MARINE ENVIRONMENTAL SURVEY

OK OKAT, KOSRAE

By

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INTRODUCTION

Historical Background

Kosrae's first European contact occurred in 1824 when Louis Duperrey anchored the corvette "Coquille" at what was to be called Okat Harbor (or Coquille Harbor). The first report of Kosrae (Fig. 1) was that of Lesson (1824) who wrote a general statement of the island and the harbor and included comments on the marine animals found in the area. In 1827 the ship "Senyavin," captained by F. Lütke, visited Kosrae, and the ship's naturalist F. H. Kittlitz reported on the plants and animals for the island (Lütke 1835). Dumont d'Urville, a naturalist with Duperrey, visited Kosrae later and discussed some natural history aspects (d'Urville 1835). In 1880 the German naturalist Otto Finsch visited Kosrae and wrote several naturalist-oriented articles (Finsch 1880). The most extensive study, although mainly anthropological, of Kosrae was carried out in 1910 by E. Sarfert. This report, published in 1919, appeared after Kosrae had become mandated to Japan. Only a few reports appeared during Japanese times.

Interestingly enough, sixty years passed before the next biological investigations occurred. In 1970 the National Marine Fisheries Service research vessel "Townsend Cromwell" visited Lelu and stopped at Okat for one day, collecting information on potential fisheries and on bait fish.

An airplane runway was proposed for Kosrae in 1974. An environmental study was carried out through Fred Wild and Associates and Pacific Architects and Engineers. Several sites were suggested, and the reef flat at Okat was selected. The environmental survey led to the development of a model of Okat Harbor by Woodward-Clyde Consultants. This entire final environmental impact statement is the basis for the present study (Federal Aviation Administration 1977).

In 1978 a wastewater master plan was carried out. Several sites were discussed, Okat only as a minor pollution area (Brewer 1978). During the same year an extensive Caroline Island wetland study was founded by the U. S. Army Corps of Engineers. Seventeen stations were investigated on Kosrae, three being in the Tafunsak-Okat area (Stennerman and Proby 1978). At about the same time, a reef-archaeology survey was conducted by the Pacific Science Institute in the Okat area under the auspices of the TTPI Historic Preservation Office.

The University of Guam Marine Laboratory was contacted by the University of Hawaii (Contract No. HC2360) to carry out a baseline environmental survey of the Okat area in conjunction with the development of a proposed reef-flat runway. The University of Hawaii Water Resources Research Center is the prime contractor under a Department of Navy, Pacific Division, Naval Facilities Engineering Command Contract [U. S. Navy Contract No. N62742-78-C-0067].

Scope of Work

The services to be provided under this contract shall include but not be restricted to the following:

1. Collect samples of fish from the study area and perform the necessary radioimmunoassay tests on the samples to determine background levels of ciguatoxin present in the fish community. Conduct a review of existing and historical occurrences of ciguatera outbreaks at Kosrae. Document the findings along with the ciguatoxin data.

2. Perform detailed current studies to document circulation patterns and to predict movement of materials to be generated during construction. Current velocities and directions should be taken under prevailing wind conditions, at different depths, and under rising and falling tide conditions sufficient to establish the physical characteristics of the study area.

3. Conduct benthic and fish surveys in the study area to confirm the abundance and distribution of corals, invertebrates, benthic flora and fauna, and fish population identified in "Marine Biological and Ecological Assessment for Proposed Airport-Harbor Development, Island of Kosrae, TTPI," by Kenneth R. Kvammen (December 1974). Document any differences in the present marine community and that described by the above reference.

4. Review technical reports and other literature concerning dredging and fill operations and their impact to water quality and the marine environment. Recommend limits for turbidity based on marine biological impacts. [Turbidity currents were studied cooperatively with the University of Hawaii and will be detailed in a separate report.]

5. Prepare recommendations to mitigate against environmental degradation or destruction, or to substantiate preservation of areas of unique biological value.

Personnel

L. G. Eldredge, Professor of Biology--General survey coordination, reconnaissance, and invertebrates.

The following University of Guam Marine Laboratory graduate students participated:

Bruce Best--Marine plants
Mitchell Chernin--Corals
Roy K. Kropp--Invertebrates
Robert Myers--Fishes
Thomas Smalley--Currents

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We also want to thank Peter H. Denton, owner and skipper of the Yacht "Endurance," for putting up with us and our variously smelling animals; Kenny Wenzel and Paul Pyle, our crew members; and Nancy Seifers and Nadia Bazzana, our "noble" cooks; as well as "Little Judy Brown," our mascot.

We also want to thank the National Marine Fisheries Service, Honolulu Biological Laboratory, for providing unpublished information from the "Townsend Cromwell" cruise to Kosrae in 1971 and Sam Price, Pacific Studies Institute, for providing us with his historic preservation survey of the Okat reef and harbor survey. Richard Croft, Fisheries Officer, Ponape, provided information on the *Acanthaster* starfish survey of Kosrae in 1973.

At the University of Guam, we want to give a special thanks to Al Blaz, Assistant to the President, for his help in seeing us through the pile of paperwork necessary to meet the plane. At the Marine Laboratory, acknowledgements are extended to R. H. Randall for his help identifying corals; Jeanine Stojkovich and R. T. Tsuda for their help with the algae; and Barry Smith for his help in identifying gastropods. C. Carlson and P. J. Hoff identified the opisthobranch mollusks. M. J. Gawel, Trust Territory Department of Planning, made the preliminary identifications of the soft corals. Jo Eldredge and Gretchen Grimm spent many hours making the current drogues. Special thanks to Debbie Van Sciver and Terry Balajadia who each typed various parts of the report and to the Marine Laboratory Marine technicians whose wise advise and skillful assistance made the trip a reality.

METHODS

Water Circulation

Water circulation patterns were determined mainly by the use of collapsible drift drogues of 1 m^2 vane-surface area constructed according to the design of Dr. E. D. Stroup of the Department of Oceanography, University of Hawaii. Each drogue was suspended from two 1-gallon (3.8 ℓ) plastic jugs and weighted down by one 20-cm piece of No. 11 re-bar weighing approximately 1.6 kg.

Drift drogues were released at depths of 1-2 m and 5-6 m at a number of selected stations in the harbor and were allowed to drift for varying periods of time during different phases of the tidal cycle. No sets of the drogues were effected, however, over the full duration of an outgoing tide from mean high water to mean low water, since mean high water always occurred at night and the drift drogues lacked any type of device for their detection at night. Drogue positions were estimated by using a hand-bearing compass to triangulate on three fixed landmarks; distance traveled by each drogue was determined after drawing the drogue path on the map. Drogue velocity, which ideally represents current velocity for the water mass, was then calculated from these data.

Circulation patterns over areas of the reef were determined by the release of fluorescein dye. The time required for the dye patch to travel 10 m and the direction of movement were recorded. Surface current velocity was then calculated from these data.

In association with drift drogue and fluorescein dye observations, wind direction and speed in knots were also determined by using a hand held anemometer. This was done to determine possible wind effects on drogue movement and on the surface water movement studied with dye.

General Reconnaissance

A qualitative survey of invertebrates was made by conducting several collecting forays to different areas of the reef flat. These areas were:

Harbor margin--an area of mixed seagrasses and sand within the triangle formed by connecting the locations of transects 4, 5, and 1c (Fig. 2). The area was exposed during low tides and contained numerous small, shallow tidepools. Both day and night collections were made.

South Hole--A large, 100-m diameter, hole about 4.5 m deep at the southwest corner of the reef flat. The sandy bottom of the hole was sampled with a hand dredge.

North Hole--A hole of 75-m diameter located about 650 m northeast of South Hole. Collections were made along the coral and rubble areas at the hole's southern margin. Additionally, twelve Pocillopora damicornis colonies were collected from this area and analyzed for symbiotic organisms.

Gabert Island--A low vegetation-covered reef-flat island which has a diameter of approximately 100 m. The north and south margins were circled with moderate-sized boulders; the west or seaward side, with small boulders and rubble which meet consolidated and eroded, raised limestone seaward; and landward (or toward the east), a slightly elevated sand spit, approximately 100 m long, was edged with small boulders. This was the only "beach" habitat in the study area. Collections of intertidal and supratidal organisms were made.

South margin of Okat reef flat--The presence of numerous large boulders and blocks at the somewhat depressed margin indicates that the zone was probably the most exposed during storm conditions. Small boulders and rubble were interspersed among them, and mixed seagrasses carpet much of the area toward the reef. Collections were made among the boulders and seagrasses.

North margin of south reef flat--This margin, south of the harbor itself, was much more heavily (Fig. 2) abraded. There were only a few widely scattered boulders and overturned Acropora colonies. No seagrasses were observed. Collections were made on the reef flat during the day.

General collections were also made at the following island locations:

Lelu--Collections at Lelu were made mainly at the reef-flat area southeast of Lelu Point. The area was primarily reef-flat pavement with scattered boulders and overturned coral heads. The boulder-rubble zone increased near the channel margin and at Lelu Point itself. Patches of sand were widely scattered. A few mangrove trees (Sonneratia) grew on the reef flat at the point. The shore west of Lelu Point was primarily volcanic and extended irregularly subtidally, being interspersed with patches of sand and rubble. A narrow band of seagrass bordered the shore. Specimens were collected on the reef flat, along the sandy shore, and from the volcanic bluffs. Additional specimens were collected from seawalls and docks, and at a rubble-filled boat launching site west of the main dock.

Pukusrik--Collections were made from a rocky intertidal area located between Lelu and Tafunsak. The area consisted of small- to medium-sized boulders and extended about 150 m seaward of the beach. No live corals were seen in the boulder zone. All collections were made by turning over rocks to expose invertebrates. The shoreline was a 10 m wide sandy beach from which some collections were made.

Tafunsak--Three separate areas at Tafunsak, along the north coast of Kosrae, were investigated. Gastropods were collected from a seawall in the village. The shore was composed of coarse sand that was exposed at low tides. South of Tafunsak two different mangrove areas were investigated. Landward of the road, in the mangrove wetland composed of *Bruguiera gymnorhiza*, *Lumnitzera littorea*, and *Rhizophora apiculata*, gastropods and fiddler crabs were collected. To seaward, at a moderately steep coarse-sand beach, ghost crabs were collected. Intertidally, the mangrove *Sonneratia alba* was the main vegetation form with a mixed seagrass and algal carpet where gastropods and fiddler crabs were found.

Marine Plants

Marine plants were quantified by a modified point-quadrat method (Tsuda 1972). This method consisted of randomly dropping a 25 x 25-cm gridded quadrat with 16 internal cross-points ten times per transect (every ten-meter mark for 100-m transects or every five meters for a 50-m transect). A total of 2880 points was sampled along the 18 transects at the Okat study site.

Percent cover, calculated by taking the total points at which a species occurred divided by the total points per transect, and frequency of occurrence, calculated by taking the number of quadrat tosses in which a species occurred divided by the total number of tosses per transect, were enumerated for each transect. Both cover and frequency values were converted to percentages by multiplying them by 100.

Plants were collected from each transect zone plus general collections were made from other Okat areas. These specimens were soaked in 10% formalin, then pressed and labeled for deposit in the herbarium at the Marine Laboratory, University of Guam.

Corals

Coral distribution along eleven transects was analyzed by using the point-quarter technique (Cottom et al. 1953). The transects were established by placing a plastic surveyors tape along the bottom at the locations indicated in Figure 2. Sample points were established at five (50-m tape) or ten-meter (100-m tape) intervals along the tape. A line bisecting the sample point at right angles to the transect line established four quadrants around the point. The coral nearest the sample point in each quadrant was located and the specific name, diameter, and distance from the center of the colony to the sample point was recorded. If no colony was observed within a maximum distance of one meter from the sample point, the quadrant was recorded as having no colony with a diameter of zero, and a sample point to colony distance of one meter.

From the point-quarter data the following calculations were used to estimate the population and community parameters.

$$\text{total density of all species} = \frac{\text{unit area}}{(\text{mean point-to-coral distance})^2}$$

$$\text{relative density} = \frac{\text{individuals of a species}}{\text{total individuals of all species}} \times 100$$

$$\text{density} = \frac{\text{relative density of a species}}{100} \times \text{total density of all species}$$

$$\text{total percent coverage} = \text{total density of all species} \times \text{average coverage value for all species}$$

$$\text{relative percent coverage} = \frac{\text{percent coverage for a species}}{\text{total coverage for all species}} \times 100$$

$$\text{frequency} = \frac{\text{number of points at which a species occurs}}{\text{total number of points}}$$

$$\text{relative frequency} = \frac{\text{frequency value for a species}}{\text{total frequency value for all species}} \times 100$$

$$\text{importance value} = \text{relative density} + \text{relative percent coverage} + \text{relative frequency}$$

The presence of additional coral species not found in the transect samples was determined for each zone by making repeated observations along each side of the transect line and adjacent areas. The number of coral species and an estimate of their abundance were determined according to Randall's scale (Amesbury et al. 1976) where: D = dominant, the predominant coral within a zone; A = abundant, a species generally distributed throughout a reef zone; C = common, a species generally present but with a patchy distribution within the zone; O = occasional, a species with only localized distribution within a reef zone; and R = rare, a species represented by only one or two occurrences within a reef zone.

When possible, corals were identified in the field; however, taxonomic problems are numerous and representative colonies were brought back to the University of Guam Marine Laboratory for positive identification by Richard H. Randall.

Invertebrates

Two types of transect methods were used to determine the abundance of macroinvertebrates. The first employed a 6-m diameter circular quadrat. The area of the quadrat, 28.3 m^2, was greater than the 24 m^2 minimum size suggested for quantifying macroinvertebrates (Birkeland et al. 1976). The center of each quadrat was determined by a haphazard toss of a hammer within 8 m on either side of the transect tape. This method was used on transects 1a, 1b, and 1c.

This method proved to be very cumbersome; therefore, the remaining transects were run using a meter stick held perpendicular to the transect line. On the reef flat 25-m^2 quadrats were used by dividing the transect tape into 12.5-m segments and counting organisms within one meter on either side of the tape. For subtidal transects 20-m^2 quadrats were used because the transect tape was only marked every 5 m.

An area of particularly high holothurian density, about 200 m northeast of South Hole, was sampled using two haphazardly selected 10-m transects. The meter-stick technique was used.

The abundance of Nerita plicata was measured at two high intertidal areas near Gabert Island. This was accomplished by ten haphazard tosses of a 25 x 25 cm quadrat in each of the two areas. Specimens occurring in each of five randomly selected 25-cm sections of the quadrat were counted. The areas selected were both boulder zones--one on island's shaded north shore and the other on its sunny south shore. These data were analyzed by a Mann-Whitney U-test (Sokal and Rohlf 1969).

Fishes

Resident fishes were censused by swimming along 50-m transect lines and counting the number of each species seen within 1.5 m of either side of the line and up to 3 m above the line in each of 10 five-meter intervals. Each transect thus covered approximately 150 m^2 of reef surface. Transects were laid entirely within a particular habitat type. Reef-flat transects could be seen only at high tide when there was more than 0.6 m of water over the line. Fifty-meter transects were chosen because of the limited amount of high-tide time available, and unless otherwise indicated, were run from the 25 to 75-m markers along the same line used for quantification of other animals and plants. Fish species not counted along the transects but seen in the vicinity within the same habitat were listed for each station. A subjective assessment of fishes present in areas not covered by transecting, particularly deeper channels and outer reef slopes, was made by listing species seen during reconnaissance dives or incidentally while spearfishing for ciguatera samples or while being towed alongside a skiff. Estimates of the relative abundances of each species were recorded. Observations in the field were based primarily on the descriptions of Schultz et al. (1953-1966) and Masuda et. al. (1975). When possible, specimens were collected and/or photographed, with particular attention paid to those species that were not recognized or are poorly known.

From the transect data it was possible to determine relative abundances and absolute densities of the fishes observed. Transect data in conjunction with results of subjective observations were used to construct a master table listing all species with estimates of their relative abundances in each habitat investigated. From this table Jaccard coefficients of similarity (Sokal and Sneath 1963) between the fish faunas of all possible habitat pairs could be calculated.

Ciguatera Testing

Limited evidence suggests that the creation of new benthic substrates by dredging or construction activities may provide favorable conditions for the outbreak of ciguatera fish poisoning. In an attempt to assess current levels of toxicity, flesh and gonad samples of a variety of fishes, collected by spear and hook and line, in the study area were sent to Dr. Yoshitsugi Hokawa at the John A. Burns School of Medicine in Honolulu for radioimmunoassay. In addition, local health officials and fishermen were interviewed to obtain information on the historical background of ciguatera incidence at Kosrae.

RESULTS AND DISCUSSION

General Description

Four qualitative transects were established perpendicular to shore on the northern reef flat of Okat Harbor, Kosrae (Fig. 2). These transects provided data on zonational patterns across the flat, as well as for the determination of sites for quantitative transects within the various zones.

Transect 1 was located between Sawansaku and Molaniel Islands and ran 1775 m to the reef margin; this is approximately the same location of Transect 1 (Federal Aviation Administration 1977, p. 89). This transect was divided into four zones based upon predominant flora, fauna, or geological composition. Zone A, 0-169 m, was characterized by the alga Halimeda macroloba and also contained numerous sand patches. Zone B, 169-1046 m, was a mixed seagrass zone containing three species of seagrasses--Enhalus acoroides, Thalassia hemprichii, and Cymodocea rotundata. Zone C, 1046-1600 m, consisted of a mixed coral zone dominated by Porites lutea and P. andrewsi. Interspersed among the corals was the alga Turbinaria ornata. The last zone for this transect, Zone D, 1600-1775 m, was primarily reef-rock pavement and algal turf. No boulders were observed in this area which was in contrast with the two other transects extending to the reef margin. At low tide the entire reef flat, except for the North and South Holes, two moat areas perpendicular to this transect between 750-900 m on Transect 1 and 1376-1452 m, and scattered local depressions, was completely exposed. The flat was flooded by approximately 1 to 1.5 m of water at high tide.

Transect 2, the northernmost transect on the flat, extended 430 m to the reef margin and had three distinct zones. Zone A, 0-235 m, was a mixed-seagrass zone primarily composed of Cymodocea rotundata with occasional patches of Enhalus acoroides. Zone B, 235-289 m, consisted of mixed seagrass and coral rubble. Scattered colonies of Porites lutea, P. andrewsi, and Pavona sp. were also present. Zone C, 289-430 m, was composed of reef pavement and rubble; large boulders, probably lifted onto the flat during storms, were also evident.

Transect 3 extended 500 m from the northern harbor reef margin to the center of South Hole; three zones were apparent. Zone A, 0-50 m, included the harbor reef margin which was composed of large coral heads of Porites lutea. A mixed-seagrass bed primarily of Enhalus and Thalassia extended from the edge of the harbor margin to 460 m and comprised Zone B. Zone C, 460-500 m, extended from the edge to the center of South Hole. The predominant species along the edge were Porites andrewsi and large foliaceous colonies of Turbinaria sp. Skirting the edge of South Hole and among the coral were tall stands of Enhalus. Coral rubble was also present in the region. The center of South Hole was primarily sand and scattered patches of coral rubble; the depth at low tide was approximately 4.5 m.

To the south of Transect 3 and extending to the reef margin west of Gabert Island was an extensive boulder patch. Southwest storms with sufficient wave action were probably responsible for this topographical feature.

Transect 6 was divided into four zones and extended 1230 m from the mangrove to the reef margin. The zones along this transect were not as distinct as those on the other transects. Zone A, 0-384 m, was a mixed-seagrass zone with Enhalus acoroides as the predominant species. Zone B, 384-789 m, was composed of mixed corals. Microatolls of Porites lutea and small colonies of P. andrewsi were common along the scattered patches of Enhalus. Zone C, 789-918 m, was a Turbinaria ornata area with microatolls of P. lutea. Zone D, 918-1230 m, was composed of reef pavement and rubble; numerous small boulders were also present.

The remaining transects in Figure 2 were all quantitative and were either 50 or 100 m in length; Transects 4, 5, OR-1 and North and South Hole, were 50 m in length; whereas Transects 7, 8 and SRF were 100 m long. All transects intersecting the four qualitative transects were 100 m. Additionally, Transects SRF and 6c were staked with 1.3 cm re-bar as permanent transects for future comparisons either during or after construction of the airport.

Water Circulation

Drogue movements were plotted in Figures 3 and 4, with corresponding field data and results given in Table 1. Prevailing winds, generally from the east-northeast at 6-12 knots, appeared to have little effect upon the 1- and 5-m drift drogues themselves, since the float presented little area above the water surface. Observations of the movement of 1-m drogues at Station 3 also substantiated this lack of wind effect, since the general pattern of drogue drift under wind velocities of less than 1 knot was the same as drift patterns of 1-m drogues influenced by wind velocities of 6.5-9.0 knots (Table 1) at Stations 4 and 5 (Fig. 4).

Circulation patterns within the harbor, in the area of proposed dredging for the pier (Stations 3, 4, and 5), appear to be the result of tidal water movement off the reef from the north on the ebb tide and from the west through the harbor entrance and over the reef from the north on the flood tide. The movement of 1-m drogues at Stations 3, 4, and 5 showed general north-northeast to south-southwest movement on the outgoing tide and a northwest to southeast movement on the incoming tide (Fig. 4). The larger of the two patch reefs within the harbor appeared to have an affect upon circulation patterns of the surface waters in close proximity to its east side. Figure 4 (Sta. 3, 1-A) shows the abrupt change in drogue drift of approximately 137° from a south-southeast direction to an east-northeast direction when the drogue came within 50 m of the east side of the patch reef. Drogue velocities in this area (Stations 3, 4 and 5) were influenced by changing water velocities at different times in the tidal cycle. Wind velocities did not appear to influence drogue velocities (Table 1). Drogue velocities in general were greater during mid ebb tide to mean low water (Table 1). Drogue velocities on rising tides ranged from 33-93 and 71-93 m/hr, respectively, when in the immediate area of the proposed pier and when farther out in the harbor. Velocities experienced on falling tides likewise followed this pattern, since they ranged from 42-164 and 251-428 m/hr for the two areas. Drogues released at Station 3 (Fig. 4) experienced the highest and lowest velocities in the immediate area of the proposed pier and out in the harbor itself. Drogues 1-A and 2-A at Station 3 moved at 307 and 164 m/hr, respectively, during mid ebb tide when released directly adjacent to the reef. Their velocities increased to 339 and 428 m/hr, respectively, when they were farther away from this partially enclosed area. Drogues 2-A and 2-B displayed no observable change in position, whereas over the following incoming tide from mean low water to mean high water 2-A and 2-B moved at velocities of 33 and 38 m/hr, respectively. Movements of the 1-m and 5-m drogues at Station 1 (Fig. 3) suggested different circulation patterns for these water masses at the same period in the tidal cycle. It generally appears that at the beginning and the end of the ebb tide, surface and subsurface waters follow approximately the same drift patterns, as is indicated in Figure 3 and Table 1. Drogues 1-A, 2-A, and 1-B and 2-B (1 m and 5 m, respectively) show the greatest difference in surface and subsurface drogue movement, whereas drogues 1-C and 2-C (1 m and 5 m) show the same general northeast to southwest flow. One-meter drogue velocities at Station 1 ranged from 175-216 to 0-180 m/hr, whereas those for 5-m drogues ranged from 50-142 to 55-155 m/hr on the falling and on the flooding tides, respectively. Surface drogues experienced the highest and lowest velocities. At the end and the beginning of the falling tide, 1-m drogues, 1-A and 1-C, moved at 175 and 216 m/hr, respectively, whereas during the first hour of a flooding tide drogue 1-A did not move. Five-meter drogues (2-A, 2-B and 2-C) in general moved at a more constant velocity (Table 1) during the portion of the tidal cycle studied.

Station 2 (Fig. 3) drogues drifted in an east to west direction. This indicated a surface movement of water in the harbor mouth which flows out of the harbor during both the falling and rising tides. Subsurface water also appears to follow this pattern, since drogues 2-D and 2-G (5 m) moved west, out of the harbor entrance; however, there was a subsurface current that ran along the seaward reef margin in a south to north direction during the flood tide. One-meter drogues--1-D, 1-E, 1-F, 1-G, and 1-H--were not left in long enough (Table 1) to actually determine if there was any surface current in this direction. Velocities of 1-m and 5-m drogues at Station 2 ranged from 320-427 and 294-374 m/hr and 277-285 and 538-601 m/hr during the ebb and flood tides, respectively. Surface drogue velocities on the ebb tide were slightly higher than those of subsurface velocities, whereas the reverse was noted on the flood tide but with a greater difference existing between the two values (Table 1).

Fluorescein dye studies were conducted in a number of areas on the reef flat, particularly in the area of proposed dredging of the small boat channel along the mangrove margin. Dye patches 1-16 (Figs. 3 and 4), released in the area of the proposed small boat channel, were run under conditions of prevailing winds of less than 1 knot and, therefore, little wind effect was noticable. Dye patches 1-10 were released during an ebb tide and showed a general northeast to southwest flow along the mangrove and out over the reef in front of Molaniel Island (Fig. 3). Similarly, dye patches 11-14 released during a flood tide followed approximately the same patch. Dye patches 15 and 16 indicated water movement into the channel between the mangroves and the island. Remaining dye patches were released at a number of sites on the south reef flat under prevailing wind conditions of 5.0 - 13.5 knots from the north-east. Movement of patches 17-23 (Fig. 4) in general were affected by wind and surf breaking on the reef margins in the areas where the dye was released.

Marine Plants

By using a modified point-quadrat sampling technique (see transect methods section), percent cover and frequency were calculated for the marine plants as well as for the gastropods, holothurians, sponges, stony corals, and soft corals. Areas of exposed sand and rock substrate were also quantified. Therefore, by examination of Table 2, a general idea of relative abundance and patchiness of the benthic flora and fauna at the Okat study area can be formed.

Forty-five species belonging to 33 genera of marine plants have been identified to date from the Okat study area. Although this represents a good diversity, there was a conspicuous lack of large brown algae, i.e., Sargassum and Hydroclathrus. It is doubtful whether their absence could be attributed to lack of nutrients, considering the adjacent mangrove and river-export ecosystems, but was probably caused by daily desiccation (Tsuda 1974). Daily tidal range was up to 1.5 m, thereby leaving only the deep (4.5 m) reef-flat holes and the moat areas subtidal. Up to 22 species of plants were noted in these deeper reef-flat refuge areas. Marine-plant cover for the 13 reef-flat transects, excluding margin and slope transects, was 69.2% (s=26.67). Average floral cover for all 18 transects was 57.6%. This average was higher for the reef-flat areas only because of the lack of the space-competing corals and the increased cover by seagrasses (on the flat).

The seagrasses were the predominant marine plant on the reef flat. They ranged from 5% to over 90% cover on individual transects, with a mean value of 40.2% (n=12, s=34.2). Cryptically underlying the more extensive Cymodocea rotundata, Enhalus acoroides, and Thalassia hemprichii beds were small Halimeda opuntia, coralline red algae, holothurians, gastropods, and sponges. Enhalus acoroides collected from the North Hole area (see Figure 2) approached 2 m in blade length.

The ubiquitous blue-green algae were prevalent along the reef-flat transects and were recorded as percent cover in sandy areas. Schizothrix calcicola forms a sand-alga matrix adding stability to the reef flat substrate.

In addition to the abundant Halimeda opuntia, the most frequently encountered of the 17 recorded green algae were Caulerpa racemosa, Dictyosphaeria cavernosa, and H. macroloba. These three algae were observed or collected along 50% of the transects.

Lobophora variegata and Turbinaria ornata were the most common brown algae. They were recorded on 61% and 50% of the transects, respectively. Although percent cover was low for Lobophora, Turbinaria accounted for up to 17% of the cover along the seaward reef-margin study site (Transect 6c).

The small red coralline genera such as Amphiroa and Porolithon were common along most of the reef transects. Hard substrate samples were collected, many of which supported these and other red microturfs. Halymenia durvillaei and Desmia hornemanni were collected from the deeper channel study sites. Sixteen species of red algae were recorded from the Okat area.

Graphs depicting relationships between four functional benthic groups and overall plant diversity are presented in Figure 5. The two sets of linear extrapolated curves reveal an inverse relationship between plant diversity and percent seagrass cover. Following the diminishing seagrass cover and concurrent rise in algal diversity, the percent cover by corals increases. This rise in coral cover mirrors the increase of subtidal areas and hard platform substrates. In summary, as one transects the zones from the mangrove area seaward, zones of > 90% sand are followed by zones of seagrass, macroalgae and turfs, and finally sparse coral patches, respectively.

Forty-one of the 45 marine plant species reported from this study have been deposited in the University of Guam Herbarium by the author.

Corals

Coral coverage on the Okat harbor reef flat was restricted to an outer reef moat and localized holes and depressions because the flat was exposed at low tides and therefore not condusive to coral growth; transects 1a, 1b, 1c, 2a, 3a, 6a, and 6b (Fig. 2) were in a mixed-seagrass zone and did not support coral growth.

The predominant coral in the outer moat and localized holes and depressions was Porites lutea. Along transects 1d and 1e, this species made up 47.8 and 73.04% of the coral colonies surveyed, respectively. Along Transect 6c Porites andrewsi was predominant and made up 38.46% of the corals quantified. Microatolls of Porites lutea were also present along this transect and comprised 25% of the corals surveyed. The high density of corals on the reef flat, as compared to the percent of coverage on transects 1d, 1e, and 6c (2.41, 1.77, and 3.86/m^2, respectively), was the result of small colony formations; mean diameters of colonies along the three transects ranged from 2.45 to 20.58 cm (Tables 3, 4, and 7).

Kvammen (Federal Aviation Administration 1977) estimated the reef-flat coral coverage to be between five and ten percent. The percent coverage of reef flat corals surveyed in this study was below five percent. The difference in the two estimates was probably the result of transect locations.

The North and South Hole transects (Fig. 2, Table 10 and 11) had relatively high coral coverage (41.14 and 65.35%, respectively). In both, Porites andrewsi was the predominant coral. The differences encountered at the two locations were represented by colony diameters and densities. The density of corals at the North Hole transect was $2.62/m^2$, whereas along the South Hole transect density was only $1.29/m^2$. The mean diameter of P. andrewsi along the South Hole transect as compared to North Hole transect was 77.32 and 67.9 cm, respectively. Also, the presence of a foliaceous Turbinaria colony at the South Hole transect, with a mean diameter of 283.66 cm, accounted for the major difference between the two sites.

Transects 4 and 5 were both located on the reef margin along the north side of the harbor. Porites lutea was the predominant coral and represented 75.91 and 68.78% of the species quantified, respectively (Table 5 and 6). Transect 5, located closer to the harbor mouth, was subject to tidal flushing and therefore less siltation from the mangrove community than Transect 4. As a result, there was a greater diversity of corals along Transect 5 (7 species) as compared to Transect 4 (3 species). Additionally, Transect 5 had a greater density and percent of substrate coverage than Transect 4 (5.4 corals per m^2 and 5.7% coverage vs 1.22 corals per m^2 and 3.03% coverage, respectively).

Transect 7, located on the north side of the harbor mouth, had the greatest diversity of the transects surveyed (13 species). The high percent of coverage (39.58%) resulted from the presence of large colonies of Diploastrea heliopora which comprised 64.48% of the corals quantified (Table 8). The large mean diameter of D. heliopora (109.69 cm) accounted for the relatively low density of 2.15 corals per m^2. This transect, like Transect 5, was not subject to heavy siltation from the mangrove community and was at a greater depth.

In contrast, Transect 8, located on the south side of the harbor mouth, had a percent substrate coverage comparable to the reef-flat transects (5.21%). Massive Porites lutea and columnar Porites (S.) iwayamaensis colonies formed pinnacles and knolls over much of the transect (52.59 and 40.12% of the corals quantified, respectively).

Transect SRF had a density of 2.27 corals per m^2 and a percent substrate coverage of 10.13%. The predominant corals along the transect were Porites (ramose sp. 1) and Acropora hebes comprising 85.48 and 7.25% of the corals quantified, respectively (Table 12). This transect was run perpendicular to the reef margin and intersected several zones. Corals were restricted to an inner moat area similar to the outer reef moat of Transects 1d, 1e, and 6c.

Transect OR-1, located on the reef slope, had an overall density of 3.12 corals per m^2 and percent substrate cover of 2.94% (Table 13).

There was a high species diversity with 13 species quantified. The transect was placed across numerous surge channels, and the presence of heavy surf made quantification difficult. The estimate of percent cover of 2.94% was probably low; and alternative method (see Table 2) yielded 33.8%, a more realistic value. The general area was characterized by numerous colonies of Acropora, Montipora, and Hydnophora.

A qualitative listing and the relative abundance of corals found on or in the vicinity of the eleven transects are in Table 14.

Macroinvertebrates

Holothurians were the most conspicuous macroinvertebrates found on the Okat reef flat. The two most abundant invertebrates occurring on transects were Holothuria atra and Stichopus chloronotus (Tables 15 and 16). Both species had their highest transect densities along the longitudinal midline of the reef flat. This line approximated the transition region between the inner seagrass beds and the outer mixed coral-rubble zone.

An area of mixed seagrass and sand about 200 m north of the South Hole, had very high densities of H. atra. The mean value of 261 individuals per 10 m^2 is among the highest recorded densities for the species (see Bakus 1973). Stichopus chloronotus was virtually absent from this area. This was unusual, since the species showed high densities to the south (Transect 3a) and moderate densities to the north (Transect 1d).

Two other holothurians also were occasionally abundant. Holothuria hilla and Stichopus horrens were common under rocks or coral on Transects 1d, 6b, and 6c (H. hilla only). Interestingly, neither species was present under rocks or coral on Transect SRF.

Subtidal transects along the harbor margin (4, 5, 7, and 8) had holothurian populations distinctly different than those of the reef-flat transects. Overall, holothurian densities were lower than on the reef flat. Three species--H. edulis, S. chloronotus, and H. atra were present subtidally but in considerably lower densities, than on the reef flat. S. horrens and H. hilla were absent from subtidal transects. No holothurians were counted on Transect OR-1 although Actinopyga mauritiana was seen nearby.

Stichopus chloronotus was the predominant sea cucumber in the two large reef-flat holes. Holothuria atra was also present but at a low density.

Thirty-nine species of echinoderms were collected (Table 20). The only asteroids recorded on transects were Linckia laevigata, L. multifora, and an unidentified small blue-gray Linckia. None of these occurred in great abundance. Two corallivorous starfish, Culcita novaeguineae and Acanthaster planci, were observed at Okat. However, only a few specimens of each were seen. Wass (1973) found only two A. planci during a starfish survey.

No echinoids were counted on any reef-flat transect. Two species were found on off-reef transects and were among the most abundant animals on Transect OR-1. These were Astropyga radiata and Echinometra mathaei.

Ophiocoma scolopendrina was the only significantly abundant ophiuroid and was found only on reef-flat transects.

The echinoderm data for Okat showed some interesting deviations from data gathered at Yap and Ulithi in the Western Carolines. Three of the most common echinoderms at Yap--Actinopyga echinites, Mespilia globulus, and Protoreaster nodosus--were not found at Okat. Conversely, Stichopus chloronotus and Holothuria atra, the most common at Okat, were found in low abundance at Yap (Grosenbaugh 1978). H. edulis occurred in seagrass at Yap but was found only on sandy debris at Okat. The reef flat data for Ulithi (Tsuda et al. 1978) was very similar to that for Okat. H. atra was the most abundant holothurian at Ulithi and occurred in relatively high densities. In addition to not being found at Okat, M. globulus and P. nodosus occurred in greater density at Yap (Grosenbaugh 1978) than any echinoid or asteroid in the present study.

Crustaceans were not quantified because of their arcane habitats. Also field identification of species was difficult. Table 18 lists the results of several collections at Okat and other locations on Kosrae.

The predominant macrocrustaceans in the seagrass beds at Okat were probably the hermit crabs (Diogenidae, Paguridae). Collections were made and several of the species from Kosrae represent substantial eastward extensions of their known distributional ranges.

Among the diogenids, Calcinus aff. pulcher had been previously recorded only as far east as the Mariana Islands (Wooster 1979). The status of this species is being studied by Janet Haig of the Allan Hancock Foundation, University of Southern California. This hermit was found subtidally on Transect 7 and was collected from live coral.

The previous eastern boundary for the small pagurid, Pylopaguropsis zebra, was northwest Australia until the discovery of one specimen on Guam, Mariana Islands (Wooster 1979) and now its subsequent discovery on Kosrae. Wooster's (1979) specimen was found at a depth of 10 m on coral rubble which contrasts with Okat where specimens were found intertidally mixed in with algae samples.

A filter-feeding pagurid Orthopagurus harmsi, which dwells in abandoned polychaete worm tubes, previously known only as far east as Guam (Wooster 1979) is now known from the Eastern Caroline Islands. O. harmsi was collected from worm tubes in Porites iwayamaensis and Montipora sp. along Transects 7 and 8.

The record of the portunid Thalamita pilumnoides from Kosrae substantially extends that species' northeastern limit from the Marianas (Stephenson 1972). This crab was found in a dredge sample from the South Hole.

If the identification of one portunid as Thalamita demani is confirmed, the Kosrae record extends its eastern limit from the Philippines (Stephenson 1972). One specimen was found from a tide pool in the seagrass beds.

A third portunid, Portunus longispinosus bidens, was found at Okat. This subspecies of the taxonomically troubled P. longispinosus complex was previously recorded only from Ceylon and Japan (Stephenson 1972). Several specimens were collected from seagrass beds near the harbor margin.

The most common crabs within the rock and rubble zone were members of the brachyuran family Xanthidae and the anomuran Porcellanidae. Both groups were found underneath rocks within the zone.

Of the rocky intertidal xanthids only the record of Liomera laevis from Kosrae represents a range extension. It was previously known only as far east as the Philippines (Sakai 1976). At Okat it occurred underneath rocks in the seagrass beds.

The porcellanids, Petrolisthes asiaticus, P. fimbriatus, P. lamarckii, and P. lamarckii var. rufescens were widely scattered over the reef flats north and south of Okat harbor. All were previously recorded from Malem, Kosrae (Miyake 1942).

The families Grapsidae and Ocypodidae were the most common high intertidal crustaceans. The confirmation of the grapsid Varuna litterata would extend its range from Japan, its present eastern limit (Sakai 1976). The ghost crab Ocypode stimpsoni also has not been recorded farther east than Japan (Sakai 1976).

A male-female pair of the palaemonid shrimp, Conchodytes tridacnae, were found within the large bivalve Pinctata margaritifera from Transect 5.

Nearly 150 species of mollusks were collected at Okat (Table 19). The most common species at Okat were the small cowries Cypraea moneta and C. annulus. However, these were not quantified on transects because their cryptic lifestyle increases the possibility of an inaccurate count.

Gastropods which were quantified on transects were the topshells Trochus incrassatus and T. niloticus, the tiger cowrie Cypraea tigris, and the marble cone Conus marmoreus.

Although low in abundance on transects the distribution of the commercially valuable Trochus niloticus was interesting. Only smaller individuals (< 5 cm) were found on the reef flat. Large individuals (> 10 cm) were found near subtidal Transects 8 and OR-1. Often groups of 4-5 individuals were found. This size distribution was comparable to those found for several locations on Guam (Stojkovich and Smith 1978).

Another trochid, Monilea philippiana, was found at Puksurik. Previously this species has been recorded only from Samoa and Fiji (Cernohorsky 1972).

Analysis of the Nerita plicata data from Gabert Island, by the Mann-Whitney U-test, showed the northern, shaded population to be significantly greater than the sun-drenched southern population ($p < 0.001$; $t=3.5242$; $n=49$). Since the habitats were similar the difference in population size could probably be explained by the lower level of thermal stress to which the shaded population was exposed.

Other macroinvertebrates were recorded. The percent cover and frequency of gastropods, holothurians, sponges, and crustaceans are listed in Table 2. Several anthozoan species were recorded. Specimens of alcyonacean soft corals were collected and preliminary identifications of ten species have been made (Table 17). Several species of sponges were collected but identification, except for three species, was nearly impossible. Cinachyra australiansis (Carter) occurred on the reef flat, and Spirastrella vagabunda Ridley, and Dysidea herbacea Keller grew among the seagrasses in the boulder zone at the south end of the Okat reef flat. Two antipatharian species were collected from the deeper subtidal areas near the channel entrance.

Coral Commensals--Colonies of Pocillopora damicornis collected from the North Hole were found to have several species of associated crustaceans and mollusks (Tables 18 and 19, column 5). Crabs of the genus Trapezia were the predominant crustaceans. These were usually found in male-female pairs with only one or two pairs per colony. Snapping shrimp (Alpheidae) were represented by several pairs of Alpheus lottini and a single specimen of A. brevipes.

One colony of Pocillopora eydouxi (near Transect OR-1) yielded specimens of T. rufopunctata. Also present was the hapalocarcinid, Pseudocryptochirus kahe. The discovery of this species at Okat is the first record of living specimens collected outside of Hawaii (McCain and Coles 1979).

Members of the family Coralliophilidae were the most common coral-living mollusks at Okat. Coralliophila violacea was the most common. Two species of Leptoconchus were found. L. lamarkii was collected from Porites iwayamaensis and L. striatus from Leptoria sp. Both were taken from Transect 7.

Fishes

At least 337 species of fishes were observed in the Okat reef area. Most of these occurred in one or more of eleven habitats and are listed with estimates of their relative abundances in Table 21. Results of fifteen transects falling into seven of the habitats are presented in Tables 22-27. Transects were not carried out, but reconnaissance dives were made in all of the remaining habitats except the mangrove forest. The harbor and channel floor were not investigated because of extremely poor visibility and depths below practical limits. Jaccard coefficients of similarity between the fish faunas of all possible habitat pairs, excluding the mangrove forest are given in Table 28. A list of fish species not observed during the present survey but previously recorded from Kosrae is presented in Table 29.

Results of transects, reconnaissance dives, and collections are discussed under individual habitat headings below.

Mangroves--Observations here were incidental. The landward side of the entire Okat reef area was bordered by an extensive mangrove forest dissected by canopy-covered saltwater channels. Channel depth varied from 0.5 to 1 m at low tide. An abundance of algae (Halimeda sp. and Caulerpa sp.) and the seagrass Enhalus acoroides commonly covered a mud and leaflitter substrate. An unidentified Apogon, relatively small lethrinids, Gerres sp. (probably G. argyreus), and Siganus spinus were seen in large numbers. Sphaeramia orbicularis congregated around prop-root systems, and large schools of mullet (Mugilidae) were occasionally seen along the forest margin.

Seagrass Beds--This habitat contained transects 1a, 1b, and 1c and with the exception of occasional small holes and a relatively sandy area shoreward, was exposed at low tide. Forty-three species of fishes were seen here (Table 22), ten (23%) of which were restricted to this habitat. The lowest transect counts, in terms of numbers of species seen on transects (6 to 24) and in the vicinity of transects (17 to 25), and the lowest densities ($\bar{Y}$ = 0.71 indiv./m^2) occurred here. Mulloidichthys flavolineatus and Siganus spinus were the most abundant species and occurred here in higher numbers than elsewhere. Most of the larger species here presumably migrated elsewhere during the ebbing tide, whereas many of the smaller ones lived in or near pockets where were permanently submerged. The fish fauna in this habitat was most similar to that of the moat (Jaccard coefficient of similarity, J = 0.25), least similar to that of the channel slope (J = 0.01), and one of the two most unique ($\bar{J}$ = 0.13).

Moat--This habitat as defined here was the subtidal portion of the reef flat seaward of the intertidal portion of the seagrass beds and has a substrate consisting of various combinations of sand, living coral, rubble, and/or seagrass. This habitat was investigated both at Okat reef (Transects 1d, 6b, and 6c) and on the reef flat south of Okat harbor (SRF). Depths during low tide (excluding tops of coral heads) ranged from 0.3 to 0.7 m. Eighty-seven species were seen in this habitat, six of which were not seen elsewhere (Table 23). Densities ranged from 1.81 to 3.91 invi./m ($\bar{Y}$ = 2.43). The damselfishes Dascyllus aruanus, Eupomacentrus albifasciatus, E. lividus, and Glyphidodontops biocellatus dominated the counts and were more abundant here than elsewhere. Economically important species such as Epinephelus merra and Scolopsis cancellatus were encountered in moderate numbers. The fish fauna of this habitat was most similar to that of the lagoon margin (J = 0.42) and the reef-flat holes (J = 0.38).

Outer Reef Flat--This zone was located immediately seaward of the moat and extended to the breaker zone of the reef margin. The substrate consisted of consolidated limestone covered in most places with a veneer of loose rubble and rocks and contained little living coral. It was subject to the almost constant motion of waves which had broken over the reef margin, but continued on to the moat as a secondary surge except during low tides when much of this area was exposed. Only one transect (1e) was studied here. Thirty-one species were seen here, 28 on the transect with a combined density of 3.89 indiv./m^2. Glyphidodontops glaucus, extremely rare elsewhere, accounted for 49% of the individuals counted and was remarkably evenly distributed over the length of the line ($\bar{Y}$ = 28.8/15 m , S = 8.3, w = 15-41 for ten equal intervals). Also abundant were juvenile Thalassoma spp., Halichoeres trimaculatus, and Acanthurus triostegus. Few large fish were seen. Although only one species was not seen elsewhere, this habitat's lack of faunal resemblance to the others made it one of the three most unique ($\bar{J}$ = 0.14). This area was most similar to the moat (J = 0.27).

Reef Flat Holes--Two large shallow holes in the Okat reef flat were investigated. Both were about 4.5 m deep with fine sand bottoms and margins of the seagrass Enhalus acoroides, coral (mostly Porites andrewsi), rubble, and sand. The single transect in each hole was placed along the margins in order to sample the fish fauna over as wide a variety of substrate types as possible (Table 26). The holes contained the highest number of species (108), the highest densities ($\bar{Y}$ = 9.55 indiv./m^2; see comments below), and largest individual fishes (with the exception of one shark) of any habitat within the confines of the reef flat. The high densities were mainly caused by large swarms of juvenile Ctenochaetus striatus which moved over the tops of coral heads. Large numbers of Chromis caerulea and Dascyllus melanurus aggregated in the water column above the coral. Large individuals of Lutjanus fulvus were common and several reef predators, not seen elsewhere within the reef flat such as Lutjanus bohar, Lethrinus microdon, Carangoides ferdau, Caranx melampygus, and Plectorhynchus lineatus, occurred here as well. These reef-flat hole fish faunas were closest to that of the lagoon margin (J = 0.47) and the moat (J = 0.38), but sixteen species (15%) were not seen elsewhere. Although the position of the transects and the large swarms of Ctenochaetus resulted in inflated density figures, the presence of numerous mullids, scarids, carangids, and lutjanids over the open sand indicated that these holes clearly maintained a higher biomass as well as higher diversity of reef fishes than the surrounding reef flat and probably served as a refuge area during low tide.

Harbor Margin--This habitat extended from the edge of the reef flat to a depth of about 5 m on the upper slope of Okat harbor and consisted of numerous large coral heads (mainly Porites lutea) on a fine sand substrate. Two transects (4 and 5) were run, yielding an average density (Table 24) of 2.58 indiv./m^2. Large swarms of juvenile Ptereleotris evides and fewer numbers of Pomacentrus pavo were present in the eastern end (Transect 4), whereas scarids and acanthurids were more abundant in the west, nearer the channel. Lutjanids, lethrinids, and mullids were seen in all areas. Small Caranx melampygus were often seen and two large groups of Carangoides orthogrammus were seen in the vicinity of a coral head (Galaxea) at a depth of 3-5 m. Although 14 species (16%) were not seen elsewhere, this habitat's fish fauna was one of the two least unique (J = 0.25) and bore a close resemblance to those of the reef flat holes (J = 0.47) and the moat (0.42).

Channel Margin--This habitat consisted of the upper portion of the Okat harbor channel. The northern margin (Transect 7) represented a fairly abrupt transition between barren reef flat and vertical channel wall and consisted of large, cavernous formations of living and dead lobate corals from the surface to a narrow (sometimes absent) shelf at 3-6 m. Numerous soft and scleractinian coral formations were present along the edge of the shelf and extended down the nonvertical portions of the slope. The southern margin of the channel (Transect 8) was considerably wider and contained areas of rubble and sand with pockets of mangrove litter (transported on the outgoing tide) as well as coral formations similar to those of the northern margin. The lower limit of the channel margin was set at 8 m, the approximate lower limit of horizontal shelf development. This habitat had the most diverse fish fauna of any investigated (Table 25), containing 150 species, 17 (11%) of which were not seen elsewhere, and had one of the highest densities ($\bar{Y}$ = 6.33 indiv./m^2). The most numerous fishes were small aggregating planktivores such as juvenile Ptereleotris evides, Chromis lepidolepis, C. margaritifer, juvenile Thalassoma spp. (mostly on Transect 7), Anthias spp., and juvenile of the herbivorous Ctenochaetus striatus. Numerous large lutjanids (e.g. Lutjanus argentimaculatus and L. bohar), scarids (e.g. Bolbometopon muricatus and S. chlorodon), and acanthurids, and the giant wrasse Cheilinus undulatus and the trigger fish Pseudobalistes flavimarginatus were seen in this habitat. The fish fauna here was one of the two least unique (J = 0.25), showing close affinities with that of the outer reef terrace (J = 0.43) and outer reef margin and slope environments (J values from 0.26 to 0.29).

Channel Slope--Observations in this habitat were limited to two reconnaissance dives (totaling about one hour) below the area of Transect 7 from 9 to 30 m. The substrate consisted of buttresses of living coral, primarily tiered Porites iwayamaensis and shear limestone faces alternating with a steep tallus slope which continued well below 50 m. The slope was steep, from overhanging ledges to 60° and although at places there was a continuum with the channel margin, only fishes seen below 8 m were considered. Fifty-eight species were seen, one of them only here. Large lutjanids as well as caesionids, carangids, and large Pseudobalistes flavimarginatus were seen regularly. In the water column below 15 m a large Gymmosarda unicolor and numerous Naso hexacanthus were observed. This habitat's faunal composition was one of the two most unique (J = 0.13) although it had relatively close affinities with those of the outer reef dropoff (J = 0.36) and the channel margin (J = 0.28).

Outer Reef Margin--As defined here, this habitat was the upper portion of the seaward reef slope subject to the effects of surge but below the breaker zone and consisted of numerous alternating coral-covered ridges and sand and rubble-strewn gullies perpendicular to the edge of the reef flat. It extended to a depth of about 6 m and was best developed along the northeast extremity of Okat reef and absent south of Gabert Island. Sixty-nine species were seen in this habitat, 7 (10%) nowhere else. The single transect (Table 27) gave a density of 6.79 indiv./m^2, mostly swarms of juveniles of Thalassoma spp. and Ptereleotris evides. Several pomacentrids (Chromis vanderbilti, Eupomacentrus fasciolatus.

and Ptectroglyphidodon dicki), the hawkfish Paracirrhites arcatus, and surgeonfish Acanthurus lineatus were abundant. This habitat's fish fauna was closest to that of the outer reef terrace (J = 0.30) and channel margin (J = 0.29).

Outer Reef Terrace--This was the portion of the seaward reef slope immediately below the outer reef margin which sloped gently (5-15°) down to the upper edge of a steep dropoff. In the northeast this zone was as wide as 150 m and extended to a depth of 20 m or more; to the southwest it narrowed as the upper margin of the dropoff became shallower, forming a narrow band 10 to 20 m wide and 2-6 m deep near the channel entrance. The substrate was almost entirely living coral, primarily table-like Acropora, forming large irregular mounds. Observations here and along the dropoff were limited to a few hours of reconnaissance dives and incidental observations while spearfishing for ciguatera samples or being towed alongside a skiff. This habitat supported a diverse fish fauna of 149 species, 27 (18%) of which were not seen elsewhere. Large lutjanids, lethrinids, mullids, scarids, and acanthurids, all economically important, were abundant. Some, such as Lutjanus gibbus, L. kasmira, L. fulviflamma, Monotaxis grandoculis, and Macolor niger were occasionally seen in aggregations of 20 to 100 or more. The whitetip reef shark, Trienodon obesus, was seen here regularly. This habitat's fish fauna was most similar to that of the channel margin (J = 0.43) and the outer reef dropoff (J = 0.34).

Outer Reef Dropoff--This was the region of the seaward reef slope which began as shallow as 4 m near the channel entrance and which plunged steeply (60-90°) down below the limits of coral reef development. The substrate was mostly live coral (mainly plate-like Acropora spp. and the branching Porites andrewsi) interspersed with areas of steep tallus slope, particularly south of the channel. Observations were carried out to a depths of 30 m. Eighty-eight species of fishes were seen in this habitat, 9 (10%) of which were not seen elsewhere. Enormous schools of lutjanids, mainly Lutjanus gibbus and L. fulviflamma, were observed up and down the slope from the top to over 30 m. Large groups of Naso brevirostris and Naso hexacanthus were seen in the water column. A few gray reef sharks, Carcharhinus amblyrhynchos were observed at 30 m. Numerous mixed species aggregations of Anthias dispar, Anthias sp., Chromis lepidolepis, and C. vanderbilti were common from the outer portion of the terrace to over 30 m. This habitat's fish fauna was closest to that of the channel slope (J = 0.30) and the outer reef terrace (J = 0.34).

Summary--Okat reef supported an extremely diverse assemblage of fishes. Three hundred and thirty-seven species were observed in the eleven habitats investigated. A large proportion, 116 species (35%), were restricted to single habitats, whereas 100 (30%) ranged widely in three or more habitats. The most ubiquitous fishes were Parapeneus barberinus which was seen in nine habitats, and Lethrinus harak, Chaetodon auriga, C. citrinellus, C. vagabundus, and Chromis margaritifer which were each seen in eight habitats. Glyphidodontops biocellatus was characteristicly found in all reef-flat habitats. The mangrove and seagrass habitats supported the most depauperate fish faunas, whereas the channel margin and outer reef terrace supported rich faunas of as many as 150 species. The most distinctive habitats were the mangrove, seagrass, and channel slope while the lagoon and channel margins more closely resembled many others. The fewest numbers of individuals were found in the seagrass beds. The seagrass beds also had the lowest densities of fishes, whereas the reef-flat holes, outer reef margin and channel margin had very high densities, mainly swarms of juveniles and small planktivores.

Comparison of Present Study to 1974 Assessment

The 1974 Kvammen survey (Federal Aviation Administration 1977) was carried out in only a few days. Even though fifteen "transects" were diagrammed on Plate No. XIII, there appears to be no quantitative data in the report; therefore, no way to conduct a before-and-after study. The species collected at that time are named without specific area of collection. The present survey collected many more species than the 1974 survey. Interesting enough, the earlier report mentioned many species the present one did not find. Actually about 40% of the invertebrates listed on page 102 were not found during the present survey. Such large, obvious forms as Protoreaster nodusus and Diadema setosum were not seen. Some other species given are most likely misidentifactions. It is unfortunate that the present deposition of the species is not given.

The zones described by Kvammen appear, generally, to be the same areas as those found in the present study. The "marine meadows" are actually composed of three seagrass species of which Enhalus acoroides is the most abundant along most of the transects.

In an overview, there were actually only a few "differences" observed between the 1974 survey and the present one. The manner of interpreting what was observed was quite different. The present study allow future comparative analysis of the Okat reef area.

Areas of Unique Biological Value

The fringing Okat reef area contained a number of shallow-water habitats, especially a wide zone of seagrasses. The Okat harbor margin was rich in a variety of corals; however, the deeper parts were composed mainly of a fine, black silt. The water above the bottom was very turbid. Throughout the entire area, eighteen quantitative transects were made, and several sites were sampled qualitatively. This collecting yielded a high number of species and a relatively high diversity. However this diversity was not unusual. Most of the species found are known from widespread Indo-Pacific locations. A few species collected from Kosrae represented a considerable eastward extension of their ranges.

The shoreward mangrove community is noteworthy and has been suggested for preservation (Stemmermann and Proby 1978).

Ciguatera Testing

Interviews with local health officials and numerous fisherman indicated that historically ciguatera poisoning has been a minor problem. Only two cases were recalled in recent memory, both having occurred approximately three years ago. In one case a family was poisoned after eating a large balistid, probably _Pseudobalistes flavimarginatus_ and in the other case another family was poisoned after eating a barracuda, _Sphyraena_ sp. weighing approximately 10 kg. It was not known whether parts of these fishes other than the flesh were eaten. In both cases all victims recovered after a period of a few weeks.

In an attempt to determine the extent of ciguatera in the Okat Reef area, 16 specimens of 13 species likely to be toxic were collected and samples of their flesh and liver were tested by radioimmune assay (Table 30).

One species, _Cheilinus diagrammus_ had toxic flesh while two others, _Epinephelus caeruleopunctatus_ and _Ctenochaetus striatus_ had flesh of questionable toxicity. Liver samples of two additional species, _Caranx lugubris_ and _Epibulus insidiator_ were toxic. While other, larger specimens of fishes such as snapper, _Lutjanus argentimaculatus_, and the whitetip reef shark _Trienodon obesus_ were toxin free, the percentage of economically important species with flesh or livers of questionable or definite toxicity indicate that there is the potential for a ciguatera problem in the area. It is surprising that more cases of poisoning have not been reported. As construction and dredging activities proceed, ciguatera levels should be monitored carefully, since evidence elsewhere has indicated such activities may provide favorable conditions for outbreaks of poisoning.

CONCLUSIONS

Because of the physiographic configuration of Okat reef, surface water current direction and speed were primarily controlled by tidal flow. The reef flat was exposed at low tide and covered during high tide. Dredged material from the boat channel will mostly flow southward toward the harbor. Silt derived from runway fill should also flow southward. The coral community at the harbor margin is presently one adjusted to living in silt-laden waters. However the entire harbor margin itself will be dredged.

Silt derived from construction operations will generally flow southward. Presently, the harbor itself has a fine silt bottom and the patch reefs and southern reef margin are covered with a fine silt and have biotic communities which reflect at silt streaa. Construction-derived in the harbor itself should cause the heavier silt particles to fallout in an already silted area.

Construction of the boat channel will destroy a considerable part of the solid reef flat; therefore removing a great deal of habitat itself. However, with a channel along the mangrove coast, general current circulation patterns may increase, supplying a greater water mass which may assist in removing silt-laden water in currents toward the harbor mouth. After construction, this channel may act as a fish nursery ground much like the two reef-flat holes do now. Since the channel will contain water continuously, corals will probably settle in areas with appropriate hard substrate. The shading brought about by the bridge may also increase densities of fishes.

The bridges or causeways to the airfield and to the proposed dock should have adequate culverts to allow normal water ciruclation. The bridge to the airfield should have enough navigation space to allow outtriggers to pass through. Since the water flowed generally southward there are no specific recommendations about actual locations of culvert-produced circulation. Since this area was dry and exposed during normal low tides, water flow is normally quite irregular. Generally, as the tide began to increase there was a seepage of water on the exposed reef flat northward from the harbor. Water would enter the causeway-surrounded area from both the north and south with open culverts in the causeway. During outgoing tides the water would flush to the south.

The environmental stress of releasing silt into water is a threat to the biotic communities of the area. The harbor margin itself will be destroyed, as will both sides of the harbor entrance. The deeper water silt plume will exist through the harbor entrance, and silt which settles will only add to the silt-covered bottom. The biotic communities to the south are already silt adjusted. Permanent transects were made at T-6c and SRF so that future investigations would have a definite reference point.

Dredged areas will eventually be recolonized. Motile animals, which would probably leave during construction, would probably return upon completion of active operations.

LITERATURE CITED

Amesbury, S. S., R. T. Tsuda, R. H. Randall, C. E. Birkeland, and F. Cushing. 1976. Limited current and underwater biological survey of the Donitsch sewer outfall site, Yap, Western Caroline Islands. Univ. Guam Mar. Lab. Tech Rept. 24:1-49.

Bakus, G. J. 1973. The biology and ecology of tropical holothurians. pp. 325-267. In O. A. Jones and R. Endean (eds.). Biology and geology of coral reefs. Volume II, Biology 1. Academic Press, N. Y. 480 p.

Birkeland, C., R. T. Tsuda, R. H. Randall, S. S. Amesbury, and F. Cushing. 1976. Limited current and underwater survey of a proposed sewer outfall site on Malakal Islands, Palau. Univ. Guam Mar. Lab. Tech. Rept. 25:1-59.

Brewer, W. A. 1978. Wastewater facilities plan Kosrae District, Trust Territory of the Pacific Islands. PAE International, Los Angeles.

Cernohorsky, W. O. 1972. Marine shells of the Pacific. Volume II. Pacific Publications, Sydney. 411 p.

Cottam, G., J. T. Curtis, and B. W. Hale. 1953. Some sampling characteristics of a population of randomly dispersed individuals. Ecology 35:741-757.

Federal Aviation Administration. 1977. Final environmental impact statement, Kosrae Airport, Kosrae Island, Kosrae District, Trust Territory of the Pacific Islands. PGA A75-0010-01. 485 p.

Finsch, O. 1880. Beobachtungen uber die Vogel der insel Ponape, Kuschai, Carolines. Cabanas' J. Ornithol. 28:283-310.

Grosenbaugh, D. A. 1978. Qualitative assessment of the echinoderms in Yap Lagoon. pp. 81-86. In R. T. Tsuda (ed.). Marine biological survey of Yap Lagoon. Univ. Guam Mar. Tech. Rept. 45.

Lesson, R. P. 1825. Notice sur l'ile de Oulan ~~of~~ ou Strong. J. Voy. 26: 129-170, 273-303.

Lütke, F. 1835. Voyage autour du monde, execute par order de Sa Majeste l'empereur Nicolas les sur la Corvette Le Seniavine, dans les annees 1826, 1827, 1828 et 1829. Paris.

Masuda, H., C. Araga, and T. Yoshino. 1975. Coastal fishes of southern Japan. Tokai Univ. Press, Tokyo. 379 p.

McCain, J. C., and S. L. Coles. 1979. A new species of crab (Brachyura, Hapalocarcinidae) inhabiting pocilloporid corals in Hawaii. Crustaceana 36(1):81-89.

Miyake, S. 1942. Studies on the decapod crustaceans of Micronesia, III. Porcellanidae. Palao Trop. Biol. Stat. Stud. 2:329-379.

Sakai, T. 1976. Crabs of Japan and the adjacent seas. 3 Volumes. Kodansha Ltd., Tokyo.

Sarfert, E. 1919. Kusae. Ergebnisse der Südsee-Expedition 1908-10, II, Ser. B, 4.

Schultz, L. P., and collaborators. 1953-1966. Fishes of the Marshall and Marianas Islands. Bull. U. S. Nat. Mus. 202, 3 volumes.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry. W. H. Freeman, San Francisco. 776 p.

Sokal, R. R., and P. H. A. Sneath. 1963. Principles of numerical taxonomy. W. H. Freeman, San Francisco. 359 p.

Stemmermann, L., and F. Proby. 1978. Inventory of wetland vegetation in the Caroline Islands. 2 volumes. VTN Pacific, Honolulu.

Stephenson, W. 1972. An annotated check list and key to the Indo-west Pacific swimming crabs (Crustacea: Decapoda: Portunidae). Bull. Roy. Soc. New Zealand 10:1-64.

Stojkovich, J. O., and B. D. Smith. 1978. Survey of edible marine shellfish and sea urchins on the reefs of Guam. Aquatic Wildlife Res. Tech. Rept. 2:1-65.

Tsuda, R. T. 1972. Morphological, zonational, and seasonal studies of two species of Sargassum on the reefs of Guam. Proc. Seventh Internat. Seaweed Symp. Univ. Tokyo Press, Tokyo. pp. 40-44.

Tsuda, R. T. 1974. Seasonal aspects of the Guam Phaeophyta (brown algae). Proc. Second Internat. Symp. Coral Reefs, Australia, 1:43-47.

Tsuda, R. T., M. I. Chernin, J. O. Stojkovich, D. R. Lassuy, and B. D. Smith. 1978. Current and underwater biological survey for selected sewer outfall sites in the Yap Central Islands and on Falalop Islands, Ulithi Atoll, Yap Outer Islands. Univ. Guam Mar. Lab. Tech. Rept. 26:1-101.

d'Urville, J. S. C. D. 1835. Voyage pittoresque autour de monde. Vol. 2. Paris.

Wass, R. C. 1973. Observations by the Marine Resources Survey Team on Kusaie Island. Ponape Marine Resources. 2 p.

Wooster, D. C. 1979. The shallow-water hermit crabs of the Mariana Islands (Decapoda, Paguridea: Coenobitidae, Diogenidae, Paguridae). Unpubli. M.S. Theses, University of Guam. 179 p.

FIGURES

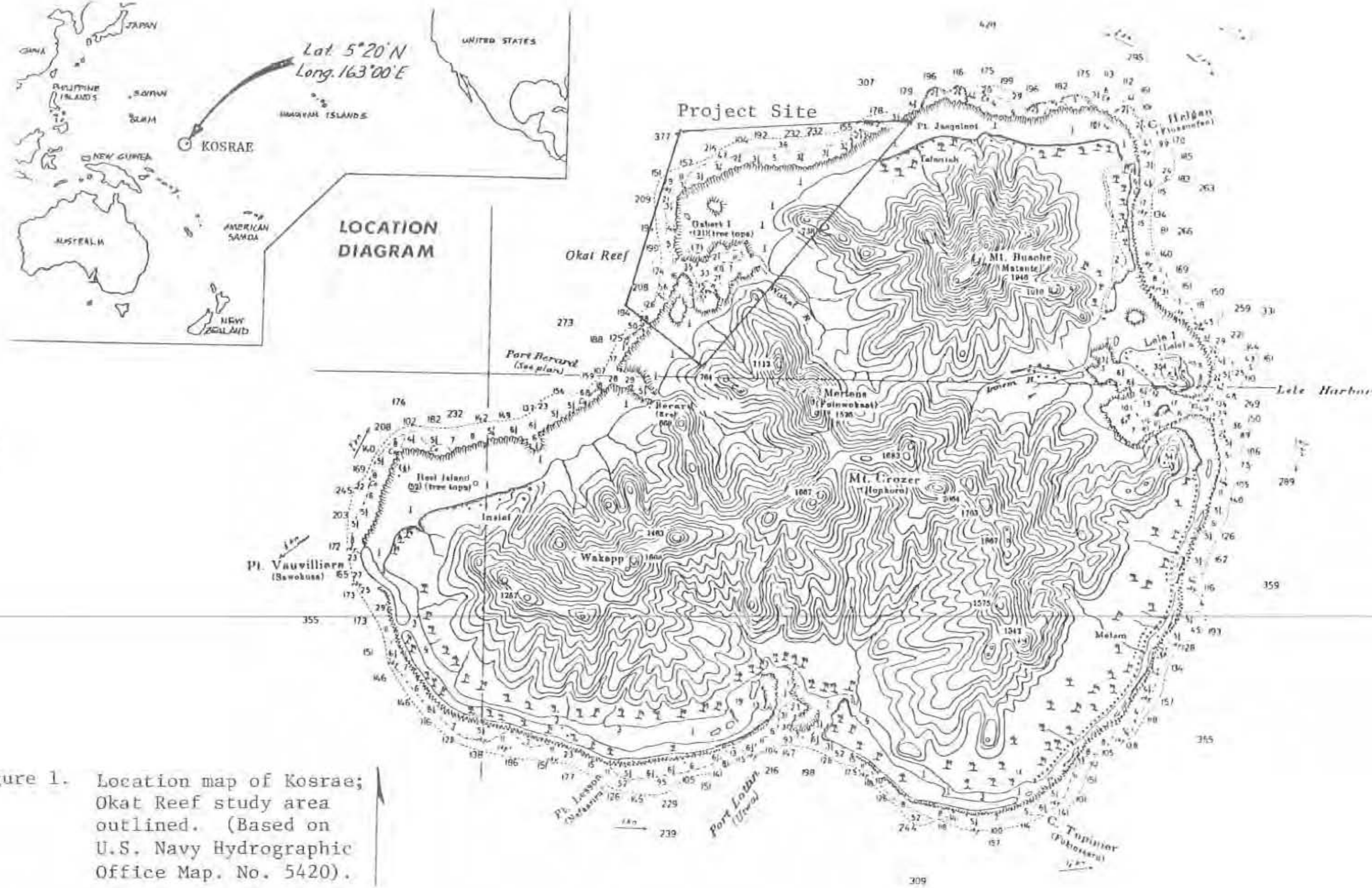


Figure 1. Location map of Kosrae; Okat Reef study area outlined. (Based on U.S. Navy Hydrographic Office Map. No. 5420).

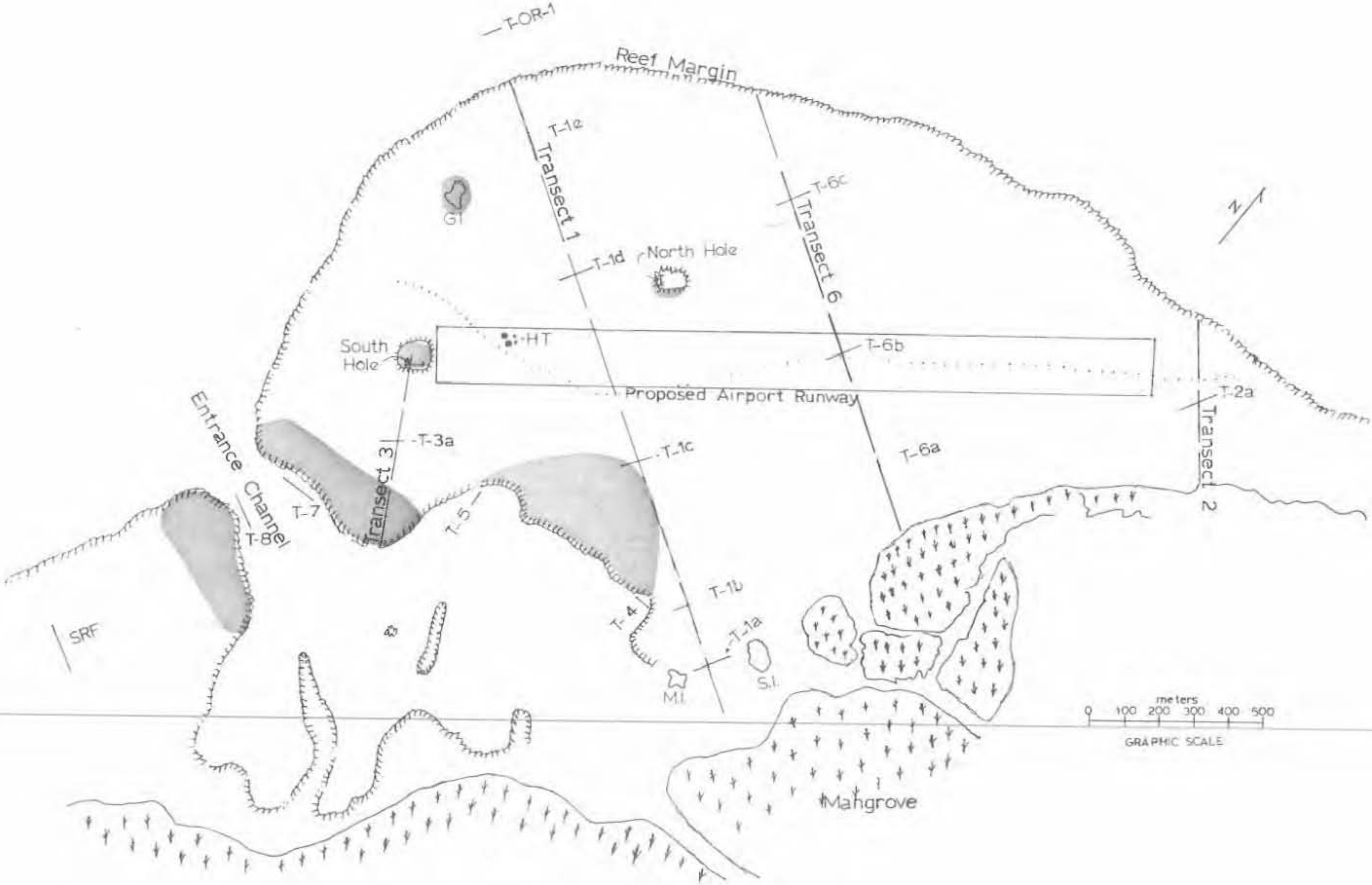


Figure 2. Location map of Okat reef and harbor area, showing locations of transects and general collecting areas (shaded) [HT = holothurian transect, G.I. = Gabert Island, M.I. = Molaneil Island, S.I. = Sawansaku Island].

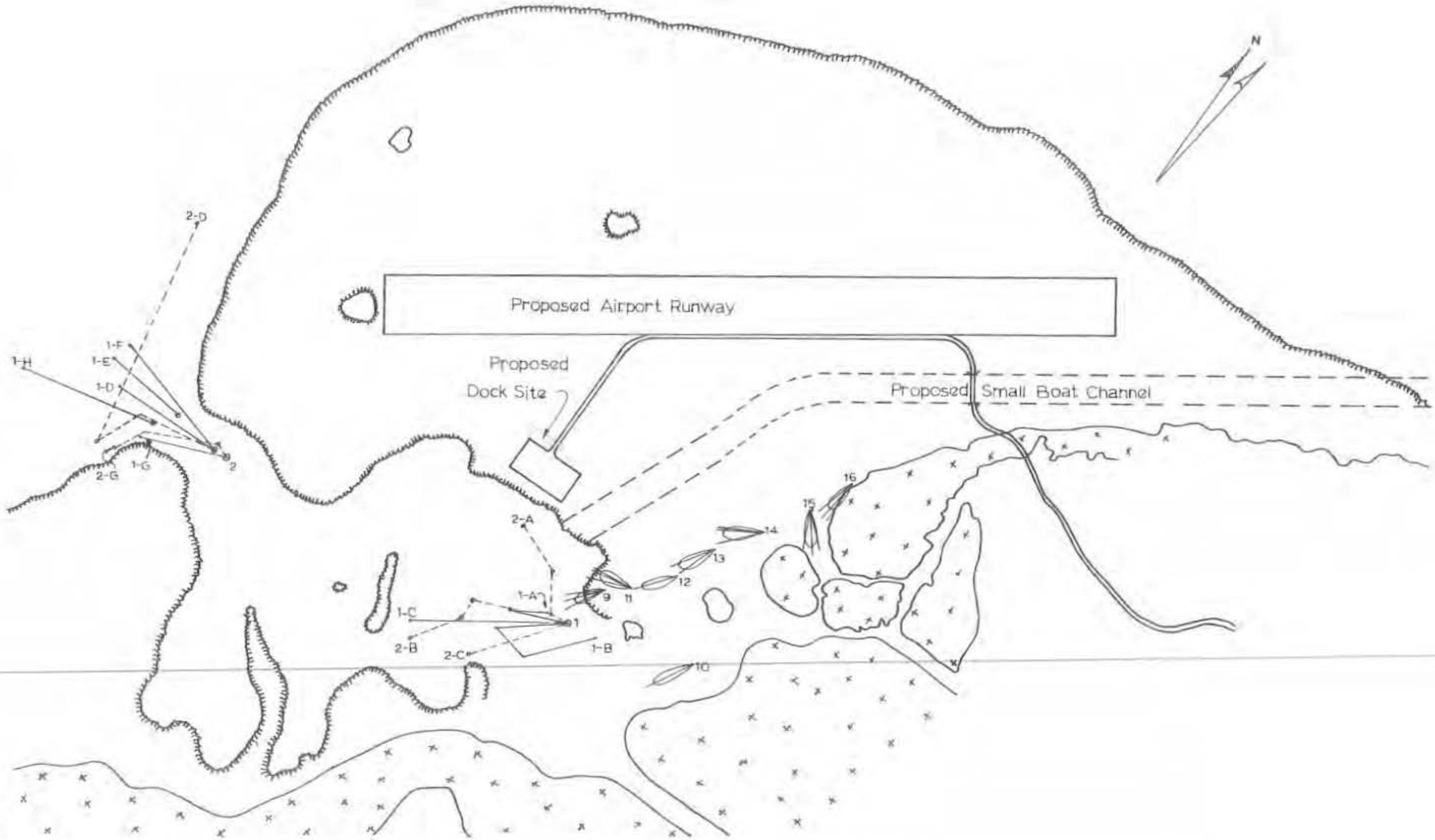


Figure 3. Drift patterns of 1 m and 5 m drogues released at Stations 1 and 2. ⟶ represents 1 m drogue; - - - - - -→ represents 5 m drogue; ⊙ represents approximate area of release. Also represented are approximate paths of travel of dye patches 9-16. Lines indicate direction of travel of replicate dye releases at a particular station.

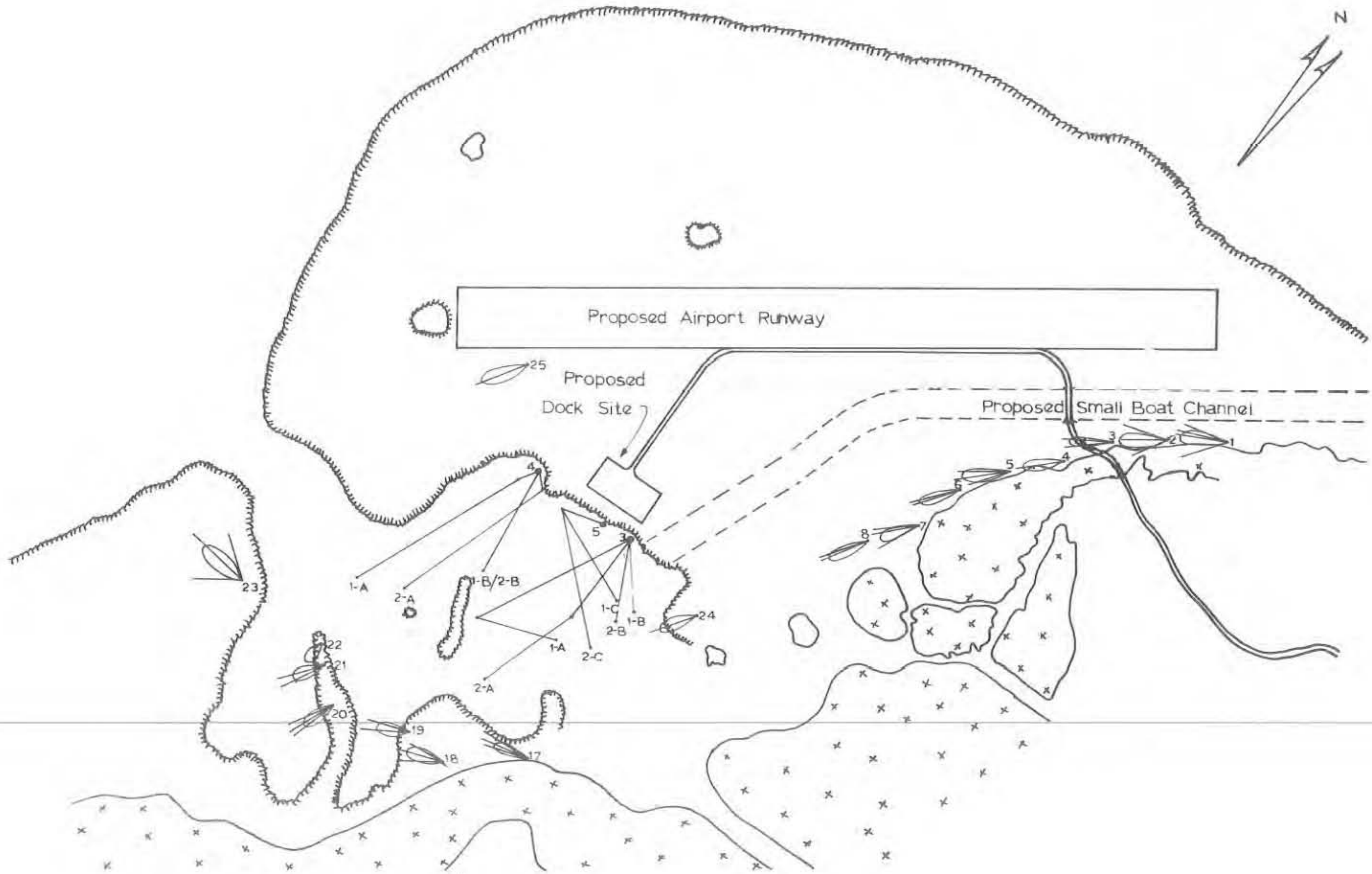


Figure 4. Drift patterns of 1 m drogues released at Stations 3, 4, and 5. ⊘ represents approximate are of release. Also represented are approximate paths of travel of dye patches 1-8 and 17-25. Lines indicate direction of travel of replicate dye releases at a particular station.

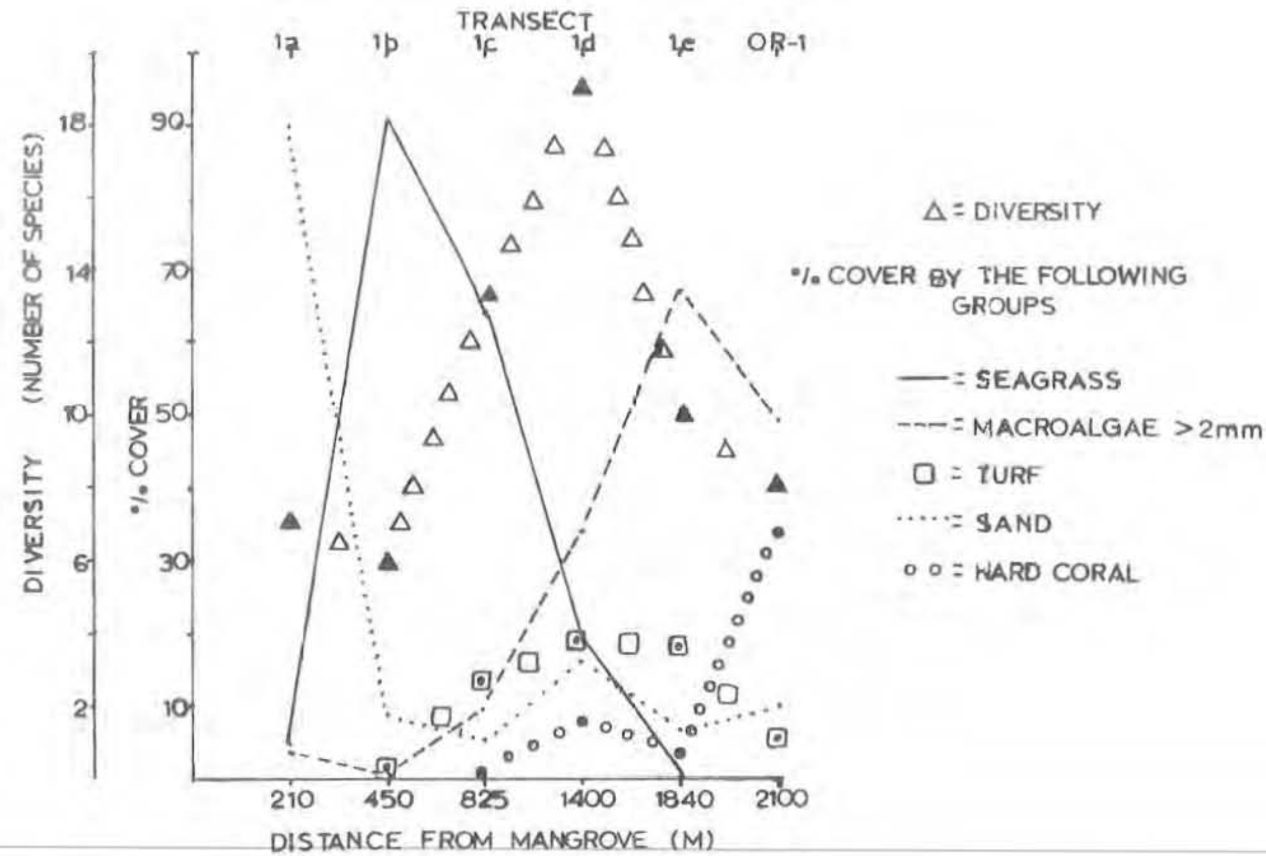


Figure 5a

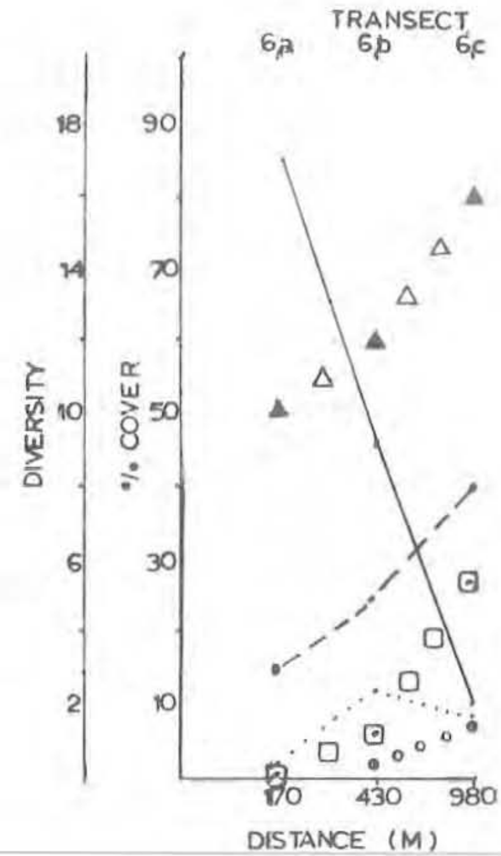


Figure 5b

Figure 5. Two sets of linear extrapolations which depict percent cover for four sessile reef-flat functional groups; seagrasses, macroalgae, turf, and hard corals. In addition, plant diversity and percent cover by sand are graphed. Data for this figure were obtained from transerts along two perpendicular lines extending from the mangroves seaward (see Figure 2 for transect locations). Note that Figure 5b is similar to Figure 5a if one only considers transects 1b, 1c, and 1d of Figure 5a. Also note the inverse relationship between seagrass and diversity. Shaded triangles, dots in circles and squares indicate actual data.

FIGURES LEGEND

6-1. Okat reef toward the east from Gabert Island; sand-bar "beach" in foreground.

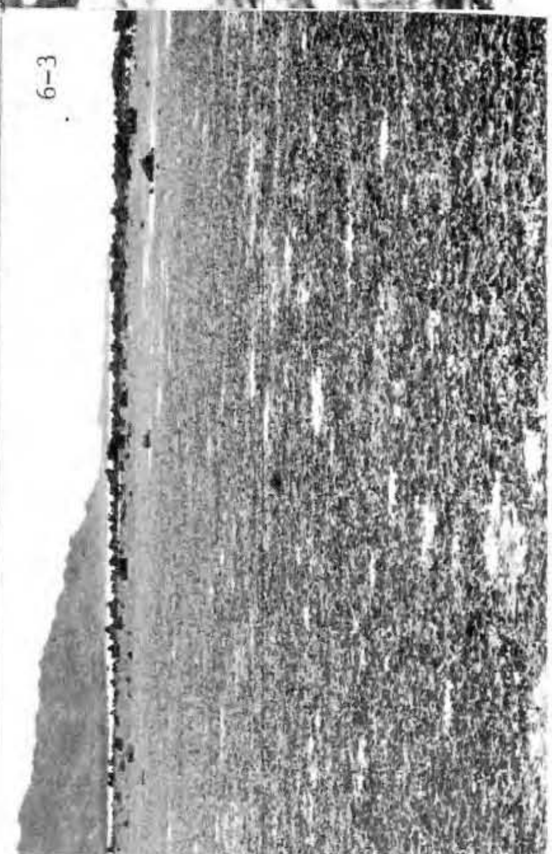
6-2. Rubble and boulder strewn Okat reef near margin on north side of harbor.

6-3. Mixed seagrass zone (near Transect 3a) on south end of Okat reef, large boulder and block area at north entrance to harbor in background.

6-4. Coral boulder with *Nerita plicata* on south side of Gabert Island.

6-1

6-2



6-3

6-4

TABLES

Table 1. Paths, velocities, and direction of movement of drift drogues released in the study area. The drift directions given for the points when drogue positions were determined are only indicative of straight-line movement even though actual paths travelled may be curved. Directions indicated for drogue paths are those toward which the drogue was moving whereas wind directions are those from which the wind was blowing.

Date	Release Station	Drogue No.	/Depth (m)	Time in	ΔTime (Min)	Distance (m)	Drogue Velocity (m/hr)	Drift Direction	Time	Wind Direction	Velocity (Knots)	Remarks	
May 26	1	1-A	1	0815	60	175	175	240	0815	60	5.0		
		2-A	5	0825	60	50	50	254				Hung-up on Endurance twice after release	
		1-A	1	0915	60	0	0	0	0915	50	12.5		
		2-A	5	0925	60	120	120	319					
		1-A	1	1015	65	110	102	52	1015	67	7.0	Tide	
		2-A	5	1015	60	155	155	285				Time	Height(m)
		1-B	1	1130	105	205	117	224	1130	104	10.0		
		2-B	5	1125	115	270	141	241				0313	1.6
		1-B	1	1315	55	115	105	95	1315	113	11.5	0935	0.5
		2-B	5	1320	55	60	55	174				1534	1.4
		1-B	1	1410	70	210	180	33	1410	95	8.5	2127	0.5
		2-B	5	1415	70	160	137	207					
		1-C	1	1530	125	450	216	229	1530	44	9.5		
		2-C	5	1530	125	295	142	210					
									1735	100	6.0		
May 27	2	1-D	1	0845	45	320	427	262	0845	44	11.0	Tide	
		2-D	5	0845	100	475	285	232				Time	Height(m)
		1-E	1	0935	45	240	320	269	0935	83	9.0		
		2-D	5	1025	70	680	583	342				0348	1.6
		1-F	1	1030	60	375	375	279	1030	90	7.5	1011	0.5
		1-G	1	1510	50	245	294	241	1510	55	9.5	1607	1.4
		2-G	5	1510	50	50	60	287				2159	0.5
		1-H	1	1600	60	410	410	252	1600	78	10.5		
		~~2-G~~	~~5~~	~~1600~~	~~66~~	~~305~~	~~277~~	~~226~~					
May 29	3	1-A	1	0745	90	460	307	201	0745	111	<1.0	Tide	
		2-A	1	0745	95	260	164	175					
		1-A	1	0915	40	225	339	64	0920	—	<1.0	Time	Height(m)
		2-A	1	0920	40	285	428	193					

Table 1. continued.

Date	Release Station	Drogue No./Depth (m)		Time in	ΔTime (Min)	Distance (m)	Drogue Velocity (m/hr)	Drift Direction	Time	Wind Direction	Velocity (Knots)	Remarks	
		1-B	1	1007	60	0	0	0	1007	16	$<$ 1.0	0452	1.5
		2-B	1	1007	60	0	0	0				1121	0.3
		1-B	1	1105	360	200	33	136	1105	—	$<$ 1.0	1715	1.3
		2-B	1	1105	360	230	38	148					
May 30	4	1-A	1	0830	70	60	51	207	0830	72	6.5	Tide	
		2-A	1	0830	70	50	42	128					
		1-A	1	0940	123	515	251	196	0940	54	9.0	Time	Height(m)
		2-A	1	0940	123	460	224	192					
		1-B	1	1155	205	310	92	167	—	—	—	0527	1.5
		2-B	1	1155	205	310	92	167				1156	0.7
												1750	1.2
May 31	5	1-C	1	0955	120	120	60	249	0955	25	8.5	Tide	
		2-C	1	0955	120	120	60	249					
		1-C	1	1155	244	290	71	108	1155	359	8.0	Time	Height(m)
		2-C	1	1155	244	380	93	127					
												0601	1.5
												1235	0.8
												1830	1.1

equency and percent cover of algae, seagrasses, and macroinvertebrates at Okat, Kosrae. This list
ecklist of the marine algae and seagrasses found along the transects and at the mangrove and channel
of Okat. Plain numbers indicate percent cover; numbers in parenthesis, frequency converted to percent.
4(10) = 9.4% cover, only found at 10% of the sample sites, indicating a patchy distribution.] Species
the vicinity of the transects are marked with an x. Algae turf includes microalgae which was impossible
in the field. Names marked with an asterisk (*) denote specimen deposited in the University of Guam
the author. The degree symbol (°) indicates a sea urchin (echinoid); and the plus (+) indicates that
ole was not as extensively collected as the North Hole, although they are similar habitats.

	TRANSECTS 1a	1b	1c	1d	1e	OB-1	2a	3a	4	5	6a	6b	6c	7	8	SRF	N. Hole	S. Hole	Mangrove areas	S. Channel Slope
Anthophyta (Seagrasses)																				
*Cymodocea rotundata Ehrenb. and Hempr. ex Aschers.							80.6(100)	56.9(90)											x	
*Enhalus acoroides (L.f.) Royle	9.5(10)	91.3(100)	38.8(100)	0.6(10)				x			x	16.3(40)					8.1(10)	x		
*Thalassia hemprichii (Ehrenb.) Aschers.	x		25.7(60)	17.5(40)							85.0(100)	30.0(90)	10.0(50)			6.9(30)	x	10.0(10)	x	
Cyanophyta (Blue-greens)																				
*Microcoleus lyngbyaceus (Kutz.) Crouan	x				6.2(30)		x				x		x	x		x	1.9(10)		x	x
*Schizothrix calcicola (Ag.) Gomont			x	2.5(20)	21.2(80)	x	1.2(10)	2.5(40)			4.4(70)	13.7(60)	9.4(50)					16.3(30)		x
*S. mexicana Gomont				x	1.3(20)			0.6(10)			0.6(10)	x		1.2(10)						
Chlorophyta (Greens)																				
Acetabularia moebii Solms-Laubach				x																
*Avrainvillea amadelpha f. submersa Gepp				0.6(10)	x								x			x	x			
*Boodlea composita (Harv.) Brand				x																
*Caulerpa brachypus Harvey											x	x								
*C. cupressoides (West) C. Ag.									x											
*C. racemosa (Forskal) J. Ag.				0.6(10)	x	0.6(10)	1.2(20)	7.5(40)					x			x	1.9(10)	x		
*C. serrulata (Forskal) J. Ag.			0.6(10)	0.6(10)					x	0.6(10)			x			x	0.6(10)			
*C. sertularioides (Gmel.) Howe												x					x			
*Dictyosphaeria cavernosa (Forskal) Boerg.			x	x				0.6(10)	x	x	x		x	0.8(10)			0.6(10)			
*Halimeda cf. copiosa Goreau and Graham														x	x					x
*H. incrassata (Ellis) Lamx.					3.8(20)											x	1.3(10)			
*H. macroloba Decaisne	3.8(30)	x	1.3(20)									4.4(30)	0.6(10)	x	1.2(10)		0.6(10)		x	
*H. opuntia (L.) Lamx.		x	5.6(40)	3.1(30)	5.0(30)		x	1.9(10)			8.8(80)		3.8(40)	x	0.6(10)	1.9(30)	8.1(60)	11.9(30)	x	
*H. simulans Howe				3.1(30)							x	x								
*Neomeris annulata Dickie																1.3(20)				
*Valonia fastigiata Harvey			x									0.6(10)								
*V. ventricosa J. Ag.										x							x			
Phaeophyta (Browns)																				
*Dictyota bartayresii Lamx.														1.2(10)	3.1(10)	1.3(10)	1.9(10)		x	
*Dictyota sp.									x					1.2(10)					x	
*Lobophora variegata (Lamx.) Womersley	x	x		5.0(30)	8.1(40)	1.9(20)			x			1.3(10)	5.6(30)	x		8.1(50)	1.3(10)			
*Padina sp.	x		1.9(20)				1.9(10)						1.2(20)							
*Sargassum cristaefolium C. Ag.			x				x													
*Turbinaria ornata (Turner) J. Ag.			x	10.6(60)	6.9(40)			9.4(40)		1.2(10)	x		16.9(60)			x	1.2(10)			
Rhodophyta (Reds)																				
*Actinotrichia fragilis (Forskal) Boerg.							x							x						x
*Amphiroa foliacea Lamx.																				x
*A. fragilissima (L.) Lamx.		x	x			x	x	x					x	x	x		x			
Centroceras sp.				x																
Ceramium sp.				x									x			1.9(10)				
*Desmia hornemanni Lyngbye										x				1.2(10)	x					x
Gelidium sp.						9.4(40)														
*Gracilaria arcuata Zanard.																			x	
*Halymenia durvillaei Bory															x					
*Hypnea sp.				x		2.3(10)	x		x							x	1.3(10)			
*Jania capillacea Harvey																	x			
*Jania sp.		x	x			x			x				x				x			
*Laurencia cf. papillosa (Forskal) Grev.	x			x													x			
*Metagoniolithon sp.																x				
*Peyssonnelia rubra (Grev.) J. Ag.														x			x			
*Porolithon sp.				8.1(60)	14.4(70)	34.4(60)		x		x		3.1(30)	2.5(30)		2.5(20)	8.1(20)	2.5(10)			
Algal turf			13.1(20)	17.5(50)	16.9(70)	5.0(20)	12.5(70)		8.8(10)	41.3(80)		5.6(40)	28.9(60)	2.5(20)	15.6(40)	20.6(60)	11.9(10)			
Macroinvertebrates																				
Gastropods	0.6(10)					0.6(30)		0.6(10)				1.3(20)				0.6(10)		1.3(10)		
Holothurians			3.1(30)	2.5(20)	1.9(20)			5.6(70)		0.6(10)		6.9(50)	3.1(40)	1.2(10)	0.6(10)°		0.6(10)			
Porifera			3.1(40)		0.6(10)		0.6(10)	3.1(50)			0.6(10)	1.9(20)		8.8(20)			2.5(20)	2.5(10)		
Crustaceans						0.6(10)														
Live coral				8.1(50)	3.1(20)	33.8(80)				16.9(60)		1.3(10)	7.5(40)	41.9(60)	24.4(70)	33.1(60)	27.5(60)	43.7(90)		
Dead coral										1.3(10)		1.2(10)			11.3(30)	8.1(30)	11.2(50)	5.6(30)		
Soft coral						1.2(10)				7.5(40)				22.5(40)	6.9(10)					
Sand	90.0(100)	8.7(60)	5.0(20)	16.3(70)	6.3(50)	10.0(40)	1.9(30)	9.4(60)	86.9(90)	10.0(30)	0.6(10)	12.5(90)	8.7(40)	8.8(10)	13.1(70)	5.6(20)	10.6(20)	8.7(20)		
Rock			1.9(10)						1.2(10)	20.6(60)			2.5(20)	8.8(10)	19.4(30)	2.5(10)	4.4(30)			
Detritus	0.6(10)			1.1(10)				1.9(10)	3.1(40)				1.2(20)		1.2(20)					
No. of Plant Genera	7	5	12	16	8	8	10	9	6	6	8	9	14	10	6	12	17	5+		
No. of Plant Species	7	6	13	19	10	9	10	10	7	6	10	12	16	13	9	15	22	5		
Total Percent Plant Cover	9.8	91.3	37.0	69.6	83.8	53.8	92.4	79.4	8.8	43.1	98.8	75.0	76.9	7.9	23	50.1	63.7	38.2		

Total No. of Genera (all transects)	33
Total No. of Species (all transects)	45

Table 3. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 1d (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

	Size Distribution of Colonies, Diameters (cm)										
Corals	n	$\bar{Y}$	s	w	Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
<u>Pocillopora damicornis</u>	6	17.65	12.0	3-36	0.5	23.81	0.49	20.69	0.70	22.3	66.8
<u>Porites andrewsi</u>	8	17.12	12.75	4-44	0.7	33.33	0.66	27.58	0.94	29.9	90.81
<u>Porites lutea</u>	15	14.36	11.48	2-42	0.9	42.86	1.25	51.72	1.50	47.8	142.38
Overall Density 2.41 per m^2											
Percent Substrate Coverage 3.14%											

Table 4. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 1 e (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative of Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
<u>Pocillopora</u> <u>damicornis</u>	8	8.90	4.46	2-19	0.8	44.4	0.786	44.4	0.34	16.67	105.47
<u>Pocillopora</u> sp. (red)	1	18.33	--	--	0.1	5.6	0.099	5.6	0.15	7.35	18.55
<u>Porites</u> <u>lobata</u>	1	12.00	--	--	0.1	5.6	0.099	5.6	0.06	2.94	14.14
<u>Porites</u> <u>lutea</u>	5	18.25	20.17	1-55	0.5	27.78	0.492	27.78	1.44	73.04	128.6
<u>Favites</u> <u>abdita</u>	3	5.88	1.02	4-10	0.3	16.66	0.295	16.66	0.05	2.45	35.77

Overall Density 1.77 per m^2

Percent Substrate Coverage 2.04%

Table 5. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 4 (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Pavona decussata	1	26.38	--	--	0.1	9.09	0.11	9.09	0.496	16.37	34.55
Pavona varians	2	11.95	6.4	5-17	0.2	18.18	0.22	18.18	0.234	7.72	44.08
Porites lutea	8	14.07	15.67	2-52	0.8	72.72	0.89	72.72	2.300	75.91	221.35

Overall Density 1.22 per/m^2

Percent Substrate Coverage 3.03%

Table 6. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 5 (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an important value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameter.

Corals	Size Distribution of Colonies Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Acropora humilis	1	5.92	--	--	0.1	5.88	0.146	2.7	0.007	0.123	8.7
Acropora hyacinthus	1	4.47	--	--	0.1	5.88	0.146	2.7	0.004	0.070	8.66
Porites andrewsi	2	22.18	2.87	14-27	0.1	5.88	0.292	5.4	0.212	3.74	15.02
Porites lutea	28	16.84	19.66	3.78	1.0	58.8	4.05	75.67	3.899	68.78	203.25
Favia pallida	1	19.34	--	--	0.1	5.88	0.146	2.7	0.079	1.39	9.97
Favia speciosa	1	11.49	--	--	0.1	5.88	0.146	2.7	0.28	0.494	9.07
Platygyra daedalea	3	26.44	16.52	13-53	0.2	11.76	0.437	8.1	1.439	25.38	45.24
Overall Density 5.4 per m^2											
Percent Substrate Coverage 5.7%											

Table 7. Size distribution, frequency, density, [illegible] ate covered by corals on Transect 6c (Fig. 2), Okat Harbor, Kosrae. Relative values o[illegible] sity, and per cent of substrate covered are also given and an importance value is calcu[illegible] m of these [illegible] e values. The symbols under "Size Distribution" represent the number of [illegible] (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies, Diameters (cm) n	$\bar{Y}$	s	w	Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
Stylocoeniella armata	1	2.4[illegible]	--	--	0.1	4.34	0.12	3.12	0.01	0.1	7.55
Pocillopora damicornis	4	9.53	5.55	3-18	0.3	13.04	0.48	12.5	0.11	7.1	32.64
Pavona divaricata	2	3.00	1.41	2-4	0.1	4.34	0.24	6.25	0.01	0.28	10.87
Porites andrewsi	5	20.19	10.22	3-39	0.4	17.39	0.60	15.63	0.60	38.46	71.48
Porites lut[illegible]	13	9.83	5.12	4-28	0.9	39.13	1.56	40.63	0.39	25.00	104.76
Porites m[illegible]	2	20.58	8.32	10-70	0.2	8.69	0.24	6.25	0.22	14.10	29.04
Goniastrea [illegible]	2	5.62	1.94	3-7	0.2	8.69	0.24	6.25	0.02	1.78	16.22
Heliopora coerulea	3	17.60	5.34	9-31	0.1	4.34	0.36	9.38	0.24	15.38	29.10
Overall Density 3.84 per m^2											
Percent Substrate Coverage 1.56%											

Table 9. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 8 (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) and range (w) of colony diameters.

	Size Distribution of Colonies, Diameters (cm)										
Corals	n	$\bar{Y}$	s	w	Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
Stylocoeniella armata	1	7.94	–	–	0.1	5.26	0.178	4	0.02	0.384	9.64
Acropora arbuscula	2	12.29	10.32	5–24	0.2	10.53	0.256	8	0.13	2.49	21.02
Acropora digitifera	1	6.92	–	–	0.1	5.26	0.128	4	0.01	0.192	9.45
Porites andrewsi	1	17.00	–	–	0.1	5.26	0.128	4	0.09	1.72	10.98
Porites lutea	7	33.00	13.51	19–73	0.5	26.32	0.89	28	2.74	52.59	106.91
Porites (Subcolumnar sp. 1)	1	7.00	–	–	0.1	5.26	0.128	4	0.02	0.384	9.64
Porites (Synarea) iwayamaensis	8	26.21	12.95	13–64	0.4	21.05	1.02	32	2.09	40.12	93.17
Favia pallida	2	3.74	1.04	3–5	0.2	10.53	0.256	8	<0.01	0.173	18.70
Platygyra lamellina	1	12.00	–	–	0.1	5.26	0.128	4	0.04	.768	10.03
Cyphastrea microphthalma	1	14.28	–	–	0.1	5.26	0.128	4	0.06	1.15	10.41

Overall Density 3.2 per m^2

Percent Substrate Coverage 5.21%

Table 8. Size distribution, frequency, density, and percent of substrate covered by corals on Transect 7 (Fig.2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) and range (w) of colony diameters.

Corals	Size Distribution of Colonies, Diameters				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Acropora hyacinthus	1	6.48	-	-	0.1	4.0	0.077	3.57	0.01	0.02	7.59
Montipora chrenbergii	1	17.97	-	-	0.1	4.0	0.077	3.57	0.09	0.23	7.80
Montipora verrucosa	1	17.00	-	-	0.1	4.0	0.077	3.57	0.08	0.20	7.77
Pavona (Polyastrea) obtusata	1	8.94	-	-	0.1	4.0	0.077	3.57	0.02	0.05	7.62
Porites lutea	7	58.11	37.86	12-128	0.5	20.0	0.538	25.00	9.04	22.83	67.83
Porites cf. P. andrewsi	2	33.74	13.07	20-56	0.2	8.0	0.154	7.14	0.68	1.72	16.86
Porites (Synarea) iwayamaensis	3	34.66	17.62	16-56	0.3	12.0	0.230	10.71	1.18	2.98	25.69
Favia pallida	1	30.59	-	-	0.1	4.0	0.077	3.57	0.26	0.66	8.23
Platygyra daedalea	2	13.62	2.36	11-18	0.2	8.0	0.154	7.14	0.11	0.28	15.42
Diploastrea heliopora	5	109.69	87.83	8-280	0.4	16.0	0.384	17.85	25.52	64.48	98.33
Plesiastrea sp.	1	22.23	-	-	0.1	4.0	0.077	3.57	0.14	0.35	7.92
Galaxea fascicularis	1	8.06	-	-	0.1	4.0	0.077	3.57	0.02	0.05	7.62
Heliopora coerulea	2	49.48	61.61	5-117	0.2	8.0	0.154	7.14	2.43	6.14	21.28

Overall Density 2.15 per m^2

Percent Substrate Coverage 39.58%

Table 10. Size distribution, frequency, density, and percent of substrate covered by corals on South Hole Transect (Fig. 2), Okat Harbor, Kosrae. Relative vabues of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies, Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Porites andrewsi	5	77.32	55.58	17-162	0.2	50.00	0.94	71.43	47.43	72.58	194.01
Porites (Synarea) iwayamaensis	1	89.32	-	-	0.1	25.00	0.176	14.28	8.88	13.59	54.87
Turbinaria sp.	1	283.96	-	-	0.0	25.00	0.176	14.28	9.04	13.83	53.11

Overall Density 1.29 per m^2

Percent Substrate Coverage 65.35%

Table 11. Size distribution, frequency, density, percent of substrate covered by corals on North Hole Transect (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observation (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies, Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Covers	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Pocillopora damicornis	3	15.7	8.8	7-32	0.2	12.5	0.303	11.54	0.271	0.659	24.70
Montipora (Trabeculate sp.1)	1	20.78	---	---	0.1	6.25	0.101	3.85	0.131	0.318	10.42
Porites andrewsi	14	67.9	67.7	11-271	0.7	43.75	1.417	53.85	37.54	91.24	188.84
Porites lutea	2	54.57	36.49	23-85	0.2	12.5	0.202	7.69	2.20	5.35	25.54
Porites (Synarea) iwayamaensis	2	16.81	15.41	5-32	0.2	12.5	0.202	7.69	0.242	0.588	20.78
Euphyllia glabrescens	4	22.78	13.04	7-44	0.2	12.5	0.403	15.34	0.753	1.83	29.71

Overall Density 2.62 per m^2

Percent Substrate Coverage 41.14%

Table 12. Size distribution, frequency, density, and percent of substrate covered by corals on Transect SRF (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean ($\bar{Y}$), standard deviation (s) range (w) of colony diameters.

Corals	Size Distribution of Colonies, Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Pocillopora damicornis	4	13.47	6.96	4-20	0.4	21.05	0.45	20.0	0.344	3.39	44.44
Acropora dwaricata	1	5.92	-	-	0.1	5.26	0.11	5.0	0.014	0.14	10.39
Acropora hebes	3	20.32	17.79	5-44	0.3	15.78	0.34	15.0	0.73	7.25	38.03
Porites andrewsi	3	12.92	5.68	6-19	0.3	15.78	0.34	15.0	0.22	2.19	32.97
Porites lichen	2	10.61	1.0	8-16	0.1	5.26	0.23	10.0	0.89	0.88	16.14
Porites lutea	4	5.91	1.98	5-24	0.4	21.05	0.45	20.0	0.06	0.59	41.64
Porites (arborescent sp. 1)	2	97.84	53.94	66-138	0.2	10.53	0.23	10.0	8.66	85.48	106.01
Platygyra daedalea	1	4.92	-	-	0.1	5.26	0.11	5.0	0.01	<0.09	10.35

Overall Density 2.27 per m^2

Percent Substrate Coverage 10.13%

Table 13. Size distribution, frequency, density, and percent of substrate covered by corals on Transect OR-1 (Fig. 2), Okat Harbor, Kosrae. Relative values of frequency, density, and percent of substrate covered are also given and an importance value is calculated from the sum of these three values. The symbols under "Size Distribution" represent the number of observations (n) and the mean (Y), standard deviation (s) and range (w) or colony diameters.

Corals	Size Distribution of Colonies, Diameters (cm)				Frequency	Relative Frequency	Density per m^2	Relative Density	Percent of Cover	Relative Percent of Cover	Importance Value
	n	$\bar{Y}$	s	w							
Pocillopora eydouxi	1	13.96	–	–	0.1	4	0.12	4	0.06	2.01	10.01
Acropora danai	3	10.26	2.81	8–81	0.3	12	0.37	12	0.10	3.53	27.53
Acropora humilis	3	18.56	4.18	15–32	0.3	12	0.37	12	0.34	11.43	35.43
Acropora hyacinthus	1	42.00	–	–	0.1	4	0.12	4	0.55	18.84	26.84
Acropora irregularis	3	22.23	14.09	8–48	0.3	12	0.37	12	0.58	19.83	43.83
Montipora ehrenbergii	2	22.50	12.85	9–36	0.2	8	0.24	8	0.38	12.89	28.89
Porites lutea	1	8.00	–	–	0.1	4	0.12	4	0.02	0.68	8.68
Favia speciosa	2	16.68	18.12	3–30	0.2	8	0.24	8	0.28	9.52	25.52
Favites abdita	1	9.80	–	–	0.1	4	0.12	4	0.03	1.02	9.02
Goniastrea edwardii	4	18.30	8.15	9–42	0.4	16	0.50	16	0.48	16.46	48.46
Platygyra daedalea	1	8.37	–	–	0.1	4	0.12	4	0.02	0.75	8.75
Hydnophora monticulosa	2	9.81	2.56	8–15	0.2	8	0.24	8	0.06	2.11	18.11
Millepora platyphylla	1	8.94	–	–	0.1	4	0.12	4	0.02	0.75	8.75

Overall Density 3.12 per m^2

Percent Substrate Coverage 2.94%

Table 14. List of corals observed within the study area by transects. Symbols represent their relative abundance around the various transects. D=dominant, A=abundant, O=occasional, R=rare.

CORALS	TRANSECTS 1d	1e	4	5	6c	7	8	SRF	NH	SH	OR
CLASS - ANTHOZOA											
ORDER - SCLERACTINIA											
SUBORDER - ASTROCOENIINA											
FAMILY - ASTROCOENIIDAE											
Stylocoeniella armata (Ehrenberg)	R	O	R		R	O	O		R		R
FAMILY - THAMNASTERIIDAE											
Psammocora contigua (Esper)	R		O	O							
Psammocora digitata Milne Edwards & Haime						R	R				
Psammocora explanatula (Vanderhorse)						R					
Psammocora (Ramose sp. 1)		R									
FAMILY - POCILLOPORIDAE											
Seriatopora hystrix Dana							R				O
Pocillopora damicornis (Linnaeus)	O	A			A	O	O	O	O	O	O
Pocillopora danae Verrill		R			R					R	R
Pocillopora elegans Dana							R				
Pocillopora eydouxi Milne Edwards & Haime											O
Pocillopora meandrina Dana	O	O			O	R		R			
Pocillopora sp. (Red)					R						
FAMILY - ACROPORIDAE											
Acropora arbuscula (Dana)							O				O
Acropora divaricata (Brueggemann)								R		R	O
Acropora diversa (Dana)						R	R				O
Acropora florida (Dana)										R	R
Acropora formosa (Dana)				O							
Acropora humilis (Dana)						R	R				O
Acropora hyacinthus (Dana)			R			R	R				O
Acropora intermedia (Milne Edwards & Haime)											O
Acropora irregularis (Brook)											R

Table 14. continued.

CORALS	TRANSECTS 1d	1e	4	5	6c	7	8	SRF	NH	SH	OR
Acropora kenti (Brook)											R
Acropora monticulosa (Dana)							R				
Acropora nasuta (Dana)							R				R
Acropora ocellata (Dana)											O
Acropora palmarae Wells											R
Acropora smithi (Bernard)											R
Acropora wardi (Dana)											O
Acropora (Corymbose sp. 1)											O
Acropora (Corymbose sp. 2)											O
Acropora (Corymbose sp. 3)							R				
Astreopora myriophthalma (Lamarck)						R	R				R
Montipora digitata (Dana)			R	R				O		O	
Montipora divaricata Brueggemann		O	A	O				O			
Montipora ehrenbergii Verrill							R				R
Montipora socialis Bernard											R
Montipora venosa (Ehrenberg)						R					
Montipora verrilli Vaughan						R					
Montipora verrucosa (Lamarck)							R				O
Montipora (Tuberculate sp. 1)							R				
SUBORDER - FUNGIINA											
FAMILY - AGARICIIDAE											
Pavona decussata Dana			O	O					O		
Pavona divaricata (Lamarck)			O						O		
Pavona multivensis (Linnaeus)							O				
Pavona varians Verrill									R		
Pavona (Explanate sp. 1)						R					
Pavona (Foliaceous sp. 1)							R				
Pavona (Polyastrea) obtusata (Quelch)	R	R	O	R			O				
Pavona (Polyastrea) venosa (Ehrenberg)			R								
Pachyseris rugosa (Lamarck)					R						
Pachyseris speciosa (Dana)						R					

Table 14. continued.

CORALS	TRANSECTS 1d	1e	4	5	6c	7	8	SRF	NH	SH	OR
FAMILY - FUNGIIDAE											
Fungia (*Ctenactis*) *echinata* (Pallas)							O	O			
Fungia (*Fungia*) *fungites* (Linnaeus)			O				O	O			
Fungia (*Pleuractis*) *scutaria* Lamarck						O		A			
Herpolitha limax (Esper)											R
Halomitra irregularis Gardiner						R					
FAMILY - PORITIDAE											
Goniopora arbuscula Umbgrove								R	R		
Goniopora lobata Milne Edwards & Haime							R				
Porites andrewsi Vaughan	O	O			O	O	O		D	D	O
Porites annae (Crossland)	R										
Porites australiensis Vaughan						O	O				
Porites cocosensis Wells						R		R	O	O	
Porites lichen Dana								O		O	
Porites lobata Dana		O						O			
Porites lutea Milne-Edwards & Haime	A	A	D	D	A	O	A	O	R	R	R
Porites murrayensis Vaughan	O	O			O		O				
Porites nigricans Wells		R					O	A	O		
Porites (Ramose sp.1)					R				R		
Porites (*Synarea*) *convexa* Verrill							R	O			
Porites (*Synarea*) *horizontalata* Hoffmeister							A		O		
Porites (*Synarea*) *iwayamaensis* Eguchi						O	A	O	O		
FAMILY - FAVIIDAE											
Favia pallida Dana		R	R	R		O	O				O
Favia rotumana (Gardiner)						R					
Favia speciosa (Dana)						O					O
Favia stelligera (Dana)							R				R
Favites abdita (Ellis & Solander)			R			O					R
Favites pentagona (Ehrenberg)											R
Favites virens (Dana)					R						
Goniastrea edwardsi Chevalier											O
Goniastrea pectinata (Ehrenberg)		R		R							

Table 14. continued.

CORALS	TRANSECTS 1d	1e	4	5	6c	7	8	SRF	NH	SH	OR
Goniastrea retiformis (Lamarck)	O		R	R	R	O	O				R
Platygyra daedalea (Ellis & Solander)		O		R			O				O
Platygyra lamellina (Ehrenberg)		O					O				O
Diploastrea heliopora (Lamarck)						D	O				
Leptoria phrygia (Ellis & Solander)						R	R				O
Hydnophora microconos (Lamarck)											R
Hydnophora exesa (Pallas)							O				
Leptastrea bottae Milne-Edwards & Haime								R			
Leptastrea purpurea (Dana)	R				R	R	R				R
Montastrea curta (Dana)						R					R
Cyphastrea microphthalma (Lamarck)						R					
FAMILY OCULINIDAE											
Galaxea fascicularis (Linnaeus)			R			R	R				
FAMILY - MERULINIDAE											
Merulina ampliata (Ellis & Solander)							R				R
FAMILY - MUSSIDAE											
Lobophyllia corymbosa (Forskaal)									O		
Lobophyllia costata (Dana)						O	R				
Symphyllia agaricia Milne Edwards & Haime											R
FAMILY - PECTINIIDAE											
Echinophyllia aspera (Ellis & Solander)							R				
SUBORDER - CARYOPHYLLIINA											
FAMILY - CARYOPHYLLIDAE											
Euphyllia glabrescens Chamisso & Eysenhardt							R			R	
Physogyra lichtensiteini Milne-Edwards & Haime							R				
SUBORDER - DENDROPHYLLIINA											
FAMILY - DENDROPHYLLIIDAE											
Turbinaria sp. 1						R					
Turbinaria sp. 2							R			R	
ORDER - COENOTHECALA											
FAMILY - HELIOPORIDAE											
Heliopora coerulea (Pallas)	O	R			O	O	O				R

Table 14. continued

CORALS	TRANSECTS 1d	1e	4	5	6c	7	8	SRF	NH	SH	OR
ORDER - STOLONIFERA											
FAMILY - TUBIPORIDAE											
<u>Tubipora</u> <u>musica</u> (Linnaeus)											R
CLASS - HYDROZOA											
ORDER - MILLEPORINA											
FAMILY - MILLEPORIDAE											
<u>Millepora</u> <u>dichtoma</u> Forskaal						R	R	R			O
<u>Millepora</u> <u>platyphyllia</u> Hemprich & Ehrenberg								O			O
ORDER - STYLASTERINA											
FAMILY - STYLASTERIDAE											
<u>Distichopora</u> <u>violacea</u> Pallas						R					

Total Genera 35

Total Species 105

Table 15. Abundance of macroinvertebrates (individuals/10m^2) at Okat, Kosrae.

	Reef Flat Intertidal Transects											Subtidal Transects						
	3A	1A	1B	1C	1D	1E	6A	6B	6C	2A	SRF	SH	NH	4	5	7	8	OR-1
Porifera																		
Purple sponge													0.3	9.6	3.2		0.05	
Annelida																		
Spirobranchus sp.														1.4	0.1	0.8		
Mollusca																		
Astraea rhodostoma																0.1		0.3
Conus marmoreus				0.04									0.4	0.1	0.1			
Cypraea tigris				0.1									0.3			0.05		
Drupa ricinus																		3.0
Terebra subulata		0.14																
Trochus incrassatus											0.05							0.4
T. niloticus					0.05	0.15									0.1	0.05	0.05	0.1
Arca sp.																	0.05	
Tridacna maxima									0.05									0.1
Echinodermata																		
Linkia [blue-gray]					0.15			0.15							0.3		0.3	
Linkia laevigata						0.1			0.05		0.05							
L. multifora						0.1					0.1					0.2		
Astropyga radiata																0.05	0.05	2.0
Echinometra mathaei															0.1			1.7
Ophiocoma scolopendrina					0.1	0.3			0.05	0.05								
Stichopus chloronatus	33.0		0.06	0.2	11.4			27.35	9.85		13.25	6.6	4.4		4.6	0.15	0.1	
S. horrens					0.6		0.1	5.2										
Bohadschia argus															0.1	0.05	0.1	
B. graeffei																0.05		
Holothuria hilla				0.22	8.3	0.45		3.65	4.35									
H. atra	45.6		21.77	26.6	24.6	27.9	16.4	31.95	15.3	0.95	8.05	0.1	1.5		0.1	-	1.4	
H. edulis															2.5	0.6	0.55	

Table 16. Density of holothurians (individuals/10 m^2) at site 200 m north of South Hole.

	Transect A 1	2	Transect B 1	2	$\bar{Y}$	s
Holothuria atra	262	273	253	256	261.0 ±	8.83
Stichopus chloronotus	-	-	-	2		-

Table 17. Anthozoans recorded from Okat, Kosrae.

	TRANSECT 5	TRANSECT 7	TRANSECT 8	OR-1
Anthozoa				
Alcyonacea				
Aloyoniidae				
Cladiella sp.				x
Sarcophyton sp. 1		x		
Sarcophyton spp.		x	x	
Sinularia sp. 1 [cf. polydactyla (Ehrenberg)]	x			
Sinularia sp. 2	x			
Sinularia sp. 3				
Sinularia sp. 4		x		
Sinularia sp.	x		x	
Neptheidae				
Dendronephthya sp.				
unidentified sp.				x
Zoanthidea				
?Palythoa sp.		x		
Antipatharia				
Antipathes ?undulata van Pesch				
Cirrhipathes anguina Dana	x	x		

Table 18. Crustaceans from Kosrae.
Plus (+) denotes observed but not collected. (Okat: Intertidal- 1, sand; 2, seagrass; 3, rock and/or rubble; Subtidal- 4, sand; 5, live coral; 6, rock and/or rubble; 7, mangrove. Other locations: 8, Lelu; 9, Pukusrik; 10, Tafunsak.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Crustacea										
Stomatopoda										
Gonodactylidae										
Gonodactylus incipens Lanchester									x	
Pseudosquilla hieroglyphica Manning			x							
Isopoda										
Ligiidae										
Ligia sp.			x							
Decapoda										
Alpheidae										
Alpheus brevipes Stimpson					x					
A. lottini Guérin					x					
Alpheus sp.			x							
Palaemonidae										
Conchodytes tridacnae Peters				x						
Stenopodidae										
Stenopus hispidus (Olivier)		x				x				
Palinuridae										
Panulirus longipes (A. Milne Edwards)						x				
P. versicolor (Latreille)						x				
Homaridae										
+Enoplometopus sp.	x	x	x	x						
Callianassidae										
Upogebia sp.		x								
Porcellanidae										
Petrolisthes asiaticus (Leach)			x					x	x	
P. fimbriatus Borradaile			x					x	x	
P. lamarckii (Leach)			x					x	x	
P. lamarckii var. rufescens (Heller)			x					x	x	
Diogenidae										
Calcinus elegans (H. Milne Edwards)			x							
C. gaimardi (H. Milne Edwards)						x				
C. laevimanus Randall		x	x							
C. latens (Randall)		x	x							
Calcinus aff. pulcher Forest					x					

Table 18. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Calcinus sp. 1								x		
Clibanarius corallinus (H. Milne Edwards)								x		
C. striolatus Dana							x			
Dardanus deformis (H. Milne Edwards)		x								
D. guttatus (Olivier)						x				
D. lagopodes (Forskaal)					x					
D. megistos (Herbst)		x								
D. scutellatus (H. Milne Edwards)		x								
Paguridae										
Orthopagurus harmsi Gordon					x					
Pylopaguropsis zebra (Henderson)		x	x							
Coenobitidae										
Coenobita rugosa H. Milne Edwards			x						x	
Dromiidae										
Dromidiopsis cranioides (DeMan)		x								
Hapalocarcinidae										
Fungicola utinomi (Fize and Serene)					x					
Hapalocarcinus marsupialis Stimpson					x					
Pseudocryptochirus kahe McCain and Coles					x					
unidentified spp.					x					
Calappidae										
Calappa hepatica (Linnaeus)	x	x								
Portunidae										
Portunus longispinosus bidens (Laurie)		x								
Scylla serrata (Forskaal)		x								
Thalamita crenata (Latreille)		x	x							
?T. demani Nobili		x								
T. pilumnoides Borradaile				x						
T. sima H. Milne Edwards		x								
Xanthidae										
Cymo melanodactylus deHaan					x					
Domecia hispida Eydoux and Souleyet					x					
+Eriphia sebana (Shaw and Nodder)			x					x		
Etisus dentatus (Herbst)			x							
Liomera cf. laevis (A. Milne Edwards)		x								
L. rugata (H. Milne Edwards)			x							
?Pseudoliomera remota (Rathbun)			x							

Table 18. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Tetralia glaberrima (Herbst)					x					
?*Trapezia dentata* Dana					x					
T. guttata Ruppell					x					
T. ferruginea Latreille					x					
T. maculata (Macleay)					x					
T. rufopunctata (Herbst)					x					
Zozymus aeneus (Linnaeus)			x							
unidentified spp.		x	x		x					
Grapsidae										
+*Grapsus tenuicrustatus* (Herbst)			x					x		
Pachygrapsus minutus A. Milne Edwards							x			
P. planifrons deMan										x
Percnon abbreviatum (Dana)			x					x		
P. planissimum (Herbst)			x					x	x	
?*Varuna litterata* (Fabricius)							x			
Gecarcinidae										
+*Cardisoma* sp.									x	
Ocypodidae										
Ocypode cordimana Desmarest										x
O. stimpsoni Ortman	x								x	x
Uca chlorophthalmus crassipes (Adams and White)										x
U. vocans vocans (Linnaeus)										x
Majidae										
Composcia retusa Latreille		x								
Huenia proteus deHaan		x								
unidentified sp.		x								
Parthenopidae										
Parthenope (*Rhinolambrus*) sp.		x								

Table 19. Molluscs from Kosrae.
Asterisk (*) denotes specimen collected dead. (Okat: Intertidal- 1, sand; 2, seagrass; 3, rock and/or rubble; Subtidal- 4, sand; 5, live coral; 6, rock and/or rubble; 7, mangrove. Other Locations: 8, Lelu; 9, Pukusrik; 10, Tafunsak.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Gastropoda										
Patellidae										
unidentified spp.								x		
Trochidae										
Euchelus atratus (Gmelin)	x	x								
**Monilea philippiana* Dunker									x	
Tectus pyramis (Born)					x					
Trochus incrassatus Lamarck		x	x					x		
T. niloticus Linnaeus		x	x			x				
Turbinidae										
Astraea rhodostoma (Lamarck)					x	x				
Turbo argyrostomus Linnaeus			x			x				
**T. petholatus* Linnaeus						x				
Neritidae										
Nerita albicilla Linnaeus								x		
N. grayana Recluz							x			
N. plicata Linnaeus			x					x		x
N. polita Linnaeus			x					x	x	
N. reticulata Karsten								x		x
Nerita sp.			x							
Neritina bensoni Recluz										x
Littorinidae										
Littorina coccinea (Gmelin)			x					x		x
L. scabra (Linnaeus)			x				x	x		
L. undulata Gray								x		x
Littorina sp.								x		
Nodolittorina millegrana (Philippi)								x		
Tectarius sp.		x								
Planaxidae										
unidentified sp.								x		
Cerithidae										
Cerithium columna Sowerby	x		x							
**C. echinatum* (Lamarck)						x				
C. nodulosum Bruguiere		x	x					x		
C. cf. zonatus		x								
Cerithium spp.		x	x					x		

Table 19. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Cerithidae (cont.)										
Rhinoclavis aspera (Linnaeus)				x						
R. sinensis (Gmelin)				x						
Strombidae										
Lambis lambis Linnaeus		x	x	x						
Strombus gibberulus (Roeding)		x		x						
S. luhuanus Linnaeus		x	x							
S. mutablis Swainson	x									
Capulidae										
Capulis danieli (Crosse)		x								
Capulis sp.		x								
Calyptraeidae										
Cheilea equestris (Linnaeus)						x				
Cypraeidae										
Cypraea annulus Linnaeus		x	x		x			x		
**C. arabica* Linnaeus						x				
C. caputserpentis (Linnaeus)			x							
C. carneola Linnaeus		x								
C. depressa Gray		x								
C. erosa Linnaeus		x				x				
**C. globulus* Linnaeus			x							
C. helvola Linnaeus			x							
**C. isabella* Linnaeus						x				
C. lynx Linnaeus		x	x							
C. moneta Linnaeus		x	x			x		x		
**C. poraria* Linnaeus									x	
**C. testudinaria* Linnaeus		x								
C. tigris Linnaeus		x	x	x		x				
C. vitellus Linnaeus		x				x				
Naticidae										
Natica gualtieriana Recluz	x	x								
N. zonalus Recluz		x								
Polinices melanostomus (Gmelin)		x								
**P. tumidus* (Swainson)		x								
Tonnidae										
**Tonna perdix* (Linnaeus)		x								
Cymatiidae										
Cymatium muricinum (Roeding)		x								
C. nicobaricum (Roeding)			x							

Table 19. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Bursidae										
Bursa buffonia (Gmelin)			x							
B. cruentata (Sowerby)			x							
B. granularis (Roeding)			x							
Muricidae										
Drupa morum Roeding			x							
D. ricinus (Linnaeus)			x		x	x		x		
D. rubusidaeus Roeding			x							
Drupella cornus (Roeding)		x	x			x				
Morula biconica (Blainville)			x					x		
M. granulata (Duclos)			x					x		
M. margaritacola (Broderip)		x			x		x			
M. uva (Roeding)			x							
Morula sp.						x				
Nassa serta (Bruguiere)			x							
Thais hippocastanum (Philippi)			x					x		
Magilidae										
Coralliophila pyriformis Kira					x					
C. violacea (Keiner)					x					
Leptoconchus lamarckii (DeShayes)					x					
L. striatus Ruppell					x					
Quoyula monodonta (Blainville)					x					
**Rapa rapa* Linnaeus			x							
Columbellidae										
Pyrene ocellata (Link)			x					x		
Buccinidae										
Cantharus fumosus Dillwyn	x		x							
C. undosus Linnaeus			x							
Engina mendicaria (Linnaeus)	x	x						x		
Engina sp.				x						
Nassariidae										
Nassarius albescens (Dunker)	x									
**N. margaritiferus* (Dunker)									x	
**N. papillosus* (Linnaeus)						x				
N. vitiensis (Hombron and Jaquinot)							x			
Fasciolariidae										
Latirus sp.						x				
Peristernia sp.			x							
Vasidae										
Vasum turbinellus (Linnaeus)						x				

Table 19. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Harpidae										
**Harpa amouretta* (Roeding)		x								
Mitridae										
Imbricaria punctata Swainson		x								
Mitra eremitarum (Roeding)	x	x								
M. mitra Linnaeus		x	x							
M. paupercula (Linnaeus)								x		
**M. stictica* (Link)								x		
M. acuminata (Swainson)			x							
Vexillum plicarium (Linnaeus)		x								
Conidae										
**Conus capitaneus*			x							
C. catus Hwass			x							
C. chaldeus Roeding			x							
C. coronatus Gmelin		x						x		
C. distans Hwass						x				
C. ebraeus Linnaeus		x						x		
C. eburneus Hwass		x								
C. flavidus Lamarck								x		
**C. geographus* Linnaeus			x	x						
C. litoglyphus Hwass				x						
**C. litteratus* Linnaeus		x								
C. lividus Hwass						x				
C. magus Linnaeus	x	x	x			x				
C. marmoreus Linnaeus	x	x	x	x		x				
C. miles Linnaeus				x						
C. miliaris Hwass			x							
C. musicus Hwass		x								
C. pulicarius Hwass		x	x	x						
C. rattus (Hwass)			x							
C. sanguinolentus Quoy and Gaimard		x								
C. sponsalis Hwass		x	x			x		x		
C. vexillum Gmelin		x								
Terebridae										
Terebra affinis Gray				x						
T. babylonia Lamarck				x						
T. columellaris Hinds				x						
T. crenulata (Linnaeus)								x		
**T. felina* (Dillwyn)								x		
T. maculata (Linnaeus)				x						
T. paucistriata (E.A. Smith)				x						
T. subulata (Linnaeus)	x									

Table 19. (cont.)

	OKAT							OTHER LOCATIONS		
	Intertidal			Subtidal						
	1	2	3	4	5	6	7	8	9	10
Janthinidae										
*Janthina sp.									x	
Pyramidellidae										
Pyramidella acus (Gmelin)	x	x	x	x						
P. terebellum (Mueller)				x						
Hydatinidae										
Hydatina physis (Linnaeus)		x								
Bullidae										
*Bulla vernicosa Gould			x							
Aplysiidae										
Dolabrifera dolabrifera Linnaeus		x								
Phyllaplysia taylori (Dall)			x							
Phyllidiidae										
Phyllidia elegans Bergh						x				
P. trilineata (Cuvier)						x				
Phyllidia cf. variabilis (Collingswood)						x				
Phyllidia cf. tula Marcus and Marcus						x				
Ellobiidae										
Melampus flavus (Gmelin)			x					x	x	x
Bivalvia										
Arcidae										
Arca sp.					x					
Mytilidae										
Modiolus sp.									x	
Pteriidae										
Pinctata margaritafera (Linnaeus)				x				x		
Spondylidae										
Spondylus sp.						x				
Chamidae										
Chama iostoma Conrad	x									
unidentified sp.						x				
Cardiidae										
Fragrum fragrum (Linnaeus)	x		x							
Tridacnidae										
Tridacna maxima (Roeding)			x			x				
Veneridae										
Pitar sp.		x		x						

Table 20. Echinoderms from Kosrae.

Plus(+) denotes observed but not collected. (Okat: Intertidal- 1, sand; 2, seagrass; 3, rock and/or rubble: Subtidal- 4, sand; 5, live coral; 6, rock and/or rubble.)

	OKAT					
	Intertidal			Subtidal		
	1	2	3	4	5	6
Crinoidea						
Comasteridae						
Comanthus benneti (J. Müller)					x	
Asteroidea						
Oreasteridae						
Choriaster granulatus Lütken						x
+Culcita novaeguineae Müller and Troschel					x	x
Ophidiasteridae						
Linckia laevigata (Linnaeus)		x	x			
L. multifora (Lamarck)			x			x
Linckia sp. [Blue-gray]			x			x
Neoferdina cf. offreti (Koehler)						x
Acanthasteridae						
+Acanthaster planci (Linnaeus)					x	
Echinasteridae						
Echinaster luzonicus (Gray)						x
Ophiuroidea						
Ophiotrichidae						
Macrophiothrix longipeda (Lamarck)			x			
Ophiocomidae						
Ophiocoma pica Müller and Troschel			x		x	
O. scolopendrina (Lamarck)		x	x			
?Ophiocomella sexradia (Duncan)			x			
Ophiomastix caryophyllata Lütken					x	
Echinoidea						
Cidaridae						
Eucidaris metularia (Lamarck)			x			
Diadematidae						
Astropyga radiata (Leske)					x	x
Diadema savignyi Michelin			x			
Echinothrix calamaris (Pallas)		x	x			
Toxopneustidae						
Tripneustes gratilla (Linnaeus)		x				

Table 20. (cont.)

	OKAT					
	Intertidal			Subtidal		
	1	2	3	4	5	6
Echinometridae						
Echinometra mathaei (deBlainville)			x			x
Holothuridea						
Holothuriidae						
Actinopyga mauritiana (Quoy and Gaimard)						x
Bohadschia argus Jaeger				x		
B. graeffei (Semper)				x		
B. marmorata Jaeger		x				
Holothuria (Halodeima) atra Jaeger		x	x	x		x
H. (Halodeima) edulis Lesson				x		
H. (Mertensiothuria) leucospilota (Brandt)		x	x			
H. (Mertensiothuria) pervicax Selenka			x			
H. (Solenkothuria) moebii Ludwig			x			
H. (Thymiosycia) hilla Lesson		x	x			
Stichopidae						
Stichopus chloronotus Brandt		x	x	x		x
S. horrens Selenka			x			
Thelenota ananas (Jaeger)				x		
Phyllophoridae						
Afrocucumis africana (Semper)			x			
Synaptidae						
Euapta godeffroyi (Semper)		x				
Synapta maculata (Chamisso and Eysenhardt)		x				
Synaptid sp.		x				

Table 21. Ecological distribution of fishes observed in the Okat Reef area with estimates of relative abundances based on transect counts and qualitative observation. (Refer to text for definition of habitats and key below for explanation of symbols.)

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Carcharhinidae (Requiem sharks)											
<u>Carcharhinus</u> <u>amblyrhynchos</u> (Bleeker)											O
<u>C. melanopterus</u> (Quoy & Gaimard)			R							R	
<u>Trienodon</u> <u>obesus</u> (Ruppell)										O	O
Dasyatidae (Sting rays)											
Unid. sp.[1]						R					
Mobulidae (Manta rays)											
<u>Manta</u> sp.[2]											R
Muraenidae (Moray eels)											
<u>Echidna</u> <u>nebulosa</u> (Ahl)			R								
<u>Gymnothorax</u> <u>flavimarginatus</u> (Ruppell)						R					
<u>G. javanicus</u> (Bleeker)							R				
<u>G. pictus</u> (Ahl) +		C									
<u>G. undulatus</u> (Lacepede)							R				
<u>G. richardsoni</u> (Bleeker)		O									
Ophichthidae (Snake eels)											
<u>Myrichthys</u> <u>colubrinus</u> (Boddaert)		R									
Synodontidae (Lizardfishes)											
<u>Saurida</u> <u>gracilis</u> (Quoy & Gaimard) + ‡		O	R		R	O	O				
<u>Synodus</u> sp. ‡						O	C				
Carapidae (Pearlfishes)											
<u>Carapus</u> sp.[3] + ‖‖											
Exocoetidae (Flyingfishes)											
<u>Cypselurus</u> <u>brachypterus</u> Richardson[4] + ‡ ‖‖											
Hemirhamphidae (Halfbeaks)											
<u>Hemirhamphus</u> <u>marginatus</u> (Forsskal) +		O				O					
Atherinidae (Silversides)											
<u>Praenesus</u> sp. +		C				A					

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Holocentridae (Squirrelfishes)											
Adioryx caudimaculatus (Ruppell)							R	O		O	O
A. microstomus (Gunther) +				O	R					R	
A. spinifer (Forsskal)			O		R	R			R	O	
A. tiere (Cuvier & Valenciennes) +							R		O	C	
Adioryx sp.[5] + ‖		O									
Flammeo laevis (Gunther) +					R						
F. opercularis (Cuvier & Valenciennes)					R						
F. sammara (Forsskal) +			O		A	O					
Myripristis adustus Bleeker ‡										O	
M. amaenus (Castlenau)					R						
M. murdjan (Forsskal) +		O			R	O	O			C	O
M. pralinius Cuvier +					O						
M. violaceus Bleeker					O		R				
Aulostomidae (Trumpetfishes)											
Aulostomus chinensis (Linnaeus)					O	R					
Fistulariidae (Cornetfishes)											
Fistularia commersoni Ruppell					C	R	O				
Syngnathidae (Pipefishes & Seahorses)											
Corythoichthys intestinalis Ramsay + ‡		O	O		O	C	R				
Scorpaenidae (Scorpionfishes)											
Pterois antennata (Bloch)						R					
P. volitans (Linnaeus) + ‡						O					
Scorpaenodes guamensis (Quoy & Gaimard) +		O									
Synanceia verrucosa Bloch & Schneider + ‡					O		R				
Caracanthidae (Velvetfishes)											
Caracanthus sp. +							O				
Serranidae (Groupers)											
Anthias dispar (Herre & Montalban) + ‡							C	A		A	A
A. pascalus (Jordan & Tanaka) ‡							A	C			O
Anthias sp.[6] ‡						O					
Anthias sp.[7] ‡							C	A		A	A
Cephalopholis argus (Bloch & Schneider) ‡					R		R		O	O	O
C. miniatus (Forsskal) ‡ +								R			O
C. leopardus (Lacepede)							O	O			
C. urodelus (Bloch & Schneider)							R		R	O	O
Cephalopholis sp.[8] + ‡								O			O
Gracila albomarginata (Fowler & Bean) +										R	
Epinephelus caeruleopunctatus (Bloch) ‡										R	

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Epinephelus hexagonatus (Bloch & Schneider)										R	
E. merra (Bloch)			C		C	R	R			O	O
E. microdon (Bleeker)											R
E. spilotoceps Schultz							R		R	O	
Epinephelus sp.9											R
Epinephelus sp.										R	
Plectropomus leopardus (Lacepede)										R	
Grammistidae (Soapfishes)											
Grammistes sexlineatus (Thunberg) ‡			O		R						
Pseudochromidae (Basslets)											
Pseudochromis porphyreus Lubbock & Goldman								R			O
P. xanthochir Bleeker							R				
P. fuscus Muller & Troschel			R								
Plesiopidae (Prettyfins)											
Plesiops corallicola Bleeker		O									
Apogonidae (Cardinalfishes)											
Apogon angustatus Smith & Radcliffe +							R				
A. kallopterus Bleeker					O	O			O		
A. novemfasciatus Smith & Radcliffe +		C	C	O	O	C	O				
A. nubilus Garman +		R	R		O						
A. nigrofasciatus Lachner							R				
Apogonichthys ocellatus Weber +		R									
Apogonichthys sp.		R									
Apogon sp.			O								
Apogon sp.	A										
Archamia fucata (Cantor) ‡					O						
A. leptacanthus Bleeker + ‡					A						
Cheilodipterus macrodon (Lacepede)											R
C. quinquelineatus Cuvier & Valenciennes							O			O	
Sphaeramia orbicularis (Cuvier)	A										
Branchiostegidae (Tilefishes)											
Hoplolatilus starcki Randall & Dooley								O			O
Carangidae (Jacks)											
Carangoides orthogrammus Jordan & Gilbert +					R	C					
C. lugubris Poey ‡								O			O
C. melampygus (Cuvier & Valenciennes) ‡					R	O	O	O		O	O
Caranx sp.		R									
Decapterus sp.										O	
Trachinotus blochii (Lacepede)						O					

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Lutjanidae (Snappers)											
Aphareus furcatus (Lacepede) ‡							R	O	O	C	O
A. rutilans Cuvier & Valenciennes							O			O	
Aprion virescens Cuvier & Valenciennes											R
Lutjanus argentimaculatus (Forsskal)							R	O			
L. bohar (Forsskal) ‡					R	R	R			O	C
L. fulvus (Bloch & Schneider) +		O			A	C	R	O		C	C
L. gibbus (Forsskal)										A	A
L. kasmira (Forsskal) + ‡		R			R	C				C	
L. monostigmus (Cuvier & Valenciennes)						O	R		O	O	O
L. fulviflamma (Forsskal) ‡										A	A
L. semicinctus Quoy & Gaimard			R						R	O	O
Lutjanus sp. +		R			O	O					
Lutjanus sp.					R						
Lujanus sp. + ‡										R	
Caesionidae (Fusiliers)											
Caesio caerulaureus Lacepede							O	C		C	C
C. xanthonotus Bleeker ‡							O	C		C	C
Caesio sp.						O	O			O	
Pterocaesio tile (Cuvier & Valenciennes)							O	C			C
Nemipteridae (Threadfins)											
Scolopsis cancellatus (Cuvier & Valenciennes) ‡		C	O	R	R	C			O		
Pomadasyidae (Sweetlips)											
Plectorhynchus cinctus (Temminck & Schlegel)										R	
P. goldmanni (Bleeker)										R	
P. lineatus (Linnaeus)					R						
P. nigrus (Cuvier & Valenciennes)										O	
Lethrinidae (Emperors)											
Gnathodentex aureolineatus (Lacepede)					C						
Lethrinus harak (Forsskal) ‡	C	R	R		R	O	R		O	O	
L. nematacanthus Bleeker + ‡[10]											
L. miniatus (Bloch & Schneider)							R	R	R	O	O
L. kallopterus Bleeker										R	
Lethrinus sp.	C	R	R			O					
L. microdon Valenciennes					R					O	O
L. variegatus Valenciennes										R	
Monotaxis grandoculis (Forsskal)			R		O	O	C			C	O
Macolor niger (Forsskal) ‡								R	R	C	

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Leiognathidae (Mojaras)											
Gerres sp.	C										
Mullidae (Goatfishes)											
Mulloidichthys flavolineatus (Lacepede)+ ‡		A	O	O	A	C	O				
M. vanicolensis (Cuvier & Valenciennes)									R		
Parupeneus barberinus (Lacepede) +		C	O	R	R	C	O		O	C	O
P. bifasciatus (Lacepede) ‡			R			R	O		O	C	C
P. cyclostomus (Lacepede) [11]			O	R	R	O	O		O	O	
P. indicus (Shaw)		A			O		R			O	
P. trifasciatus (Lacepede)		O	C	O	A	C	A			C	
Parupeneus sp. + ‖											
Pempheridae (Sweepers)											
Pempheris oualensis Cuvier & Valenciennes +							O				
Kyphosidae (Rudderfishes)											
Kyphosus cinerascens (Forsskal)							R		O	O	
K. lembus (Cuvier & Valenciennes) [12]											
Ephippidae (Spadefishes)											
Platax orbicularis (Forsskal) ǂ										O	O
Chaetodontidae (Butterflyfishes)											
Chaetodon auriga Forsskal + ǂ		O	O	R	C	C	R		O	O	
C. bennetti Cuvier							O	R		R	
C. citrinellus Cuvier +			O	O	R	C	O	O	O	C	
C. ephippium Cuvier		C	O	R	O	O	R			C	
C. kleini Bloch					R	O	C	O			
C. lunula (Lacepede)					C		O		O	O	
C. melannotus Bloch & Schneider +			R		R						
C. mertensii Cuvier						R		R			
C. meyeri Schneider + ǂ							R			O	O
C. ornatissimus Cuvier							R			R	
C. punctatofasciatus Cuvier							R	O		O	O
C. raflessi Bennett ǂ			O							O	
C. reticulatus Cuvier			R						O	O	
C. trifasciatus Park			O		A	O	R		O	O	
C. ulietensis Cuvier					O						
C. unimaculatus Bloch							O				
C. vagabundus (Linnaeus) + ǂ		O	O	O	O	O	O		O	O	
Forcipiger flavissimus Jordon & McGregor							R	O	O		
Heniochus chrysostomus Cuvier ǂ			O		R		O	O		O	
H. monoceros Cuvier & Valenciennes							O	O			

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Heniochus singularis Smith & Radcliffe											O
H. varius (Cuvier) +							O	O		O	O
Megaprotodon trifascialis (Quoy & Gaimard)			R						R	C	
Pomacanthidae (Angelfishes)											
Centropyge bicolor (Bloch) ‡			R				O				
C. flavissimus (Cuiver & Valenciennes)							R		R		
C. heraldi Schultz Woods & Schultz							R				
C. loriculus (Gunther) ‡							O	O		O	C
C. multicolor Randall & Wass											O
C. multifasciatus Smith & Radcliffe								O			O
C. vrolicki (Bleeker) ‡					R	O	O	O		O	
Euxiphipops xanthometapon (Bleeker)							R				
Pygoplites diacanthus (Boddaert) + ‡							O	O		O	O
Pomacentridae (Damselfishes)											
Abudefduf sexfasciatus (Lacepede)							O			O	
A. sordidus (Forsskal)[13]			O								
A. waigiensis (Quoy & Gaimard)				O			O			O	
Amblyglyphidodon aureus (Cuvier & Valenciennes) +							R	O			O
A. curacao (Bloch)						O					
Amphiprion chrysopterus Cuvier & Valenciennes) ‡							O			O	
A. perideraion Bleeker							O				
Chromis acares Randall & Swerdloff ‡							A				
C. agilis Smith							O	O			O
C. amboinensis (Bleeker) ‡							O	C			O
C. elerae Fowler & Bean							O				
C. caerulea (Cuvier & Valenciennes) + ‡			O		A	C					
C. lepidolepis Bleeker ‡						C	A	A		A	A
C. margaritifer Fowler +			R		O	O	A	O	O	C	O
C. ternatensis (Bleeker)											O
C. vanderbilti (Fowler) ‡							A	C	A	A	A
C. xanthura (Bleeker) ‡							O		O	C	C
Chromis sp.[14]							R	O			C
Chromis sp.							O				O
Dascyllus aruanus (Linnaeus) +			A		A	O					
D. melanurus Bleeker + ‡			C		A						
D. trimaculatus (Ruppell) +					R		R		A	O	
Eupomacentrus albifasciatus (Schlegel & Muller)			A	A	R	R					
E. fasciolatus (Ogilby)									A		
E. lividus Bleeker ‡			C		A	O					

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Eupomacentrus nigricans (Lacepede) +			C		A	C	R				
Glyphidodontops biocellatus (Quoy & Gaimard) +		A	A	A	C	C					
G. glaucus (Cuvier & Valenciennes)			O	A							
G. leucopomus (Lesson)				O					C		
G. traceyi (Woods & Schultz) +			R		R		A	C		O	C
Lepidozygous tapienosoma (Bleeker) ‡						O					
Plectroglyphidodon dickii (Lienard)						R	O		A	C	
P. imparipennis (Vaillant & Sauvage)									O		
P. johnstonianus Fowler & Ball							R		O		
P. lacrymatus (Quoy & Gaimard)			R				R				
P. leucozona (Bleeker)			O			R					
Pomacentrus pavo Bloch + ‡					A	A					
P. philippinus Evermann & Seale + ‡					R	O	A	C		O	O
Cirrhitidae (Hawkfishes)											
Cirrhitichthys oxycephalus (Bleeker) + +						C	C		C	O	
Cirrhitus pinnulatus (Bloch & Schneider)									R		
Paracirrhites arcatus (Cuvier & Valenciennes)			O				R		C	O	O
P. forsteri (Schneider)						R	O		O	O	
P. hemistictus (Gunther)									R		
Paracirrhites sp. ‡										R	
Mugilidae (Mullets)											
Unid. sp.[15]	A										
Sphyraenidae (Barracudas)											
Sphyraena sp.					R						
Labridae (Wrasses)											
Anampses twisti Bleeker										R	R
Bodianus anthioides (Gunther)								R			
B. axillaris (Bennett)											R
B. mesothorax (Schneider)										R	
Cheilinus diagrammus (Lacepede) ‡				O						O	
C. fasciatus (Bloch)					R					R	O
C. rhodochrous Gunther							R	O		O	O
C. trilobatus Lacepede			R	R	O				O	O	R
C. undulatus (Ruppell)					R		R	R		R	
Cheilio inermis (Forsskal)			O								
Cirrhilabrus sp.[16] ‡					R						R
Coris gaimardi (Quoy & Gaimard)										R	
Epibulus insidiator (Pallas) + ‡			R		O		R			O	O

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Gomphosus varius Lacepede + ‡			R		O		O		O	O	O
Halichoeres centriquadrus (Lacepede)						R	O	O	O	O	
H. hoevenii (Bleeker)					R		R				
H. margaritaceus (Valenciennes)				A					C		
H. marginatus Ruppell				R			R		O		
H. trimaculatus (Quoy & Gaimard) +		A	C	A	O	O					
Hemigymnus fasciatus (Bloch)					R						R
H. melapterus (Bloch)			O		O	R					
Labroides bicolor Fowler & Bean			R		R		O	O	R	O	O
L. dimidiatus (Cuvier & Valenciennes)					O	O	O		O	O	
L. pectoralis Randall & Springer ‡										O	O
Pseudocheilinus hexataenia (Bleeker)							O	O		O	O
P. tetrataenia Schultz										R	
Pseudodax moluccanus Gunther							R	R			
Stethojulis bandanensis (Bleeker)			O	O	O	O	R		O		
S. strigiventor (Bennett)		C	O								
Thalassoma amblycephalus (Bleeker) ‡			O	O		O	O		O		
T. hardwickei (Bennett)			O	O	O	O	O				
T. quinquevittata (Lay & Bennett)			C	R		O	O		A		
T. lunare (Linnaeus)			O			O					
T. lutescens (Lay & Bennett)			O				O			O	
Thalassoma spp.[17] + ‖			C	A	C	A	A	C	A	C	C
Xyrichtys taeniourus (Lacepede)			R		R	R				R	
Scaridae (Parrotfishes)											
Bolbometapon muricatus (Cuvier & Valenciennes)							O	O		O	O
Calotomus spinidens (Quoy & Gaimard) +		R	O	C	O	O	R				
Cetoscarus bicolor (Ruppell)										R	O
Scarops rubroviolaceus (Bleeker)										O	
Scarus chlorodon Jenyns							O	O			
S. fasciatus Cuvier & Valenciennes										C	
S. forsteri Cuvier & Valenciennes							R				
S. ghobban Forsskal										O	
S. gibbus Ruppell								O		O	O
S. globiceps Cuvier & Valenciennes			R				O			O	
S. harid Forsskal					O						
S. lepidus Jenyns										O	O
S. niger Forsskal							R			R	
S. oviceps Cuvier & Valenciennes			R		O	R	O		O	O	
S. sexvittatus Ruppell										R	
S. sordidus Forsskal			C		C	A	O		O	C	
S. venosus Cuvier & Valenciennes										R	R
S. javanicus Bleeker							O			O	
Scarus sp.[1]						O	O				

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Scarus sp. 2[18] ‖			O		C		C				
Scarus sp. 3‖			C	O	O	O	O				
Scarus sp. 4‖			C		C	C	O				
Scarus sp. 5‖					O						
Scarus sp. 6‖			R		O						
Mugiloididae (Sand Perches)											
Parapercis sp.						R					
Blenniidae (Blennies)											
Aspidontus teaniatus Quoy & Gaimard +					O						
Cirripectes variolosus (Cuvier & Valenciennes)							O		C	O	
Ecsenius bicolor (Day)							O			C	R
E. opisfrontalis Chapman & Schultz							O				
E. yaeyamaensis (Aoyagi)									O		
Meiacanthus atrodorsalis (Gunther)					O		O				
Blennid sp. +						R					
Plaglotremus rhynorhynchus (Bleeker)					R	R					
P. tapienosoma (Bleeker)			R		O	O	O				
Salarias fasciatus (Bloch) +		R	O	C	R						
Blennid sp.									C		
Tripterygiidae (Triplefins)											
Unid. sp. +			R						R		
Callionymidae (Dragonets)											
Unid. sp.						O					
Gobiidae (Gobies)											
Acentrogobius ornatus (Ruppell) +		O	O		R	O					
Amblygobius albimaculatus (Ruppell) +		R	O		O	O					
Periophthalmus koelreuteri (Pallas)[19] + ‡											
Asteropteryx semipunctatus Ruppell		O	O			R					
Ctenogobiops sp.						R					
Cryptocentrus koumansi (Whitley) ‡		O	R			O					
Eviota sp.							R				
Fusigobius neophytus (Gunther) + ‡			O		O	O					
Gnatholepis puntang (Bleeker) +					R						
Gnatholepis sp.			R		O	O					
Nemateleotris magnificus Fowler									O	O	O
Paragobiodon echinocephalus (Ruppell) + ⦀			R								

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Ptereleotris evides (Jordan & Hubbs) +					C	A	A		A		
Valenciennea strigatus (Broussonet)						O					
V. sexguttatus (Cuvier & Valenciennes) + ǂ						O					
Gobiid sp.				R							
Acanthuridae (Suregonfishes)											
Acanthurus glaucoparieus Cuvier							O		O	C	
A. lineatus (Linnaeus) +						O	O		C	C	
A. mata (Cuvier)			R								
A. nigricaudus			R				O		O	O	
A. nigrofuscus (Forsskal)			C	O	C	A	O		O	O	
A. nigroris (Cuvier & Valenciennes)					O		C				
A. olivaceus Bloch & Schneider					C	C	C				
A. thompsoni (Fowler)							C	O		O	
A. triostegus (Linnaeus) +		C	A	A	C	O	O			C	
A. xanthopterus Cuvier & Valenciennes							O		O	O	
Acanthurus sp. 1[20] ∥					R	C					
Acanthurus sp. 2 + ∥		A		R		C	O		O		
Acanthurus sp. 3 ∥			O		O		O				
Axinurus thynnoides (Cuvier & Valenciennes)										R	
Ctenochaetus cyanoguttatus Randall +							O		R	O	
C. striatus (Quoy & Gaimard) + ‡			A	O	A	C	A		C	A	
Naso brevirostris (Valenciennes)			R		O				R	O	C
N. hexacanthus (Bleeker) + ‡							C	C		O	C
N. lituratus (Bloch & Schneider)			R				R	O	O	O	
N. unicornis (Forsskal)					O					O	
N. vlamingi (Valenciennes) + ǂ										O	O
Naso sp.[21] ∥					O						
Zebrasoma scopas (Cuvier)					C	O	C			O	
Z. veliferum (Bloch)					R	R				O	
Zanclidae (Moorishidol)											
Zanclus cornutus (Linnaeus)			R		O	O	O			O	O
Siganidae (Rabbitfishes)											
Siganus argenteus					O						
S. chrysospilos (Bleeker) [22]											
S. puellus (Temminck & Schlegel)			R								
S. spinus (Linnaeus) +	A	A	O	O							
S. virgatus (Cuvier & Valenciennes)										R	O
Siganus sp. ǂ										O	
Scombridae (Tunas)											
Gymnosarda unicolor (Ruppell) ‡								O		O	

Table 21. continued

TAXA	Mangroves	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Bothidae (Left-eye Flounders)											
<u>Bothus</u> sp.		R	R			R	R				
Balistidae (Triggerfishes)											
<u>Balistapus</u> <u>undulatus</u> (Park)					R		O	O	R	O	O
<u>Balistoides</u> <u>viridescens</u> (Bloch & Schneider)										R	
<u>Melichthys</u> <u>niger</u> (Bloch)									O	O	
<u>M.</u> <u>vidus</u> (Solander)							O		R	O	O
<u>Odonus</u> <u>niger</u> (Ruppell)							O			C	C
<u>Pseudobalistes</u> <u>flavimarginatus</u> (Ruppell) ‡							O	O		O	
<u>Rhinecanthus</u> <u>aculeatus</u> (Linnaeus) +		R	R								
<u>Sufflamen</u> <u>bursa</u> (Bloch & Schneider)							R				
<u>S.</u> <u>chrysoptera</u> (Bloch & Schneider)						O	C				
Monocanthidae (Filefishes)											
<u>Amanses</u> <u>scopas</u> (Cuvier)										R	
<u>Cantherhines</u> <u>dummerilli</u> (Hollard)										O	
Ostraciontidae (Trunkfishes)											
<u>Ostracion</u> <u>meleagris</u> Shaw											R
Tetraodontidae (Puffers)											
<u>Arothron</u> <u>hispidus</u> (Linnaeus)		O									
<u>A.</u> <u>immaculatus</u> (Bloch & Schneider)		O									
<u>A.</u> <u>nigropunctatus</u> (Bloch & Schneider)											R
<u>Canthigaster</u> <u>solandri</u> (Richardson) +						R	R				
<u>C.</u> <u>valentini</u> (Bleeker) +					R						
Diodontidae (Porcupinefishes)											
<u>Diodon</u> <u>hystrix</u> Linnaeus)										R	

Key: A=Abundant; ≥ 21 individuals on any one transect or > approximately 40 individuals sighted per diver hour, whichever is greater. C=Common; 6-20 per transect or 11-40 per diver hr. O=Occasional; 2-5 per transect or 2-10 per diver hr. R=Rare; not more than one individual sighted on any one dive.

+ Specimen(s) deposited at the University of Guam Marine Laboratory.

‡ Photographs available.

‖ Unidentified juveniles which may be previously listed. Not included in the species counts or the analysis of data.

‖‖ Not included on the analysis of data.

Table 21. continued

FOOTNOTES

1. One large individual seen at 2 m on the sand slope in Okat Harbor. Large sting rays are said to be common in many of the large reef flat holes.

2. Also occasionally seen breaking the surface in Okat Harbor.

3. Two specimens obtained from the bottom of a bucket containing an asteroid, Culcita navaeguineae from the north-east hole.

4. One specimen inadvertently landed in a skiff while we were fishing for ciguatara samples in the channel at night.

5. Several collected in tidepools at night or by poisoning. This species may represent the juveniles of one of the above.

6. An undescribed species in the subgenus Pseudanthias also known from the Hawaiian Islands and other Indo-Pacific localities.

7. Closely resembles Anthias evansi Smith from the Indian Ocean.

8. Undescribed species similar to Cephalapholis aurantius (Valenciennes).

9. One large individual about 1 m SL seen briefly.

10. Collected by handlining at about 10 m in the channel at night.

11. Includes two color morphs; one is often known as Parupeneus chrysenydros (Lacepede).

12. Collected by a local fisherman on the seaward side of Okat Reef.

13. Juveniles were abundant in rocky pools along the shoreline at the extreme northern end of Okat Reef.

14. Chromis sp. "A" of Allen (1975).

15. Occasional large schools of one or more species were seen near the surface in Okat Harbor and along the margins of the mangrove forest.

16. Undescribed sp. known from southern Japan, Guam and Enewetak Atoll (J. Shepard, pers. comm.)

17. Unid. juveniles, probably mostly T. amblycephalus.

18. Scarus spp. 2-6 represent five distinct juvenile forms, some or all of which may be identical with the adults of species previously listed.

19. Common on exposed mud flats inshore of the mangrove forest at the northern end of Okat Reef.

Table 21. continued

20. *Acanthurus* spp. 1-3 represent three distinct juvenile forms, some or all of which may be identical with the adults of species previously listed.

21. Probably a juvenile of one of the previously listed species.

22. Speared by a local fisherman, exact locality unknown.

Table 22. Fishes censused on Transects 1a, 1b, and 1c. Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects. Transects are arranged from most inshore (left) to most offshore (right).

SPECIES	TRANSECTS 1a	1b	1c
Gymnothorax pictus			1
Myrichthys colubrinus	*		
Saurida gracilis		*	1
Apogon novemfasciatus	*	*	8
Apogonichthys sp.	1		1
Caranx sp.	*	*	
Lutjanus fulvus	1	*	
L. kasmira		*	
Scolopsis cancellatus		*	7
Lethrinus harak	*	*	1
Lethrinus sp.	1	*	*
Mulloidichthys flavolineatus	*	99	35
Parupeneus barberinus	*	6	8
P. indicus	20	11	28
P. trifasciatus		1	2
Chaetodon auriga		*	5
C. ephippium		*	8
C. vagabundus		*	3
Glyphidodontops biocellatus		*	28
Halichoeres trimaculatus	*	1	24
Stethojulis strigiventor	1		11
Calotomus spinidens		*	
Salarias fasciatus			1
Acentrogobius ornatus			3
Amblygobius albimaculatus	*	*	
Asteropteryx semipunctatus		*	3
Cryptocentrus koumansi	2		
Gobiid sp.	1		1
Acanthurus triostegus			9
Acanthurus sp.	*		1
Siganus spinus		50	86
Bothus sp.	*		
Rhinecanthus aculeatus		*	1
No. Species on transect	7	6	24
No. Species in vicinity of transect	17	22	25
No. individuals on transect	27	168	276
No. individuals per m^2	0.18	1.12	1.18

Table 23. Fishes censused on Transects 1d, 1e, 6b, 6c and the South Reef Flat (SRF). Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects. Transects 1d, 1e, 6b, and 6c are arranged from most inshore (left) to most offshore (right).

SPECIES	TRANSECTS 6b	1d	6c	1e	SRF
Carcharhinus melanapterus			*		
Echidna nebulosa		1			
Saurida gracilis		*			*
Adioryx spinifer		2			
Flammeo sammara		3			*
Fistularia commersonii					*
Corythoichthys intestinalis			*		2
Epinephelus merra	3	2	6		1
Grammistes sexlineatus		2			
Pseudechromis fuscus		1			
Apogon novemfasciatus	4	8	1	4	1
A. nubilus	1				
Apogon sp.		2			
Lutjanus semicinctus			*		
Scolopsis cancellatus	4	5	5	1	2
Lethrinus harak	1	*	1		
Lethrinus sp.		*			
Monotaxis grandoculis		1			*
Mulloidichthys flavolineatus		*	3	3	*
Parupeneus barberinus	5		1	*	
P. bifasciatus					1
P. cyclostomus		*	*	1	2
P. trifasciatus	3	2	2	5	14
Chaetodon auriga	4	1	4	1	1
Chaetodon citrinellus	1	3	3	1	1
C. ephippium	4		3	1	*
C. melannotus			1		
C. rafflessi					*
C. reticulatus					*
C. trifasciatus			1		5
C. vagabundus			1	*	1
Heniochus chrysostomus					1
Megaprotodon trifascialis					1
Abudefduf waigiensis				2	
Chromis caerulea	3				*
C. margaritifer			*		
Dascyllus aruanus	89	15	4		59
D. melanurus		2	11		
Eupomacentrus albifasciatus		49	91	28	83
E. lividus	17	16	1		109
E. nigricans	*	5	14		47
Glyphidodontops biocellatus	77	90	93	21	70
G. glaucus			5	288	

Table 23. continued

SPECIES	TRANSECTS				
	6b	1d	bc	1e	SRF
Glyphidodontops leucopomus				4	
G. traceyi					*
Plectroglyphidodon lacrymatus			1		
P. leucozona			4		4
Paracirrhites arcatus					1
Cheilinus trilobatus		1		1	
Cheilio inermis			2		
Epibulus insidiator					*
Gomphosus varius			2		*
Halichoeres margaritaceus				21	
H. marginatus				*	
H. trimaculatus	8	8	19	37	15
Hemigymnus melapterus	1	*	*		1
Labroides bicolor					*
Stethojulis bandenensis		2	4	5	2
S. strigiventor	2				
Thalassoma amblycephalus				1	
T. hardwicke	1	1	3	3	
T. lunare					1
T. lutescens					*
T. quinquevittata		*	5	*	8
Thalassoma sp. (unid. juveniles)		2	22	71	17
Xyrichtys taeniourus		*			
Calotomus spinidens	2	1	5	13	
Scarus globiceps					*
S. oviceps					1
Scarus sordidus	12	*			8
Scarus sp. 2		4			
Scarus sp. 3	7			1	1
Scarus sp. 4	7		*		4
Plagiotremus tapienosoma			*		
Salarias fasciatus		4	4	6	3
Tripterigiid sp.			*		
Acentrogobius ornatus		2			*
Amblygobius albimaculatus	5				
Asteropteryx semipunctatus	4	2			*
Fusigobius neophytus	1	2			1
Gnatholepis sp.	1	1			
Gobiid sp.				*	
Acanthurus mata					*
A. nigricaudus					*
Acanthurus nigrofuscus		10		2	1
A. triostegus	*	7	12	56	24
Acanthurus sp.				1	
Acanthurus sp.					2
Ctenochaetus striatus	4	5	*	5	89
Naso brevirostris					*
N. lituratus			*		

Table 23. continued

SPECIES	6b	1d	6c	1e	SRF
Zanclus cornutus		*			*
Siganus puellus					*
S. spinus	*	*	1	1	
Bothus sp.		1			
Rhinecanthus aculeatus			*		*
No. Species on transect	27	35	33	28	37
No. Species in vicinity of transect	28	45	44	31	57
No. individuals on transect	271	263	335	584	586
No. individuals per m^2	1.81	1.75	2.23	3.89	3.91

Table 24. Fishes Censused on Transects 4 and 5. Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects.

SPECIES	TRANSECTS 4	TRANSECTS 5
Gymnothorax flavimarginatus		1
Atherinid sp.	23	
Saurida gracilis	*	3
Synodus sp.	4	
Adioryx microstomus		*
A. spinifer		*
Flammeo sammara	2	
Aulostomus chinensis		*
Fistularia commersonii		1
Corythoichthys intestinalis	9	3
Epinephelus merra		*
Apogon novemfasciatus		*
Caranx melampygus	4	
Lutjanus fulvus	1	*
L. kasmira	6	
L. monostigmus	1	
Lutjanus sp.	*	
Scolopsis cancellatus	3	6
Lethrinus harak		*
Monotaxis grandoculis	4	1
Mulloidichthys flavolineatus	6	3
Parupeneus barberinus	*	*
P. bifasciatus		*
P. cyclostomus	*	*
P. trifasciatus	8	7
Chaetodon auriga	2	3
C. citrinellus	9	7
C. ephippium	2	
C. kleini	*	1
C. mertensii	1	
C. trifasciatus	2	1
C. vagabundus	*	3
Centropyge vrolicki	1	1
Amblyglyphidodon curacao		*
Chromis coerulea		8
C. margaritifer	5	*
Dascyllus aruanus	*	3
Eupomacentrus albifasciatus		1
E. lividus		2
E. nigricans	*	11
Glyphidodontops biocellatus		7
Plectroglyphidodon dicki		*
P. leucozona	*	
Pomacentrus pava	67	
P. philippinus	*	
Cirrhitichthys oxycephalus	10	11
Paracirrhites forsteri		*

Table 24. continued

SPECIES	TRANSECTS 4	5
Halichoeres centriquadrus		*
Halichoeres trimaculatus	1	3
Hemigymnus melapterus		1
Labroides dimidiatus	3	
Stethojulis bandanensis	*	5
Thalassoma amblycephalus		2
T. hardwicke		5
T. quinquevittata	1	
T. lunare	3	*
Thalassoma sp.	25	4
Xyrichtys taeaiourus		*
Calotomus spinidens		2
Scarus oviceps		*
S. sordidus	1	31
Scarus sp. 1		6
Scarus sp. 3		2
Scarus sp. 4		*
Plagiotremus rhynorhynchus	1	
Blennid sp	*	
Acentrogobius ornatus	3	2
Asteropteryx semipunctatus		*
Cryptocentrus koumansi	2	1
Ctenogobiops sp.	*	
Fusigobius neophytus	2	3
Gnatholepis sp.	1	3
Ptereleotris evides	290	
Valenciennea sexguttatus	5	
V. strigatus		2
Acanthurus lineatus	*	4
A. nigrofuscus	2	53
A. olivaceus		6
A. triostegus	*	2
Acanthurus sp.	3	8
Acanthurus sp.	*	6
Ctenochaetus striatus	6	16
Zebrasoma scopas	*	2
Z. veliferum		*
Zanclus cornutus		*
Sufflamen chrysoptera	1	1
No. Species seen on transect	38	45
No. Species seen in vicinity of transect	55	66
No. individuals on transect	520	254
No. individuals per m^2	3.47	1.69

Table 25. Fishes censused on Transects 7 and 8. Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects.

SPECIES	TRANSECTS 7	TRANSECTS 8
Gymnothorax undulatus		1
Saurida gracilis	1	2
Synodus sp.		7
Adioryx caudimaculatus	1	*
A. tiere		1
Myripristis murdjan	*	*
M. violaceus	*	
Fistularia commersonii		2
Corythoichthys intestinalis		*
Synanceia verrucosa		*
Caracanthus sp.	*	
Anthias dispar	19	*
A. pascalus	32	
Anthias sp.	6	
Cephalopholis argus	*	
C. leopardus	3	
C. urodelus	*	
Epinephelus merra	*	1
E. hexaganatus	*	
E. spilotoceps		*
Pseudochromis xanthochir		1
Apogon angustatus		*
A. novemfasciatus		*
A. nigrofasciatus	*	
Cheilodipterus quinquelineatus		*
Caranx melampygus	2	*
Aphareus furcatus		1
A. rutilans	5	
Lutjanus argentimaculatus	*	
L. bohar	*	
L. fulvus	*	*
L. monostigmus	1	
Caesio caerulaureus	*	
C. xanthonotus	*	4
Caesio sp.	2	
Pterocaesio tile	*	
Lethrinus harak	*	
L. miniatus	*	
Monotaxis grandoculis	*	7
Mulloidichthys flavolineatus	*	
Parupeneus barberinus	*	*
P. bifasciatus	*	*
P. cyclostomus	*	*
P. indicus		*
P. trifasciatus	9	22
Kyphosus cinerascens	1	

Table 25. continued

SPECIES	TRANSECT 7	8
Pempheris oualensis	*	
Chaetodon auriga	*	*
C. bennetti	2	
C. citrinellus	*	2
C. ephippium	*	*
C. kleini	1	14
C. lunula	*	2
C. meyeri	1	1
C. ornatissimus		*
C. punctatofasciatus	1	
C. trifasciatus		1
C. unimaculatus	*	2
C. vagabundus	3	*
Forcipiger flavissimus	1	
Heniochus chrysostomus	*	*
H. monoceros	*	
H. varius	*	*
Centropyge bicolor		3
C. flavissimus	*	
C. heraldi		1
C. loriculus	*	
C. vrolicki	*	2
Euxiphipops xanthometapon	*	
Pygoplites diacanthus	1	2
Abudefduf waigiensis		*
A. sexfasciatus	4	*
Amblyglyphidodon aurea	1	
Amphiprion chrysopterus	*	
A. perideraion		*
Chromis acares	48	
C. agilis	*	
C. amboinensis	*	
C. elerae	*	
C. lepidolepis	139	5
C. margaritifer	39	46
C. vanderbilti	24	*
C. xanthura	2	*
Chromis sp. "A"	*	
Chromis sp.	5	4
Dascyllus trimaculatus		*
Eupomacentrus nigricans		1
Glyphidodontops traceyi	34	19
Plectroglyphidodon dicki	1	3
P. cf. johnstonianus		1
P. lacrymatus	1	*
Pomacentrus philippinus	28	14
Cirrhitichthys oxycephalus	15	7
Paracirrhites arcatus	*	*
P. forsteri	2	1

Table 25. continued

SPECIES	TRANSECT 7	8
Cheilinus rhodochrous	*	
C. undulatus		*
Epibulus insidiator		*
Gomphosus varius	1	
Halichoeres centriquadrus		2
H. hoevenii	1	
H. marginatus	1	*
Labroides bicolor	2	*
L. dimidiatus		3
L. pectoralis	1	1
Pseudocheilinus hexataenia	2	3
Pseudodax moluccanus	*	
Stethojulis bandanensis	*	*
Thalassoma amblycephalus	5	3
T. hardwicke	*	*
T. quinquevittata	4	*
T. lutescens	1	
Thalassoma sp. (unid. juveniles)	410	*
Bolbometopon muricatus		*
Calotomus spinidens		1
Scarus chlorodon	*	
S. forsteri		1
S. globiceps	*	3
S. niger	1	
S. oviceps	*	
S. javanicus	*	
S. sordidus	*	2
Scarus sp. 1	1	
Scarus sp. 2		6
Scarus sp. 3	1	
Scarus sp. 4		5
Cirripectes variolosus	1	*
Ecsenius bicolor	2	
E. opisfrontalis		1
Meiacanthus atrodorsalis		4
Plagiotremus tapienosoma	1	4
Eviota sp.	*	
Ptereleotris evides	285	75
Acanthurus glaucoparieus	1	2
A. lineatus	5	*
A. nigricaudus		*
A. nigrofuscus	2	1
A. nigroris		19
A. olivaceus	8	10
A. thompsoni	10	
A. triostegus		*
A. xanthopterus	*	
Acanthurus sp.	9	15
Acanthurus sp.	4	

Table 25. continued

SPECIES	TRANSECT 7	8
Ctenochaetus cyanoguttatus		2
C. striatus	212	210
Naso hexacanthus	6	
N. lituratus		*
Zebrasoma scopas	3	7
Zanclus cornutus	1	*
Bothus sp.	*	
Balistapus undulatus	*	
Melichthys vidua	4	
Odonus niger		*
Pseudobalistes flavimarginatus	*	
Sufflamen bursa		1
S. chrysoptera	*	7
Canthigaster solandri	*	
No. Species seen on transect	62	56
No. Species seen invicinity of transect	118	101
No. individuals on transect	1,420	478
No. individuals per m^2	9.47	3.19

Table 26. Fishes censused in the North Hole (NH) and the South Hole (SH). Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects.

SPECIES	TRANSECTS NH	SH
Saurida gracilis	*	1
Adioryx microstomus	2	
A. spinifer	1	
Flammeo laevis	*	1
F. opercularis	*	
F. sammara	37	3
Myripristis amaenus	1	
M. murdjan		1
M. pralinius		3
M. violaceus		3
Aulostomus chinensis	2	2
Fistularia commersonii		7
Corythoichthys intestinalis	*	2
Synanceia verrucosa		*
Cephalopholis argus		*
Epinephelus merra		6
Grammistes sexlineatus		1
Apogon kallopterus		4
A. novemfasciatus		2
A. nubilus		*
Archamia fucata		*
A. leptacanthus		100
Cheilodipterus quinquelineata		*
Caranx melampygus		*
Carangoides orthogrammus		*
Lutjanus bohar		*
Lutjanus fulvus	32	2
L. kasmira	1	1
Lutjanus sp.	3	
Lutjanus sp.	*	
Scolopsis cancellatus	*	1
Plectorhynchus lineatus	*	
Gnathodentex aureolineatus	8	
Lethrinus harak	*	*
Lethrinus microdon		*
Monotaxis grandoculis	*	2
Mulloidichthys flavolineatus	25	
Parupeneus barberinus	*	1
P. cyclostomus	1	1
P. indicus	*	3
P. trifasciatus	2	21
Chaetodon auriga	12	4
C. citrinellus	1	*
C. ephippium	7	1

Table 26. continued

SPECIES	TRANSECTS NH	SH
Chaetodon kleini	*	1
C. melannotus	1	
C. lunula	12	
C. trifasciatus	25	17
C. ulietensis	4	
C. vagabundus	3	*
Hemiochus chrysostomus		*
Centropyge vrolicki		1
Chromis caerulea	163	230
C. margaritifer	3	
Dascyllus aruanus	5	87
D. melanurus	114	19
D. trimaculatus	1	
Eupomacentrus albifasciatus	*	
E. lividus	30	46
E. nigricans	36	4
Glyphidodontops biocellatus	14	19
G. traceyi		1
Pomacentrus pavo	22	6
P. philippinus		1
Sphyraena sp.	*	
Cheilinus diagrammus		3
C. fasciatus		*
C. trilolatus	*	2
C. undulatus		*
Cirrhilabrus sp.		*
Epibulus insidiator	5	2
Gomphosus varius	2	
Halichoeres hoeveni	1	1
H. trimaculatus	1	4
Hemigymnus fasciatus	*	
H. melapterus		1
Labroides bicolor		*
L. dimidiatus	1	*
Stethojulis bandanensis		1
Thalassoma hardwicke	3	2
Thalassoma sp. (unid. juveniles)	6	
Xyrichtys taeniourus		*
Calotomus spinidens		1
Scarus harid	4	1
S. oviceps	*	3
S. sordidus	13	14
Scarus sp. 4	16	
Scarus sp. 2	16	17
Scarus sp. 3	1	
Scarus sp. 5	2	1
Scarus sp. 6	2	2

Table 26. continued

SPECIES	TRANSECTS NH	SH
Aspidontus taeniatus	4	1
Meiacanthus atrodorsalis	1	
Plagiotremus rhynorhynchus	1	
P. tapienosoma	1	
Salarias fasciatus		1
Acentrogobius ornatus	1	
Amblygobius albimaculatus		5
Fusigobius neophytus	2	
Gnatholepis puntang		*
Gnatholopis sp.	2	
Ptereleotris evides	6	
Acanthurus nigrofuscus	10	4
A. nigroris		5
A. olivaceus	1	6
A. triostegus	3	6
Acanthurus sp.	1	
Acanthurus sp.		3
Ctenochaetus striatus	1,108	369
Naso brevirostris		2
Naso sp.	1	
Naso sp.		2
Zebrasoma scopas	9	6
Z. veliferum	*	
Zanclus cornutus		*
Siganus argenteus	1	
Balistapus undulatus		1
Canthigaster valentini		1
No. Species on transect	59	65
No. Species in vicinity of transect	77	86
No. individuals on transect	1,793	1,072
No. individuals per m^2	11.95	7.15

Table 27. Fishes censused on the reef margin. Total number of each species seen is indicated; asterisks denote species seen in the immediate area, but not seen on the transects.

SPECIES	TRANSECT ORM
Adioryx tiere	*
A. spinifer	*
Cephalopholis argus	3
C. urodelus	*
Epinephelus spilotoceps	*
Aphareus furcatus	*
Lutjanus monostigmus	*
L. semicinctus	*
Scolopsis cancellatus	4
Lethrinus harak	*
L. miniatus	*
Macolor niger	*
Mulloidichthys vanicolensis	*
Parupeneus barberinus	*
P. bifasciatus	*
P. cyclostomus	2
Kyphosus cinerascens	*
Chaetodon auriga	*
C. citrinellus	2
C. lunula	*
C. reticulatus	*
C. trifasciatus	*
C. vagabundus	*
Forcipiger flavissimus	*
Megaprotodon trifascialis	*
Centropyge flavissimus	*
Chromis margaritifer	2
C. vanderbilti	74
C. xanthura	*
Dascyllus trimaculatus	21
Eupomacentrus fasciolatus	25
Glyphidodontops leucopomus	8
Plectroglyphidodon dicki	37
P. imparipennis	*
P. johnstonianus	5
Cirrhitichthys oxycephalus	6
Cirrhitus pinnulatus	*
Paracirrhites arcatus	15
P. forsteri	4
P. hemistictus	1
Cheilinus trilobatus	*
Gomphosus varius	3
Halichoeres centriquadrus	2
H. margaritaceus	11
H. marginatus	*
Labroides bicolor	*
L. dimidiatus	*

Table 27. continued

SPECIES	TRANSECT ORM
Stethojulis bandanensis	4
Thalassoma amblycephalus	4
T. quinquevittata	30
Thalassoma sp. (unid. juveniles)	491
Scarus oviceps	*
S. sordidus	*
Cirripectes variolosus	8
Ecsenius sp.	1
Blennid sp.	10
Tripterygiid sp.	1
Ptereleotris evides	215
Acanthurus glaucopareius	4
A. lineatus	15
A. nigricaudus	*
A. nigrofuscus	3
A. xanthopterus	*
Acanthurus sp.	1
Ctenochaetus cyanoguttatus	1
C. striatus	6
Naso lituratus	*
Zebrasoma veliferum	*
Balistapus undulatus	*
Melichthys niger	*
M. vidua	*
No. Species seen on transect	33
No. Species in vicinity of transect	69
No. individuals on transect	1,090
No. individuals per m^2	6.79

Table 28. Jaccard coeffients of similarity between the fish faunas observed in 10 habitats. The value of the coefficient ranges from 0 to 1 with a value 0 indicating no faunal similarity between habitat pairs and a value of 1.0 indicating identical faunas.

	Seagrass Beds	Moat	Outer Reef Flat	Reef Flat Holes	Harbor Margin	Channel Margin	Channel Slope	Outer Reef Margin	Outer Reef Terrace	Outer Reef Dropoff
Seagrass Beds	–	0.25	0.24	0.19	0.26	0.09	0.01	0.05	0.06	0.02
Moat		–	0.27	0.38	0.42	0.22	0.04	0.24	0.19	0.08
Outer Reef Flat			–	0.18	0.21	0.11	0.01	0.18	0.07	0.02
Reef Flat Holes				–	0.47	0.27	0.08	0.16	0.22	0.13
Harbor Margin					–	0.29	0.07	0.20	0.21	0.08
Channel Margin						–	0.28	0.29	0.43	0.26
Channel Slope							–	0.09	0.21	0.36
Outer Reef Margin								–	0.30	0.13
Outer Reef Terrace									–	0.34
Outer Reef Slope										–
Mean	0.13	0.23	0.14	0.23	0.25	0.25	0.13	0.18	0.23	0.16

Table 29. Fishes reported from Kosrae that were not observed during the present survey.

SPECIES	SOURCE
Carcharhinidae	
*Carcharhinus spallanzani**	Final EIS
Echinorhinidae	
Unid. sp.	Paul Mead
Squalidae	
Unid. sp.	Paul Mead
Dasyatidae	
Dasyatis granulatus (MacLeay)	Final EIS
Engraulidae	
Stolephorus heterolobus (Ruppell)	Townsend Cromwell
S. indicus (Van Hasselt)	Townsend Cromwell
Holocentridae	
Adioryx cornutus (Bleeker)	Final EIS
Serranidae	
Epinephelus chlorostigma (Cuvier & Valenciennes)	Paul Mead
E. morrhua (Cuvier & Valenciennes)	Paul Mead
E. retouti	Paul Mead
Variola louti (Forsskal)	Paul Mead
Carangidae	
Seriola purpurascens Temminck & Schlegel	Paul Mead
Lutjanidae	
Etelis carbunculus Cuvier	Paul Mead
E. oculatus Cuvier	Paul Mead
Lutjanus malabaricus (Bloch & Schneider)	Paul Mead
L. sebae (Cuvier & Valenciennes)	Paul Mead
Pristipomoides auricilla (Jordan, Evermann & Tanaka)	Paul Mead
P. flavipinnis Shinohara	Paul Mead
Tropidinius zonatus (Cuvier & Valenciennes)	Paul Mead
Gempylidae	
Ruvettus pretiosus Cocco	Paul Mead
Unid. sp.	Paul Mead
Chaetodontidae	
Forcipiger longirostris (Broussonet)	Final EIS
Pomacentridae	
Amphiprion melanopus Bleeker	Final EIS
Acanthuridae	
Paracanthurus hepatus (Linnaeus)	Final EIS

Table 30. Fishes assayed for ciguatera poisoning.

Species	Wet Weight in g	Size in mm*	RESULTS** Flesh 1	Samples 2	Liver
Carcharhinidae					
Trienodon obesus	1) 4,320	759 PCL	-	-	-
	1) 5,510	798 PCL	-	-	-
Serranidae					
Epinephelus caeruleopunctatus	1) 680	304 SL	±	-	-
E. hexagonatus	1) 310	226 SL	-	-	
Lutjanidae					
Lutjanus argentimaculatus	1) 2,980	484 SL	-	-	-
	2) 1,530	370 SL	-	-	-
Carangidae					
Caranx lugubris	1) 930	365 FL	-	-	+
	2) 790	330 FL	-	-	+
Pomadasyidae					
Plectorhyuchus nigrus	1) 930	301 SL	-	-	-
Kyphosidae					
Kyphosus lembus	1) 1,320	333 SL	-	-	-
Ephippidae					
Platax orbicularis	1) 2,140	304 SL	-	-	-
Labridae					
Cheilinus rhodochrous	1) 280	204 SL	-	-	
	2) 175	180 SL	-	-	
C. diagrammus	1) (portion of fish lost)		+	+	
Epibulus insidiator	1) 560	238 SL	-	-	+
Acanthuridae					
Ctenochaetus striatus	1) 67	111 SL	-	±	
	2) 36	101 SL	-	±	
C. cyanoguttatus	1) 49	105 SL	-	-	

*The following abbreviations are used for length measurements: PCL = pre-caudal length; SL = standard length; FL = fork length.

**+ indicates toxicity levels exceeding 50,000 CPM/g, ± indicates levels from 35,000-50,000 CPM/g, and - indicates levels below 35,000 CPM/g. If left blank, sample was too small to be tested.