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A SURVEY OF THE MARINE ENVIRONMENT
NEAR THE CITY OF MONTEREY OCEAN OUTFALL

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Long Beach, California

STATE WATER RESOURCES CONTROL BOARD
CONTRACT (F&G S-1362)

MARINE RESOURCES
Administrative Report 73-5

June 1973

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CITY OF MONTEREY OCEAN OUTFALL ^{1/}

INTRODUCTION

The California Department of Fish and Game and the State Water Resources Control Board (through Regional Board #3, Central Coast) entered into an agreement whereby Department biologist-divers conducted a sub-tidal ecological investigation of the marine environment in the vicinity of the City of Monterey ocean outfall. The objective of the study was to provide the Regional Water Quality Control Board with data to assist them in evaluating the effects of the discharge on the marine environment.

The determinations made by biologist-divers included: (i) the number and diversity of the plant and animal life; (ii) substrate characteristics; and (iii) physical parameters, including water temperature, dissolved oxygen levels and clarity. Additionally, benthic samples were obtained by the divers and/or by a Ponar grab at each station.

The State Water Resources Control Board reimbursed the Department for part of the expenses incurred during this study.

AREA DESCRIPTION

The City of Monterey discharges its domestic and industrial waste water through a 30 inch diameter pipe to the shoreline east of the city and thence approximately 800 feet offshore into 30 feet of water. The discharge point is about 1500 yards NE of Monterey's Municipal Wharf No. 2 (Figure 1). The normal dry weather flow is about 3.0 to 3.5 million gallons per day (MGD) and increases to 5 MGD during wet weather.

The substrate in the discharge area consists of sand beach at the shoreline, silty-sand with low (1-3 foot) sandstone-mudstone shelves

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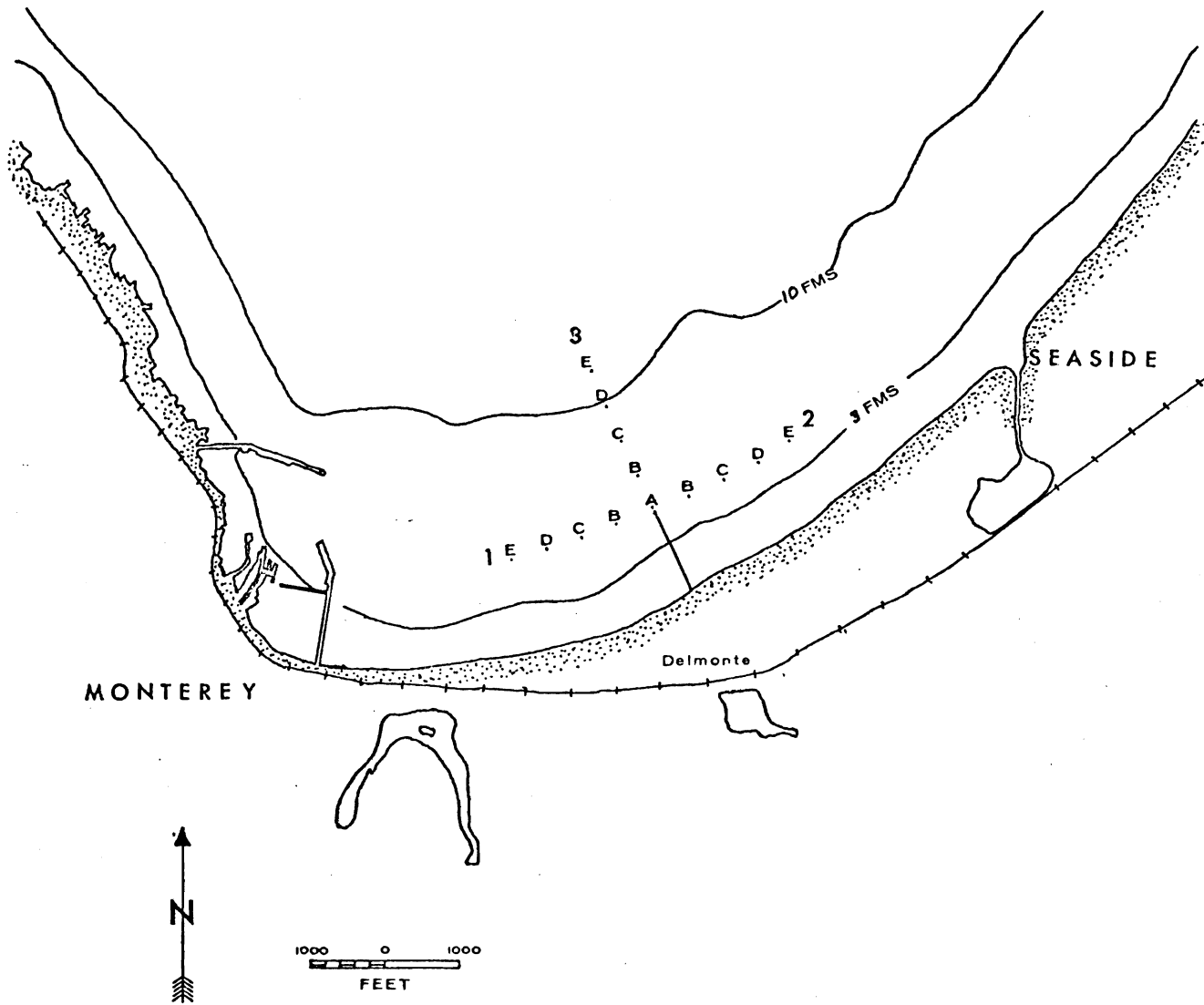


Figure 1. City of Monterey ocean discharge sampling locations, March 13 and 14, 1972.

at the discharge depth and a sand-mud bottom from approximately 35 ft of depth out to at least 70 ft deep.

Giant kelp (*Macrocystis* sp.) was present in nearly all areas where suitable substrate for attachment occurred although many plants were juveniles and did not reach the surface.

METHODS

The general methods used in this survey are described in reports of previous investigations (Turner, Ebert and Given, 1968). Field operations were conducted by Department biologists on March 13 and 14, 1972, from the Department's 92-foot research vessel, KELP BASS.

Station sites were selected along three transects each with 5 stations located at 500 ft increments starting with the discharge point (Figure 1). Station A is shared by each of the transects. The presence of a surface "boil" marking the end of the outfall was noted, and this facilitated station location. Each sampling site was marked with an anchor and buoy, and the vessel was anchored at the site. The station was then sampled, from the surface, utilizing a $1/20\text{m}^2$ Ponar grab, and/or surveyed by biologist-divers equipped with a full face mask with surface air supply and diver-to-surface communications. Multiple grabs were combined when single grabs produced insufficient sediment for analysis.

Diver occupied sampling sites on sand bottoms were defined by attaching a 3.1 m line to the station marker and inscribing an arc encompassing approximately 30m^2 . On rock bottoms a 2.2 m line was used to define the station which covers a 15m^2 area. Biologist-divers identified and enumerated all macroscopic plants and animals within the arcs.

Water temperature and dissolved oxygen determinations were made with a Martek Model DOA in situ dissolved oxygen monitor. Visibility estimates were taken by the divers at 10 ft intervals from the surface to the bottom.

General bottom conditions noted included substrate description; height, period and direction of ripple marks; and the presence of suspended organic material (leptopel) in the water column and on the bottom.

Sediment samples collected by the divers and the Ponar grab were sifted through a 0.5 mm screen, and the biota were preserved in 10% formalin preparatory to sorting and identification in the laboratory.

Due to a Department safety policy restricting diving activity in the immediate vicinity of sewage discharges, and due to a variety of substrate types encountered, we were unable to sample all stations alike. Some samples include only diver observations and collections, some only Ponar grabs, while others include both methods. Therefore, data are not always directly comparable from station to station and interpretation of results must take into account these differences.

RESULTS

Surface water temperature ranged from 13.0°C (Station 2D) to 15.1°C (Station 1E) while water temperature 30 ft deep was more constant, ranging from 12.2°C to 12.7°C (Table 1). A drop in temperature with increasing depth occurred, however, a definite thermocline was not present.

Dissolved oxygen concentrations in surface water averaged nearly 10.0 PPM and generally tended to increase with depth to 20 ft where the average was about 10.3 PPM. The lowest dissolved oxygen level recorded was 6.9 PPM at a depth of 70 ft (Station 3E).

Station A (at the discharge point) was sampled with Ponar grab only. *Macrocystis* sp. was evident at the surface about 50 ft from the discharge. The Ponar grab proved to be a poor sampler at this station due to the bottom being partially rocky (evidenced by some rock associated organisms in the samples). Only 1.75 liters of sediment were recovered from a total of 6 grabs. However, 2 genera of algae and 52 taxa of animals were

TABLE 1. Temperature, Dissolved Oxygen and Visibility Profiles for Stations Occupied in the Vicinity of the City of Monterey Ocean Discharge, March 13-14, 1972.

Date: 3-13 STATION A ^{1/} Time: 1530				
Depth(ft)	Temp(°C)	O ₂ *	Vis(ft)	Remarks
SS	13.4	10.1	No	Boil evident
10	13.1	10.2	diving	at surface.
20	13.0	10.4		No odor.
30	12.2	9.9		

Date: 3-13 STATION 1B Time: 1440				
Depth(ft)	Temp(°C)	O ₂ *	Vis(ft)	Remarks
SS	14.2	9.9	No	Discolored
10	13.5	10.3	diving	water at
20	13.1	10.4		surface.
30	12.3	9.7		Odor distinct.

Date: 3-13 STATION 2B Time: 1630				
Depth(ft)	Temp(°C)	O ₂ *	Vis(ft)	Remarks
SS	14.1	10.9	No	Discolored sur-
10	14.0	10.8	diving	face water.
20	13.2	10.5		Kelp canopy
30	12.6	10.0		present.

Date: 3-14 STATION 3B Time: 1030				
Depth(ft)	Temp(°C)	O ₂ *	Vis(ft)	Remarks
SS	13.2	9.8	No	No surface
10	13.0	9.8	diving	discoloration.
20	12.8	10.0		Kelp canopy
30	12.5	10.2		on both sides
40	12.5	9.1		of station.
45	12.0	8.4		

Date: 3-13 STATION 1C Time: 1400				
SS	Temp	O ₂	Vis	Remarks
SS	14.2	10.0	10-15	Heavy leptopel
10	13.9	10.3	10-15	throughout
20	13.2	10.4	10-15	water column.
30	12.6	9.8	8-15	

Date: 3-13 STATION 2C Time: 1700				
SS	Temp	O ₂	Vis	Remarks
SS	13.8	10.4	8	
10	14.4	10.2	8	
20	13.1	10.4	8	
30	12.3	10.0	8	
35	12.3	10.0	8	

Date: 3-14 STATION 3C Time: 1115				
SS	Temp	O ₂	Vis	Remarks
SS	13.1	10.0	20	Leptopel light
10	12.9	10.1	15	surface to 20
20	12.5	10.4	15	feet.
30	12.3	10.2	15	
40	12.0	8.6	10	Bottom sedi-
50	11.5	7.7	3	ment stirred
51	11.2	7.6	3	up.

Date: 3-13 STATION 1D Time: 1300				
SS	Temp	O ₂	Vis	Remarks
SS	14.7	9.7	10	Whitish water
10	13.8	10.3	10	at surface.
20	13.0	9.5	10	
30	12.2	9.2	10	
37	12.2	9.2	15	

Date: 3-14 STATION 2D Time: 0900				
SS	Temp	O ₂	Vis	Remarks
SS	13.0	9.9	15	Leptopel
10	12.8	9.9	15	throughout
20	12.5	10.0	15	water
30	12.5	9.9	15	column.
40	12.3	8.8	10	
47	12.2	8.8	2.5	

Date: 3-14 STATION 3D Time: 1200				
SS	Temp	O ₂	Vis	Remarks
SS	13.5	9.8	No	
10	13.1	10.0	diving	
20	12.6	10.6		
30	12.2	10.7		
40	12.0	8.9		
50	11.0	7.2		
60	11.0	7.0		

Date: 3-13 STATION 1E Time: 1220				
SS	Temp	O ₂	Vis	Remarks
SS	15.1		15	
10	13.2		12-15	
20	13.0		10	
30	12.3		6	
40	12.1		6	

Date: 3-14 STATION 2E Time: 1000				
SS	Temp	O ₂	Vis	Remarks
SS	13.5	9.3	15	No surface
10	13.0	10.0	15	discoloration.
20	12.6	10.3	15	Light leptopel
30	12.3	9.6	15	throughout
40	12.0	8.6	8-10	water column.
48	12.0	8.6	3	

Date: 3-14 STATION 3E Time: 1230				
SS	Temp	O ₂	Vis	Remarks
SS	14.4	9.8	No	
10	13.8	10.0	diving	
20	13.0	10.3		
30	12.7	10.5		
40	12.1	8.7		
50	11.1	7.2		
60	11.0	7.0		
70	10.7	6.9		

* Dissolved oxygen readings in PPM taken from aboard the vessel with a Martex Model DOA in situ dissolved oxygen monitor.

^{1/} Station "A" is shared by each of the three transects.

recorded (Table 2). A sea otter was observed foraging at this station, diving directly into the outfall boil. We could not determine what it was eating.

TRANSECT 1

Three grabs were taken at Station 1B (500 ft SW of the discharge point). This station reflected about 1/2 the number of species as did Station A. It was one of two stations where we recorded the presence of *Capetella capitata*, a polychaete worm generally associated with polluted areas. All animals recorded from this station were sand associated species.

Station 1C was established on a mixed sand-rock substrate. The rock was sandstone with ledges up to 5 ft high. The highest diversity of plants and animals was recorded at this station with rock and sand associated species found in abundance. *Macrocystis* sp. juveniles and various red algae predominated the flora while sea stars (*Pisaster giganteus* and *P. brevispinus*), small red anemones (*Corynactis californica*) and boring clams (*Chacea ovoidea*) were the most obvious animals.

The substrate was mostly sand at Station 1D (1500 ft SW of the discharge). Ripple marks in the sand with a 1 inch height and 4 inch period indicate a moderately low transport of sand. We found a limited amount of exposed sandstone with some low ledges present. Fewer animal species were recorded here than at stations to either side (1C and 1E), however, this was probably due to lack of high relief sandstone that was present at the other stations. *Macrocystis* sp. juveniles were the dominant algae in this station area.

Station 1E (the last station along this transect) was predominantly the area of sandstone shelves with a maximum relief of three feet and deeply undercut shelves. Some of the rock was covered by one inch of

TABLE 2. Plants and Animals Recorded from Transect 1, Monterey - March 13, 1972

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
ALGAE						
Red algae unid.	(P)			P	P	
<i>Bossiella orbigniana</i>			P			
<i>Bossiella</i> sp.	(P)					
<i>Calliarthron</i> sp.				(P)	A	
<i>Callophyllis</i> sp.			P	P		
Coralline algae unid.					P	
<i>Desmarestia herbacea</i>			P			
<i>Dictyneuropsis reticulata</i>			3	P	P	
<i>Fauchia</i> sp.			P	P		
<i>Fryeella gardnerii</i>			P			
<i>Goniotrichopsis</i> sp.			P			
<i>Gymnogongrus</i> sp.				P		
<i>Halidrys/Cystoseira</i>				P	C	
<i>Herposiphonia</i> sp.				(P)		
<i>Heterosiphonia asymmetria</i>			P			
<i>Lithothamnium</i> sp.			P			
<i>Macrocystis</i> sp.			A	P		Mostly juveniles
<i>Peysonnellia</i> sp.			P			
<i>Phycodrys setchellii</i>			P			
<i>Pikea pinnata</i>			P			
<i>Platythamnion</i> sp.			P			
<i>Plocamium coccineum</i>			P	P		
<i>Polyneura</i> sp.			P			
<i>Pterosiphonia</i> sp.			P			
<i>Stennogramme interrupta</i>			P			
INVERTEBRATA AND ASCIDIACEA						
Protozoa						
Foraminifera			[P]			
Porifera						
<i>Acarus erithacus</i>				P (P)	P	
Porifera unid.			[P]			
<i>Rhabdodermella nuttingi</i>			P		P	
Cnidaria						
<i>Anthopleura xanthogrammica</i>					P	
<i>Balanophyllia elegans</i>			C	P	A	

TABLE 2. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Corynactis californica</i>			A			
Hydroid (unid.)					P	
<i>Tealia columbiana</i>				1	1	Large specimens
Nematoda	(4)		[7]	7	(4) P	
Nemertea	(4)					
Platyhelmenthes	(2)				P	
Annelida						
<i>Ampharete</i> sp.		(4)				
Ampharetidae			[1]		(2)	
<i>Armandia bioculata</i>	(1)					
<i>Boccardia</i> sp.	(1)					
<i>Capitella capitata</i>		(7)				
<i>Chone</i> sp.			[1]			
<i>Chrysopetalum occidentale</i>	(1)					
Cirratulidae	(46)	(27)	[20]		[1]	
<i>Cistenides brevicoma</i>	(1)					
<i>Diopatra ornata</i>	(1)		[3]			
<i>Diopatra</i> sp.	(2)	(2)		c	(3)	
<i>Dorvillea rudolphi</i>	(1)					
<i>Eteone</i> sp.					(1)	
<i>Eudistylia polymorpha</i>			P			
<i>Exogone lourei</i>	(4)		[2]			
<i>Glycera</i> sp.	(1)					
<i>Halosydna brevisetosa</i>			[3]			
<i>Haploscoloplos elongatus</i>	(3)		[3]		(1)	
Hesionidae	(4)		[23]		(2)	
<i>Lanice conchilega</i>					(1)	
<i>Lumbrineris</i> sp.	(7)	(11)	[2]			
<i>Magelona</i> sp.		(2)				
<i>Nephtys</i> sp.		(1)				
<i>Nerinides acuta</i>	(2)					
Nereidae	(6)	(1)	[1]			
<i>Nothria</i> sp.		(1)	[1]			
Onuphidae		(1)				
<i>Ophiodromus pugettensis</i>			[1]			
Orbinidae			[1]			

TABLE 2. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Owenia collaris</i>			[1]			
<i>Pherusa</i> sp.	(4)					
Phyllodoceidae	(11)		[3]		(3)	Station A represents 3 species
<i>Platynereis bicanaliculata</i>	(5)		[3]			
Polychaete unid.			P		P	
<i>Polycirrus</i> sp.	(11)					
<i>Polydora</i> sp.	(1)					
Polynoidea			[1]			
<i>Prionospio pygmaeus</i>	(1)	(2)	[2]			
<i>Rhynchospio</i> sp.	(2)					
<i>Sabellaria cementarium</i>	(1)					
<i>Salmacina tribranchiata</i>			P	C		
<i>Serpula vermicularis</i>			1		P	
Serpulidae				P		
Spionidae	(1)					
<i>Spiophanes bombyx</i>		(1)				
<i>Sthenelanelia uniformis</i>					(2)	
Syllidae		(1)	[2]			
Terebellidae	(1)		[2]			
Sipunculida	(2)		[2]		(1)	
Arthropoda						
<i>Balanus nubilis</i>			1			
<i>Balanus</i> sp.			[8]		P	
<i>Cancer antennarius</i>					1	
<i>Cancer jordani</i>					(1)	
<i>Caprella equilibra</i>		(1)	[1]			
Caprellidae	(1)			(68)		
Copepoda					P	
<i>Cryptolithodes sitchensis</i>					1	
Cumacea	(50)	(5)	[7]			
Cyclopoid copepods			[22]			
Decapoda - zoea larva	(14)	(5)	[3]		(35)	
Euphausiacea					(8)	
Gammaridea	(176)	(15)	[34]	157	(61) 117	
Isopoda	(3)		[2]		(1) 66	

TABLE 2. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Loxorhynchus grandis</i>			1		1	
<i>Mimulus foliatus</i>				(1)		
Ostracoda	(10)		[3]		[P]	
<i>Pagurus samuelis</i>					[1]	
Paguridae	(3)		[9]	2	(5)	
<i>Pentiodtea resecata</i>					(1)	
<i>Pugettia gracilis</i>				(1)	(4) 2	
Pycnogonida			[1]			
Shrimp unid.	(2)					
<i>Spirontocaris taylora</i>			[1]			
<i>Spirontocaris</i> sp.					(20)	3 species
Mollusca						
<i>Acmaea mitra</i>					1	
<i>Acmaea</i> sp.				5	1	
<i>Acteocina culcitella</i>					(1)	
<i>Acteocina harpa</i>		(1)				
<i>Acteon punctocaelatus</i>			1		(2)	
<i>Aegires albopunctatus</i>			1			
<i>Alvinia compacta</i>	(5)		[8]			
<i>Alvinia</i> sp.				[3]	[1]	
<i>Amphissa</i> sp.			[1]		(6)	
<i>Anisodoris nobilis</i>			1		1	
<i>Astraea gibberosa</i>				1		
<i>Balcis thersites</i>			[3]			
<i>Cadlina leuteomarginata</i>			1			
<i>Caecum californicum</i>	(2)					
<i>Caecum crebricinctum</i>			[3]			
<i>Calliostoma annulatum</i>			1			
<i>Calliostoma canaliculatum</i>				1		
<i>Calliostoma</i> sp.			[8]			
<i>Ceratostoma foliata</i>			1		1	
<i>Chacea ovoidea</i>			A	P		
<i>Crepidula perforans</i>					2	
<i>Crepidatella lingulata</i>					2	
<i>Cryptochiton stelleri</i>				1	1	
<i>Dialula sandiegensis</i>					1	

TABLE 2. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Ciodora aspera</i>			[1]			
<i>Epitonium</i> sp.			[4]			
<i>Flabellinopsis iodinea</i>					1	
Gastropoda unid.	(2)		4	(7)	(2) 1	
<i>Granulina margaritula</i>			[1]			
<i>Hermisenda crassicornis</i>	(1)					
<i>Margarites</i> sp.			[1]			
<i>Megatebennus bimaculatus</i>			[2]			
<i>Megathura crenulata</i>			1		1	
<i>Mitrella carinata</i>				6	A	
<i>Mitrella gansapata</i>				5	(32)	
<i>Mitrella</i> sp.	(5)	(4)	[9]		2	
<i>Mytilus</i> sp.	(1)					
<i>Nassarius fossatus</i>	(2)				1	
<i>Nassarius mendicus</i>			[3]			
Nudibranch unid.			P			
<i>Olivella biplicata</i>		(1)				
<i>Olivella pycnia</i>	(3)	(14)	[1]		1	
<i>Ophiidermella ophioderma</i>			[1]			
<i>Parapholas californica</i>			3			
<i>Pododesmus cepio</i>			1			
<i>Polinices</i> sp.	(1)					
Polyplacophora			2	1		
<i>Protothaca</i> sp.	(3)	(2)				
<i>Rostanga pulchra</i>			[1]			
<i>Tellina</i> sp.		(1)			(1)	
<i>Tricolia compta</i>					(7)	
<i>Turbonilla</i> sp.			[5]		(2)	
Bryozoa						
Bryozoa unid.			C		P	Station C represents 3 species
<i>Phidolopora californica</i>			5			
Phoronida						
Phoronida (unid.)	(2)					
Echinodermata						
<i>Amphiodia digitata</i>	(1)		[1]			
<i>Amphipholis squamata</i>			3		(1)	

TABLE 2. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Dendraster excentricus</i>		(9)		(6)		
<i>Dermasterias imbricata</i>			1			
<i>Henricia laeviscula</i>			1		1	
Holothuroidea			P	C		
<i>Lytechinus anamesus</i>			1			
<i>Ophioplocus esmarki</i>			P			
Ophiothricidae	(2)					
<i>Ophiothrix spiculata</i>					1	
Ophiuroidea (unid.)	(2)		1			
<i>Orthasterias koehleri</i>			1		1	
<i>Pateria miniata</i>			4	P	P	
<i>Pisaster brevispinus</i>			19	P	6	
<i>Pisaster giganteus</i>			17		P	
<i>Pycnopodia helianthoides</i>			1			
Asciacea						
<i>Amaroucium californicum</i>			P			
Asciacea (unid.)			P		(2) C	
<i>Clavelina huntsmani</i>			.		C	
VERTEBRATA						
<i>Artedius</i> sp.			1			
<i>Chilara taylori</i>		(1)				
<i>Citharichthys</i> sp.				P		
<i>Coryphopterus nicholsii</i>					P	
<i>Hexagrammos decagrammus</i>					C	
<i>Orthonopias triacis</i>			P	P		
Pisces (larvae)	(3)				(5)	
<i>Rimicola muscarum</i>					(1)	
<i>Sebastes caurinus</i>					1	
<i>Sebastes chrysomelas</i>					1	
<i>Sebastes mystinus</i>			2		P	Juveniles

* Abundance Symbols:

P = Present in the area but relative abundance not estimated.

S = Sparse - widely scattered throughout the area but nowhere numerous.

C = Common - unevenly present throughout the area and only occasionally numerous.

A = Abundant - numerous and evenly distributed throughout the area.

() = Parentheses around the abundance symbol indicate occurrence in Ponar grab samples.

[] = Brackets around the abundance symbol indicate occurrence in diver taken sediment samples.

coarse sand. *Macrocystis* was not recorded here, however, other brown and red algae were noted as common to abundant. The invertebrate fauna was fairly diverse and fish were more abundant here than at any other station.

TRANSECT 2

Ponar grab samples at Station 2B (500 ft north of the discharge) probably picked up some loose sand overlying a rocky substrate as only one liter of sediment was recovered in five grab attempts and the sample contained only three animals (Table 3). The surface of the water at this station was discolored due to the discharge but a surface canopy of *Macrocystis* sp. was present.

Station 2C was located on a rocky bottom with shelves up to two feet high. Loose sand was covering about half of the area and some of the rock appeared scoured clean to the diver. Algae were sparsely represented in the area and sea stars (*Pisaster brevispinus*) were the most common animals. Some low encrusting sponges and ascidians were also present on the rocks while tubed polychaetes (*Diopatra* sp.) were common in the sand areas between rocks.

The bottom at Station 2D was a flat pavement rock area half of which was covered with two to three inches of sand. In addition a small amount of rock rubble about one foot high was present. Juvenile *Macrocystis* sp. was common in the area along with various red algae. The rock areas at this station were not heavily encrusted with animals, however, many small species not normally observed by divers were found in sediment samples, clumps of algae and other encrusting forms collected by the diver.

The last station along this transect (Station 2E) revealed a fine sand bottom with a white flocculent material accumulated along the crests of the sand ripple marks. The ripple marks were two inches high with an eighteen inch period indicating moderate sand transport in the area.

TABLE 3. Plants and Animals Recorded from Transect 2, Monterey - March 13-14, 1972

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
ALGAE						
Brown algae unid.			3			
Red algae unid.	(P)		[P]	P		
<i>Bossiella</i> sp.	(P)					
<i>Calliarthron</i> sp.			P	(P)		
<i>Lithothamnium</i> sp.				S		
<i>Macrocystis</i> sp.			S	C		Juveniles
<i>Rhodymenia</i> sp.				S		
INVERTEBRATA AND ASCIDIACEA						
Protozoa						
Foraminifera				[P]		
Porifera						
Porifera unid.			P	P		
<i>Rhabdodermella nuttingi</i>			[P]			
Cnidaria						
<i>Abietinaria</i> sp.			[P]			
<i>Aglaophenia</i> sp.			P			
<i>Anthopleura xanthogrammica</i>			G			
Anthozoa (unid.)			P	1		
<i>Balanophyllia elegans</i>				C		
<i>Tealia</i> sp.				1		
Nematoda	(4)		[3]	[1]		
Nemertea	(4)		1	(3) [C]		
Platyhelminthes	(2)			(3)		
Annelida						
<i>Armandia bioculata</i>	(1)					
<i>Boccardia</i> sp.	(1)					
<i>Chrysopetalum occidentale</i>	(1)		[5]	(2) [1]		
Cirratulidae	(46)			[4]		
<i>Cistenides brevicoma</i>	(1)					
<i>Diopatra ornata</i>	(1)			[1]		
<i>Diopatra</i> sp.	(2)		C	C		Station C up to 60/1/4 M ²
<i>Dorvillia rudolphi</i>	(1)					
<i>Exogone lourei</i>	(4)					
<i>Glycera</i> sp.	(1)			[9]		
<i>Haploscoloplos elongatus</i>	(3)					
Hesionidae	(4)			[17]		

TABLE 3. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Lumbrineris</i> sp.	(7)					
Maldanidae				[1]		
<i>Nerinides acuta</i>	(2)					
Nereidae	(6)			(2)	[1]	
<i>Ophelia assimilis</i>				[25]	[1]	
<i>Owenia collaris</i>				[1]		
<i>Pherusa</i> sp.	(4)					
Phyllodocidae	(11)		[2]	(6)		Station A, 3 spp. Station D, 2 spp.
<i>Platynereis bicanaliculata</i>	(5)		[1]			
Polychaete unid.					[P]	
<i>Polycirrus</i> sp.	(11)					
<i>Polydora</i> sp.	(1)		[3]	(1)		
<i>Prionospio pygmaeus</i>	(1)					
<i>Rhynchospio</i> sp.	(2)					
<i>Sabellaria cementarium</i>	(1)					
Spionidae	(1)		[2]			
Syllidae			[3]			2 species
Terebellidae	(1)			(1)[1]		
Sipunculida	(2)			3		
Arthropoda						
<i>Balanus</i> sp.			[A]	(P) A		
Brachyura				2		
Caprellidae	(1)			P		
Cumacea	(50)		[17]			
Decapoda - zoea larva	(14)			(100)		
Euphausiacea				[1]		
Gammaridea	(176)		[8]	(100)[96]		
Isopoda	(3)					
<i>Loxorhynchus grandis</i>			1			
<i>Mimulus foliatus</i>				1		
Ostracoda	(10)		[29]			
Paguridae	(3)	(1)		(3) 1		
<i>Pugettia richii</i>				2		
<i>Pugettia</i> sp.		(1)		1		
Shrimp unid.	(2)			(2)		
<i>Spirontocaris</i> sp.				1		

TABLE 3. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
Mollusca						
<i>Acmaea</i> sp.				1		
<i>Alvinia compacta</i>	(5)					
<i>Alvinia</i> sp.				[12]		
<i>Anisodoris nobilis</i>				1		
<i>Balcis thersites</i>				[3]		
<i>Caecum californicum</i>	(2)			(1)[9]		
<i>Caecum crebricinctum</i>				[14]		
<i>Cerithopsis carpenteri</i>				[4]		
<i>Chacea ovoidea</i>			C	S		
<i>Chione</i> sp.				[5]		
<i>Conus californicus</i>				[6]		
<i>Cooperella subdiaphana</i>				8		
<i>Epitonium</i> sp.				[2]		
<i>Fartulum</i> sp.				[2]		
<i>Flabellinopsis iodinea</i>				1		
<i>Fusinus</i> sp.				5		
Gastropoda unid.	(2)					
<i>Glans subquadrata</i>				[1]		
<i>Haliotis kamohatkana - assimilis</i>				1		
<i>Hermisenda crassicornis</i>	(1)					
<i>Ischnochiton albus</i>				1		
<i>Ischnochiton</i> sp.				7		
<i>Lyonsia californica</i>				1		
<i>Mitrella carinata</i>				1		
<i>Mitrella gausapata</i>				[5]		
<i>Mitrella</i> sp.	(5)		[3]	(2)[3]		
<i>Mytilus</i> sp.	(1)			[2]		
<i>Nassarius fossatus</i>	(2)				1	
<i>Nassarius</i> sp.				1	1	
Nudibranch unid.				(1)	6	
<i>Olivella biplicata</i>			[2]			
<i>Olivella pycnia</i>	(3)					
<i>Parapholas californica</i>			P			
Pelecypoda (unid. juveniles)			[2]	[8]		

TABLE 3. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Petricola californiensis</i>				1		
<i>Folinices</i> sp.	(1)					
Polyplacophora				2		
<i>Protothaca</i> sp.	(3)					
<i>Tegula</i> sp.				2		
<i>Tricolia</i> sp.				1		
<i>Turbonilla</i> sp.				[6]		
Bryozoa						
Bryozoa unid.		(P)		(P)	P	
<i>Filicrisia</i> sp.			[P]			
Phoronida						
Phoronida (unid.)	(2)					
Echinodermata						
<i>Amphiodia digitata</i>	(1)					
<i>Amphipholis squamata</i>				4		
<i>Dendraster excentricus</i>					5	
Holothuroidea						
				[2]		
<i>Leptasterias pusilla</i>				2		
<i>Ophiopholis aculeata</i>				2		
Ophiothricidae	(2)			5		
<i>Ophiothrix spiculata</i>				10		
Ophiuroidea (unid.)	(2)					
<i>Pateria miniata</i>			2	C		
<i>Pisaster brevispinus</i>			20	1		
<i>Solaster dawsoni</i>				2		
Ascidacea						
Ascidacea (unid.)			[P]	P		
<i>Eudistoma</i> sp.			[P]			
VERTEBRATA						
<i>Citharichthys</i> sp.				1		
Cottid unid.				1		
Pisces (larvae)	(3)			(2)		

* Abundance Symbols:

P = Present in the area but relative abundance not estimated.

S = Sparse - widely scattered throughout the area but nowhere numerous.

C = Common - unevenly present throughout the area and only occasionally numerous.

A = Abundant - numerous and evenly distributed throughout the area.

() = Parentheses around the abundance symbol indicate occurrence in ponar grab samples.

[] = Brackets around the abundance symbol indicate occurrence in diver taken sediment samples.

A two liter sample of sediment revealed only seven kinds of animals present. An unstable sand bottom will not allow the development of diverse biotic communities and this is probably the case at this station.

TRANSECT 3

Diving was used to sample only one station (3C) along Transect 3. The bottom was all sand at this station and this is probably true of the other stations along Transect 3. A fairly heavy accumulation of fine white flocculent material on the bottom was noted by the diver. Ripple marks in the sand were one-half inch high with a three inch period indicating a relatively stable sediment. The Ponar grab sample at Station 3D, in sixty feet of water, was the only sample that had a layer of black, hydrogen sulfide laden mud under the surface. All the others were fairly clean looking sand.

Samples from all four stations along Transect 3 had a similar diversity of small sand-dwelling organisms present (Table 4). The majority of the species recorded were polychaete worms or small molluscs.

DISCUSSION

The types of macroscopic plants and animals and their relative abundance observed by the divers during this survey, did not appear aberrant for similar habitat types found in the Monterey area. Fair numbers of benthic and sessile organisms were observed in the nearby rocky areas and beds of *Macrocystis* sp. appeared healthy with an abundance of small juveniles in the area.

Ponar grab samples revealed the occurrence of *Capitella capitata*, a polychaete worm reputed to be tolerant of polluted areas. These polychaetes were found at Stations 1B and 3C but, their occurrence did not seem to bear a relationship to the proximity of the discharge. However, indication of a possible response to the waste field was demonstrated

TABLE 4. Plants and Animals Recorded from Transect 3, Monterey - March 13-14, 1972

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
ALGAE						
Red algae unid.	(P)		P			
<i>Bossiella</i> sp.	(P)					
<i>Rhodymenia</i> sp.			S			
INVERTEBRATA AND ASCIDIACEA						
Protozoa						
<i>Gromia oviformis</i> - protozoa				(2)		
Cnidaria						
Anthozoa (unid.)				(1)		
Hydroid (unid.)			P			On <i>Diopatra</i> sp. tubes
Nematoda	(4)	(7)		(1)		
Nemertea	(4)	(2)	(4)	(3)		
Platyhelmenthes	(2)			(1)	(1)	
Annelida						
<i>Amaeana occidentalis</i>					(2)	
<i>Amage</i> sp.				(1)		
<i>Ampharete</i> sp.		(2)				
Ampharetidae				(6)	(2)	
<i>Aricidea</i> sp.				(2)		
<i>Armandia bioculata</i>	(1)	(2)				
<i>Boccardia</i> sp.	(1)	(1)	(1)		(1)	
<i>Capitella capitata</i>			(1)			
Capitellidae		(2)		(10)	(3)	
<i>Chone mollis</i>				(1)		
<i>Chone</i> sp.				(3)	(7)	
<i>Chrysopetalum occidentale</i>	(1)					
Cirratulidae	(46)	(46)		(27)	(6)	
<i>Cistenides brevicoma</i>	(1)			(2)		
<i>Diopatra ornata</i>	(1)	(6)		(1)	(1)	
<i>Diopatra</i> sp.	(2)		S			
<i>Dorvillea rudolphi</i>	(1)	(2)				
<i>Eteone dilatatae</i>				(1)	(2)	
<i>Exogone lourei</i>	(4)	(8)				
<i>Glycera convoluta</i>			(7)			
<i>Glycera</i> sp.	(1)	(3)	(1)	(1)	(2)	
<i>Glycinde polygnatha</i>		(1)	(4)	(12)		

TABLE 4. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Glycinde</i> sp.					(9)	
<i>Goniada brunnea</i>			(1)			
<i>Haploscoloplos elongatus</i>	(3)	(8)	(1)	(5)		
<i>Harmothoe scriptoria</i>					(2)	
Hesionidae	(4)	(2)		(12)		
<i>Laonice cirrata</i>					(1)	
<i>Lumbrineris tetraura</i>			(7)			
<i>Lumbrineris</i> sp.	(7)	(27)		(13)	(23)	
<i>Magelona sacculata</i>				(7)		
<i>Magelona</i> sp.					(3)	
Maldanidae		(3)	(1)	(5)	(3)	Station B represents 2 species
<i>Nephtys cornuta franciscana</i>				(1)		
<i>Nephtys</i> sp.				(1)	(2)	
<i>Nerinides acuta</i>	(2)					
Nereidae	(6)	(6)			(1)	
<i>Nothria</i> sp.			(7)			
Onuphidae				(2)		
<i>Ophelia assimilis</i>					(1)	
<i>Owenia collaris</i>		(1)				
Paraonidae					(1)	
<i>Pherusa</i> sp.	(4)			(1)		
<i>Pholoe glabra</i>				(10)	(3)	
Phyllodocidae	(11)	(3)		(4)	(2)	Station A represents 3 species
<i>Platynereis bicanaliculata</i>	(5)					
Polychaete unid.			P			
<i>Polycirrus</i> sp.	(11)					
<i>Polydora</i> sp.	(1)	(4)		(1)		
Polynoidea		(1)				
<i>Prionospio cirrifera</i>				(16)		
<i>Prionospio malmgreni</i>				(7)	(2)	
<i>Prionospio pinnata</i>				(1)		
<i>Prionospio pygmaeus</i>	(1)	(5)	(2)	(8)	(1)	
<i>Prionospio</i> sp.		(2)				
<i>Rhynchospio</i> sp.	(2)					
<i>Sabellaria cementarium</i>	(1)					
Spionidae	(1)					

TABLE 4. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Spiophanes bombyx</i>				(3)		
<i>Spiophanes missionensis</i>				(1)		
<i>Sthenelais verruculosa</i>					(1)	
<i>Sthenelais</i> sp.				(3)		
<i>Sthenelaniella uniformis</i>				(1)		
Syllidae		(1)		(2)		
Terebellidae	(1)					
<i>Thalenessa spinosa</i>		(2)	(1)	(1)		
Sipunculida	(2)			(1)		
Arthropoda						
Brachyura		(1)	(2)		(3)	
<i>Cancer</i> sp.		(1)	1		(1)	
Caprellidae	(1)	(6)				
Cumacea	(50)	(12)	(4)	(4)	(8)	
Decapoda - zoea larva	(14)	(A)	(A)	(A)	(A)	
Gammaridea	(176)	(56)	(6) 234	(18)	(13)	
Isopoda	(3)	(3)		(1)	(4)	
Mysidacea			1			
Ostracoda	(10)		(2)	(3)		
Paguridae	(3)		1			
Shrimp unid.	(2)		(1)	(47)		
<i>Spirontocaris</i> sp.		(7)				
Mollusca						
<i>Acteocina culcitella</i>				(10)		
<i>Acteocina harpa</i>			(1)	(1)		
<i>Acteocina</i> sp.		(5)			(5)	
<i>Acteon punctocaelatus</i>		(2)				
<i>Alvinia compacta</i>	(5)				(3)	
<i>Alvinia</i> sp.		(17)	(18)			
<i>Amphissa</i> sp.		(2)				
<i>Balcis thersites</i>					(1)	
<i>Barleeia</i> sp.					(5)	
<i>Cadulus</i> sp.		(1)		(6)	(5)	
<i>Caecum californicum</i>	(2)					
<i>Caecum crebricinctum</i>				(2)		
<i>Cyanoplax hartwegii</i>					(1)	

TABLE 4. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Cylinchma alba</i>				(3)		
<i>Dentalium</i> sp.		(1)			(2)	
<i>Epitonium tinctum</i>				(5)		
<i>Epitonium</i> sp.					(7)	
Gastropoda unid.	(2)	(3)		(35)	(8)	
<i>Hermisenda crassicornis</i>	(1)					
<i>Lacuna</i> sp.				(1)		
<i>Mitrella gansapata</i>		(2)				
<i>Mitrella</i> sp.	(5)		(1) 11	(1)	(4)	
<i>Mytilus</i> sp.	(1)					
<i>Nassarius fossatus</i>	(2)					
<i>Nassarius</i> sp.					(1)	
<i>Nuculana</i> sp.		(5)				
<i>Olivella baetica</i>					(1)	
<i>Olivella pyenia</i>	(3)				(1)	
<i>Opalia</i> sp.				(2)		
Pelecypoda (unid. juveniles)		(7)		(22)	(2)	
<i>Polinices</i> sp.	(1)					
<i>Protothaca</i> sp.	(3)		(2)			
<i>Solen sicarius</i>					(1)	
<i>Tellina modesta</i>		(10)				
<i>Tellina</i> sp.				(9)		
<i>Tricolia pulloides</i>		(1)				
<i>Tricolia</i> sp.			1			
<i>Turbonilla</i> sp.		(11)		(4)	(6)	
Turridae					(1)	
<i>Vitrinella</i> sp.				(12)	(3)	
Chaetognatha						
Chaetognatha (unid.)		(1)	(1)			
Phoronida						
Phoronida (unid.)	(2)					
<i>Phoronis vancouverensis</i>		(4)				
Hemichordata						
Hemichordata (Enteropneusta)				(5)		
Echinodermata						
<i>Amphiodia digitata</i>	(1)		(2)			

TABLE 4. Contd.

Scientific name	Station and Abundance*					Remarks
	A	B	C	D	E	
<i>Amphipholis</i> sp.				(1)		
<i>Amphiura</i> sp.		(2)			(1)	
Amphiuridae				(6)		
<i>Dendraster excentricus</i>		(102)	S		(2)	
Holothuroidea				(3)	(2)	
Ophiothricidae	(2)					
<i>Ophiothrix spiculata</i>			1			
Ophiuroidea (unid.)	(2)					
Urchin - Unid.			(1)			
VERTEBRATA						
<i>Citharichthys</i> sp.			2			
Pisces (larvae)	(3)	(5)	(P)	(2)		

* Abundance Symbols:

P = Present in the area but relative abundance not estimated.

S = Sparse - widely scattered throughout the area but nowhere numerous.

C = Common - unevenly present throughout the area and only occasionally numerous.

A = Abundant - numerous and evenly distributed throughout the area.

() = Parentheses around the abundance symbol indicate occurrence in ponar grab samples.

by the distribution of cirratulid polychaetes (Tables 2, 3, and 4).

Cirratulids were most abundant at the discharge terminus and at Station 3B, while samples revealed lower numbers at stations further away.

The total number of different plants and animals recorded at each station indicates a decrease in species diversity 500 ft SW and NE of the discharge (Figure 2). However, these totals are probably more directly related to the types of samples taken and substrate type than to distance from the outfall.

CONCLUSIONS AND RECOMMENDATIONS

The biologist-divers underwater observations in the vicinity of the Monterey discharge did not indicate the waste field was affecting the plant and animal communities in the areas away from the discharge. These observations were made at points 1000, 1500 and 2000 ft from the discharge. Abundance and diversity of algae, invertebrates and fish observed at each station were dependent on substrate type and height of relief.

Ponar grab samples revealed an increased population of cirratulid polychaetes at stations nearest the outfall.

The results of this survey indicate the need for additional sampling in the area of greatest impact. Subsequent sampling is needed within 1000 ft of the discharge with replicate samples taken to define sampling error. Additionally, use of divers in collecting sediment samples might give more uniform results as the Ponar grab was not effective at all stations. These additional data are needed to substantiate or further describe the effect of the waste field on the distribution of the benthic populations in the discharge area.

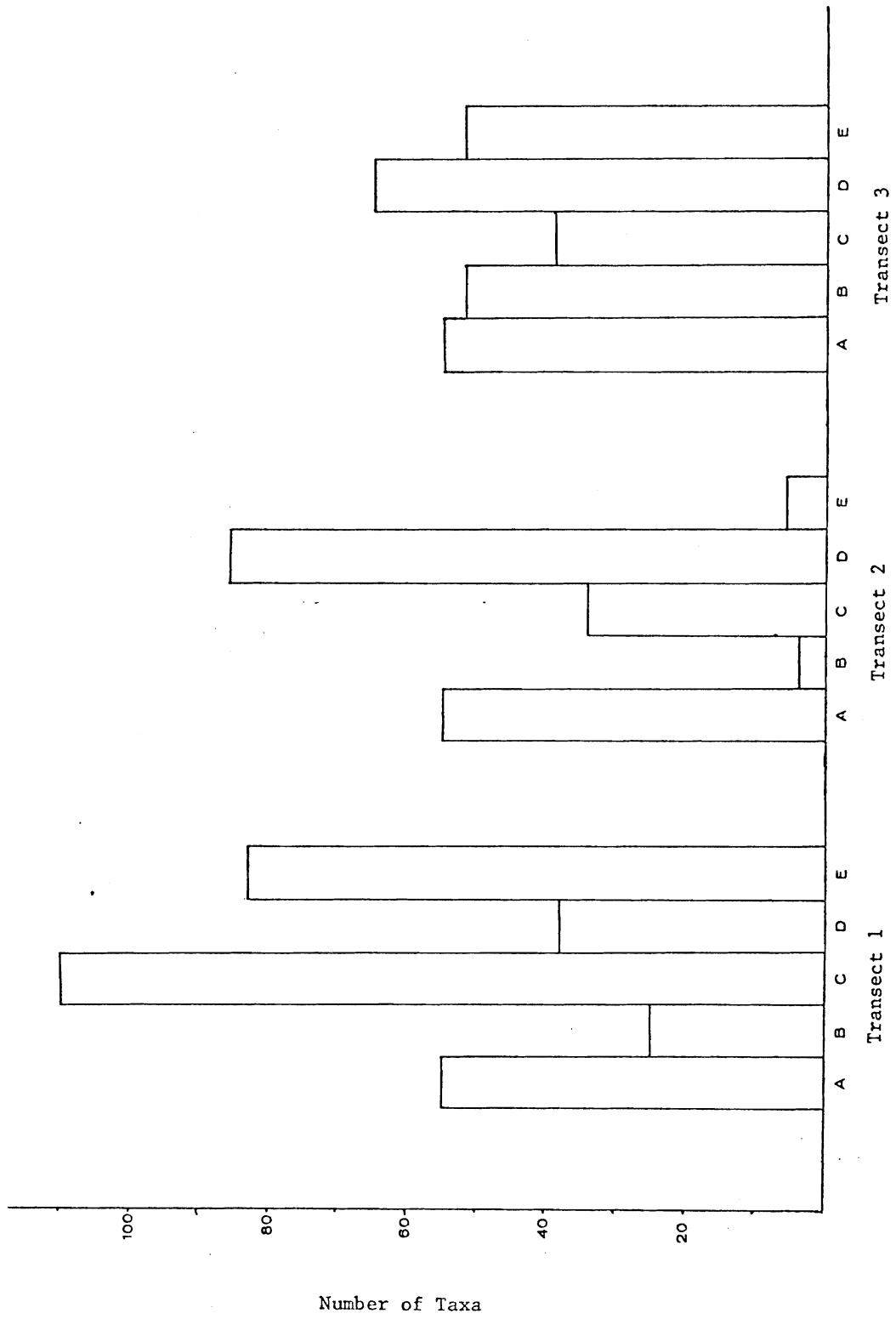


Figure 2. Number of taxa recorded at stations near Monterey sewage discharge, March 13 and 14, 1972.

ACKNOWLEDGMENTS

Thanks are due to Mel Odemar, Dan Odenweller, Pete Haaker, Brad Myers, Richard Dixon and the captain and crew of the R/V KELP BASS for their assistance in conducting the field work. My thanks also go to Cynthia Klepadlo, Brad Myers, Richard Dixon, Ken Wilson, and Richard Moe for many hours of sorting and identification of collections, and to Charel Cueva for typing the manuscript.

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