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CHARACTERIZATION OF INSHORE SAMOAN FISH COMMUNITIES

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I. Introduction.

American Samoa's burgeoning population and economic growth have given rise to increased fishing effort (Wass, ~~in press~~ 1983) and a multiplication of shoreline development projects. Both have a generally adverse effect on the marine environment resulting in declining catches and reduced production of fishery resources.

Historically, the Samoans were very much aware of the need to conserve and protect their marine resources. Conservation practices included reef tenure and a complex system of taboos reserving certain species and sizes of fish for the chiefs and restricting effort to certain seasons and locations. The acquisition of Western culture and its attendent legal system, however, has caused the disappearence of many of the traditional management methods in the more populated and developed areas. Modern fisheries management requires the resurrection and reinforcement of selected traditional practices and the blending of these with methods and regulations based on comprehensive resource inventories and scientific study. The present investigation was designed to aid these management efforts through definition of the basic inshore habitats around Tutuila Island, American Samoa and a determination of the composition and magnitude of the associated fish resources.

Tutuila is located in the tropical South Pacific at 14° south latitude and 171° west longitude at the midpoint of the Samoan archipelago. It is a high island with a rugged basaltic terrain and a land area of about 140 km^2. The temperature range is 20-33° C. and annual precipitation averages about 450 cm.

The southern coast of Tutuila is bordered by a more or less continuous fringing reef flat varying in width from about 50 to 900 m. Much of this flat is exposed at low tide though there are natural depressions as deep as a few meters and dredged areas as deep as six meters. An irregularly sloping reef terrace averaging about 40 m. in width extends seaward of the reef crest on the outer edge of the reef flat. The reef front at the seaward margin of the terrace slopes steeply and often vertically from four to ten meters at the upper edge to a gently sloping sand and rubble bottom at 20 to 40 m.

The southern coast is indented by four prominent bays offering dissimilar habitats. Pago Pago Bay is the largest and is bordered by the most populous and developed area of the island. Though most of the bay is over 60 m. deep, sewage outfalls, effluent from tuna canneries, bilgewater and waste from moored vessels and shoreline runoff contribute toward a decline in water quality near the back of the bay. Pala Lagoon is a shallow, mangrove-fringed bay averaging about two meters in depth. Tidal flow across a reef flat and through a narrow channel accounts for its limited circulation. Larsen and Fagatele Bays form a third type of bay habitat. They have wide mouths and are exposed to wind and current. Both are volcanic craters with steeply sloping sides above and below the ocean surface and are over 200 m. deep. There is little human habitation or development along their shores and almost no fresh water runoff so water quality is high.

A submerged barrier reef comprised of Taema and Nafanua Banks and intervening reefs parallels much of the southern coast. It is separated from Tutuila by a distance of two to three kilometers and a depth of 80 to 120 m. The reefs rise to within 15 to 20 m. of the surface and slope off on either side to a sand and rubble bottom at 30 to 40 m.

Reef flats are a less conspicuous feature of the northern coastline of Tutuila, being limited primarily to the inner margins of numerous bays and coves. Steeply sloping basaltic terrain characterizes the exposed portions of shoreline. A submerged reef terrace directly abuts the rocky shore in most areas and extends seaward for 10 to 50 m. before plunging to a sand and rubble bottom at 20 to 40 m.

Existing studies of Samoan fishes consist largele of taxonomic investigations and portions of environmental assessments. Jordan and Seale (1906) conducted the first comprehensive survey of Samoan ichthyofauna. Their Fishes of Samoa lists 475 species for the archipelago. Schultz (1943) lists 441 Samoan fishes and includes keys to aid in their identification. The taxonomy of these and other investigators is updated and 967 species are recorded in a recent publication by the author (Wass, MS). Speci s names used in the present study are derived from that paper.

Most of the literature concerned with the ecology and community composition of Samoan fishes is contained within environmental assessments conducted prior to the construction of docks, sewage outfalls, boat harbors, shoreline protection revetments, etc. For the most part the data are purely descriptive lacking analysis and interpretation. These publications also have the disadvantage of unavailability in most libraries. Living Marine Resources, Inc. (1974a, 1974b) and Dames and Moore (1975) include descriptions of fish communities within Pago Pago Bay. Randall and Devaney (1974), Helfrich and collaborators (1975), FHA and Dept. of Public Works (1976) and Devaney and Suzumoto (1977) present data summarizing observations of fishes in various areas around Tutuila and the neighboring islands of Aunu'u, Ofu and Olosega.

The American Samoa Coral Reef Inventory (1981) describes the habitats and associated biological communities for most of the inshore areas of American Samoa. It has much wider geographic coverage than the other studies but, again, analysis is lacking beyond a subjective ranking of species abundance and little attempt is made to relate the influence of ecological factors to the observed distribution.

Investigators in other areas of the tropical Pacific have examined these relationships in considerable detail. The Hawaiian fauna has probably received the most attention beginning with a pioneering study by Brock (1954) who was the first to combine the use of SCUBA and visual fish censuses. Gosline (1965) discussed vertical zonation of Hawaiian fishes and related it primarily to wave action. Hobson (1974) characterized the fish communities associated with five habitats in Kona and related composition to environmental parameters as part of his detailed study of feeding relationships. Fish community composition is characterized for major habitat types and related to environmental factors such as water movement, bottom configuration, substrate composition, depth, nutrient levels, predation, etc. for the Marshall Islands by Hiatt and Strasburg (1960), for the Great Barrier Reef by Talbot and Goldman (1972), for Fanning Island by Chave and Eckert (1974) and for a lagoon in Guam by Jones and Chase (1975).

Each of these studies implies that presence or absence of a species can be predicted if its ecological requirements are known. Smith (1977, 1978) has reached the same conslusion from his investigations of Carribean fish communities. A different viewpoint is expressed by Sale (1975, 1977, 1978a, 1978b) and Sale and Dybdahl (1975) who have found that the presence or absence of one or more of a group of damselfishes or certain other small reef fishes with similar ecological requirements is the result of random factors including chance colonization. Brock, et. al.(1979) conclude that the "lottery hypothesis" may account for species distributions on a small areal scale and over a short timespan, but that a relatively deterministic pattern emerges if a larger area is considered and that the fishes are a persistent and predictable entity within a specific habitat.

II. Methods.

A. Data Collection.

Study locations were chosen to represent all of the common inshore habitats around Tutuila. At each of 57 sites, the fishes were enumerated by a technique patterned after that of Jones and Chase (1975). A weighted transect line 100 m. long and divided into five equal sections was laid on the bottom in a more or less straight line. When transecting reef flat habitats which are subject to varying degrees of wave action depending upon depth and distance from the reef crest, the line was laid perpendicular to the shoreline with the seaward end as near the reef crest as surf conditions allowed. The two-year study period enabled a choice of days when wave action was least for conducting surveys. For most reef flat stations it was, therefore, possible to position the seaward end of the transect at the reef crest where wave action is normally high. Reef flat width was one of the primary factors governing the selection of transect sites. Relatively narrow reefs were generally chosen to enable the transect to span most or all of the distance between the reef crest and the shoreline. For sites where the reef was much wider than 100 m., the transect was situated across the slightly deeper mid-reef zone where fish biomass and diversity are greatest because of the shelter afforded by coral and reef rock.

At study sites beyond the breakers and in deeper water, the transect line was generally laid parallel to the depth contour at 4 to 15 m. where the gently sloping reef terrace merges with the steeply sloping reef front. This interface harbors the richest coral growth, has the greatest structural complexity and borders deep water. These factors all serve to increase fish diversity and biomass. A few transects were also sited along shallow basalt shorelines and along the deep base of reef fronts as well as across and around coral pinnacles in Pago Pago Bay.

Transects were positioned near natural or man-made landmarks such as large rocks, channels or concrete structures. Exact locations and depth were carefully noted to facilitate relocation because no permanent markers were used. ~~Approximately~~

Approximately 15 minutes after the line was laid, a single observer equipped with SCUBA swam the transect. All fishes observed within one meter on either side of the line and two meters above it were identified to species, counted and their total lengths estimated to the nearest inch. If the transect was on a reef flat, the data were kept separate for each 20-meter section to distinguish species preferences for different amounts of wave action, depths and types of substrate. At ~~the~~ deeper stations where environmental conditions were relatively uniform, the data were not sectioned.

Holes and cracks in the reef within the transect corridor were inspected for nocturnal and secretive fishes and the substrate was examined for cryptic species. ~~There is no doubt, however, that~~ many of these fishes, however, were probably not ~~un~~detected resulting in an underestimate of their abundance. Being wary of divers, larger and more transient fishes tend to depart the transect corridor at the approach of the observer so they, too, are under-censused by this procedure. Even clearly visible fishes that have no tendency to hide or flee the approach of a diver are subject to inaccurate counts because of their diversity and numbers and because of their constant motion in and out of the transect corridor.

In spite of these shortcomings, the visual census technique is considered a valuable tool for studying reef fish populations and is widely used. It is of greatest value for making relative comparisons between fish communities at different times or locations rather than as a quantitative method for assessing the precise composition of a particular community. All censuses were conducted by the author to reduce variability due to observer bias.

Twenty to thirty minutes were required to enumerate the fishes on the transect. Data were recorded on a tape recorder in an underwater housing with the microphone inserted within the mouthpiece of a regulator. The tape was transcribed by the observer on the same day it was recorded.

About an hour after the transect was censused, the observer returned to the area with an underwater slate and ~~pent~~ spent 20 minutes seeking out and listing species that were not recorded during the census. The search was conducted within 20 m. of the transect line and within the same depth range. Depth and bottom characteristics under each section of the line were also noted at this time. ~~While~~ Though no quantitative information resulted from this species search, it facilitated a more complete description of the fish community by providing information on the presence of wary, uncommon, cryptic and secretive species not observed during the census. The listing increased the species richness data for the study sites by 22-67%. [illegible]

Observations were conducted during daylight hours under optimal conditions of underwater visibility. Reef flat stations were transected at high tide when species diversity and biomass are maximized (Hiatt and Strasburg, 1960). ~~(For some of the analyses, cryptic, transient, etc. species or those recorded only during the species search were not used)~~

B. Data Analysis

1. Dendrographs.

No attempt was made to discriminate fish communities or to define habitat types before the surveys were initiated. Upon their completion, a dendrograph analysis (McCammon, 1968; McCammon and Wenniger, 1970) was used to objectively group stations with similar fish communities. Environmental characteristics common to the stations within a group could then be used to define the habitat.

The dendrograph is a tree-like diagram depicting mutual relationships between and within groups of stations. The distance between any two adjacent stations on the vertical axis is proportional to their dissimilarity. The spacing between the left margin of the dendrograph and the vertical lines linking ~~connecting~~ stations or groups of stations is inversely proportional to the degree of similarity within the grouping. Close spacing and linking ~~connecting~~ lines near the left margin are, thus, indicative of a closely related group of stations.

2. Similarity Coefficients.

The dendrograph requires a similarity measure between all pairs of stations as the basic unit of data. Two coefficients of similarity were computed for each pair in the present study. Jaccard's coefficient of similarity (Jaccard 1901, 1908) is based on the presence or absence of species at one or both stations of the pair. It can be defined as the percentage of species common to both stations and is formulated as:

$$S_j = \frac{c}{a+b+c} \times 100$$

where a is the number of species unique to station A, b is the number of species unique to station B and c is the number of species common to both stations.

The Bray-Curtis coefficient of similarity (Bray and Curtis, 1957) includes information on the number of individuals of each species. It is derived from the quantitative modification of Sorensen's coefficient (Sorensen, 1948) as first applied by Motyka, et. al. (1950):

$$S_m = \frac{2w}{A + B} \times 100$$

where A is the number of individuals of all species at station A, B is the number of individuals of all species at station B and w is the sum of the lesser of the counts for station A or B for those species occurring at both stations. Bray and Curtis adjusted the values of A and B to 100 and computed percent values for each species count. The above formula, thus, reduces to:

$$S_{bc} = \frac{2w}{100 + 100} \times 100 = w$$

where w is the sum of the lesser of the percent values for station A or B for those species occurring at both stations.

3. Data Sets.

The survey data were arranged into three ~~different~~ data sets for each station. Similarity coefficients were computed for each set for all station pairs and subjected to dendrograph analysis.

One set consists of the transect species plus the species list from the subsequent random search. This set contains the most information relative to species presence and absence but only Jaccard coefficients could be computed since there is no information on numerical abundance for the random-search species.

The second set consisted of the transect census data for each station. Both Jaccard and Bray-Curtis coefficients were computed for all station pairs.

The third set consisted of census data for just the common and highly visible transect species. Cryptic, tiny, secretive or nocturnal species were excluded as were those that are rarely seen and those not positively identified on a repeatable basis. The species arbitrarily chosen for exclusion are those most subject to census error due to observational difficulties and those which are too uncommon to have regular distribution within a community. Approximately one-fifth of the species observed during the study were excluded from this set. Their numbers comprise a much smaller proportion of the total number of individuals observed. Jaccard and Bray-Curtis coefficients were computed from this data set.

The above analyses resulted in five dendrographs which could be examined singly and in combination for patterns of station grouping.

4. Community Characterization.

The following numerical characteristics were examined for the communities distinguished through dendrograph analysis:

a. Density. Density is defined as number of individuals per hectare and was computed for each habitat as:

$$\text{density} = \frac{\text{total count for a species on all transects}}{\text{number of transects} \times 200 \text{ m.}^2} \times \frac{10{,}000 \text{ m.}^2}{\text{ha.}}.$$

Species can be ranked according to their density as one measure of their importance within a fish community.

Relative densities were computed as:

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

b. Biomass. The weight of a fish can be estimated by the relationship:

$$\text{weight} = (\text{length})^3 \times \text{conversion factor}.$$

Conversion factors vary for each species depending upon body form and were derived from lists provided by the Hawaii Coastal Zone Data Bank and the Division of Aquatic and Wildlife Resources, Government of Guam. No conversion factors were available for Samoan species which are uncommon or do not occur in Hawaii or Guam. In these cases, conversion factors for closely related species with similar shapes and size ranges were used. The error arising from this procedure is thought to be of no greater magnitude than that incurred by underwater enumeration and length estimation. Weight was computed for each transect individual using its estimated length. Weights were summed for each species and converted to biomass (kg./ha.) for each habitat by the formula:

$$\text{biomass} = \frac{\text{total weight for a species on all transects}}{\text{number of transects} \times 200 \text{ m.}^2} \times \frac{10{,}000 \text{m.}^2}{\text{ha.}}$$

Again, species can be ranked according to their biomass as a measure of their importance within a community.

Relative biomass was computed as:

$$\text{relative biomass} = \frac{\text{biomass for a species}}{\text{total biomass for all species}} \times 100.$$

c. Dominance Measure. A ranking of the significance of a species to a community by a density measure is obviously weighted in favor of smaller species which are far more numerous than larger species in tropical inshore habitats. A ranking based on biomass is probably a better indication of importance but it suffers from not taking numbers into account. Most ecologists would argue that 100 damselfishes with a total weight of one kilogram play a greater role in the community than a single parrotfish of the same weight. The best measure is a combination of density and biomass values. A dominance measure was computed for each species as:

dominance measure = relative density + relative biomass.

d. Constancy. The three measures of species importance listed above are derived ~~entirely~~ from the transect data alone. A fourth measure is termed constancy. It utilizes both the transect data and the list of species obtained during the subsequent 20-minute search. ~~It~~ and is computed as:

$$\text{constancy} = \frac{\text{no. of surveys on which a species was observed}}{\text{total no. of surveys}} \times 100.$$

Species highly ranked by this measure may not be particularly large or abundant but are an important component of the community because ~~they are always present.~~ of their consistent occurrence.

III. RESULTS.

Sixty-three fish community surveys were conducted at 57 sites around the island of Tutuila. Site locations are shown in Figure 1. Four of the sites were resurveyed one or more times to determine the degree of data variability resulting from imprecision of the survey methods and to assess the magnitude of changes in community structure occurring over time. A site at Cape Larsen was resurveyed at intervals of four days, ten weeks and 82 weeks. Sites at Nafanua Bank, Taema Bank and Whale Rock were resurveyed at intervals of 10 weeks, 24 weeks and 63 weeks respectively.

A total of 356 species of fishes were observed during the transects and subsequent 20 minute searches. The average number per survey was 86.2 (range = 44 ~~to~~ - 122). The average number of species observed on the transects alone was 44.9 (range = 18 ~~to~~ - 76) so the 20 minute search approximately doubled the number of species recorded for a particular site. The average number of individual fishes counted during the transects was ~~433.2~~ 432.9 (range = ~~197~~ 202 ~~to~~ - 738).

The weight of a fish can be estimated by the relationship:

weight = $(\text{length})^3$ x ~~(a constant~~ conversion factor).

Conversion factors vary for each species depending upon body form and were derived from lists provided by the Hawaii Coastal Zone Data Bank and the Division of Aquatic and Wildlife Resources, Government of Guam. Conversion factors for closely related species with similar shapes and size ranges were used for Samoan species not appearing on these lists. Estimated lengths of the transect fishes were used to calculate transect biomass for each species. These values were summed to calculate transect biomass for all species.

Fish biomass estimates for the 63 transects averaged ~~7.10~~ 7.04 kg. (range = 1.04 - 22.39 kg.) which is equivalent to ~~355.0~~ 352.2 kg./ha. Fishes with estimated lengths of five inches or greater made up ~~62%~~ 60.4 of the biomass while those with lengths less than five inches comprised ~~38%~~ 39.6 of the biomass.

39.6
60.4

Before proceeding with community [illegible] ... [illegible]
examine the combined data from all transects.

The survey results are broken down by species in Table I which lists density (individuals/ha.) by species for all ~~63~~ [surveyed] locations in the first column. Only those species which were observed on ten or more surveys are listed. They total ____. Their synonyms and a complete listing of the fishes of Samoa are catalogued by Wass (1981).

Table II ranks the top 20 species by each of the four measures described above for all ~~survey~~ locations. Surveys were conducted in ~~all~~ [each] of the assumed or potential habitat types around Tutuila and, while the survey locations were not consciously proportioned relative to the areal coverage of the various habitats around Tutuila, the relation is a rough approximation of the actual situation. The listings in Table II are, therefore, more or less applicable to the fish fauna of Tutuila as a whole and worthy of study.

The surgeonfish, Ctenochaetus striatus, ranks first in all four lists and is clearly the most important species in the fauna.

Members of the damselfish family (Pomacentridae) dominate the density ranking and comprise 13 of the top 20 species. All are small, the largest (Stegastes nigricans) not exceeding 12 cm. in total length and most smaller than 8 cm. Four ~~species of~~ surgeonfishes (~~Family~~ Acanthuridae), two ~~species of~~ wrasses (~~Family~~ Labridae) and juvenile parrotfishes (~~Family~~ Scaridae) comprise the remainder of the list. Some of these species attain lengths of 20 cm. but the majority of individuals are much smaller.

The biomass ranking is dominated by parrotfishes (Scaridae) which constitute nine of the top twenty species. All attain lengths of at least 25 cm. and most of the listed species can exceed 40 cm. The remaining species are mostly surgeonfishes (Acanthuridae) and damselfishes (Pomacentridae).

Examination of the dominance measure ranking, which combines relative density and relative biomass, shows damselfishes (pomacentridae) to be most important as they comprise 11 species. Surgeonfish (Acanthuridae) and parrotfishes (Scaridae) each comprise four species.

The top twenty species in the constancy of occurrence ranking include six surgeonfishes (Acanthuridae), four damselfishes (Pomacentridae), three wrasses (Labridae), three goatfishes (Mullidae), two butterflyfishes (Chaetodontidae), one parrotfish (Scaridae) and one angelfish (Pomacanthidae). This ranking shows a greater diversity of families than the other three which are so clearly dominated by damselfishes or parrotfishes. Half of the species do not occur in the other rankings. Though not large or numerous, these species are important components of the Samoan fauna because of their ubiquitous distribution.

DENDROGRAPHS.

Five dendrographs were constructed to examine the relationships between stations, two using Bray-Curtis similarity coefficients computed for data sets II and III and three using Jaccard coefficients for sets I, II and III. ~~They~~ Though differ~~ed~~ing somewhat in the ordering of stations and in composition of the clusters, ~~but the groupings~~ all five showed considerable resemblance.

The dendrograph constructed from Jaccard coefficients computed for data set II ~~(Figure 2)~~ does the best job of clustering stations into coherent groups which can be related to habitat types. The inclusion of species observed during the random search (data set I) obscures the relationships, perhaps because many are cryptic or secretive and likely to have been ~~be~~ present, but unobserved at some stations. The wary and less common species also account for a relatively large proportion of the random search species. They tend to be larger and wider-ranging and, therefore, not so characteristic of a particular habitat. Apparently, the lesser amount of information contained within set III was insufficient for adequate discrimination of community relationships when only species presence/absence data are considered.

Of the Bray-Curtis dendrographs, the best results were obtained from data set III. The clusters showed logical relationships and few stations were grouped irrationally. The inclusion of enumeration data for species more subject to census error (set II) due to their cryptic or secretive nature seemed to confuse the relationships.

The dendrograph resulting from the computation of Jaccard similarity coefficients for data set II is illustrated in Figure 2. It is gratifying to note the close association between surveys repeated for the same site. The degree of this association serves both as a measure of the precision of the census technique and as an indication of the amount of variability in community size and structure arising from seasonal and other ecological factors.

Surveys numbered 22, 23, 32 and 62 were conducted at intervals of 4 days, 10 weeks and 82 weeks in the same area at Cape Larsen. Dissimilarity with the initial survey increases with time but all show a closer relationship amongst themselves than to any of the other surveys. This is also the case for surveys 39 and 54 conducted at a 24-week interval in the same area at Taema Bank. Surveys 40 and 63 conducted at Whale Rock with an interval of 63 weeks do not show as close an association. This could be the result of the relatively long interval between surveys or a number of other factors. Surveys 49 and 56 were conducted ten weeks apart at the same site on Nafanua Bank. Though the survey interval was relatively short, they show greater dissimilarity than the other replicated surveys. This is probably due to an invasion of the Crown-of-Thorns Starfish (*Acanthaster planci*) during the ten-week interval and the resultant death of an estimated 75% of the hard coral (primarily *Acropora* spp.) in the area.

The highest order groupings in Figure 2 consist of the 44 surveys conducted on reef fronts and deeper reefs seaward of the reef flats (branch I in the figure) and the 19 surveys conducted on the reef flat and in the shallows adjacent to the shoreline (branch II in the figure). The two major groups are broken down into sub-groups and finally to groups associated with particular habitats as faunal similarity increases. Some physical and biological factors which may account for the higher order bifurcations of the dendrograph in Figure 2 are listed in Table III. Chief among them are probably depth, water movement, salinity and temperature ranges, availability of shelter, adjacent physiography and substrate characteristics.

Figure 2. A dendrograph grouping the 63 surveys through use of Jaccard Similarity Coefficients computed for all transect pairs from species presence/absence data. The vertical distance between adjacent horizontal lines representing individual transects is proportional to the degree of dissimilarity between transects. The horizontal distance between the vertical lines linking transects and groups of transects and the column of transect numbers is inversely proportional to the degree of similarity within the group of transects linked by the line. Table III refers to the labels on the branches of the higher order bifurcations.

~~The dendrograph resulting from the computation of Jaccard similarity coefficients for data set II is illustrated in Figure 2. Eleven clusters can be associated with habitats types as delineated in the figure.~~ Only three of the surveys are ~~illogically~~ grouped within the morphological habitats delineated in Figure 2. Alofau Reef Front (No. 19) is clustered amongst the Inner Bay Fronts though located on the South Shore. Faga'alu Reef Front (No. 44) doesn't fall clearly within any cluster though located in the Outer Bay. Nu'uuli Reef Front (No. 55) is clustered with the North Shore Fronts though located on the South Shore. In the analysis which follows, these surveys are included amongst the habitats with which they are geographically associated rather than as grouped by the dendrograph.

Tula Reef Front (No. 45) is a special case. It is located on the eastern tip of Tutuila and, therefore, not within any of the delineated habitats. The dendrograph clusters it within the Offshore Banks habitat ~~surveys~~ but for this analysis it is included in ~~with~~ the Miscellaneous grouping along with four other surveys ~~areas~~ (~~survey~~ Nos. 1, 34, 37 and 43) which lack ~~are not closely related~~ geographic and/or physiographic relationship to the delineated habitats. ~~These areas~~ The miscellaneous group also lack faunal similarity with other areas as shown by Figure 2.

Summary data from surveys comprising the eleven clusters of the dendrograph in Fig. 2 are averaged for each habitat in Table IV. Dominant species are ranked for the eleven habitats in Tables V - XV.

Habitat Descriptions and Fish Community Characterizations

1. North Shore Fronts. Surveys ~~Nos.~~ 22, 23, 24, 28, 29, 31, 32, 35, and 62.

Six locations fall within the North Shore Fronts habitat. All occur along the north coast which is generally the leeward side of the island and are, thus, subject to less violent wave action. The shoreline consists of rugged slopes or rocks along which there is little or no reef flat development interspersed with small bays with well-developed but relatively small reef flats. In the most protected portions of bays, north shore fronts tend to be nearly verticle and relatively shallow (upper edge at 2-5 m. dropping to a depth of 8-15 m.). In the most exposed areas, they tend to slope steeply and irregularly from 5-10 m. at the upper edge to 25-35 m. at the bottom. The transects were conducted just below the upper edges of the fronts at depths of 2-10 m. Coral growth in these areas is lush and diverse providing lots of shelter for fishes. Live coral coverage was generally estimated at 60-70%. Acropora spp. exhibiting tabular growth forms were dominant. Branching Acropora, staghorn Acropora, Porites and Pocillopora were also abundant. The reef front at Vatia (No. 35) had less coral coverage (estimated at 40%) and a somewhat different species composition of corals. ~~Likewise,~~ the dendrograph in Fig. 2 shows that its fish community is the most dissimilar of the group comprising the North Shore Fronts.

During the 72-week period between surveys 32 and 62, the Cape Larsen site was invaded by Acanthaster. Most of the Acropora was killed and live coral coverage was reduced to an estimated 10-20%. Fig. 2 ~~The coral kill~~, however, indicates ~~resulted in~~ only a small increase in fish ~~community~~ dissimilarity. ~~as shown by Fig. 2.~~ This is in contrast to the considerably greater dissimilarity apparently resulting from a coral kill by Acanthaster on Nafanua Bank ~~as~~ mentioned above.

Table IV shows that the average number of species censused during the transects (50.3) and the average total number of species (96.8) observed during the entire survey for each station fall near the midpoints for all seven of the reef front and deeper reef habitats. Likewise, average total transect biomass (7.85 kg.), average diversity (2.9077) and average eveness (.3634) are close to the averages for the seven deeper habitats.

Dominant fishes ~~in this habitat~~ are ranked in Table V. Unquestionably, Damselfishes are ~~without question~~ the most abundant members of the ~~fish~~ community. Eight of the top nine ~~most abundant~~ species belong to this family, with Plectroglyphidodon dickii ~~is~~ the most abundant. ~~species.~~ Allen (1975) has recorded ~~its~~ the association of this species with Acropora corals which comprise a large portion of the substrate within the North Shore Fronts habitat. Ctenochaetus striatus ranks first in the biomass column accounting for almost twice the biomass of second-ranking P. dickii ~~which ranks second.~~ A number of families make significant contributions to the fish biomass including Scaridae, Acanthuridae and Pomacentridae. When relative density and relative biomass are summed, the pomacentrids are again seen to be the dominant family with P. dickii the dominant species. Thirty species were observed during all nine of the surveys.

Space limitations preclude a more detailed discussion of the contents of the table ranking dominant fishes for the North Shore Fronts habitat. Even cursory study by the reader will yield much additional information relative to the numerical, biomass and trophic structure of the fish community.

2. Pago Bay Patches Surveys 2, 11, 40 and 63.

The four surveys were conducted on the tops and upper edges of three patch reefs or pinnacle reefs occurring in the outer portion of Pago Pago Bay. The reefs are more or less flat on top averaging about 5 m. in depth with numerous channels and irregularities. The substrate is hard with few or no sand patches because of the considerable surge. The sides slope almost vertically to the bottom at depths of 30-70 m. Grampus Rock (Survey 11) and Whale Rock (Surveys 40 and 63) are less than 50 m. in diameter and are completely isolated by very deep water. The reef off Faga'alu (Survey 2) is much larger and is narrowly connected to the fringing reef along the shore of the bay.

Live coral coverage on the tops of Grampus and Whale Rocks was estimated at only 10-30%. Considerably more coral and shelter occurred on the upper portions of the flanks with staghorn Acropora and Montipora the dominant species. Census transects for both these reefs were laid across the top at depths of about 5 m. then over the edge and around the shoulders at about 10 m. The transect at the Faga'alu reef was entirely on the top at a depth averaging about 7 m. Live coral coverage was about 70% with Pocillopora and Acropora the dominant species.

Table IV shows the Pago Bay Patches habitat has fewer species and less diversity than the other reef front and deeper reef habitats. This is probably the result of the relative uniformity of the habitat. The bottom is entirely hard, lacking the occasional patches of sand found in most habitats and the coral species lack diversity. The patch reefs are also isolated from all other benthic habitats and are, thus, closed to species which might feed in one habitat and shelter in another or strayfrom the habitat of their preference. The average eveness value is also the lowest of any of the deeper

Shannon Weiner, too

habitats indicating that relatively few species account for the bulk of the population.

Table VI shows these species to be Pomacentrus brachialis, Ctenochaetus striatus and Abudefduf sexfasciatus. A. sexfasciatus which feeds on zooplankton and benthic algae (Allen, 1975) was particularly abundant on the upper slopes of Grampus and Whale Rocks while C. striatus, a benthic algae feeder (Hiatt and Strasburg, 1960), was much more abundant on the reef off Faga'alu. P. brachialis was particularly abundant along the reef edges where it feeds on zooplankton and benthic algae (Allen, 1975). C. striatus and A. sexfasciatus account for most of the biomass and are also ranked first and second by the dominance measure in the third column of Table VI. Thirty-eight species were observed on all four of the transects.

3. South Shore and Outer Bay Fronts. Surveys 19, 21, 38, 44, 47, 48, 51 and 55.

Eight of the survey sites fall within the geographic bounds of this habitat though only five are grouped by the dendrograph (Fig. 2). Two of the sites (Surveys 44 and 47) are located in the outer portion of Pago Pago Bay and the remainder are scattered along the southern coast of the island from Alofau to Atao villages. These fronts generally consist of a steep coraline slope sometimes cut by channels or ridges which abuts the fringing reef terrace on the shoreward side at a depth of 5-10 m. and drops to a sandy bottom at 20-30 m. on the seaward side. Sand patches may occur in the channels and irregularities in the reef structure provide considerable shelter for fishes and their prey. Live corals are abundant covering 40-70% of the bottom and diverse with species of Acropora, Pocillopora and Porites dominating. Soft corals (Alcyonaria?) are also common. Transects were conducted at 7-13 m. near the upper edge of the slope where corals and fishes are most abundant.

The fish community in this habitat shows relationship to that of the previous habitat (Fig. 2) though considerably more speciose and having a slightly higher average diversity (Table IV). Again, Pomacentrus brachialis and Ctenochaetus striatus are the most common species (Table VII). Plectroglyphidodon dickii, however, ranks third in this habitat while Abudefduf sexfasciatus does not even occur among the top twenty. C. striatus again ranks first in biomass but Scarus japanensis ranks second and nine species of scarids occur among the top 20 fishes in the biomass column indicating their relatively high degree of dominance in the South Shore and Outer Bay Fronts habitat. Only three parrotfishes are listed among the top twenty species in the biomass column of Table VI. A further indication of their importance is found by examing the lists of fishes occurring on every survey conducted within each of the two habitats. Seven members of the parrotfish family were observed on all eight of the surveys within the South Shore and Outer Bay Fronts habitat while only two were observed on all four surveys within the Pago Bay Patches habitat.

Pomacentrus brachialis and Ctenochaetus striatus are seen to occupy the first two positions in the dominance measure column of Table VII. Thirty-eight species were found to be common to all eight surveys within this habitat.

4. Exposed Basalt Terraces. Surveys 4 and 8.

Only two sites within this habitat were surveyed. The habitat is restricted to the vicinity of basaltic promentories and is characterized by a narrow basaltic terrace directly abutting a rugged shoreline of rocks and cliffs on the shoreward side and a steep slope tp very deep water on the seaward side. The terrace itself has little slope but is somewhat irregular with low ledges and large lava boulders scattered about. The depth varies from 5 to 18 m. Corals are of mixed species and cover about 50% of the bottom. Pocillopora and Acropora predominate. Porites and Millipora are also abundant. Because the habitat is continually subjected to strong surge and currents, coral heads tend to be small or encrusting, thus, providing less shelter than in most other areas. There is also little sand on the bottom.

The fish community is characterized by a relatively large number of species and the most individuals of any of the deeper habitats (Table IV). The biomass of fishes smaller than five inches averages less than that for any of the deeper habitats while the biomass of fishes larger than five inches is greater. The species largely responsible for the high density are Chromis vanderbilti and C. acares (Table VIII), TWO ~~///~~ small planktivorous damselfishes whidh commonly aggregate around coral heads or rubble (Allen, 1975). Ctenochaetus striatus and Plectroglyphidodon dickii are also very abundant. An abundance of large C. striatus at both sites is responsible for the high biomass offishes greater than five inches in length. Its average biomass (140 kg./ha.) within this habitat is greater than that recorded for a single species in any of the other ten habitats. C. striatus also ranks first in the dominance measure column. It is followed by C. vanderbilti and C. acares. Because only two surveys were conducted within this habitat, an unusually large number of species (70) occurred on all surveys.

5. Coral Rich Rronts. Surveys 3, 9, 10, 13, 14, and 59.

The six surveys conducted within this habitat do not form a coherent group in the dendrograph in Fig. 2. Rather, they appear as part of a larger group which also includes the Offshore Banks Habitat. Both habitats are characterized by low turbidity and uniform high salinity associated with a lack of fresh water runoff. Both habitats also possess good circulation as the result of their exposure to current and strong swell. Physiographic characteristics which distinguish the Coral Rich Front habitat from that of the Offshore Banks include the presence of adjacent fringing reefs (except Station 10) and a greater amount of shelter for fishes. The habitat is also distinguished by a high percentage of coral coverage (averaging about 70%). Staghorn Acropora dominates the diverse assemblage of corals which also includes other growth forms of Acropora, as well as Pocillopora, Porites, Montipora and deveral other genera.

Station 10 falls geographically within the Offshore Banks habitat as it is located on the shallowest portion of Taema Bank. However, it more closely resembles the Coral Rich Front Habitat in terms of depth, coral diversity and the abundance of shelter provided by Large blocks of coral.

Except at Station 10, the transects were laid a few meters below the upper edges of the fronts at depths of 10-20 m. where coral growth was must luxurient and fishes were most numerous. The Taemb Bank transect was laid on the bottom and across the coral blocks on a compass heading.

The average number of transect species and average number of total species were the highest for any habitat as indicated in Table IV as was species diversity. Average transect biomass, particularly that for larger species, was also greater than that for any of the other habitats studied.

Table IX shows that *Chromis acares*, *Ctenochaetus striatus* and *Plectroglyphidodon dickii* are numerically dominant within the habitat and that *C. striatus* and *Scarus sordidus* account for the greatest biomass though closely follwed by three other species of *Scarus* and *Caranx melampygus*. Biomass estimates for 15 species are greater than 10 kg./ha. Scarids are clearly the dominant family in terms of biomass and are followed by acanthurids. *C. striatus*, *C. acares* and *P. dickii* rank 1-2-3 when relative density and biomass are combined. Thirty-nine species were observed at all six of the stations within this habitat.

6. Offshore Banks. Surveys 39, 41, 49, 54, 56, and 58.

Six surveys fall within the Offshore Banks Habitat as delineated in Figure 2. (Station 45 is included within the miscellaneous category as noted above.) Two of the surveys were conducted in the same location along the seaward slope of Taema Bank and four surveys were made in three locations on the seaward slope of Nafanua Bank. The transects were laid at depths of 18-26 m. which is deeper than that of the other habitats. Coral coverage was about 30% at ahe Taema site and 70% at the Nafanua sites. Again, *Acropora* was the dominant genus of a diverse assemblage. The reef contours of this habitat tend to be smoother than in the previous habitat offering less shelter and structural diversity. This is reflected by obsservation of fewer fish species in this habitat when compared to the previous one though the total number of species observed and species diversity remain high (Table IV). Fish density and biomass, however, are lower than that found for any of the reef front and deeper reef habitats.

Numbrically dominant species are *Plectroglyphidodon dickii*, *Chromis iomelas*, *Ctenochaetus striatus* and *Pomacentrus brachialis* (Table X.). *C. striatus*, *Scarus sordidus* and *Acanthurus glaucoparieus* are dominant when considering biomass. Fifty-two species were observed during all six surveys indicating a relatively high degree of faunal uniformity.

Amongst the dominant species, the major differences between the fish populations of the Coral Rich Fronts and the Offshore Banks appears to be the lower number of Chromis acares and Ctenochaetus striatus and the higher number of Acanthurus glaucoparieus on the Offshore Banks.

7. Inner Bay Fronts. Surveys 7, 12, 18, 52 and 53.

The dendrograph in Figure 2 clusters five surveys within this habitat. (A sixth, station 19, has been grouped within the South Shore and Outer Bay Front habitat as noted above.) The lack of surge and current, higher nutrient levels and greater turbidity distinguish this from the other reef front and deeper reef habitats. These factors account for decreased coral coverage (0% at Station 7 located farthest back in Pago Pago Bay ~~and/about/~~ to about 40% at Stations 12 and 18 located toward the entrance to the bay) and coral communities dominated by species of Montipora, Porites and Acropora as well as alcyonarian (?) corals adapted to conditions of reduced water movement and increased turbidity , siltation and pollution. Colonial anemones and sponges also cover a significant portion of the substrate. The transects were laid at depths of 5-12 m. near the upper edge of the steep and sometimes vertical slopes rimming the bay. These slopes generally extend from the reef flat at about 2 m. to the floor of the bay at 40-60 m. Considerable shelter is provided for fishes and their prey by deep cracks and caverns which are most prevalent on the upper and steepest portion of the slopes.

The Inner Bay Fronts temd to have fewer fish species than five of the other six reef front and deeper habitats (Table IV). Fish density and biomass fall near the averages but a greater proportion of the biomass appears to be comprised of small fishes than for the other habitats.

Ctenochaetus striatus and Pomacentrus brachialis, the two most abundant species observed on the Inner Bay Fronts (Table XI), retain the position of dominance they have shown among all the reef front and deeper reef habitats. Meicanthus ditrema, ranked third in density was not observed in any other habitat, however, nor were eight of the remaining 17 ~~spps~~ numerically dominant species. C. striatus again ranks first in biomass but eight of the remaining 19 species in the biomass column do not occur within the top 20 of the other six deeper habitats. The fish community associated with the Inner Bay Fronts appears to be characterized by a lack of pomacentrids, ~~scarids and labrids~~ and a plethora of chaetodontids. Only 18 species were observed at all stations. The number of species common to all stations jumps to 35 when Station 7 is excluded. The dissimilarity of its fish community is also evident from Figure 2 and is probably the result of its location which is much nearer the back of the bay than the other stations.

8. Protected and Inner Flats. Surveys Ø 5, 6 and 15.

The dendrograph in Figure 2 distinguishes four reef flat habitats All are located shoreward of the breakers zone at the reef crest and are characterized by shallow water, considerable water movement, and sizeable variations in salinity, temperature, turbidity and exposure to air and sunlight. The dendrograph also shows a relationship between the Protected and Inner Flats habitat and the Depressed Flats habitat. The two are distinguished primarily by depth and related factors. All but the smallest fishes are forced off most of the Protected and Inner Flats habitat by the receding tide. Periodic exposure to air, high temperature (on sunny days) and low salinity (during periods of heavy rainfall) also keep the habitat relatively free of the corals, anemones and sponges which cover much of the substrate in deeper areas. Corals (Porites, Pavona, Acropora) do cover about 10% of the bottom but they are restricted to the deeper portions of the habitat.

Three of the survey stations fall within the Protected and Inner Reef Flat habitat. Utulei and Faga'alu Reefs are not located as far back in the bay as some of the reefs included within the General Reef Flat Habitat discussed below. They are "protected", however, in that they are not oriented toward the prevailing swell. The third station at Lauli'i is an exposed location. The transect, however, was located on the inner half of a verywide reef flat. Much of the waves' force is, thus, absorbed on the outer portion of the flat. It can also be argued that the fishes living on the seaward edge of Lauli'i reef, and hence containing the elements of the population which are more characteristic of the exposed habitats, were isolated from the transect site by the distance involved.

The number of fish species and individuals was similar to the other reef flat habitats as shown in Table IV. The Protected and Inner Flats habitat, however, appears to have a substantially greater biomass of fishes smaller than five inches and a lessor biomass of fishes larger than five inches than the other reef flat habitats.

Ctenochaetus striatus is, again, the numerically dominant species by a wide margin (Table XII). The damselfish Stegastes albifasciatus and juvenile parrotfishes also occur at high densities. these same three species also domimate the biomass statistics for the habitat. All feed predominately on algae. Twenty-five species were observed on all three transects.

9. Dredged Flats. Surveys 16 and 27.

Surveys were conducted on two reef flats that had been dredged 10-15 years previously. Depths ranged between ~~two and eight ft~~ one and three m under the transects. Live coral was abundant with species of staghorn Acropora, Porites and Pavona covering 50-60% of the bottom. The remainder was sand.

This habitat has more fish species and greater diversity (Table IV) than the other reef flat habitats. The most abundant species are three damselfishes (Table XIII) including a benthic algal feeder, Stegastes nigricans, (Allen, 1975) and two planktivores (Allen, 1975), Chromis caerulea and Dascyllus aruanus. A mullet, Liza vaigiensis, ranks first in the biomass column. This species typically occurs in wide ranging schools. By chance, eight relatively large individuals happened to be observed on one of the two transects. It was not even observed during the species search at the other station. This observation resulted in a vast overestimate of its actual importance within the habitat. It actuality, it probably does not even occur within the top twenty species. S. nigricans and Ctenochaetus striatus are, therefore, dominant in terms of biomass. Thirty-nine species were observed at both stations.

10. Exposed Basalt Shoreline. Surveys 33 and 36.

Two surveys were conducted within the Exposed Basalt Shoreline habitat. This habitat occurs along much of the northern coast of Tutuila and consists of the basalt slope extending from the ~~hg~~ high-tide level to the submerged reef terrace at a depth of 6-10 m. It is characterized by constant surge and breaking waves at the shallower depths because there is no fringing reef flat to weaken the swell. The bottom consists of an irregular hard slope occasionally bisected by deep channels of sand and rubble. Pocil-lopora, Millipora and encrusting species of Porites cover about 20% of the bottom. Coralline algae is abundant.

Transects were laid parallel to the shoreline at depths of 1-5 m. Table IV shows that the Exposed Basalt Shoreline has the highest fish density and the lowest biomass of any habitat. It also has the least diversity and the lowest eveness value. These figures indicate the Exposed Basalt Shoreline habitat has a great many very small individuals comprized of only a few species. The species are seen to be the damselfish Glyphidodontops leucopomus and the wrasse Thallassoma quinquevittatum in Table XIV. T. quin-quevittatum accounts for the greatest biomass of any species and is followed by the surgeonfish Acanthurus lineatus. G. leucopomus and T. quinquevittatum have much higher dominance measures than any other species in the community. Thirty-six species were observed during both surveys.

Station	Habitat	Habitat Code	Location	Total Species	Transect Species	Transect Individuals	Transect Biomass
1	Deep Reef (bank)	12. MISC	Taema Bank, Inshore edge	106	50	353	11.78 kg.
2	Deep Reef (patch)	2. PBP	Large reef off Fagaalu Bay	86	55	570	15.99
3	Reef Front, South Sh.	5. CRF	Aunu'u Island, Auasi side	111	62	~~478~~ 476	18.78
4	Deep reef (terrace)	4. NET	Steps Point, west side	113	54	~~698~~ 696	12.52
5	Reef Flat, South sh.	8. PIF	Faga'alu reef flat	44	25	628	5.66
6	Reef Flat, Pago Bay	8. PIF	Utulei reef flat	68	36	624	7.21
7	Deep reef (patch)	7. IBF	Back bay reef off OMR	66	46	~~556~~ 552	~~16.58~~ 13.04
8	Deep reef (terrace)	4. NET	Sail Rock Point	103	55	~~372~~ 374	8.83
9	Reef front, South sh.	5. CRF	Fatuasina Point, off Freddie's Beach	113	59	404	9.36
10	Deep reef (bank)	5 CRF	Taema Bank, rockpile	117	67	~~365~~ 367	12.03
11	Deep reef (patch)	2. PBP	Patch reef off Aua by red nun bouy	68	41	~~513~~ 501	11.23
12	Reef Front, Pago Bay	7. IBF	Utulei reef front	93	51	459	6.18
13	Reef Front, South sh.	5. CRF	Auasi reef front	116	75	620	15.72
14	Reef Front, exposed	5. CRF	Larsen Bay reef front	122	62	~~464~~ 463	6.69
15	Reef flat, south sh.	8. PIF	Lauli'i reef flat	44	26	~~231~~ 232	2.73
16	Reef flat, deeper	9. DF	Alofau reef flat	55	42	454	6.37
17	Reef flat, Pago Bay	11. GRF	Aua reef flat (Mayor Line)	59	38	~~418~~ 417	4.86
18	Reef front, Pago Bay	7. IBF	Aua reef front (end of Mayor Line)	88	58	530	13.01
						8720	

Station	Habitat	Habitat Code	Location	Total Species	Transect Species	Transect Individuals	Transect Biomass
19	Reef front, South sh.	3. SSOBF	Alofau reef front	112	59	433	15.64 kg.
20	Reef flat, North sh.	11. GRF	Fagasa reef flat	50	30	667	3.72
21	Reef front, South sh.	3. SSOBF	Lauli'i reef front	108	53	~~434~~ 438	9.00
22	Reef front, North sh.	1. NSF	Cape Larsen reef front (control) 6/10/77	101	52	~~464~~ 465	12.36
23	Reef front, North sh.	1. NSF	" " " " " 6/14/77	93	43	~~469~~ 466	6.85
24	Reef front, North sh.	1. NSF	Sita Bay reef front	96	55	~~563~~ 582	5.58
25	Reef flat, North sh.	11. GRF	Sita Bay reef flat	50	29	~~510~~ 484	3.59
26	Reef flat, North sh.	11. GRF	Poloa reef flat	60	31	391	2.18
27	Reef flat, deeper	9. DF	Faga'itua reef flat	75	46	~~316~~ 370	3.34
28	Reef front, North sh.	1. NSF	Poloa reef front	117	76	731 733	22.39
29	Reef front, North sh.	1. NSF	Aásu reef front	96	44	391	4.84
30	Reef flat, North sh.	11. GRF	Aásu reef flat	55	29	502	4.71
31	Reef front, North sh.	1. NSF	Fagasa reef front	82	47	~~607~~ 609	4.90
32	Reef front, North sh.	1. NSF	Cape Larsen reef front (control) 8/26/77	104	54	522	7.24
33	Reef flat (shoreline)	10. ERNS	Cape Larsen shoreline	58	31	591	2.64
34	Deep reef (base of front)	12. MISC	Cape Larsen reef front	98	50	~~318~~ 320	4.86
35	Reef front, North sh.	1. NSF	Vatia reef front	77	30	285	1.04
36	Reef flat (shoreline)	10 ERNS	East of Fagasa bay shoreline	54	38	606	2.14
						8855	

Station	Habitat	Habitat Code	Location	Total Species	Transect Species	Transect Individuals	Transect Biomass
37	Deep reef (base of front)	12.Misc	East of Fagasa Bay	67	30	210	1.16 kg.
38	Reef front, South sh.	3.SSOBF	Fatumafuti reef front	99	47	375	6.23
39	Deep reef (bank)	6.OB	Taema Bank, seaward slope 10/24/77	105	47	~~387~~ 385	7.58
40	Deep reef (patch)	2.PBP	Whale Rock, Pago Bay 10/26/77	78	46	~~435~~ 434	4.28
41	Deep reef (Bank)	6.OB	Nafanua Bank, in front of Amouli	103	48	255	4.98
42	Reef flat, Pago Bay	11.GRF	Rainmaker Hotel reef flat	55	21	251	1.42
43	Reef flat, Pago Bay	12.Misc	Reef flat west of Malaloa Wharf	46	36	738	5.66
44	Reef front, Pago Bay	3.SSOBF	Faga'alu reef front	97	59	644	10.82
45	Reef front, South sh.	12.Misc	Tula reef front	101	55	~~431~~ 925	8.47
46	Reef flat, South sh.	11.GRF	Auasi reef flat	57	26	~~261~~ 252	5.21
47	Reef front, Pago Bay	3.SSOBF	Reef front just inside Breakers Pt.	108	54	~~382~~ 381	5.74
48	Reef front, South sh.	3.SSOBF	Faga'itua reef front	107	47	451	6.47
49	Deep reef (bank)	6.OB	Nafanua Bank, western tip, seaward 2/9/78	105	50	~~316~~ 317	7.09
50	Reef flat	11.GRF	Fagatele Bay reef flat	61	21	~~337~~ 341	3.49
51	Reef front	3.SSOBF	Atao reef front (ataulome)	107	47	~~359~~ 360	4.66
52	Reef front, Pago Bay	7.IBF	Lepua reef front	92	51	415	9.47
53	Reef front, Pago Bay	7.IBF	Rainmaker Hotel reef front	90	50	~~301~~ 303	3.57
54	Deep reef (bank)	6.OB	Taema Bk, seaward slope, same as #39 9/12/78	106	55	~~517~~ 259 680	8.51

Station	Habitat	Habitat Code	Location	Total Species	Transect Species	Transect Individuals	Transect Biomass
55	Reef front, South sh.	~~12. APC~~ 3.SS OBF	Nu'uuli reef front	107	40	273	3.82 kg.
56	Deep reef (bank)	6. OB	Nafanua Bank (same as # 49) 4/20/78	112	44	~~309~~ 308	6.62
57	Reef flat	11. GRF	Atao reef flat (Atauloma)	48	18	~~197~~ 202	1.66
58	Deep reef (bank)	6. OB	Nafanua Bank (near Aunu'u)	121	48	297	5.90
59	Reef Front	5. CRF	Fagatele Bay reef front	113	46	370	6.00
60	Reef flat, Pago Bay	11. GRF	Lepua reef flat	56	20	289	1.14
61	Reef flat, South sh.	11. GRF	Nu'uuli reef flat	47	26	360	1.38
62	Reef front, North sh.	1. NSF	Cape Larsen reef front (control) 1/4/79	105	52	~~392~~ 313	5.42
63	Deep reef (Patch)	2. PBP	Whale Rock, Pago Bay (same as # 40) 1/10/79	78	47	401	8.01
			RANGE	44-122	18-76	~~197~~ 202-738	1.04-22.39
			MEAN	86.2	44.9	~~433.2~~ 432.9	~~7.10~~ 7.04 kg.

2893

27224

TABLE II. Rank order of top 20 species for all 63 surveys by density (individuals/ha.), biomass (kg./ha.), dominance measure (relative density + relative biomass) and constancy of occurrence (number of surveys on which the species occurred). A total of ~~27,292~~ 27,274 individuals with an estimated weight of ~~447.3~~ 443.8 kg. were observed during the 63 transects.

Species	Density	Species	Biomass	Species	D. M.	Species	Constancy (C. of O.)
C. striatus	2,375	C. striatus	49.6	C. striatus	25.0	C. striatus	61
P. brachialis	1,925	S. japanensis	12.3	P. brachialis	~~11.9~~ 12.0	A. nigrofuscus	57
G. leucopomus	1,574	P. brachialis	10.8	P. dickii	8.8	L. dimidiatus	57
P. dickii	1,452	A. lineatus	10.3	G. leucopomus	7.9	P. chryserydros	56
C. acares	725	S. sordidus	10.3	A. lineatus	4.2	G. varius	55
P. vaiuli	665	A. glaucopareius	8.4	S. albifasciatus	3.9	P. vaiuli	52
S. albifasciatus	595	P. dickii	7.5	Scarus spp. (juv.)	3.9	C. reticulatus	51
P. lacrymatus	506	S. chlorodon	7.4	S. japanensis	3.7	N. literatus	51
T. quinquevittata	470	Scarus spp. (juv.)	7.3	S. sordidus	3.7	P. bifasciatus	51
C. iomelas	431	S. psitticus	7.2	P. vaiuli	3.6	A. lineatus	50
A. nigrofuscus	398	A. sexfasciatus	7.0	C. acares	3.5	S. sordidus	50
G. cyanea	398	S. gibbus	6.5	A. glaucopareius	3.4	H. hortulanus	49
Scarus spp. (juv.)	397	S. tricolor	6.0	A. nigrofuscus	3.1	G. cyanea	48
S. fasciolatus	313	C. xanthura	5.4	P. lacrymatus	3.0	A. glaucoparieus	47
C. xanthura	300	S. rubroviolaceus	4.8	A. sexfasciatus	2.9	C. flavissimus	46
P. johnstonianus	286	A. furcatus	4.6	C. xanthura	2.9	C. vagabundus	46
A. lineatus	273	N. literatus	4.5	T. quinquevittata	2.9	Z. scopas	46
S. nigricans	243	A. nigrofuscus	4.5	S. psitticus	2.6	P. trifasciatus	45
A. glaucoparieus	221	S. oviceps	4.3	C. iomelas	2.2	P. dickii	46
T. hardwickei	201	C. melampygus	4.1	S. fasciolatus	2.1	P. lacrymatus	44

TABLE III. Some factors which may be responsible for the higher order bifurcations of the dendrograph in Figure 2. The labels correspond to those on the branches of the figure.

I. Richer coral growth; more shelter for fishes; less variation in temperature and salinity.

II. Shallower; greater water movement; greater exposure to sunlight.

I. A. Greater water movement; richer coral growth.

I. B. More nutrients and pollutants; higher turbidity.

I. A. 1. More fresh water runoff.

I. A. 2. Greater water movement; higher water quality.

I. A. 1. a. Greater salinity variation.

I. A. 1. b. High swell; adjacent to basaltic shoreline rather than coraline reef flats; hard bottom with little sand.

I. A. 1. a. (1). Northern exposure to swell currents, etc.; adjacent to steeply sloping shoreline of basalt rocks or relatively small coral reef flats.

I. A. 1. a. (2). Southern exposure.

I. A. 1. a. (2). (a). Surrounded by deep water with no adjacent reef flats; no relatively shallow sandy areas in vicinity.

I. A. 1. a. (2). (b). Adjacent to coral reef flats inshore.

I. A. 2. a. Richer and more diverse coral growth; ~~more shelter for fishes.~~

I. A. 2. b. Surrounded by deep water with no adjacent reef flats or shoreline.

II. A. Less water movement.

II. B. Larger breakers; more exposure to air at low tide.

II. A. 1. Occupancy by fishes somewhat dependent upon tide; adjacent to large sandy patches.

II. A. 2. Deeper; subject to continuous occupancy by fishes; more coral and shelter.

II. B. 1. Basaltic substrate; continuous exposure to breakers and swell; subject to continuous occupancy.

II. B. 2. Coraline substrate; cyclic exposure to breakers and air; most fishes forced off at low tide.

Table IV. Survey data averages for the eleven habitats and the two major groups delineated in Figure 2.

Habitat	No. Surveys	No. Transect Species	No. Total Species	No. Transect Individs.	Transect Biomass (kg) Fish<5" T.L.	Transect Biomass (kg) Fish≥5" T.L.	Total Transect Biomass (kg)	Shannon-Weiner Diversity	Hiep's New Evenness Index
1. North Shore Fronts	9	50.3	96.8	494.0	2.89	4.96	7.85	2.9007	.3634
2. Pago Bay Patches	4	47.2	77.5	476.5	3.40	6.48	9.88	2.6692	.3017
3. South Shore ~~and~~ & Outer Bay Fronts	8	52.0	105.6	419.4	2.96	4.84	7.80	2.7592	.3037
4. ~~Nearshore~~ Exposed Fault Terraces	2	54.5	108.0	535.0	2.06	8.62	10.68	2.9661	.3468
5. Coral Rich Fronts	6	61.8	115.3	450.0	2.83	8.60	11.43	3.2238	.4038
6. Offshore Banks	6	48.7	108.7	305.2	2.10	4.68	6.78	3.1583	.4773
7. Inner Bay Fronts	5	51.2	85.8	451.8	3.61	5.44	9.05	2.9500	.3687
Miscellaneous Fronts & Deeper Reefs	4	46.2	93.0	327.0	1.97	4.60	6.57	2.9089	.4000
average? ~~TOTAL~~ - Reef Fronts & Deeper Reefs	44	51.4	99.7	429.0	2.80	5.72	8.52	2.9439	.3711
8. Protected ~~and~~ & Inner Flats	3	29.0	52.0	494.7	4.84	0.36	5.20	2.3314	.3476
9. edged Depressed Flats	2	44.0	65.0	412.0	2.32	2.54	4.86	2.6792	.3185
10. Exposed ~~Rock~~ Fault Shelf	2	34.5	56.0	598.5	1.82	0.57	2.39	2.0516	.2034
11. General Reef Flats	11	26.3	54.4	377.8	1.88	1.15	3.03	2.1835	.3359
Miscellaneous Reef Flats	1	36.0	46.0	738.0	4.73	0.93	5.66	1.7768	.1403
average ~~TOTAL~~ - Reef Flats	19	29.9	54.8	442.1	2.54	1.10	3.64	2.2237	.3117
GRAND TOTAL average	63	44.9	86.2	432.9	2.71	4.33	7.04	2.7267	.3532

TABLE V. *North Shore Front* habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~4,424~~ 4446 individuals with an estimated weight of 70.62 kg. were observed during the 9 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
P. dickii*	4,450	C. striatus*	39.99	P. dickii*	23.43	a. furcatus
P. brachialis*	2,717	P. dickii*	21.21	C. striatus*	18.98	B. undulatus
C. striatus*	2,050	S. japonensis	17.83	P. brachialis*	14.18	C. argus
C. acnes*	1,900	M. berndti	14.36	C. acnes*	7.82	C. peleuensis
N. metallicus	1,072	G. aureolineatus	14.12	C. xanthurus*	6.09	C. reticulatus
P. lacrymatus*	972	C. dumerili	13.27	N. metallicus	5.36	C. trifasciatus
G. cyaneus*	878	P. brachialis*	12.47	P. lacrymatus*	5.17	C. vagabundus
C. xanthurus*	744	C. xanthurus*	12.08	S. japonensis	4.77	H. hortulanus
C. atripectoralis	639	S. chlorodon	11.90	M. berndti	4.63	L. bicolor
P. arcatus	483	M. flavolineatus	10.24	G. aureolineatus	4.32	L. dimidiatus
G. varius*	472	S. rubroviolaceus	9.85	G. cyaneus*	3.76	L. unilineatus
C. margaritifer	411	S. gibbus	9.41	M. flavolineatus	3.67	L. fulvus
P. [illegible]*	406	C. unodelus	8.95	C. dumerili	3.49	N. literatus
Scarus spp. (juv)	389	S. frenatus	8.72	C. unodelus*	3.09	P. forsteri
S. fasciolatus	383	S. oviceps	8.15	S. chlorodon	3.05	P. bifasciatus
C. stigmaticus	372	S. taeniurus	7.31	P. arcatus	2.97	P. evides
P. johnstonianus	338	A. lineatus*	7.16	C. atripectoralis	2.77	P. diacanthus
P. vaiuli	311	M. vidua	6.89	S. rubroviolaceus	2.53	S. sordidus
T. hardwickei	267	S. tricolor	6.51	S. gibbus	2.44	Z. veliferum
M. flavolineatus	261	A. glaucoparieus*	5.26	[illegible]	[illegible]	

TABLE VI. Pago Bay Patches habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~1,719~~ 1906 individuals with an estimated weight of 39.51 kg. were observed during the 4 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
P. brachialis*	5,162	C. striatus*	106.83	C. striatus*	39.36	B. undulatus
C. striatus*	4,225	A. sexfasciatus*	92.06	A. sexfasciatus*	28.56	C. pardalis
A. sexfasciatus*	2,362	S. japonensis	43.98	P. brachialis*	27.46	C. lunula
S. fasciolatus*	1,150	P. brachialis*	28.58	S. japonensis	9.11	C. ornatissimus
P. dickii*	1,075	P. tile	22.18	S. fasciolatus*	6.86	C. reticulata
P. vaiuli*	900	A. glaucopareius*	21.23	A. glaucopareius*	5.82	C. vagabundus
A. nigrofuscus*	888	S. sordidus*	15.04	P. dickii*	5.72	C. diagrammus
P. lacrymatus	775	A. lineatus	14.63	P. tile	5.18	C. oxycephalus
T. quinquevittatum*	738	P. kohleri	14.62	A. nigrofuscus*	4.86	C. margaritifer
A. glaucopareius*	362	C. argus*	12.02	T. quinquevittatum*	4.53	D. trimaculatus
C. solandri*	312	P. diacanthus*	10.84	P. vaiuli*	4.49	F. flavissimus
C. stigmaticus	288	S. fasciolatus*	10.04	S. sordidus*	4.15	G. leucogramma
P. lacrymatus*	275	S. spinus*	9.53	P. kohleri	4.01	H. fasciatus
G. varius*	262	T. lutescens*	8.47	P. lacrymatus	3.84	H. moniorus
S. sordidus*	262	T. quinquevittatum*	7.09	A. lineatus	3.59	H. varius
T. lutescens*	262	A. achilles	6.32	T. lutescens*	2.81	L. dimidiatus
P. kohleri	250	P. dickii*	5.97	C. argus*	2.64	N. literatus
C. sebae	238	A. nigrofuscus*	5.62	P. diacanthus*	2.61	P. richardsoni
G. cyaneus*	225	G. varius*	5.32	G. varius*	2.18	Z. cornutus
C. flavissimus*	200	M. vidua	4.55	S. spinus*	[illegible]	

3 South Shore and Outer Bay Fronts

TABLE VII. ______ habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~3,35?~~ 3355 individuals with an estimated weight of 62.38 kg. were observed during the 8 transects surveyed within this habitat.

[illegible]

Species	Density	Species	Biomass	Species	D. M.	Species Observed On All Surveys
P. brachialis*	5,381	C. striatus*	47.58	P. brachialis*	32.90	A. scopas
C. striatus*	2,412	S. japanensis*	29.34	C. striatus*	23.71	B. undulatus
P. dickii*	1,725	P. brachialis*	28.44	P. dickii*	10.48	C. flavissimus
S. psittacus	875	S. rubroviolaceus*	26.78	S. psittacus	10.39	C. ephippium
P. lacrymatus*	769	S. psittacus	24.19	S. japanensis*	8.07	C. ornatissimus
C. iomelas	725	S. chlorodon	23.25	S. rubroviolaceus*	6.93	C. argus
P. vaiuli*	619	Scarus spp.	10.57	S. chlorodon	6.05	E. insidiator
P. johnstonianus*	450	L. fulvus*	9.46	P. lacrymatus*	9.70	H. hortulanus
Scarus spp.-juv	412 <406	P. dickii*	8.77	Scarus spp.	4.66	H. varius
P. leucotaenia*	369	S. frenatus	8.62	C. iomelas	3.61	P. bifasciatus
C. reticulatus*	356	A. glaucopareius*	7.90	P. vaiuli*	3.36	P. chrysozonus
G. varius*	306	S. gibbus*	7.90	A. glaucopareius*	3.22	P. trifasciatus
A. glaucopareius*	250	S. jonesi	6.82	L. fulvus*	3.07	P. diacanthus
C. pelewensis*	250	F. sammara	5.38	C. reticulatus*	2.93	S. niger
C. stigmaticus	238	P. oualensis	5.19	P. johnstonianus*	2.55	S. oviceps
D. trimaculatus	200	C. reticulatus*	4.78	S. frenatus	2.33	S. spinus
Z. scopas*	194	M. grandoculis*	7.76	S. gibbus*	2.21	T. lutescens
C. xanthurus*	181	C. xanthurus*	4.64	C. xanthurus*	2.08	
C. trifasciatus*	169	S. sordidus*	4.57	C. acuilis	1.96	
~~M. atrodorsalis~~	~~15?~~	A. furcatus*	4.11	G. varius*	1.95	

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TABLE VIII. ~~Nearshore~~ Exposed, Terrace (Reef) habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~965~~ 1070 individuals with an estimated weight of 21.35 kg. were observed during the 2 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
C. vanderbilti*	5,225	C. striatus*	140.18	C. striatus*	35.62	Too many to list
~~C. acares*~~	~~3,000~~					
C. striatus*	2,500	S. tricolor*	38.45	C. vanderbilti*	19.84	because only 2
				C. acares*	11.37	
P. dickii*	2,450	A. lineatus*	29.73	P. dickii*	10.90	surveys
T. quinquevittatum*	1,625	A. glaucopareius*	29.35	A. glaucopareius*	8.12	
P. richardsoni*	1,500	S. frenatus*	24.71	T. quinquevittatum*	7.68	
S. fasciolatus*	1,125	S. sordidus*	20.95	S. tricolor*	7.67	
P. arcatus*	800	Scarus spp.	19.25	S. frenatus*	6.89	
P. vaiuli*	775	Mel. niger	15.15	A. lineatus*	6.50	
A. glaucopareius*	700	C. modestus*	13.90	P. richardsoni*	5.965	
C. modestus*	625	P. imperator*	13.15	S. fasciolatus*	6.03	
S. frenatus*	600	M. vidua*	11.23	P. arcatus*	4.125	
A. nigrofuscus*	500	B. bursa	10.13	S. sordidus*	4.402	
P. coelestis*	500	A. furcatus	9.92	C. modestus*	4.00	
C. varolosus*	325	S. fasciolatus*	9.69	Scarus spp. (juv)	3.80	
~~C. acares*~~	~~300~~	T. hardwickei	9.31	P. vaiuli*	3.34	
A. lineatus*	250	P. dickii*	4.26	A. nigrofuscus*	3.29	
C. flavissimus*	250	T. quinquevittatum*	8.60	Mel. niger	3.12	
C. margaritifer*	250	P. multifasciatus*	8.42	P. imperator*	2.55	
C. xanthurus*	250	P. [illegible]*	8.13	M. vidua*	2.47	
P. johnstonianus*	250	N. literatus*	7.94	~~B. bursa~~	~~2.78~~	

TABLE IX. Coral Rich Front habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~2,655~~ 2700 individuals with an estimated weight of 68.57 kg. were observed during the 6 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	Species Observed On All Surveys
C. acares*	2,567	C. striatus*	58.69	C. striatus*	21.34	A. lineatus
C. striatus*	2,492	S. sordidus*	36.35	C. acares*	11.60	A. scopas
P. dickii*	2,033	S. chlorodon	28.42	P. dickii*	10.81	A. chinensis
P. brachialis*	1,700	Scarus spp. (juv.)	28.22	P. brachialis*	9.42	B. undulatus
P. vaiuli*	1,342	C. melampygus	27.83	S. sordidus*	7.21	C. bispinosus
C. iomelas*	1,208	S. oviceps	25.01	Scarus spp. (juv.)	7.05	C. flavissimus
P. johnstonianus*	742	S. gibbus	24.49	P. vaiuli*	6.72	C. trifasciatus
P. lacrymatus*	708	N. tuberosus	21.17	C. iomelas*	5.77	C. oxycephalus
C. xanthura*	617	A. glaucopareius*	19.47	A. glaucopareius*	5.34	E. insidiator
Scarus spp. (juv.)	475	A. furcatus*	18.40	C. melampygus	5.17	F. flavissimus
A. glaucopareius*	433	S. tricolor	14.67	S. chlorodon	5.12	H. [illegible]
C. reticulatus*	417	C. xanthura*	12.52	C. xanthura*	4.93	H. chrysostomus
O. longirostris	358	S. japanensis	11.52	S. oviceps	4.84	H. varius
C. strigosus	342	P. brachialis*	10.65	S. gibbus	4.33	L. bicolor
M. flavolineatus	333	P. dickii*	10.16	P. johnstonianus*	3.97	L. dimidiatus
C. solandri*	242	C. strigosus	9.15	P. lacrymatus*	3.87	L. rubrolabiatus
G. varius*	225	N. lituratus*	8.40	N. tuberosus	3.74	Mac. niger
P. hexataenia	200	A. [illegible]	7.93	A. furcatus*	3.56	P. forsteri
S. sordidus*	192	M. grandoculis*	7.32	C. strigosus	3.12	P. [illegible]
P. arcatus*	159	N. [illegible]	7.23	C. reticulatus*	[illegible]	P. diacanthus

TABLE X. Offshore Banks habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~1,833~~ 1831 individuals with an estimated weight of 90.68 kg. were observed during the 6 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	Species Observed On All Surveys
P. dickii*	2,125	C. striatus*	39.49	C. striatus*	19.19	A. thompsoni
C. ovalis*	1,317	S. sordidus*	24.67	P. dickii*	17.11	A. scopas
C. striatus*	1,150	A. glaucopareius*	20.57	A. glaucopareius*	10.22	A. twistii
P. brachialis*	1,142	P. tile*	16.35	P. brachialis*	9.11	B. undulatus
P. vaiuli*	975	L. bohar*	15.81	C. ovalis*	9.09	C. sandwichensis
P. johnstonianus*	858	C. strigosus*	12.31	S. sordidus*	8.64	C. argus C. modestus
P. lacrymatus*	858	P. dickii*	10.78	P. vaiuli*	7.11	C. oxycephalus C. [illegible]
A. glaucopareius*	633	Ct. bicolor	10.33	P. lacrymatus*	6.97	C. pelewensis C. reticulatus
C. acares	625	S. gibbus*	10.33	C. strigosus*	6.63	C. unimaculatus
C. strigosus*	458	C. xanthura*	7.57	P. johnstonianus*	6.59	E. insidiator F. flavissimus
C. bispinosus*	367	A. maculiceps*	6.40	P. tile*	6.35	H. hortulanus
C. xanthura*	367	M. grandoculis*	6.40	L. bohar*	4.82	H. varius L. dimidiatus
C. stigmaticus*	242	G. aureolineatus	5.74	C. xanthura*	4.63	P. forsteri
P. tile*	233	N. hexacanthus	5.60	C. acares	4.14	P. bifasciatus P. chrysurus
S. sordidus*	208	M. vidua*	5.54	C. bispinosus*	3.35	P. moluccanus
C. flavissimus*	200	P. brachialis*	5.53	Ct. bicolor	3.10	P. hollisi
G. varius*	200	N. brevirostris	5.29	S. gibbus*	3.10	P. diacanthus
P. arcatus*	200	C. melampygus	4.64	G. aureolineatus	2.24	S. oualensis S. tricolor
P. lepotaenia*	200	N. literatus	4.50	M. grandoculis*	2.11	T. lutescens
A. nigrofuscus*	183	M. [illegible]	4.88	A. maculiceps*	2.05	Z. cornutus

TABLE XI. Inner Bay Fronts habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of 2,259 individuals with an estimated weight of 45.27 kg. were observed during the 5 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
C. striatus*	3,370	C. striatus*	61.89	C. striatus*	28.56	B. undulatus
P. brachialis	3,290	A. lineatus	25.95	P. brachialis	18.44	C. ulietensis
M. ditrema	2,060	S. psittacus	25.04	M. ditrema	9.29	C. vagabundus
P. vaiuli	1,730	S. japonensis	22.00	P. vaiuli	7.64	C. quinquelineatus
G. cyaneus	770	M. grandoculis*	21.61	A. lineatus	6.66	H. monoceros
A. leucogaster	750	P. diacanthus*	18.60	S. psittacus	6.15	P. chrysurus
C. pelewensis	540	P. brachialis	17.64	A. leucogaster	6.11	S. ghobban
H. melanurus	530	L. fulvus*	14.02	M. grandoculis*	6.10	
M. atrodorsalis*	530	A. leucogaster	12.68	S. japonensis	5.30	
Z. cornutus*	370	S. taeniurus	11.29	P. diacanthus*	4.60	
H. acuminatus	340	Z. cornutus*	11.09	L. fulvus*	4.12	
N. metallicus	330	A. xanthopterus	10.30	Z. cornutus*	4.09	
Scarus spp. (juv)	310	M. flavolineatus	9.15	G. cyaneus	3.55	
H. varius*	300	H. acuminatus	8.95	H. acuminatus	3.98	
M. grandoculis*	300	E. fuscoguttatus	8.46	C. pelewensis	3.08	
A. nigrofuscus*	290	S. niger	7.24	S. taeniurus	2.76	
C. lunula*	260	A. sexfasciatus	6.51	H. melanurus	2.66	
C. flavissimus	250	C. lunula*	5.42	A. xanthopterus	2.59	
P. lacrymatus	240	P. vaiuli	5.67	C. lunula*	2.57	
Z. scopas*	240	P. trifasciatus*	5.53	M. flavolineatus	2.55	

TABLE VI. Protected and Inner Flats habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of 1,484 ok individuals with an estimated weight of 15.60 kg. were observed during the 3 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
C. striatus*	8,483	C. striatus*	98.87	C. striatus*	72.34	C. citrinellus
S. albifasciatus*	3,100	Scarus spp. (juv.)*	32.75	S. albifasciatus*	24.14	C. trilobatus
Scarus spp. (juv.)*	2,650	S. albifasciatus*	30.18	Scarus spp. (juv.)*	23.31	G. varius
S. nigricans*	1,533	S. sordidus*	20.06	S. nigricans*	13.25	H. marginatus
S. sordidus*	1,250	S. nigricans*	18.32	S. sordidus*	12.77	H. melapterus
T. hardwickei*	1,150	A. nigrofuscus*	9.07	T. hardwickei*	6.77	P. bifasciatus
G. leucopomus*	817	T. hardwickei*	5.52	A. nigrofuscus*	6.66	S. fasciatus
A. nigrofuscus*	783	H. margaritaceus	2.45	G. leucopomus*	3.92	Z. cornutus
H. melanurus	617	D. aruanus	2.33	H. melanurus	3.06	
G. glaucus	500	H. trimaculatus*	2.23	D. aruanus	2.64	
D. aruanus	433	Sig. spinus*	2.15	G. glaucus	2.46	
G. cyaneus*	417	A. chinensis	1.90	H. margaritaceus	2.22	
C. caerulea	367	E. merra*	1.90	G. cyaneus*	1.87	
H. margaritaceus	317	M. flavolineatus	1.70	A. triostegus*	1.84	
A. triostegus*	300	C. sulandri*	1.66	C. caerulea	1.54	
G. bioccellatus	200	A. triostegus*	1.63	H. trimaculatus*	1.40	
A. lineatus	167	G. leucopomus*	1.61	G. bioccellatus*	1.25	
H. trimaculatus*	133	H. melanurus	1.48	Sig. spinus*	1.23	
P. vaiuli*	133	S. [illegible]*	1.32	A. lineatus	1.07	
S. bandanensis*	133	S. bandanensis*	1.26	E. merra*	1.07	

TABLE XIII. Dredged Flats habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~822~~ 824 individuals with an estimated weight of 9.71 kg. were observed during the 2 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
S. nigricans*	4,750	L. vaigiensis	94.57	L. vaigiensis	39.92	A. sexfasciatus
C. caeruleus*	3,550	S. nigricans*	21.36	S. nigricans*	31.85	C. solandri
D. aruanus*	2,500	C. striatus*	20.80	C. caeruleus*	19.89	C. citrinellus
C. striatus*	2,175	D. aruanus*	9.68	C. striatus*	19.12	E. insidiator
T. hardwickei*	700	T. hardwickei*	9.54	D. aruanus*	16.13	G. varius
S. lividus*	600	Scarus spp. (juv.)*	8.22	T. hardwickei*	7.33	H. chrysopterus
G. cyaneus*	475	S. lividus*	7.98	S. lividus*	6.21	H. [illegible]
Scarus spp (juv.)*	450	S. oviceps*	7.59	Scarus spp. (juv.)*	5.58	L. fulvus
C. quinquelineatus	325	C. caeruleus*	6.45	S. oviceps*	4.35	M. grandoculis
G. citrinus*	325	G. aureolineatus*	4.96	G. aureolineatus*	2.77	P. trifasciatus
C. trifasciatus*	250	E. merra*	3.87	G. cyaneus*	2.59	P. raiali
H. trimaculatus*	250	Caranx sp. (juv.)	3.48	C. trifasciatus*	2.54	S. spinus
S. oviceps*	250	C. trifascialis*	3.21	E. merra*	2.32	S. trilineatus
O. longirostris*	225	M. flavolineatus*	3.01	H. trimaculatus*	1.93	Z. cornutus
L. vaigiensis	200	A. nigrofuscus*	2.39	C. quinquelineatus	1.91	
A. nigrofuscus*	175	O. meleagris	2.22	A. nigrofuscus*	1.83	
E. merra*	150	C. trifascialis*	2.15	O. longirostris*	1.77	
G. biocellatus*	150	L. bilineatus*	2.12	G. citrinus*	1.72	
G. aureolineatus*	150	A. triostegus*	2.00	Caranx sp. (juv.)	1.67	
S. sordidus*	150	H. melapterus*	1.78	M. flavolineatus*	1.60	

TABLE XV. General Reef Flat habitat. Rank order of top 20 species by density (individuals/ha.), biomass (kg./ha.) and dominance measure (relative density + relative biomass). Species observed during all surveys conducted within this habitat are designated with an asterisk (*) if listed in the rank orders. If unlisted in the rank orders, they are listed in alphabetical order in the right-hand column. A total of ~~4,150~~ 4156 individuals with an estimated weight of 33.36 kg. were observed during the 11 transects surveyed within this habitat.

Species	Density	Species	Biomass	Species	D. M.	additional Species Observed On All Surveys
G. leucopomus* + bicolor	6,509	A. lineatus*	25.15	G. leucopomus*	41.34	P. bifasciatus
S. albifasciatus	2,532	C. striatus	20.39	S. albifasciatus	22.37	R. rectangulus
G. glaucus	1,173	S. albifasciatus	13.60	A. lineatus*	22.24	S. spinus
C. striatus	1,168	A. nigrofuscus	10.52	C. striatus	19.63	
A. lineatus*	1,068	G. leucopomus*	10.43	A. nigrofuscus	10.67	Species Observed on 10 Surveys
A. nigrofuscus	705	A. triostegus*	9.44	A. triostegus*	9.45	
A. triostegus*	609	N. literatus*	8.71	G. glaucus	7.38	A. sordidus
T. quinquevittatum	600	T. hardwickei*	4.72	N. literatus*	6.28	A. nigrofuscus
H. margaritaceus*	573	S. fasciolatus	4.08	T. quinquevittatum	5.54	C. striatus
G. cyaneus	532	T. quinquevittatum	3.57	T. hardwickei*	5.39	G. cyaneus
H. marginatus	468	S. fosteri	3.40	H. margaritaceus*	5.16	G. glaucus
T. hardwickei*	432	H. margaritaceus*	3.25	S. fasciolatus	4.47	G. varius
S. fasciolatus	336	T. fuscum*	2.97	H. marginatus	3.98	H. marginatus
P. leucozona	277	Scarus spp. (juv)	2.78	G. cyaneus	3.14	H. trimaculatus
Scarus spp. (juv)	295	H. marginatus	2.27	Scarus spp. (juv)	3.14	S. albifasciatus
C. citrinellus*	155	G. glaucus	1.78	P. leucozona	2.62	S. bandanensis
P. dickii	114	P. leucozona	1.75	T. fuscum*	2.46	T. quinquevittatum
N. literatus*	100	T. purpureum	1.71	S. fosteri	2.43	
S. bandanensis	100	C. citrinellus*	1.62	C. citrinellus*	1.87	
T. fuscum*	95	A. guttatus	1.50	A. guttatus	1.25	

Table XVI. Fish family dominance for the eleven habitats and two major groups distinguished by the dendrograph in Figure 2. The data are derived from the dominance measure columns for the top 20 species in Tables V - XV and include the listed number (No.) of species and the sum of their dominance measures (D.M.) for each family.

	Pomacentridae		Acanthuridae		Scaridae		Labridae		Chaetodontidae		Lethrinidae		Serranidae		Lutjanidae		Cirrhitidae		Pomacanthidae		Caesionidae		Miscellaneous	
Habitat	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.	No.	D.M.
1. NSF	8	68.7	1	18.5	4	12.8	1	2.4			1	4.3	1	3.1			1	3.0					3	11.8
2. PBP	6	77.0	5	57.9	2	11.1	3	9.5					1	2.6					1	2.6	2	9.2		
3. SSOBF	8	61.8	2	26.9	7	40.6	1	2.0	1	2.9					1	3.0								
4. EBT	5	51.4	4	53.5	5	28.8	1	7.7					1	4.0			1	4.1	1	2.6			2	5
5. CRF	8	57.1	4	33.4	5	28.4			1	2.7					1	3.6							1	5.3
6. OB	8	64.6	4	38.0	3	14.8					2	4.3			1	4.8			1	3.4	1	6.4		
7. IBF	4	35.7	3	37.9	3	14.3	1	2.7	3	9.2	1	6.1			1	4.1			1	4.6			3	13
Total	47	416.3	23	266.1	29	150.8	7	24.3	5	14.8	4	14.7	3	9.7	4	15.5	2	7.1	4	13.2	3	15.6	9	50..
8. PIF	7	37.7	4	81.9	3	49.3	4	13.5					1	1.1									1	1.
9. DF	5	76.7	2	20.9	2	10.0	2	9.2	1	2.5	1	2.8	1	2.3									6	48.8
10. EBS	6	80.5	4	26.9			3	51.4									2	6.6					5	14
11. GRF	6	81.3	6	69.5	2	5.5	5	22.6	1	1.9														
Total	24	276.2	16	199.2	7	64.8	14	96.7	2	4.4	1	2.8	2	3.4			2	6.6					12	64.4
GRAND TOTAL	71	692.5	39	465.3	36	215.6	21	121.0	7	19.2	5	17.5	5	13.1	4	15.5	4	13.7	4	13.2	3	15.6	21	203.0

Table XVI. Fish family dominance for the eleven habitats and two major groups distinguished by the dendrograph in Figure 2. The data are derived from the dominance measure columns for the top 20 species in Tables V - XV and include the listed number (No.) of species and the sum of their dominance measures (D.M.) for each family.

Habitat	Pomacen-tridae No.	Pomacen-tridae D.M.	Acanth-uridae No.	Acanth-uridae D.M.	Scaridae No.	Scaridae D.M.	Labridae No.	Labridae D.M.	Chaeto-dontidae No.	Chaeto-dontidae D.M.	Lethrin-idae No.	Lethrin-idae D.M.	Serran-idae No.	Serran-idae D.M.	Lutjan-idae No.	Lutjan-idae D.M.	Cirrhit-idae No.	Cirrhit-idae D.M.	Pomacan-thidae No.	Pomacan-thidae D.M.	Caesion-idae No.	Caesion-idae D.M.	Miscel-laneous No.	Miscel-laneous D.M.
1. NSF	8	68.7	1	18.5	4	12.8	1	2.4			1	4.3	1	3.1			1	3.0					3	11.[illegible]
2. PBP	6	77.0	5	57.9	2	11.1	3	9.5					1	2.6					1	2.6	2	9.2		
3. SSOBF	8	61.8	2	26.9	7	40.6	1	2.0	1	2.9					1	3.0								
4. EBT	5	51.4	4	53.5	5	28.8	1	7.7					1	4.0			1	4.1	1	2.6			2	5
5. CRF	8	57.1	4	33.4	5	28.4			1	2.7					1	3.6							1	.5
6. OB	8	64.6	4	38.0	3	14.8					2	4.3			1	4.8			1	3.4	1	6.4		
7. IBF	4	35.7	3	37.9	3	14.3	1	2.7	3	9.2	1	6.1			1	4.1			1	4.6			3	
Total	47	416.3	23	266.1	29	150.8	7	24.3	5	14.8	4	14.7	3	9.7	4	15.5	2	7.1	4	13.2	3	15.6	9	[illegible]
8. PIF	7	37.7	4	81.9	3	49.3	4	13.5					1	1.1									1	1.
9. DF	5	76.7	2	20.9	2	10.0	2	9.2	1	2.5	1	2.8	1	2.3									6	43.5
10. EBS	6	80.5	4	26.9			3	51.4									2	6.6					5	14
11. GRF	6	81.3	6	69.5	2	5.5	5	22.6	1	1.9														
Total	24	276.2	16	199.2	7	64.8	14	96.7	2	4.4	1	2.8	2	3.4			2	6.6					12	64.4
GRAND TOTAL	71	692.5	39	465.3	36	215.6	21	121.0	7	19.2	5	17.5	5	13.1	4	15.5	4	13.7	4	13.2	3	15.6	21	203.0