CIP GENERATION PROJECT

2018 COMMUNITY BENEFITS PROGRAM

REEF FISH MONITORING PROJECT

YEAR 11 RESULTS

Prepared For:

Environmental Department
Hawaiian Electric
P.O. Box 2750
Honolulu, Hawaii 96840-0001

Prepared By:

Richard Brock, Ph.D.
Environmental Assessment, LLC
1232 Lunalilo Home Road
Honolulu, Hawaii 96825

EA,LLC Report No. 2019-02

April 2019

EXECUTIVE SUMMARY

The development of an electrical generating facility at Campbell Industrial Park (CIP) Barbers Point was the impetus to initiate a quarterly environmental monitoring program to follow changes, if any, in coral reef fish communities in the Barbers Point - Kahe Point area. This document is the eleventh annual report for this effort covering the period from December 2007 through December 2018 with a focus on the surveys completed in 2018. On a quarterly basis, this study monitors the status of coral reef fish communities at sixteen permanently marked sites offshore of Barbers Point on the southeast to Nanakuli Beach Park about 7.9 km to the northwest. These 16 monitoring stations are in waters from 5 to 12 m in depth and thus are subject to impact from high surf events.

Survey work in 2018 was hampered by inclement weather. The 2018 surveys were completed on 11 May (1st quarter), 28 June (2nd quarter), 27 November (3rd quarter) and 10 January 2019 (4th quarter). Neither the first nor the fourth quarter 2018 work could be completed in a timely fashion due to poor weather conditions. Record high ocean water temperatures, due to a protracted El Nino event commencing in 2015 created extended periods of large surf through much of 2018. The high ocean water temperatures has continued off and on generating storms elsewhere and ultimately generating surf that has impacted Hawaiian shorelines. As a result, the first quarter 2018 survey could not be completed until 11 May and the fourth quarter survey could not be carried out until 10 January 2019. These recent poor weather problems have been encountered commencing in late 2014 through 2018. To avoid confusion with data not collected within a given 2014-2018 quarterly survey period below, the date of the actual survey is given but the data is assigned to the quarter in which it was to be collected.

Because of Hawaiian Electric's construction/operation of the generating station at Kahe Point as well as the developments at West Beach and Barbers Point Harbor, long-term marine environmental data covering the status of fish and coral communities are available commencing from the mid-1970's up to present. The most comprehensive of those efforts occurred with the Hawaiian Electric Environmental program in support of the Kahe Generating Station (KGS) at Kahe Point. The Hawaiian Electric monitoring program documented changes that occurred to marine communities following three major storm events: the January 1980 event, Hurricane Iwa in November 1982 and Hurricane Iniki in September 1992 all of which severely impacted coral reef communities in the area. These studies demonstrated the impact of those storm events and not the operation of the Kahe facility as the major source of impact to marine communities of the Kahe area.

In the present study there were no statistically-significant changes in the mean number of fish species, mean number of individual fish censused, or in the mean standing crop per transect among the forty-four surveys conducted between 2007-2018, thus demonstrating stability in these communities. All species of fishes censused in the present study have been assigned to one of five feeding guilds (or trophic categories): herbivores (species feeding on algae), planktivores (species that feed on zooplankton up in the water column), omnivores (species that feed on both algae and small animals), coral feeders which are a specialized group feeding on coral tissue or mucous, and carnivores which are species feeding on smaller fishes and invertebrates living on the coral reef. Of the 153 species of fishes encountered in the forty-four surveys, twenty-six species are herbivores, fifteen are planktivores, seven are omnivores, eight are coral feeders and 97 are carnivores. Fifteen of the sixteen monitored locations are established on natural substratum where 80% of the fish standing crop is comprised of herbivores and carnivores. However, at one station established on the KGS warm-water discharge (Station 16), herbivores are largely replaced by planktivores but carnivores remain important as elsewhere. The reasons for this shift

in dominance is due to the thermally-elevated discharge creating a unidirectional current that discharges particulate materials. The steel and armor rock covering the discharge pipe also provides a high degree of shelter space at this station.

This monitoring program continues to follow changes in coral reef fish communities. The data collected in the first year represent the preconstruction baseline (December 2007 - December 2008), while data collected in the second year represents the construction phase (January - September 2009) and the data collected in the third through eleventh years (2010-2018) represent the operational phase of the plant. The sixteen stations geographically fall into four groups along the 7.9 km of coastline; on the southeast are four stations offshore of the generation plant at CIP (Station nos. 1-4), three stations seaward of Ko'Olina Resort (nos. 5-7), five stations fronting the KGS (nos. 8-12), three stations north of Kahe Point (13-15) and the Kahe Station discharge pipe (no. 16). Statistical analysis of the fish community parameters measured in this study (i.e., number of species, number of individuals and standing crop) on natural substratum found that the diversity of fish species, the number of individual fish as well as the standing crop, is significantly greatest at the three Ko'Olina stations over those in the other three groups over the 2007-2018 survey period. These three parameters were least at the seven Kahe stations. These differences are attributed to better benthic community development offshore of Ko'Olina than elsewhere. The above analysis excluded data from Station 16 (the Kahe discharge pipe) because it is a man-made structure and not comprised of natural substratum as is present at all other stations. However, to better understand the differences among the sixteen stations, the three fish community parameters (mean number of species per transect, mean number of individuals per transect and mean estimated biomass per transect) were statistically examined comparing all stations. Two findings emerge: (1) the Kahe discharge pipe station had a clearly-separable and significantly greater mean number of species, individuals and standing crop present over all other stations and (2) the means for all parameters from all other stations were not statistically separable except for six stations (numbers 1, 2, 9, 10, 11 and 14) where the number of fish species was significantly less than all other stations which is due to (1) the lack of three-dimensional structure providing shelter space for fishes at these stations and (2) the short transect length used at station 11 (i.e., 10.5 m) versus 50 m at all other sites. Thus the development in the fish communities at the fifteen stations situated on natural substratum monitored in this study pales relative to that found at the man-made Kahe discharge pipe.

Seven of the permanently marked monitoring stations in this study have been used in previous Hawaiian Electric studies and the methods used herein are similar, allowing comparative analysis of the data. Comparing earlier fish community data (1976-1984) to present (2007-2018) data finds that there are no statistically significant differences in the annual mean number of fish species or annual mean number of individual fish censused per transect despite the imposition of three major storm events in 1980, 1982 and 1992, suggesting that the fish communities have recovered from these disturbances. These documented storm events impacted marine communities offshore of the Barbers Point and Kahe Point areas. These impacts were probably greatest on the coral communities which are the source of much of the natural local topographical relief, creating shelter for fishes. If disturbance to the coral community occurs frequently and corals are known to be slow-growing, they are unable to contribute much to the local topography, upon which many fish species depend thus keeping the fish community at an earlier point in community succession. The early studies demonstrated the large impact that these storms had at the time on corals as well as the movement of sand away from the Kahe area leaving much near-barren limestone present today and continues to be scoured by small wave events keeping benthic community development to a minimum. This has resulted in a relatively poor development of the fish communities at many of the Kahe sample sites which continues to today. Where topographical relief and benthic communities are well-developed, the fish communities are likewise better developed. Given

the long-term data set spanning 43 years and the apparent lack of strong significant changes occurring to fish communities with the three early storm events which is probably related to some level of recovery, suggests that the variation seen in the measures of the fish community used in this study will continue to fluctuate at a similar magnitude in future monitoring events as this program continues. Furthermore, the analysis of the 2007-2018 data suggest that benthic community development/topographic complexity, creating shelter for fishes, remain the overriding factors determining the degree of development in fish communities at the stations monitored in this study. Since these factors were heavily impacted by the early storm events many years ago (as documented by Hawaiian Electric), the present findings will probably continue much the same in future years of this study.

TABLE OF CONTENTS

INTRODUCTION

1. Purpose

Hawaiian Electric constructed a generating station on vacant portions of its existing Barbers Point Tank Farm in Campbell Industrial Park (CIP) on the island of O'ahu. This generating facility was constructed to fill an urgent need for new generating capacity on the island, especially during peak loading periods, normally on weekdays between 5 and 9 pm. The generating station consists of a single 120 megawatt (MW) combustion turbine (CT) and two single 2 MW capacity black-start diesel engine generators. The system was designed to be fueled primarily by biofuels which assists in fulfilling the State's goals of energy security and sustainability. However, alternative fuels (e.g., diesel, naphtha, etc.) may be used if biofuels are unavailable.

The single CT generation unit utilizes approximately 600 gallons per minute (gpm) of water which is used for water injection into the CT for air pollution control, equipment cooling, plant washdown, landscape irrigation and domestic use by operating personnel. Disposal of used water is via injection wells on the facility site. Thus, unlike the nearby Kahe Generating Station (KGS) where seawater is used for cooling in the plant and discharged back into the marine environment, the CIP plant does not discharge cooling water into the nearby ocean thus precluding or significantly reducing the potential for environmental impacts to occur in the marine environment.

As part of the environmental monitoring program for the CIP Generating Station, it was suggested that a coral reef fish monitoring program be put in place to track the changes, if any, that may occur with fish populations offshore of the plant at Barbers Point. Data were initially collected from December 2007 to December 2008 representing the preconstruction baseline, in 2009 representing the "construction period" of the generating facility and in 2010 representing the commencement of the operational phase of the plant and continuing through 2018. The 2007 to 2008 information was presented in Brock (2009), the "during construction" information was given in Brock (2010) and data collected since the commencement of plant operations in 2010 are produced annually. The continuing operational phase data for 2018 are presented herein.

Since Hawaiian Electric had this type of monitoring plan in place for the offshore area of its Kahe power plant in the 1970's and 1980's, the CIP monitoring consists of reassessment of some of those locations which provide information on the changes that have occurred to fish communities in the Barbers Point - Kahe Point area over the last 40-plus years. This study addresses the question, "What are the changes in the coral reef fish community structure that occur through time in the Barbers Point - Kahe Point area?" Community structure is defined as the diversity of species, their abundance and biomass as well as their place in the food web of the coral reef. This document addresses this question and represents the eleventh annual report since

monitoring began for the CIP Generating Station and the ninth annual report since it began operating. This report includes a comparative assessment to baseline and during plant construction periods.

2. Natural Events and Impacts to Hawai'i's Coral Reefs

It is a common belief that coral reefs and their fish communities exist in stable environments which have resulted in the high diversity of species that is often seen in these systems. More recent data has shown that the environment in which coral reefs exist is dynamic, i.e., undergoing constant change, thus the organisms are subjected to a variety of stresses, resulting in shifts in community structure and abundance of species (Grassle 1973, Connell 1978, Dollar and Tribble 1993). Indeed, the concept that "intermediate levels of disturbance" may result in higher diversity has been demonstrated in a number of studies of coral communities (Connell 1978, Dollar 1982, Grigg 1983). Benign environments result in final successional stages of coral community development with low species diversity where one or just a few species dominate. This decrease in species diversity is found also with the coral-associated fish communities. Stability in coral species populations has been recently viewed as ever-changing in time and space, where species diverge by genetic drift due to isolation or converge by hybridization, producing constant change which has been described as reticulate evolution (Veron 1995).

Stochastic (i.e., random) processes create a non-equilibrium situation in coral reef communities. A major causal mechanism of stochastic events is the occurrence of occasional storms, which have been shown to be the single most important factor influencing the structure, diversity, and abundance of coral communities in Hawai'i (Dollar 1982, Grigg 1983, Dollar and Tribble 1993). Coral reefs have been described as "temporally varying mosaics" (Bak and Luckhurst 1980) in which the coral community undergoes a continual cycle of disturbance or removal and recovery or renewal. The effects of severe disturbance that drive this cycle have been documented for specific reef areas. The removal or destructive phase due to large storm events has been recorded in the Caribbean (Ball *et al*. 1967, Perkins and Enos 1968, Stoddart 1969, 1974, Woodley *et al.* 1981) and in the Pacific (Blumenstock *et al.* 1961, Cooper 1966, Dollar 1982, Dollar and Tribble 1993, Done *et al.* 1991, Harmelin-Vivien and Laboute 1986, Maragos *et al.* 1973, Ogg and Koslow 1978).

Following the impact of large storm events that disrupt the coral and fish communities is a period of regrowth. This period has received less study because the recovery of most coral communities is a slow process and because having pre-storm study sites where post-storm sampling can be done is rare (Dollar and Tribble 1993). Corals are relatively slow-growing and long-lived, thus the successional processes on most reefs take place on a scale of years to decades (Grigg and Maragos 1974).

In exposed locations in Hawai'i, storm waves keep coral communities at an early point in succession (Dollar 1982, Grigg 1983, Dollar and Tribble 1993). Under such situations, coral colonies never attain any significant size and growth forms are usually prostrate, thus reducing

their exposure to wave energy. Since much of the development in the associated fish community is related to the topographical complexity of the substratum (Risk 1972) and much of this complexity is directly due to the growth of corals, fish community development is usually reduced where coral communities are poorly developed and shelter space is lacking. Besides topographical complexity providing shelter habitat for fishes, the highly variable shelter created by coral communities serves a wide range of invertebrate and algal communities which may be forage for many fish species. Thus the development of coral reef fish communities is often directly linked to the degree of development of coral communities and factors that negatively affect the coral community frequently will have a similar negative impact to the fish community.

In general, many corals in Hawai'i have relatively slow growth rates, and many species produce annual growth bands much like the large conifers of temperate forests (Knutson *et al.* 1972). The large hemispherical colonies of *Porites lobata* do this, accreting about a centimeter per year in radial diameter. In Hawai'i, *P. lobata* colonies may attain diameters in excess of 4 m, thus large colonies may be more than 150 years in age. Under these circumstances, significant storm events do not have to occur with much frequency to have a strong influence on the successional state and development of coral communities where this species occurs.

Since 1980, three major storm events have created large surf that have caused impacts to Hawai'i's reefs over levels that normally occur. The January 1980 storm brought waves which attained heights of at least 6 m, from a south-southwest direction to the islands (Dollar 1982) thus impacting the Barbers Point - Kahe Point region. The next major storm event was Hurricane Iwa, which struck the islands in November 1982. Again, storm waves which attained estimated heights of 9 m, impacted the south and west shores of all islands (Coles and Fukuda 1984). The most recent major storm event was Hurricane Iniki, which passed over Kauai on 11 September 1992 with sustained winds up to 144 miles per hour (mph). It also created large surf that again impacted the south and west shores of O'ahu with storm generated surf arriving from a south-southeast (SSE) direction. On the south shore of O'ahu, wave heights were estimated to reach 8 m (Brock, personal observations).

3. Hawaiian Electric's Environmental Monitoring Program: A Synopsis of Impacts Associated with the Construction and Operation of the Kahe Generating Station (1970's-1980's)

As part of the National Pollutant Discharge Elimination System (NPDES) permit conditions allowing the discharge of thermally-elevated cooling water into the marine environment at Kahe Point, Hawaiian Electric was required to monitor the status of the coral, algae and fish communities in the offshore waters fronting and in the vicinity of the plant. The findings from these early monitoring efforts provide an excellent overview of the environmental changes that occurred in the Kahe Point area prior to the three storm events in 1980, 1982 and 1992 and after the January 1980 and November 1982 events. Studies on coral coverage showed a significant decrease of 7% from 1973 to 1975 and an additional 13% from 1975 to 1977. These decreases were correlated with proximity to the Kahe plant discharge but the analyses did not determine

whether the disturbance associated with outfall construction or plant operation were definitive factors producing the mortality. In contrast to the increased mortality, settlement and growth of coral recruits increased with proximity to the outfall after the plant began operating, which suggests that outfall construction rather than plant operation was the major factor in producing the mortality. Fish populations throughout the study area showed no changes except on the marginal reefs to the northeast of the outfall where both the numbers of species and individuals censused decreased following the commencement of outfall operations. However, the number of intertidal species on the rocky shoreline increased in the areas of thermal impingement (Coles *et al.* 1985a).

In 1978 the analysis of all reef fish population data collected since the beginning of the offshore outfall operation in December 1976 indicated that fish populations were being displaced from the immediate vicinity of the outfall (Coles 1979). The impact caused by the January 1980 "Kona" storm that generated extreme surf on the south and western shores of the islands was much greater than the changes observed from 1976 to 1978. The Kahe study area was heavily impacted by waves at that time. Subsequent survey work found that the 1980 storm was responsible for reductions in coral coverage, fish populations and the redistribution of beach sand that were all much greater than the subtle changes which had occurred in these parameters over the previous seven years (Coles *et al.* 1981).

In 1981, the generating capacity of the Kahe Station was increased by the addition of Unit 6 to a total of 651 MW, which increased the cooling water flow to 846 million gallons per day (mgd), a 33% increase above the flow rate for Units 1 to 5. With this change came a reduction in the surface plume area to about one-half while the area of benthic thermal impingement nearly doubled, but was restricted primarily to offshore sand areas. A result of these changes was a moderation in coral coverage declines observed previously but coral reef fish populations continued to decline probably in response to the decrease in reef habitat produced by the 1980 storm (Coles *et al.* 1982).

In November 1982, Hurricane Iwa struck the Hawaiian Islands with most of the damage occurring on Kauai. On O'ahu, damage was greatest along the northwest coastline which included the Kahe Point area. Waves and winds were substantially greater than seen in the January 1980 event with waves heights estimated at 30 feet (Noda 1983). As described in Coles *et al.* (1985a, page 16):

"Surprisingly, coral communities in shallow water areas appeared relatively undisturbed by hurricane wave turbulence. However, reefs further offshore at depths of 20 feet or more appeared to have been substantially destroyed by the force of breaking waves. Measurements of reef coral coverage and fish populations just prior to the hurricane had indicated stable populations compared to the previous year, indicating that damage had resulted from the catastrophic forces released by the hurricane. A further observation of interest was that sand along the reef front had been swept away by the hurricane's waves, exposing reef pavement and rubble that had been buried by up to five feet of sand.

The 1983 monitoring investigations verified the preliminary conclusions that had been determined shortly after Hurricane Iwa occurred. Quantitative estimates indicated substantial reductions in coral, algal and fish communities corresponding to locations where hurricane wave forces had been greatest. Due to removal of sand from shallow areas and the extreme cutting back of beaches that had occurred during the hurricane, sand entrainment through the Kahe Station was substantially less in 1983 than during previous years. A study of coral recolonization in the area indicated a positive influence of the Kahe outfall in the re-establishing of reef corals on denuded reef surfaces."

Coles and Fukuda (1984) noted the net significant decrease in coverage of 18.7% between 1979-1980 due to the January 1980 storm as measured at the Kahe permanent monitoring stations. Hurricane Iwa contributed a further significant decline of coral offshore of the Kahe facility; in 1982-83 the net change in coral coverage decreased 5.4%. The greater decline in coverage with the 1980 storm relative to Hurricane Iwa was probably related to two facts: (1) since the wave energy of the January 1980 event was less than the 1982 hurricane, the impact of that energy was probably released at shallower depths where coral coverage had been high and (2) Hurricane Iwa occurred just two years after the January 1980 storm event leaving little time for significant coral recovery to occur.

4. The Impact of Hurricane Iniki

As noted above, Hurricane Iniki struck the Hawaiian Islands in September 1992 with high waves impacting the south and west shores of all islands. Fifty-four days after Hurricane Iniki, a qualitative survey was carried out to determine the extent of damage to coral communities in the vicinity of the KGS (Brock 1992a). Fourteen of the more than 38 permanently marked monitoring stations were visited. With respect to coral damage, two general findings emerged. The first finding was damage due to storm waves to corals was minimal and was primarily restricted to the cauliflower coral *Pocillopora meandrina.* The reasons for this restricted damage was related to the branching nature of this species as well as the fact that this coral frequently colonizes the tops of high points on hard bottom (i.e., limestone ridges and boulders). In these locations, cauliflower corals have relatively greater exposure to wave energy impinging on the bottom than would coral colonies situated down in depressions. The second finding was that the greatest damage to corals occurred at those stations situated in areas with greatest exposure to wave forces impinging from the SSE direction which was consistent with the direction of Hurricane Iniki's storm waves. The field survey noted that a considerable amount of sand was removed by the storm at some stations with a net result of a greater amount of hard substratum previously covered by sand was now exposed and available for benthic recruitment. Only one station examined in the study showed evidence of net deposition of loose materials (i.e., coral rubble and broken live pieces) while at all other stations, sand, broken live corals and rubble were not present and assumed to have been advected to deeper water seaward and outside of the study area (Brock 1992a). These findings were similar to those noted in Mamala Bay, southeast of Kahe study area (Brock 1996).

As noted above, Hawaiian Electric carried out environmental surveys following the January 1980 storm and Hurricane Iwa in 1982. Several key observations emerge in comparing the findings following the 1980 storm to those from the post-Hurricane Iniki study: (1) the January 1980 event had a much greater impact to the Kahe coral communities relative to Hurricane Iniki; (2) it caused considerable deposition of sand at many stations which in some cases caused burial of corals; and (3) it was responsible for significant abrasion of many corals which was not obvious following Hurricane Iniki. The finger coral, *Porites compressa*, was present at many of monitoring stations in 1980 and by the time of the post-Iniki survey, this species contributed little to the coverage estimates at sampled stations. Because of its relatively delicate skeletal structure, *P. compressa* is prone to damage by storm surge (Dollar 1982) and the storms since 1980 have probably contributed to the decline of this species at many Kahe Point locations (Brock 1992a).

The energy from the high amplitude, short period waves generated by all three storm events (January 1980, November 1982 and September 1992) was dissipated in deeper water thus coral communities in these deeper areas were potentially exposed to greater impacts (see Dollar 1982, Walsh 1983). As noted by Coles and Fukuda (1984), fully 90 percent of the coral coverage offshore of the Kahe generating facility was at depths of 10 m or more prior to the January storm. These deeper water coral communities apparently received much of the damage in 1980 and again in 1982 with much of that damage occurring to the finger coral, *Porites compressa*. Brock (1992b) examined marine communities southeast of the Barbers Point Deep Draft Harbor two weeks after Hurricane Iniki and found considerable damage to corals below 13 m and the damage was greatest in areas exposed to a SSE swell. Coral communities inshore of this or those protected from a direct SSE swell direction, appeared to have suffered little impact. Brock's observations included the disappearance of a large amount of loose coral rubble in the 12 to 22 m depth range where rubble that had accumulated intermittently along the base of a submarine cliff. Individual estimated volumes were in excess of 2,000 cubic meters (m^3) over linear distances of 30-50 m and this material was not found within diving depths (from shore to 30 m).

As noted by Brock (1992a, page 5):

"The two storms preceding Hurricane Iniki produced opposite impacts subtidally with respect to the movement of sand offshore of the Kahe facility. The January 1980 storm resulted in the deposition of sand over many reef areas, thus burying or scouring benthic communities. In contrast, Hurricane Iwa resulted in 3 to 5 feet of sand being removed along the seaward edge of the reef exposing coral reef framework that had been formerly covered. Coles and Fukuda (1983) noted '...sand which had been deposited by the Kahe outfall and swept on to the reefs by previous storms was completely removed from along the entire reef front. The substratum available in the area is now similar to the conditions when marine monitoring began in 1973...'. It appears that Hurricane Iniki also removed sand from the area seaward of the forereef but to a much lesser extent than in the November 1982 event (i.e., up to 0.75 m in 1992 versus up to 1.5 m in 1982); perhaps the sand had not returned before the 11 September 1992 storm."

Three strong storms commencing in January 1980 and ending 12 years later with Hurricane

Iniki documented change to the bottom communities in the Barbers Point - Kahe Point area. These changes also created a negative impact to the resident fish communities which has been documented elsewhere in Hawai'i (Walsh 1983). The findings from these past studies, therefore, indicate that knowledge of the past environmental history can lead to a better understanding of the biological resources present in the area today. This environmental history provides the basis for the present study.

METHODS

The fish communities at sixteen permanently marked sites are monitored on a quarterly schedule. These sixteen sites are located in the Barbers Point to Nanakuli area on the west coast of O'ahu (see below). The monitoring of fish communities is carried out using a visual census method. The sampling protocol occurs in the following sequence: on arrival at a given station, the individual conducting the visual fish census enters the water and carries out the visual census over a 50 m long by 4 m wide corridor run parallel to shore. (Station 16, which is located on the Kahe facility's discharge pipe, runs perpendicular to shore and station 11 is only 10.5 m in length). All fishes within this area to the water's surface are counted. Data collected include the species, numbers of individuals and an estimate of the length of each individual fish counted. The length data are later converted to standing crop estimates using linear regression techniques. The diver equipped with SCUBA, transect line, slate and pencil enters the water, counts and notes all fishes in the prescribed area (method modified from Brock 1954). The 50 m transect line is paid out as the census progresses, thereby avoiding any previous underwater activity in the area which could frighten wary fishes. The length data are used in making estimates of biomass for each species present coupling the length data with species-specific regression coefficients (Ricker, 1975, Brock and Norris 1989).

Fish abundance and diversity are often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a relatively short transect (50 m in length) has proven adequate in sampling many Hawaiian benthic communities. In addition, the transect length used by Coles *et* al. (1985a) was also 50 m thus making the present counts collected under this program comparable to the earlier data collected by Hawaiian Electric. However as noted above, Station 11 which was originally established by Hawaiian Electric in the 1970's is only 10.5 m in length.

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (family Muraenidae) and nocturnal species, e.g., squirrelfishes (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus, family Scorpaenidae; the flatfishes, family Bothidae) might still be missed. Obviously, the effectiveness

of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate individual sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparison between surveys. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally-active fishes (Brock 1982).

In the analysis of the data, all fishes encountered were classified as to their primary foraging behavior as a means to better understand the trophic relationships in the fish communities. These functional groups are carnivores which includes all fishes feeding on other coral reef animals (fish and invertebrates) greater than zooplankton in size, planktivores which are species that feed primarily on zooplankton and detritus in the watercolumn, herbivores which are species feeding primarily on algae, omnivores which are usually small species that feed on a combination of algae and benthic animals and the coral feeders which are a specialized group of fishes that feed on coral polyps and mucous. The determination of which species were in each feeding guild utilized the findings of Hiatt and Strasburg (1960), Hobson (1974), Brock *et al*. (1979) and Randall (2007). Non-parametric statistical procedures are primarily used thus avoiding the requirements for normality in the data, etc. that are necessary in parametric statistical analyses.

RESULTS AND DISCUSSION

1. Station Locations

To assess the status of coral reef fish communities in the Kahe-Barbers Point area, sixteen permanently marked stations were established. These stations are spread along 7.9 km (4.9 miles) of coastline fronting the CIP Generating Station at Barbers Point on the southeast to the south boundary of the Nanakuli Beach Park on the northwest and their approximate positions are shown in Figure 1 and more precise locations (latitude/longitude) are given in Table 1. Eight stations were established in 2008, prior to the pre-construction monitoring event and the rest are stations established for the Hawaiian Electric environmental monitoring program in the 1970's. Four stations are located offshore of Campbell Industrial Park at Barbers Point in waters from 7 to about 10 m in depth. These stations (Station nos. 1 - 4, Table 1) are used to monitor the status of fish communities in closest proximity to the CIP Generation site and are located to the southeast of the Barbers Point Harbor entrance channel. Two stations are located northwest of the Barbers Point Harbor entrance channel fronting the Ko'Olina Resort and Paradise Cove area (Station nos. 5 and 6, Table 1). Again the water depths at these two stations are from 7 to 9 m. Coles *et al.* (1985) monitored fish community structure at seven stations fronting and adjacent to the KGS. These seven stations are also monitored in the present study (here numbered as Station nos. 7 through 13 in Table 1) to obtain information on the status of these fish communities today and to compare the fish community structure today to what was present at these same locations more than 40 years ago. These stations are in water ranging from 5 m to 12 m in depth.

The previous Hawaiian Electric environmental monitoring program also monitored a control

station offshore of Nanakuli (Coles *et al.* 1985a) which has also been added to the stations monitored under the present program (here Station 14, Table 1). A second control station (Station 15, Table 1) approximately 70 m north of Station 14 has been established for the present monitoring program. Finally Station 16 was established on the Kahe discharge pipe directly offshore of the KGS in water from 5 to 7 m in depth.

As noted above, the locations of all stations are shown in Figure 1. The “start point” for each station is marked using 90 cm long nylon cable ties and small subsurface floats that are tied to the substratum in proximity to the start point for each transect. Because of high public use by dive tour operators and individuals SCUBA diving from shore fronting the KGS, Stations 7 - 12 as well as Station 16 have not been marked but rely on prominent natural points on the local substratum. Past experience in permanently marking biological monitoring stations in “high use” areas results in divers removing materials of anthropogenic origin thus destroying and negating this method for relocation of stations. Low-cost modern global positioning systems (GPS) can put the diver/monitor within a few feet of any known point. The GPS waypoints for each of the 16 stations sampled in this study are given in Table 1.

2. The 2007-2008 (Preconstruction) Data

During the preconstruction period, fish transect data were collected on five occasions commencing on 27 December 2007. In 2008, transect work was carried out on 4 April, 30 May, 19 August and on 25 November. As noted above, sixteen stations were routinely sampled in this study and these early data are presented in Brock (2009). In the first survey, twelve of the sixteen stations were sampled; missing were Stations 4 (East 4), 5 and 6 (Ko'Olina 1 and 2) and 16 (Hawaiian Electric discharge pipe). The second survey carried out on 4 April only missed one site, Station 16 (the Hawaiian Electric discharge pipe) and by the third survey on 30 May 2008 all sixteen sites were sampled. The Hawaiian Electric thermally-elevated discharge (Station 16) was added as a monitoring station because of the well-developed fish community present at that location. Because station 16 is unusual with a highly developed community on a man-made structure, it is treated separately in many of the analyses below. In total, 122 species of fishes were censused in these first five surveys (Brock 2009).

3. The 2009 During Construction Data

In 2009 field surveys were conducted on 19 March, 11 May and 21 July. When the fourth quarter 2009 period commenced, weather deteriorated with a series of fronts that started in October 2009 and carried though unabated to April 2010. Locally, these weather fronts brought surf as did weather fronts occurring elsewhere in the Pacific which affected the south, west, northwest and north coastline of O'ahu. Surf from these directions impinge on some or all of the sample sites precluding field sampling during these periods. The result was that the fourth quarter 2009 field survey was not completed. Thus the analysis below includes data from the first three quarters of 2009, which represent the during construction period for the new generation facility at Campbell Industrial Park.

4. The 2010 through 2018 Operational Phase Data

In 2010 field surveys were carried out on 29 March, 14 May, 12 August and 29 October, representing the first year of operations of the new generating facility at Campbell Industrial Park. Although the data collection phases have been split into “preconstruction”, “during construction” and operational periods, it should be noted that the CIP Generating Station is situated well inland of the ocean and its operation has no direct input to the sea. The 2011 surveys were carried out on 25 February, 16 June, 29 July and 23 November, the 2012 surveys were completed on 2 May, 23 May, 23 July and 2 November 2012, the 2013 surveys were conducted on 3 May, 14 June, 20 September and 18 December 2013. Inclement weather (surf and strong wind) precluded the timely collection of data for the first quarter of 2012, 2013, 2014 and 2015. The surveys were carried out once the weather became favorable. In 2014, surveys were completed on 8 May, 6 June, 26 September 2014 and due to intervening inclement weather (surf) the fourth quarter survey was not completed until 27 February 2015. In 2015, field surveys were carried out on 6 April, 18 June, 21 October 2015 and the fourth quarter was carried out on 8 April 2016. Due to extremely poor water clarity on 21 October 2015 offshore of Campbell Industrial Park (visibility approximately four feet), four CIP stations (Stations 1 - 4) were not sampled despite numerous attempts throughout the survey.

In 2016, quarterly surveys were carried out on 15 April, 5 July, 18 August and once again due to inclement weather, the fourth quarter 2016 survey was not completed until 15 March 2017. The 2017 surveys were conducted on 18 May, 2 June, 29 August and 21 December. Two of the 2018 surveys were hampered by inclement weather; the first quarter 2018 survey was completed on 11 May, the second quarter on 26 June, third quarter on 19 November and the fourth quarter on 10 January 2019. In this report, the four 2014 surveys are referred to as having been completed in 2014 and similarly, the four 2015, four 2016 and the four 2018 surveys are again referred to having been completed in their respective sample year to reduce confusion when viewing the data.

Commencing in July 2015 and continuing until the end of October 2015, the Hawaiian Islands experienced the greatest number of major storm events (15 in total) on record. Although many of these storm events passed near the islands creating high surf conditions on exposed coastlines, the tracks are never predictable thus precluding any sampling while a storm is in proximity.

The record number of storm events passing through Hawaiian waters in 2015 and continuing into 2016 are related to major weather patterns and global warming. In 2015, the Pacific Ocean was influenced by an El Nino weather system that had formed along the equator and another unusually persistent body of water which lies offshore of the North American coast. The warmer-than-usual water is impacting marine life across the Pacific rim and creating storms that have caused widespread problems for coastlines and people in the Pacific region. The body of warm water offshore of North America (sometimes referred to as “the blob”) may be related to a longer-term cycle of heating and cooling known as the Pacific Decadal Oscillation (PDO) which may be switching from a cooling phase to a warming phase. The PDO is a long period (spanning

decades) of relatively cooler or warmer water. Additionally, the input of pollutants to the atmosphere from human activities continues to contribute to the heating of the world's oceans and atmosphere. Each of these phenomena operate on different time scales but presently they appear to be synchronized and their collective effects may be powerful.

Since about year 2000, the PDO has been in a cool state, which has allowed the ocean to soak up considerable heat generated by greenhouse gases as part of climate change. This may have kept global average surface temperatures from rising. Presently, the PDO appears to be entering a warming phase and some believe that strong El Ninos tend to nudge the cycle into a new phase to provide a larger boost to global warming. These phenomena appear to have increased ocean water temperatures and as a result have impacted coral reefs causing massive coral bleaching events as well as increasing the number and magnitude of tropical storm events which Hawaii experienced in 2015.

The 2018 data are presented herein along with a comparative analysis of all data collected to date. The complete data set from the four 2018 surveys is given in Appendix 1 and this information is summarized in Table 2 along with the earlier (2007-2017) information. Drawing on some of these data and excluding Station 16, we may ask the question, "Are there any statistically significant differences among the mean number of fish species documented per transect, the mean number of individual fish censused per transect or the mean estimated standing crop in grams per square meter (g/m^2) among the forty-four 2007-2018 sample periods?" To address this question two non-parametric tests were used: the Kruskal-Wallis analysis of variance (ANOVA) and the Student-Newman-Kuels (SNK) Test. The Kruskal-Wallis ANOVA is able to demonstrate statistically significant differences among parameter means (by date) but cannot show where those differences are. The SNK Test is used to group related sample means and separate those means that are significantly different from one another. The results of these analyses are given in Table 3. Referring to Table 3, the Kruskal-Wallis ANOVA noted one statistically significant difference among the mean number of fish species per transect but the SNK Test failed to do so suggesting that there are no statistically significant differences present among the forty-four survey periods. Both the mean number of individual fish per transect and the mean standing crop of fish present in g/m^2 per transect noted no significant differences exist among the forty-four sample dates for these two parameters. These results point out that when considering grand means for the number of species, number of individuals or biomass (in g/m^2) per transect on each of the forty-four sample dates, there are no significant differences. Thus at this level of analysis (i.e., grand means), there is no statistical separation among the dates which suggests a level of stability in the fish communities at these sample sites.

Station 16 established on the terminus of the KGS discharge pipe is discussed separately because it is a man-made structure and deployed in an area with sand bottom. The outfall pipe is permitted to discharge up to 861 million gallons per day (mgd) of thermally-heated seawater at its terminus. The topographical relief afforded by the steel and basalt rock substratum as well as coverage by corals is considerably more conducive habitat for many fishes than the nearby surrounding natural reefs and the discharge of thermally-elevated water additionally serves to

attract many fishes. These features result in an enhancement of the local fish community making the structure of the fish community very different than that of the fifteen natural substratum reef sites sampled in this study. Thus as noted above, the results of fish censuses undertaken at Station 16 are discussed separately in most analyses.

The fishes censused in the forty-four (2007-2018) surveys were assigned to one of five trophic categories or feeding guilds. As noted above, these groups are herbivores (species that feed on algae), planktivores or species that feed up in the water column on zooplankton, omnivores that feed both on plant material as well as small animals, coral feeders which are a specialized group feeding on coral tissue and mucous, and the carnivores which are species feeding on fishes and invertebrates found on coral reefs. In the five surveys carried out during the preconstruction (2007-2008) period, there were 122 species of fishes encountered at the sixteen sample sites. The three surveys conducted in 2009 (during plant construction) found 107 species of fishes at these sixteen sample sites. For the nine years covering the operational phase of the facility, there were 109 species of fishes recorded at the sixteen sites in 2010, 106 species in 2011, 100 species in 2012, 107 species in 2013, 110 species in 2014, 109 species in 2015, 110 species in 2016, 100 species in 2017 and in the four surveys covering 2018 there were 110 species observed at the sixteen sites. In total among the forty-four surveys, 153 species of fishes have been recorded among the sixteen survey sites. Forty-four percent or 68 species encountered were in common among the forty-four surveys carried out over the eleven-year period. These data suggest a reasonable level of stability in these fish communities.

Of the 153 species of fishes recorded over the forty-four surveys, 63.4% (97 species) are carnivores, 17.0% (26 species) are herbivores, 9.8% (or 15 species) are planktivores, 4.6% (7 species) are omnivores and 5.2% (8 species) are coral feeders. The assignment of fish species to the five trophic categories are given in Appendix 1 of this report as well as in Brock (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017) for species encountered on each transect during earlier survey dates. Table 4 summarizes the feeding guild information by survey date providing the mean percent contribution by weight of each trophic category for stations in two groups; the first group includes Stations 1 through 15 (natural substratum) and the second group considers only Station 16 (the Kahe outfall station). Although the data in Table 4 are in summary form, two facts emerge: (1) that the majority (here 88.8%) of the weight of fishes censused at the first fifteen stations is comprised of herbivores and carnivores and (2) the importance of herbivores is largely replaced by planktivores at the Kahe outfall station (Station 16, here 24.9%) but carnivores remain important at Station 16 (57.8%) as they are elsewhere. The large volume of thermally-elevated water (up to 861 mgd) is probably serving as a source of food (entrained particles that have passed through the plant) and a warm and strong unidirectional current that attracts and holds planktivorous species that naturally orient themselves into the current seeking food. In addition, the steel and armor rock superstructure that covers the Kahe facility's discharge pipe along with high coral coverage provides habitat shelter and for some fish species a suitable substratum for spawning. A considerable part of the planktivore biomass at Station 16 is comprised of two sergeant major or mamo species (*Abudefduf abdominalis* and the recently recognized *Abudefduf vaigiensis*) both of which not only feed in the discharge plume and

environs, but also lay demersal eggs on the rocky substratum overlaying the discharge pipe. These two species along with the paletail unicornfish or kala lolo (*Naso brevirostris*) dominate the planktivore biomass at this site together comprising almost 41% of the total estimated standing crop present based on the 2008-2013 data but in 2014 it had decreased to 27%, in 2015 to 7%, in 2016 back up to 28%, in 2017 it had decreased to 4% and in 2018 it was estimated to be 6.8% of the total estimated standing crop at this station.

5. Differences in Fish Community Structure in the Study Area

This study was undertaken to follow changes in coral reef fish communities as part of the environmental monitoring program related to the development of the CIP generation facility. Sixteen sites spread along 7.9 km of coastline are monitored (Figure 1); referring to Figure 1, these sites geographically fall into four groups: on the southeast are four stations offshore of Campbell Industrial Park (CIP) and the generation plant (Station nos. 1-4 or East 1 through 4), three stations seaward of Ko'Olina Resort (Station nos. 5-7 or Ko'Olina 1 and 2 as well as Hawaiian Electric 1D), five stations fronting the KGS facility (Station nos. 8-12 or Hawaiian Electric 5B, 7B, 7C, 7D, and 7E) and three stations to the north of Kahe Point (Station nos.13-15 or Hawaiian Electric 10C, Nanakuli 1 and 2). Because Station 16 (the Kahe discharge pipe) is a man-made structure and not natural substratum like the other fifteen monitored sites, it is excluded from the present analysis.

The question, "Are there any statistically significant differences among the mean number of fish species per transect, the mean number of individual fish per transect or the mean estimated standing crop (in g/m^2) per transect among the four above geographic groups of stations established on natural substratum and sampled in the 2007-18 period?" can be answered again using the Kruskal-Wallis ANOVA and the SNK Test. The results of these statistical procedures are given in Table 5. As noted previously, the Kruskal-Wallis ANOVA can discern whether means differ significantly, but cannot show where those differences are thus the SNK Test is used to demonstrate which means differ significantly from the others. In all cases the ANOVA noted significant differences exist among the four areas (i.e., CIP, Ko'Olina, Kahe and Nanakuli) for all three parameters (i.e., mean number of fish species per transect, mean number of individual fish per transect and mean standing crop of fishes per transect). The SNK Test demonstrated that the mean number of fish species, individuals and standing crops are significantly greater and statistically separable at the Ko'Olina group of stations over the three other station groups (Table 5). Furthermore with the mean number of fish species, the East , Nanakuli and Kahe station groups were related due to overlap thus the data were not statistically separable. However, the mean number of individual fish censused per transect by station group as well as the mean standing crop data for both the East and Nanakuli station groups were significantly greater than found with the Kahe group of stations (Table 5). Coral community development (coverage) appears to be greater at the three Ko'Olina stations than found at any of the other transect sites and may be responsible for the greater diversity of fish species, numbers of individuals and standing crops present there.

Summarizing the results presented in Table 5, several trends are apparent. First, there is no statistical separation among the Nanakuli, Kahe and CIP station groups for the mean number of fish species but as noted above, the Nanakuli and CIP mean number of individual fish per transect as well as the standing crops per transect are significantly greater than found at the Kahe group of stations). Secondly, the Nanakuli group of stations ranked second to the Ko'Olina group of stations for two of the three measures (i.e., mean number of fish species per transect and mean number of individual fish per transect). These results are not unexpected because the development of benthic communities, including corals, is greater at Ko'Olina than it is offshore of most Kahe and Nanakuli stations and at all Campbell Industrial Park stations where the topographical complexity, which often serves as shelter for fishes, is probably the least among the four station groups. Benthic community development, which includes the development of corals and topographical complexity, are probably less at the North group of stations (Station nos. 13-15) relative to Ko'Olina but greater than found offshore of Kahe or Campbell Industrial Park. The probable reason for the greater estimated standing crops at the CIP and Nanakuli stations over those found at Kahe stations is the presence of cover serving as shelter for fishes. At CIP Station 1 there is a natural circular depression (about ten meters in diameter and 1.5 meters deep) having undercut ledges located about 6 meters shoreward of station 1 and at Stations 13 and 15 there is considerable cover created by the spur and groove formations. Because these geologic features serve as shelter for these diurnally-active fishes (i.e., wrasses, surgeonfishes, goatfishes, etc.), which if present and foraging out across the substratum away from the cover, will occasionally pass through the transect during censusing resulting in higher biomass estimates.

The final statistical analysis of the 2007-2018 fish census data examines the mean number of fish species per transect, the mean number of individual fish per transect and the mean fish biomass per transect (in g/m^2) examining each of the sixteen stations again using the Kruskal-Wallis ANOVA and the SNK Test. In this analysis, the question is “Are there any statistically significant differences between the mean number of fish species per transect, the mean number of individual fish per transect or the mean estimated standing crop among the 16 stations sampled in 2007-2018 period?” The results are given in Table 6. Referring to Table 6, the Kruskal-Wallis ANOVA noted strong statistical differences among the means for all three parameters but the SNK Test found few clearly significant differences. These differences were: (1) the Kahe discharge pipe station has a statistically greater mean number of fish species, individuals and standing crop over all other stations; (2) with the mean number of fish species per station there are four other statistically separable groups (see Table 6) and (3) with both the mean number of individual fish censused as well as the mean standing crop per station, all fifteen natural substratum stations show no statistically separable differences due to overlap.

The low means for all three parameters at Stations 11 and 14 (Table 6) are probably related to the poorly developed coral community at both stations resulting in little shelter present and most importantly, to the short transect length (10.5 m) at Station 11 relative to all others which are 50 m in length. The obviously greater mean number of species, number individuals and standing crop at the Kahe discharge pipe is related to the presence of ample shelter, a unidirectional flow

of thermally-elevated water and sufficient food resources present relative to all other stations which are located on natural substratum.

6. Fishery Resources

Appendix 1 in this report as well as in Brock (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018) provides lists of all fish species observed over the forty-four 2007-2018 surveys. In these lists are both species that are sought-after by commercial, subsistence and recreational fishers as well as species that are usually not. In the usually sought-after group of species, most of the individual fishes encountered on the transects were juveniles but occasionally adult individual fishes were observed. Among the species seen include a number of small schools of the mackerel scad or opelu (*Decapterus macarellus*), especially around stations fronting the KGS in the December 2007 survey and scattered through the various stations, and sample dates were seen adults of the moano kea (*Parupeneus cyclostomus*), omilu (*Caranx melampygus*), smaller individuals (papio) of the barred jack (*Carangoides ferdau*), lemon spot jack (*C. orthogrammus*), ulua aukea (*Caranx ignobilis*) and pa'opa'o (*Gnathanodon speciosus*). Adults of other species seen include the lai (*Scomberoides lysan*), uku (*Aprion virescens*), wahanui (*Aphareus furca*), the introduced ta'ape (*Lutjanus kasmira*) especially at Stations 5, 6, 13 and 16, to'au (*Lutjanus fulvus*), weke (*Mulloidichthys flavolineatus*), weke'ula (*M. vanicolensis*), munu (*Parupeneus insularis*), moano (*P. multifasciatus*), malu (*P. pleurostigma*), kumu (*P. porphyreus*), nenue (*Kyphosus sandwicensis*), 'a'awa (*Bodianus bilunulatus*), kupoupou (*Cheilio inermis*), po'ou (*Oxycheilinus unifasciatus*), laenihi (*Iniistius umbrilatus*), the parrotfishes or uhus (*Scarus rubroviolaceus, S. psittacus, S. sordidus, S. perspicillatus, Calotomus carolinus*), the surgeonfishes including paku'iku'i (*Acanthurus achilles*), palani (*A. dussumieri*), maikoiko (*A. leucoparieus*), ma'i'i'i (*A. nigrofuscus*), maiko (*A. nigroris*), na'ena'e (*A. olivaceus*), manini (*A. triostegus*), pualu (*A. xanthopterus* and *A. blochii*), kole (*Ctenochaetus strigosus*), kala lolo (*Naso brevirostris*), kala holo (*N. hexacanthus*), umaumalei (*N. lituratus*), kala (*N. unicornis*), paki'i (*Bothus pantherinus*), humuhumu ele'ele (*Melichthys niger*), humuhumu hi'ukole (*M. vidua*), and the loulu (*Aluterus scriptus*). Besides these species as adults, juveniles of these and other species (e.g., the mu - *Monotaxis grandoculis*) were seen. Many of the adult individual fishes in the highly sought-after group were seen at varying distances away from the actual census areas, thus some species do not appear in the station counts (Appendix 1 of this and earlier reports).

In the 2015 surveys we encountered the bigeye scad or akule (adult) halalu (juveniles; *Selar crumenophthalmus*) at Station 13 (offshore of "Tracks") on two surveys. The akule is an important species to the local inshore fishery. In the June 2015 survey a portion of a large school entered the transect area where ~150 individuals were censused that made up 52% of the overall standing crop at this station which was estimated at 600 g/m^2. On the 21 October 2015 survey as we approached Station 13, a group of net fishermen moved in and rapidly deployed their net on a school of akule. When they were finished and had left, we carried out our census where a group of ~250 remaining akule crossed through the transect contributing 65% to the estimated standing crop which was 161 g/m^2 which served to maintain the relatively high standing crop of fish

frequently encountered at this station.

As noted above, the fourth quarter 2015 survey was carried out on 8 April 2016 where at Station 6 (Ko'Olina 2), the estimated standing crop of fishes was 45 g/m^2. The overall grand mean standing crop for this station from 2008 to 8 April 2016 was 164 g/m^2. Missing were many larger individuals of the usually seen surgeonfish (manini, maiko, pualo, palani, na'ena'e, maikoiko) and parrotfish species (uhu, palukaluka, uhu-uliuli, etc.). Returning to this station for the first quarter 2016 survey seven days later at 0945 hours, we encountered a vessel with four divers who were in the process of netting fish at this location. We returned about 4.5 hours later to conduct the visual fish census at Station 6 and found an estimated fish standing crop of 45 g/m^2. The second quarter 2016 survey (5 July 2016) at Station 6 noted the estimated standing crop had increased to 173 g/m^2 and by the third quarter (18 August 2016) survey, it was up to 245 g/m^2 where na'ena'e comprised 33% of the total weight and maiko made up an additional 22% to the total biomass of fishes present at this station. As mentioned elsewhere, cover or shelter space is relatively well-developed at Ko'Olina 2 which suggests that when removal of many individual adult fish occurs in such an area as through fishing activities, they are replaced by others seeking this appropriate habitat. This observation is well-known to many fishermen and has been noted on other natural substratum areas (Brock, *et al.* 1979) as well as on artificial reefs (Brock and Norris, 1989 and see below).

The above observations are supported by the data from the KGS discharge pipe. Usually the most consistent location for finding many of the sought-after fish species both as adults and as juveniles is on the armor rock and coral-encrusted steel protective cover for the KGS discharge pipe (Station 16). Because of the high degree of shelter provided by the armor rock as well as the well-developed coral community present on it and also due to the outfall (discharge), many species congregate there. Among these episodically are many mamo (two species recognized, the Hawaiian mamo - *Abudefduf abdominalis* and the recently recognized species *Abudefduf vaigiensis*). Under the cover of the rocks are seen menpachi (*Myripristes amaneus*), aweoweo (*Heteropriacanthus cruentatus*) and 'upapalu (*Apogon kallopterus*). In the December 2007 survey an estimated 200 grey mullet or ama'ama (*Mugil cephalus*) were encountered at Station 13. These fish had an average estimated length of 33 cm (~13 inches) contributing an estimated weight of 97.7 kilograms (215 lbs) to the standing crop at this station. On many surveys of the KGS discharge pipe large schools of adult and subadult white weke (*Mulloidichthys flavolineatus*), weke'ula (*Mulloidichthys vanicolensis*) and ta'ape (*Lutjanus kasmira*) are encountered where they diurnally rest alongside of the discharge pipe (they generally forage at night) and occasionally enter the transect area and are censused resulting in high standing crop estimates as was the case in three of the four 2018 surveys.

Many coral reef species other than fish are caught and consumed by people; among these are specific algae and a number of invertebrates. Some individuals are interested in the collection of shells and when these usually cryptic species are seen at a station, they are so noted. Two species of molluscs have been observed on several occasions in the 2007-2018 surveys; these are the tiger cowry (*Cypraea tigris*) and the triton shell (*Charonia tritonis*). A species important in the

making of fishing lures is the black-lipped pearl oyster or pa (*Pinctado margaritifera*) which is protected by law and is commonly seen at many of the survey sites. The octopus or he'e (*Octopus cyanea*) was occasionally encountered at some of the stations. Individual he'e ranged from less than a pound in weight up to an estimated four pounds. The sought-after alga, limu kohu (*Asparagopsis taxiformis*) is seasonally common at many of the stations sampled in this study.

7. Standing Crops

Coral reefs function as relatively closed systems and thus in the pristine situation may represent the accumulation of carbon over a considerable period of time (Johannes *et al.* 1972). Some of this carbon is tied up in the living biomass of the reef of which fishes are only a part. Goldman and Talbot (1975) have suggested that a reasonable maximum biomass of coral reef fishes is approximately 200 g/m^2 or 2,000 kilograms per hectare (kg/ha). Space and cover are important agents governing the distribution of coral reef fishes (Sale 1977). Similarly the standing crop of fishes on a reef is correlated with the degree of vertical relief of the substratum (Risk 1972). Studies conducted on coral reefs in Hawai'i and elsewhere have estimated fish standing crops to range from 20 to 200 g/m^2 (Brock 1954, Goldman and Talbot 1975, Brock *et al.*1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, the variation in standing crop appears to be related to the variation in the local topographical complexity of the substratum which is governed, in part, by the degree of development in the coral community. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in lower estimated standing crops (0.2 to 20 g/m^2). Local studies (Brock and Norris 1989) suggest that with the manipulation (increasing) of habitat space or food resources (Brock 1987), fish standing crops may approach 2,000 g/m^2. Thus under certain circumstances, coral reefs may be able to support much larger standing crops of fishes than previously realized.

High standing crops (i.e., above 200 g/m^2) were encountered during most surveys at several stations. In the 27 December 2007 survey at Station 9 where the estimated standing crop was 290 g/m^2, the opelu (*Decapterus macarellus*) made up 89% of this total at that location. Opelu are a coastal neritic species meaning that they school and move freely through the coastal waters which is very different than many coral reef fish species that have much smaller areas in which they forage. Similarly at Station 13 where the standing crop was estimated to be 594 g/m^2, the school of grey mullet or ama'ama (*Mugil cephalus*) described above comprised 82% of the total biomass. Again, ama'ama are usually seasonal in their appearance in coastal waters and travel over large areas of Hawai'i's waters. In the 4 April 2008 survey at Station 2, a school of 60 adult na'ena'e (*Acanthurus olivaceus*) swam through the census area bringing the total estimated biomass to 238 g/m^2 and these fish comprised 84% of the total weight present at this station. The 30 May 2008 survey noted a high standing crop at Station 16 (358 g/m^2) where the mamo (*Abdufduf abdominalis* and *A. viagiensis*) made up 29% of the total and the kala lolo (*Naso brevirostris*) added 13% to the total estimated weight at this station. On 19 August 2008 at

Station 16, the estimated biomass was 396 g/m^2 and again, the mamo comprised 51% of the total and a school of opelu passed through the census area and contributed 22% to the standing crop present at this station. In the 25 November 2008 survey at Station 16 where the estimated standing crop was 225 g/m^2, the two mamo species again comprised 38% of the biomass present at that time. In 19 March 2009, Station 6 had an estimated sanding crop of 259 g/m^2 and the palukaluka (*Scarus rubroviolaceus*) contributed 16% of the standing crop while the na'ena'e (*Acanthurus olivaceus*) added 40% to the biomass at this station. At Station 16 the where the standing crop was estimated to be 577 g/m^2, two mamo species made up 15%, the kala lolo (*Naso brevirostris*) contributed 15% and the uhu (*Scarus sordidus*) added 22% to the standing crop present. In 11 May 2009, Station 5 had an estimated standing crop of 224 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 33% of it while at Station 16 where the standing crop was estimated to be 425 g/m^2, the two mamo species comprised 20% of the total weight present. The 21 July 2009 survey noted that the estimated standing crop at Station 4 was 209 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 70% of it while at Station 5 the standing crop was 267 g/m^2 and again, na'ena'e made up 30% of the total biomass present. The standing crop of fishes at Station 16 was estimated to be 431 g/m^2 and the two mamo species made up 27% of it while the kala lolo (*Naso brevirostris*) added 8% to the biomass present.

The 29 March 2010 survey noted only one station with an estimated standing crop greater than 200 g/m^2; this was Station 16 where the standing crop was 561 g/m^2 and the opelu (*Decapterus macarellus*) comprised 26% and the kala lolo (*Naso brevirostris*) made up 24% of the total estimated standing crop at this station. The 14 May survey encountered estimated standing crops in excess of 200 g/m^2 at two stations; Station 5 noted a biomass of 242 g/m^2 with the na'ena'e (*Acanthurus olivaceus*) contributing 62% of this estimated weight and the kole (*Ctenochaetus strigosus*) adding another 13% to the total weight at this station. The estimated standing crop at Station 16 was 390 g/m^2 and the two mamo species (*Abudefduf abdominalis* and *A. viagiensis*) contributed 35% of this estimated weight and the kala lolo (*Naso brevirostris*) added 25% to the total at this station. In the 12 August 2010 survey the standing crop at Station 15 was estimated to be 207 g/m^2 and the whitebar surgeonfish or maiko'iko (*Acanthurus leucoparieus*) provided 27% of this total and the na'ena'e (*Acanthurus olivaeus*) added 52% to the standing crop at this station. Again the estimated biomass at Station 16 in the August 2010 survey was elevated (603 g/m^2) and five species were important contributors: the opelu (*Decapterus macarellus* - 25%), the two mamo species (*Abudefduf abdominalis* and *A. viagiensis* - 13%), the hinalea lauwili (*Thalassoma duperrey* - 18%) and the kala lolo (*Naso brevirostris* - 11%). The 29 October 2010 survey found three stations with estimated standing crops in excess of 200 g/m^2. The standing crop at Station 7 was estimated to be 245 g/m^2 and the humuhumu ele'ele (*Melichthys niger*) added 49% to the total and the red weke or weke'ula (*Mulloidichthys vanicolensis*) contributed 26%. At Station 9 the standing crop was estimated to be 730 g/m^2 where a large school of white weke (*Mulloidichthys flavolineatus*) in the transect area made up 99% of the biomass at this station. Finally at Station 16 the biomass was estimated to be 554 g/m^2 and several schools of opelu (*Decapterus macarellus*) made up 41% of the total and a school of blue-lined snapper or ta'ape (*Lutjanus kasmira*) added 23% to the total at this station.

The 25 February 2011 survey noted only one station with a high estimated standing crop which was Station 16 on the Kahe discharge pipe where the estimated standing crop was 430 g/m^2 and the bluelined snapper or ta'ape (*Lutjanus kasmira*) comprised 52 percent of it and the kala lolo (*Naso breivrostris*) made up 21 percent of the estimated weight at this station. The 16 June survey found a high standing crop (273 g/m^2) at Station 3 where the na'ena'e (*Acanthurus olivaceus*) made up 75 percent of the total estimated weight recorded at this station. At Station 6 the standing crop was estimated to be 206 g/m^2 and the palukaluka (*Scarus rubroviolaceus*) contributed 38 percent to this and the na'ena'e (*Acanthurus olivaceus*) added 27 percent to this estimated biomass while at Station 16 the standing crop was estimated to be 318 g/m^2 and the two mamo species (*Abudefduf abdominalis* and *A. viagiensis*) added 25 percent while the kala lolo (*Naso brevirostris*) contributed 33 percent to the total at this station. In the 29 July 2011 survey the standing crop at Station 3 was 435 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 89 percent of the total while at Station 6 where the standing crop was 234 g/m^2, the na'ena'e comprised 22 percent and the palukaluka (*Scarus rubroviolaceus*) added 24 percent to the biomass at this station. Again the standing crop at Station 16 was high (436 g/m^2) and the ta'ape (*Lutjanus kasmira*) contributed 32 percent, the weke'ula (*Mulloidichthys vanicolensis*) added 23 percent while the kala lolo (*Naso brevirostris*) comprised 17 percent of the biomass at this station. Finally the 23 November 2011 survey found a high standing crop at Station 2 (263 g/m^2) and Station 3 (379 g/m^2) both due to the na'ena'e (*Acanthurus olivaceus*) making up 67 percent at Station 2 and 60 percent at Station 3. At Station 10 on this date, a school of weke'ula (*Mulloidichthys vanicolensis*) made up 71 percent of the estimated 318 g/m^2 and at Station 16 another school of weke'ula comprised 66 percent of the total 681 g/m^2 estimated biomass at this station.

In the four 2012 surveys, all standing crop estimates at stations in the 2 May and 23 July surveys were less than 200 g/m^2. However in the 23 May 2012 survey at Station 16 the standing crop of fishes was estimated to be 214 g/m^2 and the species contributing heavily to this biomass include the Indo-Pacific sergeant (*Abudefduf vaigiensis*) which added 19% to the station total. In the 2 November 2012 survey, the standing crop again at Station 16 was estimated to be 334 g/m^2 and a school of mackerel scad or opelu (*Decapterus macarellus*) contributed 50% to this biomass and the hinalea lauwili (*Thalassoma duperrey*) added 14% and the Indo-Pacific sergeant (*Abudefduf vaigiensis*) accounted for 11% of the total at this station.

Four surveys were completed in 2013 with the first being carried out on 3 May. Standing crop estimates at three stations exceeded 200 g/m^2; at Station 5 (Ko'Olina 1) the estimated biomass was 238 g/m^2 due largely to the manini (*Acanthurus triostegus*) making up 36% of the total and the na'ena'e (*Acanthurus olivaceus*) adding 46% to the total at this station. At Station 8 (Kahe 5-B) the standing crop was estimated to be 225 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 91% of the total at this station. Once again opelu (*Decapterus macarellus*) were present around the Kahe plant outfall (Station 16) during the 3 May 2013 survey comprising 50% of the total standing crop that was estimated to be 348 g/m^2. The 14 June 2013 survey noted a high standing crop at Station 2 (238 g/m^2) which was due to the na'ena'e (*Acanthurus olivaceus*) making up 85% of the estimated biomass at this station and at Station 16 (Kahe outfall) the

standing crop was estimated to be 294 g/m^2 and the uhu (*Scarus sordidus*) comprised 27% of the total and the two mamo species (*Abdufduf abdominalis* and *A. viagiensis*) contributed 21% to the total at this station. The 20 September 2013 survey noted an extremely high standing crop (1,619 g/m^2) at Station 9 (Kahe 7B), 98% of which was due to a school of pelagic halfbeaks or iheihe (*Hyporhamphus pacificus*) passing through the transect area during the census. The standing crop at Station 12 (Kahe 7E) was estimated to be 372 g/m^2 and a passing school of the opelu (*Decapterus maracrellus*) made up 75% of that total. Once again the standing crop at Station 16 (Kahe discharge) was estimated to be 413 g/m^2 and the opelu (*Decapterus macarellus*) contributed 11%, the uhu (*Scarus psittacus*) added 28% and the two mamo species (*Abudefduf abdominalis* and *A. vaigiensis*) provided 24% to the total for this station. The fourth quarter survey was carried out on 18 December 2013 where at Station 2 (CIP 2) the standing crop was estimated to be 281 g/m^2 and na'ena'e (*Acanthurus olivaceus*) added 67% and at Station 16 (Kahe outfall) the standing crop was estimated to be 296 g/m^2 and the weke'ula (*Mulloidichthys vanicolensis*) contributed 39%, the hinalea lauwili (*Thalassoma duperrey*) added 15% and the two mamo species (*Abudefduf abdominalis* and *A. viagiensis*) provided 13% to the total at this station.

The first quarter 2014 survey carried out on 8 May noted only Station 16 (Kahe discharge pipe) having an estimated standing crop greater than 200 g/m^2; in this case the standing crop was 346 g/m^2 where the ta'ape (*Lutjanus kasmira*) contributed 32% and the two mamo species (*Abudefduf abdominalis* and *A. vaigiensis*) added 27% to the total. In the second quarter survey on 6 June 2014 at Station 13 (Kahe 10), the estimated standing crop was 236 g/m^2 where a school of akule (*Selar crumenophthalmus*) made up 30% of the total and the often resident school of ta'ape (*Lutjanus kasmira*) was encountered during the census and they contributed 53% to the total estimated standing crop. At Station 16 (Kahe pipe), the standing crop was estimated to be 253 g/m^2 and the paletail unicornfish or kala lolo (*Naso brevirostris*) made up 16% and the two mamo species (*Abudefduf abdominalis* and *A. vaigensis*) comprised 32% of the total at this station. The third quarter 2014 survey was carried out on 26 September and at Station 1 (CIP 1) the standing crop was estimated to be 336 g/m^2 where the manini (*Acanthurus triostegus*) made up 10%, the na'ena'e (*Acanthurus olivaceus*) added 37% and the pualu (*Acanthurus blochii*) contributed 33% to the total at this station. At Station 6 (Ko'Olina 2) the standing crop was estimated to be 212 g/m^2 and the nenue (*Kyphosus bigibbus*) contributed 20% and the na'ena'e (*Acanthurus olivaceus*) added 32% to the total at this station. Finally on this same date at Station 16 (Kahe pipe) the standing crop was estimated to be 215 g/m^2 and the ta'ape (*Lutjanus kasmira*) made up 12% of the total, the hinalea lauwili (*Thalassoma duperrey*) and uhu (*Scarus sordidus*) each added 11% to the total at this station. As noted above, near-continuous high surf in the October 2014 through early February 2015 period precluded carrying out the fourth quarter 2014 field work until 27 February 2015 where three of the sixteen stations had standing crops above 200 g/m^2. Station 7 (Kahe 1D) had an estimated standing crop of 215 g/m^2 where the yellowstripe goatfish or weke (*Mulloidichthys flavolineatus*) made up 13% of the total, the maiko (*Acanthurus nigroris*) added 19% and the humuhumu 'ele'ele (*Melichthys niger*) contributed 28% to the total present at this station. In this fourth quarter survey, Station 13 (Kahe 10) had an estimated standing crop of 471 g/m^2 where the weke (*Mulloidichthys flavolineatus*) contributed

40% of the total and the weke'ula (*Mulloidichthys vanicolensis*) added 48% to this standing crop. Lastly, Station 16 (Kahe pipe) had an estimated standing crop of 386 g/m^2 where the ta'ape (*Lutjanus kasmira*) comprised 25%, the uhu (*Scarus sordidus*) added 22% and the two mamo species (*Abudefduf abdominalis* and *A. vaigiensis*) contributed 21% to the total for this station.

The 6 April 2015 first quarter survey noted an estimated standing crop of 231 g/m^2 at Station 1 (CIP-1) where 63% of this biomass was comprised of the na'ena'e (*Acanthurus olivaceus*). At Station 7 (1-D) the standing crop was estimated to be 229 g/m^2 and the humuhumu ele'ele (*Melichthys niger*) contributed 56% to this total. Station 13 (Kahe 10) also had a high biomass of fish present (313 g/m^2) and the resident school of weke (*Mulloidichthys flavolineatus*) comprised 85% of that standing crop. Finally at Station 16 (KGS pipe), the standing crop was estimated to be 254 g/m^2 and both weke (*Mulloidichthys flavolineatus*) contributed 23% and the hinalea lauwili (*Thalassoma duperrey*) added 20% to this standing crop. The second quarter 2015 survey was conducted on 18 June where high standing crops were encountered at three stations; Station 4 (CIP-4) had an estimated standing crop of 248 g/m^2 where the na'ena'e (*Acanthurus olivaceus*) made up 80% of the weight present. At Station 13 (Kahe-10) the standing crop was estimated to be 600 g/m^2 and the akule (*Selar crumenophthalmus*) contributed 52% to this total and the weke (*Mulloidichthys flavolineatus*) made up 24% of the biomass present. Finally at Station 16 (KGS pipe), the biomass was estimated to be 506 g/m^2 where the weke (*Mulloidichthys flavolineatus*) comprised 45% of the total and the ta'ape (*Lutjanus kasmira*) made up 35% of the biomass present. The third quarter 2015 survey was carried out on 21 October 2015 and the biomass was elevated at three stations: Station 5 (Ko'Olina-1) where the standing crop was estimated to be 1,196 g/m^2 and the ta'ape (*Lutjanus kasmira*) made up 66%, at Station 15 (Nanakuli-2) where it was 280 g/m^2 and the maikoiko (*Acanthurus leucoparieus*) contributed 30% along with the na'ena'e (*Acanthurus olivaceus*) adding 25% and at Station 16 (KGS pipe) where the standing crop was estimated to be 559 g/m^2 and the weke (*Mulloidichthys flavolineatus*) comprised 34% of this along with the ta'ape (*Lutjanus kasmira*) adding 38% to the total. As noted above, the fourth quarter 2015 field survey was not undertaken until 28 April 2016 when the weather cooperated. In this fourth quarter survey three stations all had elevated standing crops; these were Station 2 (CIP-2) where the biomass was estimated to be 291 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 86% of it, at Station 5 (Ko'Olina-1) where the standing crop was 517 g/m^2 and the ta'ape (*Lutjanus kasmira*) comprised 69% of the total and at Station 16 (KGS pipe) where the biomass was estimated to be 281 g/m^2 and the uhu (*Scarus sordidus*) added 32% to the total and the hinalea lauwili (*Thalassoma duperrey*) contributed 25% to the total.

In the first quarter (15 April) 2016 survey, elevated standing crops were present at five of the sixteen stations: Station 2 (CIP-2) the standing crop was estimated to be 395 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) comprised 70% while the manini (*Acanthurus triostegus*) added 12%. The estimated standing crop was 256 g/m^2 at Station 3 (CIP-3) where the na'ena'e (*Acanthurus olivaceus*) comprised 62% of the total and the ringtail surgeonfish or pualu (*Acanthurus blochii*) added 16% to the total biomass at this station. Station-5 (Ko'Olina 1) the biomass was estimated to be 969 g/m^2 and the ta'ape (*Lutjanus kasmira*) made up 87% of the

total present. At Station 13 (Kahe-10) the standing crop was estimated to be 400 g/m^2 and again the ta'ape contributed 63% while the weke (*Mulloidichthys flavolineatus*) added 15% to the total. Station 16 (KGS pipe) had a estimated standing crop of 719 g/m^2 in the first quarter 2016 survey and two species were responsible for much of the biomass present; these were the ta'ape (*Lutjanus kasmira*) contributing 34% and the weke'ula (*Mulloidichthys vanicolensis*) adding 39% to the total at this station. The second quarterly 2016 survey was carried out on 5 July where once again the na'ena'e (*Acanthurus olivaceus*) added 41% and the pualu (*Acanthurus blochii*) contributed 15% to the estimated 379 g/m^2 at Station 1 (CIP-1). The standing crop at Station 5 (Ko'Olina-1) was estimated to be 385 g/m^2 and the ta'ape (*Lutjanus kasmira*) made up 74% of the total at this station. The standing crop was elevated at Station 15 (Nanakuli-2) in the July 2016 survey (319 g/m^2). Three species contributed heavily to this biomass; these were the ta'ape adding 17%, the emperor or mu (*Monotaxis grandoculis*) contributing 22% and the maiko (*Acanthurus nigroris*) providing 25% to the total at this station. Again in the July 2016 survey the standing crop was high on Station 16 (KGS pipe - 802 g/m^2) and the weke (*Mulloidichthys flavolineatus*) added 36% to the total, the weke'ula (*Mulloidichthys vanicolensis*) provided 25% and the ta'ape (*Lutjanus kasmira*) contributed 10% to the total at this station. The third quarter 2016 survey carried out on 18 August where the standing crop at Station 1 (CIP-1) was estimated to be 334 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) comprised 64% of the total present. At Station 5 (Ko'Olina-1) the standing crop was 210 g/m^2 and the ta'ape (*Lutjanus kasmira*) made up 67% of the biomass present while at Station 6 (Ko'Olina-2) where the estimated biomass was 245 g/m^2, the na'ena'e (*Acanthurus olivaceus*) contributed 33% and the maiko (*Acanthurus nigroris*) added 22% to the total. The fourth quarterly survey was carried out on 15 March 2017 where Station 2 (CIP-2) had a standing crop estimated to be 243 g/m^2 and the na'ena'e (*Acanthurus olivaceus*) made up 74% of the biomass present. The standing crop at Station 15 (Nanakuli-2) was estimated to be 213 g/m^2 and the mu (*Monotaxis grandoculis*) comprised 41% and the whitebar surgeonfish or maikoiko (*Acanthurus leucoparieus*) made up 39% of the total biomass present. Finally, the estimated standing crop at Station 16 (KGS pipe) was 810 g/m^2 where the ta'ape (*Lutjanus kasmira*) contributed 21% and the weke'ula (*Mulloidichthys vanicolensis*) added 57% to the total at this station.

In the four 2017 surveys, the yellowfin goatfish or weke'ula (*Mulliodichthys vanicolensis*) contributed significantly to the estimated standing crop at the KGS discharge pipe (Station 16). In 18 May 2017 a school of weke'ula contributed 57% of the total standing crop (estimated to be 1,010 g/m^2), in 6 June 2017, they added 32% to the total estimated standing crop at 702 g/m^2, 29 August 2017 it was 26% of an estimated total of 650 g/m^2 and in 21 December 2012 it was 33% where the total was estimated to be 1,042 g/m^2. Also in the 21 December 2012 survey a related species (the yellowstripe goatfish or weke - *Mulloidichthys flavolineatus*) added 52% to the total estimated standing crop at this station. In the 29 August 2017 survey many adult bullethead parrotfishes or uhu (*Scarus sordidus*) were present on the warm-water discharge contributing 53% to the estimated standing crop; these fish were possibly aggregated for spawning.

Finally, in 2018 the ta'ape (*Lutjanus kasmira*) made up 79 percent of the Station 16 estimated standing crop (1,635 g/m^2) in the 11 May survey, 32% in the 19 November survey (Station 16

standing crop = 890 g/m^2) and 10% in the 10 January 2019 survey (Station 16 standing crop = 972 g/m^2). A large school of resting white weke (*Mulloidichthys flavolineatus*) at Station 16 in the 26 June 2018 survey comprised 46% of the standing crop present (here 824 g/m^2). The 19 November 2018 survey at Station 3 censused a large aggregation of redlip parrotfish or uhu palukaluka (*Scarus ruboviolaceus*) comprising 93% of the estimated standing crop present (here 547 g/m^2). Finally in the 10 January 2019 survey of Station 16 (standing crop 972 g/m^2) weke'ula (*Mulloidichthys vanicolensis*) made up 49% of the biomass present.

A simple review of the above data finds that the same species often contribute substantially to the estimated standing crops at the same stations over time. Reasons for this include the fact that many species forage over relatively large areas thus often appear and cross through the transect area while a census is in progress and secondly some species such as the ta'ape (*Lutjanus kasmira*), the weke (*Mulloidichthys flavolineatus*) and weke'ula (*Mulloidichthys vanicolensis*) aggregate and rest during the daylight hours and forage after dark. These resting species often do so in areas where considerable vertical relief (shelter) is present as at Station 16 (KGS pipe). Diurnal foraging species that have contributed heavily to the standing crops in this study include the na'ena'e (*Acanthurus oliveceus*), maiko (*Acanthurus nigroris*), manini (*Acanthurus triostegus*), pualu (*Acanthurus blochii* and *A. xanthopterus*), uhus (*Scarus sordidus* and *S. psittacus*) and uhu palukaluka (*Scarus rubroviolaceus*). In other instances such as at the Kahe outfall station (Station 16), the presence of a unidirectional flow of warm discharge water containing particles that may serve as food as well as the high degree of topographical complexity all serve to draw both sedentary and more mobile fish species to the area including opelu (*Decapterus macarellus*) and as noted above, ta'ape (*Lutjanus kasmira*) and weke'ula (*Mulloidichthys vanicolensis*).

8. Comparative Analysis of Hawaiian Electric's Early Biological Data to the 2007-2018 Data

As noted above, Hawaiian Electric's environmental monitoring program started in the 1970's. Many of the same survey sites are being monitored today. These early data are given in Coles *et al.* (1985b) and in a summary table (Table 33) in Coles *et al.* (1985a). Fish transect data from seven stations sampled in the 1976-1984 period fronting the Kahe Generating facility have been compared to the 2007-2018 data collected from those same sites. The previous survey sites include Station 7 (#1-D started in 1979), Station 8 (#5-B started in 1976), Station 10 (#7-C started in 1976), Station 11 (#7-D started in 1976), Station 12 (#7-E started in 1980), Station 13 (#10-C started in 1979) and Station 14 (Nanakuli-1 control started in 1979). In this analysis, the annual means for the number of fish species and number of fish individuals encountered over those seven stations in common between the two groups of surveys are compared by addressing the question, "Are there any statistically significant differences among the annual mean number of fish species or annual mean number of individual fish censused per transect over the 1979-1984 and 2007-2018 periods?" Again, to address this question two non-parametric tests were used: the Kruskal-Wallis analysis of variance (ANOVA) and the Student-Newman-Kuels (SNK) Test. The Kruskal-Wallis ANOVA is used to demonstrate statistically significant differences

among parameter means (by date), but cannot show where those differences are and the SNK Test is used to group related sample means and separate those means that are significantly different from one another.

The results of these analyses are given in Table 7 and referring to this table, it is shown that there are no significant differences among either of the annual means for the number of fish species censused per transect or the number of individual fish observed per transect despite the imposition of three major storm events. With respect to the annual mean number of species per transect, we find the greatest annual means occurring prior to the January 1980 storm event and the lowest mean (1983) occurring following Hurricane Iwa in 1982. With the annual mean number of individual fish seen per transect, the highest means occur with the recent (2007-2018) surveys and the lowest means following Hurricane Iwa (1983), but the order among the dates does not parallel that for the mean number of fish species (Table 7). Thus not all species of fish were impacted to the same degree with the occurrence of these two early high wave events. Fish standing crop information was not readily available for Stations 7, 8, 10, 11, 12, 13 or 14 in the early (1976-1984) Hawaiian Electric dataset except for 1984, thus it was not included in the above (Table 7) analysis. However, the non-parametric Wilcoxon Two-Sample Test was used to examine the mean estimated standing crop of fishes in 1984 at the above seven stations comparing this mean to the mean estimated biomass at these stations in the 2007-2018 dataset. Despite the mean estimated standing crop (here 64 g/m^2) being greater in 2007-2018 than in 1984 (26 g/m^2), the Wilcoxon Two-Sample Test failed to find any statistically significant differences ($p>0.16$, n.s., where a $p<0.05$ signifies significance) in the estimated standing crop at these seven stations sampled minimally 22 years apart. Again the standing crop statistical results support those found with the mean number of fish species or the mean number of individual fish censused per transect (Table 7).

In summary, there are no statistically significant differences among the annual mean number of fish species or individuals censused utilizing data that span a 43-year period (1976-2018) at seven monitoring stations fronting the Kahe Generating Station despite the imposition of three major storm events in 1980, 1982 and 1992 (see Section 2 of this report). These data suggest that the fish communities have to some extent recovered from these disturbances.

9. Federally Protected Species

When encountered during field work, federally protected species are noted. Five species that are encountered (or heard underwater) around the high Hawaiian Islands are the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricata*), the spinner porpoise (*Stenella longirstris*), the Hawaiian monk seal (*Monachus schauinslandi*) and present seasonally, the humpback whale (*Megaptera novaeangliae*).

Because of low population numbers, the Hawaiian green sea turtle was given protection under the federal Endangered Species Act in the mid-1970's. Green turtles as adults are known to forage and rest in the shallow waters around the main Hawaiian Islands. Reproduction in the

Hawaiian population occurs primarily during the summer months in the Northwest Hawaiian Islands with adults migrating during the early summer to these isolated atolls and returning in the late summer or early fall. In the main Hawaiian Islands, green turtles rest during the day along ledges, caves or around large coral mounds in coastal waters usually from 15 to 20 m in depth. Under the cover of darkness, turtles will travel inshore to shallow subtidal and intertidal habitats for foraging on algae or limu. (Balazs *et al.* 1987). The normal range of these daily movements between resting and foraging areas is about one kilometer (Balazs 1980, Balazs *et al.* 1987). In general, appropriate algal forage for these turtles is found in shallow waters inshore of the resting areas. Selectivity of algal species consumed by Hawaiian green turtles appears to vary with the locality of sampling, but stomach content data show *Acanthophora spicifera* (an introduced species) and *Amansia glomerata* to quantitatively be the most important (Balazs *et al.* 1987); the preferences may be due to the ubiquitous distribution of these algal species.

The Hawaiian green turtle population has rebounded under the more than 30 years of federal protection afforded to it such that today, green turtles are commonly seen in the waters fronting most beaches around the islands. In contrast, the hawksbill turtle is much less common and much less is known about its biology in Hawaiian waters. Hawksbill turtles do not attain the size of green turtles in Hawaiian waters, nest on very small and isolated beaches around the main islands and are omnivorous in their feeding habitats. In the waters surveyed under the present study, no hawksbill turtles have been observed.

Green turtles were observed on thirty of the forty-four surveys completed to date. Almost all turtles seen were juveniles (i.e., having a carapace length estimated to be less than 75 cm) except for a pair of adults (estimated straight-line carapace lengths = 90 cm) in the 10 August 2010 survey at Station 9 and a single individual (~85 cm) at Station 5 in the 20 September 2013 survey. Some turtles were sleeping while others observed were actively swimming. There is a depression in the limestone at Station 8 where green turtles often rest; in 2009 a small (~45 cm straight-line carapace length) green turtle was observed in this depression in the 19 March and 21 July 2009 surveys. In the 12 August 2010 and 16 June 2011 surveys this same depression was occupied by a ~65 cm sleeping juvenile turtle. On the 23 November 2011 survey two turtles (~ 60 cm and ~70 cm) were found in this same depression sleeping and on the 23 May 2012 survey this depression was occupied by an ~75 cm resting turtle. In the 14 June 2013 survey an approximate 45 cm turtle was observed resting in the same depression at Station 8 and in the 20 September 2013 survey, a ~60 cm turtle was resting at this same location as was the case in the 8 May 2014 survey. This same depression was once again occupied by a ~40 cm turtle in the 18 December 2013 survey and this same Station 8 depression was occupied by an ~70 cm turtle on 15 April 2016 survey. The 18 May 2017 survey noted one small (~50 cm) turtle resting in the same depression and during the 2 June 2017 survey, a small 50 cm turtle swam alongside of the census taker at Station 8 for the length of the 50 m transect. This latter turtle may be the same individual encountered on many other occasions at this station.

In the four 2018 surveys subadult turtles were observed; in the 11 May and 26 June surveys a small (~60 cm) turtle was encountered in the same depression at Station 8. In the 26 June 2018

survey at Station 10 an approximate 65 cm turtle was swimming to the north and on the same day a 50 cm turtle was seen at Station 12 again swimming north. In the 11 November 2018 survey at Station 6 a 75 cm turtle was swimming in a southerly direction and in the 10 January 2019 survey another 75 cm turtle was observed at Station 11 swimming in a northerly direction while at Station 13 another 60 cm individual was again moving in a northerly direction. Finally at Station 15 a small (~60 cm) turtle was swimming in a westerly direction following the deployed transect line.

Turtles have been encountered elsewhere around the sixteen stations sampled in this study. In the 25 November 2008 survey six green turtles were found resting on the bottom in a depression just seaward of Station 5 and again on the 23 May 2012 survey a single juvenile turtle (~70 cm) was observed at Station 16 (the Kahe Generating Station warm-water discharge) swimming in a northwest direction and in the 18 December 2013 survey a ~40 cm individual green turtle was seen swimming towards shore along the discharge pipe. In the 14 June 2013 survey, green turtles were also observed at Station 6 (~70 cm) and a second individual at Station 9 (~75 cm). Turtles were again observed around the Kahe plant discharge in two of the four 2014 surveys; the first was encountered on 6 June (~70 cm individual) and again on 27 February 2015 (~50 cm individual). Green turtles observed in the 2015 quarterly surveys on 6 April at Station 3 (~40 cm individual) on 18 June at Station 13 (~65 cm individual) and on 8 April 2016 fourth quarter survey an ~ 65 cm turtle was observed at Station 10. In the April 2016 survey at Station 5 (Ko'Olina 1) a ~60 cm was seen swimming north, at Station 8 another ~60 cm turtle was seen swimming south. On the 5 July 2016 survey at Station 16 (KGS pipe) a ~60 cm turtle was seen swimming alongside of the discharge pipe on the western side in a seaward direction and on 18 August 2016 a ~75 cm individual was observed swimming in a northwest direction at Station 13 (Kahe-10). In no cases were any tags or tumors identified on any of the turtles observed to date.

For many years, Hawaiian monk seals were not observed very often around the main Hawaiian Islands probably because much of the population was located in the Northwest Hawaiian Islands. However over time, the population numbers of this species have declined but despite this, in recent years an increasing number of Hawaiian monk seals are now present on the beaches around the main islands with the occasional female giving birth on island beaches. The reason(s) for these changes in the population are unknown but the result is monk seals are now occasionally observed by us while carrying out environmental surveys around the main islands. On the 30 May 2008 survey an adult male monk seal approached the vessel while at anchor at Station 14. This seal carried a tag (not readable at distance) and it swam around the vessel and subsequently left heading towards the shoreline. This seal has not been seen since. In the 14 June 2013 survey while conducting census work on the Kahe facility discharge pipe, a spear fisherman swam up to the survey vessel and reported that two monk seals were presently on the beach resting near the discharge pipe. He said that on the day prior, this pair of seals took all of his speared fish and one of the seals was “aggressive”. These seals were not observed by tghe observer. Finally on 8 May 2014 while anchored on the discharge pipe, a large seal was observed inshore of where the fish census was being conducted. This seal did not approach either the vessel or survey divers.

It should be noted that the endangered humpback whale is known to frequent island waters in their annual migrations to Hawaiian wintering grounds. They normally arrive in island waters about December and depart by April. In general their distribution in Hawaii appears to be limited to the 180 m (100 fathom) isobath and in shallower waters (Nitta and Naughton 1989). Whales were observed further seaward of the Barbers Point - Kahe Point study area and their songs could be heard underwater during 27 December 2007, 19 March 2009, 24 March 2010, 25 February 2011, 18 December 2013, 27 February 2015, 15 March 2017 (for the 4th quarter 2016 survey) and 10 January 2019 (for the 4th quarter 2018 survey).

Spinner porpoises are occasionally observed in the Kahe Point area and were first encountered there during this study on the 30 May 2008 survey where three pods were seen each having about 35 individuals present. In the 14 May 2010 survey, a pod of about 30 individuals passed by during a census at Station 10 and in the 23 July 2012 survey a small pod of approximately 20 porpoises were traveling northwest seaward of Stations 5 and 6. On the 18 December 2013 survey a small pod of spinner porpoises (estimated 15 individuals), were observed moving west just seaward of Station 7. Finally in the November 2018 survey a small pod was seen near Station 8. Hawaiian spinner porpoises are known to rest in shallow bays during the day and at night move offshore to feed on midwater fishes and squids that rise to the surface to forage.

10. Long-Term Perspective on the Barbers Point-Kahe Point Fish Communities

As noted and documented above, the three early storm events (1980, 1982 and 1992) all impacted marine communities offshore of the Barbers Point - Kahe Point areas. These impacts were probably greatest on the coral communities which due to their sessile nature, must withstand the wave forces impinging on them or perish. Corals are relatively slow-growing and depending on the species, individual colonies may live for a considerable time and in doing so create habitat for fishes and other reef species. If disturbance to the coral community is relatively frequent, surviving corals probably do not contribute much to the three-dimensional structure of the habitat, thus keeping the fish community development in an earlier successional stage than it might otherwise be. Storms not only directly impact the living resources but also the geological condition of reef areas. As noted by the early Hawaiian Electric studies, considerable sand movement occurred with the first two major storms that occurred in 1980 and 1982 and today much of the area west of the Kahe facility’s ocean outfall is now nearly devoid of sand leaving a near-featureless hard bottom that is scoured with passing small wave events that retard benthic and fish community development. A similar situation exists east of the Barbers Point Harbor entrance channel where considerable hard (limestone) substratum is present with much of it having poor benthic community development. This again results in a poorly developed resident fish community, which is what we see in much of the area today and did so forty plus years ago (Brock, personal observations). Thus the measures of fish community development used here (the diversity of species and numbers of individuals present as well as the standing crop) do not suggest well-developed resident fish communities at many of the sample sites. However, where topographical complexity is greater and benthic communities are better developed, the resulting fish communities are well-developed. This is best illustrated at Station 16 located at the terminus

of the Kahe facility discharge, where, despite high use which includes snorkel/dive tours as well as spear fishermen, the fish community remains relatively well-developed. The high degree of development in the resident fish communities on the Kahe discharge structure lend further support to the lack of negative impact due to the operation of the discharge.

Given the long-term extant data set spanning 40 plus years and the apparent lack of strong significant changes occurring with the three early (1980, 1982 and 1992) storm events (which is probably due to some level of recovery in the intervening period), suggests the variation seen in the measures of the fish community used here will continue to fluctuate at a similar magnitude in future monitoring events as this program moves forward. The 43 years of well-documented environmental history for the Barbers Point - Kahe Point area (completed largely by the Hawaiian Electric environmental program), provides much of the explanation to the degree of development of resident fish communities we encounter in the area today.

LITERATURE CITED

Bak, R. and B. Luckhurst. 1980. Constancy and change in coral reef habitats along depth gradients at Curacao. Oecologia *47*:145-155.

Balazs, G.H. 1980. Synopsis of biological data on the green turtle in the Hawaiian Islands. NOAA Tech. Memorandum, NMFS. NOAA-TM-NMFS-SWFC-7. 141p.

Balazs, G.H., R.G. Forsyth and A.K.H. Kam. 1987. Preliminary assessment of habitat utilization by Hawaiian green turtles in their resident foraging pastures. NOAA Tech. Memorandum, NMFS. NOAA-TM-NMFS-SWFC-71. 107p.

Ball, M., E. Shinn and K. Stockman. 1967. The geological effects of Hurricane Donna in south Florida. J. Geol. *75*:583-597.

Blumenstock, D., F. Fosberg and C. Johnson. 1961. The re-survey of typhoon effects on Jaluit Atoll in the Marshall Islands. Nature *189*:618-620.

Brock, R.E. 1982. A critique on the visual census method for assessing coral reef fish populations. Bull. Mar. Sci. *32*:269-276.

Brock, R.E. 1987. An assessment of the fishes and macrobenthos off the Kahuku coast, Oahu in relation to an aquaculture effluent. Prepared for AECOS, Inc., Kailua, Hawaii. 16p.

Brock, R.E. 1992a. Status of coral communities fronting the Kahe Generation Facility, Kahe Point, Oahu following Hurricane Iniki. Prepared for the Environmental Department, Hawaiian Electric Co., Inc., Honolulu. Environmental Assessment Co. Report No. 92-17. 12p.

Brock, R.E. 1992b. Status of the green turtle (*Chelonia mydas*) population fronting the

proposed Campbell drainage channel to serve the Kapolei Business Park. Prepared for Engineering Concepts, Inc., 250 Ward Avenue, Suite 206, Honolulu. Environmental Assessment Co. Report No. 92-15. 14p.

Brock, R.E. 1996. A study of the impact of Hurricane Iniki on coral communities at selected sites in Mamala Bay, O'ahu, Hawai'i. Project Report PR-96-09. Water Resources Research Center, University of Hawaii, Honolulu. vii+23p.

Brock, R.E. 2009. CIP generation project 2008 community benefits program: reef fish monitoring project year 1 results. Prepared for the Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2009-07. 38p+appendices.

Brock, R.E. 2010. CIP generation project 2009 community benefits program: reef fish monitoring project year 2 results. Prepared for the Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2010-009. 38p+appendices.

Brock, R.E. 2011. CIP generation project 2010 community benefits program: reef fish monitoring project year 3 results. Prepared for the Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2011-002. 41p+appendices.

Brock, R.E. 2012. CIP generation project 2011 community benefits program: reef fish monitoring project year 4 results. Prepared for the Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2012-010. 42p+appendices.

Brock, R.E. 2013. CIP generation project 2012 community benefits program: reef fish monitoring project year 5 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2013-008, 45p+appendices.

Brock, R.E. 2014. CIP generation project 2013 community benefits program: reef fish monitoring project year 6 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2014-05, 47p+appendices.

Brock, R.E. 2015. CIP generation project 2014 community benefits program: reef fish monitoring project year 7 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2015-08, 49p+appendices.

Brock, R.E. 2016. CIP generation project 2015 community benefits program: reef fish monitoring project year 8 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2016-09, 54p+appendices.

Brock, R.E. 2017. CIP generation project 2016 community benefits program: reef fish monitoring project year 9 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2017-07, 58p+appendices.

Brock, R.E. 2018. CIP generation project 2017 community benefits program: reef fish monitoring project year 10 results. Prepared for the Environmental Department, Hawaiian Electric, P.O. Box 2750, Honolulu, Hawaii 96840-0001. Environmental Assessment, LLC, Report No. 2018-01, 61p+appendices.

Brock, R.E., C. Lewis and R.C. Wass. 1979. Stability and structure of a fish community on a coral patch reef in Hawaii. Mar. Biol. *54*:281-292.

Brock, R.E. and J.E. Norris. 1989. An analysis of the efficacy of artificial reef designs in tropical waters. Bull. Mar. Sci. *44*:934-941.

Brock, V.E. 1954. A preliminary report on a method of estimating reef fish populations. J. Wildlife Mgmt. *18*:297-308.

Coles, S.L. 1979. Annual report. Kahe Generating Station. NPDES monitoring program, vol. 1 text. Honolulu. 263pp

Coles, S.L. and D.T. Fukuda. 1984. Annual report: Kahe generating station NPDES monitoring program. Vol. I, Text. Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840.

Coles, S.L., D.T. Fukuda and C.R. Lewis. 1981. Annual report. Kahe Generating Station. NPDES monitoring program, vol.1 text. Honolulu, 237 pp.

Coles, S.L., D.T. Fukuda and C.R. Lewis. 1982 Annual report. Kahe Generating Station. NPDES monitoring program, vol.1 text. Honolulu, 221p.

Coles, S.L., D.T. Fukuda and K.S. Oda. 1985a. Annual report Kahe Generating Station NPDES monitoring program. Vol. I. Text. Environmental Department, Hawaiian Electric Company, Inc., P.O. Box 2750, Honolulu, Hawaii 96840. v+172p.

Coles, S.L., D.T. Fukuda and K.S. Oda. 1985b. Annual report. Kahe generating station NPDES monitoring program. Vol. II, Appendices. Environmental Department, Hawaiian Electric

Company, Inc., P.O. Box 2750, Honolulu, Hawaii 96840, 168p.

Connell, J. 1978. Diversity in tropical rain forests and coral reefs. Science *199*:1302-1310.

Cooper, M. 1966. Destruction of marine fauna and flora in Fiji caused by the hurricane of February 1965. Pacif. Sci. *20*:137-141.

Dollar, S. 1982. Wave stress and coral community structure in Hawaii. Coral Reefs *1*:71-81.

Dollar, S. and G. Tribble. 1993. Recurrent storm disturbance and recovery: a long-term study of coral communities in Hawaii. Coral Reefs *12*:223-233.

Done, T., P. Dayton, A. Dayton and R. Steger. 1991. Regional and local variability in recovery of shallow coral communities: Moorea, French Polynesia and central Great Barrier Reef. Coral Reefs *9*:183-192.

Goldman, B. and F.H. Talbot. 1975. Aspects of the ecology of coral reef fishes. In: Biology and Geology of Coral Reefs, ed. O.A. Jones and R. Endean, pp. 125-154. Vol. III, Biology 2. Academic Press, New York.

Grassle, J. 1973. Variety in coral reef communities. Biology and geology of coral reefs, Biology 1, vol. 2, ed. O.A. Jones and E. Endean, pp. 247-270. New York: Academic Press.

Grigg, R.W. 1983. Community structure, succession and development of coral reefs in Hawaii. Mar. Ecol. Prog. Ser. *11*:1-14.

Grigg, R.W. and J.E. Maragos. 1974. Recolonization of hermatypic corals on submerged lava flows in Hawaii. Ecology *55*:387-395.

Harmelin-Vivien, M. and P. Laboute. 1986. Catastrophic impact of hurricanes on atoll outer reef slopes in the Tuamotu (French Ploynesia). Coral Reefs *5*:55-62.

Hiatt, R.W. and D.W. Strasburg. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. Ecol. Monogr. *30*:65-127.

Hobson, E.S. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. Fish. Bull. *72*:915-1031.

Johannes, R.E., *et al.* 1972. The metabolism of some coral reef communities: a team study of nutrient and energy flux at Eniwetok. Bioscience *22*:541-543.

Knutson, D.W., R.W. Buddemeier and S.V. Smith. 1972. Coral chronometers: seasonal growth

bands in reef corals. Science *177*:270-272.

Maragos, J., G. Baines and P. Beveridge. 1973. Tropical cyclone Bebe creates a new land formation on Funafuti Atoll. Science *181*:1161-1164.

Nitta, E.T. and J.J. Naughton. 1989. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region; Report No. 2, humpback whale, *Megaptera novaeangliae*. Tech. Rept. EL-89-10. Prepared by NMFS, NOAA, Honolulu for the U.S. Army Engineer Waterways Experiment Station, Ms.

Noda, E.K. 1983. Affects of Hurricane Iwa, November 23, 1982 offshore of Kahe Point, Oahu. Unpublished report prepared for Research Corp. of the University of Hawaii.

Ogg, J. and J. Koslow. 1978.The impact of typhoon Pamela (1976) on Guam's coral reefs and beaches. Pacif. Sci. *32*:1056-118.

Perkins, R. and P. Enos. 1968. Hurricane Betsy in the Florida-Bahamas area - Geological effects and comparison with Hurricane Donna. J. Geol. *76*:710-717.

Randall, J.E. 2007. Reef and shore fishes of the Hawaiian Islands. Sea Grant College Program, University of Hawai'i, Honolulu. xiv+546p.

Ricker, W.E. 1975. Handbook of computations for biological statistics of fish populations. Fish. Res. Bd. Canada, Bull. 119. 300p.

Risk, M.J. 1972. Fish diversity on a coral reef in the Virgin Islands. Atoll. Res. Bull. *153*:1-6.

Sale, P.F. Maintenance of high diversity in coral reef fish communities. Amer. Nat. *111*:337-359.

Stoddart, D. 1969. Post-hurricane changes on the British Honduras reefs and cays: re-survey of 1965. Atoll Res. Bull. *13*:1-25.

Stoddart, D. 1974. Post-hurricane changes on the British Honduras reefs: re-survey of 1972. Proc. 2nd Int. Coral Reef Symp. *2*:473-483.

Veron, J.E.N. 1995. Corals in space and time. UNSW Press, Sydney, NSW, Australia 2052.

Walsh, W.J. 1983. Stability of a coral reef fish community following a catastrophic storm. Coral Reefs *2*:49-63.

Woodley, J. *et al*. 1981. Hurricane Allen's impact on Jamaican coral reefs. Science *214*:749-755.

TABLE 1. Latitude and Longitude waypoints (in decimal minutes) for each of the sixteen permanently marked fish monitoring stations utilized in this study (GPS waypoints courtesy of the Environmental Department, Hawaiian Electric). Note that the first survey carried out on 27 December 2007 did not sample station numbers 4, 5, 6 and 16. The second survey on 4 April 2008 missed station 16 while surveys carried out subsequently have sampled all sixteen sites.

Station No.	Station Area Name	Latitude	Longitude	Remarks
1	East 1	21°18.237' N	158°07.024'W	New- offshore CIP
2	East 2	21°18.452'N	158°07.152'W	New - offshore CIP
3	East 3	21°18.558'N	158°07.239'W	New - offshore CIP
4	East 4	21°18.406'N	158°07.285'W	New - offshore CIP
5	Ko'Olina 1	21°19.724'N	158°07.581'W	New - offshore Ko'Olina
6	Ko'Olina 2	21°19.904'N	158°07.693'W	New - offshore Ko'Olina
7	HECO station 1D	21°20.763'N	158°07.773'W	Old Hawaiian Electric station
8	HECO station 5B	21°21.145'N	158°07.819'W	Old Hawaiian Electric station
9	HECO station 7B	21°21.239'N	158°07.855'W	Old Hawaiian Electric station
10	HECO station 7C	21°21.255'N	158°07.881'W	Old Hawaiian Electric station
11	HECO station 7D	21°21.268'N	158°07.893'W	Old Hawaiian Electric station
12	HECO station 7E	21°21.272'N	158°07.977'W	Old Hawaiian Electric station
13	HECO station 10C	21°21.522'N	158°07.925'W	Old Hawaiian Electric station
14	Nanakuli Control 1	21°22.329'N	158°08.440'W	Old Hawaiian Electric station
15	Nanakuli Control 2	21°22.353'N	158°08.462'W	New control station
16	On Outfall	21°21.193'N	158°07.869'W	New north side of outfall

TABLE 2. Summary of the fish censuses carried out at sixteen locations on forty-four surveys over the 2007 - 2018 period. The percent of the total biomass is that assigned to each of five trophic categories: (herbivores, planktivores, omnivores, carnivores and coral feeders) is also given. Note that these percentages are rounded to the nearest whole number and that Stations 1-4 were not samples on 21 October 2015 due to poor water clarity.

					% Total Biomass (g)				
Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	Herb.	Plankt.	Omni	Carni	CF
27-Dec-07	1	12	69	15	18		1	51	30
	2	19	155	143	87			9	4
	3	30	189	41	28		6	51	15
	4	Not sampled							
	5	Not sampled							
	6	Not sampled							
	7	28	306	92	40		40	19	1
	8	25	241	43	51	7	3	39	
	9	23	259	290	6	1	1	92	
	10	17	261	154		9	3	88	
	11	13	23	104	6		5	82	7
	12	34	581	63	21	1	24	51	3
	13	31	580	594	85	3	1	11	
	14	18	124	7	23	2	3	72	
	15	23	164	94	51		8	40	1
	16	Not sampled							
04-Apr-08	1	10	129	8		1	1	59	39
	2	25	333	238	89		1	9	1
	3	18	146	21	38		7	54	1
	4	25	270	116	57		3	37	3
	5	34	307	146	81	2	2	13	2
	6	31	292	164	67	1	2	29	1
	7	21	365	158	14		75	11	
	8	27	499	29	26	5	4	64	1
	9	17	75	74	25	1	1	73	
	10	11	117	8	42	1	5	52	
	11	6	21	4		1	2	97	
	12	25	390	31		1	15	79	5
	13	16	401	62	3	15	7	70	5
	14	12	260	14	1	1		98	
	15	17	214	129	83		1	15	1
	16	Not sampled							
30-May-08	1	12	77	9		1	17	82	
	2	21	220	64	65			34	1
	3	22	136	37	24		9	62	4
	4	30	293	49	28	1	23	45	3
	5	30	250	84	73		8	20	2
	6	32	265	132	77	1	7	14	1
	7	24	292	94	21		53	25	1
	8	26	412	75	70	9	1	20	
	9	21	152	95	21	67	1	11	
	10	21	167	55	60	14	3	23	
	11	12	81	21	35	2	37	26	
	12	25	453	14		4	28	60	8
	13	24	263	24	5	11	18	66	
	14	26	188	20	9		1	67	23
	15	13	80	34	69		3	26	2
	16	42	1205	358	8	43	2	47	

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g) Herb.	Plankt.	Omni	Carni	CF
19-Aug-08	1	19	155	13	1		9	90	
	2	20	280	120	85		2	13	
	3	23	231	40	27		5	66	2
	4	26	415	108	43	8	6	43	
	5	24	227	69	67		9	22	2
	6	35	302	165	79	1	6	14	
	7	24	213	65	9		56	35	
	8	27	463	39	49	1	2	47	
	9	23	235	34	56	4	6	34	
	10	39	201	33	9	1	5	85	
	11	32	126	41	1	2	23	57	17
	12	23	514	33	19	2	13	56	10
	13	21	385	63	45	16	4	35	
	14	19	192	8	4	1		95	
	15	15	104	16	44	1	2	47	6
	16	37	1023	396	3	55	1	41	
25-Nov-08	1	6	20	2			6	53	40
	2	10	41	4	21		6	73	
	3	21	100	12	47	3	3	46	1
	4	20	165	79	54		1	45	
	5	31	289	91	81		1	17	1
	6	36	263	189	82	2	4	10	2
	7	31	394	60	37		36	27	
	8	33	147	29	49	6	1	43	1
	9	25	374	171	14	1		85	
	10	31	364	62	45	4	2	49	
	11	9	52	18	44	1	2	53	
	12	31	426	19	17	6	30	38	9
	13	32	931	155	20	57	4	18	1
	14	19	170	15	38		1	61	
	15	24	234	171	91		2	7	
	16	40	1017	225	10	49	1	39	1
19-Mar-09	1	14	93	13	11		1	83	5
	2	14	102	15	16		2	79	3
	3	22	126	21	18		23	50	8
	4	18	125	25	21		18	61	
	5	27	302	113	82		2	14	2
	6	33	370	259	91	2	1	5	1
	7	32	349	91	41	1	44	13	1
	8	21	353	31	32	1	3	63	1
	9	17	111	74	6		2	92	
	10	13	52	14	35			64	1
	11	5	7	4		1		99	
	12	28	251	15	34	2	2	57	5
	13	30	458	84	17	5	6	72	
	14	17	84	7	35		2	63	
	15	23	148	115	92		1	6	1
	16	48	1438	577	31	34	2	32	1

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g) Herb.	Plankt.	Omni	Carni	CF
11-May-09	1	11	108	12	22		1	77	
	2	18	231	41	27		1	68	4
	3	26	224	65	64		7	27	2
	4	25	328	61	58		3	36	3
	5	31	383	224	87		3	9	1
	6	30	240	153	86	2	4	6	2
	7	26	263	51	31	1	45	22	1
	8	27	363	35	56	4	9	30	1
	9	15	88	20	51		1	48	
	10	20	159	22	32	1	14	52	1
	11	4	9	12			7	93	
	12	24	267	20	13	1	11	74	1
	13	28	459	147	20	8	1	71	
	14	11	43	6	25		8	67	
	15	17	194	174	87		1	12	
	16	39	1333	425	35	22	6	37	
21-Jul-09	1	17	141	18	2		9	81	8
	2	25	389	73	52			43	4
	3	31	301	80	26	5	31	34	4
	4	27	506	209	80		4	15	1
	5	39	582	267	65	5	6	23	1
	6	37	354	188	74	2	7	16	1
	7	33	589	155	28	2	49	21	
	8	26	800	47	47	2	7	44	
	9	27	204	70	6	4	3	87	
	10	24	212	30	15	42	2	41	
	11	10	40	12		1	2	97	
	12	26	432	20	18	6	18	46	12
	13	24	405	145	7	11	1	81	
	14	15	111	9	1	1	2	96	
	15	21	258	140	77	6	7	8	2
	16	40	1605	431	5	36	3	56	
29-Mar-10	1	17	162	30	56	0	9	25	10
	2	22	315	33	34	0	4	57	5
	3	27	197	45	70	1	10	17	2
	4	24	324	105	65	0	2	32	1
	5	31	312	129	76	4	8	10	2
	6	29	313	176	85	1	5	9	1
	7	26	336	67	26	0	46	28	0
	8	29	265	56	51	2	5	42	
	9	19	83	18	23	2	0	74	1
	10	13	53	10	40	0	21	38	
	11	10	28	14	1	0	4	95	
	12	24	245	54	7	54	15	23	0
	13	34	312	69	18	14	6	62	0
	14	11	101	7	31	0	2	65	2
	15	24	149	77	75		4	20	1
	16	29	1192	561	24	27	2	47	

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
14-May-10	1	18	94	15	55	0	8	37	
	2	17	91	14	33		7	48	13
	3	23	160	63	70	0	3	24	2
	4	16	326	85	71	0	6	19	4
	5	35	511	242	87	3	4	6	1
	6	37	241	164	82	2	3	14	1
	7	23	395	113	11	1	39	49	1
	8	26	361	80	78	2	6	13	0
	9	28	179	159	24	3	1	72	0
	10	21	119	55	53	24	2	20	0
	11	9	43	21		1	36	63	
	12	25	299	51	31	18	26	23	1
	13	31	369	57	9	35	5	50	0
	14	10	19	2	22		8	70	
	15	26	201	139	91	0	1	8	0
	16	33	1767	390	13	63	8	16	
12-Aug-10	1	22	198	157	69	0	1	31	0
	2	25	313	69	34	0	6	59	1
	3	25	225	28	42	0	8	49	1
	4	22	358	151	67	0	12	21	
	5	36	426	163	73	1	7	19	1
	6	30	233	118	63	2	11	23	1
	7	26	271	100	29	0	40	31	1
	8	24	425	62	73	1	5	21	0
	9	28	104	40	47	7	0	46	0
	10	20	106	31	24	49	4	23	0
	11	13	58	19	9	2	36	53	
	12	31	317	24	29	31	15	25	0
	13	32	359	60	11	12	10	68	
	14	13	51	23	85	0	0	14	2
	15	26	248	207	89	0	1	10	0
	16	33	1584	603	14	27	1	58	0
29-Oct-10	1	14	104	96	79		0	21	
	2	13	208	56	73		0	26	0
	3	27	183	49	61	0	6	32	2
	4	22	195	66	61	0	8	31	
	5	38	315	98	69	0	5	24	2
	6	36	294	123	79	2	3	15	2
	7	31	743	245	7	0	50	42	0
	8	28	262	24	33	1	6	60	0
	9	22	467	730	0	0	0	99	0
	10	17	57	21	31	0	10	59	1
	11	13	38	15	1	1	34	64	
	12	36	334	23	34	2	13	50	1
	13	35	478	192	23	5	1	69	1
	14	9	57	7		0	1	99	
	15	28	169	31	24	0	11	46	19
	16	35	1039	554	7	16	1	76	

TABLE 2. Continued

					% Total Biomass (g)				
Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	Herb.	Plankt.	Omni	Carni	CF
25-Feb-11	1	9	42	5	13		1	86	
	2	16	183	66	83		1	17	
	3	17	119	18	17		16	66	1
	4	20	266	25	47	1	18	34	
	5	31	307	99	54	0	4	40	1
	6	27	328	196	49	6	4	40	1
	7	18	235	93	8		67	25	
	8	25	307	33	13	7	2	77	0
	9	13	61	10	11	19	21	48	0
	10	7	26	4		0	19	80	
	11	8	15	12		0	41	59	
	12	24	243	14	29	7	21	42	1
	13	27	427	119	22	19	5	54	
	14	9	32	2	13	1	3	83	
	15	14	69	23	28	0	6	66	0
	16	24	910	430	8	32	2	59	0
16-Jun-11	1	18	162	124	91	0	1	8	0
	2	17	123	66	78	0	2	19	0
	3	27	275	273	88		1	10	1
	4	25	340	80	66	0	6	28	0
	5	24	270	74	63	5	9	22	1
	6	33	281	207	82	1	8	8	0
	7	27	434	131	35	0	32	32	
	8	27	464	37	60	6	6	28	
	9	15	54	14	25	0	18	56	0
	10	16	103	13	6	1	0	93	
	11	11	42	6	1	1	0	98	
	12	28	769	50	2	54	8	36	0
	13	29	383	75	3	8	8	79	3
	14	12	88	5	0	1		99	
	15	21	340	108	94	0	3	3	1
	16	40	1315	318	17	59	6	17	0
29-Jul-11	1	16	137	14	4		8	89	0
	2	21	183	52	59	0	2	39	0
	3	23	277	435	96	1	2	1	0
	4	26	299	52	42	0	13	44	
	5	34	333	138	88	0	1	10	1
	6	36	375	234	86	1	5	6	1
	7	23	309	100	8	2	55	35	
	8	33	802	38	42	12	3	39	4
	9	22	477	285	13	0	0	86	0
	10	11	58	5	0	1		98	
	11	9	53	2	1	9	1	90	
	12	32	297	22	3	2	42	53	1
	13	33	327	36	13	23	10	53	0
	14	12	67	5	5	0	1	93	
	15	22	113	82	84		5	11	
	16	38	864	436	4	25	1	70	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
23-Nov-11	1	15	179	161	92		0	8	0
	2	22	348	263	88		0	11	1
	3	38	320	379	92		2	5	1
	4	26	360	166	81	0	4	14	1
	5	29	320	122	83	0	3	13	0
	6	30	291	188	85	0	3	11	1
	7	26	244	68	16	0	64	19	1
	8	27	343	32	45	7	5	41	1
	9	23	102	29	61	0	4	34	0
	10	20	85	19	40	0	5	53	2
	11	13	26	50	5		10	86	
	12	34	691	24	30	4	21	44	1
	13	35	1253	318	1	6	2	91	
	14	12	44	7	56	0	1	43	
	15	17	85	16	56	0	17	21	6
	16	28	1318	681	10	19	0	70	0
02-May-12	1	9	74	16	6		7	87	
	2	13	130	27	59	0	0	40	1
	3	23	137	65	66	7	3	23	2
	4	26	251	128	52	5	3	41	
	5	29	227	93	73	0	3	22	1
	6	35	276	147	75	2	4	18	1
	7	25	315	82	17	0	43	40	0
	8	31	371	130	56	0	4	39	0
	9	21	116	20	32	1	12	54	1
	10	15	78	16	20	0	7	71	1
	11	11	31	67	79		0	20	0
	12	28	262	50	31	1	16	52	1
	13	35	339	173	7	4	3	85	0
	14	14	89	9	20	0	1	79	
	15	20	150	54	84	0	4	12	
	16	26	568	143	20	40	6	33	0
23-May-12	1	15	105	52	84	0	0	16	
	2	15	194	53	60	0	3	36	1
	3	23	176	75	69	0	4	26	2
	4	18	357	49	36	1	11	53	
	5	28	211	57	73	0	4	22	1
	6	32	259	163	85	1	6	8	0
	7	19	247	48	39	1	21	40	
	8	22	270	42	36	0	5	58	0
	9	17	59	20	25	0	5	70	0
	10	13	36	10	65		10	23	1
	11	9	23	30	44		0	56	
	12	18	211	27	9	1	32	57	1
	13	28	211	71	5	6	5	84	
	14	11	89	4	52	2	1	45	
	15	17	118	19	23	0	23	54	
	16	23	846	214	14	27	2	58	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
23-Jul-12	1	23	274	189	67	0	0	32	0
	2	18	187	55	63	0	2	35	0
	3	21	114	39	65		13	21	2
	4	19	344	36	16	1	15	68	
	5	30	185	46	60	1	10	26	3
	6	30	184	134	79	1	3	16	0
	7	24	249	50	26	0	54	20	0
	8	29	212	41	57	0	3	39	1
	9	25	81	26	43	0	6	51	1
	10	13	64	9	16	1	11	71	1
	11	9	20	82	1	2		97	
	12	24	274	32	5	1	35	55	4
	13	34	439	92	2	14	5	78	1
	14	15	54	6	1	0	1	97	
	15	19	102	88	80	11	3	5	1
	16	30	685	153	28	44	4	25	0
02-Nov-12	1	18	201	86	76	0	2	22	
	2	17	224	52	57	0	2	40	0
	3	24	147	109	86		2	11	1
	4	22	285	51	54	0	21	24	1
	5	30	259	137	78		4	17	1
	6	31	249	139	74	0	5	19	1
	7	30	662	182	25	1	25	49	0
	8	24	348	93	79	4	3	12	1
	9	32	219	155	8	0	1	91	0
	10	19	60	21	12	2	10	74	2
	11	8	14	20		0	10	90	
	12	33	530	29	26	16	15	43	1
	13	32	467	186	4	7	3	87	0
	14	16	68	6	23		4	72	
	15	23	200	108	86	0	4	10	1
	16	33	1316	334	4	23	1	73	0
03-May-13	1	18	233	128	75	0	1	24	
	2	18	165	118	83	0	2	15	0
	3	23	110	16	32		19	46	3
	4	23	302	62	59	0	12	28	1
	5	18	540	237	93	0	1	5	0
	6	30	257	104	71	2	10	16	1
	7	19	428	181	16	0	54	30	
	8	24	286	225	93	0	0	6	0
	9	14	35	19	29	0	5	66	
	10	10	17	6	71	1	5	24	
	11	7	22	26	19	0	0	80	
	12	20	186	37	45	0	34	20	1
	13	28	327	114	4	8	4	83	0
	14	10	59	4	0	0	1	99	
	15	20	183	124	88		1	10	1
	16	31	1155	347	7	14	2	77	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
14-Jun-13	1	18	214	103	60		4	36	0
	2	18	289	238	92	0	2	6	0
	3	14	181	89	71	0	0	29	
	4	22	385	70	32	0	22	45	
	5	21	342	181	89	0	1	10	0
	6	30	229	116	81	0	5	13	1
	7	28	370	97	32	0	36	31	0
	8	24	263	89	81	0	3	15	1
	9	12	106	8	3	0	19	77	
	10	10	28	8		0	31	69	
	11	6	7	8			2	98	
	12	22	409	35	15	10	48	27	0
	13	23	468	145	2	2	1	94	0
	14	9	56	4	11	0	1	88	
	15	16	167	81	84	0	6	10	0
	16	34	816	294	47	24	1	28	0
20-Sep-13	1	21	206	90	80	0	2	18	
	2	18	129	55	81		2	17	0
	3	19	132	16	28		14	49	9
	4	22	240	24	13	1	14	72	
	5	26	324	90	68	1	7	22	3
	6	31	259	126	64	2	10	23	2
	7	28	282	95	13	2	56	28	1
	8	27	184	65	80	0	3	16	1
	9	17	266	1619	0	0	0	100	0
	10	16	46	12	1	0	11	87	1
	11	15	38	9	1	1	60	37	0
	12	31	804	372	8	3	11	78	0
	13	41	432	121	36	7	3	54	0
	14	16	154	31	56		0	43	
	15	32	259	131	83	2	4	10	1
	16	36	1554	413	46	31	1	22	0
18-Dec-13	1	22	231	115	84	0	1	14	0
	2	23	261	281	93		0	6	1
	3	26	167	64	71	0	1	25	2
	4	21	251	135	63	0	14	23	0
	5	20	165	39	66		9	23	1
	6	31	281	109	76	5	7	11	1
	7	21	337	102	16	0	51	31	2
	8	24	163	37	64	0	5	30	1
	9	23	79	13	27	3	8	54	8
	10	17	73	19	18	3	7	70	1
	11	16	76	31	24	12	17	46	0
	12	35	375	27	21	3	20	55	0
	13	37	336	107	8	1	3	88	0
	14	14	64	10	41	0	1	58	
	15	23	233	163	75	19	2	4	1
	16	36	1004	296	13	16	2	69	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g) Herb.	Plankt.	Omni	Carni	CF
08-May-14	1	15	94	22	60	0	0	39	1
	2	20	120	25	37	0	10	48	5
	3	14	115	14	38	0	35	24	3
	4	19	155	71	60	0	6	34	0
	5	29	265	101	83	0	5	11	2
	6	31	211	150	89	3	4	3	1
	7	17	364	100	48		21	30	0
	8	27	287	153	68	0	1	31	0
	9	17	99	10	42	1	11	44	2
	10	13	32	8	7	0	16	75	1
	11	6	17	31	46		15	38	
	12	27	190	27	25	2	15	58	0
	13	25	529	109	37	9	1	53	0
	14	7	16	1	47			53	
	15	21	201	190	95		2	3	
	16	37	1339	346	12	37	4	47	0
06-Jun-14	1	17	155	111	71	0	0	29	0
	2	14	151	64	77		2	17	3
	3	14	73	64	65		3	32	0
	4	21	220	95	74	0	8	18	
	5	25	266	84	81		3	14	2
	6	27	269	135	87	1	2	8	2
	7	28	445	149	14	0	64	21	0
	8	24	220	41	57	3	3	36	1
	9	18	48	38	3	0	9	88	
	10	36	203	67	55	5	7	32	0
	11	8	17	78			9	91	
	12	25	187	40	34	12	14	32	8
	13	33	471	235	7	4	1	87	0
	14	8	11	11			0	100	
	15	22	152	102	88	0	4	7	0
	16	33	983	253	17	54	6	23	0
26-Sep-14	1	20	482	336	88	0	0	12	0
	2	21	292	95	83	0	3	13	0
	3	21	210	26	28	0	42	29	1
	4	33	409	167	71	0	5	23	1
	5	31	359	107	69	1	11	17	1
	6	26	371	212	87	1	8	5	0
	7	30	816	150	31	1	36	32	0
	8	27	214	18	27	1	13	58	1
	9	17	77	8	37	0	8	53	2
	10	26	152	20	6	1	5	88	0
	11	20	77	26	5	1	1	92	0
	12	35	635	48	4	4	31	61	0
	13	39	485	130	68	2	1	29	1
	14	14	148	12	43		2	54	1
	15	28	284	148	82		7	11	0
	16	36	1285	215	18	21	2	59	0

TABLE 2. Continued

					% Total Biomass (g)				
Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	Herb.	Plankt.	Omni	Carni	CF
27-Feb-15	1	18	264	153	79	0	0	21	
	2	23	360	182	87	0	2	10	1
	3	32	343	128	74	11	6	7	1
	4	28	439	175	82	0	2	16	0
	5	25	336	121	28	1	4	66	1
	6	26	260	104	77		6	17	1
	7	31	1049	215	46		29	25	0
	8	21	194	64	87	0	4	8	0
	9	10	26	8	37	0	5	57	1
	10	4	11	3			1	99	
	11	4	7	3			5	85	10
	12	19	120	33	20	18	3	59	0
	13	31	605	471	1	1	0	97	1
	14	12	59	8	44		6	50	
	15	17	197	133	93		3	4	1
	16	34	1595	386	28	29	5	38	0
06-Apr-15	1	19	400	231	89		0	11	
	2	20	278	160	89	0	2	8	1
	3	24	283	93	44	0	9	46	1
	4	37	310	142	80	0	10	8	1
	5	31	275	59	52	1	20	22	4
	6	29	381	96	58	4	16	17	6
	7	20	677	229	17		62	21	0
	8	27	146	31	18	0	10	66	6
	9	17	81	11	58	1		40	1
	10	19	47	16	67	2		31	1
	11	3	5	5			2	98	
	12	22	137	16	38	13	18	30	1
	13	26	612	313	5	1	1	93	0
	14	15	85	15	52			43	5
	15	23	174	53	73	0	11	15	1
	16	43	1246	254	24	19	2	55	0
18-Jun-15	1	19	277	129	83	0	1	16	
	2	16	249	92	84	0	2	14	0
	3	20	160	18	36	0	34	28	2
	4	19	386	248	90	0	3	7	0
	5	29	284	68	28	2	12	56	2
	6	28	190	72	63	1	13	19	4
	7	28	587	123	22	5	49	23	0
	8	25	183	39	66	7	5	21	2
	9	21	121	34	66	1	4	29	0
	10	11	43	21	62	21		16	1
	11	7	15	20	55	2	23	20	
	12	25	179	68	17	1	8	74	0
	13	25	901	600	1	3	0	96	0
	14	13	73	9	81	0		19	
	15	21	235	95	16	5	5	73	1
	16	29	1435	506	1	11	3	86	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
21-Oct-15	1	Not sampled							
	2	Not sampled							
	3	Not sampled							
	4	Not sampled							
	5	37	1734	1196	29	0	1	69	0
	6	30	379	112	77		5	17	1
	7	24	348	159	49		30	20	1
	8	27	348	74	72	2	4	20	2
	9	19	106	26	60	1	7	32	1
	10	17	45	26	45	0	4	52	
	11	8	22	16		0	20	76	4
	12	29	546	58	20	10	14	57	0
	13	26	457	161	6	4	15	75	0
	14	14	197	60	87	0	0	11	1
	15	31	316	280	68	1	0	30	0
	16	35	978	559	7	8	3	81	0
08-Apr-16	1	21	245	107	83		1	15	1
	2	25	262	291	93	0	1	5	1
	3	20	236	157	88	0	1	11	0
	4	24	370	145	74	6	4	15	0
	5	22	678	517	12	1	1	85	0
	6	22	158	45	54		13	29	4
	7	21	398	87	45		30	21	3
	8	20	410	97	86	2	1	11	0
	9	18	127	132	7	0	0	93	0
	10	14	43	22	64	2	7	27	
	11	6	10	6		0	3	97	
	12	23	651	29	15	3	48	32	1
	13	27	406	146	10	5	3	82	0
	14	15	95	43	94	0		6	
	15	21	185	151	93		0	6	0
	16	25	1039	281	36	21	13	31	0
15-Apr-16	1	21	155	171	94	0	0	5	1
	2	27	369	395	91	0	1	7	0
	3	26	209	256	89		3	7	0
	4	29	253	180	85	2	2	10	0
	5	25	1162	969	8		1	91	0
	6	20	188	48	35		42	20	3
	7	30	365	70	29	0	20	50	1
	8	26	344	62	75	0	3	19	2
	9	12	53	10	57	0	7	35	1
	10	17	57	84	16		1	83	0
	11	4	6	16	66			34	
	12	29	225	43	14	15	35	36	0
	13	34	661	400	11	2	2	85	0
	14	8	34	2	23	0		73	3
	15	21	123	80	87		5	6	2
	16	31	1722	719	3	14	1	83	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
05-Jul-16	1	27	370	379	87	0	0	13	0
	2	14	171	167	88		0	11	1
	3	16	123	32	42		2	52	4
	4	20	269	190	62	9	17	11	1
	5	24	921	385	6		3	90	1
	6	22	251	173	92		4	3	1
	7	19	334	71	37	0	33	28	2
	8	27	273	34	51	4	5	38	2
	9	18	120	11	40	2		56	1
	10	7	35	6	14	1		86	
	11	2	3	7				100	
	12	24	584	19	21	4	38	36	1
	13	29	354	90	23	3	8	65	1
	14	11	65	51	94			6	0
	15	29	292	319	54	0	4	41	0
	16	38	1543	802	5	13	2	79	1
18-Aug-16	1	23	302	334	93	0	0	7	0
	2	19	219	37	46	0	0	48	5
	3	21	178	102	60	0	3	36	1
	4	20	139	26	48		6	42	4
	5	22	486	210	15		5	79	1
	6	22	337	245	90	1	4	4	1
	7	26	289	81	29		40	28	2
	8	27	352	62	72	0	2	25	0
	9	18	233	79	11	0	1	88	0
	10	14	50	9	47	1	7	44	1
	11	2	3	4				100	
	12	26	815	41	12	3	26	59	0
	13	26	363	138	11	3	2	84	0
	14	10	86	8	13	1		78	8
	15	23	164	160	83	0	2	15	0
	16	39	1552	797	5	6	2	87	0
15-Mar-17	1	23	215	134	89	0	1	10	0
	2	24	461	243	96	0	0	2	1
	3	26	225	118	75	0	7	17	1
	4	20	309	197	88	0	8	4	0
	5	19	424	137	11	0	1	88	0
	6	23	168	141	66	0	2	31	0
	7	21	525	159	30	1	22	46	0
	8	28	206	27	65	2	9	22	2
	9	21	97	12	14	4		81	1
	10	11	43	19	65	0		35	
	11	4	6	4			6	94	
	12	28	235	24	43	3	13	40	1
	13	25	306	122	11	4	11	74	1
	14	13	86	6	27	1	0	72	
	15	29	235	213	52	0	1	47	0
	16	29	1204	810	2	6	0	92	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g) Herb.	Plankt.	Omni	Carni	CF
18-May-17	1	19	327	201	79	0	4	16	0
	2	22	385	108	82	0	2	15	1
	3	25	228	117	76	0	9	14	0
	4	19	298	69	67	0	7	26	
	5	25	837	250	22	0	2	75	0
	6	19	242	198	91		2	7	1
	7	20	352	103	23		27	50	1
	8	22	424	120	70	5	1	24	0
	9	16	133	44	27	1		71	0
	10	15	71	18	41	1	0	57	0
	11	3	5	14	27		1	72	
	12	13	125	12	33	1	39	27	0
	13	26	724	248	5	3	6	86	0
	14	12	57	6	22	0		78	
	15	22	215	214	94	0	1	4	1
	16	39	985	1010	34	1	1	64	0
02-Jun-17	1	26	400	222	90	0	1	9	0
	2	20	225	145	77	0	1	21	1
	3	20	163	30	34	0	11	54	1
	4	20	421	150	70	0	19	10	0
	5	21	817	410	16	0	3	80	0
	6	24	201	50	57	0	21	20	2
	7	17	534	180	29		32	39	1
	8	18	189	32	53	0	5	41	0
	9	13	36	10	35	0	0	65	
	10	16	39	19	68	1	0	30	1
	11	5	6	9	12		2	86	
	12	24	284	29	23	31	24	20	1
	13	27	554	216	7	3	9	82	0
	14	5	31	6	37			63	
	15	21	138	69	66		9	24	1
	16	32	1635	703	18	7	2	72	0
29-Aug-17	1	28	288	209	94	0	1	4	0
	2	21	166	78	74	0	0	24	2
	3	26	275	81	73	0	8	18	1
	4	20	902	196	80	1	8	11	0
	5	22	388	128	24	6	5	65	0
	6	30	206	112	72	1	6	20	2
	7	17	584	165	35		30	35	0
	8	29	242	33	39	2	13	43	3
	9	17	72	14	22	0		78	
	10	18	70	31	60		1	38	
	11	6	8	22	26		2	71	
	12	30	555	39	14	1	16	68	1
	13	27	1171	258	7	3	3	86	0
	14	12	89	2	24	4	7	66	
	15	19	160	179	85		0	14	0
	16	33	1313	650	54	4	0	42	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g) Herb.	Plankt.	Omni	Carni	CF
21-Dec-17	1	17	319	241	95	0	0	5	
	2	21	536	183	87	0	0	13	0
	3	20	182	124	86	0	2	10	1
	4	23	357	90	78	0	9	12	0
	5	20	221	44	47		6	43	4
	6	34	314	233	67	2	6	23	2
	7	22	769	330	14		8	77	0
	8	24	233	22	46	1	13	39	1
	9	15	279	344	2	0		98	0
	10	12	56	26	22	0	0	77	
	11	9	34	88	20	0	5	74	
	12	26	374	22	30	2	5	62	1
	13	31	931	389	4	3	2	90	0
	14	11	47	4			42	54	4
	15	25	184	158	77	0	2	20	1
	16	29	1455	1042	1	8	0	91	0
11-May-18	1	17	250	134	91	0	2	7	
	2	12	94	85	75	0	0	25	
	3	22	192	20	34	0	22	40	5
	4	17	328	121	75	0	3	22	
	5	19	272	97	70		7	20	3
	6	20	132	42	69	2	11	15	2
	7	24	485	184	14	0	19	66	0
	8	19	165	30	55	5	3	37	
	9	8	51	14	72	0		28	
	10	19	73	32	60	0	8	32	0
	11	3	5	19			9	91	
	12	24	105	20	37	0	25	37	1
	13	20	229	49	18	49	9	25	
	14	10	50	1	32	3	3	50	12
	15	25	105	208	44		2	54	0
	16	35	2008	1635	5	6	0	89	0
26-Jun-18	1	13	271	262	91	0		9	0
	2	13	105	93	89	0	0	10	1
	3	13	132	18	35	0	19	40	6
	4	15	239	66	69	0	7	23	
	5	13	129	40	48		0	50	1
	6	21	209	115	91		2	6	1
	7	21	454	122	25	0	49	26	
	8	16	191	31	48	16		36	
	9	13	41	11	57	0	0	43	
	10	16	89	29	7	0	0	93	0
	11	4	9	8	80			16	4
	12	22	199	17	12	1	58	28	0
	13	23	368	156	11	3	4	82	0
	14	14	68	3	17	1		82	
	15	19	170	130	82		1	17	
	16	33	1572	824	4	11	1	84	0

TABLE 2. Continued

Sample Date	Transect No.	No. Species	No. Individuals	Biomass g/m2	% Total Biomass (g)				
					Herb.	Plankt.	Omni	Carni	CF
19-Nov-18	1	22	366	356	95	0	0	4	0
	2	22	320	209	94	0	0	5	1
	3	17	230	547	97		0	2	0
	4	16	369	65	81	0	9	10	
	5	26	330	168	48	1	9	41	1
	6	29	324	218	60	1	11	18	11
	7	17	446	118	15	1	30	53	1
	8	15	338	22	58	1	6	34	0
	9	17	350	253	0	0	0	99	
	10	9	120	78	38	0		62	
	11	4	6	5	7		54	39	
	12	16	659	11	29	8	17	43	3
	13	25	704	413	16	1	0	83	
	14	12	86	23	87	0	0	12	
	15	20	227	233	89	4	4	3	1
	16	30	1311	890	2	5	1	92	0
10-Jan-19	1	24	365	213	85	0	0	14	0
	2	17	278	262	96	0		3	1
	3	19	190	41	60		5	31	3
	4	20	233	178	90	0	2	8	
	5	22	209	52	58	19	8	13	1
	6	23	134	44	61	0	27	10	2
	7	31	619	148	22	1	18	57	2
	8	21	177	23	51	0	15	33	1
	9	22	105	20	28	1	8	62	1
	10	9	68	60	52		1	46	0
	11	4	32	52			1	99	
	12	26	559	15	12	5	15	68	0
	13	25	477	202	13	11	2	74	0
	14	8	36	4	2	0	0	97	
	15	21	126	59	82		3	14	1
	16	22	1850	972	3	13	1	84	0

TABLE 3. Results of the Kruskal-Wallis ANOVA and the Student-Neuman-Keuls (SNK) Test addressing the question , "Are there any statistically significant differences among the mean number of fish species seen per transect, mean number of individual fish censused per transect or the mean estimated total standing crop (in g/m2) per transect for the 15 natural substrate stations among the forty-four 2007-2018 sample periods?" The Kruskal-Wallis result is given as a "p" value at the top of the entry where (p<0.05 or less for significance). The SNK Test is used to separate means that are significantly different from one another. In the body of the table are given the sample date and mean for a given parameter on that date. Letters are used to show differences with the SNK Test; letters with the same designation show means and sample dates that are related and changes in letter designation show where significant differences exist. Overlaps in letters indicate a lack of significant differences and in such cases, only the extremes may be significantly different. Bolded dates represent 2018 quarterly survey periods. Dates preceeded with a "b" refer to Table 2.

1. Mean Number of Fish Species Per Transect (p>0.02, Significant)

Date	[n]	Mean	SNK Grouping
Sep-14	15	25.9	A
Jul-09	15	25.5	A
Aug-10	15	24.9	A
Aug-08	15	24.7	A
Oct-10	15	24.6	A
Nov-11	15	24.5	A
Sep-13	15	24.0	A
Nov-08	15	23.9	A
Nov-12	15	23.9	A
Oct-15	11	23.8	A
Jul-11	15	23.5	A
Dec-13	15	23.5	A
May-10	15	23.0	A
Dec-07	12	22.8	A
Mar-10	15	22.7	A
May-08	15	22.6	A
May-12	15	22.3	A
Jul-12	15	22.2	A
Jun-11	15	22.0	A
bApr-16	15	21.9	A
Apr-15	15	21.6	A
Aug-17	15	21.5	A
Jun-14	15	21.3	A
Mar-17	15	21.0	A
Mar-09	15	20.9	A
May-09	15	20.9	A
Dec-17	15	20.7	A
Jun-15	15	20.3	A
Apr-08	15	20.3	A
Feb-15	15	20.1	A
Aug-16	15	19.9	A
Apr-16	15	19.9	A
Jan-19	**15**	**19.5**	**A**
Jul-16	15	19.3	A
May-14	15	19.2	A
bMay-12	15	19.0	A
May-13	15	18.8	A
May-17	15	18.5	A
Jun-17	15	18.5	A
Jun-13	15	18.2	A
Nov-18	**15**	**17.8**	**A**
Feb-11	15	17.7	A
May-18	**15**	**17.3**	**A**
Jun-18	**15**	**15.7**	**A**

Interpretation: The Kruskall-Wallis ANOVA noted a statistically significant difference in the mean number of fish species per transect but the SNK Test failed to do so thus there are no significant differences.

TABLE 3. Continued.

2. Mean Number of Individual Fish Per Transect (p>0.69. n.s.)

YEAR	[n]	Mean	SNK Grouping
Oct-15	11	409	A
Jul-09	15	355	A
Aug-17	15	345	A
Sep-14	15	334	A
Nov-18	**15**	**325**	**A**
Dec-17	15	322	A
Nov-11	15	313	A
May-17	15	295	A
Apr-16	15	285	A
Feb-15	15	285	A
bApr-16	15	280	A
Jul-16	15	278	A
Jun-11	15	275	A
Jul-11	15	274	A
Aug-08	15	270	A
Jun-17	15	269	A
Aug-16	15	268	A
Nov-08	15	265	A
Nov-12	15	262	A
Oct-10	15	260	A
Apr-15	15	259	A
Jun-15	15	259	A
Apr-08	15	255	A
Sep-13	15	250	A
Aug-10	15	246	A
Dec-07	15	285	A
Jan-19	**15**	**241**	**A**
Mar-17	15	236	A
Jun-13	15	234	A
May-10	15	227	A
May-09	15	224	A
May-08	15	222	A
Mar-10	15	213	A
May-13	15	210	A
Dec-13	15	206	A
Mar-09	15	195	A
Jun-14	15	193	A
May-12	15	190	A
Jul-12	15	186	A
May-14	15	180	A
Jun-18	**15**	**178**	**A**
Feb-11	15	177	A
bMay-12	15	171	A
May-18	**15**	**169**	**A**

Interpretation: There are no significant differences among the mean number of individual fish found per transect over the forty-four sample periods.

3. Mean Standing Crop of Fish in g/m2 Per Transect (p>0.66, n.s.)

YEAR	[n]	Mean	SNK Grouping
Sep-13	15	190	A
bApr-16	15	186	A
Nov-18	**15**	**181**	**A**
Dec-17	15	153	A
Dec-07	15	137	A
Apr-16	15	132	A
Jul-16	15	129	A
Nov-11	15	123	A
Feb-15	15	120	A
Oct-10	12	118	A
May-17	15	115	A
Jun-15	15	109	A
Oct-15	11	106	A
Jun-17	15	105	A
Mar-17	15	104	A
Aug-17	15	103	A
Aug-16	15	103	A
Sep-14	15	100	A
Jul-11	15	100	A
Apr-15	15	98	A
Jul-09	15	98	A
May-13	15	93	A
Nov-12	15	92	A
Jan-19	**15**	**92**	**A**
Jun-14	15	88	A
Jun-13	15	85	A
Jun-11	15	84	A
May-10	15	84	A
Dec-13	15	83	A
Aug-10	15	83	A
Apr-08	15	80	A
Jun-18	**15**	**74**	**A**
Nov-08	15	72	A
May-12	15	72	A
May-18	**15**	**70**	**A**
May-09	15	70	A
May-14	15	68	A
Jul-12	15	62	A
Mar-10	15	59	A
Mar-09	15	59	A
Aug-08	15	57	A
May-08	15	54	A
Feb-11	15	48	A
bMay-12	15	48	A

Interpretation: Despite the range in the estimated total standing crop per station over the forty-four sample dates, there are no significant differences.

TABLE 4. Percent contribution based on estimated biomass for each of five feeding guilds of fishes as determined across all fifteen natural substratum stations over forty-four survey dates in Part A. In Part B is given the same information for station 16 (Kahe outfall pipe) which was sampled commencing with the 30 May 2008 survey (n=44). In the body of the table are given the percent contribution by weight for each trophic category. Note that the December 2007 survey did not sample three of the fifteen stations and October 2015 did not sample four of fifteen stations. Data summarized from Table 2.

PART A. Stations 1 - 15:

		Mean Percent by Weight				
Date	**[n]**	**Herbivore**	**Planktivore**	**Omnivore**	**Coral Feeder**	**Carnivore**
27-Dec-07	12	35	2	8	5	50
04-Apr-08	15	35	2	8	4	51
30-May-08	15	37	7	14	3	39
19-Aug-08	15	36	2	10	3	49
25-Nov-08	15	43	5	6	4	42
19-Mar-09	15	35	1	7	2	55
11-May-09	15	44	1	8	1	46
21-Jul-09	15	33	6	10	2	49
29-Mar-10	15	44	5	9	2	40
19-May-10	15	51	6	9	1	33
12-Aug-10	15	49	7	10	1	33
29-Oct-10	15	41	1	9	1	48
25-Feb-11	15	30	6	15	1	54
16-Jun-11	15	46	6	7	1	41
29-Jul-11	15	36	4	11	1	50
23-Nov-11	15	55	2	9	1	33
02-May-12	15	42	2	8	1	48
23-May-12	15	48	1	8	1	42
23-Jul-12	15	36	2	12	1	50
02-Nov-12	15	46	3	8	1	47
03-May-13	15	52	1	10	1	37
14-Jun-13	15	50	1	12	>1	43
20-Sep-13	15	41	2	13	2	44
18-Dec-13	15	50	4	10	1	36
08-May-14	15	52	1	10	1	36
06-Jun-14	15	55	3	9	2	41
26-Sep-14	15	49	1	12	1	38
27-Feb-15	15	58	4	5	1	41
06-Apr-15	15	53	2	14	2	37
18-Jun-15	15	51	3	12	1	34
21-Oct-15	11	51	2	9	1	42
08-Apr-16	15	59	2	8	1	36
15-Apr-16	15	52	2	9	1	37
05-Jul-16	15	51	3	10	1	43
18-Aug-16	15	45	1	8	2	49
15-Mar-17	15	52	1	6	1	44
18-May-17	15	51	1	8	0	41
02-Jun-17	15	45	3	10	1	43
29-Aug-17	15	49	2	7	1	43
21-Dec-17	15	48	1	7	1	47
11-May-18	15	53	5	9	3	37
26-Jun-18	15	51	2	13	1	37
19-Nov-18	15	54	1	10	2	34
10-Jan-19	15	51	3	8	1	42
	Grand Means	46.5	2.7	9.4	1.5	42.3

PART B. Stations 16 (Outfall Pipe) Only:

Mean Percent by Weight

Date	[n]	Herbivore	Planktivore	Omnivore	Coral Feeder	Carnivore
30-May-08	1	8	43	2		47
19-Aug-08	1	3	55	1		41
25-Nov-08	1	10	49	1	>1	39
19-Mar-09	1	32	34	2	>1	32
11-May-09	1	35	22	6		37
21-Jul-09	1	5	36	3		56
29-Mar-10	1	24	27	2		47
19-May-10	1	13	63	8		16
12-Aug-10	1	14	27	1		58
29-Oct-10	1	7	16	1		76
25-Feb-11	1	8	32	2	>1	59
16-Jun-11	1	17	59	6	>1	17
29-Jul-11	1	4	25	1	>1	70
23-Nov-11	1	10	19	>1	>1	70
02-May-12	1	20	40	6	>1	33
23-May-12	1	14	27	2	>1	58
23-Jul-12	1	28	44	4	>1	24
02-Nov-12	1	4	23	1	>1	73
03-May-13	1	7	15	2	>1	77
14-Jun-13	1	47	24	1	>1	28
20-Sep-13	1	46	31	>1	>1	22
18-Dec-13	1	13	16	2	>1	69
08-May-14	1	12	37	4	>1	47
06-Jun-14	1	17	54	6	>1	23
26-Sep-14	1	18	21	2	>1	59
27-Feb-15	1	28	29	5	>1	38
06-Apr-15	1	24	19	2	>1	55
18-Jun-15	1	1	11	3	>1	86
21-Oct-15	1	7	8	3	>1	81
08-Apr-16	1	36	21	13	>1	31
15-Apr-16	1	3	14	1	>1	83
05-Jul-16	1	5	13	2	>1	79
18-Aug-16	1	5	6	2	>1	87
15-Mar-17	1	2	6	>1	>1	92
18-May-17	1	34	1	1	>1	64
02-Jun-17	1	18	7	2	>1	72
29-Aug-17	1	54	4	>1	>1	42
21-Dec-17	1	1	8	>1	>1	91
11-May-18	1	5	6	>1	>1	89
26-Jun-18	1	4	11	1	>1	84
19-Nov-18	1	2	5	1	>1	92
10-Jan-19	1	3	13	>1	>1	84
	Grand Means	15.4	24.9	2.8	0.1	57.8

TABLE 5. Results of the Kruskal-Wallis ANOVA and the Student-Neuman-Keuls (SNK) Test addressing the question, "Are there any statistically significant differences among the mean number of fish species per transect, the mean number of individual fish per transect or the mean estimated standing crop (in g/m^2) per transect among the four geographic groups of stations established on natural substratum (stations 1 - 15) and sampled in the 2007-2018 period?" The four groups of transects are CIP (station nos. 1-4), Ko'Olina (station nos. 5-7), Kahe (station nos. 8-12) and North (station nos. 13-15). Note that the four CIP stations were not sampled in the October 2015 survey. The Kruskal-Wallis result is given as a "p" value at the top of the entry where ($p<0.05$ or less for significance). The SNK Test is used to separate means that are significantly different from one another. In the body of the table are given the four geographically-related groups of stations and parameter means per transect for each of those groups. Letters are used to show differences with the SNK Test; letters with the same designation show means and station groups that are related and changes in letter designation show where significant differences exist. Overlaps in the letters indicate a lack of significant differences and in such cases, only the extremes may be significantly different.

1. Mean Number of Fish Species Per Transect by Station Group (p<0.0001, Significant)

Station Group	(n)	Mean	SNK Grouping
Ko'Olina	129	26.8	A
Nanakuli	132	21.2	B
CIP	172	20.5	B C
Kahe	220	18.9	C

Interpretation: Both the Kruskal-Wallis ANOVA and the SNK Test found significant differences among station groups, where the mean number of fish species per transect at Ko'Olina stations is significantly greater than at any of the other station groups which are all related over the forty-four sample periods.

2. Mean Number of Individual Fish Per Transect by Station Group (p<0.0001, Significant)

Station Group	(n)	Mean	SNK Grouping
Ko'Olina	129	371	A
Nanakuli	132	257	B
CIP	172	238	B
Kahe	220	191	C

Interpretation: Both the Kruskal-Wallis ANOVA and the SNK Test found significant differences among station groups, where the mean number of individual fish per transect at Ko'Olina is significantly greater than at the Nanakuli and CIP stations which are significantly greater than the Kahe station group over the forty-four sample periods.

TABLE 5. Continued.

3. Mean Standing Crop of Fishes (in g/m^2) Per Transect by Station Group (p<0.0001, Significant)

Station Group	(n)	Mean	SNK Grouping
Ko'Olina	129	145	A
CIP	172	112	B
Nanakuli	132	106	B
Kahe	220	52	C

Interpretation: Both the Kruskal-Wallis ANOVA and the SNK Test found significant differences among station groups, where the mean estimated fish standing crop was significantly greater at stations offshore of Ko'Olina than at any of the other three station groups. Both the CIP and Nanakuli station groups had a statistically greater mean standing crop than was present at the Kahe group of stations.

TABLE 6. Results of the Kruskal-Wallis ANOVA and the Student-Neuman-Keuls (SNK) Test addressing the question, "Are there any statistically significant differences among the mean number of fish species per transect, the mean number of individual fish per transect or the mean estimated standing crop (in g/m2) per transect seen among the sixteen stations established and sampled over the forty-four periods in 2007-2018?" The Kruskal-Wallis result is given as a "p" value at the top of the entry (where p<0.05 or less for significance). The SNK Test is used to separate means that are significantly different from one another. In the body of the table are given the stations, the number of times each was sampled (n) and parameter means per transect for each. Letters are used to show differences with the SNK Test; letters with the same designation show means and station groups that are related and changes in letter designation show where significant differences exist. Overlaps in the letters indicate a lack of significant differences and in such cases, only the extremes may be significantly different.

1. Mean Number of Fish Species Per Station in 2007-18 (p < 0.0001, Significant)

Station Group	[n]	Mean	SNK Grouping			
16 (Pipe)	42	34	A			
13 (HECO 10C)	44	29		B		
6 (Ko'Olina 2)	43	29		B		
5 (Ko'Olina 1)	43	27		B	C	
12 (HECO 7E)	44	26			C	
8 (HECO 5B)	44	25			C	D
7 (HECO 1D)	44	24	E		C	D
4 (East 4)	42	23	E			D
3 (East 3)	43	23	E			D
15 (Nana-2)	44	22	E			
2 (East 2)	43	19		F		
9 (HECO 7B)	44	19		F		
1 (East 1)	43	18		F		
10 (HECO 7C)	44	16		F		
14 (Nana-1)	44	13			G	
11 (HECO 7D)	44	8				H

Interpretation:
The Kruskal-Wallis ANOVA noted significant differences in the mean number of fish species per transect at the sixteen stations. The SNK Test results show that the number of fish species is significantly greater on the Kahe discharge pipe relative to all other stations on natural substratum due to overlap. However, the SNK Test notes that station 1, 2, 9, 10, 11 and 14 have significantly fewer species present due to the poor development of topographical relief that provides shelter space at all stations and a shorter transect length (10.5m versus 50m) at Station 11.

TABLE 6. Continued.

2. Mean Number of Individual Fish Censused Per Station in 2007-18 (p < 0.0001, Significant)

Station Group	[n]	Mean	Grouping			
16 (Pipe)	42	1276	A			
13 (HECO 10C)	44	503		B		
7 (HECO 1D)	43	436		B	C	
5 (Ko'Olina 1)	43	413			C	
12 (HECO 7E)	44	385			C	D
4 (East 4)	43	319	E			D
8 (HECO 5B)	44	312	E			D
6 (Ko'Olina 2)	43	264	E	F		
2 (East 2)	43	236	E	F		
1 (East 1)	43	208		F	G	
3 (East 3)	43	189		F	G	
15 (Nana-2)	44	183		F	G	
9 (HECO 7B)	44	142			G	H
10 (HECO 7C)	44	88	I			H
14 (Nana-1)	44	84	I			H
11 (HECO 7D)	44	27	I			

Interpretation:
The Kruskal-Wallis ANOVA noted statistically significant differences in the mean number of individual fish censused among the 16 transects over the forty-four surveys in 2007-18. However, the SNK Test found only one clearly-obvious statistically significant station (i.e., without overlap); this was with station 16 (Kahe discharge pipe) having significantly more individual fishes present than any other station, otherwise overlap obscures further separation.

3. Mean Estimated Fish Standing Crop (g/m2) by Station in 2007-18 (p < 0.0001, Significant)

Station Group	[n]	Mean	Grouping			
16 (Pipe)	42	458	A			
13 (HECO 10C)	44	183		B		
5 (Ko'Olina 1)	43	165		B	C	
6 (Ko'Olina 2)	43	145		B	C	
1 (East 1)	43	126		B	C	D
7 (HECO 1D)	43	125		B	C	D
15 (Nana-2)	44	125		B	C	D
2 (East 2)	43	119		B	C	D
9 (HECO 7B)	44	115		B	C	D
4 (East 4)	43	107		B	C	D
3 (East 3)	43	95	E		C	D
8 (HECO 5B)	44	55	E	F		D
12 (HECO 7E)	44	39	E	F		
10 (HECO 7C)	44	28		F		
11 (HECO 7D)	44	24		F		
14 (Nana-1)	44	11		F		

Interpretation:
Only one station (Kahe Discharge) had a statistically greater estimated standing crop of fishes present than found at any of the other fifteen stations whose estimated standing crops are all statistically related due to overlap.

TABLE 7. Results of the Kruskal-Wallis ANOVA and the Student-Neuman-Keuls (SNK) Test addressing the question , "Are there any statistically significant differences among the annual mean number of fish species per transect or the annual mean number of individual fish censused per transect among seven stations sampled in common over nineteen years encompassing a 43-year period (i.e., 1976-1984 and 2007-2018 sample periods)?" The Kruskal-Wallis result is given as a "p" value at the top of the entry where ($p<0.05$ or less for significance). The SNK Test is used to separate means that are significantly different from one another. In the body of the table are given the sample date and mean for a given parameter on that date. Letters are used to show differences with the SNK Test; letters with the same designation show means and sample dates that are related and changes in letter designation show where significant differences exist. Overlaps in the letters indicate a lack of significant differences and in such cases, only the extremes may be significantly different.

1. Mean Number of Fish Species Per Transect ($p>0.58$, n.s.)

YEAR	[n]	Mean	SNK Grouping
1976	3	29.0	A
1977	3	26.0	A
1979	6	24.3	A
1978	3	24.0	A
2007	7	23.7	A
2008	7	23.6	A
1984	7	23.4	A
1980	6	23.2	A
2010	7	22.3	A
2014	7	21.6	A
2011	7	21.1	A
2012	7	21.1	A
2009	7	21.0	A
2013	7	20.6	A
1981	6	19.2	A
2015	7	19.1	A
2016	7	19.0	A
2017	7	17.7	A
1982	6	17.7	A
2018	7	16.3	A
1983	6	15.8	A

Interpretation:
There are no significant differences among the mean number of species found per transect at these seven stations among the twenty-one years of sampling. Note that the highest annual means occur before the January 1980 storm event and the lowest follow that period as well as after the November 1982 hurricane.

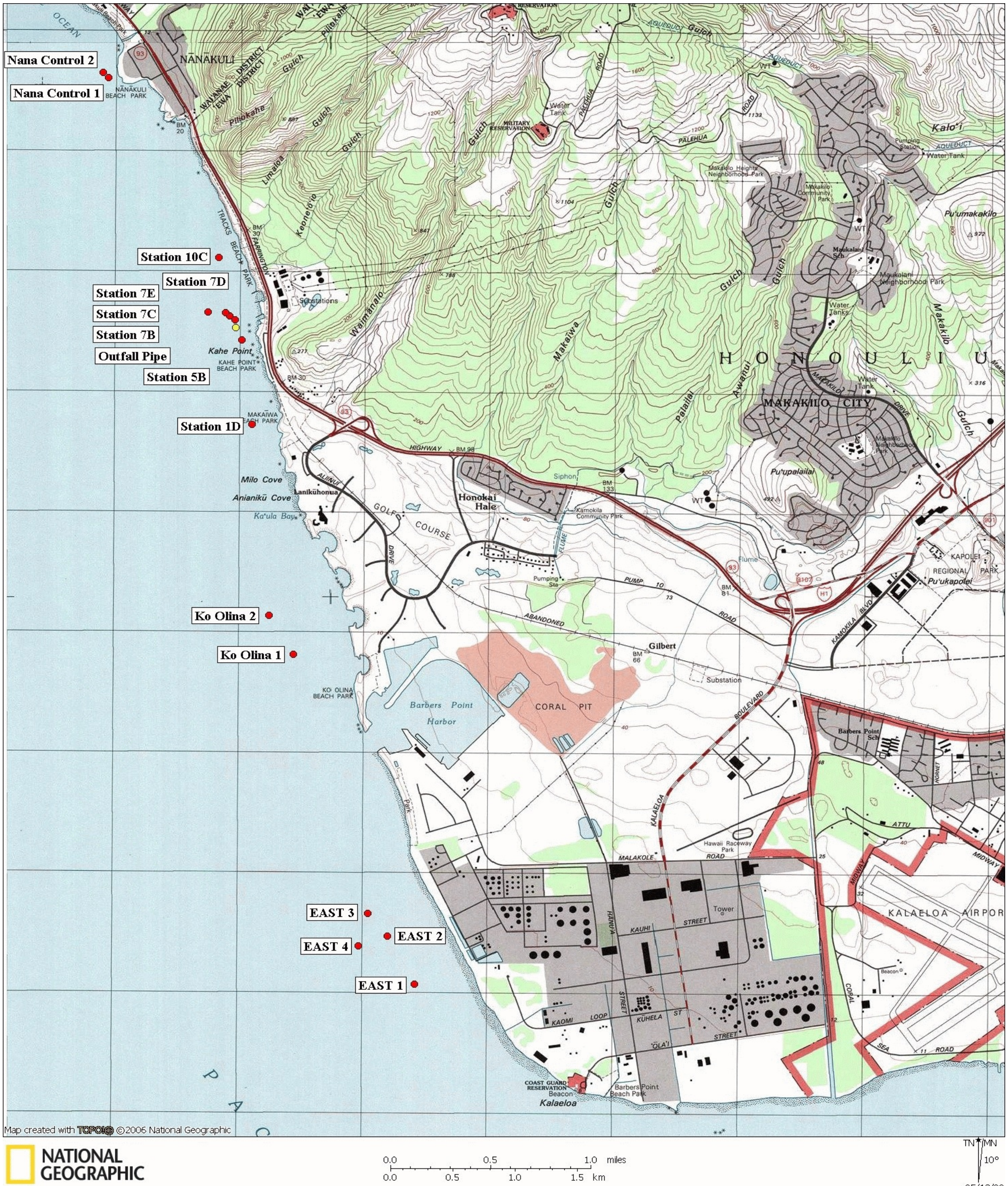
TABLE 7. Continued.

2. Mean Number of Individual Fish Per Transect (p>0.95, n.s.)

YEAR	[n]	Mean	SNK Grouping
2017	7	305.7	A
2008	7	303.1	A
2007	7	302.3	A
2011	7	276.7	A
2015	7	274.0	A
2009	7	271.7	A
2014	7	270.4	A
1980	6	250.3	A
2018	7	243.7	A
2016	7	239.6	A
2010	7	232.3	A
2013	7	224.7	A
2012	7	215.4	A
1976	3	201.7	A
1979	6	195.0	A
1981	6	173.2	A
1978	3	169.0	A
1977	3	163.0	A
1984	7	150.0	A
1982	6	141.0	A
1983	6	85.8	A

Interpretation:
There are no significant differences among the mean number of individual fish censused per transect at these seven stations among the twenty-one years of sampling. Note that the hierarchy of annual mean number of individual fish censused does not parallel that for the annual mean number of species counted at these stations. In other words, the impact of the two storm events (1980 and 1982) produced a different result with respect to the number of individual fish and the number of species counted.

FIGURE 1. Map showing the southwest coastline of Oahu from the Barbers Point Harbor on the southeast to Nanakuli Beach Park 7.9 km to the northwest. The approximate locations of each of the sixteen permanently marked stations monitored in this study are numbered. All stations except station 16 have an orientation that parallels the coastline and all are 50 m in length except for station 11 (or 7-D) which is 10.5 m in length. Station 16 is established on the terminus of the KGS ocean warm-water outfall and thus has an orientation that is perpendicular to the shoreline. Map courtesy of the Hawaiian Electric, Environmental Department.



Nana Control 2
Nana Control 1
Station 10C
Station 7D
Station 7E
Station 7C
Station 7B
Outfall Pipe
Station 5B
Station 1D
Ko Olina 2
Ko Olina 1
EAST 3
EAST 2
EAST 4
EAST 1
HONOULIU
MAKAKILO CITY
Barbers Point Harbor
CORAL PIT
KALAELOA AIRPOR
Map created with TOPO! ©2006 National Geographic
NATIONAL GEOGRAPHIC
0.0 0.5 1.0 miles
0.0 0.5 1.0 1.5 km
TN MN
10°
05/13/09

APPENDIX 1. Results of fish censuses carried out on each of four 2018 surveys conducted on 11 May (first quarter), 26 June (for the second quarter), 19 November (third quarter) and 10 January 2019 (fourth quarter). Data from the earlier surveys that comprise the first annual report are given in Brock (2009), second annual report (Brock 2010), third annual report (Brock 2011), fourth annual report (Brock 2012), fifth annual report (Brock 2013), sixth annual report (Brock 2014), seventh annual report (Brock 2015), the eighth annual report (Brock 2016) and ninth (Brock 2017). In the body of the table are given the list of fish species observed at each station, the trophic or feeding guild category for each species (where C=carnivore, H=herbivore, O=omnivore, P=planktivore and CF=coral feeder), the station number (1 through 16) as well as station name, the number of individuals of each species censused as well as the biomass (in grams) for each. Also given for each of the five trophic categories is a summary of the total number of individual fishes, the total standing crop and the percent of the total standing crop for each trophic category. Note that the total standing crop is given in grams and the area censused at each station is 200 m^2 except for station 11 (previous Hawaiian Electric Station 7-D) which the census area is 10.5 m long and 4 m wide or 42 m^2. Biomass estimates for each species are based on species-specific regression coefficients using linear regression techniques (Ricker 1975, Brock and Norris 1989).

11 MAY 2018 FIELD DATA

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Thalassoma duperrey	1	EAST1	12	328.69			
C	Thalassoma duperrey	1	EAST1	3	291.16			
C	Thalassoma duperrey	1	EAST1	9	494.54			
C	Thalassoma duperrey	1	EAST1	15	167.45			
C	Halichoeres ornatissimus	1	EAST1	1	16.45			
C	Rhinecanthus rectangulus	1	EAST1	4	343.49			
C	Rhinecanthus rectangulus	1	EAST1	1	45.36			
C	Sufflamen fraenatus	1	EAST1	1	224.79	46	1911.93	7.1
H	Scarus sordidus	1	EAST1	1	76.01			
H	Acanthurus triostegus	1	EAST1	14	648.41			
H	Acanthurus triostegus	1	EAST1	15	1500.21			
H	Acanthurus nigrofuscus	1	EAST1	43	1027.57			
H	Acanthurus nigrofuscus	1	EAST1	16	868.04			
H	Acanthurus nigroris	1	EAST1	6	4433.02			
H	Acanthurus olivaceus	1	EAST1	7	3942.19			
H	Acanthurus olivaceus	1	EAST1	4	1572.84			
H	Acanthurus olivaceus	1	EAST1	5	817.58			
H	Acanthurus blochii	1	EAST1	5	3919.05			
H	Acanthurus blochii	1	EAST1	3	3733.99			
H	Ctenochaetus strigosus	1	EAST1	5	329.32			
H	Ctenochaetus strigosus	1	EAST1	15	402.66			
H	Naso lituratus	1	EAST1	1	448.94			
H	Naso unicornis	1	EAST1	1	525.26			
H	Naso unicornis	1	EAST1	1	190.74	142	24435.85	91.2
O	Melichthys vidua	1	EAST1	2	398.06			
O	Canthigaster jactator	1	EAST1	5	37.95	7	436.01	1.6
P	Chromis vanderbilti	1	EAST1	55	17.37	55	17.37	0.1
	TOTAL	1	EAST1	250	26801.17	250	26801.17	100
C	Gymnothorax flavimarginatus	2	EAST2	1	2721.55			
C	Paracirrhites arcatus	2	EAST2	2	32.70			
C	Pseudocheilinus octotaenia	2	EAST2	1	14.41			
C	Thalassoma duperrey	2	EAST2	10	549.49			
C	Thalassoma duperrey	2	EAST2	7	78.14			
C	Thalassoma duperrey	2	EAST2	5	136.95			
C	Thalassoma duperrey	2	EAST2	3	291.16			
C	Rhinecanthus rectangulus	2	EAST2	5	429.37	34	4253.77	25.0
H	Acanthurus triostegus	2	EAST2	17	1700.24			
H	Acanthurus leucopareius	2	EAST2	3	698.03			
H	Acanthurus leucopareius	2	EAST2	2	265.40			
H	Acanthurus olivaceus	2	EAST2	13	7321.21			
H	Acanthurus olivaceus	2	EAST2	3	785.00			
H	Acanthurus blochii	2	EAST2	4	928.96			
H	Acanthurus blochii	2	EAST2	2	907.19			
H	Zebrasoma flavescens	2	EAST2	3	159.84	47	12765.87	74.9
O	Canthigaster jactator	2	EAST2	2	7.12			
O	Canthigaster jactator	2	EAST2	2	15.18	4	22.31	0.1
P	Chromis vanderbilti	2	EAST2	9	2.84	9	2.84	0.02
	TOTAL	2	EAST2	94	17044.79	94	17044.79	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus multifasciatus	3	EAST3	1	54.40			
C	Parupeneus bifasciatus	3	EAST3	1	59.77			
C	Plectroglyphidodon johnstonianı	3	EAST3	2	14.78			
C	Paracirrhites arcatus	3	EAST3	1	16.35			
C	Thalassoma duperrey	3	EAST3	10	111.63			
C	Thalassoma duperrey	3	EAST3	7	191.73			
C	Thalassoma duperrey	3	EAST3	8	439.59			
C	Gomphosus varius	3	EAST3	2	45.20			
C	Coris gaimard	3	EAST3	1	45.99			
C	Stethojulis balteata	3	EAST3	3	217.17			
C	Macropharyngodon geoffroy	3	EAST3	1	5.75			
C	Macropharyngodon geoffroy	3	EAST3	1	42.90			
C	Halichoeres ornatissimus	3	EAST3	1	25.14			
C	Halichoeres ornatissimus	3	EAST3	3	49.35			
C	Sufflamen bursa	3	EAST3	3	257.62	45	1577.38	39.6
CF	Chaetodon ornatissimus	3	EAST3	2	138.00			
CF	Chaetodon quadrimaculatus	3	EAST3	1	7.03			
CF	Chaetodon multicinctus	3	EAST3	2	13.31			
CF	Chaetodon multicinctus	3	EAST3	2	26.06	7	184.40	4.6
H	Acanthurus nigrofuscus	3	EAST3	33	788.60			
H	Acanthurus nigrofuscus	3	EAST3	28	210.69			
H	Ctenochaetus strigosus	3	EAST3	9	241.60			
H	Ctenochaetus strigosus	3	EAST3	13	98.49	83	1339.37	33.6
O	Stegastes fasciolatus	3	EAST3	6	155.88			
O	Melichthys niger	3	EAST3	2	326.67			
O	Melichthys vidua	3	EAST3	1	296.24			
O	Cantherhines sandwichiensis	3	EAST3	1	82.05			
O	Canthigaster jactator	3	EAST3	2	7.12	12	867.97	21.8
P	Chromis vanderbilti	3	EAST3	45	14.22	45	14.22	0.4
	TOTAL	3	EAST3	192	3983.34	192	3983.34	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Gymnothorax meleagris	4	EAST4	1	44.70			
C	Parupeneus multifasciatus	4	EAST4	2	54.23			
C	Parupeneus multifasciatus	4	EAST4	4	621.69			
C	Paracirrhites arcatus	4	EAST4	1	16.35			
C	Paracirrhites arcatus	4	EAST4	1	8.12			
C	Bodianus bilunulatus	4	EAST4	1	648.58			
C	Thalassoma duperrey	4	EAST4	21	575.20			
C	Thalassoma duperrey	4	EAST4	11	1067.57			
C	Thalassoma duperrey	4	EAST4	9	100.47			
C	Thalassoma duperrey	4	EAST4	23	1263.82			
C	Pseudojuloides cerasinus	4	EAST4	3	33.49			
C	Macropharyngodon geoffroy	4	EAST4	5	93.14			
C	Macropharyngodon geoffroy	4	EAST4	4	22.99			
C	Zanclus cornutus	4	EAST4	1	104.16			
C	Rhinecanthus rectangulus	4	EAST4	2	171.75			
C	Sufflamen fraenatus	4	EAST4	1	461.25	90	5287.52	21.9
H	Acanthurus nigrofuscus	4	EAST4	41	979.78			
H	Acanthurus nigrofuscus	4	EAST4	7	52.67			
H	Acanthurus olivaceus	4	EAST4	4	654.07			
H	Acanthurus olivaceus	4	EAST4	28	15768.77			
H	Naso lituratus	4	EAST4	1	448.94			
H	Naso lituratus	4	EAST4	1	72.58			
H	Naso lituratus	4	EAST4	1	205.99	83	18182.80	75.3
O	Melichthys niger	4	EAST4	2	326.67			
O	Melichthys vidua	4	EAST4	1	296.24			
O	Canthigaster jactator	4	EAST4	2	15.18	5	638.09	2.6
P	Chromis vanderbilti	4	EAST4	150	47.38	150	47.38	0.2
	TOTAL	4	EAST4	328	24155.79	328	24155.79	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Monotaxis grandoculis	5	KO1	2	955.06			
C	Monotaxis grandoculis	5	KO1	4	848.25			
C	Monotaxis grandoculis	5	KO1	3	386.68			
C	Plectroglyphidodon johnstonianı	5	KO1	3	22.18			
C	Labroides phthirophagus	5	KO1	1	1.49			
C	Thalassoma duperrey	5	KO1	9	494.54			
C	Thalassoma duperrey	5	KO1	12	328.69			
C	Thalassoma duperrey	5	KO1	2	194.10			
C	Gomphosus varius	5	KO1	3	67.80			
C	Coris gaimard	5	KO1	1	45.99			
C	Sufflamen bursa	5	KO1	2	171.75			
C	Arothron meleagris	5	KO1	1	387.13	43	3903.65	20.2
CF	Chaetodon ornatissimus	5	KO1	2	273.78			
CF	Chaetodon multicinctus	5	KO1	6	78.18			
CF	Cantherhines dumerili	5	KO1	1	301.33	9	653.29	3.4
H	Scarus sordidus	5	KO1	1	76.01			
H	Acanthurus leucopareius	5	KO1	2	265.40			
H	Acanthurus nigrofuscus	5	KO1	28	669.12			
H	Acanthurus nigrofuscus	5	KO1	23	173.07			
H	Acanthurus olivaceus	5	KO1	45	4219.60			
H	Acanthurus olivaceus	5	KO1	6	1570.00			
H	Ctenochaetus strigosus	5	KO1	27	724.79			
H	Ctenochaetus strigosus	5	KO1	49	3227.38			
H	Ctenochaetus strigosus	5	KO1	17	2246.27			
H	Ctenochaetus strigosus	5	KO1	7	53.03			
H	Zebrasoma flavescens	5	KO1	4	213.12	209	13437.79	69.6
O	Melichthys niger	5	KO1	8	1306.68			
O	Canthigaster jactator	5	KO1	3	10.69	11	1317.37	6.8
	TOTAL	5	KO1	272	19312.10	272	19312.10	100
C	Parupeneus multifasciatus	6	KO2	1	27.12			
C	Plectroglyphidodon johnstonianı	6	KO2	2	14.78			
C	Paracirrhites arcatus	6	KO2	1	8.12			
C	Labroides phthirophagus	6	KO2	1	1.49			
C	Thalassoma duperrey	6	KO2	5	136.95			
C	Thalassoma duperrey	6	KO2	6	66.98			
C	Thalassoma duperrey	6	KO2	2	194.10			
C	Thalassoma duperrey	6	KO2	8	439.59			
C	Gomphosus varius	6	KO2	6	66.25			
C	Zanclus cornutus	6	KO2	2	208.32			
C	Sufflamen bursa	6	KO2	1	85.87	35	1249.57	15.0
CF	Chaetodon ornatissimus	6	KO2	3	207.01	3	207.01	2.5
H	Scarus psittacus	6	KO2	5	189.36			
H	Acanthurus nigrofuscus	6	KO2	2	108.50			
H	Acanthurus nigrofuscus	6	KO2	15	112.87			
H	Acanthurus nigrofuscus	6	KO2	27	645.22			
H	Acanthurus olivaceus	6	KO2	5	2815.85			
H	Acanthurus olivaceus	6	KO2	8	750.15			
H	Acanthurus dussumieri	6	KO2	1	326.59			
H	Acanthurus glaucopareius	6	KO2	1	61.53			
H	Ctenochaetus strigosus	6	KO2	7	461.05			
H	Ctenochaetus strigosus	6	KO2	4	30.30			
H	Ctenochaetus strigosus	6	KO2	5	134.22			
H	Zebrasoma flavescens	6	KO2	2	106.56	82	5742.22	68.9
O	Melichthys niger	6	KO2	4	653.34			
O	Melichthys vidua	6	KO2	1	296.24			
O	Canthigaster jactator	6	KO2	1	3.56	6	953.14	11.4
P	Abudefduf abdominalis	6	KO2	6	188.00	6	188.00	2.3
	TOTAL	6	KO2	132	8339.94	132	8339.94	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Myripristis amaenus	7	KAHE1D	5	212.02			
C	Lutjanus kasmira	7	KAHE1D	140	8029.35			
C	Mulloides flavolineatus	7	KAHE1D	35	9426.93			
C	Parupeneus multifasciatus	7	KAHE1D	1	54.40			
C	Paracirrhites forsteri	7	KAHE1D	1	39.65			
C	Cirrhitus pinnulatus	7	KAHE1D	1	90.86			
C	Labroides phthirophagus	7	KAHE1D	2	2.98			
C	Thalassoma duperrey	7	KAHE1D	42	2307.85			
C	Thalassoma duperrey	7	KAHE1D	34	3299.77			
C	Thalassoma duperrey	7	KAHE1D	6	164.34			
C	Thalassoma ballieui	7	KAHE1D	1	57.46			
C	Gomphosus varius	7	KAHE1D	3	33.12			
C	Gomphosus varius	7	KAHE1D	5	113.00			
C	Sufflamen bursa	7	KAHE1D	5	429.37	281	24261.10	66.1
CF	Chaetodon ornatissimus	7	KAHE1D	1	69.00			
CF	Chaetodon ornatissimus	7	KAHE1D	1	28.53	2	97.53	0.3
H	Calotomus carolinus	7	KAHE1D	1	131.69			
H	Calotomus carolinus	7	KAHE1D	1	34.69			
H	Scarus sordidus	7	KAHE1D	1	140.01			
H	Scarus psittacus	7	KAHE1D	5	189.36			
H	Acanthurus triostegus	7	KAHE1D	7	120.17			
H	Acanthurus leucopareius	7	KAHE1D	3	200.22			
H	Acanthurus nigrofuscus	7	KAHE1D	11	596.78			
H	Acanthurus nigrofuscus	7	KAHE1D	67	1601.10			
H	Ctenochaetus strigosus	7	KAHE1D	20	1317.30			
H	Ctenochaetus strigosus	7	KAHE1D	29	778.47	145	5109.78	13.9
O	Stegastes fasciolatus	7	KAHE1D	3	77.94			
O	Melichthys niger	7	KAHE1D	43	7023.43			
O	Canthigaster rivulata	7	KAHE1D	1	22.05	47	7123.42	19.4
P	Dascyllus albisella	7	KAHE1D	7	21.62			
P	Abudefduf abdominalis	7	KAHE1D	3	94.00	10	115.62	0.3
	TOTAL	7	KAHE1D	485	36707.45	485	36707.45	100
C	Plectroglyphidodon johnstonianı	8	KAHE5B	3	9.09			
C	Plectroglyphidodon imparipennis	8	KAHE5B	2	1.72			
C	Paracirrhites arcatus	8	KAHE5B	3	49.05			
C	Paracirrhites forsteri	8	KAHE5B	1	39.65			
C	Thalassoma duperrey	8	KAHE5B	6	18.90			
C	Thalassoma duperrey	8	KAHE5B	8	776.42			
C	Thalassoma duperrey	8	KAHE5B	10	549.49			
C	Thalassoma duperrey	8	KAHE5B	5	136.95			
C	Gomphosus varius	8	KAHE5B	1	22.60			
C	Stethojulis balteata	8	KAHE5B	1	72.39			
C	Halichoeres ornatissimus	8	KAHE5B	1	9.52			
C	Zanclus cornutus	8	KAHE5B	2	208.32			
C	Rhinecanthus rectangulus	8	KAHE5B	2	171.75			
C	Sufflamen bursa	8	KAHE5B	2	171.75	47	2237.59	36.8
H	Scarus sordidus	8	KAHE5B	1	140.01			
H	Acanthurus nigrofuscus	8	KAHE5B	9	67.72			
H	Acanthurus nigrofuscus	8	KAHE5B	24	1302.06			
H	Acanthurus nigrofuscus	8	KAHE5B	26	621.32			
H	Acanthurus olivaceus	8	KAHE5B	10	937.69			
H	Naso lituratus	8	KAHE5B	1	14.90			
H	Naso lituratus	8	KAHE5B	1	72.58			
H	Naso lituratus	8	KAHE5B	1	205.99	73	3362.27	55.4
O	Cantherhines sandwichiensis	8	KAHE5B	2	164.10			
O	Canthigaster jactator	8	KAHE5B	1	3.56	3	167.66	2.8
P	Chromis vanderbilti	8	KAHE5B	38	12.00			
P	Naso hexacanthus	8	KAHE5B	4	293.43	42	305.44	5.0
	TOTAL	8	KAHE5B	165	6072.96	165	6072.96	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus pleurostigma	9	KAHE7B	1	98.25			
C	Parupeneus multifasciatus	9	KAHE7B	4	384.33			
C	Forcipiger flavissimus	9	KAHE7B	1	9.15			
C	Thalassoma duperrey	9	KAHE7B	1	27.39			
C	Sufflamen bursa	9	KAHE7B	3	257.62	10	776.73	27.8
H	Acanthurus nigrofuscus	9	KAHE7B	6	45.15			
H	Acanthurus nigrofuscus	9	KAHE7B	15	358.46			
H	Acanthurus nigrofuscus	9	KAHE7B	2	108.50			
H	Acanthurus olivaceus	9	KAHE7B	10	937.69			
H	Acanthurus olivaceus	9	KAHE7B	1	563.17	34	2012.97	72.1
P	Chromis vanderbilti	9	KAHE7B	7	2.21	7	2.21	0.1
	TOTAL	9	KAHE7B	51	2791.91	51	2791.91	100
C	Parupeneus pleurostigma	10	KAHE7C	1	98.25			
C	Parupeneus multifasciatus	10	KAHE7C	1	235.75			
C	Plectroglyphidodon johnstoniani	10	KAHE7C	1	3.03			
C	Paracirrhites arcatus	10	KAHE7C	2	16.24			
C	Thalassoma duperrey	10	KAHE7C	5	136.95			
C	Coris gaimard	10	KAHE7C	1	318.06			
C	Zanclus cornutus	10	KAHE7C	2	208.32			
C	Sufflamen bursa	10	KAHE7C	1	144.65			
C	Sufflamen bursa	10	KAHE7C	3	257.62			
C	Sufflamen fraenatus	10	KAHE7C	1	623.45	18	2042.32	32.3
CF	Chaetodon multicinctus	10	KAHE7C	2	13.31	2	13.31	0.2
H	Acanthurus triostegus	10	KAHE7C	2	92.63			
H	Acanthurus triostegus	10	KAHE7C	1	100.01			
H	Acanthurus nigrofuscus	10	KAHE7C	4	95.59			
H	Acanthurus nigrofuscus	10	KAHE7C	2	108.50			
H	Acanthurus olivaceus	10	KAHE7C	5	1308.34			
H	Acanthurus olivaceus	10	KAHE7C	13	617.20			
H	Acanthurus olivaceus	10	KAHE7C	14	1312.76			
H	Naso lituratus	10	KAHE7C	2	72.69			
H	Naso lituratus	10	KAHE7C	1	14.90			
H	Naso unicornis	10	KAHE7C	1	38.92	45	3761.55	59.6
O	Melichthys vidua	10	KAHE7C	1	199.03			
O	Melichthys vidua	10	KAHE7C	1	124.35			
O	Cantherhines sandwichiensis	10	KAHE7C	2	164.10			
O	Canthigaster coronata	10	KAHE7C	1	7.59	5	495.07	7.8
P	Chromis vanderbilti	10	KAHE7C	3	0.95	3	0.95	0.02
	TOTAL	10	KAHE7C	73	6313.19	73	6313.19	100
C	Parupeneus multifasciatus	11	KAHE7D	1	340.44			
C	Parupeneus multifasciatus	11	KAHE7D	1	235.75			
C	Sufflamen bursa	11	KAHE7D	2	171.75	4	747.94	91.5
O	Melichthys vidua	11	KAHE7D	1	69.92	1	69.92	8.5
	TOTAL	11	KAHE7D	5	817.86	5	817.86	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus multifasciatus	12	KAHE7E	4	108.47			
C	Parupeneus multifasciatus	12	KAHE7E	2	108.80			
C	Forcipiger flavissimus	12	KAHE7E	1	9.15			
C	Plectroglyphidodon johnstonianı	12	KAHE7E	3	9.09			
C	Paracirrhites arcatus	12	KAHE7E	3	49.05			
C	Paracirrhites forsteri	12	KAHE7E	1	39.65			
C	Thalassoma duperrey	12	KAHE7E	7	384.64			
C	Thalassoma duperrey	12	KAHE7E	1	97.05			
C	Coris gaimard	12	KAHE7E	1	22.07			
C	Stethojulis balteata	12	KAHE7E	1	72.39			
C	Plagiotremus ewaensis	12	KAHE7E	1	0.95			
C	Zanclus cornutus	12	KAHE7E	1	104.16			
C	Sufflamen bursa	12	KAHE7E	2	171.75			
C	Sufflamen fraenatus	12	KAHE7E	1	329.34	29	1506.55	36.8
CF	Chaetodon multicinctus	12	KAHE7E	2	13.31			
CF	Pervagor spilosoma	12	KAHE7E	1	16.22			
CF	Pervagor melanocephalus	12	KAHE7E	3	15.70	6	45.23	1.1
H	Acanthurus nigrofuscus	12	KAHE7E	7	52.67			
H	Acanthurus nigrofuscus	12	KAHE7E	5	5.22			
H	Acanthurus olivaceus	12	KAHE7E	2	523.33			
H	Acanthurus olivaceus	12	KAHE7E	1	563.17			
H	Ctenochaetus strigosus	12	KAHE7E	4	3.49			
H	Zebrasoma flavescens	12	KAHE7E	3	5.06			
H	Naso lituratus	12	KAHE7E	2	145.17			
H	Naso lituratus	12	KAHE7E	1	205.99	25	1504.10	36.8
O	Melichthys niger	12	KAHE7E	5	816.68			
O	Melichthys vidua	12	KAHE7E	1	199.03			
O	Canthigaster jactator	12	KAHE7E	2	7.12	8	1022.83	25.0
P	Chromis vanderbilti	12	KAHE7E	37	11.69	37	11.69	0.3
	TOTAL	12	KAHE7E	105	4090.40	105	4090.40	100
C	Aulostomus chinensis	13	KAHE10	1	210.62			
C	Monotaxis grandoculis	13	KAHE10	1	13.74			
C	Parupeneus multifasciatus	13	KAHE10	1	96.08			
C	Parupeneus multifasciatus	13	KAHE10	1	235.75			
C	Forcipiger flavissimus	13	KAHE10	2	18.30			
C	Paracirrhites arcatus	13	KAHE10	1	16.35			
C	Thalassoma duperrey	13	KAHE10	10	970.52			
C	Thalassoma duperrey	13	KAHE10	9	494.54			
C	Thalassoma duperrey	13	KAHE10	5	136.95			
C	Stethojulis balteata	13	KAHE10	1	72.39			
C	Sufflamen bursa	13	KAHE10	2	171.75	34	2436.98	24.9
H	Calotomus carolinus	13	KAHE10	1	72.28			
H	Acanthurus triostegus	13	KAHE10	2	92.63			
H	Acanthurus nigrofuscus	13	KAHE10	15	358.46			
H	Acanthurus nigrofuscus	13	KAHE10	12	651.03			
H	Acanthurus olivaceus	13	KAHE10	2	94.95			
H	Acanthurus olivaceus	13	KAHE10	4	375.08			
H	Naso lituratus	13	KAHE10	1	72.58	37	1717.01	17.5
O	Stegastes fasciolatus	13	KAHE10	2	51.96			
O	Melichthys niger	13	KAHE10	5	816.68			
O	Canthigaster jactator	13	KAHE10	1	7.59	8	876.23	8.9
P	Dascyllus albisella	13	KAHE10	20	61.77			
P	Abudefduf abdominalis	13	KAHE10	88	2757.27			
P	Abudefduf vaigensis	13	KAHE10	40	1874.08			
P	Naso hexacanthus	13	KAHE10	2	77.85	150	4770.96	48.7
	TOTAL	13	KAHE10	229	9801.18	229	9801.18	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Plectroglyphidodon imparipennis	14	NANA1	5	4.31			
C	Thalassoma trilobatum	14	NANA1	1	27.39			
C	Thalassoma duperrey	14	NANA1	9	28.35			
C	Thalassoma fuscum	14	NANA1	1	32.76			
C	Stethojulis balteata	14	NANA1	2	8.00			
C	Ostracion meleagris	14	NANA1	1	6.76	19	107.58	49.9
CF	Chaetodon quadrimaculatus	14	NANA1	1	25.30	1	25.30	11.7
H	Acanthurus nigrofuscus	14	NANA1	1	23.90			
H	Acanthurus nigrofuscus	14	NANA1	6	45.15	7	69.04	32.0
O	Canthigaster jactator	14	NANA1	2	7.12	2	7.12	3.3
P	Chromis vanderbilti	14	NANA1	21	6.63	21	6.63	3.1
	TOTAL	14	NANA1	50	215.69	50	215.69	100
C	Aulostomus chinensis	15	NANA2	1	88.50			
C	Monotaxis grandoculis	15	NANA2	9	17907.44			
C	Monotaxis grandoculis	15	NANA2	5	3355.58			
C	Monotaxis grandoculis	15	NANA2	1	34.79			
C	Parupeneus multifasciatus	15	NANA2	1	54.40			
C	Parupeneus multifasciatus	15	NANA2	1	27.12			
C	Parupeneus cyclostomus	15	NANA2	1	88.57			
C	Forcipiger flavissimus	15	NANA2	1	9.15			
C	Plectroglyphidodon johnstonianu	15	NANA2	1	3.03			
C	Paracirrhites forsteri	15	NANA2	1	39.65			
C	Bodianus bilunulatus	15	NANA2	1	133.12			
C	Pseudocheilinus octotaenia	15	NANA2	1	35.76			
C	Thalassoma duperrey	15	NANA2	3	164.85			
C	Macropharyngodon geoffroy	15	NANA2	2	11.50			
C	Halichoeres ornatissimus	15	NANA2	1	16.45			
C	Rhinecanthus rectangulus	15	NANA2	1	85.87			
C	Sufflamen bursa	15	NANA2	5	429.37	36	22485.14	54.0
CF	Chaetodon ornatissimus	15	NANA2	1	69.00			
CF	Chaetodon quadrimaculatus	15	NANA2	1	25.30			
CF	Chaetodon multicinctus	15	NANA2	2	26.06	4	120.37	0.3
H	Acanthurus triostegus	15	NANA2	3	138.95			
H	Acanthurus triostegus	15	NANA2	5	938.01			
H	Acanthurus leucopareius	15	NANA2	2	265.40			
H	Acanthurus leucopareius	15	NANA2	9	3366.58			
H	Acanthurus nigrofuscus	15	NANA2	4	30.10			
H	Acanthurus nigrofuscus	15	NANA2	9	215.07			
H	Acanthurus olivaceus	15	NANA2	12	6758.04			
H	Acanthurus olivaceus	15	NANA2	7	5436.23			
H	Acanthurus blochii	15	NANA2	4	928.96			
H	Ctenochaetus strigosus	15	NANA2	4	107.38	59	18184.72	43.7
O	Melichthys niger	15	NANA2	5	816.68			
O	Canthigaster jactator	15	NANA2	1	3.56	6	820.24	2.0
	TOTAL	15	NANA2	105	41610.47	105	41610.47	100

GRP	11-May-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Macropharyngodon geoffroy	16	PIPE	1	42.90			
C	Aulostomus chinensis	16	PIPE	1	112.28			
C	Fistularia commersoni	16	PIPE	1	165.95			
C	Decapterus macarellus	16	PIPE	40	7665.34			
C	Lutjanus kasmira	16	PIPE	850	261023.62			
C	Lutjanus kasmira	16	PIPE	200	11470.51			
C	Mulloides flavolineatus	16	PIPE	12	1001.34			
C	Parupeneus multifasciatus	16	PIPE	3	707.24			
C	Parupeneus multifasciatus	16	PIPE	4	384.33			
C	Parupeneus bifasciatus	16	PIPE	1	59.77			
C	Forcipiger flavissimus	16	PIPE	8	73.20			
C	Plectroglyphidodon johnstonianu	16	PIPE	3	9.09			
C	Paracirrhites arcatus	16	PIPE	10	163.49			
C	Labroides phthirophagus	16	PIPE	6	8.93			
C	Thalassoma duperrey	16	PIPE	90	8734.68			
C	Gomphosus varius	16	PIPE	5	113.00			
C	Halichoeres ornatissimus	16	PIPE	7	175.96			
C	Zanclus cornutus	16	PIPE	3	312.47	1245	292224.10	89.4
CF	Chaetodon multicinctus	16	PIPE	7	91.21			
CF	Cantherhines dumerili	16	PIPE	1	194.98	8	286.19	0.1
H	Kyphosus bigibbus	16	PIPE	3	902.22			
H	Calotomus carolinus	16	PIPE	1	34.69			
H	Scarus sordidus	16	PIPE	5	700.03			
H	Scarus sordidus	16	PIPE	3	4282.71			
H	Scarus sordidus	16	PIPE	4	2178.27			
H	Acanthurus nigrofuscus	16	PIPE	59	3200.90			
H	Acanthurus olivaceus	16	PIPE	26	2437.99			
H	Ctenochaetus strigosus	16	PIPE	12	790.38			
H	Ctenochaetus strigosus	16	PIPE	7	187.91			
H	Naso lituratus	16	PIPE	4	823.95	124	15539.04	4.8
O	Stegastes fasciolatus	16	PIPE	11	285.78			
O	Melichthys vidua	16	PIPE	2	248.69			
O	Cantherhines sandwichiensis	16	PIPE	4	328.21			
O	Canthigaster jactator	16	PIPE	9	68.32	26	931.00	0.3
P	Chaetodon miliaris	16	PIPE	4	84.67			
P	Dascyllus albisella	16	PIPE	15	46.32			
P	Abudefduf abdominalis	16	PIPE	185	5796.53			
P	Abudefduf vaigensis	16	PIPE	225	10541.68			
P	Chromis vanderbilti	16	PIPE	46	14.53			
P	Chromis ovalis	16	PIPE	130	1502.76	605	17986.49	5.5
	TOTAL	16	PIPE	2008	326966.82	2008	326966.82	100

26 JUNE 2018 FIELD DATA

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Lutjanus fulvus	1	EAST1	4	886.23			
C	Lutjanus fulvus	1	EAST1	6	933.64			
C	Lutjanus fulvus	1	EAST1	4	1215.68			
C	Parupeneus multifasciatus	1	EAST1	1	235.75			
C	Plectroglyphidodon imparipenni:	1	EAST1	2	1.72			
C	Thalassoma duperrey	1	EAST1	7	384.64			
C	Thalassoma duperrey	1	EAST1	4	388.21			
C	Thalassoma duperrey	1	EAST1	7	191.73			
C	Rhinecanthus rectangulus	1	EAST1	3	257.62			
C	Rhinecanthus rectangulus	1	EAST1	1	45.36	39	4540.59	8.6
CF	Chaetodon ornatissimus	1	EAST1	2	138.00	2	138.00	0.3
H	Acanthurus triostegus	1	EAST1	32	3200.46			
H	Acanthurus triostegus	1	EAST1	33	6190.86			
H	Acanthurus triostegus	1	EAST1	16	741.04			
H	Acanthurus leucopareius	1	EAST1	10	2326.75			
H	Acanthurus nigrofuscus	1	EAST1	33	788.60			
H	Acanthurus nigrofuscus	1	EAST1	21	1139.30			
H	Acanthurus nigroris	1	EAST1	2	2484.53			
H	Acanthurus nigroris	1	EAST1	15	11082.55			
H	Acanthurus olivaceus	1	EAST1	9	5068.53			
H	Acanthurus olivaceus	1	EAST1	3	2329.81			
H	Acanthurus blochii	1	EAST1	3	696.72			
H	Acanthurus blochii	1	EAST1	15	11757.15	192	47806.33	91.1
P	Chromis vanderbilti	1	EAST1	38	12.00	38	12.00	0.02
	TOTAL	1	EAST1	271	52496.92	271	52496.92	100
C	Plectroglyphidodon imparipenni:	2	EAST2	1	0.86			
C	Bodianus bilunulatus	2	EAST2	1	1141.37			
C	Labroides phthirophagus	2	EAST2	1	0.63			
C	Thalassoma duperrey	2	EAST2	5	136.95			
C	Thalassoma duperrey	2	EAST2	11	122.80			
C	Thalassoma duperrey	2	EAST2	6	329.69			
C	Rhinecanthus rectangulus	2	EAST2	2	171.75	27	1904.05	10.3
CF	Chaetodon ornatissimus	2	EAST2	2	138.00	2	138.00	0.7
H	Acanthurus leucopareius	2	EAST2	7	1628.73			
H	Acanthurus leucopareius	2	EAST2	6	796.20			
H	Acanthurus nigrofuscus	2	EAST2	18	430.15			
H	Acanthurus nigroris	2	EAST2	5	3694.18			
H	Acanthurus olivaceus	2	EAST2	5	1308.34			
H	Acanthurus olivaceus	2	EAST2	15	8447.55			
H	Naso lituratus	2	EAST2	1	205.99	57	16511.14	88.9
O	Canthigaster jactator	2	EAST2	2	15.18	2	15.18	0.1
P	Chromis vanderbilti	2	EAST2	17	5.37	17	5.37	0.03
	TOTAL	2	EAST2	105	18573.74	105	18573.74	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Cephalopholis argus	3	EAST3	1	638.29			
C	Thalassoma duperrey	3	EAST3	7	78.14			
C	Thalassoma duperrey	3	EAST3	5	136.95			
C	Stethojulis balteata	3	EAST3	2	71.53			
C	Halichoeres ornatissimus	3	EAST3	1	16.45			
C	Sufflamen bursa	3	EAST3	6	515.24	22	1456.60	40.2
CF	Chaetodon ornatissimus	3	EAST3	3	207.01	3	207.01	5.7
H	Calotomus carolinus	3	EAST3	1	72.28			
H	Acanthurus nigrofuscus	3	EAST3	24	573.53			
H	Acanthurus nigrofuscus	3	EAST3	33	248.31			
H	Ctenochaetus strigosus	3	EAST3	11	167.18			
H	Ctenochaetus strigosus	3	EAST3	5	134.22			
H	Ctenochaetus strigosus	3	EAST3	8	60.61	82	1256.13	34.7
O	Melichthys niger	3	EAST3	3	490.01			
O	Melichthys vidua	3	EAST3	1	199.03			
O	Canthigaster jactator	3	EAST3	1	7.59	5	696.63	19.2
P	Chromis vanderbilti	3	EAST3	20	6.32	20	6.32	0.2
	TOTAL	3	EAST3	132	3622.69	132	3622.69	100
C	Paracirrhites arcatus	4	EAST4	2	32.70			
C	Paracirrhites forsteri	4	EAST4	1	26.28			
C	Bodianus bilunulatus	4	EAST4	1	1141.37			
C	Labroides phthirophagus	4	EAST4	1	0.19			
C	Thalassoma duperrey	4	EAST4	12	659.39			
C	Thalassoma duperrey	4	EAST4	18	493.03			
C	Thalassoma duperrey	4	EAST4	26	290.24			
C	Thalassoma duperrey	4	EAST4	2	194.10			
C	Coris gaimard	4	EAST4	1	83.79			
C	Stethojulis balteata	4	EAST4	2	71.53			
C	Rhinecanthus rectangulus	4	EAST4	2	90.72	68	3083.34	23.3
H	Acanthurus triostegus	4	EAST4	5	231.58			
H	Acanthurus nigrofuscus	4	EAST4	22	525.73			
H	Acanthurus nigrofuscus	4	EAST4	13	97.82			
H	Acanthurus olivaceus	4	EAST4	6	1570.00			
H	Acanthurus olivaceus	4	EAST4	12	6758.04	58	9183.18	69.3
O	Melichthys niger	4	EAST4	3	490.01			
O	Melichthys vidua	4	EAST4	2	398.06			
O	Canthigaster jactator	4	EAST4	9	68.32	14	956.38	7.2
P	Chromis vanderbilti	4	EAST4	99	31.27	99	31.27	0.2
	TOTAL	4	EAST4	239	13254.17	239	13254.17	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Lutjanus fulvus	5	KO1	1	155.61			
C	Lutjanus kasmira	5	KO1	18	3431.64			
C	Monotaxis grandoculis	5	KO1	4	54.95			
C	Paracirrhites arcatus	5	KO1	1	16.35			
C	Labroides phthirophagus	5	KO1	1	1.49			
C	Thalassoma duperrey	5	KO1	5	136.95			
C	Thalassoma duperrey	5	KO1	2	109.90			
C	Gomphosus varius	5	KO1	2	45.20			
C	Sufflamen bursa	5	KO1	4	79.70	38	4031.78	50.4
CF	Chaetodon multicinctus	5	KO1	6	78.18	6	78.18	1.0
H	Acanthurus nigrofuscus	5	KO1	5	271.26			
H	Acanthurus nigrofuscus	5	KO1	9	67.72			
H	Acanthurus nigrofuscus	5	KO1	8	191.18			
H	Ctenochaetus strigosus	5	KO1	23	617.41			
H	Ctenochaetus strigosus	5	KO1	28	1844.22			
H	Ctenochaetus strigosus	5	KO1	6	792.80			
H	Zebrasoma flavescens	5	KO1	5	82.66	84	3867.25	48.3
O	Stegastes fasciolatus	5	KO1	1	25.98	1	25.98	0.3
	TOTAL	5	KO1	129	8003.19	129	8003.19	100
C	Parupeneus multifasciatus	6	KO2	1	472.94			
C	Thalassoma duperrey	6	KO2	2	194.10			
C	Thalassoma duperrey	6	KO2	3	33.49			
C	Thalassoma duperrey	6	KO2	7	191.73			
C	Thalassoma duperrey	6	KO2	3	164.85			
C	Gomphosus varius	6	KO2	1	39.39			
C	Halichoeres ornatissimus	6	KO2	1	16.45			
C	Zanclus cornutus	6	KO2	1	104.16			
C	Sufflamen bursa	6	KO2	1	85.87	20	1302.99	5.6
CF	Chaetodon unimaculatus	6	KO2	2	50.61			
CF	Chaetodon ornatissimus	6	KO2	2	138.00			
CF	Chaetodon quadrimaculatus	6	KO2	1	25.30			
CF	Chaetodon multicinctus	6	KO2	2	26.06	7	239.98	1.0
H	Scarus sordidus	6	KO2	1	140.01			
H	Acanthurus triostegus	6	KO2	7	700.10			
H	Acanthurus triostegus	6	KO2	3	138.95			
H	Acanthurus leucopareius	6	KO2	3	698.03			
H	Acanthurus leucopareius	6	KO2	25	1668.51			
H	Acanthurus nigrofuscus	6	KO2	19	454.04			
H	Acanthurus nigrofuscus	6	KO2	38	285.94			
H	Acanthurus nigrofuscus	6	KO2	2	204.95			
H	Acanthurus nigroris	6	KO2	37	6375.02			
H	Acanthurus nigroris	6	KO2	3	71.69			
H	Acanthurus nigroris	6	KO2	22	8605.53			
H	Acanthurus olivaceus	6	KO2	2	523.33			
H	Acanthurus glaucopareius	6	KO2	1	116.74			
H	Acanthurus glaucopareius	6	KO2	1	61.53			
H	Ctenochaetus strigosus	6	KO2	4	107.38			
H	Ctenochaetus strigosus	6	KO2	3	197.59			
H	Ctenochaetus strigosus	6	KO2	2	264.27			
H	Naso lituratus	6	KO2	2	411.98	175	21025.57	91.1
O	Melichthys niger	6	KO2	3	490.01			
O	Canthigaster jactator	6	KO2	4	30.36	7	520.37	2.3
	TOTAL	6	KO2	209	23088.91	209	23088.91	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Myripristis amaenus	7	KAHE1D	4	169.61			
C	Aulostomus chinensis	7	KAHE1D	1	210.62			
C	Lutjanus kasmira	7	KAHE1D	7	769.71			
C	Parupeneus bifasciatus	7	KAHE1D	1	59.77			
C	Plectroglyphidodon johnstonianu	7	KAHE1D	9	27.27			
C	Plectroglyphidodon imparipennis	7	KAHE1D	3	2.59			
C	Cirrhitus pinnulatus	7	KAHE1D	1	90.86			
C	Labroides phthirophagus	7	KAHE1D	1	1.49			
C	Thalassoma duperrey	7	KAHE1D	12	328.69			
C	Thalassoma duperrey	7	KAHE1D	14	769.28			
C	Thalassoma duperrey	7	KAHE1D	31	3008.61			
C	Thalassoma ballieui	7	KAHE1D	1	102.61			
C	Gomphosus varius	7	KAHE1D	3	118.18			
C	Gomphosus varius	7	KAHE1D	3	33.12			
C	Stethojulis balteata	7	KAHE1D	3	217.17			
C	Sufflamen bursa	7	KAHE1D	3	136.09			
C	Sufflamen bursa	7	KAHE1D	5	429.37	102	6475.03	26.4
H	Acanthurus triostegus	7	KAHE1D	2	92.63			
H	Acanthurus triostegus	7	KAHE1D	45	772.50			
H	Acanthurus nigrofuscus	7	KAHE1D	51	383.76			
H	Acanthurus nigrofuscus	7	KAHE1D	52	1242.65			
H	Acanthurus nigroris	7	KAHE1D	2	204.95			
H	Acanthurus nigroris	7	KAHE1D	3	162.76			
H	Ctenochaetus strigosus	7	KAHE1D	59	1583.79			
H	Ctenochaetus strigosus	7	KAHE1D	25	1646.62	239	6089.65	24.9
O	Melichthys niger	7	KAHE1D	79	7872.75			
O	Melichthys niger	7	KAHE1D	23	3756.72			
O	Melichthys vidua	7	KAHE1D	2	248.69			
O	Canthigaster jactator	7	KAHE1D	4	30.36	108	11908.52	48.6
P	Dascyllus albisella	7	KAHE1D	5	15.44	5	15.44	0.1
	TOTAL	7	KAHE1D	454	24488.64	454	24488.64	100
C	Mulloides flavolineatus	8	KAHE5B	2	260.56			
C	Parupeneus multifasciatus	8	KAHE5B	1	155.42			
C	Paracirrhites arcatus	8	KAHE5B	2	32.70			
C	Thalassoma duperrey	8	KAHE5B	8	219.12			
C	Thalassoma duperrey	8	KAHE5B	4	388.21			
C	Thalassoma duperrey	8	KAHE5B	7	384.64			
C	Gomphosus varius	8	KAHE5B	2	22.08			
C	Gomphosus varius	8	KAHE5B	1	39.39			
C	Halichoeres ornatissimus	8	KAHE5B	1	25.14			
C	Halichoeres ornatissimus	8	KAHE5B	1	16.45			
C	Zanclus cornutus	8	KAHE5B	4	416.63			
C	Rhinecanthus rectangulus	8	KAHE5B	3	136.09			
C	Sufflamen bursa	8	KAHE5B	2	171.75	38	2268.18	36.2
H	Acanthurus triostegus	8	KAHE5B	23	1065.25			
H	Acanthurus nigrofuscus	8	KAHE5B	49	1170.96			
H	Acanthurus nigrofuscus	8	KAHE5B	7	379.77			
H	Acanthurus nigrofuscus	8	KAHE5B	27	203.16			
H	Ctenochaetus hawaiiensis	8	KAHE5B	1	132.13			
H	Zebrasoma flavescens	8	KAHE5B	1	26.03	108	2977.30	47.6
P	Abudefduf vaigensis	8	KAHE5B	11	344.66			
P	Chromis vanderbilti	8	KAHE5B	17	5.37			
P	Naso brevirostris	8	KAHE5B	17	661.72	45	1011.74	16.2
	TOTAL	8	KAHE5B	191	6257.22	191	6257.22	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus multifasciatus	9	KAHE7B	2	108.80			
C	Parupeneus multifasciatus	9	KAHE7B	1	155.42			
C	Paracirrhites forsteri	9	KAHE7B	1	39.65			
C	Thalassoma duperrey	9	KAHE7B	1	54.95			
C	Coris venusta	9	KAHE7B	1	86.86			
C	Coris venusta	9	KAHE7B	1	48.38			
C	Stethojulis balteata	9	KAHE7B	1	72.39			
C	Sufflamen bursa	9	KAHE7B	4	343.49	12	909.94	42.7
H	Acanthurus triostegus	9	KAHE7B	1	46.32			
H	Acanthurus nigrofuscus	9	KAHE7B	3	71.69			
H	Acanthurus olivaceus	9	KAHE7B	1	93.77			
H	Acanthurus olivaceus	9	KAHE7B	12	569.72			
H	Naso lituratus	9	KAHE7B	1	14.90			
H	Naso lituratus	9	KAHE7B	2	255.47			
H	Naso unicornis	9	KAHE7B	1	123.12			
H	Naso unicornis	9	KAHE7B	1	38.92	22	1213.91	56.9
O	Canthigaster jactator	9	KAHE7B	1	7.59	1	7.59	0.4
P	Chromis vanderbilti	9	KAHE7B	6	1.90	6	1.90	0.1
	TOTAL	9	KAHE7B	41	2133.34	41	2133.34	100
C	Decapterus macarellus	10	KAHE7C	20	3832.67			
C	Monotaxis grandoculis	10	KAHE7C	1	34.79			
C	Parupeneus pleurostigma	10	KAHE7C	4	392.99			
C	Parupeneus multifasciatus	10	KAHE7C	1	235.75			
C	Parupeneus multifasciatus	10	KAHE7C	1	54.40			
C	Parupeneus multifasciatus	10	KAHE7C	1	96.08			
C	Forcipiger flavissimus	10	KAHE7C	3	27.45			
C	Paracirrhites arcatus	10	KAHE7C	1	16.35			
C	Thalassoma duperrey	10	KAHE7C	1	54.95			
C	Thalassoma duperrey	10	KAHE7C	1	3.15			
C	Gomphosus varius	10	KAHE7C	1	39.39			
C	Zanclus cornutus	10	KAHE7C	2	208.32			
C	Zanclus cornutus	10	KAHE7C	1	54.90			
C	Sufflamen bursa	10	KAHE7C	3	257.62			
C	Ostracion meleagris	10	KAHE7C	1	6.76	42	5315.57	92.7
CF	Chaetodon multicinctus	10	KAHE7C	2	13.31	2	13.31	0.2
H	Acanthurus nigrofuscus	10	KAHE7C	1	7.52			
H	Acanthurus nigrofuscus	10	KAHE7C	8	191.18			
H	Acanthurus olivaceus	10	KAHE7C	4	189.91	13	388.61	6.8
O	Canthigaster jactator	10	KAHE7C	1	7.59	1	7.59	0.1
P	Chromis vanderbilti	10	KAHE7C	31	9.79	31	9.79	0.2
	TOTAL	10	KAHE7C	89	5734.88	89	5734.88	99.999999
C	Thalassoma duperrey	11	KAHE7D	1	54.95	1	54.95	16.3
CF	Chaetodon multicinctus	11	KAHE7D	2	13.31	2	13.31	4.0
H	Acanthurus nigrofuscus	11	KAHE7D	1	54.25			
H	Acanthurus nigrofuscus	11	KAHE7D	1	23.90			
H	Acanthurus olivaceus	11	KAHE7D	4	189.91	6	268.06	79.7
	TOTAL	11	KAHE7D	9	336.32	9	336.32	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Decapterus macarellus	12	KAHE7E	2	260.56			
C	Parupeneus multifasciatus	12	KAHE7E	3	163.20			
C	Parupeneus multifasciatus	12	KAHE7E	3	81.35			
C	Parupeneus multifasciatus	12	KAHE7E	3	9.36			
C	Forcipiger flavissimus	12	KAHE7E	3	27.45			
C	Paracirrhites forsteri	12	KAHE7E	1	16.35			
C	Thalassoma duperrey	12	KAHE7E	8	219.12			
C	Thalassoma duperrey	12	KAHE7E	3	33.49			
C	Gomphosus varius	12	KAHE7E	1	11.04			
C	Coris venusta	12	KAHE7E	1	23.64			
C	Pseudojuloides cerasinus	12	KAHE7E	3	9.45			
C	Stethojulis balteata	12	KAHE7E	1	35.76			
C	Plagiotremus ewaensis	12	KAHE7E	1	2.43			
C	Sufflamen bursa	12	KAHE7E	1	85.87	34	979.06	28.3
CF	Chaetodon multicinctus	12	KAHE7E	2	13.31	2	13.31	0.4
H	Calotomus carolinus	12	KAHE7E	3	10.64			
H	Acanthurus nigrofuscus	12	KAHE7E	5	37.62			
H	Acanthurus nigrofuscus	12	KAHE7E	4	95.59			
H	Acanthurus olivaceus	12	KAHE7E	1	163.52			
H	Zebrasoma flavescens	12	KAHE7E	3	5.06			
H	Naso lituratus	12	KAHE7E	1	72.58			
H	Naso unicornis	12	KAHE7E	1	38.92	18	423.94	12.3
O	Melichthys niger	12	KAHE7E	5	816.68			
O	Melichthys vidua	12	KAHE7E	3	373.04			
O	Melichthys vidua	12	KAHE7E	4	796.12			
O	Canthigaster jactator	12	KAHE7E	3	10.69	15	1996.52	57.8
P	Chromis vanderbilti	12	KAHE7E	130	41.07	130	41.07	1.2
	TOTAL	12	KAHE7E	199	3453.91	199	3453.91	100
C	Selar crumenophthalmus	13	KAHE10	65	8468.14			
C	Lutjanus kasmira	13	KAHE10	131	14404.59			
C	Monotaxis grandoculis	13	KAHE10	1	34.79			
C	Parupeneus multifasciatus	13	KAHE10	2	471.50			
C	Parupeneus multifasciatus	13	KAHE10	2	192.16			
C	Paracirrhites arcatus	13	KAHE10	1	16.35			
C	Thalassoma duperrey	13	KAHE10	9	873.47			
C	Thalassoma duperrey	13	KAHE10	5	274.74			
C	Thalassoma duperrey	13	KAHE10	8	219.12			
C	Coris gaimard	13	KAHE10	1	45.99			
C	Rhinecanthus rectangulus	13	KAHE10	1	45.36			
C	Sufflamen bursa	13	KAHE10	2	171.75			
C	Sufflamen fraenatus	13	KAHE10	1	461.25	229	25679.22	82.2
CF	Chaetodon multicinctus	13	KAHE10	2	26.06	2	26.06	0.1
H	Acanthurus triostegus	13	KAHE10	50	2315.75			
H	Acanthurus leucopareius	13	KAHE10	1	66.74			
H	Acanthurus nigrofuscus	13	KAHE10	2	108.50			
H	Acanthurus nigrofuscus	13	KAHE10	16	382.35			
H	Acanthurus nigrofuscus	13	KAHE10	3	22.57			
H	Acanthurus olivaceus	13	KAHE10	1	93.77			
H	Acanthurus olivaceus	13	KAHE10	1	19.74			
H	Naso lituratus	13	KAHE10	1	72.58			
H	Naso lituratus	13	KAHE10	1	311.61	76	3393.64	10.9
O	Stegastes fasciolatus	13	KAHE10	1	25.98			
O	Melichthys niger	13	KAHE10	7	1143.35			
O	Melichthys vidua	13	KAHE10	1	124.35			
O	Canthigaster jactator	13	KAHE10	2	15.18	11	1308.86	4.2
P	Dascyllus albisella	13	KAHE10	26	80.30			
P	Abudefduf abdominalis	13	KAHE10	15	469.99			
P	Abudefduf vaigensis	13	KAHE10	9	281.99	50	832.28	2.7
	TOTAL	13	KAHE10	368	31240.05	368	31240.05	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus multifasciatus	14	NANA1	2	54.23			
C	Parupeneus cyclostomus	14	NANA1	1	2.81			
C	Plectroglyphidodon imparipenni:	14	NANA1	6	5.17			
C	Thalassoma duperrey	14	NANA1	8	25.20			
C	Thalassoma duperrey	14	NANA1	7	191.73			
C	Thalassoma duperrey	14	NANA1	3	164.85			
C	Thalassoma lutescens	14	NANA1	1	32.76			
C	Stethojulis balteata	14	NANA1	1	14.41			
C	Halichoeres ornatissimus	14	NANA1	1	1.18			
C	Plagiotremus ewaensis	14	NANA1	2	4.85			
C	Rhinecanthus rectangulus	14	NANA1	1	45.36	33	542.56	81.8
H	Calotomus carolinus	14	NANA1	1	72.28			
H	Acanthurus triostegus	14	NANA1	3	12.71			
H	Acanthurus nigrofuscus	14	NANA1	1	23.90			
H	Acanthurus nigrofuscus	14	NANA1	3	3.13			
H	Acanthurus olivaceus	14	NANA1	1	0.69	9	112.72	17.0
P	Chromis vanderbilti	14	NANA1	26	8.21	26	8.21	1.2
	TOTAL	14	NANA1	68	663.49	68	663.49	100
C	Mulloides flavolineatus	15	NANA2	4	1460.84			
C	Parupeneus multifasciatus	15	NANA2	3	466.27			
C	Parupeneus multifasciatus	15	NANA2	2	108.80			
C	Parupeneus multifasciatus	15	NANA2	4	108.47			
C	Chaetodon lunula	15	NANA2	5	179.97			
C	Bodianus bilunulatus	15	NANA2	1	648.58			
C	Thalassoma duperrey	15	NANA2	4	109.56			
C	Thalassoma duperrey	15	NANA2	1	97.05			
C	Gomphosus varius	15	NANA2	1	39.39			
C	Stethojulis balteata	15	NANA2	1	35.76			
C	Halichoeres ornatissimus	15	NANA2	2	50.27			
C	Halichoeres ornatissimus	15	NANA2	1	16.45			
C	Rhinecanthus rectangulus	15	NANA2	1	45.36			
C	Sufflamen bursa	15	NANA2	4	343.49			
C	Sufflamen fraenatus	15	NANA2	1	461.25			
C	Sufflamen fraenatus	15	NANA2	1	224.79	36	4396.32	16.9
H	Acanthurus triostegus	15	NANA2	3	562.81			
H	Acanthurus leucopareius	15	NANA2	13	1725.10			
H	Acanthurus leucopareius	15	NANA2	57	13262.49			
H	Acanthurus nigrofuscus	15	NANA2	11	596.78			
H	Acanthurus nigrofuscus	15	NANA2	7	52.67			
H	Acanthurus nigrofuscus	15	NANA2	9	215.07			
H	Acanthurus nigroris	15	NANA2	3	307.42			
H	Acanthurus nigroris	15	NANA2	5	3694.18			
H	Ctenochaetus strigosus	15	NANA2	3	80.53			
H	Zebrasoma flavescens	15	NANA2	17	905.76	128	21402.82	82.3
O	Melichthys niger	15	NANA2	1	163.34			
O	Canthigaster jactator	15	NANA2	5	37.95	6	201.29	0.8
	TOTAL	15	NANA2	170	26000.43	170	26000.43	100

GRP	26-Jun-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Myripristis amaenus	16	PIPE	29	2380.40			
C	Decapterus macarellus	16	PIPE	80	15330.68			
C	Lutjanus kasmira	16	PIPE	225	5817.90			
C	Mulloides flavolineatus	16	PIPE	280	75415.44			
C	Mulloides vanicolensis	16	PIPE	49	4436.33			
C	Mulloides vanicolensis	16	PIPE	120	27278.03			
C	Parupeneus multifasciatus	16	PIPE	1	235.75			
C	Parupeneus multifasciatus	16	PIPE	1	155.42			
C	Forcipiger flavissimus	16	PIPE	4	36.60			
C	Paracirrhites arcatus	16	PIPE	12	196.18			
C	Cirrhitops fasciatus	16	PIPE	1	15.63			
C	Novaculichthys taeniourus	16	PIPE	1	20.63			
C	Thalassoma duperrey	16	PIPE	12	659.39			
C	Thalassoma duperrey	16	PIPE	6	164.34			
C	Thalassoma duperrey	16	PIPE	47	4561.44			
C	Gomphosus varius	16	PIPE	5	55.21			
C	Coris venusta	16	PIPE	2	173.73			
C	Anampses chrysocephalus	16	PIPE	3	77.65			
C	Zanclus cornutus	16	PIPE	9	937.42			
C	Zanclus cornutus	16	PIPE	12	288.51			
C	Sufflamen bursa	16	PIPE	5	429.37	904	138666.06	84.1
CF	Chaetodon ornatissimus	16	PIPE	3	207.01			
CF	Pervagor spilosoma	16	PIPE	2	72.38	5	279.38	0.2
H	Calotomus carolinus	16	PIPE	1	339.30			
H	Calotomus carolinus	16	PIPE	1	72.28			
H	Scarus sordidus	16	PIPE	12	912.16			
H	Scarus sordidus	16	PIPE	4	938.60			
H	Acanthurus nigrofuscus	16	PIPE	18	976.54			
H	Acanthurus nigrofuscus	16	PIPE	105	2509.19			
H	Ctenochaetus strigosus	16	PIPE	5	329.32			
H	Naso lituratus	16	PIPE	3	217.75			
H	Naso lituratus	16	PIPE	1	205.99	150	6501.14	3.9
O	Stegastes fasciolatus	16	PIPE	14	363.72			
O	Melichthys vidua	16	PIPE	8	1592.24			
O	Canthigaster jactator	16	PIPE	3	22.77	25	1978.74	1.2
P	Chaetodon kleini	16	PIPE	32	209.86			
P	Chaetodon miliaris	16	PIPE	20	423.36			
P	Dascyllus albisella	16	PIPE	33	5548.69			
P	Abudefduf abdominalis	16	PIPE	75	2349.94			
P	Abudefduf vaigensis	16	PIPE	145	4543.22			
P	Chromis ovalis	16	PIPE	148	1710.83			
P	Naso brevirostris	16	PIPE	20	778.49			
P	Naso brevirostris	16	PIPE	15	1846.77	488	17411.17	10.6
	TOTAL	16	PIPE	1572	164836.49	1572	164836.49	100

19 NOVEMBER 2018 FIELD DATA

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Cephalopholis argus	1	EAST1	1	336.42			
C	Lutjanus fulvus	1	EAST1	5	1107.79			
C	Parupeneus multifasciatus	1	EAST1	1	155.42			
C	Plectroglyphidodon imparipennis	1	EAST1	4	3.45			
C	Thalassoma duperrey	1	EAST1	4	219.80			
C	Thalassoma duperrey	1	EAST1	10	31.51			
C	Thalassoma duperrey	1	EAST1	2	54.78			
C	Stethojulis balteata	1	EAST1	1	14.41			
C	Halichoeres ornatissimus	1	EAST1	2	50.27			
C	Rhinecanthus rectangulus	1	EAST1	1	85.87			
C	Rhinecanthus rectangulus	1	EAST1	1	45.36			
C	Sufflamen fraenatus	1	EAST1	3	988.01	35	3093.09	4.3
CF	Chaetodon quadrimaculatus	1	EAST1	3	75.91	3	75.91	0.1
H	Acanthurus triostegus	1	EAST1	7	324.21			
H	Acanthurus triostegus	1	EAST1	49	4900.70			
H	Acanthurus leucopareius	1	EAST1	7	928.90			
H	Acanthurus nigrofuscus	1	EAST1	21	1139.30			
H	Acanthurus nigrofuscus	1	EAST1	51	1218.75			
H	Acanthurus nigrofuscus	1	EAST1	11	82.77			
H	Acanthurus nigroris	1	EAST1	11	8127.21			
H	Acanthurus olivaceus	1	EAST1	40	22526.81			
H	Acanthurus dussumieri	1	EAST1	3	1693.06			
H	Acanthurus dussumieri	1	EAST1	2	476.17			
H	Acanthurus dussumieri	1	EAST1	7	6273.22			
H	Acanthurus blochii	1	EAST1	36	16329.38			
H	Acanthurus blochii	1	EAST1	4	226.80			
H	Naso lituratus	1	EAST1	3	1867.07			
H	Naso unicornis	1	EAST1	3	1575.77	255	67690.12	95.2
O	Melichthys vidua	1	EAST1	1	199.03			
O	Canthigaster jactator	1	EAST1	3	10.69	4	209.72	0.3
P	Chromis vanderbilti	1	EAST1	69	51.52	69	51.52	0.1
	TOTAL	1	EAST1	366	71120.36	366	71120.36	100
C	Cephalopholis argus	2	EAST2	1	336.42			
C	Parupeneus multifasciatus	2	EAST2	1	96.08			
C	Parupeneus multifasciatus	2	EAST2	2	108.80			
C	Chaetodon auriga	2	EAST2	1	48.39			
C	Chaetodon lunula	2	EAST2	1	35.99			
C	Paracirrhites arcatus	2	EAST2	3	49.05			
C	Thalassoma duperrey	2	EAST2	7	384.64			
C	Thalassoma duperrey	2	EAST2	9	100.47			
C	Thalassoma duperrey	2	EAST2	8	219.12			
C	Gomphosus varius	2	EAST2	1	11.04			
C	Rhinecanthus rectangulus	2	EAST2	4	181.45			
C	Sufflamen bursa	2	EAST2	4	343.49	42	1914.95	4.6
CF	Chaetodon ornatissimus	2	EAST2	4	276.01	4	276.01	0.7
H	Scarus rubroviolaceus	2	EAST2	3	2685.17			
H	Scarus rubroviolaceus	2	EAST2	2	1347.51			
H	Acanthurus triostegus	2	EAST2	16	1600.23			
H	Acanthurus leucopareius	2	EAST2	5	333.70			
H	Acanthurus nigrofuscus	2	EAST2	26	621.32			
H	Acanthurus nigrofuscus	2	EAST2	52	391.28			
H	Acanthurus nigroris	2	EAST2	18	4812.28			
H	Acanthurus nigroris	2	EAST2	12	8866.04			
H	Acanthurus olivaceus	2	EAST2	17	9573.89			
H	Acanthurus olivaceus	2	EAST2	20	5233.34			
H	Acanthurus blochii	2	EAST2	13	1273.69			
H	Zebrasoma flavescens	2	EAST2	3	159.84			
H	Naso lituratus	2	EAST2	2	411.98			
H	Naso lituratus	2	EAST2	2	255.47			
H	Naso lituratus	2	EAST2	3	1867.07	194	39432.81	94.2
O	Melichthys vidua	2	EAST2	1	199.03			
O	Canthigaster jactator	2	EAST2	1	3.56	2	202.59	0.5
P	Chromis vanderbilti	2	EAST2	78	24.64	78	24.64	0.1
	TOTAL	2	EAST2	320	41851.00	320	41851.00	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Cephalopholis argus	3	EAST3	1	229.32			
C	Parupeneus bifasciatus	3	EAST3	1	11.60			
C	Plectroglyphidodon johnstonianu	3	EAST3	2	1.72			
C	Thalassoma duperrey	3	EAST3	9	494.54			
C	Thalassoma duperrey	3	EAST3	5	485.26			
C	Thalassoma duperrey	3	EAST3	10	273.90			
C	Thalassoma duperrey	3	EAST3	9	100.47			
C	Gomphosus varius	3	EAST3	1	11.04			
C	Sufflamen bursa	3	EAST3	1	85.87			
C	Sufflamen fraenatus	3	EAST3	1	144.65			
C	Sufflamen fraenatus	3	EAST3	1	461.25	41	2299.63	2.1
CF	Chaetodon ornatissimus	3	EAST3	2	138.00	2	138.00	0.1
H	Scarus sordidus	3	EAST3	2	1550.14			
H	Scarus psittacus	3	EAST3	1	786.15			
H	Scarus rubroviolaceus	3	EAST3	25	29000.20			
H	Scarus rubroviolaceus	3	EAST3	10	27338.74			
H	Scarus rubroviolaceus	3	EAST3	25	45909.49			
H	Acanthurus nigrofuscus	3	EAST3	17	406.25			
H	Acanthurus nigrofuscus	3	EAST3	35	263.36			
H	Ctenochaetus strigosus	3	EAST3	25	189.40			
H	Ctenochaetus strigosus	3	EAST3	31	832.16			
H	Ctenochaetus strigosus	3	EAST3	3	197.59			
H	Zebrasoma flavescens	3	EAST3	5	8.44	179	106481.93	97.3
O	Stegastes fasciolatus	3	EAST3	5	129.90			
O	Melichthys vidua	3	EAST3	2	398.06			
O	Canthigaster jactator	3	EAST3	1	3.56	8	531.52	0.5
	TOTAL	3	EAST3	230	109451.09	230	109451.09	100
C	Lutjanus fulvus	4	EAST4	1	104.24			
C	Plectroglyphidodon johnstonianu	4	EAST4	1	1.72			
C	Paracirrhites arcatus	4	EAST4	5	81.74			
C	Paracirrhites forsteri	4	EAST4	1	39.65			
C	Thalassoma duperrey	4	EAST4	3	164.85			
C	Thalassoma duperrey	4	EAST4	9	246.51			
C	Thalassoma duperrey	4	EAST4	2	194.10			
C	Thalassoma duperrey	4	EAST4	15	167.45			
C	Halichoeres ornatissimus	4	EAST4	1	16.45			
C	Rhinecanthus rectangulus	4	EAST4	3	136.09			
C	Sufflamen fraenatus	4	EAST4	1	144.65	42	1297.46	10.0
H	Acanthurus nigrofuscus	4	EAST4	60	451.48			
H	Acanthurus nigrofuscus	4	EAST4	32	764.71			
H	Acanthurus olivaceus	4	EAST4	7	3942.19			
H	Acanthurus olivaceus	4	EAST4	19	4971.67			
H	Naso lituratus	4	EAST4	5	362.92	123	10492.97	80.8
O	Melichthys niger	4	EAST4	2	326.67			
O	Melichthys vidua	4	EAST4	4	796.12			
O	Canthigaster jactator	4	EAST4	4	14.25	10	1137.04	8.8
P	Dascyllus albisella	4	EAST4	3	0.24			
P	Chromis vanderbilti	4	EAST4	191	60.34	194	60.58	0.5
	TOTAL	4	EAST4	369	12988.04	369	12988.04	100

	19-Nov-18						GROUP	GROUP
GRP	SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	BIOMASS	PERCENT
C	Cephalopholis argus	5	KO1	1	2459.47			
C	Lutjanus fulvus	5	KO1	1	104.24			
C	Lutjanus kasmira	5	KO1	1	307.09			
C	Monotaxis grandoculis	5	KO1	8	572.22			
C	Monotaxis grandoculis	5	KO1	2	424.13			
C	Monotaxis grandoculis	5	KO1	17	8118.01			
C	Plectroglyphidodon imparipennis	5	KO1	1	0.86			
C	Paracirrhites arcatus	5	KO1	1	16.35			
C	Thalassoma duperrey	5	KO1	4	388.21			
C	Thalassoma duperrey	5	KO1	8	439.59			
C	Thalassoma duperrey	5	KO1	8	219.12			
C	Thalassoma ballieui	5	KO1	1	167.53			
C	Thalassoma ballieui	5	KO1	1	372.53			
C	Stethojulis balteata	5	KO1	1	35.76			
C	Sufflamen bursa	5	KO1	3	257.62	58	13882.73	41.3
CF	Chaetodon unimaculatus	5	KO1	4	101.22			
CF	Chaetodon ornatissimus	5	KO1	2	138.00			
CF	Chaetodon multicinctus	5	KO1	4	52.12	10	291.34	0.9
H	Scarus psittacus	5	KO1	1	554.69			
H	Acanthurus triostegus	5	KO1	2	200.03			
H	Acanthurus triostegus	5	KO1	6	277.89			
H	Acanthurus leucopareius	5	KO1	6	796.20			
H	Acanthurus nigrofuscus	5	KO1	48	1147.06			
H	Acanthurus nigrofuscus	5	KO1	12	90.30			
H	Acanthurus nigroris	5	KO1	4	2955.35			
H	Acanthurus olivaceus	5	KO1	70	3323.39			
H	Acanthurus dussumieri	5	KO1	2	653.19			
H	Acanthurus glaucopareius	5	KO1	1	61.53			
H	Ctenochaetus strigosus	5	KO1	49	3227.38			
H	Ctenochaetus strigosus	5	KO1	2	53.69			
H	Ctenochaetus strigosus	5	KO1	14	1849.87			
H	Zebrasoma flavescens	5	KO1	4	104.12			
H	Zebrasoma flavescens	5	KO1	4	213.12			
H	Naso lituratus	5	KO1	2	411.98			
H	Naso lituratus	5	KO1	1	72.58	228	15992.36	47.6
O	Melichthys niger	5	KO1	14	2286.70			
O	Melichthys niger	5	KO1	3	744.09			
O	Canthigaster jactator	5	KO1	4	14.25	21	3045.04	9.1
P	Abudefduf abdominalis	5	KO1	13	407.32	13	407.32	1.2
	TOTAL	5	KO1	330	33618.79	330	33618.79	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Cephalopholis argus	6	KO2	1	2043.61			
C	Cephalopholis argus	6	KO2	1	638.29			
C	Apogon kallopterus	6	KO2	1	1520.97			
C	Parupeneus multifasciatus	6	KO2	1	27.12			
C	Parupeneus multifasciatus	6	KO2	1	54.40			
C	Parupeneus bifasciatus	6	KO2	1	176.01			
C	Parupeneus bifasciatus	6	KO2	1	394.35			
C	Forcipiger flavissimus	6	KO2	2	18.30			
C	Chaetodon lunula	6	KO2	3	107.98			
C	Bodianus bilunulatus	6	KO2	1	467.86			
C	Bodianus bilunulatus	6	KO2	1	1141.37			
C	Labroides phthirophagus	6	KO2	3	1.88			
C	Thalassoma duperrey	6	KO2	3	82.17			
C	Thalassoma duperrey	6	KO2	3	164.85			
C	Thalassoma duperrey	6	KO2	2	22.33			
C	Coris gaimard	6	KO2	1	83.79			
C	Zanclus cornutus	6	KO2	2	208.32			
C	Sufflamen bursa	6	KO2	4	578.60			
C	Sufflamen bursa	6	KO2	2	171.75	34	7903.94	18.1
CF	Chaetodon unimaculatus	6	KO2	6	151.82			
CF	Chaetodon ornatissimus	6	KO2	57	3933.12			
CF	Chaetodon ornatissimus	6	KO2	2	273.78			
CF	Chaetodon multicinctus	6	KO2	2	26.06			
CF	Cantherhines dumerili	6	KO2	1	301.33	68	4686.11	10.7
H	Scarus psittacus	6	KO2	1	1873.52			
H	Scarus rubroviolaceus	6	KO2	1	2255.55			
H	Scarus rubroviolaceus	6	KO2	1	232.75			
H	Acanthurus triostegus	6	KO2	28	1296.82			
H	Acanthurus triostegus	6	KO2	16	1600.23			
H	Acanthurus leucopareius	6	KO2	4	266.96			
H	Acanthurus leucopareius	6	KO2	19	2521.31			
H	Acanthurus leucopareius	6	KO2	7	1628.73			
H	Acanthurus nigrofuscus	6	KO2	9	2406.14			
H	Acanthurus nigrofuscus	6	KO2	25	597.43			
H	Acanthurus nigrofuscus	6	KO2	18	135.44			
H	Acanthurus nigrofuscus	6	KO2	5	271.26			
H	Acanthurus nigroris	6	KO2	6	4433.02			
H	Acanthurus olivaceus	6	KO2	7	3942.19			
H	Acanthurus glaucopareius	6	KO2	1	116.74			
H	Acanthurus glaucopareius	6	KO2	1	61.53			
H	Ctenochaetus strigosus	6	KO2	5	134.22			
H	Ctenochaetus strigosus	6	KO2	14	922.11			
H	Ctenochaetus strigosus	6	KO2	7	924.94			
H	Zebrasoma flavescens	6	KO2	9	234.27			
H	Zebrasoma flavescens	6	KO2	7	372.96	191	26228.12	60.1
O	Melichthys niger	6	KO2	3	744.09			
O	Melichthys niger	6	KO2	9	1470.02			
O	Melichthys vidua	6	KO2	12	2388.36	24	4602.47	10.5
P	Abudefduf abdominalis	6	KO2	7	219.33	7	219.33	0.5
	TOTAL	6	KO2	324	43639.97	324	43639.97	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Aulostomus chinensis	7	KAHE1D	1	140.29			
C	Decapterus macarellus	7	KAHE1D	12	2299.60			
C	Chaetodon fremblii	7	KAHE1D	1	20.91			
C	Plectroglyphidodon imparipennis	7	KAHE1D	3	2.59			
C	Thalassoma duperrey	7	KAHE1D	11	1726.92			
C	Thalassoma duperrey	7	KAHE1D	25	684.76			
C	Thalassoma duperrey	7	KAHE1D	47	4561.44			
C	Thalassoma duperrey	7	KAHE1D	32	1758.36			
C	Thalassoma ballieui	7	KAHE1D	3	307.83			
C	Zanclus cornutus	7	KAHE1D	5	274.49			
C	Sufflamen bursa	7	KAHE1D	9	772.86	149	12550.05	53.2
CF	Chaetodon ornatissimus	7	KAHE1D	3	207.01			
CF	Chaetodon quadrimaculatus	7	KAHE1D	1	25.30	4	232.31	1.0
H	Scarus sordidus	7	KAHE1D	2	71.99			
H	Acanthurus nigrofuscus	7	KAHE1D	76	571.87			
H	Acanthurus nigrofuscus	7	KAHE1D	91	2174.63			
H	Ctenochaetus strigosus	7	KAHE1D	26	697.94	195	3516.43	14.9
O	Melichthys niger	7	KAHE1D	66	6577.23			
O	Melichthys vidua	7	KAHE1D	3	597.09	69	7174.32	30.4
P	Abudefduf vaigensis	7	KAHE1D	4	125.33			
P	Chromis vanderbilti	7	KAHE1D	25	7.90	29	133.23	0.6
	TOTAL	7	KAHE1D	446	23606.35	446	23606.35	100
C	Parupeneus multifasciatus	8	KAHE5B	2	54.23			
C	Plectroglyphidodon johnstonianus	8	KAHE5B	3	9.09			
C	Paracirrhites arcatus	8	KAHE5B	2	32.70			
C	Thalassoma duperrey	8	KAHE5B	3	164.85			
C	Thalassoma duperrey	8	KAHE5B	1	156.99			
C	Thalassoma duperrey	8	KAHE5B	3	9.45			
C	Thalassoma duperrey	8	KAHE5B	2	54.78			
C	Thalassoma lutescens	8	KAHE5B	1	63.55			
C	Zanclus cornutus	8	KAHE5B	5	520.79			
C	Rhinecanthus rectangulus	8	KAHE5B	4	181.45			
C	Sufflamen bursa	8	KAHE5B	3	257.62	29	1505.51	34.1
CF	Pervagor spilosoma	8	KAHE5B	1	16.22	1	16.22	0.4
H	Acanthurus nigrofuscus	8	KAHE5B	15	112.87			
H	Acanthurus nigrofuscus	8	KAHE5B	93	2222.42			
H	Ctenochaetus strigosus	8	KAHE5B	4	3.49			
H	Naso lituratus	8	KAHE5B	1	205.99	113	2544.77	57.7
O	Melichthys vidua	8	KAHE5B	1	199.03			
O	Cantherhines sandwichiensis	8	KAHE5B	1	82.05	2	281.08	6.4
P	Chromis vanderbilti	8	KAHE5B	193	60.97	193	60.97	1.4
	TOTAL	8	KAHE5B	338	4408.54	338	4408.54	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Decapterus macarellus	9	KAHE7B	120	22996.02			
C	Lutjanus kasmira	9	KAHE7B	75	14298.51			
C	Mulloides flavolineatus	9	KAHE7B	90	11725.12			
C	Parupeneus multifasciatus	9	KAHE7B	1	96.08			
C	Parupeneus multifasciatus	9	KAHE7B	2	471.50			
C	Paracirrhites arcatus	9	KAHE7B	2	32.70			
C	Thalassoma duperrey	9	KAHE7B	1	97.05			
C	Thalassoma duperrey	9	KAHE7B	1	27.39			
C	Coris venusta	9	KAHE7B	1	23.64			
C	Stethojulis balteata	9	KAHE7B	1	35.76			
C	Zanclus cornutus	9	KAHE7B	3	164.70			
C	Sufflamen bursa	9	KAHE7B	4	343.49	301	50311.96	99.3
H	Acanthurus nigrofuscus	9	KAHE7B	1	23.90			
H	Acanthurus olivaceus	9	KAHE7B	1	163.52	2	187.41	0.4
O	Melichthys vidua	9	KAHE7B	1	124.35			
O	Canthigaster coronata	9	KAHE7B	2	15.18			
O	Canthigaster jactator	9	KAHE7B	1	3.56	4	143.09	0.3
P	Dascyllus albisella	9	KAHE7B	4	12.35			
P	Chromis vanderbilti	9	KAHE7B	39	12.32	43	24.67	0.05
	TOTAL	9	KAHE7B	350	50667.14	350	50667.14	100
C	Decapterus macarellus	10	KAHE7C	45	8623.51			
C	Parupeneus pleurostigma	10	KAHE7C	1	98.25			
C	Parupeneus multifasciatus	10	KAHE7C	2	310.84			
C	Sufflamen bursa	10	KAHE7C	7	601.11	55	9633.71	61.5
H	Acanthurus triostegus	10	KAHE7C	34	3400.48			
H	Acanthurus nigrofuscus	10	KAHE7C	3	71.69			
H	Acanthurus nigrofuscus	10	KAHE7C	4	217.01			
H	Acanthurus nigroris	10	KAHE7C	2	204.95			
H	Acanthurus olivaceus	10	KAHE7C	13	2125.71	56	6019.85	38.4
P	Dascyllus albisella	10	KAHE7C	9	7.23	9	7.23	0.05
	TOTAL	10	KAHE7C	120	15660.79	120	15660.79	100
C	Paracirrhites arcatus	11	KAHE7D	1	3.45			
C	Sufflamen bursa	11	KAHE7D	1	85.87	2	89.32	38.8
H	Naso unicornis	11	KAHE7D	3	16.31	3	16.31	7.1
O	Melichthys vidua	11	KAHE7D	1	124.35	1	124.35	54.1
	TOTAL	11	KAHE7D	6	229.97	6	229.97	100
C	Parupeneus multifasciatus	12	KAHE7E	10	271.17			
C	Parupeneus multifasciatus	12	KAHE7E	2	192.16			
C	Parupeneus multifasciatus	12	KAHE7E	5	15.60			
C	Paracirrhites arcatus	12	KAHE7E	4	13.78			
C	Thalassoma duperrey	12	KAHE7E	1	54.95			
C	Thalassoma duperrey	12	KAHE7E	1	27.39			
C	Zanclus cornutus	12	KAHE7E	1	54.90			
C	Sufflamen bursa	12	KAHE7E	4	343.49	28	973.44	42.8
CF	Chaetodon ornatissimus	12	KAHE7E	1	69.00			
CF	Chaetodon multicinctus	12	KAHE7E	4	3.31	5	72.31	3.2
H	Acanthurus nigrofuscus	12	KAHE7E	21	158.02			
H	Acanthurus nigrofuscus	12	KAHE7E	10	10.44			
H	Acanthurus olivaceus	12	KAHE7E	3	17.20			
H	Acanthurus olivaceus	12	KAHE7E	4	375.08			
H	Ctenochaetus strigosus	12	KAHE7E	3	2.61			
H	Naso lituratus	12	KAHE7E	5	21.19			
H	Naso lituratus	12	KAHE7E	1	72.58	47	657.12	28.9
O	Melichthys vidua	12	KAHE7E	3	373.04			
O	Canthigaster coronata	12	KAHE7E	2	15.18			
O	Canthigaster jactator	12	KAHE7E	3	3.68	8	391.90	17.2
P	Chromis vanderbilti	12	KAHE7E	570	180.06			
P	Chromis hanui	12	KAHE7E	1	0.75	571	180.80	7.9
	TOTAL	12	KAHE7E	659	2275.57	659	2275.57	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Aulostomus chinensis	13	KAHE10	1	27.72			
C	Lutjanus kasmira	13	KAHE10	250	47661.71			
C	Mulloides vanicolensis	13	KAHE10	30	2716.12			
C	Mulloides vanicolensis	13	KAHE10	45	14911.88			
C	Parupeneus pleurostigma	13	KAHE10	2	196.50			
C	Parupeneus multifasciatus	13	KAHE10	1	54.40			
C	Parupeneus multifasciatus	13	KAHE10	2	54.23			
C	Forcipiger flavissimus	13	KAHE10	5	45.75			
C	Paracirrhites arcatus	13	KAHE10	2	32.70			
C	Thalassoma duperrey	13	KAHE10	9	100.47			
C	Thalassoma duperrey	13	KAHE10	7	679.36			
C	Thalassoma duperrey	13	KAHE10	10	273.90			
C	Thalassoma duperrey	13	KAHE10	12	659.39			
C	Thalassoma lutescens	13	KAHE10	1	63.55			
C	Stethojulis balteata	13	KAHE10	3	107.29			
C	Zanclus cornutus	13	KAHE10	2	109.80			
C	Rhinecanthus rectangulus	13	KAHE10	2	171.75			
C	Rhinecanthus rectangulus	13	KAHE10	1	45.36			
C	Sufflamen bursa	13	KAHE10	1	85.87			
C	Sufflamen fraenatus	13	KAHE10	2	449.59	388	68447.34	82.8
H	Calotomus carolinus	13	KAHE10	1	2683.87			
H	Calotomus carolinus	13	KAHE10	1	1676.08			
H	Acanthurus triostegus	13	KAHE10	3	51.50			
H	Acanthurus triostegus	13	KAHE10	45	2084.18			
H	Acanthurus triostegus	13	KAHE10	28	2800.40			
H	Acanthurus nigrofuscus	13	KAHE10	1	102.47			
H	Acanthurus nigrofuscus	13	KAHE10	51	1218.75			
H	Acanthurus nigrofuscus	13	KAHE10	34	1844.58			
H	Naso lituratus	13	KAHE10	2	411.98	166	12873.81	15.6
O	Stegastes fasciolatus	13	KAHE10	4	103.92			
O	Cantherhines sandwichiensis	13	KAHE10	2	164.10			
O	Canthigaster jactator	13	KAHE10	2	7.12	8	275.15	0.3
P	Dascyllus albisella	13	KAHE10	13	40.15			
P	Abudefduf abdominalis	13	KAHE10	12	375.99			
P	Abudefduf vaigensis	13	KAHE10	13	609.07			
P	Chromis vanderbilti	13	KAHE10	104	32.85	142	1058.07	1.3
	TOTAL	13	KAHE10	704	82654.37	704	82654.37	100
C	Parupeneus multifasciatus	14	NANA1	3	163.20			
C	Parupeneus multifasciatus	14	NANA1	4	108.47			
C	Plectroglyphidodon imparipennis	14	NANA1	10	8.62			
C	Thalassoma duperrey	14	NANA1	3	9.45			
C	Thalassoma lutescens	14	NANA1	1	32.76			
C	Stethojulis balteata	14	NANA1	1	35.76			
C	Rhinecanthus rectangulus	14	NANA1	1	45.36			
C	Rhinecanthus rectangulus	14	NANA1	2	171.75	25	575.37	12.5
H	Acanthurus triostegus	14	NANA1	3	300.04			
H	Acanthurus triostegus	14	NANA1	4	185.26			
H	Acanthurus nigrofuscus	14	NANA1	5	37.62			
H	Acanthurus olivaceus	14	NANA1	4	375.08			
H	Acanthurus olivaceus	14	NANA1	8	1308.13			
H	Acanthurus olivaceus	14	NANA1	3	1179.63			
H	Acanthurus olivaceus	14	NANA1	2	523.33			
H	Zebrasoma flavescens	14	NANA1	2	106.56	31	4015.66	87.2
O	Canthigaster jactator	14	NANA1	1	3.56	1	3.56	0.1
P	Chromis vanderbilti	14	NANA1	29	9.16	29	9.16	0.2
	TOTAL	14	NANA1	86	4603.75	86	4603.75	100

GRP	19-Nov-18 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Gymnomuraena zebra	15	NANA2	1	583.54			
C	Parupeneus multifasciatus	15	NANA2	1	96.08			
C	Parupeneus multifasciatus	15	NANA2	2	54.23			
C	Parupeneus multifasciatus	15	NANA2	1	235.75			
C	Stethojulis balteata	15	NANA2	1	463.80			
C	Zanclus cornutus	15	NANA2	1	104.16	7	1537.56	3.3
CF	Chaetodon ornatissimus	15	NANA2	2	138.00			
CF	Chaetodon quadrimaculatus	15	NANA2	4	101.22			
CF	Chaetodon multicinctus	15	NANA2	1	0.83	7	240.05	0.5
H	Calotomus carolinus	15	NANA2	1	2683.87			
H	Acanthurus triostegus	15	NANA2	9	900.13			
H	Acanthurus leucopareius	15	NANA2	47	6236.91			
H	Acanthurus leucopareius	15	NANA2	6	400.44			
H	Acanthurus leucopareius	15	NANA2	56	13029.81			
H	Acanthurus nigrofuscus	15	NANA2	13	310.66			
H	Acanthurus nigrofuscus	15	NANA2	14	105.34			
H	Acanthurus nigroris	15	NANA2	3	2216.51			
H	Acanthurus olivaceus	15	NANA2	18	10137.06			
H	Acanthurus olivaceus	15	NANA2	5	3883.02			
H	Ctenochaetus strigosus	15	NANA2	3	2.61			
H	Ctenochaetus strigosus	15	NANA2	5	134.22			
H	Zebrasoma flavescens	15	NANA2	2	3.38			
H	Zebrasoma flavescens	15	NANA2	2	106.56			
H	Naso lituratus	15	NANA2	4	1246.46	188	41397.00	88.7
O	Stegastes fasciolatus	15	NANA2	3	44.29			
O	Melichthys niger	15	NANA2	7	1736.22			
O	Canthigaster jactator	15	NANA2	1	3.56	11	1784.07	3.8
P	Naso brevirostris	15	NANA2	14	1723.65	14	1723.65	3.7
	TOTAL	15	NANA2	227	46682.33	227	46682.33	100
C	Aulostomus chinensis	16	PIPE	2	421.24			
C	Decapterus macarellus	16	PIPE	75	14372.51			
C	Lutjanus kasmira	16	PIPE	300	57194.06			
C	Mulloides flavolineatus	16	PIPE	125	33667.61			
C	Mulloides vanicolensis	16	PIPE	160	53020.00			
C	Chaetodon fremblii	16	PIPE	1	20.91			
C	Paracirrhites arcatus	16	PIPE	3	49.05			
C	Paracirrhites forsteri	16	PIPE	2	79.29			
C	Thalassoma duperrey	16	PIPE	31	1703.42			
C	Thalassoma duperrey	16	PIPE	13	1261.68			
C	Stethojulis balteata	16	PIPE	3	217.17			
C	Zanclus cornutus	16	PIPE	8	833.26			
C	Sufflamen bursa	16	PIPE	4	343.49	727	163183.68	91.7
CF	Chaetodon ornatissimus	16	PIPE	2	138.00			
CF	Chaetodon multicinctus	16	PIPE	6	78.18			
CF	Exallias brevis	16	PIPE	1	29.55	9	245.73	0.1
H	Scarus sordidus	16	PIPE	1	544.57			
H	Scarus sordidus	16	PIPE	2	152.03			
H	Acanthurus nigrofuscus	16	PIPE	49	1170.96			
H	Ctenochaetus strigosus	16	PIPE	6	792.80			
H	Ctenochaetus strigosus	16	PIPE	9	592.78			
H	Ctenochaetus strigosus	16	PIPE	23	617.41	90	3870.55	2.2
O	Stegastes fasciolatus	16	PIPE	28	727.45			
O	Melichthys niger	16	PIPE	7	1143.35			
O	Melichthys vidua	16	PIPE	1	124.35			
O	Canthigaster jactator	16	PIPE	7	24.93			
O	Canthigaster rivulata	16	PIPE	1	13.65	44	2033.73	1.1
P	Chaetodon kleini	16	PIPE	7	45.91			
P	Chaetodon miliaris	16	PIPE	5	105.84			
P	Dascyllus albisella	16	PIPE	25	77.21			
P	Abudefduf abdominalis	16	PIPE	175	5483.20			
P	Abudefduf vaigensis	16	PIPE	90	2819.93			
P	Chromis vanderbilti	16	PIPE	135	42.65			
P	Chromis agilis	16	PIPE	4	2.99	441	8577.72	4.8
	TOTAL	16	PIPE	1311	177911.41	1311	177911.41	100

10 JANUARY 2019 FIELD DATA

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Lutjanus fulvus	1	EAST1	5	1107.79			
C	Lutjanus fulvus	1	EAST1	3	466.82			
C	Parupeneus multifasciatus	1	EAST1	2	680.89			
C	Parupeneus multifasciatus	1	EAST1	1	472.94			
C	Chaetodon lunula	1	EAST1	1	35.99			
C	Plectroglyphidodon imparipennis	1	EAST1	2	1.72			
C	Bodianus bilunulatus	1	EAST1	1	1462.82			
C	Labroides phthirophagus	1	EAST1	1	1.49			
C	Thalassoma duperrey	1	EAST1	3	164.85			
C	Thalassoma duperrey	1	EAST1	5	55.82			
C	Rhinecanthus rectangulus	1	EAST1	1	45.36			
C	Rhinecanthus rectangulus	1	EAST1	3	257.62			
C	Sufflamen fraenatus	1	EAST1	1	329.34			
C	Sufflamen fraenatus	1	EAST1	1	144.65			
C	Diodon hystrix	1	EAST1	1	660.12	31	5888.21	13.8
CF	Chaetodon ornatissimus	1	EAST1	1	136.89	1	136.89	0.3
H	Acanthurus triostegus	1	EAST1	11	509.47			
H	Acanthurus triostegus	1	EAST1	12	1200.17			
H	Acanthurus triostegus	1	EAST1	27	5065.25			
H	Acanthurus leucopareius	1	EAST1	9	1194.30			
H	Acanthurus nigrofuscus	1	EAST1	27	203.16			
H	Acanthurus nigrofuscus	1	EAST1	5	271.26			
H	Acanthurus nigrofuscus	1	EAST1	30	716.91			
H	Acanthurus nigroris	1	EAST1	6	143.38			
H	Acanthurus olivaceus	1	EAST1	15	8447.55			
H	Acanthurus olivaceus	1	EAST1	12	3140.00			
H	Acanthurus olivaceus	1	EAST1	14	3663.34			
H	Acanthurus dussumieri	1	EAST1	3	501.65			
H	Acanthurus dussumieri	1	EAST1	5	5511.28			
H	Acanthurus blochii	1	EAST1	5	2267.97			
H	Naso lituratus	1	EAST1	3	934.84			
H	Naso unicornis	1	EAST1	3	1575.77			
H	Naso unicornis	1	EAST1	1	881.55	188	36227.87	85.1
O	Melichthys vidua	1	EAST1	1	199.03			
O	Canthigaster jactator	1	EAST1	1	3.56	2	202.59	0.5
P	Chaetodon miliaris	1	EAST1	3	63.50			
P	Chromis vanderbilti	1	EAST1	140	44.22	143	107.73	0.3
	TOTAL	1	EAST1	365	42563.29	365	42563.29	100
C	Plectroglyphidodon johnstonianu	2	EAST2	1	3.03			
C	Paracirrhites arcatus	2	EAST2	1	16.35			
C	Paracirrhites forsteri	2	EAST2	1	39.65			
C	Pseudocheilinus octotaenia	2	EAST2	1	14.41			
C	Thalassoma duperrey	2	EAST2	20	223.27			
C	Thalassoma duperrey	2	EAST2	14	383.47			
C	Thalassoma duperrey	2	EAST2	12	659.39			
C	Thalassoma duperrey	2	EAST2	7	22.05			
C	Halichoeres ornatissimus	2	EAST2	1	16.45			
C	Rhinecanthus rectangulus	2	EAST2	2	90.72			
C	Rhinecanthus rectangulus	2	EAST2	3	257.62			
C	Sufflamen bursa	2	EAST2	1	85.87	64	1812.28	3.5
CF	Chaetodon ornatissimus	2	EAST2	2	273.78	2	273.78	0.5
H	Calotomus carolinus	2	EAST2	1	707.00			
H	Acanthurus triostegus	2	EAST2	6	600.09			
H	Acanthurus leucopareius	2	EAST2	5	663.50			
H	Acanthurus nigrofuscus	2	EAST2	14	334.56			
H	Acanthurus nigrofuscus	2	EAST2	11	82.77			
H	Acanthurus nigroris	2	EAST2	6	4433.02			
H	Acanthurus nigroris	2	EAST2	11	4302.77			
H	Acanthurus nigroris	2	EAST2	18	1844.53			
H	Acanthurus olivaceus	2	EAST2	33	18584.62			
H	Acanthurus olivaceus	2	EAST2	58	15176.69			
H	Acanthurus olivaceus	2	EAST2	4	3106.42			
H	Zebrasoma flavescens	2	EAST2	7	372.96	174	50208.92	96.0
P	Chromis vanderbilti	2	EAST2	38	12.00	38	12.00	0.02
	TOTAL	2	EAST2	278	52306.99	278	52306.99	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Cephalopholis argus	3	EAST3	1	1355.30			
C	Parupeneus multifasciatus	3	EAST3	1	54.40			
C	Parupeneus bifasciatus	3	EAST3	1	59.77			
C	Forcipiger flavissimus	3	EAST3	2	18.30			
C	Plectroglyphidodon johnstonianu	3	EAST3	2	6.06			
C	Labroides phthirophagus	3	EAST3	1	1.49			
C	Thalassoma duperrey	3	EAST3	11	301.30			
C	Thalassoma duperrey	3	EAST3	7	78.14			
C	Thalassoma duperrey	3	EAST3	7	384.64			
C	Gomphosus varius	3	EAST3	2	22.08			
C	Coris gaimard	3	EAST3	1	8.57			
C	Stethojulis balteata	3	EAST3	1	35.76			
C	Sufflamen bursa	3	EAST3	3	257.62	40	2583.43	31.2
CF	Chaetodon ornatissimus	3	EAST3	2	138.00			
CF	Chaetodon multicinctus	3	EAST3	10	130.30	12	268.30	3.2
H	Acanthurus nigrofuscus	3	EAST3	38	908.09			
H	Acanthurus nigrofuscus	3	EAST3	43	323.56			
H	Acanthurus olivaceus	3	EAST3	5	2815.85			
H	Ctenochaetus strigosus	3	EAST3	2	1.74			
H	Ctenochaetus strigosus	3	EAST3	12	90.91			
H	Ctenochaetus strigosus	3	EAST3	27	724.79			
H	Naso lituratus	3	EAST3	1	127.73	128	4992.67	60.3
O	Stegastes fasciolatus	3	EAST3	9	233.82			
O	Melichthys vidua	3	EAST3	1	199.03	10	432.85	5.2
	TOTAL	3	EAST3	190	8277.25	190	8277.25	100
C	Gymnomureana zebra	4	EAST4	1	325.01			
C	Parupeneus multifasciatus	4	EAST4	2	6.24			
C	Plectroglyphidodon johnstonianu	4	EAST4	1	1.72			
C	Paracirrhites arcatus	4	EAST4	7	114.44			
C	Paracirrhites forsteri	4	EAST4	1	39.65			
C	Bodianus bilunulatus	4	EAST4	1	648.58			
C	Labroides phthirophagus	4	EAST4	1	1.49			
C	Thalassoma duperrey	4	EAST4	14	156.29			
C	Thalassoma duperrey	4	EAST4	9	246.51			
C	Thalassoma duperrey	4	EAST4	10	549.49			
C	Stethojulis balteata	4	EAST4	1	35.76			
C	Rhinecanthus rectangulus	4	EAST4	1	45.36			
C	Rhinecanthus rectangulus	4	EAST4	1	144.65			
C	Rhinecanthus rectangulus	4	EAST4	6	515.24	56	2830.43	7.9
H	Acanthurus nigrofuscus	4	EAST4	11	262.87			
H	Acanthurus nigrofuscus	4	EAST4	16	120.39			
H	Acanthurus nigroris	4	EAST4	3	307.42			
H	Acanthurus olivaceus	4	EAST4	26	6803.34			
H	Acanthurus olivaceus	4	EAST4	5	3883.02			
H	Acanthurus olivaceus	4	EAST4	34	19147.79			
H	Acanthurus blochii	4	EAST4	2	1567.62	97	32092.46	90.1
O	Stegastes fasciolatus	4	EAST4	4	103.92			
O	Melichthys niger	4	EAST4	1	163.34			
O	Melichthys vidua	4	EAST4	2	398.06			
O	Canthigaster jactator	4	EAST4	2	7.12	9	672.44	1.9
P	Dascyllus albisella	4	EAST4	2	1.61			
P	Chromis vanderbilti	4	EAST4	69	21.80	71	23.40	0.1
	TOTAL	4	EAST4	233	35618.74	233	35618.74	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Decapterus macarellus	5	KO1	4	333.78			
C	Lutjanus fulvus	5	KO1	1	221.56			
C	Monotaxis grandoculis	5	KO1	1	34.79			
C	Parupeneus multifasciatus	5	KO1	1	11.05			
C	Parupeneus multifasciatus	5	KO1	1	54.40			
C	Forcipiger flavissimus	5	KO1	1	9.15			
C	Plectroglyphidodon johnstonianu	5	KO1	1	3.03			
C	Paracirrhites arcatus	5	KO1	1	16.35			
C	Thalassoma duperrey	5	KO1	7	191.73			
C	Thalassoma duperrey	5	KO1	5	274.74			
C	Thalassoma duperrey	5	KO1	2	22.33			
C	Sufflamen bursa	5	KO1	2	171.75	27	1344.66	12.9
CF	Chaetodon unimaculatus	5	KO1	2	50.61			
CF	Chaetodon multicinctus	5	KO1	6	78.18	8	128.79	1.2
H	Acanthurus triostegus	5	KO1	7	324.21			
H	Acanthurus triostegus	5	KO1	2	200.03			
H	Acanthurus nigrofuscus	5	KO1	5	37.62			
H	Acanthurus nigrofuscus	5	KO1	13	310.66			
H	Acanthurus nigroris	5	KO1	1	54.25			
H	Ctenochaetus strigosus	5	KO1	30	1975.95			
H	Ctenochaetus strigosus	5	KO1	21	2774.81			
H	Ctenochaetus strigosus	5	KO1	13	348.97			
H	Zebrasoma flavescens	5	KO1	2	52.06	94	6078.56	58.2
O	Stegastes fasciolatus	5	KO1	2	51.96			
O	Melichthys niger	5	KO1	5	816.68			
O	Canthigaster jactator	5	KO1	3	10.69	10	879.32	8.4
P	Abudefduf abdominalis	5	KO1	60	1879.95			
P	Abudefduf vaigensis	5	KO1	4	125.33			
P	Chromis vanderbilti	5	KO1	6	1.90	70	2007.18	19.2
	TOTAL	5	KO1	209	10438.51	209	10438.51	100
C	Forcipiger flavissimus	6	KO2	2	18.30			
C	Plectroglyphidodon imparipennis	6	KO2	1	0.86			
C	Paracirrhites arcatus	6	KO2	1	16.35			
C	Labroides phthirophagus	6	KO2	2	2.98			
C	Thalassoma duperrey	6	KO2	7	384.64			
C	Thalassoma duperrey	6	KO2	5	136.95			
C	Thalassoma duperrey	6	KO2	3	33.49			
C	Halichoeres ornatissimus	6	KO2	1	25.14			
C	Zanclus cornutus	6	KO2	2	208.32			
C	Sufflamen bursa	6	KO2	1	85.87	25	912.90	10.4
CF	Chaetodon unimaculatus	6	KO2	2	50.61			
CF	Chaetodon ornatissimus	6	KO2	2	138.00	4	188.61	2.2
H	Scarus sordidus	6	KO2	1	1427.57			
H	Acanthurus nigrofuscus	6	KO2	27	645.22			
H	Acanthurus nigrofuscus	6	KO2	11	82.77			
H	Acanthurus nigroris	6	KO2	3	307.42			
H	Acanthurus olivaceus	6	KO2	1	93.77			
H	Acanthurus olivaceus	6	KO2	3	785.00			
H	Acanthurus glaucopareius	6	KO2	1	61.53			
H	Ctenochaetus strigosus	6	KO2	4	107.38			
H	Ctenochaetus strigosus	6	KO2	9	1189.20			
H	Ctenochaetus strigosus	6	KO2	5	329.32			
H	Zebrasoma flavescens	6	KO2	3	159.84			
H	Naso lituratus	6	KO2	1	127.73	69	5316.76	60.8
O	Melichthys niger	6	KO2	10	1633.35			
O	Melichthys vidua	6	KO2	3	597.09			
O	Cantherhines sandwichiensis	6	KO2	1	82.05			
O	Canthigaster jactator	6	KO2	2	7.12	16	2319.62	26.5
P	Chromis vanderbilti	6	KO2	20	6.32	20	6.32	0.1
	TOTAL	6	KO2	134	8744.21	134	8744.21	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Myripristis amaenus	7	KAHE1D	5	212.02			
C	Monotaxis grandoculis	7	KAHE1D	1	326.42			
C	Mulloides flavolineatus	7	KAHE1D	40	10773.63			
C	Mulloides vanicolensis	7	KAHE1D	7	633.76			
C	Parupeneus multifasciatus	7	KAHE1D	1	27.12			
C	Forcipiger flavissimus	7	KAHE1D	1	9.15			
C	Plectroglyphidodon johnstonianu	7	KAHE1D	1	1.72			
C	Paracirrhites arcatus	7	KAHE1D	3	49.05			
C	Cirrhitus pinnulatus	7	KAHE1D	1	90.86			
C	Cirrhitops fasciatus	7	KAHE1D	1	15.63			
C	Thalassoma duperrey	7	KAHE1D	28	1538.57			
C	Thalassoma duperrey	7	KAHE1D	24	2329.25			
C	Thalassoma duperrey	7	KAHE1D	19	520.42			
C	Gomphosus varius	7	KAHE1D	4	44.17			
C	Halichoeres ornatissimus	7	KAHE1D	1	16.45			
C	Zanclus cornutus	7	KAHE1D	2	109.80			
C	Sufflamen bursa	7	KAHE1D	2	171.75	141	16869.75	56.9
CF	Chaetodon quadrimaculatus	7	KAHE1D	1	25.30			
CF	Chaetodon multicinctus	7	KAHE1D	2	26.06			
CF	Cantherhines dumerili	7	KAHE1D	1	442.38	4	493.74	1.7
H	Scarus sordidus	7	KAHE1D	13	467.93			
H	Scarus sordidus	7	KAHE1D	10	760.13			
H	Acanthurus nigrofuscus	7	KAHE1D	130	3106.62			
H	Acanthurus nigrofuscus	7	KAHE1D	97	729.89			
H	Ctenochaetus strigosus	7	KAHE1D	8	526.92			
H	Ctenochaetus strigosus	7	KAHE1D	9	68.18			
H	Ctenochaetus strigosus	7	KAHE1D	31	832.16	298	6491.83	21.9
O	Stegastes fasciolatus	7	KAHE1D	3	77.94			
O	Melichthys niger	7	KAHE1D	49	4883.10			
O	Melichthys vidua	7	KAHE1D	3	373.04			
O	Cantherhines sandwichiensis	7	KAHE1D	1	82.05			
O	Canthigaster jactator	7	KAHE1D	2	7.12			
O	Canthigaster rivulata	7	KAHE1D	1	7.59	59	5430.84	18.3
P	Dascyllus albisella	7	KAHE1D	6	18.53			
P	Abudefduf abdominalis	7	KAHE1D	5	156.66			
P	Chromis vanderbilti	7	KAHE1D	81	25.59			
P	Chromis ovalis	7	KAHE1D	25	148.29	117	349.07	1.2
	TOTAL	7	KAHE1D	619	29635.24	619	29635.24	100
C	Parupeneus multifasciatus	8	KAHE5B	4	217.60			
C	Forcipiger flavissimus	8	KAHE5B	2	18.30			
C	Chaetodon auriga	8	KAHE5B	2	96.78			
C	Plectroglyphidodon johnstonianu	8	KAHE5B	2	3.44			
C	Paracirrhites arcatus	8	KAHE5B	2	32.70			
C	Thalassoma duperrey	8	KAHE5B	4	109.56			
C	Thalassoma duperrey	8	KAHE5B	7	78.14			
C	Thalassoma duperrey	8	KAHE5B	5	274.74			
C	Macropharyngodon geoffroy	8	KAHE5B	5	93.14			
C	Halichoeres ornatissimus	8	KAHE5B	1	25.14			
C	Zanclus cornutus	8	KAHE5B	3	312.47			
C	Rhinecanthus rectangulus	8	KAHE5B	2	90.72			
C	Sufflamen bursa	8	KAHE5B	2	171.75	41	1524.49	32.8
CF	Chaetodon multicinctus	8	KAHE5B	2	26.06	2	26.06	0.6
H	Acanthurus nigrofuscus	8	KAHE5B	58	1386.03			
H	Acanthurus nigrofuscus	8	KAHE5B	10	75.25			
H	Acanthurus nigrofuscus	8	KAHE5B	14	759.53			
H	Acanthurus nigroris	8	KAHE5B	4	95.59			
H	Zebrasoma flavescens	8	KAHE5B	2	52.06			
H	Naso lituratus	8	KAHE5B	1	14.90	89	2383.35	51.2
O	Stegastes fasciolatus	8	KAHE5B	1	25.98			
O	Melichthys niger	8	KAHE5B	3	298.97			
O	Melichthys vidua	8	KAHE5B	3	373.04			
O	Canthigaster jactator	8	KAHE5B	3	10.69	10	708.67	15.2
P	Chromis vanderbilti	8	KAHE5B	35	11.06	35	11.06	0.2
	TOTAL	8	KAHE5B	177	4653.63	177	4653.63	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Mulloides flavolineatus	9	KAHE7B	1	191.63			
C	Parupeneus pleurostigma	9	KAHE7B	1	98.25			
C	Parupeneus multifasciatus	9	KAHE7B	2	192.16			
C	Parupeneus multifasciatus	9	KAHE7B	1	27.12			
C	Parupeneus multifasciatus	9	KAHE7B	1	54.40			
C	Parupeneus multifasciatus	9	KAHE7B	1	235.75			
C	Parupeneus multifasciatus	9	KAHE7B	2	310.84			
C	Paracirrhites arcatus	9	KAHE7B	1	16.35			
C	Thalassoma duperrey	9	KAHE7B	3	33.49			
C	Thalassoma duperrey	9	KAHE7B	1	27.39			
C	Thalassoma duperrey	9	KAHE7B	2	109.90			
C	Gomphosus varius	9	KAHE7B	1	39.39			
C	Stethojulis balteata	9	KAHE7B	2	71.53			
C	Zanclus cornutus	9	KAHE7B	1	104.16			
C	Sufflamen bursa	9	KAHE7B	6	515.24			
C	Sufflamen fraenatus	9	KAHE7B	1	461.25	27	2488.85	62.1
CF	Chaetodon multicinctus	9	KAHE7B	2	13.31			
CF	Pervagor melanocephalus	9	KAHE7B	1	16.22	3	29.53	0.7
H	Acanthurus triostegus	9	KAHE7B	1	100.01			
H	Acanthurus leucopareius	9	KAHE7B	1	232.68			
H	Acanthurus nigrofuscus	9	KAHE7B	5	271.26			
H	Acanthurus nigrofuscus	9	KAHE7B	8	191.18			
H	Acanthurus olivaceus	9	KAHE7B	1	47.48			
H	Naso unicornis	9	KAHE7B	1	278.71	17	1121.31	28.0
O	Melichthys vidua	9	KAHE7B	2	248.69			
O	Cantherhines sandwichiensis	9	KAHE7B	1	82.05			
O	Canthigaster jactator	9	KAHE7B	2	7.12	5	337.87	8.4
P	Dascyllus albisella	9	KAHE7B	6	18.53			
P	Chromis vanderbilti	9	KAHE7B	47	14.85	53	33.38	0.8
	TOTAL	9	KAHE7B	105	4010.94	105	4010.94	100
C	Decapterus macarellus	10	KAHE7C	40	5211.16			
C	Sufflamen bursa	10	KAHE7C	4	343.49	44	5554.66	46.4
CF	Pervagor spilosoma	10	KAHE7C	1	36.19	1	36.19	0.3
H	Acanthurus triostegus	10	KAHE7C	6	600.09			
H	Acanthurus nigroris	10	KAHE7C	1	172.30			
H	Acanthurus olivaceus	10	KAHE7C	13	5111.73			
H	Acanthurus blochii	10	KAHE7C	1	232.24			
H	Naso lituratus	10	KAHE7C	1	127.73	22	6244.09	52.2
O	Melichthys vidua	10	KAHE7C	1	124.35	1	124.35	1.0
	TOTAL	10	KAHE7C	68	11959.28	68	11959.28	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Decapterus macarellus	11	KAHE7D	25	2086.12			
C	Paracirrhites arcatus	11	KAHE7D	2	16.24			
C	Sufflamen bursa	11	KAHE7D	1	85.87	28	2188.22	99.4
O	Canthigaster jactator	11	KAHE7D	4	14.25	4	14.25	0.6
	TOTAL	11	KAHE7D	32	2202.47	32	2202.47	100
C	Aulostomus chinensis	12	KAHE7E	1	12.84			
C	Parupeneus multifasciatus	12	KAHE7E	9	99.46			
C	Parupeneus multifasciatus	12	KAHE7E	5	135.58			
C	Parupeneus multifasciatus	12	KAHE7E	19	59.26			
C	Plectroglyphidodon johnstonianu	12	KAHE7E	2	1.72			
C	Paracirrhites arcatus	12	KAHE7E	1	3.45			
C	Cirrhitops fasciatus	12	KAHE7E	1	8.23			
C	Labroides phthirophagus	12	KAHE7E	2	2.98			
C	Pseudocheilinus octotaenia	12	KAHE7E	1	14.41			
C	Thalassoma duperrey	12	KAHE7E	3	291.16			
C	Thalassoma duperrey	12	KAHE7E	1	54.95			
C	Pseudojuloides cerasinus	12	KAHE7E	4	12.60			
C	Stethojulis balteata	12	KAHE7E	1	72.39			
C	Macropharyngodon geoffroy	12	KAHE7E	4	22.99			
C	Zanclus cornutus	12	KAHE7E	2	208.32			
C	Sufflamen bursa	12	KAHE7E	2	171.75			
C	Sufflamen fraenatus	12	KAHE7E	1	224.79			
C	Sufflamen fraenatus	12	KAHE7E	1	623.45	60	2020.33	68.2
CF	Chaetodon multicinctus	12	KAHE7E	2	13.31	2	13.31	0.4
H	Centropyge potteri	12	KAHE7E	1	10.62			
H	Acanthurus nigrofuscus	12	KAHE7E	24	25.05			
H	Acanthurus nigrofuscus	12	KAHE7E	5	37.62			
H	Ctenochaetus strigosus	12	KAHE7E	11	9.59			
H	Zebrasoma flavescens	12	KAHE7E	6	10.13			
H	Naso lituratus	12	KAHE7E	2	255.47			
H	Naso lituratus	12	KAHE7E	1	4.24	50	352.71	11.9
O	Melichthys niger	12	KAHE7E	1	163.34			
O	Melichthys vidua	12	KAHE7E	2	248.69			
O	Canthigaster coronata	12	KAHE7E	1	13.65			
O	Canthigaster jactator	12	KAHE7E	4	8.82	8	434.50	14.7
P	Chromis vanderbilti	12	KAHE7E	434	137.10			
P	Chromis hanui	12	KAHE7E	5	3.73	439	140.83	4.8
	TOTAL	12	KAHE7E	559	2961.68	559	2961.68	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Mulloides vanicolensis	13	KAHE10	80	26510.00			
C	Parupeneus multifasciatus	13	KAHE10	4	108.47			
C	Parupeneus multifasciatus	13	KAHE10	2	471.50			
C	Parupeneus multifasciatus	13	KAHE10	5	480.41			
C	Forcipiger flavissimus	13	KAHE10	2	18.30			
C	Plectroglyphidodon imparipennis	13	KAHE10	1	0.86			
C	Thalassoma duperrey	13	KAHE10	6	66.98			
C	Thalassoma duperrey	13	KAHE10	3	470.98			
C	Thalassoma duperrey	13	KAHE10	4	388.21			
C	Thalassoma duperrey	13	KAHE10	6	164.34			
C	Thalassoma duperrey	13	KAHE10	7	384.64			
C	Gomphosus varius	13	KAHE10	1	11.04			
C	Stethojulis balteata	13	KAHE10	1	35.76			
C	Macropharyngodon geoffroy	13	KAHE10	1	18.63			
C	Rhinecanthus rectangulus	13	KAHE10	4	343.49			
C	Sufflamen bursa	13	KAHE10	3	257.62			
C	Sufflamen fraenatus	13	KAHE10	1	329.34	131	30060.57	74.3
CF	Chaetodon multicinctus	13	KAHE10	2	26.06			
CF	Pervagor spilosoma	13	KAHE10	2	32.43	4	58.49	0.1
H	Calotomus carolinus	13	KAHE10	1	2138.86			
H	Acanthurus triostegus	13	KAHE10	18	833.67			
H	Acanthurus triostegus	13	KAHE10	4	68.67			
H	Acanthurus leucopareius	13	KAHE10	5	663.50			
H	Acanthurus nigrofuscus	13	KAHE10	17	127.92			
H	Acanthurus nigrofuscus	13	KAHE10	21	501.84			
H	Acanthurus nigrofuscus	13	KAHE10	18	976.54			
H	Naso lituratus	13	KAHE10	1	72.58	85	5383.58	13.3
O	Stegastes fasciolatus	13	KAHE10	3	77.94			
O	Melichthys vidua	13	KAHE10	3	597.09			
O	Canthigaster rivulata	13	KAHE10	1	22.05	7	697.08	1.7
P	Dascyllus albisella	13	KAHE10	31	95.74			
P	Abudefduf abdominalis	13	KAHE10	108	3383.92			
P	Abudefduf vaigensis	13	KAHE10	16	749.63			
P	Chromis vanderbilti	13	KAHE10	95	30.01	250	4259.30	10.5
	TOTAL	13	KAHE10	477	40459.02	477	40459.02	100
C	Parupeneus multifasciatus	14	NANA1	2	54.23			
C	Parupeneus multifasciatus	14	NANA1	3	9.36			
C	Parupeneus multifasciatus	14	NANA1	1	11.05			
C	Parupeneus multifasciatus	14	NANA1	3	163.20			
C	Plectroglyphidodon imparipennis	14	NANA1	6	5.17			
C	Thalassoma duperrey	14	NANA1	4	219.80			
C	Thalassoma duperrey	14	NANA1	3	33.49			
C	Thalassoma duperrey	14	NANA1	1	97.05			
C	Thalassoma duperrey	14	NANA1	2	6.30			
C	Thalassoma duperrey	14	NANA1	2	54.78			
C	Stethojulis balteata	14	NANA1	1	35.76			
C	Stethojulis balteata	14	NANA1	1	14.41	29	704.60	97.3
H	Acanthurus nigrofuscus	14	NANA1	2	15.05	2	15.05	2.1
O	Canthigaster jactator	14	NANA1	1	3.56	1	3.56	0.5
P	Chromis vanderbilti	14	NANA1	4	1.26	4	1.26	0.2
	TOTAL	14	NANA1	36	724.48	36	724.48	100

GRP	10-Jan-19 SPECIES	RB	STATION	NO.	BIOMASS	NO. IND.	GROUP BIOMASS	GROUP PERCENT
C	Parupeneus multifasciatus	15	NANA2	1	235.75			
C	Paracirrhites arcatus	15	NANA2	1	16.35			
C	Cirrhitus pinnulatus	15	NANA2	1	265.78			
C	Thalassoma duperrey	15	NANA2	3	291.16			
C	Thalassoma duperrey	15	NANA2	8	89.31			
C	Thalassoma duperrey	15	NANA2	4	219.80			
C	Thalassoma duperrey	15	NANA2	7	191.73			
C	Stethojulis balteata	15	NANA2	3	107.29			
C	Anampses cuvier	15	NANA2	1	115.17			
C	Sufflamen bursa	15	NANA2	1	85.87	30	1618.20	13.7
CF	Chaetodon ornatissimus	15	NANA2	2	138.00			
CF	Chaetodon multicinctus	15	NANA2	2	13.31	4	151.32	1.3
H	Acanthurus triostegus	15	NANA2	4	185.26			
H	Acanthurus leucopareius	15	NANA2	8	2992.51			
H	Acanthurus leucopareius	15	NANA2	21	2786.71			
H	Acanthurus nigrofuscus	15	NANA2	3	22.57			
H	Acanthurus nigrofuscus	15	NANA2	15	358.46			
H	Acanthurus nigroris	15	NANA2	7	1206.08			
H	Acanthurus olivaceus	15	NANA2	3	1179.63			
H	Acanthurus blochii	15	NANA2	2	195.95			
H	Acanthurus blochii	15	NANA2	3	466.75			
H	Ctenochaetus strigosus	15	NANA2	3	22.73			
H	Ctenochaetus strigosus	15	NANA2	7	187.91			
H	Zebrasoma flavescens	15	NANA2	1	1.69			
H	Zebrasoma flavescens	15	NANA2	5	130.15	82	9736.40	82.2
O	Stegastes fasciolatus	15	NANA2	2	51.96			
O	Stegastes fasciolatus	15	NANA2	4	29.57			
O	Melichthys niger	15	NANA2	1	163.34			
O	Cantherhines sandwichiensis	15	NANA2	1	82.05			
O	Canthigaster jactator	15	NANA2	2	7.12	10	334.04	2.8
	TOTAL	15	NANA2	126	11839.95	126	11839.95	100
C	Myripristis amaenus	16	PIPE	25	1060.08			
C	Lutjanus kasmira	16	PIPE	350	20073.38			
C	Lutjanus kasmira	16	PIPE	100	19064.69			
C	Mulloides flavolineatus	16	PIPE	90	17247.02			
C	Mulloides vanicolensis	16	PIPE	415	94336.51			
C	Parupeneus multifasciatus	16	PIPE	8	1885.99			
C	Forcipiger flavissimus	16	PIPE	3	27.45			
C	Chaetodon fremblii	16	PIPE	4	189.32			
C	Thalassoma duperrey	16	PIPE	35	1923.21			
C	Thalassoma duperrey	16	PIPE	60	5823.12			
C	Thalassoma purpureum	16	PIPE	1	946.59			
C	Gomphosus varius	16	PIPE	4	248.12			
C	Zanclus cornutus	16	PIPE	6	329.39			
C	Sufflamen bursa	16	PIPE	3	257.62	1104	163412.48	84.1
CF	Chaetodon multicinctus	16	PIPE	4	52.12	4	52.12	0.0
H	Scarus sordidus	16	PIPE	2	469.30			
H	Acanthurus nigrofuscus	16	PIPE	20	477.94			
H	Acanthurus nigrofuscus	16	PIPE	10	542.52			
H	Acanthurus nigrofuscus	16	PIPE	35	263.36			
H	Naso unicornis	16	PIPE	7	3676.80			
H	Naso unicornis	16	PIPE	3	116.77	77	5546.70	2.9
O	Stegastes fasciolatus	16	PIPE	40	1039.21	40	1039.21	0.5
P	Dascyllus albisella	16	PIPE	35	108.09			
P	Abudefduf abdominalis	16	PIPE	290	9086.45			
P	Abudefduf vaigensis	16	PIPE	200	13277.50			
P	Chromis ovalis	16	PIPE	75	866.98			
P	Naso hexacanthus	16	PIPE	25	973.11	625	24312.12	12.5
	TOTAL	16	PIPE	1850	194362.63	1850	194362.63	100