

**QUANTITATIVE SURVEY OF FISHES**

**AT HANAUMA BAY, OAHU**

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## MATERIALS AND METHODS

A total of five transects were conducted in the bay, one in each of the five distinct zones indicated on Figure 1.

Each survey site was transected with 100 m line deployed on the ocean floor. Transects 1, 2, 4, and 5 were parallel to the beach, and Transect 3 was perpendicular to the beach to avoid crossing different zones.

Ten minutes after each line was deployed, two surveyors began the visual fish census. Each surveyor swam parallel to the line directly abreast of the other, about 2 m above the ocean floor. All fishes observed within 3 m to either side of each surveyor, up to the ocean surface, was identified and the total length in inches, including the number of each, was recorded on waterproof paper. The waterproof paper and a pencil was attached to a plastic slate. The visual census method used was a variation of the one used by V. E. Brock, 1954; and R.E. Brock, 1982.

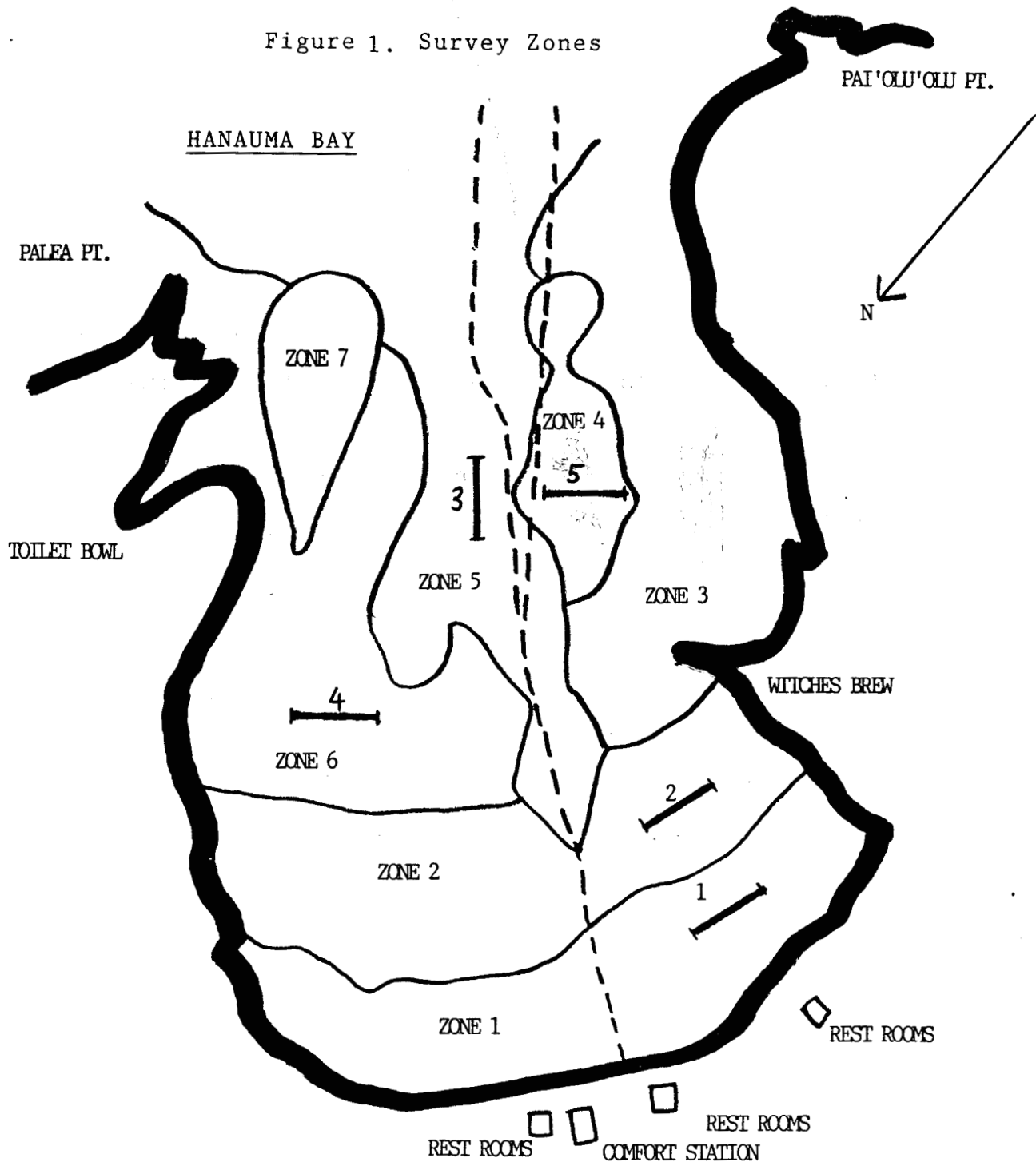
Biomass of the observed fishes was calculated using the length (X), number (Y), and DAR constant (Z) of each species in the formula:

$$X^3YZ(4047/1200)$$

The combined data from each of the transects was used to determine:

1. Number of species (diversity index)
2. Number of families
3. Number of individuals per species (#/acre)
4. Biomass (pounds/acre)
5. Five most dominant species in terms of abundance
6. Five most dominant species in terms of biomass

Figure 1. Survey Zones



- Hanauma Bay Survey Zones  
Zone 1: shallow reef flat  
Zone 2: reef crest and buttress zone  
Zone 3 & 6: Porites lobata gardens  
Zone 4 & 7: Porites compressa gardens  
Zone 5: sand flats

## RESULTS

Table 1 shows the results from Transect 1, conducted on the shallow reef flat (Zone 1). Due to difficulty in conducting this transect (shallow water), the length of the surveyed area was reduced to a length of 50 m. The biomass calculations were adjusted for this area reduction by substituting the formula:  $X^2YZ(4047/600)$

A total of 139 fishes were observed, representing 28 species from 10 families. The average number of fishes per acre was 937.555 with an average biomass of 384.049 pounds per acre. The five dominant species by abundance were *Acanthurus triostegus*, *Thalassoma duperrey*, *Acanthurus xanthopterus*, *Kyphosus bigibbus* (equal third), *Abudefduf sordidus*, and *Parupeneus multifasciatus*. The five dominant species by biomass were *Acanthurus xanthopterus*, *Kyphosus biggibus*, *Chaenomugil leuciscus*, *Abudefduf sordidus*, and *Mugil cephalus*. The five dominant species by abundance accounted for 68.0% of the standing crop. Transect 1 ranked third in average abundance, and fourth in biomass.

Fifty species of fishes representing 15 families, with a total of 586 individuals, were observed in Transect 2 (Table 2). The average abundance was 1976.285 fishes per acre with a biomass of 560.196 pounds per acre. The five dominant species by abundance were *Acanthurus nigrofuscus*, *Thalassoma duperrey*, *Acanthurus xanthopterus*, *Ctenochaetus strigosus*, and *Stegastes fasciolatus*. The five dominant species by biomass were *Acanthurus xanthopterus*, *Acanthurus nigrofuscus*, *Scarus rubroviolaceus*, *Kyphosus bigibbus*, and *Acanthurus dussumieri*. The five dominant species by abundance comprised 57.0% of the total standing crop. Transect 2 ranked first in average abundance and second in biomass.

Only 89 fishes representing 27 species from 15 families were observed on Transect 3 (Table 3). The transect had an average abundance of 300.152 fishes per acre with a biomass of 421.223 pounds per acre. The five dominant species by abundance were *Thalassoma duperrey*, *Albula neoguianica*, *Acanthurus xanthopterus*, *Mulloides flavolineatus*, and *Ctenochaetus strigosus*. The five dominant species by biomass were *Conger cinereus*, *Albula neoguianica*, *Acanthurus xanthopterus*, *Acanthurus olivaceus*, and *Mugil cephalus*. The five dominant species by abundance accounted for 51.1% of the total standing crop. Transect 3 ranked fifth in

average abundance and third in biomass.

Table 4 lists the results from Transect 4, where a total of 172 fishes representing 25 species from 13 families were observed. The transect had an average abundance of 580.070 fishes per acre with a biomass of 111.743 pounds per acre. The five dominant species by abundance were *Thalassoma duperrey*, *Acanthurus nigrofuscus*, *Acanthurus nigroris*, *Canthigaster jactator*, and *Parupeneus bifasciatus*. The five dominant species by biomass were *Scarus sordius*, *Acanthurus nigrofuscus*, *Acanthurus nigroris*, *Thalassoma duperrey*, and *Gymnothorax meleagris*. The five dominant species by abundance accounted for 49.9% of the total standing crop. Transect 4 ranked fourth in average abundance and fifth in biomass.

A total of 451 fishes representing 46 species in 15 families were observed in Transect 5 (Table 5). Transect 5 had an average abundance of 1520.998 fishes per acre and a biomass of 739.570 pounds per acre. The five dominant species by abundance were *Thalassoma duperrey*, *Acanthurus triostegus*, *Abudefduf abdominalis*, *Acanthurus xanthopterus*, and *Acanthurus nigrofuscus*. The five dominant species by biomass were *Acanthurus xanthopterus*, *Acanthurus triostegus*, *Albula neoguianica*, *Thalassoma duperrey*, and *Scarus sordidus*. The five dominant species by abundance accounted for 55.5% of the total standing crop. Transect 5 ranked second in average abundance and first in biomass.

The endemic saddle wrasse *Thalassoma duperrey* was the most abundant species observed, ranked first or second in all five transects. The *pualu*, *Acanthurus xanthopterus*, was one of the five most abundant species in four transects. It also ranked among the five dominant species by biomass in four transects.

## DISCUSSION

Transect 1 was conducted along a 50 m line rather than a 100 m line due to water depths too shallow for effective survey work. Conducting this transect during a higher tide would be desirable, as well as additional transects in each zone during various tides, hours, and conditions. This may provide a more accurate assessment of the fish populations in these zones. The quantification of the fishes observed may be underestimated due to poor underwater visibility, nocturnal, cryptic, or wary species.

Table 1. Fish survey results, Transect 1, Hanauma Bay.

Species:

**MUGILIDAE**

<i>Chaenomugil leuciscus</i>		40.470	3	27.196
<i>Mugil cephalus</i>		13.490	5	22.210

**MULLIDAE**

<i>Mulloidies flavolineatus</i>		33.725		10.743
<i>Parupeneus multifasciatus</i>	5	53.960		21.559
<i>Parupeneus pleurostigma</i>		26.980		6.216

**KYPHOSIDAE**

<i>Kyphosus bigibbus</i>	3	80.940	2	55.849
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**CHAETODONTIDAE**

<i>Chaetodon auriga</i>		13.490		2.914
<i>Chaetodon miliaris</i>		6.745		0.514
<i>Chaetodon ornatissimus</i>		6.745		7.892
<i>Chaetodon quadrimaculatus</i>		6.745		0.801

**POMACENTRIDAE**

<i>Abudefduf sordidus</i>	4	67.450	4	23.014
<i>Plectroglyphidodon imparipennis</i>		6.745		0.034
<i>Stegastes fasciolatus</i>		6.745		0.184

**LABRIDAE**

<i>Thalassoma duperrey</i>	2	101.175		8.532
<i>Thalassoma trilobatum</i>		6.745		1.365
<i>Stethojulis balteata</i>		26.980		0.797
<i>Anampses cuvier</i>		6.745		2.176

**ACANTHURIDAE**

<i>Acanthurus blochii</i>		26.980		6.236
<i>Acanthurus leucopareius</i>		6.745		1.078
<i>Acanthurus nigrofuscus</i>		13.490		1.602
<i>Acanthurus nigroris</i>		40.470		18.649
<i>Acanthurus triostegus</i>	1	195.605		15.711
<i>Acanthurus xanthopterus</i>	3	80.940	1	136.714
<i>Ctenochaetus strigosus</i>		20.235		2.138
<i>Naso lituratus</i>		20.235		7.694

**MONACANTHIDAE**

<i>Pervagor spilosoma</i>		6.745		0.354
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**OSTRACIONTIDAE**

<i>Ostracion meleagris</i>		13.490		1.355
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**CANTHIGASTERIDAE**

<i>Canthigaster jactator</i>		6.745		0.522
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Total species = 28  
Total families = 10

Total = 937.555 Total = 384.049

Table 2. Fish survey results, Transect 2, Hanauma Bay.

Species:

<b>MULLIDAE</b>			
<i>Mulloides flavolineatus</i>	3.372		1.316
<i>Parupeneus multifasciatus</i>	16.860		2.950
<b>KYPHOSIDAE</b>			
<i>Kyphosus bigibbus</i>	43.842	4	30.251
<b>CHAETODONTIDAE</b>			
<i>Chaetodon auriga</i>	10.118		4.830
<i>Chaetodon fremblii</i>	10.118		1.227
<i>Chaetodon lineolatus</i>	6.745		1.457
<i>Chaetodon lunula</i>	20.235		1.606
<i>Chaetodon miliaris</i>	33.725		3.058
<i>Chaetodon multicinctus</i>	20.235		1.560
<i>Chaetodon ornatissimus</i>	20.235		9.114
<i>Chaetodon quadrimaculatus</i>	6.745		0.410
<i>Chaetodon trifasciatus</i>	3.372		1.796
<i>Chaetodon unimaculatus</i>	3.372		0.224
<b>CARANGIDAE</b>			
<i>Carangoides orthogrammus</i>	6.745		2.260
<b>POMACENTRIDAE</b>			
<i>Abudefduf abdominalis</i>	107.920		8.112
<i>Abudefduf sordidus</i>	23.608		4.699
<i>Plectroglyphidodon johnstonianus</i>	33.725		0.638
<i>Stegastes fasciolatus</i>	5	131.528	8.332
<b>LABRIDAE</b>			
<i>Thalassoma ballieui</i>	50.588		13.106
<i>Thalassoma duperrey</i>	2	300.152	18.138
<i>Gomphosus varius</i>	23.608		1.294
<i>Stethojulis balteata</i>	40.470		1.419
<b>SCARIDAE</b>			
<i>Calotomus carolinus</i>	6.745		9.441
<i>Calotomus zonarcha</i>	3.372		1.991
<i>Scarus dubius</i>	57.332		6.746
<i>Scarus perspicillatus</i>	3.372		7.218
<i>Scarus rubroviolaceus</i>	53.960	3	48.400
<i>Scarus sordidus</i>	6.745		2.730
<b>CIRRHITIDAE</b>			
<i>Cirrhitus pinnulatus</i>	3.372		0.925
<b>BLENNIIDAE</b>			
<i>Cirripectes vanderbilti</i>	16.862		0.561
<b>ACANTHURIDAE</b>			
<i>Acanthurus achilles</i>	16.862		2.250
<i>Acanthurus blochii</i>	3.372		2.631
<i>Acanthurus dussumieri</i>	13.490	5	22.019
<i>Acanthurus nigrofuscus</i>	1	330.505	2
<i>Acanthurus nigroris</i>	6.745		1.573

<i>Acanthurus triostegus</i>		13.490		1.518
<i>Acanthurus xanthopterus</i>	3	202.350	1	224.841
<i>Ctenochaetus strigosus</i>	4	148.390		11.923
<i>Zebrasoma flavescens</i>		10.118		1.619
<i>Naso lituratus</i>		33.725		17.400
<b>ZANCLIDAE</b>				
<i>Zanclus cornutus</i>		6.745		1.173
<b>BALISTIDAE</b>				
<i>Melichthys niger</i>		20.235		6.385
<i>Rhinecanthus aculeatus</i>		3.372		0.728
<i>Sufflamen bursa</i>		3.372		1.030
<b>MONACANTHIDAE</b>				
<i>Aluterus scriptus</i>		6.745		8.712
<i>Cantherhines dumerili</i>		3.372		1.897
<i>Cantherhines sandwichiensis</i>		3.372		0.063
<i>Pervagor spilosoma</i>		23.608		1.914
<b>OSTRACIIDAE</b>				
<i>Ostracion meleagris</i>		13.490		0.132
<b>CANTHIGASTERIDAE</b>				
<i>Canthigaster jactator</i>		43.842		0.656

Total species = 50  
 Total families = 15

Total = 1976.285 Total = 560.196



Table 3. Fish survey results, Transect 3, Hanauma Bay.

Species:

<b>ALBULIDAE</b>				
<i>Albula neoguianica</i>	2	37.098	2	110.340
<b>CONGRIDAE</b>				
<i>Conger cinereus</i>		3.372	1	152.977
<b>FISTULARIIDAE</b>				
<i>Fistularia commersonii</i>		3.372		0.004
<b>MUGILIDAE</b>				
<i>Mugil cephalus</i>		3.372	5	11.801
<b>MULLIDAE</b>				
<i>Mulloidies flavolineatus</i>	4	26.980		2.273
<i>Parupeneus multifasciatus</i>		6.745		1.527
<i>Parupeneus pleurostigma</i>		3.372		0.520
<b>CHAETODONTIDAE</b>				
<i>Chaetodon lunula</i>		3.372		0.903
<b>CARANGIDAE</b>				
<i>Carangoides orthogrammus</i>		3.372		1.821
<b>POMACENTRIDAE</b>				
<i>Chromis vanderbilti</i>		3.372		0.018
<i>Plectroglyphidodon johnstonianus</i>		6.745		0.120
<i>Stegastes fasciolatus</i>		3.372		0.092
<b>LABRIDAE</b>				
<i>Thalassoma duperrey</i>	1	43.843		4.684
<i>Coris venusta</i>		3.372		0.185
<i>Stethojulis balteata</i>		6.745		0.455
<b>SCARIDAE</b>				
<i>Scarus perspicillatus</i>		3.372		7.218
<i>Scarus rubroviolaceus</i>		3.372		0.605
<b>ACANTHURIDAE</b>				
<i>Acanthurus nigrofuscus</i>		16.862		1.416
<i>Acanthurus olivaceus</i>		20.235	4	11.920
<i>Acanthurus triostegus</i>		10.118		3.123
<i>Acanthurus xanthopterus</i>	3	33.725	3	97.101
<i>Ctenochaetus strigosus</i>	5	23.608		0.943
<i>Zebrasoma flavescens</i>		3.372		2.210
<b>ZANCLIDAE</b>				
<i>Zanclus cornutus</i>		3.372		0.430
<b>BALISTIDAE</b>				
<i>Sufflamen bursa</i>		13.490		5.640
<b>MONACANTHIDAE</b>				
<i>Cantherhines dumerili</i>		3.372		2.832
<b>CANTHIGASTERIDAE</b>				
<i>Canthigaster factator</i>		6.745		0.065

Total species = 27  
Total families = 15

Total = 300.152 Total = 421.223

Table 4. Fish survey results, Transect 4, Hanauma Bay.

Species:

**MURAENIDAE**

*Gymnothorax meleagris* 3.372 5 8.195

**MULLIDAE**

*Mulloides flavolineatus* 3.372 2.890

*Parupeneus bifasciatus* 5 33.725 3.386

*Parupeneus multifasciatus* 23.608 5.136

**CHAETODONTIDAE**

*Chaetodon quadrimaculatus* 3.372 0.400

*Chaetodon unimaculatus* 16.862 3.150

**CARANGIDAE**

*Scombroides lysan* 3.372 3.497

**POMACENTRIDAE**

*Plectroglyphidodon imparipennis* 3.372 0.017

*Plectroglyphidodon johnstonianus* 20.235 0.091

*Stegastes fasciolatus* 3.372 0.218

**LABRIDAE**

*Thalassoma duperrey* 1 151.763 4 14.529

*Coris venusta* 16.862 0.573

*Stethojulis balteata* 6.745 0.166

**SCARIDAE**

*Scarus sordidus* 13.490 1 21.712

**CIRRHITIDAE**

*Cirrhitops fasciatus* 3.372 0.160

*Paracirrhites arcatus* 3.372 0.158

**BLENNIIDAE**

*Cirripectes vanderbilti* 3.372 0.112

**ACANTHURIDAE**

*Acanthurus nigrofuscus* 2 114.665 2 21.263

*Acanthurus nigroris* 3 74.195 3 16.052

*Acanthurus olivaceus* 13.490 4.457

*Acanthurus triostegus* 6.745 1.311

*Ctenochaetus strigosus* 3.372 0.147

**BALISTIDAE**

*Sufflamen bursa* 6.745 3.074

**MONACANTHIDAE**

*Pervagor spilosoma* 10.118 0.531

**CANTHIGASTERIDAE**

*Canthigaster jactator* 4 40.470 0.518

Total species = 25

Total = 580.070 Total = 111.743

Total families = 13

Table 5. Fish survey results, Transect 5, Hanauma Bay.

Species:

**ALBULIDAE**

*Albula neoguianica* 26.980 3 52.755

**FISTULARIIDAE**

*Fistularia commersonii* 3.372 0.116

**LUTJANIDAE**

*Lutjanus fulvus* 3.372 3.007

**MULLIDAE**

*Parupeneus bifasciatus* 23.608 5.156

*Parupeneus multifasciatus* 26.980 5.709

*Parupeneus pleurostigma* 6.745 0.656

*Parupeneus porphyreus* 6.745 0.742

**CHAETODONTIDAE**

*Chaetodon auriga* 3.372 0.422

*Chaetodon fremblii* 6.745 0.297

*Chaetodon lunula* 13.490 8.966

*Chaetodon miliaris* 23.608 3.512

*Chaetodon multicoloratus* 3.372 0.438

*Chaetodon ornatissimus* 10.118 4.932

*Chaetodon quadrimaculatus* 16.862 2.585

*Chaetodon trifasciatus* 6.745 0.877

*Chaetodon unimaculatus* 6.745 0.877

**POMACENTRIDAE**

*Abudefduf abdominalis* 3 118.038 30.676

*Abudefduf sordidus* 3.372 1.180

*Chromis hanui* 3.372 0.107

*Chromis vanderbilti* 74.195 0.232

*Plectroglyphidodon johnstonianus* 10.118 0.096

*Stegastes fasciolatus* 6.745 0.436

**LABRIDAE**

*Thalassoma duperrey* 1 269.800 4 35.878

**SCARIDAE**

*Calotomus carolinus* 6.745 12.216

*Calotomus zonarchus* 50.588 2.622

*Scarus dubius* 23.608 2.036

*Scarus perspicillatus* 13.490 23.964

*Scarus sordidus* 20.235 5 35.753

**CIRRHITIDAE**

*Paracirrhites arcatus* 3.372 0.066

**ACANTHURIDAE**

*Acanthurus achilles* 16.862 10.572

*Acanthurus blochii* 30.352 16.628

*Acanthurus nigrofuscus* 5 77.568 11.908

*Acanthurus nigroris* 50.588 28.281

*Acanthurus olivaceus* 33.725 3 38.180

<i>Acanthurus triostegus</i>	2	242.820	2	62.939
<i>Acanthurus xanthopterus</i>	4	87.685	1	269.389
<i>Ctenochaetus strigosus</i>		10.118		0.860
<i>Zebrasoma flavescens</i>		50.588		17.457
<i>Naso lituratus</i>		16.862		22.578
<b>ZANCLIDAE</b>				
<i>Zanclus cornutus</i>		6.745		2.360
<b>BALISTIDAE</b>				
<i>Melichthys niger</i>		13.490		4.521
<i>Melichthys vidua</i>		3.372		4.938
<i>Sufflamen bursa</i>		10.118		5.186
<b>MONACANTHIDAE</b>				
<i>Cantherhines dumerili</i>		3.372		0.691
<i>Pervagor spilosoma</i>		10.118		0.868
<b>TETRAODONTIDAE</b>				
<i>Arothron meleagris</i>		3.372		4.587
<b>CANTHIGASTERIDAE</b>				
<i>Canthigaster factator</i>		53.960		1.318
Total species = 46		Total = 1520.998 Total = 739.570		
Total families = 15				

### LITERATURE CITED

- Brock, R.E. 1982. *A Critique of the Visual Census Method for Assessing Coral Reef Fish Populations*. Bulletin of Marine Science 32(1): 269-276.
- Brock, V.E. 1954. *A Preliminary Report on a Method of Estimating Reef Fish Populations*. Jour. of Wildlife Management 18(3): 297-308.