

OFU REEF SURVEY  
BASELINE ASSESSMENT AND RECOMMENDATIONS FOR LONG-TERM  
MONITORING OF THE PROPOSED NATIONAL PARK, OFU, AMERICAN SAMOA

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FINAL REPORT TO THE NATIONAL PARK SERVICE

PAGO PAGO, AMERICAN SAMOA

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Photographs

## INTRODUCTION AND GENERAL PURPOSE

The U.S. Congress has authorized the Department of the Interior to enter into a lease agreement with the Governor of American Samoa to establish the National Park of American Samoa (Congressional Record, 1988). This park would include a nearshore reef area along the southern coast of the island of Ofu. This fringing reef on Ofu provides a natural lagoon habitat which is uncommon in American Samoa. This area supports a local subsistence fishery and provides excellent opportunities for diving and snorkeling.

A survey of the nearshore reefs in the area of the proposed national park at Ofu was conducted between 7-12 September, 1992. The goals of this survey were to: 1) collect baseline data on the current status of reefs and reef resources in the area, 2) to establish long-term monitoring stations to enable documentation of the health of the reef communities through time, and 3) to contribute information to a comprehensive coastal resource survey of Tutuila and the Manua Islands. The overall purpose of the work was to design and implement the biotic components of a reef monitoring program for the areas within and adjacent to the proposed national park site.

History has shown that tropical coral reef ecosystems are vulnerable to the impacts of hurricanes, runoff, eutrophication, sedimentation, dredging, outbreaks of disease or predators, and overfishing. Many (or most) reef resources are resilient, and can often recover from physical damage (e.g. from storms, dredging) *if* other stresses are not present. Combinations of stresses, particularly high levels of nutrients and sediments, usually result in profound and long-term changes in reef habitats especially when coupled with storm damage and/or overfishing. Indicators of such impacts (or recovery from stresses) are those that can sensitively measure significant changes on reef systems over periods of time that are meaningful to resource managers. Since natural reef systems are usually spatially and temporally variable, indicators must be able to detect trends above the "noise" of this natural variability. In this study, we utilized a combination of tested methodologies that provide both

a "snapshot" of the status of Ofu reef resources at the time of the initial survey and, when applied in long-term monitoring, a sensitive measure of significant trends or changes within the proposed park boundaries.

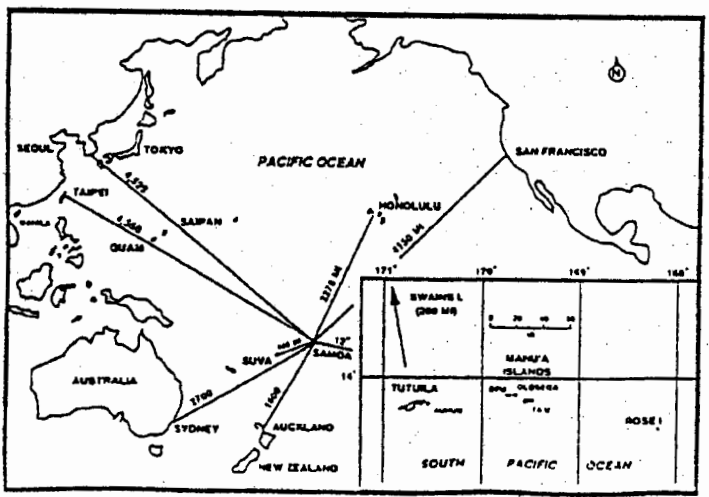
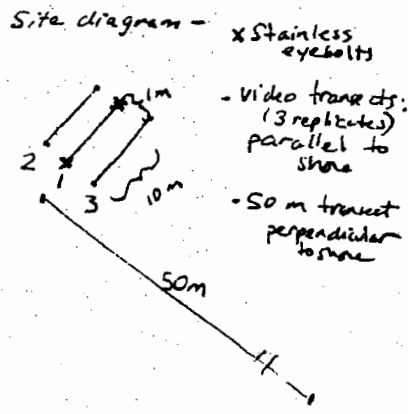
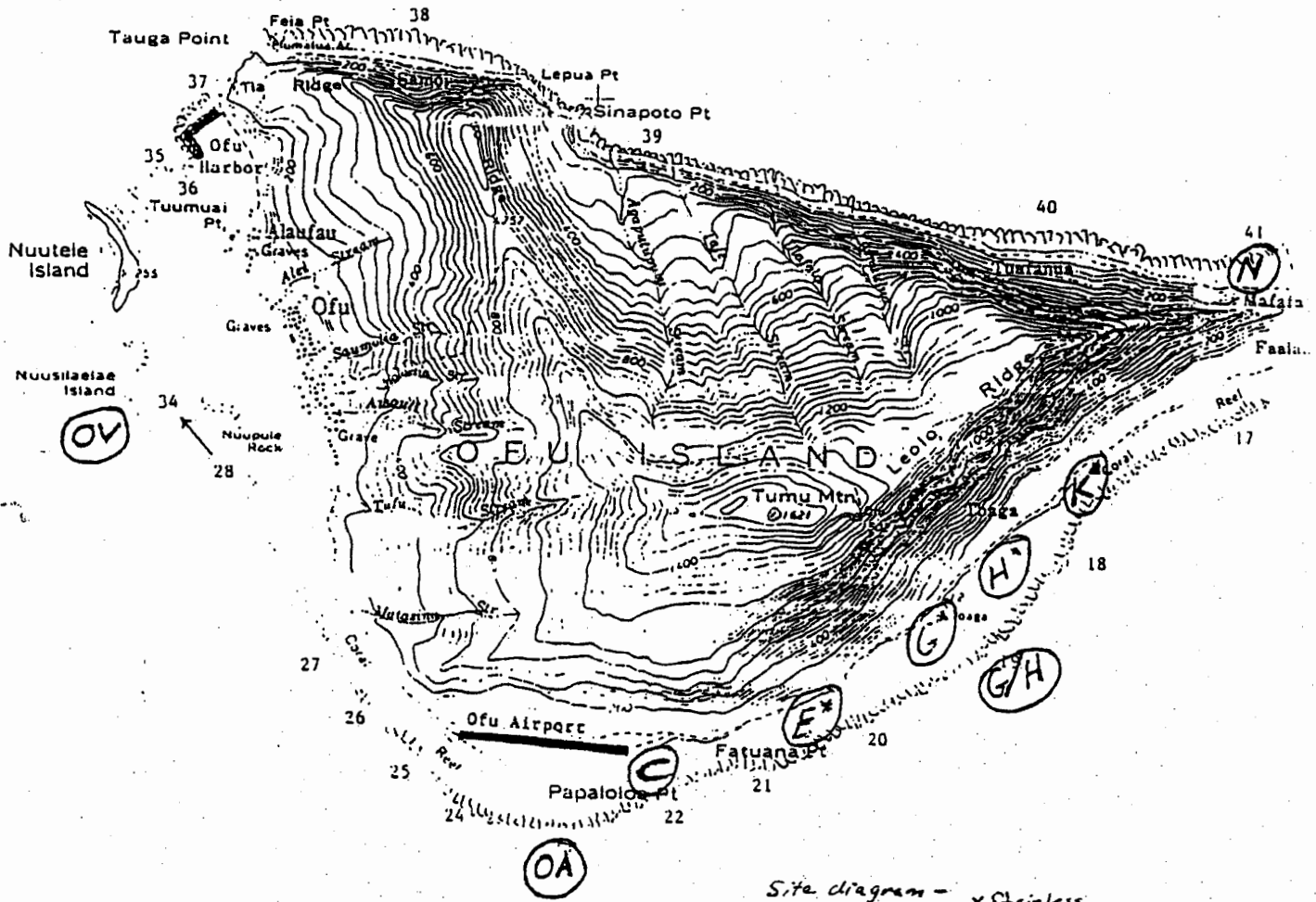
#### **SITE SELECTION AND BASIC METHODOLOGIES**

Survey sites and long-term monitoring stations were selected after consultation with Park Superintendent, Doug Cuillard, and initial reconnaissance surveys of reefs along the entire southeast shore of Ofu, on the northeast shore, and near Ofu Village. Six permanent stations were identified by shoreside lineups (recorded by notes, photos, and video). Sites were also marked with stainless steel eyebolts labeled with plastic tags (Figure 1). Pilot holes (1/4") were drilled into dead coral heads at each end of a central 10 m long transect (parallel to the shoreline) at each site. Eyebolts were then screwed into the pilot holes, and underwater epoxy was applied around the openings to further secure the bolts. Similar labeled eyebolts have been shown to remain in place for at least three years on Hawaiian reefs (C. Hunter, pers. obs.).

Although each station was permanently marked to facilitate positioning of transect lines, it is important to note that comparability of future surveys is *not* dependent on *exact* relocation of transects. The six nearshore sites were chosen as being generally representative of the back reef lagoon areas. Due to the within-site replication and robustness of the methods used in this study, future surveys at approximately the same depths and distances from shore will provide comparable estimates of the status of reef resources.

Stations were located within the broad fringing reef zone along the southeast (Sites C, E, G, H, and K) and northeast (Site N) shores of Ofu; Sites C and E corresponded to sites identified by Itano and Buckley (1988) in a Department of Marine and Wildlife Resources (DMWR) survey of Manua reefs. Letter designations of sites were retained for consistency with the DMWR records. In addition, surveys were conducted on outer reef slopes near the airport (OA), offshore of sites G/H (GH), and near Ofu Village (OV). The latter site was

Figure 1. Locations of visual censuses conducted on Ofu Island, American Samoa. Asterisks denote location codes within proposed national park.



located near a rebar stake installed by Itano and Buckley (1988). All sites will be precisely marked on the USNPS maps of the park (USNPS/Towill/Corial, in preparation).

### Site Locations

**Site C.** This site is located approximately 40 m offshore, in line with the landing lights on the west end of the airstrip (Telephone Pole #32). The site is about 3/4 of the distance between the shoreline and the emergent reef crest pavement. Depth is 0.1-1.2 m. Site C was surveyed previously by Itano and Buckley (1988), but their survey stakes were not found in the 1992 survey.

**Site E.** This site is 90 m from the shoreline at Telephone Pole #43, and 8-9 m ESE of the second of two (looking toward shore) large basalt boulders. Depth ranges from 0-2 m. It is in the approximate vicinity of Itano and Buckley (1988) Site E. Depth is 0.5-1.2 m. A sand groove (1-5 m wide) provides easy swimming access to the site from the beach, although there is a shallow bank (emergent at low tide) between the sand groove and the transect sites.

**Site G.** This site is about 75 m west of the hurricane house, approximately half way between the beach and reef crest (~80 m from the shoreline). The transects are in a visual line with a cave on the mountainside and a large boulder on the beach. Depth varies from 0.2-1.5 m.

**Site H.** This site is approximately 100 m east of the hurricane house (Telephone Pole #57), and aligned on shore with the end of the beachrock and a rock-faced escarpment on the cliffs above. It is approximately 75 m from shore, at 0.2-1.5 m in depth.

**Site K.** Site K is located about 10 m offshore from Telephone Pole #76. Depth varies from 0.1-1 m.

**Site N.** This site was located on the northeastern shoreline, approximately 100 m from the shore at Telephone Pole #100, and about 50 m shoreward of the reef pavement. Depth varies from 0.1-1 m.

**Airport (OA).** This site is aligned offshore of Site E, directly off the east end of the airstrip, at a depth of 9-17 m, and in the vicinity of Site 23, Itano and Buckley (1988).

**Hurricane House (G/H).** This site is offshore, mid-way between Sites G and H, in 5-17 m depth. The area is similar in location and description to Site 17 (Itano and Buckley, 1988).

**Ofu Village (OV).** The site is about 100 m west of the Ofu Village ava, at 9-17 m depth. The site is located at a large re-bar stake installed by DMWR biologists in October, 1986. The stake was still firmly in place near the base of a reef spur at 50' depth and in good condition.

Surveys were divided into five aspects addressing the major biotic features of Ofu reef sites: general reef structure and substratum characteristics, corals, macro-invertebrates, macro-algae, and reef fishes. Synoptic surveys were conducted by a research team consisting of specialists in corals/ invertebrates (C. L. Hunter, University of Hawaii), phycology (W. H. Magruder, Bishop Museum), fisheries (A. M. Friedlander, Hawaii Cooperative Fisheries Unit and University of Hawaii), and underwater videography (K.Z. Meier, Corial, Inc.). Video and still photographic records of all sites are included with this report.

## General Reef Characteristics, Corals, and Macro-invertebrates

Corals and macro-invertebrates at each site were described and quantified using comparative and complementary methods:

### General Area Description

An initial, rapid, qualitative description estimated the general structure of the area: reef depth and slope, and percentages of sand, rubble, and hard substratum (as live coral, dead standing coral, or reef pavement). Field notes were made of damage to living corals from bleaching, disease, and predation by crown-of-thorns starfish (*Acanthaster*) or corallivorous snails (*Drupella*).

### Coral Diversity and Abundance

Living corals provide the structural framework, habitat, and food for near-shore biotic communities. At each site, all species of corals within a circular area of approximately 30 m in diameter (700 m<sup>2</sup>) were recorded and assigned a relative abundance value of 1-5, as follows: 5=>80%, 4=31-80%, 3=11-30%, 2=6-10%, 1=1-5% (Done and Navin, 1990). Photos and video records were taken of most coral species encountered; these records are useful for species validations and can be used for future training in field identification of Samoan corals.

### Substratum Diversity and Abundance

A 50 m linear transect tape was stretched over the substratum in an orientation perpendicular to the shoreline. The number of centimeters occupied by substratum types under the tape was recorded for scleractinian (stony) corals, non-scleractinian corals, sponges, or algae (turf, macro, filamentous, or blue-green mat). At some sites, the seaward end of the transect tape extended over the exposed reef crest and these transects were shortened accordingly.



### Macro-invertebrate Diversity and Abundance

All macro-invertebrates greater than 1 cm in diameter within a 5 m wide belt transect (2.5 m on either side of 50 m transect tape) were enumerated, and the results extrapolated to numbers/m<sup>2</sup> and percent cover/m<sup>2</sup>. Cryptic organisms or infauna necessitating destructive sampling techniques were not included in this survey.

### Video Records of Coral, Algal, and Substratum Abundance

Three 10 m transects were established at each site in an orientation parallel to the shoreline and footed on their west ends by the 50 m transect. These transects were permanently marked by tagged eyebolts set 10 m apart. The center transect (#1) ran between the two eyebolts, with the other two transects on each side at a distance of 1 m (#2=shoreward, #3=seaward). A multi-colored nylon transect line clearly marked at 10 cm intervals was stretched over the 10 m distance and anchored or tied securely at each end to the eyebolts or around small coral heads. Video records were then made from a vertical perspective at a distance of approximately 0.5 m above the transect line. The photographer attempted to move at a slow and steady pace from west to east along the transect, filming a continuous area of approximately 30x30 cm. Care was taken to check the camera housing front-port for bubbles periodically, particularly on the shallow reef flats where daytime photosynthesis causes evolution of oxygen from benthic plants.

General video records were made of each area, and of particularly unique or unusual colonies or reef formations. A measure of spatial heterogeneity within each area was also obtained by laying a chain (1 cm links) under the middle transect line, taking care that the chain conformed to the bottom topography (the transect tape was stretched at a distance of .05-.5 m above the bottom). The length of chain necessary to cover a horizontal distance of 10 m under the transect line was then recorded. The ratio of chain length to horizontal

distance along the bottom provided an index of spatial heterogeneity and estimated vertical relief for each area.

### Video Record Analysis

Two commendable attributes of video analysis of coral reef habitats are: 1) the permanence and reproducibility of the data, and 2) ease and speed of analysis. Video records can also be used for training, review of local biota, and for non-destructive sampling of biota for later identification or confirmation by experts.

Original 8 mm videotape recordings were transferred to VHS format for data analysis (8 mm format is more fragile and can be damaged through repeated playback). An acetate sheet was marked with three sets of 10 randomly determined points (30 points total). Point locations were marked at grid intersections (e.g.  $100 \times 100 = 10,000$  possible points) defined by pairs of computer-generated random numbers. (Point locations can also be obtained from random number tables.) The marked acetate sheet was then affixed to a VHS monitor screen for analysis of areal coverage of each substratum or organism type. [Note for future analyses: this method is independent of the size of the acetate overlays or VHS monitor used.]

Video records of each 10 m transect were paused at each of 10 pre-determined, randomly-selected frames. Organisms or substratum types beneath each of the 30 points overlaying the stilled frame were then recorded on standardized data sheets (see appendix). These data (3 transects  $\times$  10 frames/transect  $\times$  30 points/frame = 900 points within a total quantified area of  $9 \text{ m}^2$  (3 transects  $\times$  10m length  $\times$  0.3 m width )) were summarized and averaged to provide estimates of organism and substratum abundance within each site. Data sheets and formats for analysis with Microsoft (Macintosh) Excel [also compatible with Microsoft (IBM) Excel] are provided on disk files with this report. The total time required for analysis of the 6 sites, with 3 transects/site, was approximately 29 h.

## RESULTS

The fringing reefs on the southern shores of Ofu Island, Manua Group, American Samoa, harbor a diverse and beautiful coral community. A well-developed reef crest along much of the southeastern shore protects a shallow (to 2.5 m) lagoon characterized by large, isolated blocks of massive *Porites* (up to 7 m in diameter) and *Acropora* thickets separated by sand, rubble, and areas of semi-consolidated limestone. Exceptional snorkeling in calm, clear water, unique coral formations, and high fish abundance were found within the park boundaries, particularly near Sites E, G, and H (Telephone Poles 42-50).

Summaries for each site, comparisons among sites, and comparisons among data collection methods are presented in the attached tables. Raw data for video transects and censuses are included as an appendix to this report.

Percent cover of coral ranged from 6.7-30.4% among the six permanent monitoring sites established in September, 1992 (Table 1). Although Maragos, *et al.* (in prep.) reported a total of 93 coral species as common or abundant at one or more of the 11 sites surveyed on Ofu and Olosega in 1991, the number of species recorded per 700 m<sup>2</sup> site in the present study ranged from 12-29. A combined total of 64 species of corals were recorded from all sites in this study (initial reconnaissance survey of the southeast reefs, permanent reef flat sites, and three offshore sites). The most dominant corals at most sites were the massive *Porites*; extensive thickets of *Acropora* were dominant at Site H. Branching, blade-like, or encrusting *Millepora* (fire coral) was also abundant at all sites.

Algal cover was relatively low at all sites surveyed, comprising 6.2-17.3% of the areal cover. Most of the algae encountered were fine turfs growing on dead coral skeletons and calcareous reef framework. Damselfish "farming" algal turf territories were common at most sites, particularly Sites G & H. Algal diversity is discussed in a separate section of the report.

The most common macro-invertebrates on the southeastern lagoon reef were sea cucumbers (up to 0.4 *Stichopus*/m<sup>2</sup>) and urchins (up to 0.04 *Diadema*/m<sup>2</sup>). Few edible mollusks (*Tridacna* or *Trochus*) were seen, and although the survey team observed that

numerous octopus (about 10/day) were caught by local fishermen during the period of this study, none were encountered in the survey areas.

### Site Summaries

Observations for each site are summarized in Appendix II (corals) and Appendix III (macroinvertebrates).

**Site C.** Large *Porites* heads and emergent micro-atolls surrounded by *Millepora dichotoma* and *Heliopora coerulea* ("blue coral") occurred about 10 m from the west end of the Site C transects. This was the area of highest *Heliopora* abundance of any site, and may represent the highest abundance in American Samoa (Itano and Buckley, 1988). Massive favids, encrusting *Montipora*, and *Pocillopora damicornis* were also common. Some recent *Acanthaster* predation ( $\sim 0.3 \text{ m}^2$ ) was noted on a *Montipora cf informis* colony at the east end of Transect C-1 (see photo). *Stichopus chloronotus*, the green sea cucumber, was very abundant on sandy substratum ( $0.7/\text{m}^2$ ). The ratio of live vs. dead coral cover was 1:1 at this site, and the index of spatial heterogeneity was 1.3.

**Site E.** This area had the highest percentage of hard substratum of all reef flat sites (75%). Coral diversity was high (27 species recorded), with *Millepora dichotoma*, *Leptoria phrygia*, *Pocillopora meandrina*, and layered plates of bright yellow-green *Turbinaria reniformis* being among the most notable. Two *Acanthaster* (alamea, crown-of-thorns) were found at the site, near fresh feeding scars on massive *Porites*. One of the *Acanthaster* was found on the same colony four days later. The ratio of live vs. dead coral cover was 1:2.3 at this site, and the index of spatial heterogeneity was 1.5.

**Site G.** Massive and branching *Porites*, and *Millepora dichotoma* dominated this site. The ratio of live vs. dead coral cover was 1:1, and the index of spatial heterogeneity was 1.3.

**Site H.** This site exhibited the highest percent cover of live coral (30.4%) along the southeast fringing reef, with extensive thickets of branching *Acropora* (often inhabited by

territorial damselfish) dominating the area. One *Acanthaster* and several fresh feeding scars were observed near the transects. The ratio of live vs. dead coral cover was 1:1 at this site, and the index of spatial heterogeneity was 1.5.

**Site K.** Much of the area was rubble (30%) or sand (30%). Species diversity (12 species) was lowest among the six permanent sites, and was dominated by massive *Porites* and the favid, *Goniastrea retiformis*. Much of the *Porites* was covered by anomalous (tumorous?) growths that appeared to be preferentially grazed by fish as evidenced by numerous feeding scars. Diseased or tumorous tissue was rare or absent at other sites. *Diadema* and the sea cucumber, *Bohadschia argus* were common in the area, and five *Tridacna* were noted within the 250 m<sup>2</sup> transect. One *Acanthaster* was observed near the transects. The ratio of live vs. dead coral cover was 1:4 at this site, and the index of spatial heterogeneity was 1.3.

**Site N.** A large (2 m diameter) patch of tumbled *Porites* heads and a bright purple-colored massive *Porites* were in the middle of Transect N-1. This site had the lowest percentage of hard substratum (20%) and coral abundance (6.7%). Massive *Porites*, encrusting *Montipora cf informis*, and *Acropora humilis* were the most common coral species. Blue-green bacterial mats were common overlying sand in the area. The ratio of live vs. dead coral cover was 1:3 at this site, and the index of spatial heterogeneity was 1.3.

#### **Offshore Sites:**

**Airport (OA).** The topography of the site was very low-relief (index of spatial heterogeneity= 1.1), with the bottom consisting primarily of consolidated limestone mixed with pockets of sand. It is apparent that this area is subject to frequent scouring and wave action. Coral cover was low (5%) and was composed primarily of small colonies of encrusting *Astreopora*, *Montipora*, and *Porites*. Urchins (*Echinothrix* sp.) were abundant in bored holes in the limestone. A green sea turtle (*Chelonia midas*) swam through the area during the survey. The ratio of live:dead coral was 1:1.0.

**Hurricane House (G/H).** This site is mid-way between Sites G and H, offshore in 5-17 m depth. The moderate spur and groove topography was primarily hard substratum (95%), with a high coral cover of 40%. The dominant coral taxa were *Goniastrea retiformis* and *Acropora robusta*. Two *Tridacna* were noted within the 250 m<sup>2</sup> belt transect. The ratio of live vs. dead coral cover was 1.1:1 at this site, and the index of spatial heterogeneity was 1.3.

**Ofu Village (OV).** There was evidence of extensive, but not recent, damage to corals (possibly crown-of-thorns) that were heavily painted with a covering of coralline algae (*Porolithon sp.*). Coral diversity and cover were high (29 species, 30% cover), as was the percentage of hard substratum (95%). No one species or group of corals dominated the area. One small *Tridacna* was found, as well as 8 juvenile *Trochus* within the 250 m<sup>2</sup> belt transect. The ratio of live vs. dead coral cover was 1.5:1 at this site, and the index of spatial heterogeneity was 1.3.

#### Comparison of Data Collection Methods

Analysis of video surveys (3, 10 m transects-planar point intercepts), 50 m linear-intercept or belt transects, and visual field estimates provided different estimates of coral, invertebrate, and substratum abundance for the six permanent Ofu reef sites (Table 1). Video and visual surveys provided consistent estimates of coral abundance, while the 50 m perpendicular transects typically substantially underestimated coral abundance. However, video transects sampled too little total area to effectively quantify macro-invertebrate populations. Video transects also overestimated the percent cover of macro-invertebrates when extrapolated to larger areas. Experience obtained in the present study suggest that belt transects can rapidly cover more area, and thus provide the better estimates of abundance of organisms such as sea cucumbers, sea stars, and sea urchins.

Identification of coral species is often difficult, whether in the field or from photographic or video records. Consistent identifications of species of *Porites* and *Acropora*

are especially problematic, even for experienced workers. Collection of samples for identification, especially from small areas such as Ofu, is destructive and should be avoided when possible. Video records allow evaluation (or re-evaluation) and quantification of surveys at various levels of resolution. For example, some workers may choose to work at the level of species while others may be interested in growth forms (e.g. massive, branching, encrusting, etc. for corals). Analysis of coral cover and substratum by major forms or types will probably provide sufficient information to detect most changes (degradation, recovery, or status quo) on reefs. Visual field estimates are also important for ground-truthing and broadscale surveying; video records provide the ability to "go back in time" to evaluate changes that may not have been apparent at the time of a survey.

A checklist of coral and macroinvertebrate species identified from this survey is presented in Appendix IV.

## DISCUSSION

A coral/macroinvertebrate monitoring program was established at six permanently marked sites in the fringing lagoon reefs on the southeast and north shores of Ofu, American Samoa, within and adjacent to the boundaries of the proposed national park. The reef communities at each site appeared, with a few exceptions, to be exceptionally healthy. Coral cover and diversity were moderate to high, and the clear, calm conditions coupled with beautiful and unusual coral/limestone formations offered superb snorkeling opportunities. During this study, underwater visibility at the nearshore areas was generally 20+ meters. Coral communities such as these thrive in clear water, with low nutrients and low sedimentation necessary for their continued recruitment and survival. Proximity to shore makes these communities particularly vulnerable to land-use activities that may alter the natural conditions under which they have developed.

Ofu reef sites appeared to be similar in development compared to qualitative observations recorded in a Department of Marine and Wildlife Resources report prepared by

Itano and Buckley (1988). However, future surveys can use the quantitative data provided in the present report to improve the sensitivity in measurement of any changes in abundance and diversity in the reef community. Specifically, percent coral and algal cover should be monitored, with particular attention to changes in macro-algal abundance. Due to limitations of time, size-frequency measurements of coral colonies were not made. Such measurements provide an excellent basis for following reef disturbance/recovery processes, and should be included with high priority in all subsequent surveys.

The condition of the diseased massive *Porites* colonies at Site K should be followed closely for indications of recovery or spread of the disease. Of further interest is the apparent absence or substantial decrease in abundance of two important sea cucumber species: *Theleota ananas* and *Actinopyga mauritiana*. Both of these species were reported as common by Itano and Buckley (1988), but were not recorded at any of the sites surveyed in September, 1992.

Ofu reefs support a variety of important resources: fishing (reef fish, octopus, *Trochus*, and *Tridacna*), as well as having tourism potential for recreational snorkeling, diving, fishing, and underwater photography. In addition, they represent the eastern-most distributions in the Pacific for a number of coral genera (*Heliopora*, *Euphyllia*, *Diploastrea*, *Oulophyllia*, and possibly others). Within the boundaries of the proposed national park, the corals in the 1-2 m deep lagoonal areas of the fringing reef (unique in American Samoa) provide a diverse and visually impressive habitat within a protected environment.



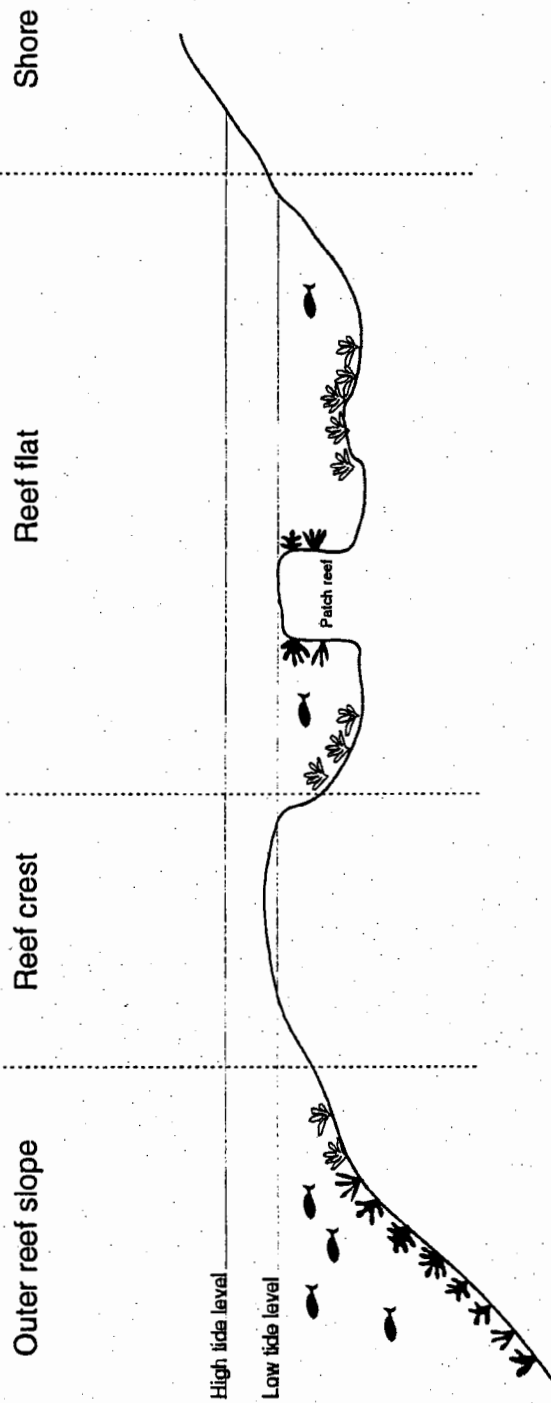


Figure 2. Diagrammatic cross section of the fringing reef at the proposed National Park on Ofu, American Samoa.

Table 1. Summary and comparison of results of Ofu surveys using different methods.

**DATA SOURCE: VIDEO TRANSECTS**

3 parallel 10 m transects, 10 frames each, 30 points/frame

| <u>SITES:</u> | <u>C</u> | <u>E</u> | <u>G</u> | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>Offshore Sites</u> |               |
|---------------|----------|----------|----------|----------|----------|----------|--------------|----------------|-----------------------|---------------|
|               |          |          |          |          |          |          |              |                | <u>G/H</u>            | <u>OFU V.</u> |
| CORALS #SPP.  | 29       | 26       | 23       | 25       | 12       | 21       | 22.67        |                | Analyses              |               |
| % COVER       | 10.3     | 17.33    | 18.8     | 30.4     | 23.9     | 6.7      | 17.91        |                | not performed         |               |
| SUBSTRATUM    | 80.56    | 67.3     | 72.9     | 52.3     | 65.6     | 78.7     | 69.56        |                |                       |               |
| RUBBLE        | 4.4      | 1.3      | 10.4     | 23.7     | 14.9     | 33.9     | 14.77        |                |                       |               |
| SAND          | 49.4     | 31.3     | 36.2     | 5.2      | 35.3     | 14.7     | 28.68        |                |                       |               |
| ALGAE         | 6.2      | 13.78    | 10.3     | 17.3     | 10.3     | 14.7     | 12.10        |                |                       |               |
| TURF          | 6.2      | 13.8     | 10.3     | 17.3     | 10.3     | 13.6     | 11.92        |                |                       |               |
| INVERTS       | 2.8      | 1.6      | 0.1      | 0        | 0        | 0        | 0.75         |                |                       |               |

**DATA SOURCE: VISUAL FIELD ESTIMATE**

| <u>SITES:</u> | <u>C</u> | <u>E</u> | <u>G</u> | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>Offshore Sites</u> |               |              |
|---------------|----------|----------|----------|----------|----------|----------|--------------|----------------|-----------------------|---------------|--------------|
|               |          |          |          |          |          |          |              |                | <u>G/H</u>            | <u>OFU V.</u> | <u>MEANS</u> |
| CORALS #SPP.  | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| % COVER       | 10       | 15       | 25       | 30       | 10       | 5        | 15.83        | 5              | 40                    | 30            | 25.00        |
| SUBSTRATUM    |          |          |          |          |          |          |              |                |                       |               |              |
| RUBBLE        | 20       | 5        | 10       | 15       | 30       | 20       | 16.67        | 2              | 20                    | 20            | 14.00        |
| SAND          | 50       | 20       | 40       | 20       | 30       | 60       | 36.67        | 18             | 5                     | 5             | 9.33         |
| ALGAE         | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| TURF          | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| INVERTS       | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |

**DATA SOURCE: 50 M PERPENDICULAR LINEAR/BELT TRANSECT**

| <u>SITES:</u> | <u>C</u> | <u>E</u> | <u>G</u> | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>Offshore Sites</u> |               |              |
|---------------|----------|----------|----------|----------|----------|----------|--------------|----------------|-----------------------|---------------|--------------|
|               |          |          |          |          |          |          |              |                | <u>G/H</u>            | <u>OFU V.</u> | <u>MEANS</u> |
| CORALS #SPP.  | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| % COVER       | 5.98     | 18.33    | 11.08    | 4.96     | 0.36     | 0.76     | 6.91         | 2.04           | 14.34                 | 9.20          | 8.53         |
| SUBSTRATUM    | 88.95    | 73.37    | 81.10    | 92.80    | 87.34    | 87.04    | 81.10        | 79.96          | 85.32                 | 69.92         | 78.40        |
| RUBBLE        | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| SAND          | --       | --       | --       | --       | --       | --       | --           | --             | --                    | --            | --           |
| ALGAE         | 5.08     | 6.60     | 5.18     | 1.40     | 12.10    | 12.20    | 7.09         | 18.00          | 0.34                  | 20.20         | 12.85        |
| TURF          | 3.75     | 6.00     | 5.14     | 0.50     | 12.00    | 0.80     | 4.70         | 16.00          | 0.20                  | 20.20         | 12.13        |
| INVERTS       | 0.51     | 0.17     | 0.07     | 0.09     | 0.12     | 0.02     | 0.16         | 0.26           | 0.01                  | 0.02          | 0.10         |

-- data not recorded

### Seaweeds of the proposed National Park on Ofu, American Samoa

The seaweed flora at the proposed National Park site on Ofu is characteristic of most tropical Pacific islands and is indicative of a pristine, low nutrient reef environment. It is a healthy coral and coralline algae community with extensive grazing by fish and invertebrates. A list of the specimens collected and observed at Ofu is provided in Appendix V. All specimens with collection numbers were mounted on slides and will be deposited at the Bishop Museum in Honolulu. Due to the limited field time of this study and necessity of bringing the specimens back to Honolulu for mounting and identification, it is estimated that the species collected may represent only about 1/3 of the total seaweed species present at Ofu.

The seaweeds identified from Ofu reefs seem to be fairly common throughout the tropical Pacific Ocean, although one species of red seaweed (*Rhodolacne decussata*) has been previously found in only three other locations in the world. Several of the unidentified species may be new to science and/or not formally described, but are probably more widespread than just Ofu or American Samoa.

Most of the seaweeds in the park area are coralline red seaweeds and small turf-forming red, brown, or green algal species. Red seaweeds are by far the most diverse division present, followed by green seaweeds and then brown seaweeds. Larger seaweeds are primarily limited to vertical and overhanging sides of the lagoon reef structure and to specific areas of the reef crest, such as near deep channels. Although most of the seaweeds present were inconspicuous and small, they have a very important part in reef community.

The basic structure of the reef (Figure 2) is very typical of tropical Pacific reefs, with the outer reef slope dominated by corals up to a depth of about 10-15 feet. Seaweeds growing on the outer reef slope area are mostly limited to small red species in holes or cracks or on the lower non-living portions of coral colonies. From 10-15 feet deep, up to and including the reef crest, the dominant benthic organisms are seaweeds, mostly crustose corallines and small turfs, although some of the larger fleshy seaweeds such as *Caulerpa* and *Chlorodesmis* are found near the avas or small channels in the reef crest. The reef crest is a

critical part of the reef structure and is built primarily by crustose coralline seaweeds such as *Porolithon*. The reef flat area is again dominated by corals, with larger fleshy seaweeds (primarily *Halimeda*) mostly confined to the lower vertical sides of reef structure (Figure 1) or small caves; small turf algae are confined to the lower non-living parts of erect corals and to rubble areas. The immediate shoreline is mostly sand although there are a few areas with basalt boulders or hard sandstone with small filamentous algae growing on them.

Healthy tropical reefs have high levels of algal grazing by both fish and invertebrates such as sea urchins, sea cucumbers and certain mollusks. There is widespread evidence of heavy grazing on seaweeds in the park area. Large schools of herbivorous fish and large invertebrates such as urchins and holothuroids were observed feeding from the reef surface in areas with seaweeds. The elimination of large numbers of grazing fish or invertebrates will result in a rapid increase in filamentous and fleshy algal growth and a reduction in the growth of reef building corals and coralline algae. Presently the fishing pressures on reef grazers appears to be sustainable, and it would be desirable not to exceed present levels.

An illustration of the effects of limiting grazing can be observed in the beds of *Acropora* coral. There are large populations of damselfish in many of these beds that control grazing by other organisms through their aggressive behavior. The lower non-living portions of these *Acropora* coral beds have dense turfs of small filamentous seaweeds. Seaweeds are very good "competitors" for space and a reduction in the normal levels of grazing pressure would result in a large increase in algal populations, to the detriment of the community as a whole.

## Reef Fish Populations at Ofu

### INTRODUCTION

Subsistence shoreline fisheries produce the majority of the total catch and value of the domestic fishery resources in American Samoa (Ponwith, 1991). Principal fishing methods include rod/reel, handlining, free diving, gillnetting, reef gleaning, and throw netting (Craig *et al.*, 1992). Jacks (Carangidae), surgeonfishes (Acanthuridae), mullet (Mugilidae), octopus (*Octopus* sp.), and groupers (Serranidae) account for the majority of the species catch by weight.

American Samoa has experienced substantial population growth and extensive coastal development in recent years (Wass, 1982). Increased fishing effort and improved gear efficiency as well as habitat loss have placed tremendous pressures on many coastal marine resources. Nearshore ecosystems, particularly on Tutuila, have deteriorated because of land clearing, coastal road development, increased cannery waste and expanded fishing effort. Per capita catch per unit effort for reef-resident species has declined by over 50% since 1979 (Ponwith, 1991). Reef fishes are vulnerable to overfishing due to their slow growth, long life spans, and small home ranges (Munro, 1983; Ralston, 1987). Additionally, reduction of live coral cover and reef structural heterogeneity by habitat alteration and destructive fishing techniques can reduce the amount of habitat available for reef fishes, particularly juveniles (Russ, 1991).

The Manua Islands have been much less impacted by human activities than Tutuila or many other Pacific Islands. Ofu and Olosega have excellent reef resources and present an invaluable opportunity for preservation in their near-pristine state. The purpose of this aspect of the present study was to identify fish species and estimate species abundance in select locations around Ofu Island as well as to develop recommendations for long-term monitoring of these resources within and surrounding the proposed park area.

## METHODS

Visual censuses were determined to be the best non-destructive method to obtain information on the reef fish assemblages. All visual censuses were referenced to the permanent transect pins when possible to facilitate repeatability in the future. Precise locations of censuses appear in Appendix I.

Stationary point counts were conducted at all locations and consisted of counting all fishes within a defined area for a specified period of time (Bohnsack and Bannerot, 1986). The method is simple, fast, objective, repeatable, and easy to use. Stationary counts require less time than belt transects to set up and can be repeated easily with large sample sizes obtained with a minimum of effort (Thresher and Gunn, 1986). The stationary point count method was recently used to assess the shallow water reef fish stocks of Western Samoa (Samoilys and Carlos, 1991) as well as Fiji and Australia (Samoilys and Carlos, 1992). A fiberglass measuring tape was laid out and all species observed within a 10 m diameter cylinder (78.5 square meters) were counted during a 15 minute time period (Kimmel, 1992; Kimmel, 1993). Preprinted data sheets were developed from previous visual census data obtained by Wass (n.d.) and Itano and Buckley (1988). These consisted of two sheets of Nalgene polypaper containing 119 common species most likely to be encountered, along with a brief description of each species to aid in identification. A double-wide clip board was used to reduce handling time underwater. Lengths were estimated to the nearest cm for all species. A ruler attached to the clipboard aided in length estimations. The author has had extensive prior experience with this method and has previously verified length estimates. Some small wrasses (Labridae) were not easily identified to species and were pooled as juveniles. Several species of parrotfishes (Scaridae) form mixed schools when feeding and are extremely difficult to identify to species in the field (Randall *et al.*, 1990; Myers, 1991). Therefore, these individuals were grouped into a single taxon (Scaridae).

Each census was analyzed to obtain community information on fish abundance, species richness, species diversity, evenness, and size class distributions. Species diversity ( $H'$ ) was calculated using the Shannon-Weiner diversity index ( $H' = - \sum p_i \ln p_i$ ) and evenness ( $J'$ ) was calculated using  $H'/H'_{\max}$  (Zar, 1984). Comparisons of community data among sites were performed using a Kruskal-Wallis single factor analysis of variance by rank (Zar, 1984). Dunn's multiple comparison procedure for unequal sample sizes (Hollander and Wolfe, 1973) was used to identify differences between sites. Mean length of fishes among sites were analyzed using a one way analysis of variance with data  $\ln(X+1)$  transformed to conform to the assumptions of homogeneity of variances and normal distributions. Inshore and offshore censuses were pooled and community parameters compared using Mann-Whitney tests (Hollander and Wolfe, 1973).

Similarities of fish assemblages among sites were compared using the Bray-Curtis similarity coefficient:

$$D = \sum_{i=1}^s [x_{1j} \cdot x_{2j} / (x_{1j} + x_{2j})]$$

where  $x_{1j}$ ,  $x_{2j}$  are the abundances of species  $j$  in sites 1 and 2, and  $s$  is the number of species. A flexible clustering strategy of  $\beta = -0.1$  was used in the analysis (Ludwig and Reynolds, 1988; Gauch, 1991). The 25 most abundant species were used in these analyses as rare species provide little information on the basic patterns of community structure (Ludwig and Reynolds, 1988). An index of relative dominance (IRD) was calculated by multiplying the relative frequency of occurrence and the relative abundance of each species over all censuses pooled (Bohnsack *et al.*, 1992).

## RESULTS

A total of 288 species of fishes from 47 families were observed during all stationary point counts and subsequent random searches (Appendix VI). Thirty-four censuses were conducted at the nine different sites during the study. The majority of the censuses (73.5%) were conducted in the shallow back reef/lagoon habitat where water depth averaged less than 2 m.

The total number of 173 species were observed during stationary point counts with a mean of 28.4 (S.D. = 6.1) per census (Table 2). The offshore airport site (Site OA) had the highest mean abundance of fishes per census (mean = 342.0, S.D. = 52.0) but the lowest mean diversity (mean = 1.713, S.D. = 0.340) and evenness (mean = 0.539, S.D. = 0.108) of any sites censused. The blackfin dartfish (*Ptereleotris evides*) was numerically dominant and extremely abundant at this site which yielded a high mean abundance of fish but low diversity and evenness.

The two other offshore locations, Site G/H and Ofu Village (Site OV), had the highest number of species per census (mean = 38.0, S.D. = 3.0; mean = 35.0, S.D. = 1.7; respectively) along with the inshore park site E (mean = 35.3, S.D. = 2.5). Comparisons of community statistics among sites appear in Table 3.

Mean lengths of fishes were significantly different among sites (ANOVA,  $F = 315.11$  d.f. = 8,  $P < 0.001$ ). The offshore site G/H had the largest mean fish lengths observed during visual censuses (Figure 2) while the offshore airport site (OA) had the smallest mean fish size (mean = 4.607, S.D. = 2.270) followed by the backreef site N on the northeast end of the island. Fish were most numerous in the 5-10 cm size class for all sites combined, followed by those in 10-15 cm size class and those less than 5 cm (Table 4).

Cluster analysis showed that most replicate censuses conducted at sites were more similar to one another than those from other locations (Figure 3). The inshore sites E, H, and G clustered together as one group. Another group was formed with censuses conducted at inshore sites K and N. The inshore site C in front of the airport appeared to be unique relative



to the other back reef areas. The three offshore forereef census locations had distinctive fish assemblages compared to the inshore back reef areas with censuses conducted at the offshore airport site (OA) having the greatest dissimilarity among sites.

Eleven of the 25 most abundant species observed during visual censuses were damselfishes (Pomacentridae) (Table 5). The wrasses (Labridae - 4 species), surgeonfishes (Acanthuridae - 4 species), and parrotfishes (Scaridae - 3 species) followed in abundances. The south seas demoiselle (*Chrysiptera taupou*) was the most abundant species observed when all censuses were combined, this was followed by the blackfin dartfish (*P. evides*), the dusky gregory (*Stegastes nigricans*), the lined bristletooth (*Ctenochaetus striatus*), and the bullethead parrotfish (*Scarus sordidus*), respectively.

Relative frequency of occurrence, relative abundance, and an index of relative dominance (IRD) were calculated for all species. The top 25 species as ordered by IRD appear in Table 6. These indices gave similar trends to those observed by ordering based on individual abundance by species.

Abundance of fishes and number of species were significantly higher on offshore than inshore sites ( $W = 362.5$ ,  $P = 0.0036$ ;  $W = 385.5$ ,  $P = 0.0438$ , respectively) (Table 7). Species diversity and evenness were not significantly different between these habitats ( $W = 415.0$ ,  $P = 0.3904$ ;  $W = 456.5$ ,  $P = 0.4701$ , respectively). The average size of fishes was significantly larger on the inshore sites ( $t = 15.01$ ,  $P < 0.001$ ).

## DISCUSSION

This initial survey has identified differences in diversity, abundance, and size of fishes among habitats within and adjacent to the boundaries of the proposed national park on Ofu, American Samoa. The sampling strategy employed recorded a large number of commercially and recreationally important species that can be used to evaluate changes in the reef fish community over time. Using only visual census techniques underestimates cryptic and

nocturnal species (Sale and Douglas, 1981). Despite these shortcomings, non-destructive visual assessment appears to be the best available method for repeated censusing of fishes.

Wass (1984) identified 991 species of fish from American Samoa. He collected in a wide variety of habitats and depths using ichthyocides and other destructive methods. In a two year study around the island of Tutuila, American Samoa, Wass (n.d.) observed 356 species of fishes in transects and subsequent 20 minute searches in surveys conducted at 57 sites around the island. The lower number of species observed during the present study on Ofu Island (288 species) resulted from sampling in a restricted number of habitats and primarily in shallow water (<5 m).

The majority of the Ofu back reef sites appeared similar to one another in fish assemblage structure based on cluster analysis. Several of the back reef sites had species richness and diversity comparable to the two rich offshore locations, Ofu Village (OV) and Site G/H. These inshore sites were dominated by small damselfishes (Pomacentridae) and wrasses (Labridae) while more commercially and recreationally important species such as groupers (Serranidae), snappers (Lutjanidae) and large parrotfishes (Scaridae) were present at the offshore sites.

The Offshore Airport (OA) and backreef site N were observed to have the smallest fish censused. The Offshore Airport site was composed mainly of small individuals (< 5 cm) and dominated by the blackfin dartfish (*P. evides*), the white-belly damselfish (*Amblyglyphidodon leucogaster*), and the south seas demoiselle (*C. taupou*). Site N was a shallow coral rubble habitat where small wrasses (Labridae) were abundant. Although the offshore Ofu Village site (OV) contained a number of large important fisheries species, the overall size of fishes was similar to the inshore locations due to the presence of large numbers of planktivorous damselfishes (primarily, the midget chromis, *Chromis acares* and the pale-tail chromis, *C. xanthura*). Overall mean fish length was greater on the inshore sites compared to the offshore locations due primarily to the high abundance and small size of fishes at the Offshore Airport site.

The abundance and size of large predatory species commonly targeted by fishers is a good indicator of fishing pressure (Bohnsack, 1982; Russ, 1985; Russ and Alcala, 1989). Fish such as groupers are extremely vulnerable to fishing due to their curious and sedentary behavior. Groupers, primarily the peacock grouper (*Cephalopholis argus*) and the dwarf spotted grouper (*Epinephelus merra*), were commonly observed in the back reef areas at Ofu. Although common, these individuals were typically small (<15 cm) and appeared extremely wary of divers, quickly taking refuge in the reef. This behavior is frequently associated with species subjected to heavy fishing pressure. Long-term monitoring will help to detect changes in fisheries species resulting from habitat degradation and/or fishing pressure.

Table 2. Reef fish community statistics for visual censuses conducted on Ofu Island, American Samoa. Numbers are mean values for censuses performed at each location. Standard deviations are in parentheses. Diversity is the Shannon-Weiner diversity index ( $H' = - \sum p_i \log p_i$ ). Evenness ( $J' = H'/H'_{max}$ ). Asterisks denote location codes within proposed national park boundaries.

| Location Code | No. of Censuses | Total Number of Species | Abundance of Fishes | Species Richness | Diversity ( $H'$ ) | Evenness ( $J'$ ) |
|---------------|-----------------|-------------------------|---------------------|------------------|--------------------|-------------------|
| C             | 5               | 62                      | 111.8<br>(13.3)     | 25.8<br>(4.6)    | 2.535<br>(0.154)   | 0.783<br>(0.045)  |
| E*            | 4               | 71                      | 184.5<br>(13.8)     | 35.3<br>(2.5)    | 2.676<br>(0.145)   | 0.751<br>(0.031)  |
| G*            | 5               | 53                      | 162.0<br>(76.8)     | 24.4<br>(4.2)    | 2.323<br>(0.252)   | 0.731<br>(0.086)  |
| H*            | 5               | 51                      | 166.0<br>(26.0)     | 23.2<br>(2.7)    | 2.114<br>(0.241)   | 0.672<br>(0.063)  |
| K*            | 3               | 49                      | 161.7<br>(9.9)      | 30.3<br>(3.8)    | 2.470<br>(0.087)   | 0.725<br>(0.027)  |
| N             | 3               | 37                      | 149.0<br>(19.5)     | 24.7<br>(1.2)    | 2.176<br>(0.287)   | 0.678<br>(0.079)  |
| Offshore:     |                 |                         |                     |                  |                    |                   |
| AO            | 3               | 43                      | 342.0<br>(52.0)     | 24.0<br>(1.0)    | 1.713<br>(0.340)   | 0.539<br>(0.108)  |
| G/H           | 3               | 64                      | 187.3<br>(78.1)     | 38.0<br>(3.0)    | 2.854<br>(0.234)   | 0.748<br>(0.057)  |
| OV            | 3               | 65                      | 34.7<br>(46.5)      | 35.0<br>(1.7)    | 2.596<br>(0.057)   | 0.730<br>(0.024)  |
| Total         | 34              | 173                     | 181.2<br>(71.4)     | 28.4<br>(6.1)    | 2.382<br>(0.361)   | 0.715<br>(0.087)  |

Table 3. Kruskal-Wallis Rank Sums statistics for reef fish community statistics. Dunn's multiple comparison procedure ( $\alpha = 0.1$ ). Underlined medians are not significantly different. Asterisks denote location codes within proposed national park.

**Number of fishes**

| Location  | C            | G*           | N            | G/H          | K*           | H*           | E*           | OV           | OA           |
|-----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Avg. Rank | 4.8          | 13.8         | 12.5         | 17.7         | 16.0         | 18.1         | 23.4         | 26.8         | 33.0         |
| N         | 5            | 5            | 3            | 3            | 3            | 5            | 4            | 3            | 3            |
| Median    | <u>108.0</u> | <u>140.0</u> | <u>156.0</u> | <u>157.0</u> | <u>157.0</u> | <u>164.0</u> | <u>186.0</u> | <u>261.0</u> | <u>314.0</u> |

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$H = 20.98$  d.f. = 8  $p = 0.008$

**Number of species**

| Location  | H*          | G*          | C           | N           | OA          | K*          | E*          | OV          | G/H         |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Avg. Rank | 8.8         | 12.1        | 13.5        | 12.0        | 10.0        | 21.5        | 28.2        | 28.5        | 31.3        |
| N         | 5           | 5           | 5           | 3           | 3           | 3           | 4           | 3           | 3           |
| Median    | <u>22.0</u> | <u>24.0</u> | <u>26.0</u> | <u>24.0</u> | <u>24.0</u> | <u>32.0</u> | <u>35.5</u> | <u>36.0</u> | <u>38.0</u> |

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$H = 23.44$  d.f. = 8  $p = 0.003$

**Species diversity**

| Location  | OA          | H*          | N           | G*          | K*          | OV          | C           | E*          | G/H         |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Avg. Rank | 3.7         | 8.4         | 10.3        | 15.0        | 17.7        | 25.3        | 21.3        | 26.9        | 31.0        |
| N         | 3           | 5           | 3           | 5           | 3           | 3           | 5           | 4           | 3           |
| Median    | <u>1.60</u> | <u>2.16</u> | <u>2.08</u> | <u>2.33</u> | <u>2.44</u> | <u>2.61</u> | <u>2.52</u> | <u>2.67</u> | <u>2.87</u> |

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$H = 23.48$  d.f. = 8  $p = 0.003$

**Evenness**

| Location  | OA           | H*           | N            | K*           | OV           | G*           | E*           | G/H          | C            |
|-----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Avg. Rank | 3.7          | 10.4         | 13.2         | 16.0         | 16.3         | 19.4         | 22.2         | 26.2         | 26.2         |
| N         | 3            | 5            | 3            | 3            | 3            | 5            | 4            | 3            | 5            |
| Median    | <u>0.512</u> | <u>0.671</u> | <u>0.656</u> | <u>0.735</u> | <u>0.729</u> | <u>0.750</u> | <u>0.757</u> | <u>0.772</u> | <u>0.761</u> |

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$H = 16.2$  d.f. = 8  $p = 0.041$

Table 4. Mean abundance of fishes by size class from visual census data. Standard deviations are in parentheses. Asterisks denote location codes within proposed national park.

| Location        | < 5 cm          | 5-10 cm         | 10-15 cm       | 15-20 cm       | 20-25 cm       | > 25 cm       |
|-----------------|-----------------|-----------------|----------------|----------------|----------------|---------------|
| <u>Inshore</u>  |                 |                 |                |                |                |               |
| C               | 10.4<br>(10.9)  | 69.2<br>(9.3)   | 28.6<br>(14.3) | 2.8<br>(2.3)   | 0.8<br>(0.8)   | 0.0<br>(0.0)  |
| E*              | 0.0<br>(0.0)    | 79.0<br>(36.4)  | 83.0<br>(36.0) | 10.8<br>(4.3)  | 10.8<br>(20.2) | 1.0<br>(0.8)  |
| H*              | 4.6<br>(4.5)    | 115.6<br>(32.0) | 43.2<br>(16.7) | 2.6<br>(1.5)   | 0.0<br>(0.0)   | 0.0<br>(0.0)  |
| G*              | 24.4<br>(54.0)  | 55.6<br>(16.8)  | 54.6<br>(7.1)  | 17.0<br>(18.4) | 0.8<br>(1.1)   | 9.6<br>(19.8) |
| K*              | 55.3<br>(12.0)  | 46.3<br>(23.9)  | 46.3<br>(11.9) | 13.7<br>(15.9) | 0.0<br>(0.0)   | 0.0<br>(0.0)  |
| N               | 31.7<br>(28.0)  | 111.3<br>(20.2) | 5.7<br>(3.5)   | 0.3<br>(0.6)   | 0.0<br>(0.0)   | 0.0<br>(0.0)  |
| <u>Offshore</u> |                 |                 |                |                |                |               |
| OA              | 247.0<br>(32.4) | 75.7<br>(41.2)  | 15.3<br>(3.8)  | 4.0<br>(1.7)   | 0.0<br>(0.0)   | 0.0<br>(0.0)  |
| G/H             | 7.7<br>(11.6)   | 52.7<br>(28.9)  | 48.7<br>(9.9)  | 73.0<br>(57.7) | 5.3<br>(4.9)   | 0.0<br>(0.0)  |
| OV              | 74.7<br>(28.4)  | 79.0<br>(25.2)  | 63.3<br>(11.0) | 13.7<br>(4.7)  | 3.3<br>(1.2)   | 0.7<br>(0.6)  |
| Grand mean      | 42.5<br>(72.3)  | 76.8<br>(33.6)  | 44.2<br>(26.2) | 13.8<br>(25.4) | 2.3<br>(7.2)   | 1.6<br>(7.7)  |



Table 6. Index of relative dominance (IRD = relative frequency \* relative abundance), frequency of occurrence, and abundance for the top 25 species observed during visual censuses conducted at Ofu Island, American Samoa. Species are ordered by IRD. Common names from Randall et al. (1990). Relative frequency based on 34 visual point counts, relative abundance based on N = 6161.

| SPECIES  | Frequency of occurrence | Relative frequency | Frequency rank | Abundance | Relative abundance | Abundance rank | IRD   | IRD rank |
|--|-------------------------|--------------------|----------------|-----------|--------------------|----------------|-------|----------|
| <i>Chrysiptera taouon</i><br>South sea demoiselle      | 30                      | 88.24%             | 2              | 686       | 11.13%             | 1              | 98.25 | 1        |
| <i>Ctenochaetus striatus</i><br>Lined bristletooth     | 31                      | 91.18%             | 1              | 395       | 6.41%              | 4              | 58.46 | 2        |
| <i>Stegastes nigricans</i><br>Dusky gregory            | 20                      | 58.82%             | 11             | 421       | 6.83%              | 3              | 40.20 | 3        |
| <i>Scarus sordidus</i><br>Bullethead parrotfish        | 20                      | 58.82%             | 10             | 362       | 5.88%              | 5              | 34.56 | 4        |
| <i>Scarus species</i><br>Juvenile parrotfish           | 22                      | 64.71%             | 8              | 307       | 4.98%              | 6              | 32.24 | 5        |
| <i>Stegastes albifasciatus</i><br>Whitebar gregory     | 22                      | 64.71%             | 9              | 286       | 4.64%              | 7              | 30.04 | 6        |
| <i>Halichoeres trimaculatus</i><br>Threespot wrasse    | 22                      | 64.71%             | 6              | 149       | 2.42%              | 10             | 15.65 | 7        |
| <i>Chrysiptera leucopoma</i><br>Surge demoiselle       | 23                      | 67.65%             | 4              | 114       | 1.85%              | 13             | 12.52 | 8        |
| <i>Thalassoma hardwicke</i><br>Sixbar wrasse           | 25                      | 73.53%             | 3              | 100       | 1.62%              | 16             | 11.93 | 9        |
| <i>Thalassoma amblycephalum</i><br>Blunthead wrasse    | 8                       | 23.53%             | 41             | 206       | 3.34%              | 8              | 7.87  | 10       |
| <i>Stethojulis bandanensis</i><br>Bluelined wrasse     | 18                      | 52.94%             | 13             | 84        | 1.36%              | 18             | 7.22  | 11       |
| <i>Ptereleotris evides</i><br>Twotone dartfish         | 3                       | 8.82%              | 102            | 500       | 8.12%              | 2              | 7.16  | 12       |
| <i>Acanthurus nigrofuscus</i><br>Brown surgeonfish     | 19                      | 55.88%             | 12             | 78        | 1.27%              | 20             | 7.07  | 13       |
| <i>Scarus oviceps</i><br>Egghead parrotfish            | 17                      | 50.00%             | 15             | 80        | 1.30%              | 19             | 6.49  | 14       |
| <i>Pomacentrus vaiuli</i><br>Princess damsel           | 22                      | 64.71%             | 7              | 58        | 0.94%              | 24             | 6.09  | 15       |
| <i>Chrysiptera glauca</i><br>Grey damsel               | 11                      | 32.35%             | 23             | 101       | 1.64%              | 15             | 5.30  | 16       |
| <i>Halichoeres hortulanus</i><br>Checkerboard wrasse   | 23                      | 67.65%             | 5              | 44        | 0.71%              | 28             | 4.83  | 17       |
| <i>Acanthurus triostegus</i><br>Convict surgeonfish    | 12                      | 35.29%             | 18             | 78        | 1.27%              | 21             | 4.47  | 18       |
| <i>Acanthurus nigricans</i><br>Whitechock surgeonfish  | 10                      | 29.41%             | 28             | 88        | 1.43%              | 17             | 4.20  | 19       |
| <i>Chromis acares</i><br>Midget chromis                | 5                       | 14.71%             | 56             | 161       | 2.61%              | 9              | 3.84  | 20       |
| <i>Chromis viridis</i><br>Blue-green chromis           | 5                       | 14.71%             | 58             | 143       | 2.32%              | 11             | 3.41  | 21       |
| <i>Valenciennesa strigata</i><br>Blueband goby         | 12                      | 35.29%             | 21             | 58        | 0.94%              | 25             | 3.32  | 22       |
| <i>Acanthurus lineatus</i><br>Striped surgeonfish      | 13                      | 38.24%             | 17             | 50        | 0.81%              | 26             | 3.10  | 23       |
| <i>Plectroglyphidodon dickii</i><br>Dick's damsel      | 9                       | 26.47%             | 36             | 61        | 0.99%              | 23             | 2.62  | 24       |
| <i>Chaetodon citrinellus</i><br>Speckled butterflyfish | 17                      | 50.00%             | 14             | 32        | 0.52%              | 35             | 2.60  | 25       |



Table 7. Comparison of reef fish community statistics for inshore and offshore sites. Results of Mann-Whitney tests except for t-test results for average length of fishes (Ln(X+1) transformation).

|                           | Inshore         | Offshore |
|---------------------------|-----------------|----------|
| <u>Number of censuses</u> | 25              | 9        |
| <u>Number of fishes</u>   | median<br>157   | 262      |
| W = 362.5                 | P = 0.0036**    |          |
| <u>Number of species</u>  | median<br>26    | 35       |
| W = 385.5                 | P = 0.0438*     |          |
| <u>Species Diversity</u>  | median<br>2.435 | 2.613    |
| W = 415.0                 | P = 0.3904 ns   |          |
| <u>Evenness</u>           | median<br>0.740 | 0.729    |
| W = 456.5                 | P = 0.4701 ns   |          |
| <u>Average size</u>       | N = 3864        | N = 2297 |
|                           | mean<br>2.200   | 2.001    |
|                           | S.D.<br>0.489   | 0.541    |

t = 15.01    P < 0.001\*\*\*

ns = not significant (P > 0.05)

\* = P < 0.05

\*\* = P < 0.01

\*\*\* = P < 0.001

Figure 2. Mean length of fishes (cm) from visual census data. Codes for locations are given in Table 1. Error bars are standard deviations for each site. Asterisks denote location codes within proposed national park.

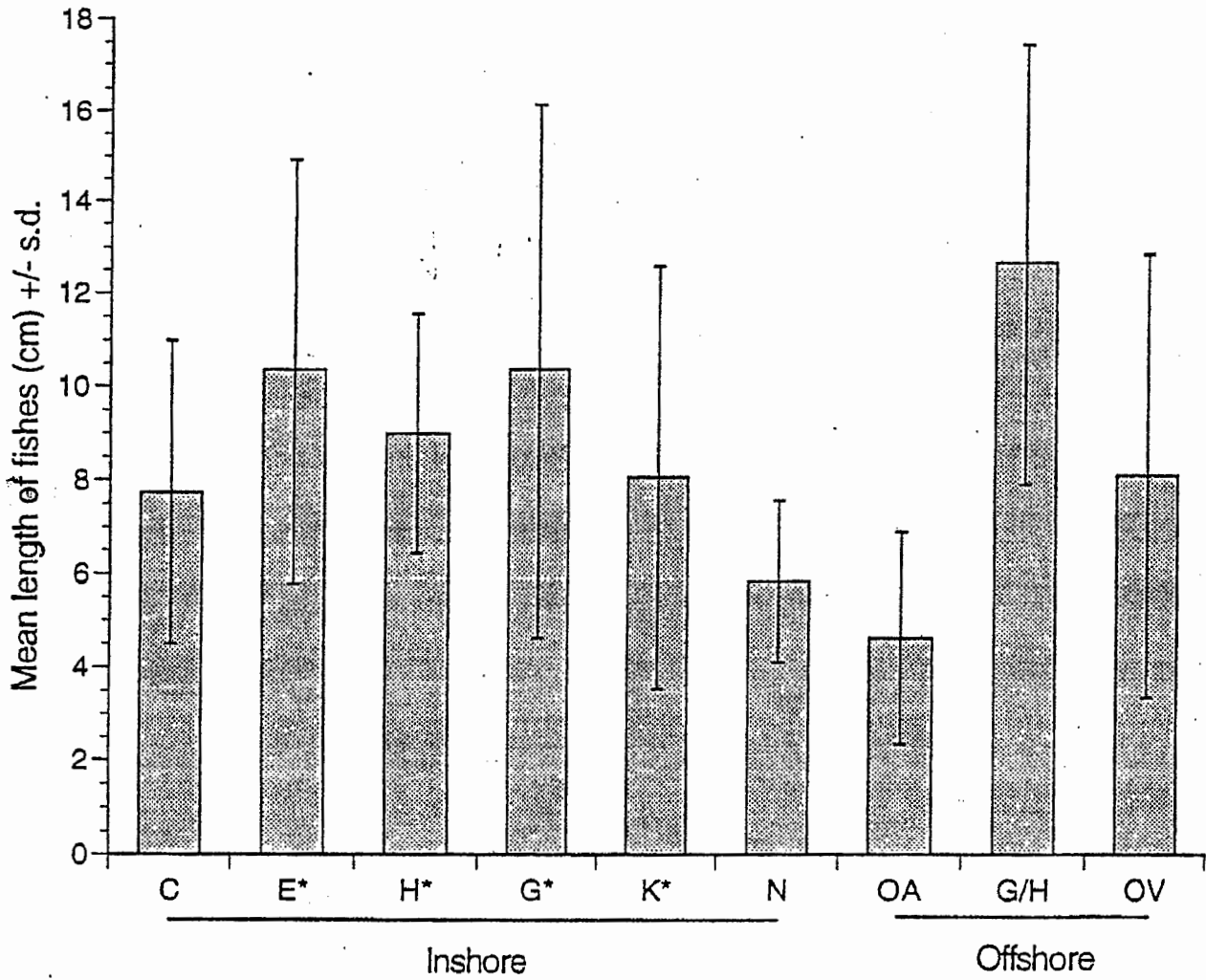
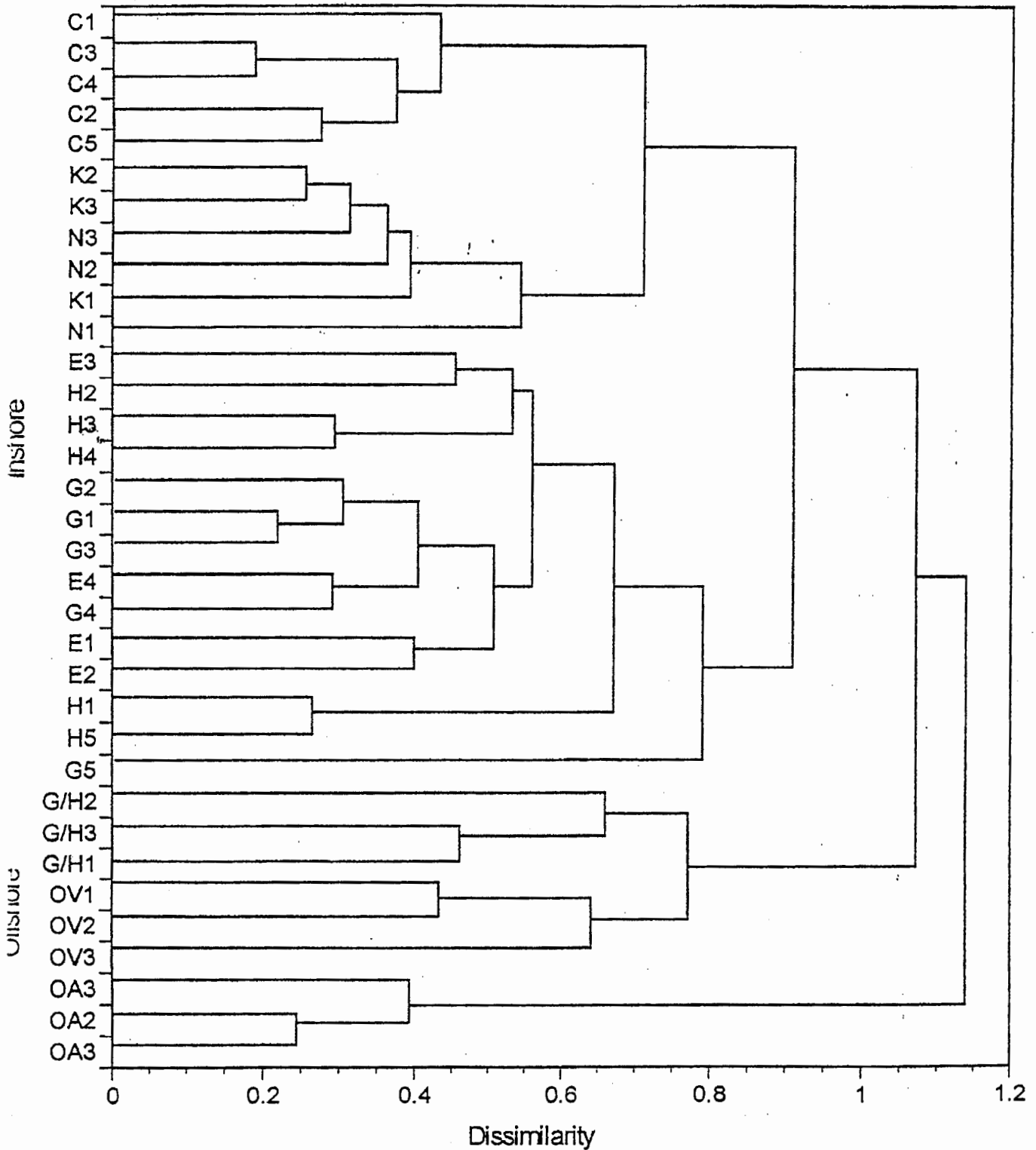


Figure 3. Dendrogram for cluster analysis of 34 stationary point counts conducted on Ofu Island, American Samoa. Bray-Curtis similarity coefficients with a flexible clustering strategy of Beta = -0.1. Details of location codes and number of censuses are given in Appendix I



## GENERAL DISCUSSION, RECOMMENDATIONS, AND MANAGEMENT OPTIONS

Marine parks, reserves and other protected areas have been established in a number of locations worldwide in an attempt to prevent habitat degradation, promote educational and recreational activities, and protect reef resources (Plan Development Team, 1990; Polunin, 1990; Roberts and Polunin, 1991). Approximately 200 coral reef habitats worldwide are now under some form of protective status (IUCN/WCMC, 1991). Monitoring programs have been developed throughout the tropics in order to develop research and management strategies for coral reef areas. The U.S. National Park Service has established long-term monitoring programs at the four National Park Service units which currently have coral reef ecosystems (Virgin Islands National Park, Buck Island Reef National Monument, Fort Jefferson National Monument, and Biscayne National Park) (Rogers, 1988). The objectives of these and similar programs are to develop standardized assessment methods, establish baseline information on coral and reef fish populations and determine natural rates of change (Rogers, 1991). The present report utilized methods similar to those developed at other national park locations, with modifications and improvements to specifically address features of the proposed park at Ofu, American Samoa.

Populations of corals, macroinvertebrates, algae, and reef fishes on Ofu's nearshore reefs appear to be in good to excellent condition in terms of health and diversity. Notable exceptions are the diseased corals at Site K, the absence or apparent decrease in number of edible sea cucumbers (*Actinopyga mauritiana* and *TheLANOTA ananas*), and the small size and wary behaviour of certain valuable reef fishes (peacock grouper and dwarf spotted grouper).

Long-term monitoring of the abundance of algae, coral, other invertebrates and fish within the park will be an important management tool. While there will probably always be disagreement among scientists as to why things change, it is very important to know accurately what changes are occurring and when. Tropical reefs in several areas in the world have been degraded due to the activities of man on land and in the ocean. The natural beauty

of Ofu has the potential to attract a large number of visitors in the future and it will be very important to know what changes occur in the marine community over time. Although the number of visitors to Ofu may not increase dramatically over the next few years, the necessary long-term approach should consider what will be happening 10, 25, or 100 years from now. It is doubtful that anyone in Hawaii 100 years ago foresaw how many people would be visiting such places as Hanauma Bay on Oahu, where daily visitors averaged around 10,000 in the early 1990's. With the goal of encouraging people to visit the park, while maintaining the pristine quality of the reef, it is useful to look at the basic conditions that maintain healthy reefs and some of the problems that have occurred in other areas of the world due to human activities.

Three critical conditions for maintaining a healthy reef at Ofu are: continued low nutrient levels, continued high fish and invertebrate grazing levels, and stable species composition. All of these are necessary for growth of the corals and coralline algae that build and maintain the reef structure.

When the growth of filamentous mat and turf forming algae is not controlled by nutrient limitation or grazing, they can rapidly increase in abundance. Algal overgrowth may severely limit the growth of reef building corals and coralline algae. Human activities that increase the amounts of nutrients entering the ocean can result in conditions that promote faster algal growth. An increase in nutrients entering the ocean could come from at least three sources:

1. An increase in nutrient concentration in groundwater moving into the ocean.
2. An increase in nutrient concentration of surface water runoff.
3. An increase in nutrients added directly to the ocean.

Of these, ground water would appear to be of the most concern. Any plans to develop visitor facilities in the park area should be done with the goal of adding *no* additional nutrients to the groundwater (e.g. from accommodations, restroom facilities). Also, any change in agricultural or horticultural practices that would involve the addition of large amounts of

fragments and new recruits) should be expected within the next 18 months. Lack of initial recovery within this time period should also signal investigation of additional stresses.

Incidence of disease or predation on corals (*Acanthaster*, *Drupella*) should be noted in all surveys.

Regular monitoring of the seaweed populations will provide early-warning of many potentially damaging impacts to the reefs at Ofu. The three areas where monitoring should be done are:

- 1. The immediate shoreline.** This is where most of the freshwater (as groundwater) enters the ocean at Ofu. Increases in the nutrient content of the groundwater are likely to first affect the immediate shoreline in areas where there is hard rock for seaweed attachment. Currently there is evidence of small nutrient inputs at several areas along the shore. These areas are sandstone embedded in the beach sand in front of the east end of the runway, in front of the lava rock outcrop about 100 m east of the runway, and at several sandstone outcrops near the hurricane house. Freshwater input in these areas is evidenced from blurring caused by fresh and seawater mixing and the presence of small thalli of green seaweeds *Enteromorpha* and *Cladophora* which are frequently associated with freshwater input areas. Although these two green seaweeds are now present only as very small thalli, less than 1 cm long, an increase in the nutrients in the ground water would allow them to increase in size. Close-up still photographs and/or video transects at these three areas at low tide along with an examination of the relative size of the seaweeds would be a simple and effective way to monitor for biological changes. The immediate shoreline is the area where human activities are most likely to increase and where any detrimental affects would likely first be observed.

- 2. Reef flat area.** An excellent method of monitoring the health of the reef flat area is to examine the growth of small filamentous and turf forming algae on corals. The ability of these small algae to overgrow living areas of corals is an easy and efficient way to monitor the "health" of the reef community. An increase in the amount of algae growing

over live coral and a resulting decrease in living coral would be a clear indication of environmental problems. An increase in seaweed populations, especially if they begin to grow over large areas of living coral, would be a clear indication that environmental conditions have changed from favoring corals to favoring seaweeds. It is probably not important to closely monitor the species of seaweeds involved, but rather their abundance as a group. These data can be extracted from the video tape and photographic records of coral and invertebrate monitoring and would require no additional field work.

**3. The reef crest.** Coralline red seaweeds are the dominant reef building organisms in this area. It is important that grazing and other factors keep the small fleshy seaweeds from overgrowing them, limiting their light supply, and therefore limiting their growth. A simple method of monitoring this areas would be at low tides when it is possible to walk safely on the exposed reef crest. Ten meter video and/or still photographic transects could be quickly and easily conducted at low tides. The areas with coralline algae alone could then be compared with the areas where fleshy or filamentous seaweeds have overgrown the coralline algae. Again, it is probably not necessary to closely monitor the species of seaweeds present, but rather the percentage of corallines alone and corallines covered by fleshy or filamentous seaweeds. A large decrease in the area with just coralline algae and a corresponding increase in the area overgrown would then suggest a reduced potential for upward reef growth.

Because of the logistical and methodological difficulties involved, and the level of resolution necessary for meaningful interpretation, water quality monitoring on Ofu is not recommended at the present time.

One of the goals of the National Park of American Samoa should be to effectively monitor and manage the shallow-water reef fishes within its jurisdiction (Clark, *et al.*, 1989). Information on the status of the fish stock and the fishery is necessary in developing proper management strategies. The Great Barrier Reef Marine Park Authority (GBRMPA, 1978) considered commercial and recreational fishing to have the most important impact on the

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Great Barrier Reef fish populations. Fish stocks are dependent on recruitment, growth rates, natural mortality, and fishing mortality. All these factors need to be considered when managing fish resources. The levels of harvest as well as the abundance of fishes need to be monitored in order to effectively manage these stocks. The questions to be addressed include the present condition of the stocks, trends and possible causes. Long-term monitoring should be formulated to best address these management objectives including biological as well as physical and chemical factors which may influence population abundance.

Fish censuses must be conducted with the financial resources available. Initial sampling should be as comprehensive as possible in order to detect seasonal changes, recruitment events, and other natural fluctuations. At a minimum, biannual sampling at permanent sites is recommended. Once these natural variations are identified, the sampling program can be scaled back as needed by personnel and financial constraints. A stratified random sampling design should be established based on mapping and identification of important and unique habitats. This should be expanded to other sites as necessary and stratified by microhabitat. Sample size should be determined statistically based on preliminary samples for which variances can be measured (Kimmel, 1992, Bohnsack *et al.*, 1992). Visual censuses should be conducted in habitats on a proportional basis to the overall microhabitat variation. Two or more observers should be used during visual censusing to increase sample size, reduce spatial variability, and improve statistical power (Beets and Friedlander, 1990). When possible, the same person/persons should conduct the monitoring to reduce observer bias over time. Censuses of offshore populations should be included to track changes in the larger fisheries-related species and to determine differences in assemblage structure among locations.

Sampling of fishing activity will provide information on relative abundance of the resources, species composition, and trends in the fishery. This data set should include information on catch and effort by species, area, and gear type. Additional information on individual species, such as length, weight, age and growth, and reproductive state will help to develop stock assessment models that are needed for effective management of the resources.



Due to the small area covered by the proposed park, comprehensive sampling of fishing effort, catch, and species composition could be performed under a modest sampling program. Interviews with fishers should be conducted on a regular basis to obtain catch and effort information. Monitoring of fishing effort could be accomplished in conjunction with other activities such as ranger patrols or during biological sampling trips through direct observations. Positive interaction with the local fishing community is essential in obtaining cooperation and accuracy in fisheries data collection.

The proposed park at Ofu has great potential to function as a protected area and provide a framework for demonstration of successful fisheries management strategies (Beets and Rogers, 1991). Management of the resources should include some types of restrictions on fishing effort within the park area. These restrictions, however, should not adversely affect the local community. Management options include gear restrictions (minimum mesh size, banning of destructive gears such as poisons, chemicals, and explosives), closed seasons once spawning periodicity of target species is known, restrictions to insure spawning success, and closed areas that can act as refuges and accumulate fish through high survival of recruits as well as immigration and retention (Parrish *et al.*, 1990).

Limiting fishing within the park should be based on high quality data and should only be undertaken with the participation and cooperation of the local fishers (Beets and Rogers, 1991). Management strategies should attempt to respect local cultures and traditions while ensuring conservation of the natural resources. The most effective marine reserves have had local involvement, public input, and education programs (Craik, 1981; Alcala, 1988; Kenchington, 1988; Plan Development Team, 1990). Fisheries management was traditionally practiced throughout Oceania prior to the arrival of European culture (Johannes, 1978, 1981; Titcomb, 1972). Principles of conservation were very strong in these cultures. Traditional village fisheries management practices included closed fishing areas and seasons along with prohibition of wanton waste. Management strategies were patterned as much as possible after local customs and beliefs in order to elicit public support (Johannes, 1978). Westernization

and changes in traditional cultural norms will require public education at all levels to sustain the fisheries and the resources.

In the southeast U.S., The Plan Development Team (1990) recommended a mixed management strategy for reef fish where 20% of the habitat was in the form of fisheries reserves and the remaining 80% managed by traditional methods to optimize yield. Simulation models suggest that closures of 10% of the total available habitat may enhance the spawning stock biomass of moderately vagile species such as surgeonfishes but larger areas are needed for species such as jacks which possess high transfer rates (DeMartini, 1993). Information on movement and exchange rates of major fish taxon are needed to accurately evaluate the effects of proposed refuge areas (Polacheck, 1990). The relatively small size of the national park area at Ofu suggests that the entire area within park boundaries be set aside as a fisheries reserve.

The establishment of a National Marine Sanctuary at Fagatele Bay on Tutuila and the associated public education program has helped to identify the cultural, historical, and biological links between Samoans and their marine environment (Thomas, 1988). Traditional social structure and use patterns were incorporated into the sanctuary process by respecting lineage and hierarchical social structure (Friske, 1992). This has made the implementation of the sanctuary at Fagatele Bay more acceptable to all parties concerned, and a similar incorporation by the National Park Service in developing plans for the Ofu component of the park is strongly supported.

It is essential that local fishers be integrated into the management process (Rogers and Teytaud, 1988; Koester, 1986; Moore, 1992). Their incorporation into the research process, information exchange and management strategies will help to insure accuracy of information, sensitivity to cultural needs and cooperation with regulations for the National Park of American Samoa.

When possible, DMWR and/or USNPS personnel should be trained to conduct Ofu reef surveys. Until such personnel are available, monitoring services can be contracted

through universities or marine biological consultants with experience and expertise in the area. A log for anecdotal reports should be established for reports/ observations by visitors and local fisherman; this log could be maintained by (and with the permission of) the Vaoto Lodge. Entries might include such observations as *Acanthaster* or *Drupella* predation on coral, unusual weather events or storms, or unusual changes in seawater temperatures, all of which would be useful in monitoring the reef communities of Ofu.

Other recommendations center on public awareness and education. It would be useful to develop a pamphlet to inform park visitors about potential dangers (e.g. currents, sharp corals, sharks, eels), as well as about environmentally responsible behavior and appropriate "reef etiquette". Hundreds of visitors walking on or bumping into the corals will certainly cause considerable damage and it is important to educate the public about this risk. A small book on the natural history of the park would be helpful in providing a way to identify the most common or unusual species and to provide written information that visitors would find interesting. Interpretive snorkel tours would be an excellent method of exposing visitors to the wonders and complexities of coral reef ecosystems.

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Appendix I. Locations of individual censuses conducted on Ofu Island, American Samoa. Censuses are referenced into sites where permanent transect are present. The second letter of the transect code refers to the east (E) or west (W) end of the transect. Asterisks denote location codes within proposed national park.

| Location code         | Census Number | Location relative to transect |
|-----------------------|---------------|-------------------------------|
| <u>Inshore</u>        |               |                               |
| C                     | 1             | At transect                   |
| C                     | 2             | 10m 315° from CE              |
| C                     | 3             | 10m 210° from CE              |
| C                     | 4             | 10m 30° from CW               |
| C                     | 5             | 10m 90° from CW               |
| E*                    | 6             | 15m 210° from EE              |
| E*                    | 7             | 10m 50° from EE               |
| E*                    | 8             | At transect                   |
| E*                    | 9             | 10m 40° from EW               |
| H*                    | 10            | 10m 270° from HW              |
| H*                    | 11            | 10m 180° from HW              |
| H*                    | 12            | 10m 150° from HE              |
| H*                    | 13            | 10m 130° from HW              |
| H*                    | 14            | At transect                   |
| G*                    | 15            | At transect                   |
| G*                    | 16            | 10m 150° from GE              |
| G*                    | 17            | 15m 230° from GW              |
| G*                    | 18            | 10m 120° from GE              |
| G*                    | 19            | 10m 10° from GE               |
| K*                    | 20            | 10m 150° from KE              |
| K*                    | 21            | 10m 180° from KE              |
| K*                    | 22            | 10m 260° from KW              |
| N                     | 23            | 10m 70° from NE               |
| N                     | 24            | 10m 100° from NE              |
| N                     | 25            | At transect                   |
| <u>Offshore</u>       |               |                               |
| Offshore airport (OA) | 26            | N/A                           |
| Offshore airport (OA) | 27            | N/A                           |
| Offshore airport (OA) | 28            | N/A                           |
| G/H                   | 29            | N/A                           |
| G/H                   | 30            | N/A                           |
| G/H                   | 31            | N/A                           |
| Ofu Village (OV)      | 32            | N/A                           |
| Ofu Village (OV)      | 33            | N/A                           |
| Ofu Village (OV)      | 34            | N/A                           |

**Appendix II. Abundance and distribution of corals and macroinvertebrates  
at nine reef sites on Ofu, American Samoa, September, 1992.**

**Site C**

**Site E**

**Site G**

**Site H**

**Site K**

**Site N**

**Site OA**

**Site GH**

**Site OV**

| OFU DATA SUMMARY--COMPARISON OF RESULTS USING DIFFERENT SURVEY METHODS |          |          |                 |          |          |          |              |                |               |               |              |
|--|----------|----------|-----------------|----------|----------|----------|--------------|----------------|---------------|---------------|--------------|
| -- data not recorded   |          |          |                 |          |          |          |              |                |               |               |              |
| DATA SOURCE: VIDEO TRANSECTS   |          |          |                 |          |          |          |              |                |               |               |              |
| 3 PARALLEL 10 M TRANSECTS, 10 FRAMES EACH, 30 POINTS/FRAME             |          |          |                 |          |          |          |              |                |               |               |              |
|  |          |          |                 |          |          |          |              | OFFSHORE SITES |               |               |              |
| <u>SITES:</u>  | <u>C</u> | <u>E</u> | <u>G</u>        | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>G/H</u>    | <u>OFU V.</u> |              |
| CORALS #SPP.   | 29       | 26       | 23              | 25       | 12       | 21       | 22.67        |                | Analyses      |               |              |
| % COVER  | 10.3     | 17.33    | <del>18.3</del> | 30.4     | 23.9     | 6.7      | 17.91        |                | not performed |               |              |
| SUBSTRATUM   | 80.56    | 67.3     | 72.9            | 52.3     | 65.6     | 78.7     | 69.56        |                |               |               |              |
| RUBBLE   | 4.4      | 1.3      | 10.4            | 23.7     | 14.9     | 33.9     | 14.77        |                |               |               |              |
| SAND   | 49.4     | 31.3     | 36.2            | 5.2      | 35.3     | 14.7     | 28.68        |                |               |               |              |
| ALGAE  | 6.2      | 13.78    | 10.3            | 17.3     | 10.3     | 14.7     | 12.10        |                |               |               |              |
| TURF   | 6.2      | 13.8     | 10.3            | 17.3     | 10.3     | 13.6     | 11.92        |                |               |               |              |
| INVERTS  | 2.8      | 1.6      | 0.1             | 0        | 0        | 0        | 0.75         |                |               |               |              |
| DATA SOURCE: VISUAL FIELD ESTIMATE                                     |          |          |                 |          |          |          |              |                |               |               |              |
|  |          |          |                 |          |          |          |              | OFFSHORE SITES |               |               |              |
| <u>SITES:</u>  | <u>C</u> | <u>E</u> | <u>G</u>        | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>G/H</u>    | <u>OFU V.</u> | <u>MEANS</u> |
| CORALS #SPP.   | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| % COVER  | 10       | 15       | 25              | 30       | 10       | 5        | 15.83        | 5              | 40            | 30            | 25.00        |
| SUBSTRATUM   |          |          |                 |          |          |          |              |                |               |               |              |
| RUBBLE   | 20       | 5        | 10              | 15       | 30       | 20       | 16.67        | 2              | 20            | 20            | 14.00        |
| SAND   | 50       | 20       | 40              | 20       | 30       | 60       | 36.67        | 18             | 5             | 5             | 9.33         |
| ALGAE  | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| TURF   | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| INVERTS  | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| DATA SOURCE: 50 M PERPENDICULAR LINEAR/BELT TRANSECT                   |          |          |                 |          |          |          |              |                |               |               |              |
|  |          |          |                 |          |          |          |              | OFFSHORE SITES |               |               |              |
| <u>SITES:</u>  | <u>C</u> | <u>E</u> | <u>G</u>        | <u>H</u> | <u>K</u> | <u>N</u> | <u>MEANS</u> | <u>Airport</u> | <u>G/H</u>    | <u>OFU V.</u> | <u>MEANS</u> |
| CORALS #SPP.   | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| % COVER  | 5.98     | 18.33    | 11.08           | 4.96     | 0.36     | 0.76     | 6.91         | 2.04           | 14.34         | 9.20          | 8.53         |
| SUBSTRATUM   | 88.95    | 73.37    | 81.10           | 92.80    | 87.34    | 87.04    | 81.10        | 79.96          | 85.32         | 69.92         | 78.40        |
| RUBBLE   | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| SAND   | --       | --       | --              | --       | --       | --       | --           | --             | --            | --            | --           |
| ALGAE  | 5.08     | 6.60     | 5.18            | 1.40     | 12.10    | 12.20    | 7.09         | 18.00          | 0.34          | 20.20         | 12.85        |
| TURF   | 3.75     | 6.00     | 5.14            | 0.50     | 12.00    | 0.80     | 4.70         | 16.00          | 0.20          | 20.20         | 12.13        |
| INVERTS  | 0.51     | 0.17     | 0.07            | 0.09     | 0.12     | 0.02     | 0.16         | 0.26           | 0.01          | 0.02          | 0.10         |

Ofu Reef Survey--1992

| Benthic Macro-Invertebrate Abundance            |                 |                  |                |                  |                |                  |                |
|---|-----------------|------------------|----------------|------------------|----------------|------------------|----------------|
| DATA SOURCE: VIDEO TRANSECTS                    |                 |                  |                |                  |                |                  |                |
| Offshore Sites                                  |                 |                  |                |                  |                |                  |                |
|   |                 | Airport          |                | G/H              |                | Ofu Village      |                |
| (Offshore Video Analyses Not Performed)         |                 |                  |                |                  |                |                  |                |
| DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT |                 |                  |                |                  |                |                  |                |
|   | Size            | Total            | % Cover        | Total            | % Cover        | Total            | % Cover        |
|   | cm <sup>2</sup> | #/m <sup>2</sup> | m <sup>2</sup> | #/m <sup>2</sup> | m <sup>2</sup> | #/m <sup>2</sup> | m <sup>2</sup> |
| Holo. atra                                      | 63.00           | .000             | .000           | .000             | .000           | .000             | .000           |
| Holo. nobilis                                   | 312.00          | .000             | .000           | .000             | .000           | .000             | .000           |
| Stichopus                                       | 63.00           | .000             | .000           | .000             | .000           | .000             | .000           |
| Bohadschia                                      | 123.75          | .000             | .000           | .000             | .000           | .000             | .000           |
| Acanthaster                                     | 706.00          | .000             | .000           | .000             | .000           | .000             | .000           |
| Tridacna  | 25.50           | .000             | .000           | .008             | .002           | .004             | .001           |
| Diadema   | 15.90           | .000             | .000           | .000             | .000           | .000             | .000           |
| Echinothrix                                     | 1.75            | 15.004           | .263           | .000             | .000           | .004             | .000           |
| Trochus   | 50.25           | .000             | .000           | .008             | .004           | .032             | .016           |
| Drupella  | 0.50            | .000             | .000           | .004             | .000           | .028             | .000           |
| Vermetid  | 1.75            | .000             | .000           | .000             | .000           | .000             | .000           |
| Turbo   | 3.00            | .004             | .000           | .000             | .000           | .004             | .000           |
| Conus   | 10.00           | .000             | .000           | .000             | .000           | .012             | .001           |
| Spider conch                                    | 352.80          | .000             | .000           | .000             | .000           | .000             | .000           |
| Spirobranchus                                   | 0.80            | .000             | .000           | .000             | .000           | .000             | .000           |
| Total   |                 | 15.01            | 0.26           | 0.02             | 0.01           | 0.08             | 0.02           |

Ofu Reef Survey--1992

| Benthic Macro-Invertebrate Abundance            |        |       |         |         |        |         |    |         |         |   |       |         |  |
|---|--------|-------|---------|---------|--------|---------|----|---------|---------|---|-------|---------|--|
| DATA SOURCE: VIDEO TRANSECTS                    |        |       |         |         |        |         |    |         |         |   |       |         |  |
|   | SITE H |       |         |         | SITE K |         |    |         | SITE N  |   |       |         |  |
|   |        |       |         | Average |        |         |    | Average |         |   |       | Average |  |
| Transects:                                      | 1      | 2     | 3       | Areal   | 1      | 2       | 3  | Areal   | 1       | 2 | 3     | Areal   |  |
|   |        |       |         | % Cover |        |         |    | % Cover |         |   |       | % Cover |  |
| Holo. atra                                      | 0      | 0     | 0       | 0.00    | 2      | 0       | 0  | 0.22    | 0       | 0 | 0     | 0.00    |  |
| Holo. nobilis                                   | 0      | 1     | 0       | 0.11    | 1      | 0       | 0  | 0.11    | 0       | 1 | 0     | 0.11    |  |
| Stichopus                                       | 0      | 0     | 0       | 0.00    | 0      | 2       | 2  | 0.44    | 0       | 0 | 0     | 0.00    |  |
| Bohadschia                                      | 1      | 0     | 1       | 0.22    | 0      | 3       | 2  | 0.56    | 1       | 0 | 1     | 0.22    |  |
| Acanthaster                                     | 11     | 0     | 0       | 1.22    | 0      | 0       | 13 | 1.44    | 11      | 0 | 0     | 1.22    |  |
| Tridacna  | 0      | 0     | 0       | 0.00    | 0      | 0       | 0  | 0.00    | 0       | 0 | 0     | 0.00    |  |
| Urchin  | 0      | 0     | 0       | 0.00    | 0      | 0       | 0  | 0.00    | 0       | 0 | 0     | 0.00    |  |
| Trochus   | 0      | 0     | 0       | 0.00    | 0      | 0       | 0  | 0.00    | 0       | 0 | 0     | 0.00    |  |
|   |        |       |         | 1.56    |        |         |    | 2.78    |         |   |       | 1.56    |  |
| DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT |        |       |         |         |        |         |    |         |         |   |       |         |  |
|   | Size   | Total |         |         | Total  |         |    | Total   |         |   | Total |         |  |
|   | cm2    | #/m2  | % Cover |         | #/m2   | % Cover |    | #/m2    | % Cover |   | #/m2  | % Cover |  |
| Holo. atra                                      | 63.00  | .000  | .000    |         | .004   | .003    |    | .008    | .005    |   | .008  | .005    |  |
| Holo. nobilis                                   | 312.00 | .008  | .025    |         | .000   | .000    |    | .004    | .012    |   | .004  | .012    |  |
| Stichopus                                       | 63.00  | .000  | .000    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Bohadschia                                      | 123.75 | .028  | .035    |         | .076   | .094    |    | .000    | .000    |   | .000  | .000    |  |
| Acanthaster                                     | 706.00 | .004  | .028    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Tridacna  | 25.50  | .004  | .001    |         | .020   | .005    |    | .000    | .000    |   | .000  | .000    |  |
| Diadema   | 15.90  | .036  | .006    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Echinothrix                                     | 1.75   | .000  | .000    |         | .004   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Trochus   | 50.25  | .000  | .000    |         | .004   | .002    |    | .000    | .000    |   | .000  | .000    |  |
| Drupella  | 0.50   | .000  | .000    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Vermetid  | 1.75   | .000  | .000    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Turbo   | 3.00   | .000  | .000    |         | .000   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Conus   | 10.00  | .000  | .000    |         | .004   | .000    |    | .000    | .000    |   | .000  | .000    |  |
| Spider conch                                    | 352.80 | .000  | .000    |         | .004   | .014    |    | .000    | .000    |   | .000  | .000    |  |
| Spirobranchus                                   | 0.80   | .000  | .000    |         | .000   | .000    |    | .004    | .000    |   | .004  | .000    |  |
| Total   |        | 0.08  | 0.09    |         | 0.12   | 0.12    |    | 0.02    | 0.02    |   | 0.02  | 0.02    |  |

Ofu Reef Survey--1992

| Benthic Macro-Invertebrate Abundance            |                         |                           |         |                             |                           |         |   |                             |         |   |    |                             |
|---|-------------------------|---------------------------|---------|-----------------------------|---------------------------|---------|---|-----------------------------|---------|---|----|-----------------------------|
| DATA SOURCE: VIDEO TRANSECTS                    |                         |                           |         |                             |                           |         |   |                             |         |   |    |                             |
|   | SITE C                  |                           |         |                             | SITE E                    |         |   |                             | SITE G  |   |    |                             |
| Transects:                                      | 1                       | 2                         | 3       | Average<br>Areal<br>% Cover | 1                         | 2       | 3 | Average<br>Areal<br>% Cover | 1       | 2 | 3  | Average<br>Areal<br>% Cover |
| Holo. atra                                      | 2                       | 0                         | 0       | 0.22                        | 0                         | 0       | 0 | 0.00                        | 2       | 0 | 0  | 0.22                        |
| Holo. nobilis                                   | 1                       | 0                         | 0       | 0.11                        | 0                         | 1       | 0 | 0.11                        | 1       | 0 | 0  | 0.11                        |
| Stichopus                                       | 0                       | 2                         | 2       | 0.44                        | 0                         | 0       | 0 | 0.00                        | 0       | 2 | 2  | 0.44                        |
| Bohadschia                                      | 0                       | 3                         | 2       | 0.56                        | 1                         | 0       | 1 | 0.22                        | 0       | 3 | 2  | 0.56                        |
| Acanthaster                                     | 0                       | 0                         | 13      | 1.44                        | 11                        | 0       | 0 | 1.22                        | 0       | 0 | 13 | 1.44                        |
| Tridacna  | 0                       | 0                         | 0       | 0.00                        | 0                         | 0       | 0 | 0.00                        | 0       | 0 | 0  | 0.00                        |
| Urchin  | 0                       | 0                         | 0       | 0.00                        | 0                         | 0       | 0 | 0.00                        | 0       | 0 | 0  | 0.00                        |
| Trochus   | 0                       | 0                         | 0       | 0.00                        | 0                         | 0       | 0 | 0.00                        | 0       | 0 | 0  | 0.00                        |
| Total   |                         |                           |         | 2.78                        |                           |         |   | 1.56                        |         |   |    | 2.78                        |
| DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT |                         |                           |         |                             |                           |         |   |                             |         |   |    |                             |
|   | Size<br>cm <sup>2</sup> | Total<br>#/m <sup>2</sup> | % Cover |                             | Total<br>#/m <sup>2</sup> | % Cover |   | Total<br>#/m <sup>2</sup>   | % Cover |   |    |                             |
| Holo. atra                                      | 63.00                   | .020                      | .0126   |                             | .020                      | .0126   |   | .000                        | .000    |   |    |                             |
| Holo. nobilis                                   | 312.00                  | .005                      | .0156   |                             | .007                      | .0218   |   | .012                        | .037    |   |    |                             |
| Stichopus                                       | 63.00                   | .690                      | .4347   |                             | .087                      | .0548   |   | .000                        | .000    |   |    |                             |
| Bohadschia                                      | 123.75                  | .035                      | .0433   |                             | .027                      | .0334   |   | .016                        | .020    |   |    |                             |
| Acanthaster                                     | 706.00                  | .000                      | .0000   |                             | .007                      | .0494   |   | .000                        | .000    |   |    |                             |
| Tridacna  | 25.50                   | .000                      | .0000   |                             | .000                      | .0000   |   | .036                        | .009    |   |    |                             |
| Diadema   | 15.90                   | .005                      | .0008   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Echinothrix                                     | 1.75                    | .000                      | .0000   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Trochus   | 50.25                   | .000                      | .0000   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Drupella  | 0.50                    | .015                      | .0001   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Vermetid  | 1.75                    | .000                      | .0000   |                             | .007                      | .0001   |   | .000                        | .000    |   |    |                             |
| Turbo   | 3.00                    | .000                      | .0000   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Conus   | 10.00                   | .000                      | .0000   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Spider conch                                    | 352.80                  | .000                      | .0000   |                             | .000                      | .0000   |   | .000                        | .000    |   |    |                             |
| Spirobranchus                                   | 0.80                    | .000                      | .0000   |                             | .020                      | .0002   |   | .004                        | .000    |   |    |                             |
| Total   |                         | 0.77                      | 0.51    |                             | 0.18                      | 0.17    |   | 0.07                        | 0.07    |   |    |                             |

SITE C

OFU 9/92

Video Transect Data

Visual Field Estimates of

Relative Coral Abundance

(multiple entries for >1

species within family/type)

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame = 300 points/transect)

| CORALS                  | Transects:             | 1 2 3         |           |           | Mean           | Mean                | Mean                | Visual Field Estimates of<br>Relative Coral Abundance<br>(multiple entries for >1<br>species within family/type)<br>5 = >80% 4 = 31-80%<br>3 = 11-30% 2 = 6-10%<br>1 = 1-5% |
|-------------------------|------------------------|---------------|-----------|-----------|----------------|---------------------|---------------------|---|
|                         |                        | (# of Points) |           |           | Point<br>Cover | % Cover<br>of Total | % Cover<br>of Coral |   |
| <i>Massive</i>          | <u>Porites</u>         | 13            | 29        | 7         | 16.3           | 5.44                | 52.71               | 3   |
|                         | <u>Favidae</u>         | 0             | 18        | 15        | 11.0           | 3.67                | 35.50               | 2+1+1+1+1   |
|                         | Other                  | 0             | 0         | 2         | 0.7            | 0.22                | 2.15                | 1+1+1   |
| <i>Encrusting</i>       | <u>Pavona</u>          | 0             | 0         | 2         | 0.7            | 0.22                | 2.15                | 1   |
|                         | Other                  | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 2+1+1+1   |
| <i>Branching</i>        | <u>Porites</u>         | 1             | 0         | 0         | 0.3            | 0.11                | 1.08                | 1   |
|                         | <u>Acropora</u>        | 0             | 0         | 1         | 0.3            | 0.11                | 1.08                | 1+1+1+1+1   |
|                         | <u>Pocillopora</u>     | 0             | 4         | 1         | 1.7            | 0.56                | 5.38                | 2+1+1   |
|                         | Other                  | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 0   |
| <i>Plates</i>           |                        | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 0   |
| <i>Other</i>            | <u>Galaxea, Fungia</u> | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 1+1   |
| <u>Millepora</u>        |                        | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 3+1   |
| <u>Helipora</u>         |                        | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 1   |
| Soft Corals             |                        | 0             | 0         | 0         | 0.0            | 0.00                | 0.00                | 0   |
| <b>Coral sub-total:</b> |                        | <b>14</b>     | <b>51</b> | <b>28</b> | <b>7</b>       | <b>10.33</b>        | <b>100.03</b>       | <b>Types:Species<br/>11:29</b>  |

| SUBSTRATUM                   |                | Points     | Mean       | % Total    | % Category   |              |              |
|------------------------------|----------------|------------|------------|------------|--------------|--------------|--------------|
|                              | Sand           | 121        | 193        | 131        | 148.3        | 49.44        | 61.38        |
|                              | Hard           | 0          | 0          | 9          | 3.0          | 1.00         | 1.24         |
|                              | Fine Sand/Turf | 116        | 37         | 78         | 77.0         | 25.67        | 31.86        |
|                              | Rubble         | 18         | 7          | 15         | 13.3         | 4.44         | 5.52         |
| <b>Substratum sub-total:</b> |                | <b>255</b> | <b>237</b> | <b>233</b> | <b>241.7</b> | <b>80.56</b> | <b>99.99</b> |

|                         |             |           |          |           |             |             |               |
|-------------------------|-------------|-----------|----------|-----------|-------------|-------------|---------------|
| ALGAE                   | Filamentous | 0         | 0        | 0         | 0.0         | 0.00        | 0.00          |
|                         | Macro       | 0         | 0        | 0         | 0.0         | 0.00        | 0.00          |
|                         | Turf        | 28        | 7        | 21        | 18.7        | 6.22        | 100.00        |
|                         | Halimeda    | 0         | 0        | 0         | 0.0         | 0.00        | 0.00          |
|                         | Blue-greens | 0         | 0        | 0         | 0.0         | 0.00        | 0.00          |
| <b>Algae sub-total:</b> |             | <b>28</b> | <b>7</b> | <b>21</b> | <b>18.7</b> | <b>6.22</b> | <b>100.00</b> |

|                          |                              |          |          |           |            |             |              |
|--------------------------|------------------------------|----------|----------|-----------|------------|-------------|--------------|
| INVERTS                  | <u>Holothuria atra</u>       | 2        | 0        | 0         | 0.7        | 0.22        | 7.99         |
|                          | <u>Holothuria nobilis</u>    | 1        | 0        | 0         | 0.3        | 0.11        | 4.00         |
|                          | <u>Stichopus chloronotus</u> | 0        | 2        | 2         | 1.3        | 0.44        | 15.99        |
|                          | <u>Bohadschia argus</u>      | 0        | 3        | 2         | 1.7        | 0.56        | 19.98        |
|                          | <u>Acanthaster planci</u>    | 0        | 0        | 13        | 4.3        | 1.44        | 51.96        |
|                          | <u>Tridacna sp.</u>          | 0        | 0        | 0         | 0.0        | 0.00        | 0.00         |
|                          | Urchins                      | 0        | 0        | 0         | 0.0        | 0.00        | 0.00         |
|                          | <u>Trochus</u>               | 0        | 0        | 0         | 0.0        | 0.00        | 0.00         |
| <b>Invert sub-total:</b> |                              | <b>3</b> | <b>5</b> | <b>17</b> | <b>8.3</b> | <b>2.78</b> | <b>99.92</b> |

Site C

|                                      |                       |                |                       |                           |
|--------------------------------------|-----------------------|----------------|-----------------------|---------------------------|
| Site                                 | C                     |                | Depth: 0.1-1.2 m      |                           |
| Date                                 | 9/12/92               |                | Slope: 0 degrees      |                           |
| Time                                 | 9:00                  |                |                       |                           |
| <b>Substratum Type:</b>              |                       |                |                       |                           |
| % hard substratum                    |                       | 30%            | live coral            | 10%                       |
|                                      |                       |                | reef pavement         | 20%                       |
| % rubble                             |                       | 20%            |                       |                           |
| % sand                               |                       | 50%            |                       |                           |
| <b>Relative Abundance of Corals:</b> |                       |                | <b>Abundance Key:</b> |                           |
|                                      |                       |                |                       | 5= >80% 4= 31-80%         |
|                                      |                       |                |                       | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose             | fine branches  |                       |                           |
| Acropora                             | cespitose             | stout branches |                       |                           |
| Acropora                             | corymbose             | fine branches  | 1                     |                           |
| Acropora                             | corymbose             | stout branches | 1                     |                           |
| Acropora                             | thicket               |                | 1                     |                           |
| Acropora (Isopora)                   | cuneata               |                | 1                     |                           |
| Acropora (Isopora)                   | palifera              |                | 1                     |                           |
| Astreopora                           | myriophthalma         |                | 1                     |                           |
| Coscinarea                           | columna               |                | 1                     |                           |
| Cyphastrea                           | massive               |                | 1                     |                           |
| Diploastrea                          | heliopora             |                |                       |                           |
| Favia                                | stelligera            |                | 1                     |                           |
| Favia                                | massive               |                | 2                     |                           |
| Favites                              | massive               |                |                       |                           |
| Fungia                               | fungites              |                |                       |                           |
| Fungia                               | scutaria              |                | 1                     |                           |
| Galaxea                              | fascicularis          |                | 1                     |                           |
| Goniastrea                           | pectinata             |                |                       |                           |
| Goniastrea                           | retiformis            |                | 1                     |                           |
| Heliopora                            | coerulea              |                | 1                     |                           |
| Hydnophora                           | exesa                 |                |                       |                           |
| Hydnophora                           | microconus            |                |                       |                           |
| Leptastrea                           | massive               |                | 1                     |                           |
| Leptoria                             | phyrgia               |                | 1                     |                           |
| Lobophyllia                          | hemprichi             |                |                       |                           |
| Millepora                            | branching (dichotoma) |                | 3                     |                           |
| Millepora                            | encrusting            |                | 1                     |                           |
| Millepora                            | plates (platyphylla)  |                |                       |                           |
| Montipora                            | encrusting            |                | 2                     |                           |
| Montipora                            | cf informis           |                | 1                     |                           |
| Montipora                            | tuberculosa           |                | 1                     |                           |
| Mycedium                             | elephantotum          |                |                       |                           |
| Pavona                               | divaricata            |                | 1                     |                           |
| Pavona                               | varians               |                | 1                     |                           |
| Pavona                               | venosa                |                |                       |                           |



Site C

|  |             |                 |             |                                     |
|--|-------------|-----------------|-------------|-------------------------------------|
| Platygyra  | daedalea    |                 |             |                                     |
| Pocillopora  | damicornis  |                 |             | 2                                   |
| Pocillopora  | eydouxii    |                 |             |                                     |
| Pocillopora  | meandrina   |                 |             | 1                                   |
| Pocillopora  | verrucosa   |                 |             | 1                                   |
| Porites  | branched    | (annae)         |             | 1                                   |
| Porites  | branched    | (cylindrica)    |             |                                     |
| Porites  | encrusting  | (lichen)        |             | 1                                   |
| Porites  | lobate      | (lobata/lutea)  |             | 3                                   |
| Porites  | rus         |                 |             |                                     |
| Sarcophyton  | sp          |                 |             |                                     |
| Sinularia  | sp          |                 |             |                                     |
| Stylophora   | pistillata  |                 |             |                                     |
| Turbinaria   | reniformis  |                 |             |                                     |
|  |             | No. Species     |             | 29                                  |
|  |             | Abundance Index |             | 36                                  |
| <u>Benthic Organisms (cm per 40 m line intercept transect)</u> |             |                 |             |                                     |
|  |             |                 |             |                                     |
| Coral  |             |                 | 239         |                                     |
| Turf algae   |             |                 | 150         |                                     |
| Macro algae  |             |                 | 33          | (Halimeda=23, green filamentous=10) |
| Bluegreen mat  |             |                 | 20          |                                     |
| Other (sand, rubble, calcareous)                               |             |                 | 3558        |                                     |
| Total organisms/transect                                       |             |                 | 442         |                                     |
| Total cm/transect  |             |                 | 4000        |                                     |
|  |             |                 |             |                                     |
| <u>Macro Invertebrates (per 40 x 5 m belt transect)</u>        |             |                 |             |                                     |
|  |             | total number    | #/sq. meter |                                     |
| Diadema  | sp          | 1               | 0.005       |                                     |
| Holothuria   | atra        | 4               | 0.020       |                                     |
| Holothuria   | nobilis     | 1               | 0.005       |                                     |
| Stichopus  | chloronotus | 138             | 0.690       |                                     |
| Bohadschia   | argus       | 7               | 0.035       |                                     |
| Drupella   | sp          | 3               | 0.015       |                                     |

SITE E

Ofu 9/92

Video Transect Data

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame = 300 points/transect)

Visual Field Estimates of

Relative Coral Abundance

(multiple entries for >1

species within family/type)

Mean Mean Mean

Point % Cover % Cover

Cover of Total of Coral

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

CORALS

Transects:

1 2 3

(# of points)

TYPES:

Massive

Porites

35 4 10 16.3 5.44 31.42

Favidae

0 0 15 5.0 1.67 9.62

Other

0 0 2 0.7 0.22 1.28

Encrusting

Pavona

5 0 0 1.7 0.56 3.21

Other

0 0 0 0.0 0.00 0.00

Branching

Porites

11 4 8 7.7 2.56 14.75

Acropora

14 0 4 6.0 2.00 11.54

Pocillopora

5 1 10 5.3 1.78 10.26

Other

0 0 0 0.0 0.00 0.00

Plates

0 0 0 0.0 0.00 0.00

Other

Galaxea Fungia

0 0 0 0.0 0.00 0.00

Millepora

9 5 14 9.3 3.11 17.95

Heliopora

0 0 0 0.0 0.00 0.00

Soft Corals

0 0 0 0.0 0.00 0.00

1

2+2+1+1+1+1+1

1

1+1

1+1

1

1+1+1+1+1

2+1

0

0

0

3+1+1

1

0

Coral sub-total:

| Points | Types | % Total | Types:Species  |
|--------|-------|---------|----------------|
| 79     | 14    | 63      | 8 17.33 100.02 |

SUBSTRATUM

Sand

| Points | Mean | % Total | % Category       |
|--------|------|---------|------------------|
| 85     | 128  | 69      | 94.0 31.33 46.54 |

Hard

|   |   |   |               |
|---|---|---|---------------|
| 2 | 4 | 8 | 4.7 1.56 2.31 |
|---|---|---|---------------|

Fine Sand/Turf

|    |     |     |                  |
|----|-----|-----|------------------|
| 73 | 118 | 107 | 99.3 33.11 49.18 |
|----|-----|-----|------------------|

Rubble

|   |   |   |               |
|---|---|---|---------------|
| 4 | 0 | 8 | 4.0 1.33 1.98 |
|---|---|---|---------------|

Substratum sub-total:

|     |     |     |                    |
|-----|-----|-----|--------------------|
| 164 | 250 | 192 | 202.0 67.33 100.00 |
|-----|-----|-----|--------------------|

ALGAE

Filamentous

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Macro

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Turf

|    |    |    |                   |
|----|----|----|-------------------|
| 42 | 38 | 44 | 41.3 13.78 100.00 |
|----|----|----|-------------------|

Halimeda

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Blue-greens

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Algae sub-total:

|    |    |    |                   |
|----|----|----|-------------------|
| 42 | 38 | 44 | 41.3 13.78 100.00 |
|----|----|----|-------------------|

INVERTS

Holothuria atra

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Holothuria nobilis

|   |   |   |               |
|---|---|---|---------------|
| 0 | 1 | 0 | 0.3 0.11 7.12 |
|---|---|---|---------------|

Stichopus chloronotus

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Bohadschia argus

|   |   |   |                |
|---|---|---|----------------|
| 1 | 0 | 1 | 0.7 0.22 14.25 |
|---|---|---|----------------|

Acanthaster planci

|    |   |   |                |
|----|---|---|----------------|
| 11 | 0 | 0 | 3.7 1.22 78.35 |
|----|---|---|----------------|

Tridacna sp.

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Urchins

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Trochus

|   |   |   |               |
|---|---|---|---------------|
| 0 | 0 | 0 | 0.0 0.00 0.00 |
|---|---|---|---------------|

Invert sub-total:

|    |   |   |                |
|----|---|---|----------------|
| 12 | 1 | 1 | 4.7 1.56 99.72 |
|----|---|---|----------------|

Site E

|                                      |                       |                |                       |                           |
|--------------------------------------|-----------------------|----------------|-----------------------|---------------------------|
| Site                                 | E                     |                | Depth: 0.05-1.2 m     |                           |
| Date                                 | 9/12/92               |                | Slope: 0 degrees      |                           |
| Time                                 | 12:00                 |                |                       |                           |
| <u>Substratum Type:</u>              |                       |                |                       |                           |
| % hard substratum                    |                       | 75%            | live coral            | 15%                       |
|                                      |                       |                | reef pavement         | 60%                       |
| % rubble                             |                       | 5%             |                       |                           |
| % sand                               |                       | 20%            |                       |                           |
| <u>Relative Abundance of Corals:</u> |                       |                | <u>Abundance Key:</u> |                           |
|                                      |                       |                |                       | 5= >80% 4= 31-80%         |
| Acropora                             | cespitose             | fine branches  | 1                     | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose             | stout branches |                       |                           |
| Acropora                             | corymbose             | fine branches  |                       |                           |
| Acropora                             | corymbose             | stout branches |                       |                           |
| Acropora                             | thicket               |                | 1                     |                           |
| Acropora                             | spp                   |                | 1                     | photos                    |
| Acropora                             | spp                   |                | 1                     | photos                    |
| Acropora                             | spp                   |                | 1                     |                           |
| Acropora (Isopora)                   | cuneata               |                |                       |                           |
| Acropora (Isopora)                   | palifera              |                |                       |                           |
| Astreopora                           | myriophthalma         |                | 1                     |                           |
| Coscinarea                           | columna               |                |                       |                           |
| Cyphastrea                           | cf microphthalma      |                | 1                     |                           |
| Cyphastrea                           | cf serailia           |                | 1                     |                           |
| Diploastrea                          | heliopora             |                |                       |                           |
| Favia                                | stelligera            |                |                       |                           |
| Favia                                | massive               |                | 1                     |                           |
| Favites                              | massive               |                | 1                     | photo                     |
| Fungia                               | fungites              |                |                       |                           |
| Fungia                               | scutaria              |                |                       |                           |
| Galaxea                              | fascicularis          |                | 1                     |                           |
| Goniastrea                           | pectinata             |                | 1                     |                           |
| Goniastrea                           | retiformis            |                | 2                     |                           |
| Heliopora                            | coerulea              |                | 1                     |                           |
| Hydnophora                           | exesa                 |                |                       |                           |
| Hydnophora                           | microconus            |                |                       |                           |
| Leptastrea                           | massive               |                |                       |                           |
| Leptoria                             | phyrgia               |                | 2                     | photo                     |
| Lobophyllia                          | hemprichi             |                |                       |                           |
| Millepora                            | branching (dichotoma) |                | 3                     | photo                     |
| Millepora                            | encrusting            |                | 1                     |                           |
| Millepora                            | plates (platyphylla)  |                | 1                     |                           |
| Montipora                            | encrusting            |                | 1                     | photo                     |
| Montipora                            | cf informis           |                | 1                     |                           |
| Montipora                            | tuberculosa           |                |                       |                           |
| Mycedium                             | elephantotum          |                |                       |                           |

Site E

|  |             |                 |                       |
|--|-------------|-----------------|-----------------------|
| Pavona   | divaricata  |                 | 1                     |
| Pavona   | varians     |                 | 1                     |
| Pavona   | venosa      |                 | 1                     |
| Platygyra  | daedalea    |                 |                       |
| Pocillopora  | damicornis  |                 | 1 photo               |
| Pocillopora  | eydouxii    |                 |                       |
| Pocillopora  | meandrina   |                 | 2                     |
| Pocillopora  | verrucosa   |                 |                       |
| Porites  | branched    | (cylindrica)    |                       |
| Porites  | encrusting  | (lichen)        |                       |
| Porites  | lobate      | (lobata/lutea)  | 1                     |
| Porites  | rus         |                 |                       |
| Sarcophyton  | sp          |                 |                       |
| Sinularia  | sp          |                 |                       |
| Stylophora   | pistillata  |                 |                       |
| Turbinaria   | reniformis  |                 |                       |
|  |             | No. Species     | 26                    |
|  |             | Abundance Index | 31                    |
| <b>Benthic Organisms (cm per 30 m line intercept transect)</b> |             |                 |                       |
| Coral  |             | 550             |                       |
| Non-scleractinian  |             | 51              | (Millepora dichotoma) |
| Turf algae   |             | 180             |                       |
| Macro algae  |             | 18              | (Dictyosphaeria)      |
| Bluegreen mat  |             | 0               |                       |
| Other (sand, rubble, calcareous)                               |             | 2201            |                       |
| Total organisms  |             | 799             |                       |
| Total cm/transect  |             | 3000            |                       |
| <b>Macro Invertebrates (per 30 x 5 m belt transect)</b>        |             |                 |                       |
|  |             | total number    | #/sq. meter           |
| Diadema  | sp          | 0               | 0.000                 |
| Holothuria   | atra        | 3               | 0.020                 |
| Holothuria   | nobilis     | 1               | 0.007                 |
| Stichopus  | chloronotus | 13              | 0.087                 |
| Bohadschia   | argus       | 4               | 0.027                 |
| Acanthaster  | sp          | 1               | 0.007                 |
| Drupella   | sp          | 0               | 0.000                 |
| Vermetid   | sp          | 1               | 0.007                 |
| Spirobranchus  | sp          | 3               | 0.020                 |

**SITE G**

Ofu 9/92

Video Transect Data

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame = 300 points/transect)

Visual Field Estimates of  
Relative Coral Abundance

(multiple entries for > 1

species within family/type)

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

**CORALS**

Transects:

**TYPES:**

*Massive*

Porites

|  | 1  | 2  | 3  | Mean<br>Point<br>Cover | Mean<br>% Cover<br>of Total | Mean<br>% Cover<br>of Coral |
|--|----|----|----|------------------------|-----------------------------|-----------------------------|
|  | 43 | 42 | 18 | 34.3                   | 11.44                       | 68.20                       |

4 + 1

Favidae

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1 (8x)

Other

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

0

*Encrusting*

Pavona

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1 + 1

Other

|  |   |    |   |     |      |      |
|--|---|----|---|-----|------|------|
|  | 0 | 10 | 0 | 3.3 | 1.11 | 6.62 |
|--|---|----|---|-----|------|------|

1 + 1

*Branching*

Porites

|  |    |   |   |     |      |       |
|--|----|---|---|-----|------|-------|
|  | 14 | 4 | 3 | 7.0 | 2.33 | 13.91 |
|--|----|---|---|-----|------|-------|

1

Acropora

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1 + 1

Pocillopora

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1

Other

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 5 | 0 | 1.7 | 0.56 | 3.31 |
|--|---|---|---|-----|------|------|

0

*Plates*

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1

*Other*

Galaxea, Fungia

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

1 + 1 + 1

Millepora

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 2 | 3 | 7 | 4.0 | 1.33 | 7.95 |
|--|---|---|---|-----|------|------|

3

Heliopora

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

0

Soft Corals

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

0

Coral sub-total:

| Points | Types | % Total | Types: Species |
|--------|-------|---------|----------------|
| 59     | 64    | 28      | 5              |
|        |       |         | 16.78          |
|        |       |         | 99.9868        |
|        |       |         | 10:23          |

**SUBSTRATUM**

Sand

| Points | Mean | % Total | % Category |
|--------|------|---------|------------|
| 90     | 80   | 156     | 108.7      |
|        |      |         | 36.22      |
|        |      |         | 49.69      |

Hard

|  |    |   |   |     |      |      |
|--|----|---|---|-----|------|------|
|  | 11 | 3 | 0 | 4.7 | 1.56 | 2.13 |
|--|----|---|---|-----|------|------|

Fine Sand/Turf

|  |    |    |    |      |       |       |
|--|----|----|----|------|-------|-------|
|  | 93 | 75 | 54 | 74.0 | 24.67 | 33.84 |
|--|----|----|----|------|-------|-------|

Rubble

|  |    |    |    |      |       |       |
|--|----|----|----|------|-------|-------|
|  | 22 | 47 | 25 | 31.3 | 10.44 | 14.33 |
|--|----|----|----|------|-------|-------|

Substratum sub-total:

|     |     |     |       |       |        |
|-----|-----|-----|-------|-------|--------|
| 216 | 205 | 235 | 218.7 | 72.89 | 100.00 |
|-----|-----|-----|-------|-------|--------|

**ALGAE**

Filamentous

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Macro

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Turf

|  |    |    |    |      |       |        |
|--|----|----|----|------|-------|--------|
|  | 24 | 32 | 37 | 31.0 | 10.33 | 100.00 |
|--|----|----|----|------|-------|--------|

Halimeda

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Blue-greens

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Algae sub-total:

|    |    |    |      |       |        |
|----|----|----|------|-------|--------|
| 24 | 32 | 37 | 31.0 | 10.33 | 100.00 |
|----|----|----|------|-------|--------|

**INVERTS**

Holothuria atra

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Holothuria nobilis

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Stichopus chloronotus

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Bohadschia argus

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Acanthaster planci

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Tridacna sp.

|  |   |   |   |     |      |        |
|--|---|---|---|-----|------|--------|
|  | 1 | 0 | 0 | 0.3 | 0.11 | 100.00 |
|--|---|---|---|-----|------|--------|

Urchins

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Trochus

|  |   |   |   |     |      |      |
|--|---|---|---|-----|------|------|
|  | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|--|---|---|---|-----|------|------|

Invert sub-total:

|   |   |   |     |      |        |
|---|---|---|-----|------|--------|
| 1 | 0 | 0 | 0.3 | 0.11 | 100.00 |
|---|---|---|-----|------|--------|

## Site G

|                                      |                       |                |                       |                           |
|--------------------------------------|-----------------------|----------------|-----------------------|---------------------------|
| Site                                 | G                     |                | Depth: 0.2-1.5 m      |                           |
| Date                                 | 9/9/92                |                | Slope: 0 degrees      |                           |
| Time                                 | 9:00                  |                |                       |                           |
| <u>Substratum Type:</u>              |                       |                |                       |                           |
| % hard substratum                    |                       | 50%            | live coral            | 25%                       |
|                                      |                       |                | reef pavement         | 25%                       |
| % rubble                             |                       | 10%            |                       |                           |
| % sand                               |                       | 40%            |                       |                           |
| <u>Spatial heterogeneity:</u>        |                       |                |                       |                           |
|                                      |                       | 13.1 m/10 m    |                       |                           |
| <u>Relative Abundance of Corals:</u> |                       |                | <u>Abundance Key:</u> |                           |
|                                      |                       |                |                       | 5= >80% 4= 31-80%         |
| Acropora                             | cespitose             | fine branches  |                       | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose             | stout branches |                       |                           |
| Acropora                             | corymbose             | fine branches  |                       |                           |
| Acropora                             | corymbose             | stout branches |                       |                           |
| Acropora                             | thicket               | med branches   | 1                     |                           |
| Acropora                             | thicket               | grandis        | 1                     |                           |
| Acropora                             | spp                   |                |                       |                           |
| Acropora                             | spp                   |                |                       |                           |
| Acropora                             | spp                   |                |                       |                           |
| Acropora (Isopora)                   | cuneata               |                |                       |                           |
| Acropora (Isopora)                   | paliifera             |                |                       |                           |
| Astreopora                           | myriophthalma         |                |                       |                           |
| Coscinarea                           | columna               |                |                       |                           |
| Cyphastrea                           | cf microphthalma      |                | 1                     |                           |
| Cyphastrea                           | cf serailia           |                | 1                     |                           |
| Diploastrea                          | heliopora             |                |                       |                           |
| Favia                                | stelligera            |                |                       |                           |
| Favia                                | massive               |                | 1                     |                           |
| Favites                              | massive               |                | 1                     |                           |
| Fungia                               | fungites              |                |                       |                           |
| Fungia                               | scutaria              |                |                       |                           |
| Galaxea                              | fascicularis          |                | 1                     |                           |
| Goniastrea                           | pectinata             |                | 1                     |                           |
| Goniastrea                           | retiformis            |                | 1                     |                           |
| Heliopora                            | coerulea              |                |                       |                           |
| Hydnophora                           | exesa                 |                |                       |                           |
| Hydnophora                           | microconus            |                | 1                     |                           |
| Leptastrea                           | massive               |                |                       |                           |
| Leptoria                             | phyrgia               |                | 1                     |                           |
| Lobophyllia                          | hemprichi             |                | 1                     |                           |
| Millepora                            | branching (dichotoma) |                | 3                     |                           |
| Millepora                            | encrusting            |                |                       |                           |
| Millepora                            | plates (platyphylla)  |                | 1                     | photo                     |
| Montipora                            | encrusting            |                | 1                     |                           |
| Montipora                            | cf informis           |                | 1                     |                           |

Site G

|  |              |                |   |
|--|--------------|----------------|---|
| Montipora  | tuberculosa  |                |   |
| Mycedium   | elephantotum |                |   |
| Pavona   | divaricata   |                |   |
| Pavona   | varians      |                | 1   |
| Pavona   | venosa       |                | 1   |
| Platygyra  | daedalea     |                | 1   |
| Pocillopora  | damicornis   |                | 1   |
| Pocillopora  | eydouxi      |                |   |
| Pocillopora  | meandrina    |                |   |
| Pocillopora  | verrucosa    |                |   |
| Porites  | branched     | (cylindrica)   |   |
| Porites  | encrusting   | (lichen)       | 1   |
| Porites  | massive      | (lobata/lutea) | 4 photos  |
| Porites  | massive      | (murrayensis)  | 1   |
| Porites  | rus          |                |   |
| Sarcophyton  | sp           |                |   |
| Sinularia  | sp           |                |   |
| Stylophora   | pistillata   |                |   |
| Turbinaria   | reniformis   |                |   |
|  |              | No. Species    | 23  |
|  |              | Abundance Inde | 28  |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                |   |
|  |              |                |   |
| Coral  |              | 554            |   |
| Non-scleractinian  |              | 132            | (Millepora dichotoma=128, Sarcophyton=3, Anemone=1) |
| Turf algae   |              | 257            |   |
| Macro algae  |              | 2              | (Halimeda)  |
| Bluegreen mat  |              | 0              |   |
| Other (sand, rubble, calcareous)                               |              | 4055           |   |
| Total organisms  |              | 945            |   |
| Total cm/transect  |              | 5000           |   |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                |   |
|  |              | total number   | #/sq. meter   |
| Diadema  | sp           | 11             | 0.044   |
| Holothuria   | atra         | 0              | 0.000   |
| Holothuria   | nobilis      | 3              | 0.012   |
| Stichopus  | chloronotu   | 0              | 0.000   |
| Bohadschia   | argus        | 4              | 0.016   |
| Acanthaster  | sp           | 0              | 0.000   |
| Drupella   | sp           | 0              | 0.000   |
| Vermetid   | sp           | 0              | 0.000   |
| Spirobranchus  | sp           | 1              | 0.004   |
| Tridacna   | sp           | 9              | 0.036   |
|  |              |                |   |
|  |              |                |   |

SITE H

Ofu 9/92

Video Transect Data

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame = 300 points/transect)

Visual Field Estimates of  
Relative Coral Abundance

(multiple entries for > 1

species within family/type)

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

| CORALS            | Types:                 | Transects: | 1 2 3         |              |                | Mean     | Mean     | Mean    | Relative Coral Abundance |
|-------------------|------------------------|------------|---------------|--------------|----------------|----------|----------|---------|--------------------------|
|                   |                        |            | (# of points) |              |                | Point    | % Cover  | % Cover |                          |
|                   |                        |            |               |              | Cover          | of Total | of Coral |         |                          |
| <i>Massive</i>    | <u>Porites</u>         |            | 3             | 13           | 2              | 6.0      | 2.00     | 6.57    | 1                        |
|                   | <u>Favidae</u>         |            | 0             | 0            | 1              | 0.3      | 0.11     | 0.37    | 1+1+1+1+1                |
|                   | Other                  |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 1+1                      |
| <i>Encrusting</i> | <u>Pavona</u>          |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 0                        |
|                   | Other                  |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 1+1                      |
| <i>Branching</i>  | <u>Porites</u>         |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 0                        |
|                   | <u>Acropora</u>        |            | 49            | 111          | 21             | 60.3     | 20.11    | 66.07   | 5 + 1 (5x)               |
|                   | <u>Pocillopora</u>     |            | 32            | 0            | 38             | 23.3     | 7.78     | 25.55   | 1+1+1                    |
|                   | Other                  |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 1                        |
| <i>Plates</i>     |                        |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 0                        |
| <i>Other</i>      | <u>Galaxea, Fungia</u> |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 1+1                      |
| <u>Millepora</u>  |                        |            | 4             | 0            | 0              | 1.3      | 0.44     | 1.46    | 1+1+1                    |
| <u>Heliopora</u>  |                        |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 0                        |
| Soft Corals       |                        |            | 0             | 0            | 0              | 0.0      | 0.00     | 0.00    | 0                        |
| Coral sub-total:  |                        |            | <u>Points</u> | <u>Types</u> | <u>% Total</u> |          |          |         | <u>Types:Species</u>     |
|                   |                        |            | 88            | 124          | 62             | 5        | 30.44    | 100.01  | 9:25                     |

| SUBSTRATUM            |                | Points      | Mean  | % Total | % Category |
|-----------------------|----------------|-------------|-------|---------|------------|
|                       | Sand           | 8 18 21     | 15.7  | 5.22    | 9.98       |
|                       | Hard           | 0 0 0       | 0.0   | 0.00    | 0.00       |
|                       | Fine Sand/Turf | 73 96 42    | 70.3  | 23.44   | 44.80      |
|                       | Rubble         | 60 18 135   | 71.0  | 23.67   | 45.23      |
| Substratum sub-total: |                | 141 132 198 | 157.0 | 52.33   | 100.01     |

| ALGAE            |             | Points   | Mean | % Total | % Category |
|------------------|-------------|----------|------|---------|------------|
|                  | Filamentous | 0 0 0    | 0.0  | 0.00    | 0.00       |
|                  | Macro       | 0 0 0    | 0.0  | 0.00    | 0.00       |
|                  | Turf        | 72 44 40 | 52.0 | 17.33   | 100.00     |
|                  | Halimeda    | 0 0 0    | 0.0  | 0.00    | 0.00       |
|                  | Blue-greens | 0 0 0    | 0.0  | 0.00    | 0.00       |
| Algae sub-total: |             | 72 44 40 | 52.0 | 17.33   | 100.00     |

| INVERTS           |                              | Points | Mean | % Total | % Category |
|-------------------|------------------------------|--------|------|---------|------------|
|                   | <u>Holothuria atra</u>       | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Holothuria nobilis</u>    | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Stichopus chloronotus</u> | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Bohadschia argus</u>      | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Acanthaster planci</u>    | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Tridacna sp.</u>          | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | Urchins                      | 0 0 0  | 0.0  | 0.00    | 0.00       |
|                   | <u>Trochus</u>               | 0 0 0  | 0.0  | 0.00    | 0.00       |
| Invert sub-total: |                              | 0 0 0  | 0.0  | 0.00    | 0.00       |



Site H

|   |                 |                |                           |
|---|-----------------|----------------|---------------------------|
| Site                                    | H               |                | Depth: 0.2-1.5 m          |
| Date                                    | 9/10/92         |                | Slope: 0 degrees          |
| Time                                    | 15:00           |                |                           |
| <u>Substratum Type:</u>                 |                 |                |                           |
| % hard substratum                       |                 | 65%            | live coral 30%            |
|   |                 |                | reef pavement 35%         |
| % rubble                                |                 | 15%            |                           |
| % sand                                  |                 | 20%            |                           |
| <u>Spatial heterogeneity:</u> 15 m/10 m |                 |                |                           |
| <u>Relative Abundance of Corals:</u>    |                 |                | <u>Abundance Key:</u>     |
|   |                 |                | 5= >80% 4= 31-80%         |
|   |                 |                | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                                | cespitose       | fine branches  |                           |
| Acropora                                | cespitose       | stout branches | 1                         |
| Acropora                                | corymbose       | fine branches  |                           |
| Acropora                                | corymbose       | stout branches | 1 photo                   |
| Acropora                                | thicket         | med branches   | 5 photo                   |
| Acropora                                | thicket         | grandis        | 1 photo                   |
| Acropora                                | spp             |                |                           |
| Acropora                                | spp             |                |                           |
| Acropora                                | spp             |                |                           |
| Acropora (Isopora)                      | cuneata         |                | 1                         |
| Acropora (Isopora)                      | palifera        |                | 1                         |
| Astreopora                              | myriophthalma   |                | 1                         |
| Coscinarea                              | columna         |                |                           |
| Cyphastrea                              | cf micropthalma |                |                           |
| Cyphastrea                              | cf serailia     |                | 1                         |
| Diploastrea                             | heliopora       |                |                           |
| Favia                                   | stelligera      |                |                           |
| Favia                                   | massive         |                | 1                         |
| Favites                                 | massive         |                | 1                         |
| Fungia                                  | fungites        |                | 1                         |
| Fungia                                  | scutaria        |                |                           |
| Galaxea                                 | fascicularis    |                | 1                         |
| Goniastrea                              | pectinata       |                |                           |
| Goniastrea                              | retiformis      |                | 1                         |
| Heliopora                               | coerulea        |                |                           |
| Hydnophora                              | exesa           |                | 1                         |
| Hydnophora                              | microconus      |                |                           |
| Leptastrea                              | massive         |                |                           |
| Leptoria                                | phyrgia         |                | 1 photo                   |
| Lobophyllia                             | hemprichi       |                |                           |
| Millepora                               | branching       | (dichotoma)    | 1                         |
| Millepora                               | encrusting      |                | 1                         |
| Millepora                               | plates          | (platyphylla)  | 1                         |
| Montipora                               | encrusting      |                | 1                         |

Site H

|  |              |                 |             |                  |
|--|--------------|-----------------|-------------|------------------|
| Montipora  | cf informis  |                 |             |                  |
| Montipora  | tuberculosa  |                 |             |                  |
| Mycedium   | elephantotum |                 |             |                  |
| Pavona   | divaricata   |                 |             |                  |
| Pavona   | varians      |                 |             |                  |
| Pavona   | venosa       |                 |             |                  |
| Platygyra  | daedalea     |                 |             |                  |
| Pocillopora  | damicornis   |                 |             | 1                |
| Pocillopora  | eydouxii     |                 |             | 1                |
| Pocillopora  | meandrina    |                 |             |                  |
| Pocillopora  | verrucosa    |                 |             | 1                |
| Porites  | branched     | (cylindrica)    |             |                  |
| Porites  | encrusting   | (lichen)        |             | 1                |
| Porites  | massive      | (lobata/lutea)  |             | 1                |
| Porites  | massive      | (murrayensis)   |             |                  |
| Porites  | rus          |                 |             |                  |
| Sarcophyton  | sp           |                 |             |                  |
| Sinularia  | sp           |                 |             |                  |
| Stylophora   | pistillata   |                 |             | 1                |
| Turbinaria   | reniformis   |                 |             |                  |
|  |              | No. Species     |             | 25               |
|  |              | Abundance Index |             | 29               |
|  |              |                 |             |                  |
|  |              |                 |             |                  |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |             |                  |
|  |              |                 |             |                  |
| Coral  |              |                 | 248         |                  |
| Non-scleractinian  |              |                 | 42          | (Millepora)      |
| Turf algae   |              |                 | 5           |                  |
| Macro algae  |              |                 | 5           | (Dictyosphaeria) |
| Bluegreen mat  |              |                 | 60          |                  |
| Other (sand, rubble, calcareous)                               |              |                 | 4640        |                  |
| Total organisms  |              |                 | 360         |                  |
| Total cm/transect  |              |                 | 5000        |                  |
|  |              |                 |             |                  |
|  |              |                 |             |                  |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |             |                  |
|  |              | total number    | #/sq. meter |                  |
| Diadema  | sp           | 9               | 0.036       |                  |
| Holothuria   | atra         | 0               | 0.000       |                  |
| Holothuria   | nobilis      | 2               | 0.008       |                  |
| Stichopus  | chloronotus  | 0               | 0.000       |                  |
| Bohadschia   | argus        | 7               | 0.028       |                  |
| Acanthaster  | sp           | 1               | 0.004       |                  |
| Drupella   | sp           | 0               | 0.000       |                  |
| Vermetid   | sp           | 0               | 0.000       |                  |
| Spirobranchus  | sp           | 0               | 0.000       |                  |
| Tridacna   | sp           | 1               | 0.004       |                  |

SITE K

Ofu 9/92

Video Transect Data

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame =300 points/transect)

Visual Field Estimates of  
Relative Coral Abundance

(multiple entries for > 1

species within family/type)

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

| CORALS                  | Transects:            | Mean          |           |           | Mean     | Mean         | Visual Field Estimates of<br>Relative Coral Abundance<br>(multiple entries for > 1<br>species within family/type)<br>5 = >80% 4 = 31-80%<br>3 = 11-30% 2 = 6-10%<br>1 = 1-5% |
|-------------------------|-----------------------|---------------|-----------|-----------|----------|--------------|--|
|                         |                       | 1             | 2         | 3         | Point    | % Cover      |  |
| TYPES:                  |                       | (# of points) |           |           | Cover    | of Total     | % Cover<br>of Coral  |
| <i>Massive</i>          | <u>Porites</u>        | 88            | 47        | 39        | 58.0     | 19.33        | 80.93  |
|                         | <u>Favidae</u>        | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
|                         | Other                 | 4             | 13        | 0         | 5.7      | 1.89         | 7.91   |
| <i>Encrusting</i>       | <u>Pavona</u>         | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
|                         | Other                 | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| <i>Branching</i>        | <u>Porites</u>        | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
|                         | <u>Acropora</u>       | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
|                         | <u>Pocillopora</u>    | 0             | 0         | 20        | 6.7      | 2.22         | 9.30   |
|                         | Other                 | 0             | 4         | 0         | 1.3      | 0.44         | 1.86   |
| <i>Plates</i>           |                       | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| <i>Other</i>            | <u>Galaxea,Fungia</u> | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| <u>Millepora</u>        |                       | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| <u>Heliopora</u>        |                       | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| Soft Corals             |                       | 0             | 0         | 0         | 0.0      | 0.00         | 0.00   |
| <b>Coral sub-total:</b> |                       | <b>92</b>     | <b>64</b> | <b>59</b> | <b>4</b> | <b>23.89</b> | <b>100.00</b>  |

Types:Species  
7:12

| SUBSTRATUM                   |                | Points     |            |            | Mean         | % Total      | % Category   |
|------------------------------|----------------|------------|------------|------------|--------------|--------------|--------------|
|                              | Sand           | 108        | 107        | 103        | 106.0        | 35.33        | 53.89        |
|                              | Hard           | 0          | 2          | 0          | 0.7          | 0.22         | 0.34         |
|                              | Fine Sand/Turf | 37         | 61         | 38         | 45.3         | 15.11        | 23.05        |
|                              | Rubble         | 18         | 40         | 76         | 44.7         | 14.89        | 22.71        |
| <b>Substratum sub-total:</b> |                | <b>163</b> | <b>210</b> | <b>217</b> | <b>196.7</b> | <b>65.56</b> | <b>99.99</b> |

|                         |             |           |           |           |             |              |               |
|-------------------------|-------------|-----------|-----------|-----------|-------------|--------------|---------------|
| ALGAE                   | Filamentous | 0         | 0         | 0         | 0.0         | 0.00         | 0.00          |
|                         | Macro       | 0         | 0         | 0         | 0.0         | 0.00         | 0.00          |
|                         | Turf        | 45        | 24        | 24        | 31.0        | 10.33        | 100.00        |
|                         | Halimeda    | 0         | 0         | 0         | 0.0         | 0.00         | 0.00          |
|                         | Blue-greens | 0         | 0         | 0         | 0.0         | 0.00         | 0.00          |
| <b>Algae sub-total:</b> |             | <b>45</b> | <b>24</b> | <b>24</b> | <b>31.0</b> | <b>10.33</b> | <b>100.00</b> |

|                          |                              |          |          |          |            |             |             |
|--------------------------|------------------------------|----------|----------|----------|------------|-------------|-------------|
| INVERTS                  | <u>Holothuria atra</u>       | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Holothuria nobilis</u>    | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Stichopus chloronotus</u> | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Bohadschia argus</u>      | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Acanthaster planci</u>    | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Tridacna sp.</u>          | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | Urchins                      | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
|                          | <u>Trochus</u>               | 0        | 0        | 0        | 0.0        | 0.00        | 0.00        |
| <b>Invert sub-total:</b> |                              | <b>0</b> | <b>0</b> | <b>0</b> | <b>0.0</b> | <b>0.00</b> | <b>0.00</b> |

Site K

|                                      |                  |                |                  |                           |
|--------------------------------------|------------------|----------------|------------------|---------------------------|
| Site                                 | K                |                | Depth: 0.1-1.0 m |                           |
| Date                                 | 9/11/92          |                | Slope: 0 degrees |                           |
| Time                                 | 10:30            |                |                  |                           |
| <u>Substratum Type:</u>              |                  |                |                  |                           |
| % hard substratum                    |                  | 40%            | live coral       | 10%                       |
|                                      |                  |                | reef pavement    | 30%                       |
| % rubble                             |                  | 30%            |                  |                           |
| % sand                               |                  | 30%            |                  |                           |
| <u>Spatial heterogeneity:</u>        |                  |                |                  |                           |
|                                      |                  | 13.2 m/10 m    |                  |                           |
| <u>Relative Abundance of Corals:</u> |                  |                |                  |                           |
|                                      |                  |                |                  | <u>Abundance Key:</u>     |
|                                      |                  |                |                  | 5= >80% 4= 31-80%         |
|                                      |                  |                |                  | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose        | fine branches  |                  |                           |
| Acropora                             | cespitose        | stout branches | 1                |                           |
| Acropora                             | corymbose        | fine branches  |                  |                           |
| Acropora                             | corymbose        | stout branches |                  |                           |
| Acropora                             | thicket          | med branches   |                  |                           |
| Acropora                             | thicket          | grandis        |                  |                           |
| Acropora                             | spp              | (cf robusta)   |                  |                           |
| Acropora                             | spp              |                |                  |                           |
| Acropora                             | spp              |                |                  |                           |
| Acropora (Isopora)                   | cuneata          |                |                  |                           |
| Acropora (Isopora)                   | palifera         |                |                  |                           |
| Astreopora                           | myriophthalma    |                |                  |                           |
| Coscinarea                           | columna          |                | 1                |                           |
| Cyphastrea                           | cf microphthalma |                |                  |                           |
| Cyphastrea                           | cf serailia      |                | 1                |                           |
| Diploastrea                          | heliopora        |                |                  |                           |
| Favia                                | stelligera       |                |                  |                           |
| Favia                                | massive          |                | 1                |                           |
| Favites                              | massive          |                |                  |                           |
| Fungia                               | fungites         |                |                  |                           |
| Fungia                               | scutaria         |                |                  |                           |
| Galaxea                              | fascicularis     |                |                  |                           |
| Goniastrea                           | pectinata        |                | 1                |                           |
| Goniastrea                           | retiformis       |                | 2                |                           |
| Heliopora                            | coerulea         |                |                  |                           |
| Hydnophora                           | exesa            |                |                  |                           |
| Hydnophora                           | microconus       |                |                  |                           |
| Leptastrea                           | massive          |                |                  |                           |
| Leptoria                             | phyrgia          |                | 1                |                           |
| Lobophyllia                          | hemprichi        |                |                  |                           |
| Millepora                            | branching        | (dichotoma)    | 1                |                           |
| Millepora                            | encrusting       |                |                  |                           |
| Millepora                            | plates           | (platyphylla)  | 1                |                           |

Site K

|  |              |                 |              |                        |
|--|--------------|-----------------|--------------|------------------------|
| Montipora  | encrusting   |                 | 1            |                        |
| Montipora  | cf foveolata |                 |              |                        |
| Montipora  | cf informis  |                 |              |                        |
| Montipora  | tuberculosa  |                 |              |                        |
| Mycidium   | elephantotum |                 |              |                        |
| Pavona   | clavus       |                 |              |                        |
| Pavona   | divaricata   |                 |              |                        |
| Pavona   | varians      |                 |              |                        |
| Pavona   | venosa       |                 |              |                        |
| Platygyra  | daedalea     |                 | 1            |                        |
| Pocillopora  | damicornis   |                 |              |                        |
| Pocillopora  | eydouxi      |                 |              |                        |
| Pocillopora  | meandrina    |                 |              |                        |
| Pocillopora  | verrucosa    |                 |              |                        |
| Porites  | branched     | (cylindrica)    |              |                        |
| Porites  | encrusting   | (lichen)        |              |                        |
| Porites  | massive      | (lobata/lutea)  |              | (some tumors, disease) |
| Porites  | massive      | (murrayensis)   | 4            | (some tumors, disease) |
| Porites  | rus          |                 |              |                        |
| Sarcophyton  | sp           |                 |              |                        |
| Sinularia  | sp           |                 |              |                        |
| Stylophora   | pistillata   |                 |              |                        |
| Turbinaria   | reniformis   |                 |              |                        |
|  |              | No. Species     | 12           |                        |
|  |              | Abundance Index | 16           |                        |
|  |              |                 |              |                        |
|  |              |                 |              |                        |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |              |                        |
|  |              |                 |              |                        |
| Coral  |              |                 | 18           |                        |
| Non-scleractinian  |              |                 | 0            |                        |
| Turf algae   |              |                 | 600          |                        |
| Macro algae  |              |                 | 5 (Halimeda) |                        |
| Filamentous algae  |              |                 | 0            |                        |
| Bluegreen mat  |              |                 | 0            |                        |
| Sponge   |              |                 | 10           |                        |
| Other (sand, rubble, calcareous)                               |              |                 | 4367         |                        |
| Total organisms  |              |                 | 633          |                        |
| Total cm/transect  |              |                 | 5000         |                        |
|  |              |                 |              |                        |
|  |              |                 |              |                        |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |              |                        |
|  |              | total number    | #/sq. meter  |                        |
| Diadema  | sp           | 85              | 0.340        |                        |
| Echinothrix  | sp           | 0               | 0.000        |                        |
| Unid. urchin   |              | 1               | 0.004        |                        |
| Holothuria   | atra         | 1               | 0.004        |                        |
| Holothuria   | nobilis      | 0               | 0.000        |                        |

Site K

|               |             |    |       |
|---------------|-------------|----|-------|
| Stichopus     | chloronotus | 0  | 0.000 |
| Bohadschia    | argus       | 19 | 0.076 |
| Acanthaster   | sp          | 0  | 0.000 |
| Drupella      | sp          | 0  | 0.000 |
| Vermetid      | sp          | 0  | 0.000 |
| Spirobranchus | sp          | 0  | 0.000 |
| Tridacna      | sp          | 5  | 0.020 |
| Trochus       | sp          | 1  | 0.004 |
| Turbo         | sp          | 0  | 0.000 |
| Conus         | sp          | 1  | 0.004 |
| Spider conch  |             | 1  | 0.004 |
|               |             |    |       |
|               |             |    |       |

SITE N

Ofu 9/92

Video Transect Data

-point coverage in 10 m video transects

(10 frames/transect, 30 points frame = 300 points/transect)

Visual Field Estimates of  
Relative Coral Abundance

(multiple entries for > 1

species within family/type)

5 = >80% 4 = 31-80%

3 = 11-30% 2 = 6-10%

1 = 1-5%

CORALS

Transects:

|                  |                       | 1             | 2  | 3  | Mean<br>Point<br>Cover | Mean<br>% Cover<br>of Total | Mean<br>% Cover<br>of Coral |                       |
|------------------|-----------------------|---------------|----|----|------------------------|-----------------------------|-----------------------------|-----------------------|
|                  |                       | (# of points) |    |    |                        |                             |                             |                       |
| Massive          | <u>Porites</u>        | 12            | 15 | 14 | 13.7                   | 4.56                        | 68.30                       | 4+1                   |
|                  | <u>Favidae</u>        | 2             | 0  | 0  | 0.7                    | 0.22                        | 3.33                        | 1(6x)                 |
|                  | Other                 | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 1                     |
| Encrusting       | <u>Pavona</u>         | 0             | 0  | 1  | 0.3                    | 0.11                        | 1.67                        | 0                     |
|                  | Other                 | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 2+1+1                 |
| Branching        | <u>Porites</u>        | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 0                     |
|                  | <u>Acropora</u>       | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 2+1+1+1               |
|                  | <u>Pocillopora</u>    | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 1+1                   |
|                  | Other                 | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 0                     |
| Plates           |                       | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 1                     |
| Other            | <u>Galaxea Fungia</u> | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 1                     |
| <u>Millepora</u> |                       | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 0                     |
| <u>Heliopora</u> |                       | 16            | 0  | 0  | 5.3                    | 1.78                        | 26.65                       | 0                     |
| Soft Corals      |                       | 0             | 0  | 0  | 0.0                    | 0.00                        | 0.00                        | 0                     |
| Coral sub-total: |                       | 30            | 15 | 15 | 4                      | 6.67                        | 99.95                       | Types:Species<br>8:20 |

|                       |                | Points | Mean | % Total | % Category |       |        |
|-----------------------|----------------|--------|------|---------|------------|-------|--------|
| SUBSTRATUM            | Sand           | 28     | 59   | 45      | 44.0       | 14.67 | 18.64  |
|                       | Hard           | 0      | 0    | 0       | 0.0        | 0.00  | 0.00   |
|                       | Fine Sand/Turf | 74     | 68   | 129     | 90.3       | 30.11 | 38.28  |
|                       | Rubble         | 105    | 140  | 60      | 101.7      | 33.89 | 43.08  |
| Substratum sub-total: |                | 207    | 267  | 234     | 236.0      | 78.67 | 100.00 |

|                  |             |    |    |    |      |       |       |
|------------------|-------------|----|----|----|------|-------|-------|
| ALGAE            | Filamentous | 0  | 0  | 0  | 0.0  | 0.00  | 0.00  |
|                  | Macro       | 0  | 0  | 0  | 0.0  | 0.00  | 0.00  |
|                  | Turf        | 60 | 18 | 44 | 40.7 | 13.56 | 92.40 |
|                  | Halimeda    | 0  | 0  | 0  | 0.0  | 0.00  | 0.00  |
|                  | Blue-greens | 3  | 0  | 7  | 3.3  | 1.11  | 7.57  |
| Algae sub-total: |             | 63 | 18 | 51 | 44.0 | 14.67 | 99.98 |

|                   |                              |   |   |   |     |      |      |
|-------------------|------------------------------|---|---|---|-----|------|------|
| INVERTS           | <u>Holothuria atra</u>       | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Holothuria nobilis</u>    | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Stichopus chloronotus</u> | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Bohadschia argus</u>      | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Acanthaster planci</u>    | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Tridacna sp.</u>          | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | Urchins                      | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
|                   | <u>Trochus</u>               | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |
| Invert sub-total: |                              | 0 | 0 | 0 | 0.0 | 0.00 | 0.00 |

Site N

|                                      |                  |                |                       |                         |
|--------------------------------------|------------------|----------------|-----------------------|-------------------------|
| Site                                 | N                |                | Depth: 0.1-1.0 m      |                         |
| Date                                 | 9/11/92          |                | Slope: 0 degrees      |                         |
| Time                                 | 12:00            |                |                       |                         |
| <u>Substratum Type:</u>              |                  |                |                       |                         |
| % hard substratum                    |                  | 20%            | live coral            | 5%                      |
|                                      |                  |                | reef pavement         | 15%                     |
| % rubble                             |                  | 20%            |                       |                         |
| % sand                               |                  | 60%            |                       |                         |
| <u>Spatial heterogeneity:</u>        |                  |                |                       |                         |
|                                      |                  | 12.5 m/10 m    |                       |                         |
| <u>Relative Abundance of Corals:</u> |                  |                | <u>Abundance Key:</u> |                         |
|                                      |                  |                |                       | 5=>80% 4=31-80%         |
|                                      |                  |                |                       | 3=11-30% 2=6-10% 1=1-5% |
| Acropora                             | cespitose        | fine branches  | 1                     |                         |
| Acropora                             | cespitose        | stout branches | 2                     |                         |
| Acropora                             | corymbose        | fine branches  |                       |                         |
| Acropora                             | corymbose        | stout branches |                       |                         |
| Acropora                             | thicket          | med branches   |                       |                         |
| Acropora                             | thicket          | grandis        |                       |                         |
| Acropora                             | spp              | (cf robusta)   | 1                     |                         |
| Acropora                             | spp              |                |                       |                         |
| Acropora                             | spp              |                |                       |                         |
| Acropora (Isopora)                   | cuneata          |                |                       |                         |
| Acropora (Isopora)                   | palifera         |                | 1                     |                         |
| Astreopora                           | myriophthalma    |                |                       |                         |
| Coscinarea                           | columna          |                |                       |                         |
| Cyphastrea                           | cf microphthalma |                | 1                     |                         |
| Cyphastrea                           | cf serailia      |                |                       |                         |
| Diploastrea                          | heliopora        |                |                       |                         |
| Favia                                | stelligera       |                |                       |                         |
| Favia                                | massive          |                | 1                     |                         |
| Favites                              | massive          |                | 1                     |                         |
| Fungia                               | fungites         |                |                       |                         |
| Fungia                               | scutaria         |                |                       |                         |
| Galaxea                              | fascicularis     |                |                       |                         |
| Goniastrea                           | pectinata        |                |                       |                         |
| Goniastrea                           | retiformis       |                | 1                     |                         |
| Heliopora                            | coerulea         |                |                       |                         |
| Hydnophora                           | exesa            |                | 1                     |                         |
| Hydnophora                           | microconus       |                |                       |                         |
| Leptastrea                           | massive          |                |                       |                         |
| Leptoria                             | phyrgia          |                | 1                     |                         |
| Lobophyllia                          | hemprichi        |                | 1                     |                         |
| Millepora                            | branching        | (dichotoma)    |                       |                         |
| Millepora                            | encrusting       |                | 1                     |                         |
| Millepora                            | plates           | (platyphylla)  |                       |                         |



Site N

|  |              |                 |             |                  |
|--|--------------|-----------------|-------------|------------------|
| Montipora  | encrusting   |                 | 1           |                  |
| Montipora  | cf foveolata |                 |             |                  |
| Montipora  | cf informis  |                 | 2           |                  |
| Montipora  | tuberculosa  |                 |             |                  |
| Mycedium   | elephantotum |                 |             |                  |
| Pavona   | clavus       |                 |             |                  |
| Pavona   | divaricata   |                 |             |                  |
| Pavona   | varians      |                 |             |                  |
| Pavona   | venosa       |                 | 1           |                  |
| Platygyra  | daedalea     |                 | 1           | photo            |
| Pocillopora  | damicornis   |                 |             |                  |
| Pocillopora  | eydouxi      |                 | 1           |                  |
| Pocillopora  | meandrina    |                 |             |                  |
| Pocillopora  | verrucosa    |                 | 1           |                  |
| Porites  | branched     | (cylindrica)    |             |                  |
| Porites  | encrusting   | (lichen)        |             |                  |
| Porites  | massive      | (lobata/lutea)  | 4           |                  |
| Porites  | massive      | (murrayensis)   | 1           |                  |
| Porites  | rus          |                 |             |                  |
| Sarcophyton  | sp           |                 |             |                  |
| Sinularia  | sp           |                 |             |                  |
| Stylophora   | pistillata   |                 |             |                  |
| Turbinaria   | reniformis   |                 | 1           |                  |
|  |              | No. Species     | 21          |                  |
|  |              | Abundance Index | 26          |                  |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |             |                  |
|  |              |                 |             |                  |
| Coral  |              |                 | 38          |                  |
| Non-scleractinian  |              |                 | 0           |                  |
| Turf algae   |              |                 | 40          |                  |
| Macro algae  |              |                 | 20          | (Dictyosphaeria) |
| Filamentous algae  |              |                 | 0           |                  |
| Bluegreen mat  |              |                 | 550         |                  |
| Sponge   |              |                 | 0           |                  |
| Other (sand, rubble, calcareous)                               |              |                 | 4352        |                  |
| Total organisms  |              |                 | 648         |                  |
| Total cm/transect  |              |                 | 5000        |                  |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |             |                  |
|  |              | total number    | #/sq. meter |                  |
| Diadema  | sp           | 7               | 0.028       |                  |
| Echinothrix  | sp           | 0               | 0.000       |                  |
| Unid. urchin   |              | 0               | 0.000       |                  |
| Holothuria   | atra         | 2               | 0.008       |                  |
| Holothuria   | nobilis      | 1               | 0.004       |                  |

Site N

|                 |             |   |       |
|-----------------|-------------|---|-------|
| Stichopus       | chloronotus | 0 | 0.000 |
| Bohadschia      | argus       | 0 | 0.000 |
| Acanthaster     | sp          | 0 | 0.000 |
| Drupella        | sp          | 0 | 0.000 |
| Vermetid        | sp          | 0 | 0.000 |
| Spirobranchus   | sp          | 1 | 0.004 |
| Tridacna        | sp          | 0 | 0.000 |
| Trochus         | sp          | 0 | 0.000 |
| Turbo           | sp          | 0 | 0.000 |
| Conus           | sp          | 0 | 0.000 |
| Spider conch    |             | 0 | 0.000 |
| Unid. gastropod |             | 1 | 0.004 |
|                 |             |   |       |
|                 |             |   |       |
|                 |             |   |       |
|                 |             |   |       |

## Offshore-G/H

|                                      |                  |                |                         |     |
|--------------------------------------|------------------|----------------|-------------------------|-----|
| Site                                 | Offshore-G/H     |                | Depth: 5-17 m           |     |
| Date                                 | 9/10/92          |                | Slope: 20 degrees       |     |
| Time                                 | 10:30            |                |                         |     |
| <u>Substratum Type:</u>              |                  |                |                         |     |
| % hard substratum                    |                  | 75%            | live coral              | 40% |
|                                      |                  |                | reef pavement           | 35% |
| % rubble                             |                  | 20%            |                         |     |
| % sand                               |                  | 5%             |                         |     |
| <u>Spatial heterogeneity:</u>        |                  |                |                         |     |
|                                      |                  | 13 m/10 m      |                         |     |
| <u>Relative Abundance of Corals:</u> |                  |                | <u>Abundance Key:</u>   |     |
|                                      |                  |                | 5=>80% 4=31-80%         |     |
|                                      |                  |                | 3=11-30% 2=6-10% 1=1-5% |     |
| Acropora                             | cespitose        | fine branches  |                         |     |
| Acropora                             | cespitose        | stout branches | 1                       |     |
| Acropora                             | corymbose        | fine branches  |                         |     |
| Acropora                             | corymbose        | stout branches |                         |     |
| Acropora                             | thicket          | med branches   |                         |     |
| Acropora                             | thicket          | grandis        |                         |     |
| Acropora                             | spp              |                | 2                       |     |
| Acropora                             | spp              |                | 1                       |     |
| Acropora                             | spp              |                |                         |     |
| Acropora (Isopora)                   | cuneata          |                |                         |     |
| Acropora (Isopora)                   | palifera         |                |                         |     |
| Astreopora                           | myriophthalma    |                |                         |     |
| Coscinarea                           | columna          |                |                         |     |
| Cyphastrea                           | cf microphthalma |                |                         |     |
| Cyphastrea                           | cf serailia      |                | 1                       |     |
| Diploastrea                          | heliopora        |                |                         |     |
| Favia                                | stelligera       |                |                         |     |
| Favia                                | massive          |                | 1                       |     |
| Favites                              | massive          |                | 1                       |     |
| Fungia                               | fungites         |                | 1                       |     |
| Fungia                               | scutaria         |                |                         |     |
| Galaxea                              | fascicularis     |                | 1                       |     |
| Goniastrea                           | pectinata        |                |                         |     |
| Goniastrea                           | retiformis       |                | 4                       |     |
| Heliopora                            | coerulea         |                |                         |     |
| Hydnophora                           | exesa            |                | 1                       |     |
| Hydnophora                           | microconus       |                |                         |     |
| Leptastrea                           | massive          |                |                         |     |
| Leptoria                             | phyrgia          |                | 1                       |     |
| Lobophyllia                          | hemprichi        |                | 1                       |     |
| Millepora                            | branching        | (dichotoma)    |                         |     |

Offshore-G/H

|  |              |                 |                    |  |
|--|--------------|-----------------|--------------------|--|
| Millepora  | encrusting   |                 | 1                  |  |
| Millepora  | plates       | (platyphylla)   |                    |  |
| Montipora  | encrusting   |                 | 1                  |  |
| Montipora  | cf informis  |                 |                    |  |
| Montipora  | tuberculosa  |                 |                    |  |
| Mycedium   | elephantotum |                 |                    |  |
| Pavona   | clavus       |                 | 1                  |  |
| Pavona   | divaricata   |                 |                    |  |
| Pavona   | varians      |                 |                    |  |
| Pavona   | venosa       |                 |                    |  |
| Platygyra  | daedalea     |                 |                    |  |
| Pocillopora  | damicornis   |                 |                    |  |
| Pocillopora  | eydouxii     |                 | 1                  |  |
| Pocillopora  | meandrina    |                 |                    |  |
| Pocillopora  | verrucosa    |                 | 1                  |  |
| Porites  | branched     | (cylindrica)    |                    |  |
| Porites  | encrusting   | (lichen)        |                    |  |
| Porites  | massive      | (lobata/lutea)  |                    |  |
| Porites  | massive      | (murrayensis)   |                    |  |
| Porites  | rus          |                 |                    |  |
| Sarcophyton  | sp           |                 | 1                  |  |
| Sinularia  | sp           |                 |                    |  |
| Stylophora   | pistillata   |                 | 1                  |  |
| Turbinaria   | reniformis   |                 | 1                  |  |
|  |              | No. Species     | 20                 |  |
|  |              | Abundance Index | 24                 |  |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |                    |  |
|  |              |                 |                    |  |
| Coral  |              |                 | 717                |  |
| Non-scleractinian  |              |                 | 0 (Millepora)      |  |
| Turf algae   |              |                 | 10                 |  |
| Macro algae  |              |                 | 7 (Dictyosphaeria) |  |
| Bluegreen mat  |              |                 | 0                  |  |
| Sponge   |              |                 | 4                  |  |
| Other (sand, rubble, calcareous)                               |              |                 | 4266               |  |
| Total organisms  |              |                 | 734                |  |
| Total cm/transect  |              |                 | 5000               |  |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |                    |  |
|  |              | total number    | #/sq. meter        |  |
| Diadema  | sp           | 0               | 0.000              |  |
| Holothuria   | atra         | 0               | 0.000              |  |
| Holothuria   | nobilis      | 0               | 0.000              |  |

## Offshore-G/H

|               |             |   |       |  |  |
|---------------|-------------|---|-------|--|--|
| Stichopus     | chloronotus | 0 | 0.000 |  |  |
| Bohadschia    | argus       | 0 | 0.000 |  |  |
| Acanthaster   | sp          | 0 | 0.000 |  |  |
| Drupella      | sp          | 1 | 0.004 |  |  |
| Vermetid      | sp          | 0 | 0.000 |  |  |
| Spirobranchus | sp          | 0 | 0.000 |  |  |
| Tridacna      | sp          | 2 | 0.008 |  |  |
| Trochus       | sp          | 1 | 0.004 |  |  |

Offshore-Airport

|                                      |                  |                |                   |                         |
|--------------------------------------|------------------|----------------|-------------------|-------------------------|
| Site                                 | Offshore-Airport |                | Depth: 9-17 m     |                         |
| Date                                 | 9/10/92          |                | Slope: 10 degrees |                         |
| Time                                 | 12:15            |                |                   |                         |
| <u>Substratum Type:</u>              |                  |                |                   |                         |
| % hard substratum                    |                  | 80%            | live coral        | 5%                      |
|                                      |                  |                | reef pavement     | 75%                     |
| % rubble                             |                  | 2%             |                   |                         |
| % sand                               |                  | 18%            |                   |                         |
| <u>Spatial heterogeneity:</u>        |                  |                |                   |                         |
|                                      |                  | 10.5 m/10 m    |                   |                         |
| <u>Relative Abundance of Corals:</u> |                  |                |                   | <u>Abundance Key:</u>   |
|                                      |                  |                |                   | 5=>80% 4=31-80%         |
| Acropora                             | cespitose        | fine branches  |                   | 3=11-30% 2=6-10% 1=1-5% |
| Acropora                             | cespitose        | stout branches | 1                 |                         |
| Acropora                             | corymbose        | fine branches  |                   |                         |
| Acropora                             | corymbose        | stout branches |                   |                         |
| Acropora                             | thicket          | med branches   |                   |                         |
| Acropora                             | thicket          | grandis        |                   |                         |
| Acropora                             | spp              |                |                   |                         |
| Acropora                             | spp              |                |                   |                         |
| Acropora                             | spp              |                |                   |                         |
| Acropora (Isopora)                   | cuneata          |                |                   |                         |
| Acropora (Isopora)                   | palifera         |                |                   |                         |
| Astreopora                           | myriophthalma    |                | 3                 |                         |
| Coscinarea                           | columna          |                |                   |                         |
| Cyphastrea                           | cf microphthalma |                | 1                 |                         |
| Cyphastrea                           | cf serailia      |                |                   |                         |
| Diploastrea                          | heliopora        |                |                   |                         |
| Favia                                | stelligera       |                |                   |                         |
| Favia                                | massive          |                |                   |                         |
| Favites                              | massive          |                | 1                 |                         |
| Fungia                               | fungites         |                |                   |                         |
| Fungia                               | scutaria         |                |                   |                         |
| Galaxea                              | fascicularis     |                | 1                 |                         |
| Goniastrea                           | pectinata        |                |                   |                         |
| Goniastrea                           | retiformis       |                |                   |                         |
| Heliopora                            | coerulea         |                |                   |                         |
| Hydnophora                           | exesa            |                | 1                 |                         |
| Hydnophora                           | microconus       |                |                   |                         |
| Leptastrea                           | massive          |                |                   |                         |
| Leptoria                             | phyrgia          |                | 1                 |                         |
| Lobophyllia                          | hemprichi        |                |                   |                         |
| Millepora                            | branching        | (dichotoma)    |                   |                         |
| Millepora                            | encrusting       |                |                   |                         |
| Millepora                            | plates           | (platyphylla)  |                   |                         |

Offshore-Airport

|  |              |                 |                  |
|--|--------------|-----------------|------------------|
| Montipora  | encrusting   |                 | 2                |
| Montipora  | cf foveolata |                 | 2                |
| Montipora  | cf informis  |                 |                  |
| Montipora  | tuberculosa  |                 | 1                |
| Mycidium   | elephantotum |                 |                  |
| Pavona   | clavus       |                 |                  |
| Pavona   | divaricata   |                 |                  |
| Pavona   | varians      |                 |                  |
| Pavona   | venosa       |                 |                  |
| Platygyra  | daedalea     |                 |                  |
| Pocillopora  | damicornis   |                 |                  |
| Pocillopora  | eydouxii     |                 |                  |
| Pocillopora  | meandrina    |                 | 1                |
| Pocillopora  | verrucosa    |                 |                  |
| Porites  | branched     | (cylindrica)    |                  |
| Porites  | encrusting   | (lichen)        |                  |
| Porites  | massive      | (lobata/lutea)  |                  |
| Porites  | massive      | (murrayensis)   | 2                |
| Porites  | rus          |                 |                  |
| Sarcophyton  | sp           |                 | 1                |
| Sinularia  | sp           |                 |                  |
| Stylophora   | pistillata   |                 |                  |
| Turbinaria   | reniformis   |                 |                  |
|  |              | No. Species     | 13               |
|  |              | Abundance Index | 18               |
|  |              |                 |                  |
|  |              |                 |                  |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |                  |
|  |              |                 |                  |
| Coral  |              | 102             |                  |
| Non-scleractinian  |              | 0               |                  |
| Turf algae   |              | 800             |                  |
| Macro algae  |              | 50              | (Dictyosphaeria) |
| Filamentous algae  |              | 50              |                  |
| Bluegreen mat  |              | 0               |                  |
| Sponge   |              | 0               |                  |
| Other (sand, rubble, calcareous)                               |              | 3998            |                  |
| Total organisms  |              | 1002            |                  |
| Total cm/transect  |              | 5000            |                  |
|  |              |                 |                  |
|  |              |                 |                  |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |                  |
|  |              | total number    | #/sq. meter      |
| Diadema  | sp           | 0               | 0.000            |
| Echinothrix  | sp           | 1               | 0.004            |
| Unid. urchin   |              | 3750            | 15.000           |
| Holothuria   | atra         | 0               | 0.000            |
| Holothuria   | nobilis      | 0               | 0.000            |

Offshore-Airport

|               |             |   |       |
|---------------|-------------|---|-------|
| Stichopus     | chloronotus | 0 | 0.000 |
| Bohadschia    | argus       | 0 | 0.000 |
| Acanthaster   | sp          | 0 | 0.000 |
| Drupella      | sp          | 0 | 0.000 |
| Vermetid      | sp          | 0 | 0.000 |
| Spirobranchus | sp          | 0 | 0.000 |
| Tridacna      | sp          | 0 | 0.000 |
| Trochus       | sp          | 0 | 0.000 |
| Turbo         | sp          | 1 | 0.004 |



Offshore-Ofu Village

|                                      |                      |                |                   |                           |
|--------------------------------------|----------------------|----------------|-------------------|---------------------------|
| Site                                 | Offshore-Ofu Village |                | Depth: 9-17 m     |                           |
| Date                                 | 9/10/92              |                | Slope: 35 degrees |                           |
| Time                                 | 15:00                |                |                   |                           |
| <u>Substratum Type:</u>              |                      |                |                   |                           |
| % hard substratum                    |                      | 75%            | live coral        | 30%                       |
|                                      |                      |                | reef pavement     | 45%                       |
| % rubble                             |                      | 20%            |                   |                           |
| % sand                               |                      | 5%             |                   |                           |
| <u>Spatial heterogeneity:</u>        |                      |                |                   |                           |
|                                      |                      | 13 m/10 m      |                   |                           |
|                                      |                      |                |                   | Abundance Key:            |
| <u>Relative Abundance of Corals:</u> |                      |                |                   | 5= >80% 4= 31-80%         |
|                                      |                      |                |                   | 3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose            | fine branches  |                   |                           |
| Acropora                             | cespitose            | stout branches | 2                 |                           |
| Acropora                             | corymbose            | fine branches  |                   |                           |
| Acropora                             | corymbose            | stout branches |                   |                           |
| Acropora                             | thicket              | med branches   |                   |                           |
| Acropora                             | thicket              | grandis        |                   |                           |
| Acropora                             | spp                  | (cf robusta)   | 1                 |                           |
| Acropora                             | spp                  |                |                   |                           |
| Acropora                             | spp                  |                |                   |                           |
| Acropora (Isopora)                   | cuneata              |                |                   |                           |
| Acropora (Isopora)                   | palifera             |                | 2                 |                           |
| Astreopora                           | myriophthalma        |                | 2                 |                           |
| Coscinarea                           | columna              |                |                   |                           |
| Cyphastrea                           | cf microphthalma     |                | 1                 |                           |
| Cyphastrea                           | cf serailia          |                | 1                 |                           |
| Diploastrea                          | heliopora            |                | 1                 |                           |
| Favia                                | stelligera           |                | 1                 |                           |
| Favia                                | massive              |                | 1                 |                           |
| Favites                              | massive              |                |                   |                           |
| Fungia                               | fungites             |                | 1                 |                           |
| Fungia                               | scutaria             |                | 1                 |                           |
| Galaxea                              | fascicularis         |                | 1                 |                           |
| Goniastrea                           | pectinata            |                |                   |                           |
| Goniastrea                           | retiformis           |                | 2                 |                           |
| Heliopora                            | coerulea             |                |                   |                           |
| Hydnophora                           | exesa                |                | 2                 |                           |
| Hydnophora                           | microconus           |                |                   |                           |
| Leptastrea                           | massive              |                |                   |                           |
| Leptoria                             | phyrgia              |                | 2                 |                           |
| Lobophyllia                          | hemprichi            |                | 1                 |                           |
| Millepora                            | branching            | (dichotoma)    |                   |                           |
| Millepora                            | encrusting           |                |                   |                           |
| Millepora                            | plates               | (platyphylla)  |                   |                           |
| Montipora                            | encrusting           |                | 1                 |                           |

Offshore-Ofu Village

|  |              |                 |                              |
|--|--------------|-----------------|------------------------------|
| Montipora  | cf foveolata |                 |                              |
| Montipora  | cf informis  |                 |                              |
| Montipora  | tuberculosa  |                 | 1                            |
| Mycedium   | elephantotum |                 | 1                            |
| Pavona   | clavus       |                 | 1                            |
| Pavona   | divaricata   |                 |                              |
| Pavona   | varians      |                 | 1                            |
| Pavona   | venosa       |                 |                              |
| Platygyra  | daedalea     |                 | 1                            |
| Pocillopora  | damicornis   |                 |                              |
| Pocillopora  | eydouxii     |                 |                              |
| Pocillopora  | meandrina    |                 |                              |
| Pocillopora  | verrucosa    |                 | 1                            |
| Porites  | branched     | (cylindrica)    |                              |
| Porites  | encrusting   | (lichen)        |                              |
| Porites  | massive      | (lobata/lutea)  | 1                            |
| Porites  | massive      | (murrayensis)   |                              |
| Porites  | rus          |                 | 1                            |
| Sarcophyton  | sp           |                 | 1                            |
| Sinularia  | sp           |                 | 1                            |
| Stylophora   | pistillata   |                 | 1                            |
| Turbinaria   | reniformis   |                 | 1                            |
|  |              | No. Species     | 29                           |
|  |              | Abundance Index | 35                           |
|  |              |                 |                              |
|  |              |                 |                              |
| <u>Benthic Organisms (cm per 50 m line intercept transect)</u> |              |                 |                              |
|  |              |                 |                              |
| Coral  |              | 460             |                              |
| Non-scleractinian  |              | 34              | (Millepora=4, Soft coral=30) |
| Turf algae   |              | 1010            |                              |
| Macro algae  |              | 0               |                              |
| Filamentous algae  |              | 0               |                              |
| Bluegreen mat  |              | 0               |                              |
| Sponge   |              | 0               |                              |
| Other (sand, rubble, calcareous)                               |              | 3496            |                              |
| Total organisms  |              | 1504            |                              |
| Total cm/transect  |              | 5000            |                              |
|  |              |                 |                              |
|  |              |                 |                              |
| <u>Macro Invertebrates (per 50 x 5 m belt transect)</u>        |              |                 |                              |
|  |              | total number    | #/sq. meter                  |
| Diadema  | sp           | 0               | 0.000                        |
| Echinothrix  | sp           | 0               | 0.000                        |
| Unid. urchin   |              | 1               | 0.004                        |
| Holothuria   | atra         | 0               | 0.000                        |
| Holothuria   | nobilis      | 0               | 0.000                        |
| Stichopus  | chloronotus  | 0               | 0.000                        |
| Bohadschia   | argus        | 0               | 0.000                        |

Offshore-Ofu Village

|                                      |                      |                |                   |  |
|--------------------------------------|----------------------|----------------|-------------------|--|
| Site                                 | Offshore-Ofu Village |                | Depth: 9-17 m     |  |
| Date                                 | 9/10/92              |                | Slope: 35 degrees |  |
| Time                                 | 15:00                |                |                   |  |
| <u>Substratum Type:</u>              |                      |                |                   |  |
| % hard substratum                    |                      | 75%            | live coral        | 30%  |
|                                      |                      |                | reef pavement     | 45%  |
| % rubble                             |                      | 20%            |                   |  |
| % sand                               |                      | 5%             |                   |  |
| <u>Spatial heterogeneity:</u>        |                      |                |                   |  |
|                                      |                      | 13 m/10 m      |                   |  |
| <u>Relative Abundance of Corals:</u> |                      |                |                   |  |
|                                      |                      |                |                   | Abundance Key:<br>5= >80% 4= 31-80%<br>3= 11-30% 2= 6-10% 1=1-5% |
| Acropora                             | cespitose            | fine branches  |                   |  |
| Acropora                             | cespitose            | stout branches | 2                 |  |
| Acropora                             | corymbose            | fine branches  |                   |  |
| Acropora                             | corymbose            | stout branches |                   |  |
| Acropora                             | thicket              | med branches   |                   |  |
| Acropora                             | thicket              | grandis        |                   |  |
| Acropora                             | spp                  | (cf robusta)   | 1                 |  |
| Acropora                             | spp                  |                |                   |  |
| Acropora                             | spp                  |                |                   |  |
| Acropora (Isopora)                   | cuneata              |                |                   |  |
| Acropora (Isopora)                   | palifera             |                | 2                 |  |
| Astreopora                           | myriophthalma        |                | 2                 |  |
| Coscinarea                           | columna              |                |                   |  |
| Cyphastrea                           | cf microphthalma     |                | 1                 |  |
| Cyphastrea                           | cf serailia          |                | 1                 |  |
| Diploastrea                          | heliopora            |                | 1                 |  |
| Favia                                | stelligera           |                | 1                 |  |
| Favia                                | massive              |                | 1                 |  |
| Favites                              | massive              |                |                   |  |
| Fungia                               | fungites             |                | 1                 |  |
| Fungia                               | scutaria             |                | 1                 |  |
| Galaxea                              | fascicularis         |                | 1                 |  |
| Goniastrea                           | pectinata            |                |                   |  |
| Goniastrea                           | retiformis           |                | 2                 |  |
| Heliopora                            | coerulea             |                |                   |  |
| Hydnophora                           | exesa                |                | 2                 |  |
| Hydnophora                           | microconus           |                |                   |  |
| Leptastrea                           | massive              |                |                   |  |
| Leptoria                             | phyrgia              |                | 2                 |  |
| Lobophyllia                          | hemprichi            |                | 1                 |  |
| Millepora                            | branching            | (dichotoma)    |                   |  |
| Millepora                            | encrusting           |                |                   |  |
| Millepora                            | plates               | (platyphylla)  |                   |  |
| Montipora                            | encrusting           |                | 1                 |  |

Offshore-Ofu Village

|  |              |                 |             |                              |
|--|--------------|-----------------|-------------|------------------------------|
| Montipora  | cf foveolata |                 |             |                              |
| Montipora  | cf informis  |                 |             |                              |
| Montipora  | tuberculosa  |                 | 1           |                              |
| Mycidium   | elephantotum |                 | 1           |                              |
| Pavona   | clavus       |                 | 1           |                              |
| Pavona   | divaricata   |                 |             |                              |
| Pavona   | varians      |                 | 1           |                              |
| Pavona   | venosa       |                 |             |                              |
| Platygyra  | daedalea     |                 | 1           |                              |
| Pocillopora  | damicornis   |                 |             |                              |
| Pocillopora  | eydouxii     |                 |             |                              |
| Pocillopora  | meandrina    |                 |             |                              |
| Pocillopora  | verrucosa    |                 | 1           |                              |
| Porites  | branched     | (cylindrica)    |             |                              |
| Porites  | encrusting   | (lichen)        |             |                              |
| Porites  | massive      | (lobata/lutea)  | 1           |                              |
| Porites  | massive      | (murrayensis)   |             |                              |
| Porites  | rus          |                 | 1           |                              |
| Sarcophyton  | sp           |                 | 1           |                              |
| Sinularia  | sp           |                 | 1           |                              |
| Stylophora   | pistillata   |                 | 1           |                              |
| Turbinaria   | reniformis   |                 | 1           |                              |
|  |              | No. Species     | 29          |                              |
|  |              | Abundance Index | 35          |                              |
|  |              |                 |             |                              |
|  |              |                 |             |                              |
| <b>Benthic Organisms (cm per 50 m line intercept transect)</b> |              |                 |             |                              |
|  |              |                 |             |                              |
| Coral  |              |                 | 460         |                              |
| Non-scleractinian  |              |                 | 34          | (Millepora=4, Soft coral=30) |
| Turf algae   |              |                 | 1010        |                              |
| Macro algae  |              |                 | 0           |                              |
| Filamentous algae  |              |                 | 0           |                              |
| Bluegreen mat  |              |                 | 0           |                              |
| Sponge   |              |                 | 0           |                              |
| Other (sand, rubble, calcareous)                               |              |                 | 3496        |                              |
| Total organisms  |              |                 | 1504        |                              |
| Total cm/transect  |              |                 | 5000        |                              |
|  |              |                 |             |                              |
|  |              |                 |             |                              |
| <b>Macro Invertebrates (per 50 x 5 m belt transect)</b>        |              |                 |             |                              |
|  |              | total number    | #/sq. meter |                              |
| Diadema  | sp           | 0               | 0.000       |                              |
| Echinothrix  | sp           | 0               | 0.000       |                              |
| Unid. urchin   |              | 1               | 0.004       |                              |
| Holothuria   | atra         | 0               | 0.000       |                              |
| Holothuria   | nobilis      | 0               | 0.000       |                              |
| Stichopus  | chloronotus  | 0               | 0.000       |                              |
| Bohadschia   | argus        | 0               | 0.000       |                              |

Offshore-Ofu Village

|               |    |   |       |
|---------------|----|---|-------|
| Acanthaster   | sp | 0 | 0.000 |
| Drupella      | sp | 7 | 0.028 |
| Vermetid      | sp | 0 | 0.000 |
| Spirobranchus | sp | 0 | 0.000 |
| Tridacna      | sp | 1 | 0.004 |
| Trochus       | sp | 8 | 0.032 |
| Turbo         | sp | 1 | 0.004 |
| Conus         | sp | 3 | 0.012 |
|               |    |   |       |
|               |    |   |       |

Appendix III. Benthic Macro-invertebrate Abundance at Ofu, September, 1992.

DATA SOURCE: VIDEO TRANSECTS

| Transects:    | SITE C |   |    |                                | SITE E |   |   |                                | SITE G |   |    |                                |
|---------------|--------|---|----|--------------------------------|--------|---|---|--------------------------------|--------|---|----|--------------------------------|
|               | 1      | 2 | 3  | Average                        | 1      | 2 | 3 | Average                        | 1      | 2 | 3  | Average                        |
|               |        |   |    | <u>Areal</u><br><u>% Cover</u> |        |   |   | <u>Areal</u><br><u>% Cover</u> |        |   |    | <u>Areal</u><br><u>% Cover</u> |
| Holo. atra    | 2      | 0 | 0  | 0.22                           | 0      | 0 | 0 | 0.00                           | 2      | 0 | 0  | 0.22                           |
| Holo. nobilis | 1      | 0 | 0  | 0.11                           | 0      | 1 | 0 | 0.11                           | 1      | 0 | 0  | 0.11                           |
| Stichopus     | 0      | 2 | 2  | 0.44                           | 0      | 0 | 0 | 0.00                           | 0      | 2 | 2  | 0.44                           |
| Bohadschia    | 0      | 3 | 2  | 0.56                           | 1      | 0 | 1 | 0.22                           | 0      | 3 | 2  | 0.56                           |
| Acanthaster   | 0      | 0 | 13 | 1.44                           | 11     | 0 | 0 | 1.22                           | 0      | 0 | 13 | 1.44                           |
| Tridacna      | 0      | 0 | 0  | 0.00                           | 0      | 0 | 0 | 0.00                           | 0      | 0 | 0  | 0.00                           |
| Urchin        | 0      | 0 | 0  | 0.00                           | 0      | 0 | 0 | 0.00                           | 0      | 0 | 0  | 0.00                           |
| Trochus       | 0      | 0 | 0  | 0.00                           | 0      | 0 | 0 | 0.00                           | 0      | 0 | 0  | 0.00                           |
| Total         |        |   |    | 2.78                           |        |   |   | 1.56                           |        |   |    | 2.78                           |

DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT

|               | SITE C                |                        |                                | SITE E                 |                                | SITE G                 |                                |
|---------------|-----------------------|------------------------|--------------------------------|------------------------|--------------------------------|------------------------|--------------------------------|
|               | Size                  | Total                  | Average                        | Total                  | Average                        | Total                  | Average                        |
|               | <u>cm<sup>2</sup></u> | <u>#/m<sup>2</sup></u> | <u>Areal</u><br><u>% Cover</u> | <u>#/m<sup>2</sup></u> | <u>Areal</u><br><u>% Cover</u> | <u>#/m<sup>2</sup></u> | <u>Areal</u><br><u>% Cover</u> |
| Holo. atra    | 63.00                 | .020                   | .0126                          | .020                   | .0126                          | .000                   | .000                           |
| Holo. nobilis | 312.00                | .005                   | .0156                          | .007                   | .0218                          | .012                   | .037                           |
| Stichopus     | 63.00                 | .690                   | .4347                          | .087                   | .0548                          | .000                   | .000                           |
| Bohadschia    | 123.75                | .035                   | .0433                          | .027                   | .0334                          | .016                   | .020                           |
| Acanthaster   | 706.00                | .000                   | .0000                          | .007                   | .0494                          | .000                   | .000                           |
| Tridacna      | 25.50                 | .000                   | .0000                          | .000                   | .0000                          | .036                   | .009                           |
| Diadema       | 15.90                 | .005                   | .0008                          | .000                   | .0000                          | .000                   | .000                           |
| Echinothrix   | 1.75                  | .000                   | .0000                          | .000                   | .0000                          | .000                   | .000                           |
| Trochus       | 50.25                 | .000                   | .0000                          | .000                   | .0000                          | .000                   | .000                           |
| Drupella      | 0.50                  | .015                   | .0001                          | .000                   | .0000                          | .000                   | .000                           |
| Vermetid      | 1.75                  | .000                   | .0000                          | .007                   | .0001                          | .000                   | .000                           |
| Turbo         | 3.00                  | .000                   | .0000                          | .000                   | .0000                          | .000                   | .000                           |
| Conus         | 10.00                 | .000                   | .0000                          | .000                   | .0000                          | .000                   | .000                           |
| Spider conch  | 352.80                | .000                   | .0000                          | .000                   | .0000                          | .000                   | .000                           |
| Spirobranchus | 0.80                  | .000                   | .0000                          | .020                   | .0002                          | .004                   | .000                           |
| Total         |                       | 0.77                   | 0.51                           | 0.18                   | 0.17                           | 0.07                   | 0.07                           |

Appendix III (cont)

DATA SOURCE: VIDEO TRANSECTS

| Transects:    | SITE H |   |   |                             | SITE K |   |    |                             | SITE N |   |   |                             |
|---------------|--------|---|---|-----------------------------|--------|---|----|-----------------------------|--------|---|---|-----------------------------|
|               | 1      | 2 | 3 | Average<br>Areal<br>% Cover | 1      | 2 | 3  | Average<br>Areal<br>% Cover | 1      | 2 | 3 | Average<br>Areal<br>% Cover |
| Holo. atra    | 0      | 0 | 0 | 0.00                        | 2      | 0 | 0  | 0.22                        | 0      | 0 | 0 | 0.00                        |
| Holo. nobilis | 0      | 1 | 0 | 0.11                        | 1      | 0 | 0  | 0.11                        | 0      | 1 | 0 | 0.11                        |
| Stichopus     | 0      | 0 | 0 | 0.00                        | 0      | 2 | 2  | 0.44                        | 0      | 0 | 0 | 0.00                        |
| Bohadschia    | 1      | 0 | 1 | 0.22                        | 0      | 3 | 2  | 0.56                        | 1      | 0 | 1 | 0.22                        |
| Acanthaster   | 11     | 0 | 0 | 1.22                        | 0      | 0 | 13 | 1.44                        | 11     | 0 | 0 | 1.22                        |
| Tridacna      | 0      | 0 | 0 | 0.00                        | 0      | 0 | 0  | 0.00                        | 0      | 0 | 0 | 0.00                        |
| Urchin        | 0      | 0 | 0 | 0.00                        | 0      | 0 | 0  | 0.00                        | 0      | 0 | 0 | 0.00                        |
| Trochus       | 0      | 0 | 0 | 0.00                        | 0      | 0 | 0  | 0.00                        | 0      | 0 | 0 | 0.00                        |
|               |        |   |   | 1.56                        |        |   |    | 2.78                        |        |   |   | 1.56                        |

DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT

|               | SITE H                  |                           |                             | SITE K                    |                             | SITE N                    |                             |
|---------------|-------------------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|-----------------------------|
|               | Size<br>cm <sup>2</sup> | Total<br>#/m <sup>2</sup> | Average<br>Areal<br>% Cover | Total<br>#/m <sup>2</sup> | Average<br>Areal<br>% Cover | Total<br>#/m <sup>2</sup> | Average<br>Areal<br>% Cover |
| Holo. atra    | 63.00                   | .000                      | .000                        | .004                      | .003                        | .008                      | .005                        |
| Holo. nobilis | 312.00                  | .008                      | .025                        | .000                      | .000                        | .004                      | .012                        |
| Stichopus     | 63.00                   | .000                      | .000                        | .000                      | .000                        | .000                      | .000                        |
| Bohadschia    | 123.75                  | .028                      | .035                        | .076                      | .094                        | .000                      | .000                        |
| Acanthaster   | 706.00                  | .004                      | .028                        | .000                      | .000                        | .000                      | .000                        |
| Tridacna      | 25.50                   | .004                      | .001                        | .020                      | .005                        | .000                      | .000                        |
| Diadema       | 15.90                   | .036                      | .006                        | .000                      | .000                        | .000                      | .000                        |
| Echinothrix   | 1.75                    | .000                      | .000                        | .004                      | .000                        | .000                      | .000                        |
| Trochus       | 50.25                   | .000                      | .000                        | .004                      | .002                        | .000                      | .000                        |
| Drupella      | 0.50                    | .000                      | .000                        | .000                      | .000                        | .000                      | .000                        |
| Vermetid      | 1.75                    | .000                      | .000                        | .000                      | .000                        | .000                      | .000                        |
| Turbo         | 3.00                    | .000                      | .000                        | .000                      | .000                        | .000                      | .000                        |
| Conus         | 10.00                   | .000                      | .000                        | .004                      | .000                        | .000                      | .000                        |
| Spider conch  | 352.80                  | .000                      | .000                        | .004                      | .014                        | .000                      | .000                        |
| Spirobranchus | 0.80                    | .000                      | .000                        | .000                      | .000                        | .004                      | .000                        |
| Total         |                         | 0.08                      | 0.09                        | 0.12                      | 0.12                        | 0.02                      | 0.02                        |

Appendix III (cont)

DATA SOURCE: VIDEO TRANSECTS

Offshore Sites

Airport                      G/H                      Ofu Village

(Offshore Video Analyses Not Performed)

DATA SOURCE: 50 M PERPENDICULAR LINEAR TRANSECT

Offshore Sites

|               | Size                  | Total                  | % Cover              | Total                  | % Cover              | Total                  | % Cover              |
|---------------|-----------------------|------------------------|----------------------|------------------------|----------------------|------------------------|----------------------|
|               | <u>cm<sup>2</sup></u> | <u>#/m<sup>2</sup></u> | <u>m<sup>2</sup></u> | <u>#/m<sup>2</sup></u> | <u>m<sup>2</sup></u> | <u>#/m<sup>2</sup></u> | <u>m<sup>2</sup></u> |
| Holo. atra    | 63.00                 | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Holo. nobilis | 312.00                | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Stichopus     | 63.00                 | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Bohadschia    | 123.75                | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Acanthaster   | 706.00                | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Tridacna      | 25.50                 | .000                   | .000                 | .008                   | .002                 | .004                   | .001                 |
| Diadema       | 15.90                 | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Echinothrix   | 1.75                  | 15.004                 | .263                 | .000                   | .000                 | .004                   | .000                 |
| Trochus       | 50.25                 | .000                   | .000                 | .008                   | .004                 | .032                   | .016                 |
| Drupella      | 0.50                  | .000                   | .000                 | .004                   | .000                 | .028                   | .000                 |
| Vermetid      | 1.75                  | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Turbo         | 3.00                  | .004                   | .000                 | .000                   | .000                 | .004                   | .000                 |
| Conus         | 10.00                 | .000                   | .000                 | .000                   | .000                 | .012                   | .001                 |
| Spider conch  | 352.80                | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Spirobranchus | 0.80                  | .000                   | .000                 | .000                   | .000                 | .000                   | .000                 |
| Total         |                       | 15.01                  | 0.26                 | 0.02                   | 0.01                 | 0.08                   | 0.02                 |



Appendix IV. Checklist of corals and macroinvertebrates observed at Ofu in September, 1992.

| <i>Genus</i>       | <i>species</i>   | descriptor     |
|--------------------|------------------|----------------|
| Corals             |                  |                |
| Acropora           | cespitose        | fine branches  |
| Acropora           | cespitose        | stout branches |
| Acropora           | corymbose        | fine branches  |
| Acropora           | corymbose        | stout branches |
| Acropora           | thicket          | med branches   |
| Acropora           | thicket          | grandis        |
| Acropora           | spp              | (cf robusta)   |
| Acropora           | spp              |                |
| Acropora           | spp              |                |
| Acropora (Isopora) | cuneata          |                |
| Acropora (Isopora) | palifera         |                |
| Astreopora         | myriophthalma    |                |
| Coscinarea         | columna          |                |
| Cyphastrea         | cf microphthalma |                |
| Cyphastrea         | cf serailia      |                |
| Diploastrea        | heliopora        |                |
| Favia              | stelligera       |                |
| Favia              | sp.              | massive        |
| Favites            | sp.              | massive        |
| Fungia             | fungites         |                |
| Fungia             | scutaria         |                |
| Galaxea            | fascicularis     |                |
| Goniastrea         | pectinata        |                |
| Goniastrea         | retiformis       |                |
| Heliopora          | coerulea         |                |
| Hydnophora         | exesa            |                |
| Hydnophora         | microconus       |                |
| Leptastrea         | sp.              | massive        |
| Leptoria           | phyrgia          |                |
| Lobophyllia        | hemprichi        |                |
| Millepora          | dichotoma        | branching      |
| Millepora          | encrusting       |                |

|             |              |            |             |
|-------------|--------------|------------|-------------|
| Millepora   | platyphylla  | plates     |             |
| Montipora   | sp.          | encrusting | → Montipora |
| Montipora   | cf foveolata |            |             |
| Montipora   | cf informis  |            |             |
| Montipora   | tuberculosa  |            |             |
| Mycedium    | elephantotum |            |             |
| Pavona      | clavus       |            |             |
| Pavona      | divaricata   |            |             |
| Pavona      | varians      |            |             |
| Pavona      | venosa       |            |             |
| Platygyra   | daedalea     |            |             |
| Pocillopora | damicornis   |            |             |
| Pocillopora | eydouxi      |            |             |
| Pocillopora | meandrina    |            |             |
| Pocillopora | verrucosa    |            |             |
| Porites     | cylindrica   | branched   |             |
| Porites     | lichen       | encrusting |             |
| Porites     | lobata/lutea | massive    |             |
| Porites     | murrayensis  | massive    |             |
| Porites     | rus          |            |             |
| Sarcophyton | sp           |            |             |
| Sinularia   | sp           |            |             |
| Stylophora  | pistillata   |            |             |
| Turbinaria  | reniformis   |            |             |

### Macro Invertebrates

|               |             |        |
|---------------|-------------|--------|
| Diadema       | sp          |        |
| Echinothrix   | sp          |        |
| Unid. urchins |             |        |
| Holothuria    | atra        |        |
| Holothuria    | nobilis     |        |
| Stichopus     | chloronotus |        |
| Bohadschia    | argus       |        |
| Acanthaster   | sp          | alamea |
| Drupella      | sp          |        |

|                  |    |
|------------------|----|
| Vermetid         | sp |
| Spirobranchus    | sp |
| Tridacna         | sp |
| Trochus          | sp |
| Turbo            | sp |
| Conus            | sp |
| Spider conch     |    |
| Unid. gastropods |    |

**Appendix V.** List of the species observed and collected at Ofu. Specimen numbers are the collection numbers of Dr. Karla McDermid at the University of Hawaii. Slide mounts of the specimens were prepared by student workers with her guidance. Identifications were made by Dr. William Magruder.

**CHLOROPHYTA (GREEN SEAWEEDS)**

| GENUS & SPECIES           | COLL# | LOCATION                         | SITE | DATE      | DEPTH |
|---------------------------|-------|----------------------------------|------|-----------|-------|
| Bryopsis sp.              | 3590  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Caulerpa racemosa         |       | Observed but not collected       |      |           |       |
| Caulerpa serrulata        |       | Observed but not collected       |      |           |       |
| Chaetomorpha antennina    |       | Observed but not collected       |      |           |       |
| Chlorodesmis sp.          | 3637  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Chlorodesmis sp.          | 3643  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Chlorodesmis sp.          | 3649  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Chlorodesmis sp.          | 3663  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Chlorodesmis sp.          | 3681  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Chlorodesmis sp.          | 3775  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cladophora sp.            | 3572  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Cladophora sp.            | 3665  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Cladophora sp.            | 3583  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Codium                    |       | Observed but not collected       |      |           |       |
| Dictyosphaeria cavernosa  |       | Observed but not collected       |      |           |       |
| Dictyosphaeria versluysii |       | Observed but not collected       |      |           |       |
| Enteromorpha sp.          | 3604  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Halimeda opuntia          | 3630  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Udotea-like green         | 3699  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Ventricaria ventricosa    |       | Observed but not collected       |      |           |       |
| unidentified green        | 3549  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| unidentified green        | 3555  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| unidentified green        | 3556  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| unidentified green        | 3559  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| unidentified green        | 3584  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified green        | 3656  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified green        | 3671  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified green        | 3698  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |

## Appendix V (cont.)

## PHAEOPHYTA (BROWN SEAWEEDS)

| GENUS & SPECIES                 | COLL# | LOCATION                         | SITE | DATE      | DEPTH |
|---------------------------------|-------|----------------------------------|------|-----------|-------|
| <i>Dictyopteris repens</i>      | 3462  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| <i>Dictyopteris repens</i>      | 3465  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| <i>Dictyopteris repens</i>      | 3524  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| <i>Dictyopteris repens</i>      | 3542  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| <i>Dictyopteris repens</i>      | 3591  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Dictyopteris repens</i>      | 3736  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Dictyopteris repens</i>      | 3767  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3474  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| <i>Dictyota friabilis</i>       | 3527  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| <i>Dictyota friabilis</i>       | 3625  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3641  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3692  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3718  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3781  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| <i>Dictyota friabilis</i>       | 3791  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| <i>Feldmania</i> sp.            | 3647  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Hinksia breviarticularis</i> |       | Observed but not collected       |      |           |       |
| <i>Hydroclathrus</i>            |       | Observed but not collected       |      |           |       |
| <i>Lobophora variegata</i>      | 3454  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| <i>Lobophora variegata</i>      | 3466  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| <i>Lobophora variegata</i>      | 3513  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| <i>Lobophora variegata</i>      | 3619  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Lobophora variegata</i>      | 3780  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| <i>Padina</i>                   |       | Observed but not collected       |      |           |       |
| <i>Sphaecelaria tribuloides</i> | 3514  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| <i>Sphaecelaria tribuloides</i> | 3744  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Sphaecelaria tribuloides</i> | 3745  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Sphaecelaria tribuloides</i> | 3746  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Sphaecelaria tribuloides</i> | 3747  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Sphaecelaria tribuloides</i> | 3762  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| <i>Turbinaria ornata</i>        |       | Observed but not collected       |      |           |       |

## Appendix V (cont.)

## RHODOPHYTA (RED SEAWEEDS)

| GENUS & SPECIES         | COLL# | LOCATION                         | SITE | DATE      | DEPTH |
|-------------------------|-------|----------------------------------|------|-----------|-------|
| Acrochaetium sp.        | 3756  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Amphiroa sp.            | 3701  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Antithamnion percurans  | 3458  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| Antithamnion sp.        | 3595  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Antithamnion sp.        | 3605  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Antithamnion antillanum | 3545  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Apoglossum sp.?         | 3613  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Ceramium byssoides      | 3660  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Ceramium sp.            | 3486  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Ceramium sp.            | 3499  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Ceramium sp.            | 3578  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Ceramium sp.            | 3632  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Ceramium sp.            | 3635  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Ceramium sp.            | 3640  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Ceramium sp.            | 3727  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Champia sp.             | 3763  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Cheilosporum sp.        | 3456  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| Chondria sp.            | 3566  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Coelothrix sp.          | 3544  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Cruania minutissima     | 3764  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3765  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3768  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3769  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3771  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3776  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3784  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3787  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3790  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Cruania minutissima     | 3792  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Dasya sp.               | 3485  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Erythrotrichia sp.      | 3642  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Falkenbergia sp.        | 3458  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| Galaxaura sp.           | 3452  | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| Galaxaura sp.           | 3648  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Galaxaura sp.           | 3652  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Galaxaura sp.           | 3757  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Galaxaura sp.           | 3758  | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Gelidiella sp.          | 3476  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Gelidiella sp.          | 3569  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Gelidiella sp.          | 3570  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Gelidiella sp.          | 3770  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Gelidiopsis sp.         | 3498  | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Gelidiopsis sp.         | 3710  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Gelidium sp.            | 3789  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Griffithsia sp.         | 3707  | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Halymenia               |       | Observed but not collected       |      |           |       |
| Herposiphonia sp.       | 3568  | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |

Appendix V (cont.)

|                         |      |                                  |      |           |       |
|-------------------------|------|----------------------------------|------|-----------|-------|
| Herposiphonia sp.       | 3616 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Herposiphonia sp.       | 3631 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Herposiphonia sp.       | 3639 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Herposiphonia sp.       | 3666 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Herposiphonia sp.       | 3684 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Herposiphonia sp.       | 3803 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Heterosiphonia sp.      | 3614 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hydrolithon             |      | Observed but not collected       |      |           |       |
| Hypnea pannosa          | 3550 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Hypnea pannosa          | 3552 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Hypnea pannosa          | 3655 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hypnea pannosa          | 3664 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hypnea sp.              | 3669 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hypnea sp.              | 3716 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hypoglossum sp.         | 3585 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Hypoglossum sp.         | 3596 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3473 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Jania sp.               | 3484 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Jania sp.               | 3493 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Jania sp.               | 3496 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| Jania sp.               | 3554 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Jania sp.               | 3638 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3650 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3658 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3691 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Jania sp.               | 3700 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Jania sp.               | 3708 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Jania sp.               | 3748 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3749 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3753 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3755 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3759 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Jania sp.               | 3786 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Jania sp.               | 3801 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Laurancia sp.           | 3709 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Laurencia sp.           | 3644 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Laurencia sp.           | 3714 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Martensia sp.           | 3450 | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| Mesophyllum mesomorphum |      | Observed but not collected       |      |           |       |
| Polysiphonia sp.        | 3562 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Polysiphonia sp.        | 3565 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| Polysiphonia sp.        | 3597 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sp.        | 3598 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sp.        | 3609 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sp.        | 3620 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sp.        | 3685 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sp.        | 3731 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sparsa     | 3676 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sparsa     | 3680 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Polysiphonia sparsa     | 3779 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| Porolithon gardineri    |      | Observed but not collected       |      |           |       |
| Porolithon onkoides     |      | Observed but not collected       |      |           |       |

Appendix V (cont.)

|                             |      |                                  |      |           |       |
|-----------------------------|------|----------------------------------|------|-----------|-------|
| Rhodolacne decussata        | 3721 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| Sporolithon                 |      | Observed but not collected       |      |           |       |
| Tolypocladia sp.            | 3793 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| unidentified Delessariaceae | 3469 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| unidentified Delessariaceae | 3500 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| unidentified Delessariaceae | 3505 | Off Hurricane House              | OG/H | 10-Sep-93 | 15 m  |
| unidentified Delessariaceae | 3561 | Off Village, Ofu                 | OV   | 10-Sep-93 | 15 m  |
| unidentified Delessariaceae | 3715 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified Delessariaceae | 3719 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified Delessariaceae | 3728 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified red alga       | 3451 | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| unidentified red alga       | 3668 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified red alga       | 3690 | Reef flat off hurricane house    | G    | 11-Sep-93 | 0-3 m |
| unidentified red alga       | 3766 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| unidentified red alga       | 3788 | Reef flat off east end of runway | C    | 12-Sep-93 | 0-3 m |
| unidentified red alga       | 3459 | Off Village, Ofu                 | OV   | 10-Sep-93 | 10 m  |
| unidentified red alga       | 3723 | Reef flat off hurricane house    | G    | 12-Sep-93 | 0-3 m |



Appendix VI. Fish species observed during underwater stationary point counts and subsequent searches at Ofu, American Samoa. Phylogenetic order based on Randall et al. (1990). Scientific and common names from Randall et al. (1990), Myers (1991), and Allen (1991). Samoan names from Wass (1984). Families are listed in capital letters with numbers of species in parentheses.

| FAMILY / Species   | Common name   | Samoan Name  |
|--|---|--|
| <b>CARCHARCHINIDAE (N=2)</b><br><i>Carcharhinus amblyrhynchos</i><br><i>Carcharhinus melanopterus</i>  | <b>REQUIEM SHARKS</b><br>Grey reef shark<br>Blacktip reef shark   | Malie<br>Malie-aloalo<br>Apeape, malie-alamata   |
| <b>MYLIOBATIDIDAE (N=1)</b><br><i>Aetobatus narinari</i>   | <b>EAGLE RAYS</b><br>Spotted eagle ray  | Fai-pe'a, fai-manu   |
| <b>MURAENIDAE (N=4)</b><br><i>Echidna nebulosa</i><br><i>Gymnothorax flavimarginatus</i><br><i>Gymnothorax meleagris</i><br><i>Gymnothorax undulatus</i>   | <b>MORAYS</b><br>Starry moray<br>Yellowmargin moray<br>Whitemouth moray<br>Undulated moray  | Pusi<br>Ai'aigua<br>Tafi-laotalo, pusi-gatala<br>Puali'i, 'ai'aiivi<br>Pusi-pulepule   |
| <b>CONGRIDAE (N=1)</b><br><i>Conger cinereus</i>   | <b>CONGER EELS</b><br>Black-edged conger  | I'au, pusi-solasulu  |
| <b>CLUPEIDAE (N = 1)</b><br><i>Spratelloides gracilis</i>  | <b>HERRINGS</b><br>Silver sprat   | Pelupelu<br>Poi, nefu  |
| <b>SYNODONTIDAE (N=3)</b><br><i>Saurida gracilis</i><br><i>Synodus binotatus</i><br><i>Synodus variegatus</i>  | <b>LIZARDFISHES</b><br>Slender lizardfish<br>Twospot lizardfish<br>Reef lizardfish  | Ta'oto<br>Ta'oto<br>Ta'oto<br>Ta'oto   |
| <b>ANTENNARIIDAE (N=1)</b><br><i>Antennarius coccineus</i>   | <b>FROGFISHES</b><br>Freckled anglerfish  | La'otale, nofu<br>La'otale, nofu   |
| <b>HOLOCENTRIDAE (N=10)</b><br><i>Myripristis adusta</i><br><i>Myripristis berndti</i><br><i>Myripristis hexagona</i><br><i>Myripristis kuntee</i><br><i>Myripristis murdjan</i><br><i>Neoniphon sammara</i><br><i>Sargocentron diadema</i><br><i>Sargocentron microstoma</i><br><i>Sargocentron spinifer</i><br><i>Sargocentron tiere</i> | <b>SQUIRRELFISHES</b><br>Shadowfin soldierfish<br>Bigscale soldierfish<br>Doubletooth soldierfish<br>Epaulette soldierfish<br>Blotcheye soldierfish<br>Spotfin squirrelfish<br>Crown squirrelfish<br>Smallmouth squirrelfish<br>Sabre squirrelfish<br>Tahitian squirrelfish | Malau<br>Malau-tuavela, malau-'uo<br>Malau-ugatele, malau-va'ava'a<br><br>Malau-pu'u<br><br>Malau-tui, malau-pe'ape'a<br>Malau-tui, malau-talapu'u, malau-<br>Malau-tianiu<br>Tamalau, mu-malau, malau-toa |
| <b>AULOSTOMIDAE (N=1)</b><br><i>Aulostomus chinensis</i>   | <b>TRUMPETFISHES</b><br>Trumpetfish   | Taoto-ena, taoto-sama, 'au'aulauti,  |
| <b>FISTULARIIDAE (N=1)</b><br><i>Fistularia commersonii</i>  | <b>FLUTEMOUTHS</b><br>Smooth flutemouth   | Taoto-ama, taotao  |

## SCORPAENIDAE (N=3)

*Pterois volitans*  
*Scorpaenopsis diabolus*  
*Scorpaenopsis macrochir*

## CARACANTHIDAE (N=1)

*Caracanthus maculatus*

## SERRANIDAE (N=11)

*Cephalopholis argus*  
*Cephalopholis leopardus*  
*Cephalopholis minitatus*  
*Cephalopholis urodeta*  
*Epinephelus fuscoguttatus*  
*Epinephelus hexagonatus*  
*Epinephelus maculatus*  
*Epinephelus merra*  
*Epinephelus tauvina*  
*Variola louti*  
*Grammistes sexlineatus*

## KUHLIIDAE (N=1)

*Kuhlia mugil*

## PRIACANTHIDAE (N=1)

*Heteropriacanthus cruentatus*

## APOGONIDAE (N=4)

*Apogon kallopterus*  
*Apogon nigrofasciatus*  
*Apogon taeniophorus*  
*Cheilodipterus quinquelineata*

## CARANGIDAE (N=4)

*Caranx ignobilis*  
*Caranx melampygus*  
*Decapterus macarellus*  
*Scomberoides lysan*

## LUTJANIDAE (N=9)

*Aphareus furca*  
*Aprion virescens*  
*Lutjanus argentimaculatus*  
*Lutjanus bohar*  
*Lutjanus fulvus*  
*Lutjanus gibbus*  
*Lutjanus kasmira*  
*Lutjanus monostigmus*  
*Macolor niger*

## CAESIONIDAE (N=2)

*Pterocaesio marri*

## SCORPIONFISHES

Red firefish  
 False stonefish  
 Flasher scorpionfish

## CROUCHERS

Spotted croucher

## GROUPERS

Peacock rockcod  
 Leopard rockcod  
 Coral cod  
 Flagtail rockcod  
 Flowery cod  
 Hexagon rockcod  
 Trout cod  
 Dwarf spotted rockcod  
 Greasy rockcod  
 Coronation trout  
 Sixline soapfish

## FLAGTAILS

Fiveband flagtail

## BIGEYES

Glasseye

## CARDINALFISHES

Iridescent cardinalfish  
 Blackstripe cardinalfish  
 Reef-flat cardinalfish  
 Five-lined cardinalfish

## JACKS

Giant trevally  
 Bluefin trevally  
 Mackerel scad  
 Double-spotted queenfish

## SNAPPERS

Small-toothed jobfish  
 Green jobfish  
 Mangrove jack  
 Red bass  
 Yellow-margined seapearch  
 Paddletail  
 Bluestripe seapearch  
 Onespots seapearch  
 Black and white seapearch

## FUSILIERS

Marr's fusilier

Laotale, nofu, i'atala  
 Sausau-lele

Tapua

Gatala, 'ata'ata, vaolo  
 Gatala-uli, loi

Mata'ele  
 Gatala-aloalo  
 Gatala-a'au  
 Gatala-puleuli  
 Gatala-aloalo, gatala-pulepule  
 Gatala-tane  
 Papa-tuauli, velo, papa  
 Taili, tusiloa

Safole

Matapula  
 Matapula

Fo  
 Fo-aialo  
 Fo-tuauli

Fo-tusiloloa

Lupo, lupota, ma, lauli, ulua, sapo'anae  
 Sapo'anae  
 Malauli-apamoana, atugaloloa  
 Atuleau, namuauli  
 Lai

Mu, palu  
 Palu-aloalo

Mu-taiva  
 Mu-a'a, mu-mea  
 Tamala, taiva  
 Mala'i  
 Savane  
 Taiva, feloitega  
 Matala'oa

Atule-toto, ulisega

|   |   |  |
|---|---|--|
| <i>Pterocaesio tile</i>   | Neon fusilier   |  |
| GERREIDAE (N=1)<br><i>Gerres species</i>  | SILVER BIDDIES<br>Silver bidy species   | Matu   |
| HAEMULIDAE (N=1)<br><i>Plectorhinchus orientalis</i>  | GRUNTS<br>Oriental sweetlip   | Mutumutu, ava'ava-moana  |
| LETHRINIDAE (N=2)<br><i>Gnathodentex aurolineatus</i><br><i>Monotaxis grandoculus</i>   | EMPERORS<br>Gold-liner sea bream<br>Big-eye bream   | Mata'ele'ele, ulamalosi, filoa<br>Mumu, tolai<br>Mu-matavaivai, matamu, matamu,  |
| HEMIPTERIDAE (N=1)<br><i>Scolopsis lineatus</i>   | CORAL BREAMS<br>Lined monocle bream   |  |
| MULLIDAE (N=7)<br><i>Mulloides flavolineatus</i><br><i>Mulloides vanicolensis</i><br><i>Parupeneus bifasciatus</i><br><i>Paraupeneus cyclostomus</i><br><i>Paraupeneus indicus</i><br><i>Parupeneus multifasciatus</i><br><i>Paraupeneus pleurostigma</i>   | GOATFISHES<br>Yellowstripe goatfish<br>Yellowfin goatfish<br>Doublebar goatfish<br>Goldsaddle goatfish<br>Indian goatfish<br>Manybar goatfish<br>Sidespot goatfish  | I'asina<br>I'asina, vete, afulu, afolu<br>Matulau-moana<br><br>Ta'uleia<br><br>Matulau-ilamutu   |
| PEMPHERIDAE (N=1)<br><i>Pempheris oualensis</i>   | SWEEPERS<br>Copper sweeper  | Manifi   |
| KYPHOSIDAE (N=2)<br><i>Kyphosus cinerascens</i><br><i>Kyphosus vaigiensis</i>   | SEA CHUBS<br>Topsail drummer<br>Long-finned drummer   | Nanue, mata-mutu, mutumutu   |
| CHAETODONTIDAE (N=23)<br><i>Chaetodon auriga</i><br><i>Chaetodon citrinellus</i><br><i>Chaetodon ephippium</i><br><i>Chaetodon lineolatus</i><br><i>Chaetodon lunula</i><br><i>Chaetodon ornatissimus</i><br><i>Chaetodon oxycephalus</i><br><i>Chaetodon pelewensis</i><br><i>Chaetodon quadrimaculatus</i><br><i>Chaetodon rafflesi</i><br><i>Chaetodon reticulatus</i><br><i>Chaetodon trifascialis</i><br><i>Chaetodon trifasciatus</i><br><i>Chaetodon ulietensis</i><br><i>Chaetodon unimaculatus</i><br><i>Chaetodon vagabundus</i><br><i>Forcipiger flavissimus</i><br><i>Forcipiger longirostris</i><br><i>Hemitaurichthys polylepis</i><br><i>Heniochus acuminatus</i><br><i>Heniochus chrysostomus</i> | BUTTERFLYFISHES<br>Threadfin butterflyfish<br>Speckled butterflyfish<br>Saddled butterflyfish<br>Lined butterflyfish<br>Raccoon butterflyfish<br>Ornate butterflyfish<br>Spotnape butterflyfish<br>Dot-and-dash butterflyfish<br>Fourspot butterflyfish<br>Latticed butterflyfish<br>Reticulated butterflyfish<br>Chevroned butterflyfish<br>Redfin butterflyfish<br>Double-saddled butterflyfish<br>Teardrop butterflyfish<br>Vagabond butterflyfish<br>Forcepsfish<br>Longnose butterflyfish<br>Pyramid butterflyfish<br>Longfin bannerfish<br>Pennant bannerfish | Tifitifi<br>Si'u, i'usamasama<br>Tifitifi-moamanu<br>Tifitifi-tuauli<br>Tifitifi-lau'a<br>Tifitifi-laumea<br>Tifitifi-'ava'ava<br><br>Tifitifi-tusiloloa<br>Tifitifi-segasega<br>Tifitifi-pule<br>Tifitifi-maona<br>Tifitifi-sae'u<br>Tifitifi-manifi<br><br>Tifitifi-matapua'a<br>Gutumanu<br>Gutumanu<br>Alosina<br>Laulaufau-laumea<br>Laulaufau-laumea |

*Heniochus monoceros*  
*Heniochus varius*

POMACANTHIDAE (N=7)

*Apolemichthys trimaculatus*  
*Centropyge bicolor*  
*Centropyge bispinosus*  
*Centropyge flavissimus*  
*Centropyge loriculus*  
*Pomacanthus imperator*  
*Pygoplites diacanthus*

POMACENTRIDAE (N=42)

*Abudefduf septemfasciatus*  
*Abudefduf sexfasciatus*  
*Abudefduf sordidus*  
*Abudefduf vaigensis*  
*Amblyglyphidodon leucogaster*  
*Amphiprion chrysopterus*  
*Amphiprion clarkii*  
*Amphiprion melanopus*  
*Chromis acares*  
*Chromis agilis*  
*Chromis amboinensis*  
*Chromis atripectoralis*  
*Chromis iomelas*  
*Chromis margaritifer*  
*Chromis ternatensis*  
*Chromis vanderbilti*  
*Chromis viridis*  
*Chromis xanthura*  
*Chrysiptera biocellata*  
*Chrysiptera caeruleolineatus*  
*Chrysiptera glauca*  
*Chrysiptera leucopoma*  
*Chrysiptera taupou*  
*Dascyllus aruanus*  
*Dascyllus reticulatus*  
*Dascyllus trimaculatus*  
*Neopomacentrus metallicus*  
*Plectroglyphidodon dickii*  
*Plectroglyphidodon imparipennis*  
*Plectroglyphidodon johnstonianus*  
*Plectroglyphidodon lacrymatus*  
*Plectroglyphidodon leucozonus*  
*Plectroglyphidodon phoenixensis*  
*Pomacentrus brachialis*  
*Pomacentrus coelestis*  
*Pomacentrus pavo*  
*Pomacentrus vaiuli*  
*Pomachromis richardsoni*  
*Stegastes albifasciatus*  
*Stegastes fasciolatus*

Masked bannerfish  
Humphead bannerfish

ANGELFISHES

Three-spot angelfish  
Bicolor angelfish  
Two-spined angelfish  
Lemmonpeel angelfish  
Flame angelfish  
Emperor angelfish  
Regal angelfish

DAMSELFISHES

Banded sergeant  
Scissor-tail sergeant  
Blackspot sergeant  
Indo-pacific sergeant  
White-belly damsel  
Orange-fin anemonefish  
Clark's anemonefish  
Red-and-black anemonefish  
Midget chromis  
Agile chromis  
Ambon chromis  
Black-tail chromis  
Half-and-half chromis  
Bicolor chromis  
Ternate chromis  
Vanderbilt's chromis  
Blue-green chromis  
Pale-tail chromis  
Twospot demoiselle  
Blueline demoiselle  
Grey damsel  
Surge demoiselle  
South seas demoiselle  
Humbug dascyllus  
Reticulated dascyllus  
Three-spot dascyllus  
Metallic demoiselle  
Dick's damsel  
Brighteye damsel  
Johnston damsel  
Jewel damsel  
Whiteband damsel  
Phoenix damsel  
Charcoal damsel  
Neon damsel  
Blue damsel  
Princess damsel  
Richardson's reef-damsel  
Whitebar gregory  
Pacific gregory

Laulaufau-laumea  
Laulaufau-laumea

Tu'u'u

Tu'u'u-matamalu  
Tu'u'u-alomu  
Tu'u'u-sama, tu'u'u-lega  
Tu'u'u-tusiuli  
Tu'u'u-vaolo, tu'u'u-moana  
Tu'u'u-moana

Tu'u'u

Mutu  
Mamo  
Mutu  
Mamo  
Tu'u'u-mamo  
Tu'u'u-lumane

Tu'u'u-lumane  
Tu'u'u-fo

Tu'u'u-palevai  
Tu'u'u-segasega  
Tu'u'u-i'usina  
Tu'u'u-i'usina

Tu'u'u-fo

Tu'u'u-i'usina  
Tu'u'u-ulavapua

Tu'u'u-tulisegasega, tu'u'u-alamu

Tu'u'u-mo'o, vaiuli-sama

Mamo  
Tu'u'u-koko  
Tu'u'u-pulelua  
Tu'u'u-segi, pipi  
Tu'u'u-i'usina

Tu'u'u-i'uuli

Tu'u'u-lau, i'usamasama

Tu'u'u-si'ugutusina

Tu'u'u-popouli

Tu'u'u-faga

Tu'u'u-segasega

Tu'u'u-segasega, teatea

Tu'u'u-vaiuli

Tu'u'u-malaumataputa

Tu'u'u-pa, ulavapuna

Tu'u'u-palea

*Stegastes lividus*  
*Stegastes nigricans*

CIRRHITIDAE (N=5)  
*Amblycirrhitus bimacula*  
*Cirrhitus pinnulatus*  
*Paracirrhitus arcatus*  
*Paracirrhitus forsteri*  
*Paracirrhitus hemistictus*

MUGILIDAE (N=2)  
*Crenimugil crenilabis*  
*Liza vaigiensis*

SPHYRAENIDAE (N=1)  
*Sphyaena barracuda*

LABRIDAE (N=42)  
*Anampses caeruleopunctatus*  
*Anampses meleagrides*  
*Anampses twistii*  
*Bodianus loxozonus*  
*Chelinus digrammus*  
*Chelinus fasciatus*  
*Chelinus oxycephalus*  
*Chelinus trilobatus*  
*Chelinus undulatus*  
*Chelinus unifasciatus*  
*Cirrhilabrus species*  
*Coris aygula*  
*Coris gaimard*  
*Epibulus insidiator*  
*Gomphosus varius*  
*Halichoeres biocellatus*  
*Halichoeres hortulanus*  
*Halichoeres margaritaceus*  
*Halichoeres marginatus*  
*Halichoeres melanurus*  
*Halichoeres miniatus*  
*Halichoeres nebulosus*  
*Halichoeres ornatissimus*  
*Halichoeres trimaculatus*  
*Hemigymnus fasciatus*  
*Hemigymnus melapterus*  
*Labrichthys unilineatus*  
*Labroides bicolor*  
*Labroides dimidiatus*  
*Macropharyngodon meleagris*  
*Novaculichthys taeniourus*  
*Pseudochelinus hexataenia*  
*Pseudochelinus octotaenia*  
*Stethojulis bandanensis*  
*Stethojulis strigiventer*

Bluntnout gregory  
Dusky gregory

HAWKFISHES  
Twinspot hawkfish  
Stocky hawkfish  
Arc-eye hawkfish  
Blackside hawkfish  
Halfspotted hawkfish

MULLETS  
Warty-lipped mullet  
Diamond-scale mullet

BARRACUDAS  
Great barracuda

WRASSES  
Bluespotted wrasse  
Spotted wrasse  
Yellowbreasted wrasse  
Blackfin hogfish  
Cheeklined maori wrasse  
Redbreasted maori wrasse  
Snooty maori wrasse  
Tripletail maori wrasse  
Humphead maori wrasse  
Ringtail maori wrasse  
Cirrhilabrus species  
Clown coris  
Yellowtail coris  
Slingjaw wrasse  
Bird wrasse  
Biocellate wrasse  
Checkerboard wrasse  
Pink-belly wrasse  
Dusky wrasse  
Tailspot wrasse  
Circle-cheek wrasse  
Nebulous wrasse  
Ornate wrasse  
Threespot wrasse  
Barred thicklip  
Blackeye thicklip  
Tubelip wrasse  
Bicolor cleaner wrasse  
Cleaner wrasse  
Blackspotted wrasse  
Rockmover wrasse  
Sixstripe wrasse  
Eightstripe wrasse  
Bluelined wrasse  
Stripebelly wrasse

Tu'u'u-moi  
Tu'u'u-moi

La'o  
Ulutu'i  
Lausiva  
Lausiva  
Lausiva, a'a

'anae  
Fuitogo, 'afa, 'anaeafa

Sapatu  
Saosao

Sugale  
Sugale-mafalagutu  
Sugale-tatanu  
Sugale-tatanu  
Sugale-a'a  
Lalafi-pulepule  
Lalafi-pulepule  
  
Lalafi-matamumu  
Lalafi, tagafa, malakea  
Lalafi

Sugale-uluto'i  
Sugale-mumu, sugale-tala'ula  
Lapega, lalafi-tua'au  
Gutusi'o, gutu'umi, sugale-lupe

Sugalea'au, sugale-pagota, ifigi  
Sugale-ululela  
Sugale-lalafi

Lape, sugale-pagota  
Sugale-gutumafia  
Sugale-laugutu, sugale-uli, sugale-  
Sugale-tafuti, atamamala  
Sugale-i'usina  
Sugale-mo'otai  
Sugale-puletasi  
Sugale-la'o, sugale-taili, sugale-gasufi  
Sugale-tusitusi  
Sugale-tusitusi  
Lape-a'au  
Lape-a'au

*Stethojulis trilineata*  
*Thalassoma amblycephalum*  
*Thalassoma hardwicke*  
*Thalassoma lutescens*  
*Thalassoma purpuraceum*  
*Thalassoma quinquevittatum*  
*Thalassoma trilobatum*

SCARIDAE (N=20)

*Calotomus carolinus*  
*Cetoscarus bicolor*  
*Hipposcarus longiceps*  
*Scarus altipinnis*  
*Scarus dimidiatus*  
*Scarus forsteni*  
*Scarus frenatus*  
*Scarus frontalis*  
*Scarus ghobban*  
*Scarus globiceps*  
*Scar microrrhinos*  
*Scar niger*  
*Scarus oviceps*  
*Scarus psittacus*  
*Scarus pyrrhurus*  
*Scarus rivulatus*  
*Scarus rubroviolaceus*  
*Scarus schlegeli*  
*Scarus sordidus*  
*Scarus spinus*

PINGUIPEDIDAE (N=2)

*Parapercis clathrata*  
*Parapercis millipunctata*

BLENNIDAE (N=9)

*Meiacanthus atrodorsalis*  
*Meiacanthus ditrema*  
*Plagiotremus rhinorhynchos*  
*Plagiotremus tapeinosoma*  
*Cirripectes polyzona*  
*Cirripectes stigmaticus*  
*Cirripectes variolosus*  
*Exallias brevis*  
*Istiblennius chrysospilos*

GOBIDAE (N=4)

*Amblyeleotris fasciata*  
*Gobiodon citrinus*  
*Valenciennesa sexguttata*  
*Valenciennesa strigata*

MICHRODESMIDAE (N=2)

*Nemateleotris magnifica*

Three-ribbon wrasse  
Bluntheaded wrasse  
Sixbar wrasse  
Sunset wrasse  
Surge wrasse  
Fivestripe wrasse  
Ladder wrasse

PARROTFISHES

Stareye parrotfish  
Bicolor parrotfish  
Longnose parrotfish  
Minifin parrotfish  
Yellowbarred parrotfish  
Whitespot parrotfish  
Bridled parrotfish  
Reefcrest parrotfish  
Bluebarred parrotfish  
Globehead parrotfish  
Steephead parrotfish  
Swarthy parrotfish  
Egghead parrotfish  
Palenose parrotfish  
Redtail parrotfish  
Surf parrotfish  
Ember parrotfish  
Schlegel's parrotfish  
Bullethead parrotfish  
Greensnout parrotfish

SANDPERCHES

Latticed sandperch  
Redbarred sandperch

BLENNIES

Yellowtail fangblenny  
Doublepore fangblenny  
Bluestripe fangblenny  
Piano fangblenny  
Barred blenny  
Reticulated blenny  
Red-speckled blenny  
Shortbodied blenny  
Goldspotted rockskipper

GOBIES

Red-banded prawn goby  
Fourbar goby  
Sixspot goby  
Blueband goby

DARTFISHES

Fire dartfish

Lape-a'au  
Sugale-aloama  
Sugale-a'au, lape-ele'ele  
Sugale-samasama  
Uloulo-gatala, patagaloa  
Lape-moana  
Uloulo-gatala, pata'ota'o

Fuga, laea, galo

Fuga-sina, mamanu, laea-mamanu,  
Ulapokea, laea-ulapokea

Fuga-alosama

Laea-mea, laea-si'imoana

Fuga-alova

Fuga-si'umu, laea-ulusama

Fuga-alosina, laea-tuavela

Fuga-matapua'a, fugausi-matapua'a,

Laea-mea, laea-mala

Fuga-matapua'a, laea-tusi

Fuga-gutumumu, fugausi-tuavela, laea-  
Fuga-a'au

Ta'oto

Ta'oto

Mano'o

Mano'o-si'umaga

Mano'o-to'ito'i

Mano'o-to'ito'i

Mano'o-la'o

Mano'o-lau, mano'o-gatala

Mano'o

Mano'o-popo

Mano'o-ulutu'i, moemimi

Mano'o-sina

Mano'o-sina

Mano'o-sugale

*Ptereleotris evides*

ACANTHURIDAE (N=25)

*Acanthurus achilles*  
*Acanthurus blochii*  
*Acanthurus guttatus*  
*Acanthurus lineatus*  
*Acanthurus maculiceps*  
*Acanthurus mata*  
*Acanthurus nigricans*  
*Acanthurus nigricauda*  
*Acanthurus nigrofusus*  
*Acanthurus nigroris*  
*Acanthurus olivaceus*  
*Acanthurus thompsoni*  
*Acanthurus triostegus*  
*Acanthurus xanthopterus*  
*Ctenochaetus binotatus*  
*Ctenochaetus hawaiiensis*  
*Ctenochaetus striatus*  
*Ctenochaetus strigosus*  
*Naso annulatus*  
*Naso brevirostris*  
*Naso lituratus*  
*Naso tuberosus*  
*Naso unicornis*  
*Zebrasoma scopas*  
*Zebrasoma veliferum*

ZANCLIDAE (N=1)

*Zanclus cornutus*

SIGNIDAE (N=3)

*Siganus argenteus*  
*Siganus punctatus*  
*Siganus spinus*

BOTHIDAE (N=1)

*Bothus mancus*

BALISTIDAE (N=11)

*Balistapus undulatus*  
*Balistoides viridescens*  
*Melichthys niger*  
*Melichthys vidua*  
*Odonus niger*  
*Pseudobalistes fuscus*  
*Rhinecanthus aculeatus*  
*Rhinecanthus rectangulus*  
*Sufflamen bursa*  
*Sufflamen chrysopterus*  
*Sufflamen fraenatus*

Twotone dartfish

SURGEONFISHES

Achilles tang  
Ringtail surgeonfish  
Whitespotted surgeonfish  
Striped surgeonfish  
White-freckled surgeonfish  
Elongate surgeonfish  
Whitecheek surgeonfish  
Blackstreak surgeonfish  
Brown surgeonfish  
Bluelined surgeonfish  
Orangeband surgeonfish  
Thompson's surgeonfish  
Convict surgeonfish  
Yellowfin surgeonfish  
Twospot bristletooth  
Black bristletooth  
Lined bristletooth  
Goldring bristletooth  
Whitemargin unicornfish  
Spotted unicornfish  
Orangespine unicornfish  
Humpnose unicornfish  
Bluespine unicornfish  
Brushtail tang  
Sailfin tang

MORRISH IDOL

Morrish idol

RABBITFISHES

Forktail rabbitfish  
Goldspotted rabbitfish  
Spiny rabbitfish

LEFT-EYED FLOUNDERS

Flowery flounder

TRIGGERFISHES

Orange-lined triggerfish  
Titan triggerfish  
Black triggerfish  
Pinktail triggerfish  
Redtooth triggerfish  
Yellow-spotted triggerfish  
Whitebanded triggerfish  
Wedge-tail triggerfish  
Scimtar triggerfish  
Flagtail triggerfish  
Bridled triggerfish

Ma'ulu

Pone, palagi, ume  
Maikolama, kolama, pone-i'umumu

Maogo

Alogo

Ponepone

Ponepone

Pone-apasama, afinamea

Pone-i'usina

Manini

Pone, pala'ia, logoulia

Ume-ulutao

Ili'ililia, umelei

Ume-uluto'i

Ume-isu

Pitopito, pe'ape'a

Pe'ape'a, laulaufau

Lo

Loloa, 'ofe'ofe, malava

Tito, loele'ele

Anefe, pa'ulu

Ali

Sumu

Sumu-aimaunu

Sumu-laulau, umu

Sumu-uli

Sumu-'apa'apasina, sumu-si'umumu

Sumu-pe'a

Sumu-laulau, umu

Sumu-uo'uo

Sumu-aloo

Sumu-pa'epa'e

Sumu-gasemoana

Sumu-gase'ele'ele

MONACANTHIDAE (N=5)

*Cantherhinus dumerilii*  
*Cantherhinus pardalis*  
*Oxymonacanthus longirostris*  
*Pervagor janthinosoma*  
*Pervagor melanocephalus*  
OSTRACIIDAE (N=1)  
*Ostracion meleagris*

TETRAODONTIDAE (N=5)

*Arothron hispidus*  
*Arothron meleagris*  
*Arothron nigropunctatus*  
*Canthigaster amboinensis*  
*Canthigaster solandri*

DIODONTIDAE (N=1)

*Diodon hystrix*

LEATHERJACKETS

Yelloweye leatherjacket  
Honeycomb leatherjacket  
Beaked leatherjacket  
Gill-blotch leatherjacket  
Black-headed leatherjacket  
BOXFISHES  
Spotted boxfish

PUFFERS

Stars and stripes puffer  
Guineafowl puffer  
Blackspotted puffer  
Ambon toby  
Solander's toby

PORCUPINEFISHES

Porcupinefish

Pa'umalo  
Pa'umalo  
Pa'umalo, falala, aimeo  
Pa'umalo-gutuumi

Pa'umalo, falala  
Moamoa  
Moamoa-uli, moamoa-sama

Sue  
Sue-vaolo  
Sue-puleuli, sue-lega  
Sue-uli, sue-lega  
Sue-lape  
Sue-mimi

Tauta, tautu





fertilizers, pesticides or herbicides on the land upslope of the proposed park should be discouraged. Even many of the most widely sold and commonly used biocides are very toxic to freshwater invertebrates and their effects on tropical marine invertebrates are almost completely unknown.

Surface runoff into the ocean appears to be minimal at present. There is very little soil on most of the land behind the proposed national park area and most rainfall quickly sinks into the porous lava rock and becomes groundwater. The small amount of soil present on most of the land will probably also limit major problems with siltation in this area. Direct input of nutrients into the ocean will probably not be a problem unless the number of visitors to the park reached the level of hundreds per day.

An increase in numbers of visitors to the proposed park area (and the support facilities to serve them) will lead to an increased risk of introducing new species of seaweeds to Ofu. Although not widely known, several species of seaweeds have been accidentally or purposely introduced to Hawaiian waters in the last 40 years and several of them have become widespread, completely replacing the species previously present in several habitats and in some cases becoming problems by washing up on resort beaches in large mats. Just as introduced plants have greatly changed the terrestrial communities of tropical Pacific islands, introduced marine plants have also changed marine communities. New marine species could be introduced by several methods: from the bottoms of boats visiting Ofu, importation of live seafood such as oysters, importation of marine aquaculture organisms.

It is recommended that future monitoring surveys at the six permanent sites be continued on a bi-annual basis. After the first two years, annual surveys should be sufficient to monitor reef health, barring any outbreaks of coral predators (e.g. *Acanthaster*, *Drupella*) or changes in land use patterns on Ofu. Declines in coral cover or increases of algal cover of  $\pm 10\%$  at any site over two consecutive surveys should be used as a minimal signal that possible causes of reef degradation should be investigated. If declines in coral abundance are the obvious result of hurricane damage, substantial indications of initial recovery (from