

**A SURVEY OF SELECTED CORAL AND FISH ASSEMBLAGES
NEAR THE WAIANAE OCEAN OUTFALL, 1992**

Anthony R. Russo

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Principal Investigator: Roger S. Fujioka

WATER RESOURCES RESEARCH CENTER

University of Hawaii at Manoa

Honolulu, Hawaii 96822

ABSTRACT

In 1992 coral growth and fish abundance were monitored at stations located on and in the vicinity of the Waianae ocean outfall diffuser. Comparisons of 1992 results with fish surveys done in previous years showed no significant differences in species composition or relative abundances of fish populations. Fish species were essentially the same as seen in similar natural biotopes around Hawaii. There were no differences in coral cover from 1991 to 1992 at a station 1.2 km south of the outfall. At the diffuser corals were becoming established in an environment which was devoid of corals in 1986. The water was clear at all stations; visibility was 12–15 m and the sediments were clean and white. No significant deleterious effects to the marine community in the vicinity of the outfall were observed.

INTRODUCTION

This report is submitted to the City and County of Honolulu in compliance with the Department of Land and Natural Resources (DLNR) requirements for the biomonitoring of corals, fishes, and macroinvertebrates in the vicinity of the Waianae ocean outfall (see ltr. 11/15/83; CPO 844, file# DA 4/11/83).

In May 1992, University of Hawaii (WRRC) and CCH oceanographic personnel completed a SCUBA survey of the marine community near the Waianae ocean outfall. This reports summarizes the results of that survey.

SURVEY STATIONS (FIG. 1)

Station W2

This station, located 1.2 km south of the zone of initial dilution (ZID) in coarse sand at a depth of approximately 30 m. An artificial reef, the sunken ship *Mahi*, is located at the station. This area is important for tourist divers and supports local dive shops as a favorite dive site. It is known for its clear water and abundance of marine life.

Station W3

This station, located at the diffuser (approx. 34 m depth). The diffuser pipe (1.5 m diam.) is buried in the sediment and covered with tremie concrete. Discharge is through risers projecting vertically from the pipe. Surrounding sediments consist of coarse carbonate sands.

Station W4

This station, located 100 m SE of the diffuser at a depth of approximately 30 m on the ZID boundary. It is located in the extreme northern part of the fish haven. The substratum consists of carbonate sands and rubble.

MATERIALS AND METHODS

At all stations fish counts were made by divers equipped with SCUBA. At Station W2 divers counted fishes along a permanently selected transect (30 m long, 6 m wide) down the centerline of the ship's deck (Brock 1982). At Station W3 fish counts were made along the terminal 30 m of the diffuser, and Station W4 counts were made along two permanent 30 m transects. Fish abundances were compared with past surveys using a non-parametric test of presence or absence (Cochran's Q-test; Green 1979). Also a Bray-Curtis Index was used to

measure similarity in species composition. At Stations W2 and W4 fish community composition, abundance, and number of species were compared with surveys from 1986, 1987, 1988, and 1991. At Station W3 comparison of fish abundance and diversity was made between 1986 and 1992. During the years between 1986 and 1992 reconnaissance (bounce) dives showed little fish activity at the diffuser and no fish were seen swimming on the transect.

Estimates of coral cover were made on selected permanent transects by bottom photography and subsequent projection of photos on a grid. Coral cover was estimated by total grid cover relative to the total area of the quadrat. At all stations the presence of all macroinvertebrates seen were recorded. Coral cover was compared between years using a paired comparison t-test to determine if there were significant differences in total coral cover.

RESULTS

Station W2

Fishes were very abundant at this station in 1992 ($N = 121$). Twenty four (24) species were represented. Fish abundance, by species, is shown in Table 1 for 1986, 1987, 1988, 1991, and 1992. In 1986 large numbers of the filefish *Pervagor spilosoma* (o'ili-uwi'uwi) (62 per transect) were seen but this species was not abundant in subsequent years. Periodic increases in abundance of this species have been reported in the past, and the last large increase in population abundance of *P. spilosoma* took place in 1985. *P. spilosoma* represented 20 to 30% of the total fish abundance in 1986. In subsequent years this filefish represented $< 5\%$ of the total abundance. The snapper *Lutjanus kasmira* (ta'ape) was also seen in large numbers in 1986 and 1987. *P. spilosoma* and *L. kasmira* together represented $> 50\%$ of the total fish abundance in 1986. In 1992 they represented 30.5% of the abundance. *L. kasmira* (ta'ape) was introduced into Hawaii from the Society Islands in the early 1950's and since then has shown a rapid rate of increase in stocks around the Hawaiian Islands. There was no significant difference in presence or absence of species between years (Q-test, $p < 0.01$). Similarity among years in species composition was high ($SI = 0.67-0.73$). Any similarity index over 0.5 is considered to be significant (Green 1979).

Coral cover was compared with a survey made in 1991. Prior to 1991 coral cover was estimated for the entire deck of the *Mahi*; in 1991 permanent quadrats were selected to conform to recent EPA suggestions. These selected quadrats were then compared for changes in coral cover from year to year. There were no significant differences in coral cover at selected quadrats between 1991 and 1992 ($p < 0.01$; Table 2). Coral cover is high on the deck of the *Mahi*; the deck platform presents an ideal place for the settlement and subsequent

colonization of corals. In 1992 coral cover (%) ranged from 19.6 to 51.9 for ten 0.75 m² selected quadrats. In 1991 coral cover ranged from 17.2 to 63.6% for the same quadrat locations. Dominant coral species recorded were *Pocillopora meandrina* (17–58%) and *Porites compressa* (1–7%). Other genera of corals seen were *Montipora* and *Pavona* but these were rare and small in size (< 6–8 cm diam.).

Other organisms seen at this station were the seastar *Acanthaster planci* (crown-of-thorns), the bryozoan *Triphyllozoan* sp., red and yellow sponges, the coralline alga *Lithothamnion* sp., and the black spiny sea urchin (wana) *Echinothrix diadema*.

Station W3

In 1992, on the diffuser transect, a total of 28 fishes were counted representing 7 species. In 1986 24 fishes were counted on the transect representing 6 species (Table 3). Fish abundance and diversity dropped in 1987 and 1988 but returned to 1986 levels in 1992. In 1987 and 1988 few fishes were seen in the area and none on the transect.

In 1992 corals were seen growing on the concrete cover of the outfall (10–15 cm diam.) and on the riser ports (8–10 cm diam.). Percent cover ranged from 1–2% of the substratum along a strip 6 m wide on the diffuser. The most dominant species of corals were *P. meandrina*, *P. lobata*, and *Montipora verrucosa*. In 1986, the year the outfall was completed and in service, no corals were seen growing on the diffuser or in its vicinity. Other macroinvertebrates recorded were 2 sea urchins, *E. diadema*, and 2 seastars *Culcita* sp.

Station W4

In 1992 a total of 12 fishes representing 5 species were recorded. In 1987 and 1988 fish abundance was higher (N = 56 and 37 respectively) representing 12 and 16 species respectively. In 1986 10 fishes were recorded representing 3 species (Table 4).

The substratum at Station W4 was covered with sand and rubble. A few small (< 10 cm diam.) *P. lobata* coral heads were seen in the area but none were recorded on the transects. Permanent quadrat areas consisted mainly of coral rubble and some algae (*Dictyota* sp. and *Lyngbya* sp.). No corals were recorded at this station in 1986, 1987, or 1988. Red and black sponges were seen in 7 of 21 quadrats along the transect.

DISCUSSION

Off the Waianae coast coral cover is low (1–2% of bottom area) and is dominated by the two coral species *Pocillopora meandrina* and *Porites lobata* (Reed et al. 1977). This dominance existed long before the modified Waianae outfall pipeline was built (circa 1986). The old outfall pipe, which discharged wastes into water < 20 m deep, was modified and extended to discharge into the 33 m isobath approximately 1.8 km offshore.

On the ship *Mahi* (Sta. W2), abundance and diversity of fishes remained high. This station has been monitored since 1986 for both fishes and corals and no decline in fish stocks or coral cover was seen in this survey. There were no significant differences over the years in either community indicator.

At the diffuser (Sta. W3) fishes were moderately abundant and corals were beginning to colonize the area, not only near the diffuser, but also on the diffuser riser ports themselves. The surrounding sediments were clean and white. In 1986, 1987, and 1988 corals were not seen at this station. In 1992 coral heads (approx. 10–15 cm diam.), of species *P. meandrina* and *P. lobata*, were becoming established.

In 1992 there was no observable indication that the Waianae ocean outfall effluent was adversely affecting the fish, coral, or macroinvertebrates at selected stations in the vicinity of discharge. Since studies made before 1986 were not at the same stations but in an area closer to shore (depth 8 m) a comparison before and after discharge cannot be made. However, generally, the dominant fish and coral species seen in 1992 were essentially the same as seen in earlier discharge years and before the outfall was modified (Reed et al. 1977). Sediments were clean, horizontal visibility was good (15–22 m), and fish abundance, diversity, and species composition in the outfall area did not vary greatly from year to year. Numbers and species of fishes seen in the late 1970's were similar to those seen in 1986 through 1992. When compared to extensive surveys done by Hobson (1984), fish species richness, species composition, and abundance were similar to those found in typical Hawaiian subtidal biotopes. Fishes normally intolerant of moderate sewage pollution, (e.g. *Dascyllus albisella* ['alo'ilo'i] and *C. multicinctus* [kikakapu]), were seen at Station W2 along with many coral heads. The growth of coral and the ship structure itself may be attracting large numbers of fish. At the diffuser corals were growing on the diffuser ports, and seemed to be thriving, where none were seen in 1986 to 1988. This study showed that there were no significant deleterious effects on the fish and coral communities, at the stations surveyed, over the years of study.

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TABLE 1. FISH ABUNDANCE (NOS./180 m²) AT STATION W2, WAIANAE
OCEAN OUTFALL SURVEY, O'AHU, HAWAII

Taxon	1986	1987	1988	1991	1992
CHAETODONTIDAE					
<i>Chaetodon miliaris</i>	25	34	21	18	13
<i>C. multicinctus</i>	2	2	0	0	1
<i>C. kleini</i>	3	5	6	2	2
<i>C. ornatissimus</i>	2	0	2	0	3
<i>Forcipiger flavissimus</i>	3	2	2	1	0
POMACANTHIDAE					
<i>Holacanthus arcuatus</i>	3	0	0	0	0
ACANTHURIDAE					
<i>Acanthurus oliveceus</i>	10	6	2	0	2
<i>Naso literatus</i>	6	2	2	1	0
<i>Naso hexacanthus</i>	2	2	3	2	1
<i>Zanclus cornutus</i>	5	3	2	0	1
<i>Ctenochaetus strigosus</i>	5	17	11	4	6
<i>Zebrasoma flavescens</i>	0	5	9	0	1
<i>A. thompsoni</i>	0	5	9	0	1
<i>A. nigris</i>	0	1	2	3	4
POMACENTRIDAE					
<i>Dascyllus albisella</i>	15	17	5	25	21
<i>Chromis agilis</i>	4	0	0	0	0
<i>C. hanui</i>	0	0	2	0	1
LABRIDAE					
<i>Thallasoma duperrey</i>	20	10	9	6	12
<i>Labroides phthirophagus</i>	2	0	1	1	1
BALISTIDAE					
<i>Sufflamen bursa</i>	0	5	4	1	2
<i>Rhinecanthus rectangulus</i>	2	1	1	1	0
<i>Melichthys vidua</i>	5	5	3	0	2
<i>Melichthys sp.</i>	1	0	0	0	0
MULLIDAE					
<i>Mulloidichthys auriflamma</i>	4	6	5	0	0
<i>Parupeneus multifasciatus</i>	8	2	1	2	2
<i>P. porphyreus</i>	15	1	1	1	3
LUTJANIDAE					
<i>Lutjanus kasmira</i>	100	82	30	50	33
MONACANTHIDAE					
<i>Pervagor spilosoma</i>	62	27	6	1	4
TETRADONTIDAE					
<i>Canthigastor jactator</i>	3	1	0	0	1
SCARIDAE					
<i>Scarus dubius</i>	1	0	0	0	1
CIRRHITIDAE					
<i>Paracirrhites forsteri</i>	0	0	1	0	2

Total (nos./180m ²)	308	238	133	121	121
Total Number of Species	25	24	25	17	24

TABLE 2. TOTAL CORAL COVER FOR SELECTED QUADRATS,
STATION W2,
1991 AND 1992, WAIANAE OCEAN OUTFALL SURVEY

	1991*		1992	
	Area (cm ²)	%	Area (cm ²)	%
AAA1	1290	17.2	1470	19.6
AAA3	2985	39.8	2880	38.4
AAB1	2790	30.5	3090	41.2
AAB2	2235	29.8	2550	34.0
AAB3	2505	33.4	2310	30.8
AAB4	4770	63.6	3990	53.2
AAC1	3060	40.8	3890	51.9
AAC2	2205	29.4	2130	28.4
AAC3	3712	49.5	3630	48.4
AAC4	2730	36.4	3200	42.7

*Total quadrat area = 7500 cm².

	TABLE 3. FISH ABUNDANCE (NOS./180 m ²) AT STATION W3, 1986 AND 1992, WAIANAE OCEAN OUTFALL SURVEY, O‘AHU, HAWAI‘I			
	Taxon	1986	1992	
	ACANTHURIDAE			
	<i>Acanthurus nigrofuscus</i>	6	10	
	<i>Acanthurus sp.</i>	0	5	
	<i>A. oliveceous</i>	3	4	
	BALISTIDAE			
	<i>Sufflamen bursa</i>	5	3	
	<i>Rhinecanthus rectangulus</i>	2	1	
	MULLIDAE			
	<i>Parupeneus porphyreus</i>	3	2	
	MONACANTHIDAE			
	<i>Pervagor spilosoma</i>	5	3	
	Total (Nos./180m ²)	24	28	
	Total Number of Species	6	7	

TABLE 4. FISH ABUNDANCE AT STATION W4, WAIANAE OCEAN OUTFALL SURVEY, O‘AHU, HAWAI‘I, 1986, 1987, 1988, 1992				
Taxon	1986	1987	1988	1992
CHAETODONTIDAE				
<i>Chaetodon miliaris</i>	0	6	2	2
<i>C. multicinctus</i>	0	1	1	0
<i>C. kleini</i>	0	1	1	0
ACANTHURIDAE				
<i>Acanthurus oliveceus</i>	0	0	8	0
<i>A. nigrofuscus</i>	4	0	0	0
<i>Zanclus cornuta</i>	0	2	1	0
POMACENTRIDAE				
<i>Dascyllus albisella</i>	0	1	0	0
<i>Chromis hanui</i>	0	1	0	0
SERRANIDAE				
<i>Anthias thompsoni</i>	0	1	0	0
LABRIDAE				
<i>Thallasoma duperrey</i>	0	1	2	5
<i>Bodianus bilunulatus</i>	0	1	1	0
<i>Labroides phthirophagus</i>	0	0	1	0
<i>Coris gaimardi</i>	0	0	1	0
BALISTIDAE				
<i>Sufflamen bursa</i>	2	1	1	3
<i>Rhinecanthus rectangulus</i>	0	0	1	0
<i>Melichthys vidua</i>	4	0	3	1
MULLIDAE				
<i>Parupeneus multifasciatus</i>	0	2	1	0
<i>P. porphyreus</i>	0	0	3	0
MONACANTHIDAE				
<i>Pervagor spilosoma</i>	0	38	9	0
CIRRHITIDAE				
<i>Paracirrhites forsteri</i>	0	0	1	0
Total (nos./180m ²)	10	56	37	12
Total Number of Species	3	12	16	5