	---
ARTHROPODS (decapods) Shrimp						
TOTAL (3)		1	1	0	0	2
ARTHROPODA (Miscellaneous)						
<i>Pycnogonum stearnsi</i>	F	---			--L	
	W	---	---	H--	---	---
	S	---	---	---	-L	---
	Z	---	---	---	---	-L
Red mites	F	---			---	
	W	H--	HM-	---	---	H--
	S	H--	H--	---	---	H--

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
ARTHROPODA (misc.) cont.	HLP	HML	HML	HML	HML
Copepoda					
Tigriopus californicus	F --- W --- S --- Z ---	---	---	---	H-- H-- H--
ARTHROPODA (Misc.)					
TOTAL (3)	1	1	1	1	3

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (cephalopods)					
Octopus sp. (washed ashore, dying)	F --- W --- S --- Z ---	---	---	---	---
TOTAL (1)	0	0	0	0	1

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (amphineurans)					
Mopalia ciliata	F H-- W -L- S -L- Z -L-	--L	-M-	-ML	-ML
Mopalia muscosa	F HL- W HLP S HLP Z -L-	HM-	HM-	-ML	HML
Nutallina californica	F --- W H-- S H-- Z H--	H--	HM-	-M-	HM-
Cyanoplax dentiens	F --- W -L- S HL- Z HL-	---	--L	---	---
Cyanoplax hartwegi	F --- W --- S --- Z ---	H--	---	---	---

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (cont.) amphineurans					
Mopalia hindsii	F --- W --- S --- Z ---	--L	--L	--L	---
Mopalia lignosa	F --- W --- S -LP Z ---	---	---	---	---
Tonicella lineata	F --- W --- S --- Z ---	---	---	---	--L
MOLLUSCA (amphineurans)					
TOTAL (8)	6	6	6	5	6

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (pelecypods)					
Hiatella sp. (including "red siphons")	F --P W H-P S HLP Z ---	HML	HML	-M-	-ML
Mytilus californianus	F H-- W H-- S H-- Z H--	HM-	HM-	HML	HML
Mytilus edulis	F H-- W H-P S H-- Z H--	HM-	HM-	HML	HML
"Boring lamellibranchs" Species not determined	F --- W --- S --- Z ---	---	-M-	---	---
White "nesting clam" Species not determined	F --- W H-- S -L- Z ---	---	---	H-L	-M-

MOLLUSCA cont. (pelecypods)

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
<i>Botula</i> sp.	F ---			---	
	W --P	---	---	---	---
	S ---	---	---	---	---
	Z -L-	---	-M-	---	---
<i>Glans carpenteri</i>	F ---			---	---
	W ---	--L	---	---	---
	S -L-	---	---	---	---
	Z ---	---	---	---	---
<i>Penitella penita</i>	F ---			---	
	W -L-	---	---	---	---
	S -L-	---	---	---	---
	Z -L-	---	---	-M-	---
<i>Petricola carditoides</i>	F ---			---	
	W --P	---	---	---	---
	S HL-	---	---	-M-	---
	Z	---	---	H--	---
<i>Protothaca stamina</i>	F ---			---	
	W ---	---	---	---	---
	S -L-	--L	---	---	---
	Z --P	--L	---	---	---
<i>Cryptomya californica</i>	F ---			-M-	
	W ---	---	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Grippina</i> sp.	F ---			---	
	W ---	---	---	--L	---
	S ---	---	---	---	---
	Z ---	---	---	---	---
<i>Hinnites multirugosa</i>	F --P			---	
	W ---	---	---	---	---
	S --P	---	---	---	---
	Z ---	---	---	---	---
<i>Mytilimeria nuttallii</i>	F ---			---	
	W ---	---	---	---	---
	S ---	---	---	---	---
	Z ---	---	---	---	--L

MOLLUSCA cont.

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML
<i>Platydon cancellatus</i>	F ---			---	
	W ---	---	---	---	---
	S H--	---	---	---	---
	Z ---	---	---	---	---
MOLLUSCA (pelecypods) TOTAL (15)	11	6	5	8	5

MOLLUSCA (gastropods)

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
Limpets					
<i>Collisella digitalis</i>	F <u>H--</u>			<u>HM-</u>	
	W <u>H-P</u>	H--	HM-	<u>HML</u>	HM-
	S <u>H-P</u>	H--	H--	<u>HML</u>	<u>HML</u>
	Z <u>H--</u>	H--	H--	<u>HM-</u>	<u>HML</u>
<i>Collisella pelta</i>	F <u>HL-</u>			<u>HML</u>	
	W <u>HLP</u>	HML	HML	<u>HML</u>	HM-
	S <u>HLP</u>	HML	HML	<u>HML</u>	<u>HML</u>
	Z <u>HLP</u>	HML	HML	<u>HML</u>	<u>HML</u>
<i>Collisella scabra</i>	F <u>H--</u>			<u>HM-</u>	
	W <u>HLP</u>	H--	H--	<u>HM-</u>	HM-
	S <u>HLP</u>	HM-	HM-	<u>HM-</u>	<u>HM-</u>
	Z <u>H--</u>	HM-	HM-	<u>HM-</u>	<u>HML</u>
<i>Notoacmea inessa</i>	F --P	-		---	
	W ---	-ML	-M-	--L	-ML
	S --P	-ML	--L	--L	--L
	Z <u>-LP</u>	--L	---	---	--L
<i>Notoacmea palacea</i>	F --P			---	
	W <u>-L-</u>	HML	--L	---	-M-
	S <u>-L-</u>	--L	--L	--L	--L
	Z <u>-L-</u>	--L	--L	---	---
<i>Notoacmea scutum</i>	F --P			---	
	W --P	H--	-ML	---	---
	S --P	H--	-M-	-M-	<u>H--</u>
	Z --P	---	---	-M-	HM-
<i>Collisella asmi</i>	F <u>-LP</u>			---	
	W <u>-L-</u>	H--	---	H--	-M-
	S <u>-LP</u>	-M-	---	<u>HML</u>	H--

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (gastropods) cont.	HLP	HML	HML	HML	HML	MOLLUSCA (gastropods) cont.	HLP	HML	HML	HML	HML
<i>Lottia gigantea</i>	F ---	---	---	---	---	<i>Megatebennus bimaculatus</i>	F ---	---	---	---	---
	W ---	---	H--	---	H--		W ---	---	---	---	---
	S ---	HM-	HM-	---	HM-		S ---	---	---	---	-M-
	Z ---	-M-	HM-	-M-	---		Z ---	---	---	---	---
<i>Trimusculus reticulatus</i>	F ---	---	---	---	---	<i>Notoacmea fenestrata</i>	F ---	---	---	---	---
	W ---	---	-M-	-ML	-M-		W ---	---	---	---	---
	S ---	---	---	-M-	-M-		S ---	---	---	---	---
	Z H--	---	---	---	---		Z ---	--L	---	---	---
<i>Collisella strigatella</i>	F ---	---	---	H--	---	<i>Tectura rosacea</i>	F ---	---	---	---	---
	W H--	---	---	---	---		W ---	---	---	---	---
	S -L-	---	---	---	---		S -L-	---	---	---	---
	Z H--	---	---	-M-	HM-		Z -L-	---	---	---	---
<i>Collisella limatula</i>	F ---	---	---	---	---	MOLLUSCA (gastropods) limpets					
	W ---	---	---	---	---	TOTAL (19)	14	10	9	11	11
	S ---	---	---	-M-	---						
	Z ---	---	-M-	H--	---	MOLLUSCA (gastropods)					
<i>Crepidula adunca</i>	F -LP	---	---	---	---	Snails					
	W -LP	--L	---	---	---	<i>Lacuna</i> sp.	F -LP	---	---	--L	---
	S -LP	--L	---	---	---		W -LP	HML	-ML	-ML	-M-
	Z ---	---	---	---	---		S -LP	-ML	--L	HML	-ML
<i>Collisella instabilis</i>	F --P	---	---	---	---		Z -LP	-ML	-ML	-ML	-ML
	W ---	---	---	---	---	<i>Littorina planaxis</i>	F H--	---	---	---	---
	S ---	---	---	---	---		W ---	H--	H--	H--	H--
	Z -L-	---	---	---	---		S H--	H--	H--	---	H--
<i>Collisella ochracea</i>	F -L-	---	---	---	---		Z ---	H--	H-L	H--	---
	W ---	---	---	---	---	<i>Littorina scutulata</i>	F HL-	---	---	---	HM-
	S ---	---	---	---	---		W H--	H--	H--	HM-	H--
	Z ---	---	---	---	---		S H--	H--	H-L	HM-	H--
<i>Crepidula</i> sp.	F -L-	---	---	---	---		Z H--	H--	H--	HM-	HML
	W ---	---	---	---	---	<i>Tegula funebris</i>	F -LP	---	---	---	HM-
	S ---	---	---	---	---		W -LP	HML	HML	HML	HM-
	Z ---	---	---	---	---		S HLP	HML	-M-	HML	HM-
<i>Haliotis cracherodii</i>	F ---	---	---	---	---		Z HL-	-M-	---	HM-	HM-
	W ---	---	---	---	-M-	<i>Thais emarginata</i>	F -LP	---	---	---	HML
	S ---	---	---	---	---		W -LP	HML	HM-	HML	HM-
	Z ---	---	---	---	---		S -LP	HML	-ML	HML	HML
							Z H--	---	---	-M-	HM-

	Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (gastropods) cont.	HLP	HML	HML	HML	HML	MOLLUSCA (gastropods) cont.	HLP	HML	HML	HML	HML
<i>Acanthina spirata</i>	F ---					<i>Turbonilla tenuicula</i>	F ---				
	W -L-	HM-	-M-		-M-		W ---				
	S -L-				-M-		S -L-				
	Z -L-	-ML	--L				Z ---				
<i>Epitonium sp.</i>	F -L-					MOLLUSCA (gastropods) snails					
	W ---					TOTAL (15)	13	11	7	7	9
	S -L-				HML						
	Z ---			-L	H-						
<i>Mitrella sp.</i>	F -LP					MOLLUSCA (gastropods)					
	W -LP	H--				Slugs					
	S HLP	--L	--L			<i>Aeolida papillosa</i>	F ---				
	Z -LP						W ---			-M-	
<i>Olivella biplicata</i>	F -L-			--L			S ---				H--
	W -L-				-M-	<i>Dialuda sandiegensis</i>	Z -L-				
	S -L-			-M-			F ---				
	Z ---						W ---	-M-			-M-
<i>Tegula brunnea</i>	F -LP						S ---		-M-		-ML
	W -LP	-ML			H--	<i>Archidoris montereyensis</i>	Z ---				
	S -LP	--L			--L		F ---			--L	
	Z -L-						W ---				-M-
<i>Amphissa sp.</i>	F ---						S ---				-M-
	W ---					<i>Coryphella trilineata</i>	Z ---				
	S H--						F ---				
	Z -M-	--L					W ---				
<i>Calliostoma canaliculatum</i>	F ---						S ---	--L			--L
	W ---	H--				<i>Hermisenda crassicornis</i>	Z ---				
	S ---						F -L-				
	Z ---						W -P				
<i>Calliostoma costatum</i>	F ---						S ---				
	W ---	-ML					Z ---	-M-			
	S ---					<i>Oncidiella sp.</i>	F ---				
	Z ---						W ---	-M-			H--
<i>Tegula montereyi</i>	F --P						S ---				H--
	W ---					<i>Rostangia pulchra</i>	Z ---				
	S ---						F ---				
	Z ---						W ---				
							S ---				
							Z ---	-M-		H--	

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
MOLLUSCA (gastropods) cont.	HLP	HML	HML	HML	HML	
<i>Hermaeina smithi</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	H	---
<i>Triopha carpenteri</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	L	---
MOLLUSCA (gastropods) slugs						
TOTAL (9)	2	5	1	5	4	

ECTOPROCTA						
<i>Cyclostomata</i> (genus, species not determined)	F	---	---	---	---	---
	W	-L-	---	---	---	---
	S	---	-L	---	---	---
	Z	---	-L	-L	---	---
<i>Membranipora tuberculata</i>	F	---	---	---	---	---
	W	---	-ML	---	---	---
	S	---	-L	-L	---	---
	Z	---	-L	---	---	---
<i>Bugula californica</i>	F	---	---	---	---	---
	W	---	-L	---	---	---
	S	---	-L	---	---	---
	Z	---	-L	---	---	---
<i>Eurystomella bilabiata</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	-L	---	---	---
	Z	---	-L	---	---	---
<i>Tricellaria occidentalis</i>	F	---	---	---	---	---
	W	-L-	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	---	---
ECTOPROCTA TOTAL (5)	2	4	2	0	0	

ENTOPROCTA						
<i>Barentsia namosa</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	---	---	---	-L
	Z	---	---	-L	---	---
<i>Barentsia gracilis</i>	F	---	---	---	---	---
	W	---	---	---	---	-L
	S	---	---	---	---	-L
	Z	---	---	---	---	---
<i>Pedicellina cernua</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	---	-L
ENTOPROCTA TOTAL (3)	0	0	1	0	3	

ECHINODERMATA						
<i>Pisaster ochraceus</i>	F	-LP	---	---	-ML	---
	W	-LP	HML	HML	-ML	HML
	S	-LP	-ML	-ML	HML	HML
	Z	-L-	-ML	-ML	-ML	-ML
<i>Pisaster brevispinus</i>	F	-L-	---	---	-L	---
	W	---	HML	---	---	---
	S	---	-ML	---	---	-M-
	Z	-L-	---	---	---	---
<i>Strongylocentrotus purpuratus</i>	F	-L-	---	---	---	---
	W	-LP	---	H-	-L	-M-
	S	-LP	---	---	---	-ML
	Z	-L-	---	---	---	HM-
<i>Patiria miniata</i>	F	-L-	---	---	---	---
	W	---	-ML	---	---	---
	S	---	---	---	---	---
	Z	---	-M-	---	---	---
<i>Cucumaria curata</i>	F	---	---	---	---	---
	W	---	---	---	---	---
	S	---	---	---	---	---
	Z	---	---	---	---	-M-

ECHINODERMATA (cont.)

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML	HML
<i>Cucumaria</i> sp.	F	-L-				
	W					
	S					
	Z					
<i>Henricia leviuscula</i>	F					
	W					
	S	-L-				
	Z					
<i>Pycnopodia helianthoides</i>	F					
	W		--L			
	S					
	Z					
ECHINODERMATA TOTAL (8)		6	4	2	3	4

CHORDATA (tunicates)

<i>Styela montereyensis</i>	F	-L-				
	W		--L	--L	--L	
	S		--L	--L		--L
	Z					
<i>Amaroucium californicum</i>	F				--L	
	W				-ML	-ML
	S		--L	--L	--L	--L
	Z		--L	--L	--L	
<i>Eudistoma psammion</i>	F					
	W		-ML	-ML	--L	-M-
	S		--L	--L		
	Z		--L	--L		
<i>Clavelina huntsmani</i>	F					
	W					
	S		--L	--L		--L
	Z		--L	--L		
<i>Distaplia occidentalis</i>	F					
	W		--L			--L
	S		--L	--L		
	Z		--L	--L		

CHORDATA (tunicates) cont.

		Soquel Point	Santa Cruz Point East	Santa Cruz Point West	Almar Street	Natural Bridges
	HLP	HML	HML	HML	HML	HML
<i>Euherdmania claviformis</i>	F					
	W		--L	--L		
	S		--L			--L
	Z		--L	--L		
<i>Distaplia</i> sp.	F					
	W		-M-			
	S					--L
	Z		--L			--L
<i>Ascidia ceratodes</i>	F	-L-				
	W					
	S					
	Z					
<i>Diplosoma pizoni</i>	F					
	W		--L			
	S		--L			
	Z					
<i>Eudistoma ritteri</i>	F					
	W					
	S		--L			
	Z		--L			
<i>Perophora annectens</i>	F					
	W					--L
	S					--L
	Z					
<i>Pyura haustor</i>	F					
	W					--L
	S					--L
	Z					
<i>Sigillinaria pulchra</i>	F					
	W					
	S					
	Z		--L			
CHORDATA (tunicates) TOTAL (13)		2	10	6	3	9
TOTAL (191)		107	96	79	86	112

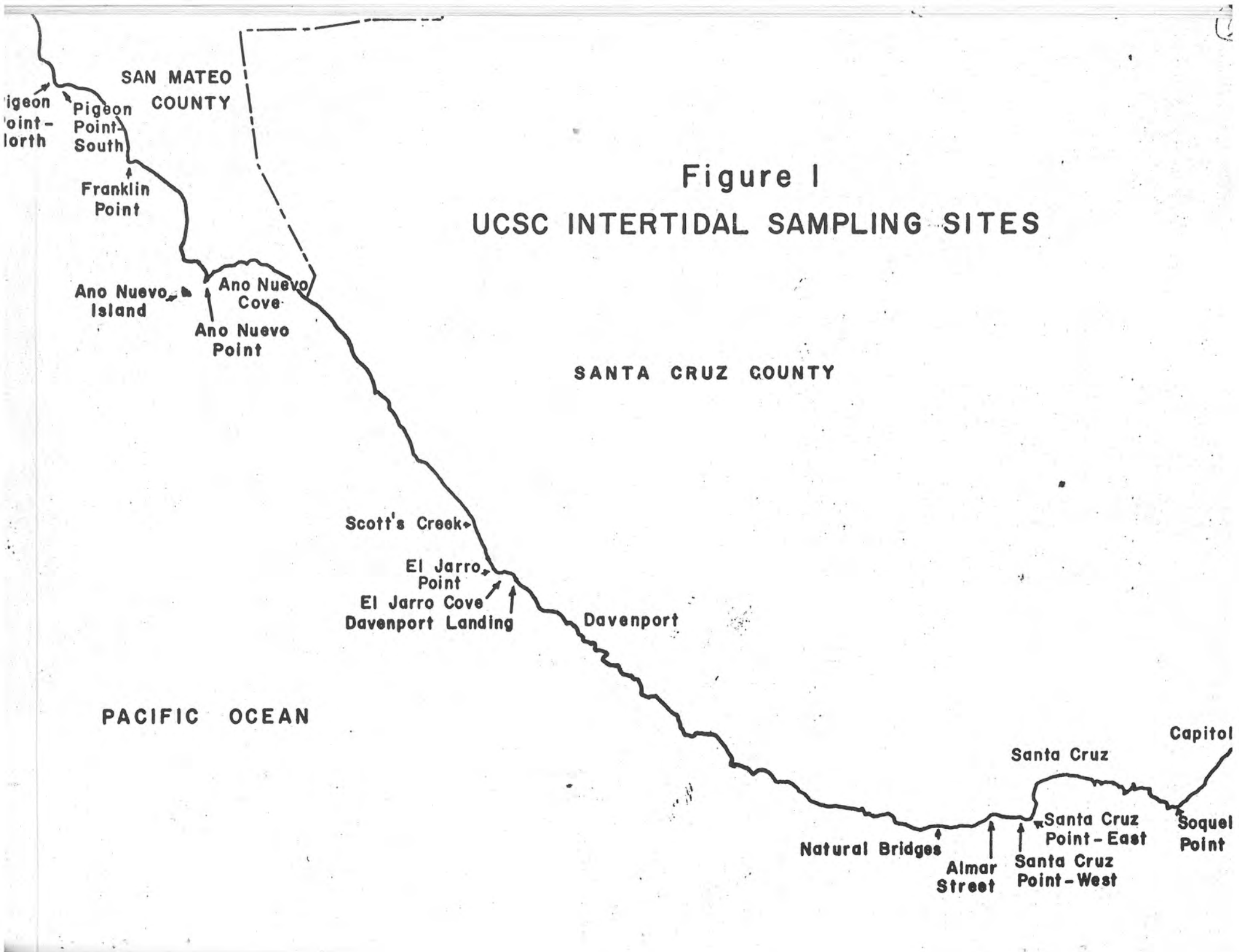


Figure 1
UCSC INTERTIDAL SAMPLING SITES

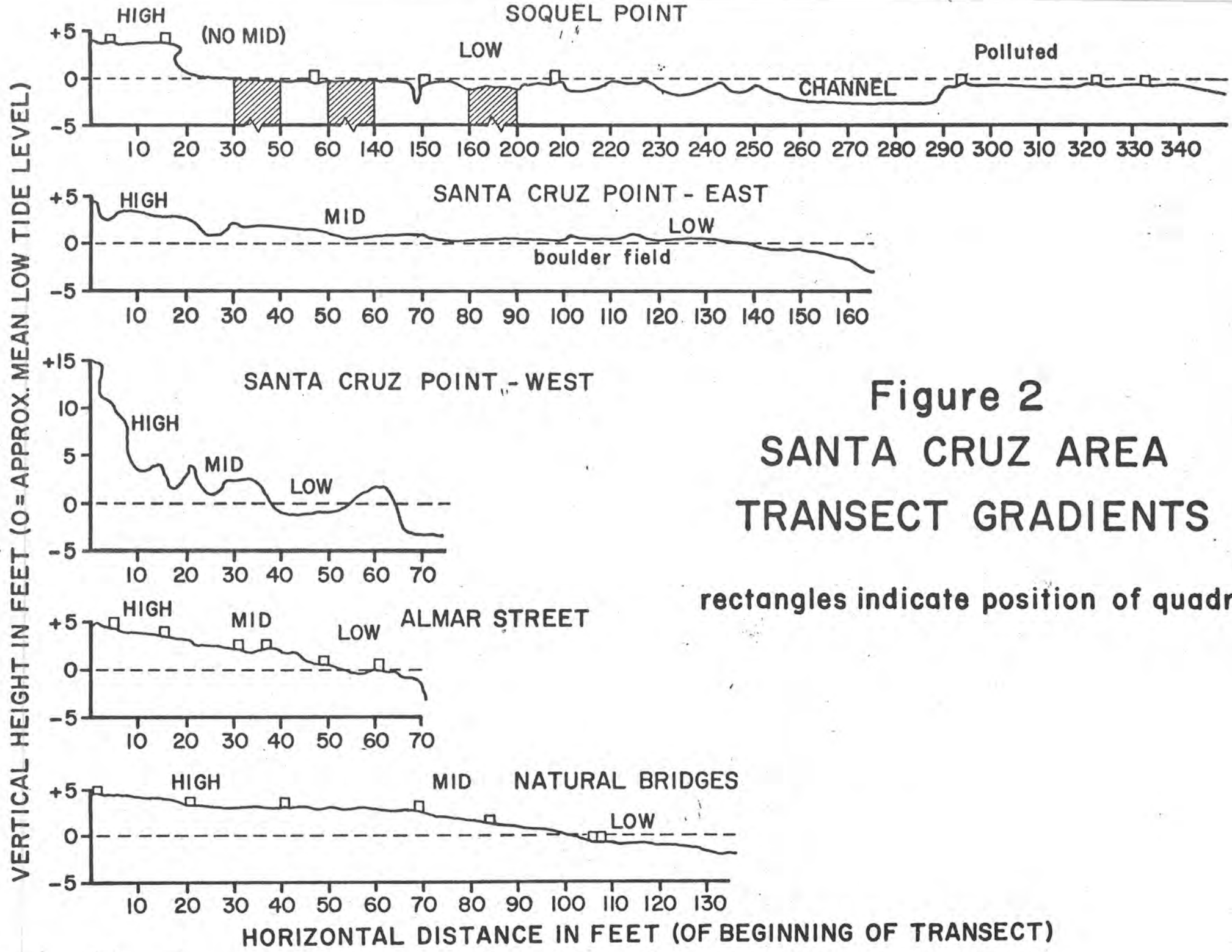


Figure 2
SANTA CRUZ AREA
TRANSECT GRADIENTS

rectangles indicate position of quadrats

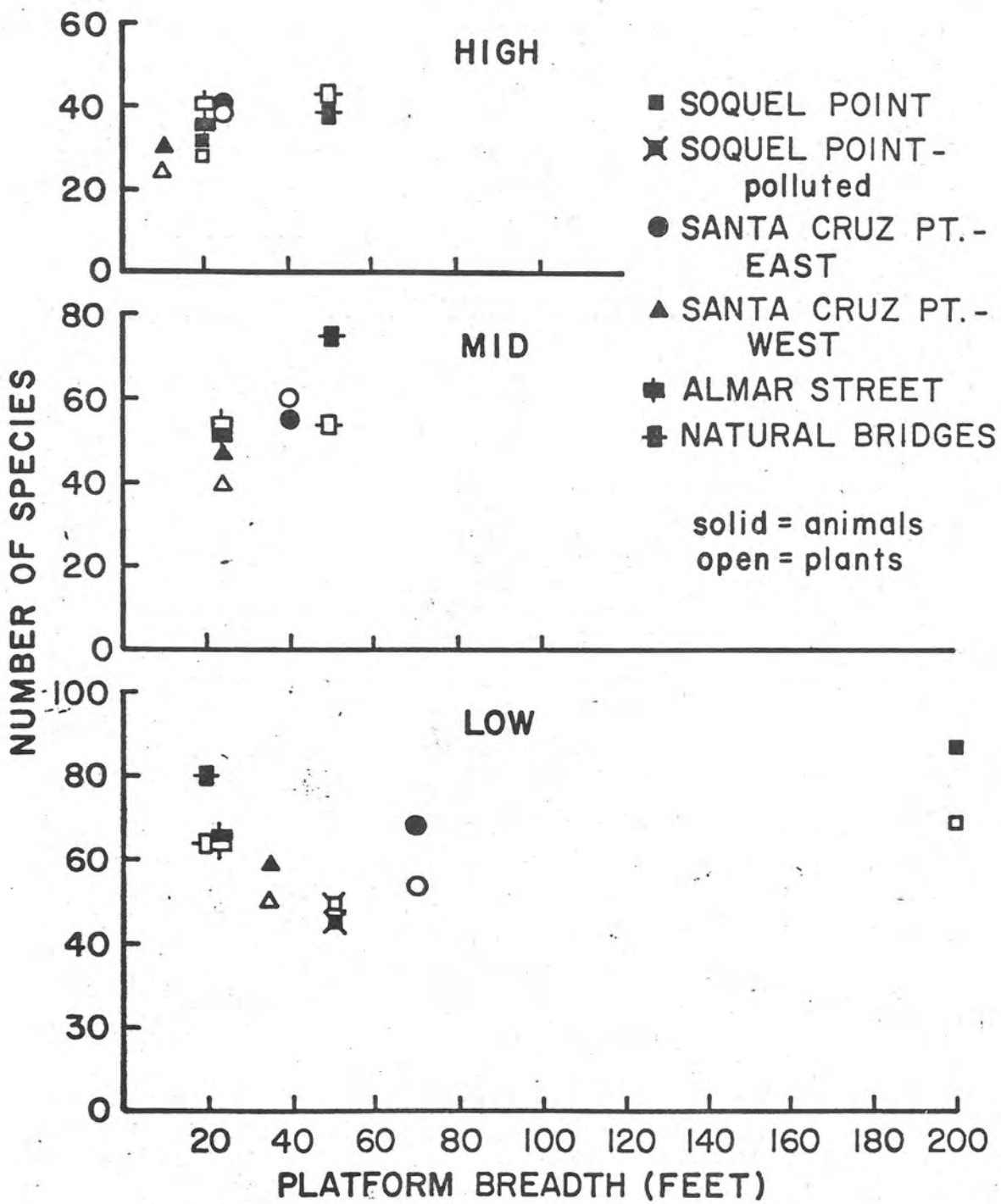


Figure 3

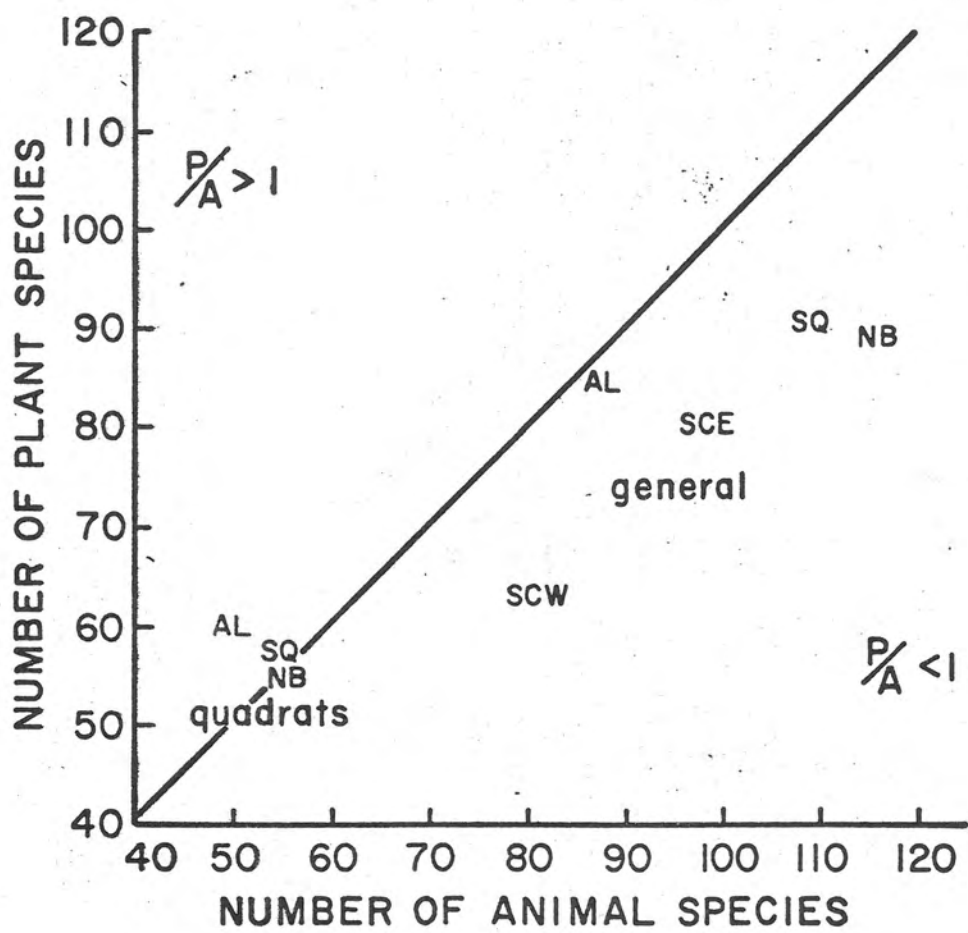


Figure 4

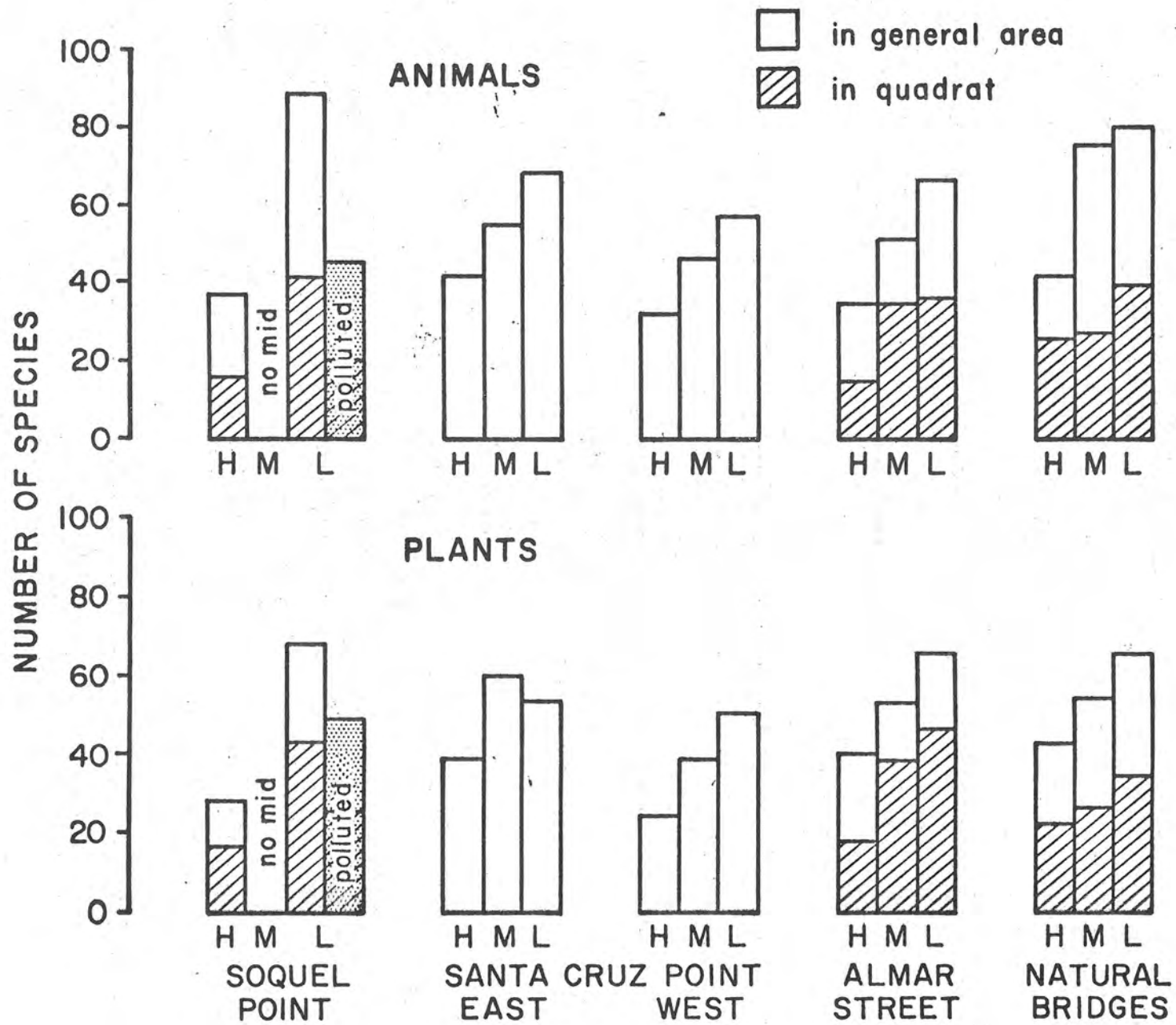


Figure 5

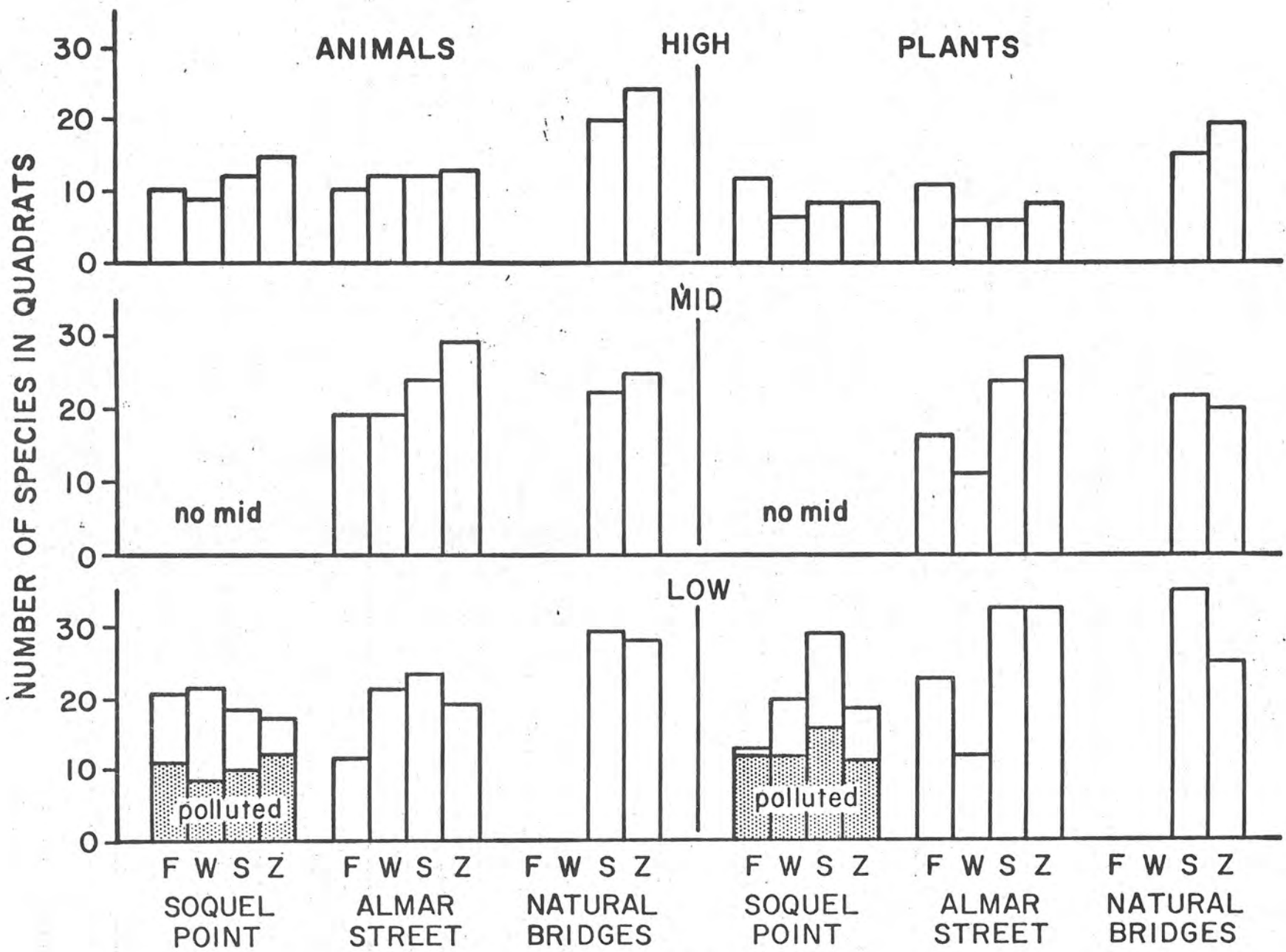


Figure 6

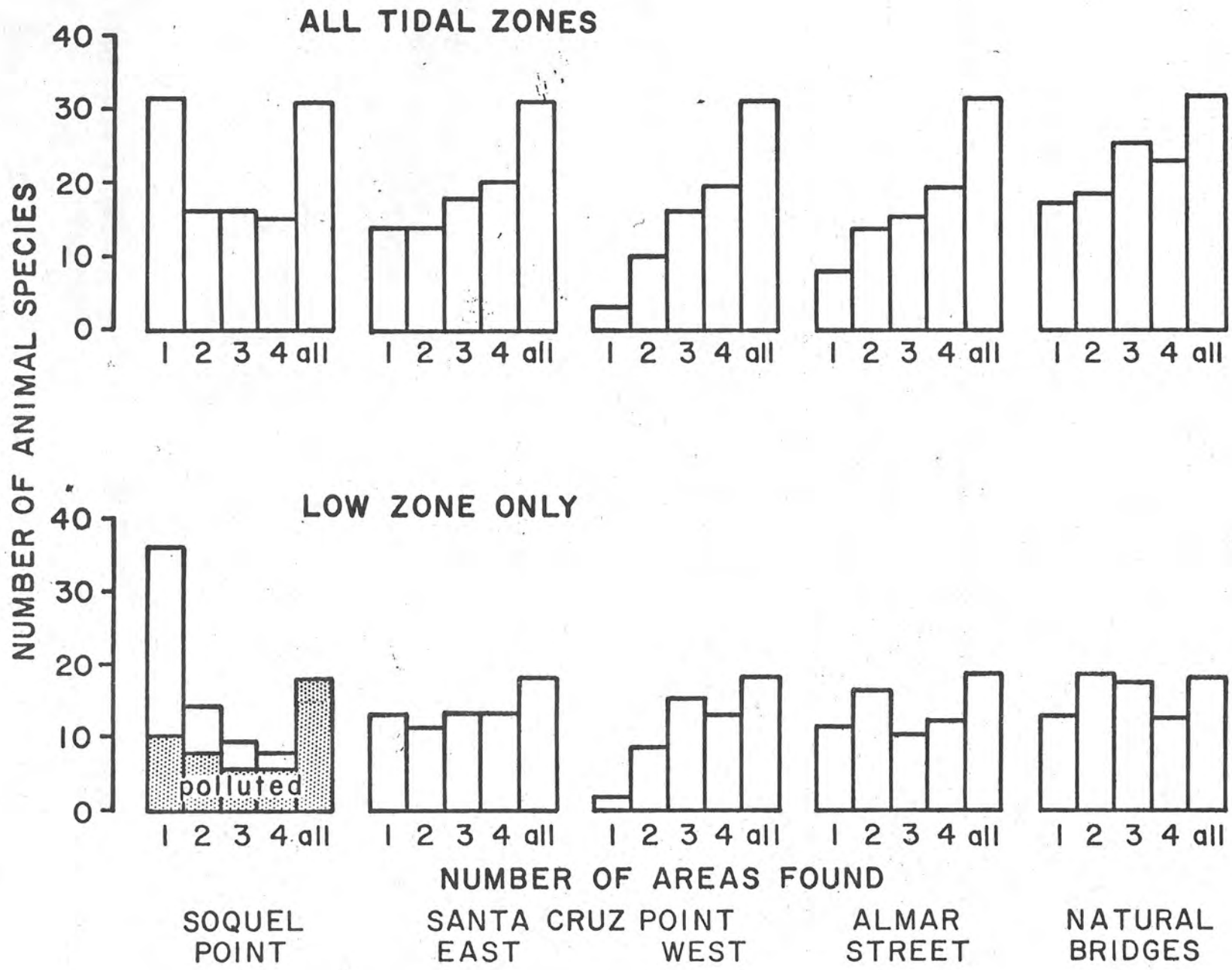
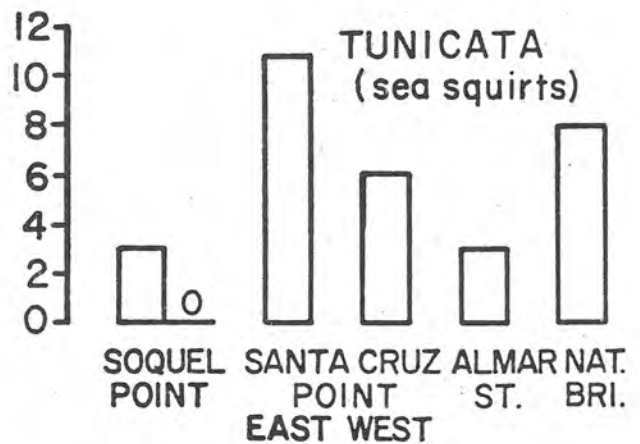
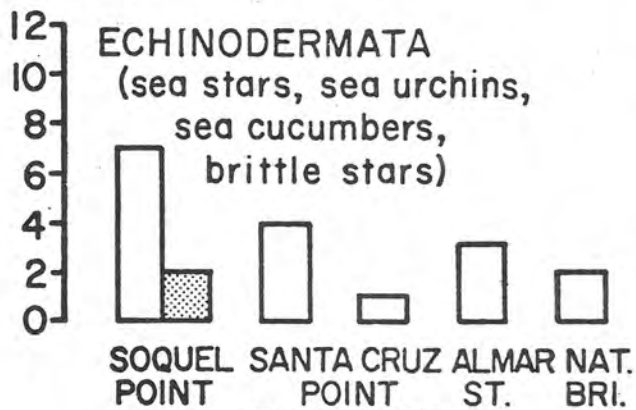
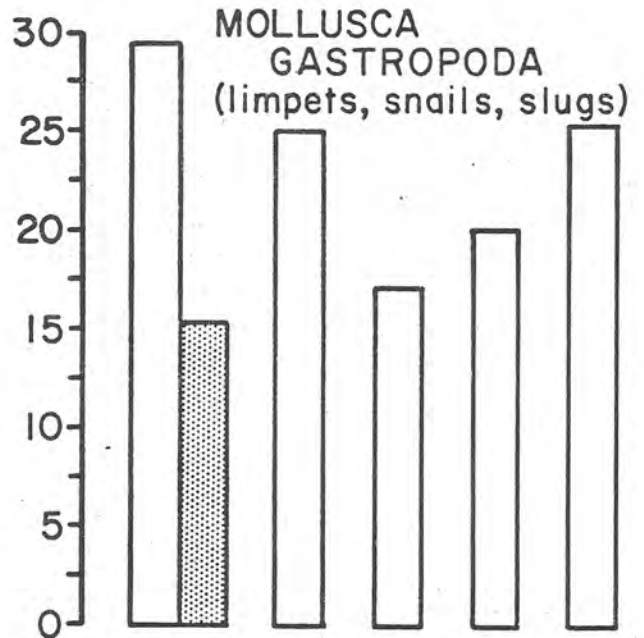
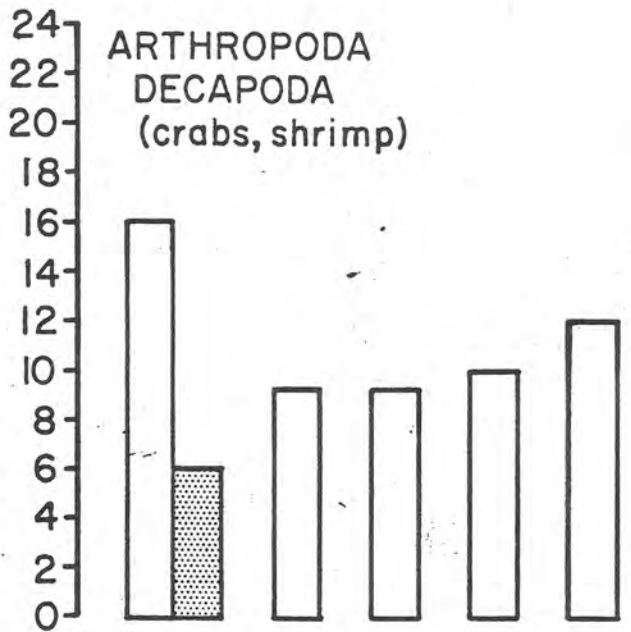
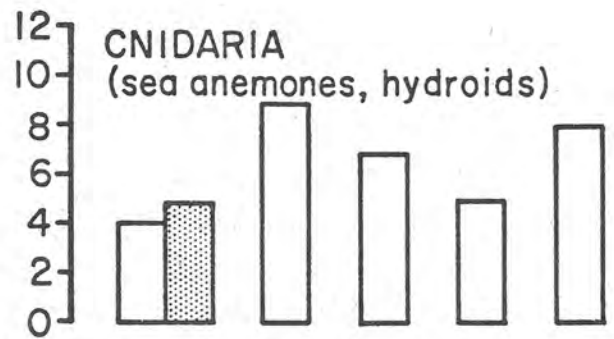
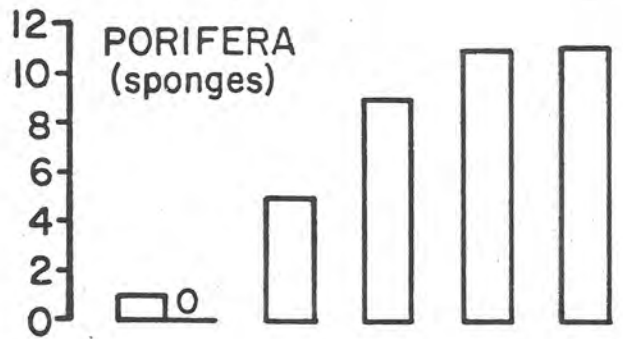


Figure 7

NUMBER OF SPECIES IN LOW ZONE



stipled indicates polluted

Figure 8