U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
DUVAL BUILDING
9450 KOGER BOULEVARD
ST. Petersburg, Florida 3370:

REPORT FOR:

[ ] COMMERCIAL FISHERIES RESEARCH AND DEVELOPMENT ACT (PL 88-309)

[ ] ANADROMOUS FISH ACT (PL 89-304)

[X] STATE/FEDERAL [ ] COUNCIL LIAISON

STATE———— TYPE OF REPORT: [ ] Quarterly (Coordination projects only)

[ ] Annual Progress or Segment

[X] Completion

PROJECT NO. **NA077FS0084** SEGMENT NO. 01-03

PROJECT TITLE **Shallow-water Reef Fish Monitoring SEAMAP-Caribbean Fisheries Independent Monitoring**

PERIOD COVERED April 1, 2000 to March 31, 2004

PREPARED BY Aida Rosario Jiménez DATE ____________

APPROVED BY Luis. E. Rodríguez Rivera DATE ____________

ABSTRACT

During the sampling period of April 1, 2000 to March 31, 2001, a total of 12 stations were sampled west of Parallel 67 of Puerto Rico. Hook and line yielded thirty-eight species representing 19 families weighing over 288 kg of finfish. The groupers, constituted 47.1% of total catch, of which two species of represented 45.7% of the hook and line catch in terms of number. During this sampling period efforts were made to mark and release these two species of groupers. In this report were considering only those individuals that were landed, not those released.

Red hinds (*Epinephelus guttatus*) and coneys (*Cephalopholis fulva*) represented by weight 19.8% and 25.8%, respectively of the total hook and line catch. The graysby (*C. cruentata*) was the third species of grouper that made up the bulk of this group category for both sampling periods. Snappers, which are considered the most valuable commercial species group, were scarcely represented.

Fish traps yielded seventeen species representing nine families weighing over 36 kg of finfish. Catches by number were dominated by the same species as for hook and line catches. Red hinds constituted 14.6% of total trap catches by number, while coneys made up 18.2%.

[redacted]

Fisheries Independent Monitoring of Shallow Water Reef Fisheries

Completion Report
to
NOAA/NMFS/SEAMAP PROGRAM

Prepared
by
Aida Rosario
Miguel Figuerola
Nilda M. Jimenéz
Dr. Richard S. Appledoorn

Submitted
by
Honorable Luis E. Rodríguez Rivera
Secretary
DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES

AUGUST 2004

La captura por unidad de esfuerzo (CPUE) por estaciones varió desde 26.48 a 88.83 g/nasa hora, y desde 47.00 a 1,433.56 g/ anzuelo hora, sin contar las capturas 0. La experiencia de los pescadores influenció el CPUE, en términos generales, los pescadores de mayor experiencia tienen un CPUE mayor que aquellos menos experimentados. Los dos pescadores de mayor experiencia capturaron sobre el 50% del total de la captura desembarcada en términos de número y de peso.

Acknowledgments

I wish to express my sincere gratitude to all who, in one way or another, contributed performed the project and to the completion of the report.

Special thanks are due to all the members of the Exploratory Fishing Project for their dedication to their work, those that are still members of this program and those that no longer are with us. To Ms. Verónica Seda and Ana Rivera which help with the edition of this report. As well to Ms. Nilda Jiménez, Ms. Milagros Cartagena, Mr. Luis A. Rivera, Mr. Hector López, Mr. Miguel Figuerola for his help in the performance of the surveys.

List of Tables

Objective

The aim of the present survey was to collect, manage, and disseminate fisheries-independent data collection of shallow water reef fish resources and their environment. These data were used to obtain catch per unit effort estimates, to determine species composition and to evaluate annual trends in the fishery. The data are also available for comparison with fisheries-dependent data collected under other statistics projects of PR and the USVI.

Approach

Assess the survey design and standardize sampling methodologies identified in the Statistical Survey Design Analysis. Establish and conduct fishery-independent surveys to obtain CPUE (biomass per unit gear), determine species composition, evaluate trends in the fishery, and characterize the fishery habitats. Data obtained from the Pilot Study were also analysed in order to establish the optimal design for the long term Reef Resources Survey.

Method

1. Sampling was carried out using fish hooks (size #06), using squid as bait, and the standard fish trap using 1-1/2" square mesh size using sardines as bait. Over the western shelf area of Puerto Rico the platform was divided into 2x2 nmile sampling units, subsequently referred as 'quadrants' (Figure 1). Quadrants were further subdivided into 16 quadrants of 0.5x0.5 nmiles for sampling purposes. Global Positioning System (GPS) established location of sub-quadrants. Some details concerning sampling were subject to minor modifications depending on logistics and prevailing conditions of weather and vessels.
2. The sampling areas were stratified based on the following depth criteria, which generally distinguish shallow water platform areas from shelf edge areas:
   a) 0-10 fathoms; (0-18 m)
   b) 11-20 fathoms; (19-36 m)
   c) 21-50 fathoms; (37-90 m)
3. Sampling frequency was assigned equally to each depth stratum a) to c) above. Within a given depth stratum, quadrant samples were assigned randomly as was the sampled sub quadrant within the selected quadrant. Five different quadrants were randomly selected per depth stratum for sampling. Ten samples were planned for each quadrant over the 12 months period of the study resulting in 50 samples per stratum, and a total of 150 samples (trips) for Puerto Rico. Numbering of sub quadrant was as follows: 1 = extreme northwest corner; 16 = extreme southeast corner; 4 = extreme northeast corner; 13 = extreme southwest corner.
4. A minimum of 12 standardized fish traps (4' x 4' 1.5') were set on any one sampling day by a single research vessel in the randomly chosen sub quadrant for the selected week. Fish traps were baited with sardine. Mesh size of traps was 1.5" square vinyl coated. The week of the year to sample any particular sub-unit was selected at random. Soak time was standardized at approximately five to six hours. Traps were set in strings of three traps per string and inter-traps distance was at least 150 feet to avoid inter-trap interference. It originally was intended to have two research vessels in operation, but this was not feasible due to mechanical complications.
5. Three lines each with three hooks (#06) per line were fished for 4-5 hours daily with standardized bait and sinker units (weights) during fish trap soak period.
6. For each trip the following data was recorded:
   A. Date, time (i.e. time out; time of soak; and time fishing with hooks).
   B. Quadrant code and sub quadrant code (1-16); GPS bearings (latitude and longitude).

Hook and Line Catches

General Catch

Hook and line yielded a total of 1,049 finfishes weighing over 288 kg. belonging to thirty-eight (38) species representative of 19 families. A single family, Serranidae, dominated the catch comprising 53.6s and 47.1.0% of total catch in terms of number and weight, respectively (Table1). This family represents the second most important one of commercial importance in Puerto Rico. In general terms, twelve (12) species comprised 93.43% of total catch by weight. On the other hand in terms of number the catch was dominated by eight (9) species, representing 94.75% of the catch.

Two species of groupers were the dominant species. The red hind, *Epinephelus guttatus*, made up 19.8% and 24.1% by number and weight, respectively. Meanwhile the coney, *Cephalopholis fulva*, represented 25.8% and 18.2%, by number and weight.

Total hook and line effort for this sampling period amounted to 560.8 hook hours and 136 line days. A total of 39 trips were performed, covering 12 stations off the west coast of Puerto Rico. The obtained total CPUE was 514.87 g/hook hours and 2,123.06-g/line day (Table 2). Average CPUE by trip in terms of g/hook hours was 512.2 ± 331.3 (Table 2). In terms of weight per trip 7,403.49 g/trip ± 4,794.9 was obtained. Catches range from zero on areas off the west coast platform to a maximum of 1,433.6 g/hook hours at station 96 in March 2001. Meanwhile, in terms of g/line day varied from zero on areas of the platform to a maximum of 5,871.33 at station 95 during October 2000 (Table 2).

Catch per unit effort by fisher

Table 3 summarizes total CPUE by fisherman for the sampling period. Of those fishers listed in Table 3, the first five (1 to 21) are regular members of the Monitoring Program. During the sampling period drastic changes in the crewmembers of the program occur.

Of those fishers listed in Table 3, the first five (1 to 21) are regular members of the Monitoring Program. As can be observed in Table 3, three fishers dominated the catches, fishers #2, #20, and #6. These three fishers accounted for over 71% and 67% of total captured finfish, both in terms of number and weight, respectively. The highest catch was accounted by fisher #20, with over half of the catch in terms of weight (50.7%). The lowest CPUE among these fishers, and the lowest, amounted to 1.34g/hook hour by fisher #1, which turns out to be the fisher with less fishing experience. Accounting for the number of trips in which fishers (regular crew members) recorded zero catches, the greater percentage was reported by fisher #1, with 15.38%.

Figure 2a plots fisher's catches in terms number of fish caught and weight of fish caught by their years of experience. The resulting trends show that catches tend to increase with the number of years of experience, although there is variability in their catches. It's appropriate to point out that the higher catches were recorded by the fisher with more years of experience (fisher 6). Deleting data points from fishers that are not regular crewmembers yield a clearer trend of the results.

Table 4 summarizes fisher catches by number and weight per station, asterisks represents stations that were not sampled by any given fisher. Stations 59, 69 and 95 were stations in which fishers catches were consistently high.

squirrelfish were caught in high numbers in station 59 (68.3%) and station 9 (14.6%). Maximum CPUE was recorded in station 9 in both terms of g/hook hour and g/line day (Table 6f)

Catch Per Unit Effort by Depth Ranges

According to the stratifying depth criteria, minimum recorded CPUE corresponded to the intermediate depth range of 19-36 m 18.47 in terms of g-hook hours; in terms of g-line day corresponded to the shallower depth with 2,062.38 (Table 7a). Maximum CPUE corresponded to the shallowest depth range in terms of g per hook hours with 548.27 and to the deepest depth range (37-90 m) 2,338.30 g/line day, respectively (Table 7a).

CPUE of red hinds by depth ranges varied from a minimum of 1.45 g/hook hours to a maximum of 8.45 g/hook hours (Table 7b). The minimum corresponded to intermediate depths of 19-36 m and the maximum to the deepest depth range of 37-90 m. In terms of g/line day, maximum corresponded to the deepest range 3,243.62 and the minimum corresponded to the shallowest depth range with 819.40. Coneys CPUE presented reported minimum CPUE at the intermediate depth range in terms of g per hook and hours with 0.57 (Table 7c). Maximum CPUE of coneys belonged to the depth range of 0-18 m. In terms of g/line day the obtained results reflect those obtained in terms of g per hook hours.

Sand tilefish yielded the maximum CPUE at the shallowest depth range with 0.35 g/hook hours and 80.72-g/line day (Table 7d). The deepest depth ranges yielded the lowest CPUE in terms of g/hook hours, 0.05; as well as, in terms of g/line yielded 19.94-g/line day.

The black dungon was almost exclusively sampled at intermediates depth ranges (Table 7e). Maximum CPUE was recorded for shallow water depth range in terms of g/hook hour and at intermediate depth ranges in terms of g/line day.

None of the sampled squirrelfish were collected at the shallow depth ranges (Tables 7f and g). Both species yielded the maximum CPUE at intermediate depth ranges in terms of g/hook hour and g/line day. Very few squirrelfishes were sampled at the depth range of more than 36 fathom. Curiously the same number of individuals was caught for both species at this depth range.

Catch Per Unit Effort by Month

Total catch summary by month is displayed in Table 8. During the quarter corresponding to July to September sampling was not carried out. The months in which the lowest number of individuals was caught corresponded to May. The highest number of individual was caught during February. October 2000, recorded the highest CPUE in terms of g/hook hours with 761.18. As well, highest CPUE in terms of g/line day was reported during October 2000, with 3,805.89.

Red hinds were captured at all sampled months with maximum CPUE recorded during October (Table 9a). The month with the lowest CPUE was December 2000, (0.28 g/hook hours and 29.29 g/line day), as well in terms of number. October yielded the highest number of sampled red hinds (Table 9a).

Coneys were caught in all sampled months. The maximum CPUE was recorded during October 3.90 g/hook hours and during November with 688.45 g/line day (Table 9b). The minimum corresponded to February 2001 in terms of g per hook hour with 0.34. In terms of g/line day the highest CPUE was recorded in May 162.10. February 2000 represented the month in which the highest number of coneys was collected meanwhile; May was the month in which the lowest number of coneys was recorded.

lowest catch per fisher shifted from one sampling period to the other. One factor affecting the results of this study was the retirement of all most experienced fishers, and the addition of none experienced crewmembers.

The area covered during this sampling period basically comprised the broadest part of the west coast platform of P.R., from the Mayagüez Bay to the southwest corner of P.R. The only stations that do not lie on the platform are those at the Bajo de Cico area. Stations closer to the shelf edge registered the highest values of CPUE. Variability in catches at different months suggests some seasonality at these areas. There is a distinctive species composition for the sampled stations, which could be related to two parameters, 1) depth; and 2) bottom or habitat type. The utmost factor seems to be the habitat type. Unfortunately, data regarding bottom type of most of the sampled stations tend to be scarce and patchy. On the other hand, depth influence in catches is quite evident for some of the species caught.

Smith and Ault (1993) found that stratification by a combination of depth and substrate composition was the most efficient sampling design for both red hinds and coneys, for a data set collected using the same methodology of the present study. Results for the present sampling period confirm these findings. Bannerot et al, 1991, stated that for an optimum stratification of the area covered in the present survey, the number of replicates within sampled stations should be increased. The stratification of data collected during the 1988-89 studies in some cases reduced the system variance by 45%. Stratification by geographic area was less efficient for traps and more efficient for hooks. Stratifying by depth was more effective for hooks in the snapper-grouper complex. Smith and Ault, 1993 found that for the red hinds, the best stratification was by season (spawning and non-spawning) and by depth. There is no data available in Puerto Rico regarding depth effects of soak time effects on trap catch rates for coneys prior to that reported by Smith and Ault (1993). These authors reported that red hind CPUE does not appear to correspond exclusively to either depth or substrate.

Of the sampled stations those that encompassed the Bajo de Cico areas, have consistently registered high values of CPUE per trip, not only during the present survey, but also during previous ones. The bottom type of this area consists mainly of sponges, soft coral, and hard coral. A trend to have higher catches in areas with hard bottom (composed mainly of sponges and coral crops) has been observed during the sampling periods. Algal plains and grass beds are more productive than sandy or muddy ones. Of the stations on the west coast platform stations 49, 59, 69, and 80 have been were consistent in high CPUE values throughout the sampled years. Station 59 and 80 are two red hind aggregations sites that definitely have some habitat similar to those of the Bajo de Cico which have been identify as an important feature for this species reproduction.

For the present survey station 59 represented the area where effort was concentrated to tag and release red hinds. The site was selected mainly for two reason the depth at which red hinds were caught, shallower than those of the Bajo de Cico reducing the mortality of the individuals. The second reason was the amount of animals that can be caught. Although higher numbers of red hinds can be fished out at Bajo de Cico the depths at which they were caught reduced the survival rate, due to baurotrauma.

Total catches in terms of number and weight by months showed two peaks, the first one in October-November, and the second from January to March. The second peak is definitely related to the red hind spawning aggregation, while for the first there is no clear indication of what might have caused.

Hook and line catches for the present sampling period is compatible with those obtained during the first three-year sampling cycle (Rosario, 1995). Serranids have dominated the catches of both sampling periods, in hook and line and fish traps. Within the serranids the most important for both sampling periods were the following species: the red hinds, coneys, and graysby, which comprised the bulk. Red hinds and coneys have been the dominant species during the two sampling survey, although their relative percentage of total catch varied slightly from one sampling period to the other.

If we were to characterize the distribution of these species along the west coast of P.R. based on the obtained results we would obtain the following: Red hinds seem to dominate in areas of hard bottom (coral crops, sponges, etc.). Meanwhile, coneys are abundant at some deep coral areas, although they can be found in sand/coral areas, whereas red hinds are not. This could be a very broad description of their distribution, basic interaction between these three species and their relative abundance at certain areas, and vertical distribution (by depth). How much of the obtained soft corals; or algal plains with sand patches, followed by soft coral, sponges, etc. In those areas a more detailed map of the sampling stations is necessary to be able to determine which parameters are determinant in the catches.

Since 1987 the FRL has monitored a spawning aggregation off the west coast of P. R., the only year in which the aggregation was not monitored was 1993. During those years the data distribution shows discreet recruitment in two of the sampled years (Rosario, unpublished). Sadovy, *et al.* 1994 demonstrated recruitment overfishing of red hinds sampled at the Bajo de Cico area, which is one of the areas monitored during the present survey. These two stations encompass the Bajo de Cico site, which is an oceanic bank northwest of Mayagüez. Bottom substrate is mainly sponges, and soft coral. Another area (Buoy #6) Abrir La Sierra was also monitored, since it has been reported as an area where most of the red hind have been caught during the last three spawning aggregations. Catches at the Abrir La Sierra (station 59) area were fairly high. These three stations comprised 80.3% of total red hind catches for the sampling period of 2000 to 2001. At all other sampled stations, red hinds catches were low in both terms of number and weight, resulting in low CPUE for these areas. During the sampling period of 2000 to 2001 red hinds catches for stations 95 and 96 were much lower due to the fact that survival of individual to be tagged was reduced by embolism when hauled. At this area the shallower depth is 18 m, which is a very small area, and the surrounding areas increase in depth rapidly making difficult the hauling of animals without suffering decompression trauma.

Coney distribution by station, on the other hand, was more constant. The only station in which very high number of coneys was reported is station 59 (Abrir La Sierra). No geographical gradient was observed at the platform regarding this species. Nonetheless, if we consider the two species of grouper that dominated the catch, a trend in their spatial distribution arises. Red hinds and coneys seem to be more or less evenly distributed within the west coast platform.

Prior to 1996 there were many factors that indicate that the population of red hinds and coneys were declining quite rapidly (age and growth; size at first maturity, etc.). Unpublished data from the Fisheries Research Laboratory showed a sharp decline in the mean size of red hinds capture off the west coast of Puerto Rico. Management measures were set in 1996 (CFMC, 1996), which establishes a close season at the spawning aggregation sites of Bajo de Cico (stations 95 and 96), Abrir La Sierra (station 59) and Tourmaline (station 80). It is necessary to monitor the effects that this management measure have over the populations of these species. Sabat (2002) found out that this management measure has been effective protecting the red hind population of these areas.

Catches of sand tilefishes were more prone at places in which the habitat was mostly sand patches. Most of sampled individuals were caught at Abrir La Sierra. These results are consistent with those obtained in previous surveys. Black dungon were caught almost exclusively in station 59 although station 96 reported high number of this species. At least from station 96 most of black dungon seam to be prone to catch at areas where coral reefs are abundant. Since at the Bajo de Cico shallow point the water transparency is so high with can say with certainty that this species is closely related to the coral reef of that area. As well in Station 59 at shallow depths we can see the bottom with clarity, we can see this fish associated to the coral of the area.

The two species of holocentrids have followed the areal distribution displayed in previous survey (Rosario, 1992, 1993 and 1996). Longjaw squirrelfish seems to be abundant to the north stations of station 59 (Figure 1), while the longspine squirrelfish are caught in greater numbers to the south of this station. Very few longjaw squirrelfish were caught of the Abrir la Sierra area, and very longspine were collected north of this area. At Abrir la Sierra both species are caught in fairly high numbers, although this seems to be a midpoint in the aereal distribution of both species.

Species Composition

Species composition is influenced by depth, the amount of effort put into the fisheries (Regier, 1973), and in a broader sense, by the general habitat that is sampled.

Black dungon are not reported as a separate species in fisheries dependent data, therefore we can not evaluate how important it is to the commercial fisheries. Information gathered from several fishers tends to point that is not a target species but if caught might be sold as triggerfish, although is mostly discarded by fishers.

Fish Traps Catches

Trap catches are highly influenced by a series of variables of which the most important is fish availability. This factor tends to be influenced markedly when using traps for short soaking periods (Munro et al. 1971; Munro, 1974c; Stevenson and Stuart-Sharkey, 1980; Beets, 1993). Other factors such as baiting effects, moon phase, presence of conspecifics, escapement of traps by fishes, the design of the trap, and the width, length, and form of the trap entrance or the funnel have been identified as important factors affecting trap catches (Munro et al. 1971; Munro, 1974a and b; Luckhurst and Ward, 1987; Beets, 1993). Nevertheless, trap catches are comparatively similar to those obtained with hook and line.

Beets (1993) demonstrated that there are differences in traps catches among shelf areas. He found differences in species abundance and composition between three sampled areas of the U.S. Virgin Islands. He proposed that although, much of the differences can be accounted by habitat differences, at least for one of the sampled areas, fishing effort is the probable cause of the observed differences.

Stevenson and Stuart-Sharkey, (1980) demonstrated an independent depth effect for red hinds captured with traps. Red hind catches (mean number and weight) were not significantly different for two tested depths (30 and 50 m). They also demonstrated a soak time effect with higher overall catches at intermediate soak times (5 days). The latter could explain the low red hind catches by traps during the two study periods, which were soaked only for 5 to 6 hrs daily. On the other hand, Thompson and Munro, (1974) stated that catch rates by hook and line showed greater variability than those of traps, mostly related to wind and current and not necessarily related to the abundance of groupers at the sampling stations.

Another consideration to be taken into account when evaluating catches is that retention of fish in a trap is not only affected by the mesh size but also by the shape of the mesh and the flexibility or "gauge" of the wire used (Rosario and Sadovy, 1991a and b). Fish size and shape are also important factors in fish ability to escape through certain mesh sizes and shapes (Sutherland *et al*, 1987). Luckhurst and Ward, (1987); Ward (1987); Ward and Nisbet (1987); and Bohnsack *et al*, 1989 has also reported on the effect of mesh size selection in Antillean fish traps.

Miller and Hunte (1987) stated that the principal limitation of traps as a survey tool is that they provide only an index of fish abundance, assuming that the fishing area of a trap is about the same for different times and places. This is a major concern when trying to extrapolate from diverse places and habitats. Miller (1989) stated that numerous factors other than density affect catch rates, besides, effort must be calibrated to convert catch rates to indices of absolute animal density.

In general, trap catches were very low compared to hook and line catches. One should keep in mind that these traps were soaked for a short period of time, which definitely is a factor that affects trap catches. Nonetheless, the obtained results if compared to landings data are significant. Matos (1993, 2000) has reported a substantial decline both in fish trap catches and the number of fish traps used in Puerto Rico. In fact as the number of fish traps has declined the number of nets has increased since the early 1990 in Puerto Rico's fishery.

Species Composition

Fish trap species composition is influenced by mesh size. From a mesh size study undertaken by the Fisheries Research Laboratory in 1990, (Rosario and Sadovy, 1991a, b); it was demonstrated that the mesh size of 1.25" x 1.25" hexagonal, caught the greatest diversity of species. Stevenson, (1978) Stevenson and Stuart-Sharkey (1980)

Length Frequency

Although, length-frequency analysis were performed separately for species caught with the two different gears, it is more appropriate to discuss both gears at the same time. Comparing the size frequency distribution of coneys sampled with hook and line and with fish traps, it can be observed that coneys sampled with traps were significantly larger than with hooks for both sampling years. These results are similar to those obtained from previous surveys (Rosario, 1992b, 1993, 1996, 1998). In the revised literature from the Caribbean area, gear selectivity has never been reported for sampled coneys. Thompson and Munro (1974) reported no gear selectivity for sampled coneys with traps and hook and line.

Similar results were obtained for the red hind, i.e. sizes of individuals caught with traps were larger on average than those captured with hook and line. The observed differences in size distribution were statistically significant (Kolmogorov-Smirnov, $d_{\square} > D_{.05}$). This is a reflection of gear selectivity, and is a trend, which has been recorded consistently in our surveys. Thompson and Munro (1974), did not find gear selectivity in the size distributions of red hind sampled with these two gears in Jamaica, although, those captured with traps (1.25" hexagonal mesh) were of slightly higher average size, similar to the results of this survey. Matos (1991), on the other hand, reported that size frequency distribution of red hinds captured with hook and line were significantly larger than those taken with fish traps, for red hinds sampled during 1988-89 and 1990.

Reproductive State

Data on spawning seasonality of selected species were collected incidentally and are compared with published literature from the region. Not all months were sampled comprehensively for all species and hence only broad patterns may be presented.

Red hinds

Red hinds are known to aggregate to spawn throughout its range. In Puerto Rico, effort has been made to monitor one of the aggregations since 1989. Erdman (1977) reported the spawning period to occur around the full moon of January or February. Erdman also reported that every several years there is a shift in the spawning pattern of this species. Other authors from the Caribbean region have reported similar results to those of Erdman (1977), which are similar to data collected during the spawning aggregation of the past twelve years. Data collected during the 1992 aggregation indicates that the spawning occurred around the full moon in late February. The results obtained from 1997 suggest several spawning, being the major event in February starting in the full moon and more pronounced in the last quarter moon. In January a small event of spawning was identified during the last quarter moon. Thompson and Munro (1974) reported ripe fishes only from December to March and the greatest number of fishes with ripe gonads were collected in January. Several authors have study the relation of the reproductive seasonality of groupers with environmental factors such as the day length, primary productivity and water temperature (Posada, 1996) and Edgardo Ojeda (personal communication), being the water temperature the factor that better fits and explain the observed variability on the spawning months . Ojeda (unpublished data) found out that red hind spawning was trigger by a mass of relative cold water (around 24□ C) intruding into the platform water column.

Data gathered by the Fisheries Research Laboratory confirms these findings, since in some years the spawning activity occurred mainly during January, or in other years during February. Sadovy, *et al* (1994a) determined that spawning is circumscribed to a period of 2-3 weeks in January/February each year, spawning through either the full or the new moon period.

One aspect of the red hind spawning aggregation that has been contended and thus far, nobody has clarified is whether red hind travel to spawn to a determined area, every year. Sadovy *et al*, 1992; demonstrated that red hinds does not necessarily moves to the nearest spawning site. On the other hand, there are indications that some spawning the sexual maturity of coneys was obtained while sampling at the red hind spawning aggregations. Several authors have reported similar results for coneys in Bermuda (Burnett-Herkes. 1975), in Belize (Carter *et al.* 1994), US Virgin Islands (Beets *et al.* 1994). Figuerola and Torres (2000) could not establish if coneys collected from the same areas covered by our survey form spawning aggregation. The results obtained of the absence of sperm competence by these authors is consistent with the direct observations made by Patrick Colin (Sadovy *et al.*, 1994a) (e.g. Colin *et al.*, 1987; Carter *et al.*, 1994; Sadovy *et al.*, 1994a and Beets *et al.* 1994) of small groups composed of one male and several females, with spawning occurring in pairs.

Rosario and Figuerola (2001) undertook a tag and release study of red hinds and coneys from January 1999 to June 1999. The aim of the survey was to characterize the movement behavior during the reproductive period of red hinds and coneys at three spawning sites (Tourmaline, Abrir La Sierra and Bajo de Cico). At the present time not a single coney (579 tagged individual) has been recaptured. Efforts were done to mark and release the coney from a single site (Abrir La Sierra) to maximize the probability of recapture. All monitoring efforts, even divers, have not been successful to locate any of this individual. Contrary to the red hinds that was a success the recapture of individuals. The sizes of coney overlapped that of red hinds, suggesting that the survival rate might be similar. Still other factors causing post-tagging mortality are involved. We need to gathered additional information on the coney to determine the probable causes in recapture failure.

Spawning periods of coney have been recorded from different surveys conducted at the Fisheries Research Laboratory to be quite variable. Erdman (1977) reported the spawning season of this species to be between the months of December to February. Rosario (1996) reported that for various sampling periods this was the most likely, although data is incidental. In Curaçao Nagelkerken (1979) reported ripe gonads from May to October. In Bermuda spawning activity has been reported form May to August (Bolden, 1994; Smith, 1971). Meanwhile coney reproduction in the Bahamas spawning has been recorded from December to January by Heemstra and Randall, 1993. Thompson and Munro (1974) reported ripe fishes between November and July, with peak spawning activity in January to March, and a subsidiary peak in June and July, for sampled coney in Jamaica. They also reported that the highest proportion of spent gonads was taken in April. Figuerola and Torres (2000) found four active males and two females recently spawned in June 1998, suggesting the possibility of some spawning activity in Puerto Rico for June. They also pointed out that the data available from their study could not establish with precision the inter-annual variability of the spawning.

For sampling period of April 1997 to March 1998 ripe individual were recorded from November to March. Data suggested several spawning events in December, January and February around the last quarter moon. Figuerola and Torres (2000) found that the reproductive season based in the presence of active mature gonads was from November to March. Nonetheless, they point out that based on the presence of hydrate ova allows to establish a principal spawning around several days of the last quarter moon in January and February. The pattern reported by them is consistent with that describe by Sadovy, *et al.* (1994a) and Shapiro, *et al.* (1993b) for the red hind in Puerto Rico. Our results are consistent with those reported by Figuerola and Torres (2000).

The sex ratio obtained in our survey varied markedly from one gear to another within the same sampling year and between the two sampling years. It ranges from 4.7:1 for hook data in 1997 to 6.2:1 (F:M) for the hook data in 1999. Trap data yielded lower sex ratios for both periods 1.9:1 for 1997 and 4.7:1 (F:M) for 1999 data. The variability could be reduced combining the data of both gears to calculate the sex ratio. Another factor affecting these results is the error introduced in the macroscopically determination of sex, especially during the non-reproductive season of the species. In Jamaica Thompson and Munro (1974) reported a sex ratio of 2.1:1 (F:M). Figuerola and Torres (2000) reported similar values 1.9:1 (F:M) of operational sex ratio for Puerto Rico, suggesting the stability of the studied population or that there is not significant impact of the fishery over the sex ratio. Their results are based on histological gonad studies, therefore, being more precise classification of sexes. Another factor that confounded the macroscopically classification of the sexes is that the coneys have been reported to be a monandric protaginous hermaphrodite species (Smith, 1959; Shapiro, 1987b; Figuerola and Torres, 2000). Figuerola and Torres (2000) found transitional individuals from 186 to 258 mm FL during all sampled month in their study with the exception of June. Coleman *et al* (1996) mentioned that the sex ratio of male to female can be diminish if the fishing activity is selective toward males or if the fishing pressure destroy the mechanisms that regulate such ratio. When any of these

As a more refined sampling protocols become established in the number of stations and replicates a better and more accurate perspective of the conditions of the resources off the west coast of Puerto Rico should be obtained. Although, to improve the picture of the resources off the west coast of Puerto Rico, some other concurrent surveys should be taken, as for example, to map bottom substrates, (at least for the sampled stations), and to determine an index of recruitment into the fisheries. As part of the three year cycle that include these surveys periods a habitat mapping survey was not completed due to the fact that we did not were able to contract the personnel to undertake the project. It is a shame that in three years we were not able to contract the personnel to perform this much needed survey. There is no excuse for such administrative failure to recognize the importance of having the appropriated personnel to carry out the programmatic responsibility contracted with the funding agency. We finally have the personnel to carry out this survey, although not in time to fulfill our responsibility with the SEAMAP program. Nonetheless, the habitat data will benefit our future surveys.

CFMC. 1996. Regulatory amendment to the fishery Management Plan for the reef fish Fishery of Puerto Rico and the U.S. Virgin Islands concerning red hind spawning aggregation closures including a regulatory impact review and an environmental assessment. Caribbean Fishery Management Council. NOAA. Hato Rey PR

Cole. J.S. 1976. Commercial fisheries survey and development. Contr. Agrop. Pesq. Dept. Agric. Puerto Rico 8(3): 1-76.

Coleman. F.C.. C. C. Koenig and L. A. Collins. 1996. Reproductive styles of shallow-water groupers (Pisces: Serranidae) in the eastern Gulf of Mexico and the consequences of fishing spawning aggregations. *Env. Biol. of Fishes* 47:129-141.

Colin. P., D. Y. Shapiro and D. Weiler. 1987. Aspects of the reproduction of two groupers. *E. guttatus* and *E. striatus* in the West Indies. *Bull. Mar. Sci.* 40:220-230.

Colin. P.L. 1984. In Reproduction in reef fishes. Thresher, R.E.T.F.H. Publ. Inc. Ltd. ISBN 0-87666-808-2. 1-398.

Colin. P.L. and I.E. Clavijo. 1988. Spawning activity of fishes producing pelagic eggs on a shelf edge coral reef southwestern Puerto Rico. Bull. Mar. Sci. 43(2): 249-279.

Collazo, J.. and J.A. Calderón. 1988. Status of fisheries in Puerto Rico 1979-1982. CODREMAR. Tech. Rep. 1(2): 1-30.

Dennis, G.D., Y. Sadovy and D. Matos. 1991. Seasonal and annual trends in commercial fisheries landings from Puerto Rico. Gulf Caribb. Fish. Inst. 44: in press 1-23.

Dooley, J.K. 1978. Systematic and biology of the tilefishes (Perciformes: Branchiostegidae and Malacanthidae). with description of two new species. NOAA Tech. Rep. NMFS circular 411: 1-78.

Eggers, D.M., N.A. Rickard, D.A. Chapman and R.R. Whitney. 1982. A methodology for estimating area fished for baited hooks and traps along a ground line. Can. J. Fish. Aquat. Sci. 39: 448-453.

Erdman, D.S. 1977. Spawning patterns of fishes from the north-east Caribbean. FAO Fish. Rep. 200: 145-170.

Figuerola. M. W. Torres Ruiz. 2000. Reproducción en el mero mantequilla (*Cephalopholis fulva*) y evaluación preliminar de la veda durante las agregaciones de desove del mero cabrilla (*Epinephelus guttatus*) en el oeste de Puerto Rico. Research Laboratory, DNR. unpublished 40 p.

García-Moliner, G.E., and J.J. Kimmel. 1986. CODREMAR/NMFS Cooperative Statistics Program. Mayagüez, Puerto Rico. Laboratorio de Investigaciones Pesqueras.

Hartsuijker, L. and W.E. Nicholson. 1981. Results of a potfishing survey on Pedro Bank (Jamaica). The relationship between catch rates, catch composition, the size of the fish and their recruitment to the fishery. Fish. Div. Minist. Agric., Jamaica. Tech. Rep. No. 4 of the Project. FAO/TCO/JAM 8902: Potfishing survey of Pedro Bank. 1-24.

Heemstra, P.C. and J. E. Randall. 1993. FAO Species catalogue. Vol.16 No. 125. Groupers of the world (Family Serranidae. subfamily Epinephelinae). Rome, Italy. 382 p.

High, W.L. and A.J. Beardsley. 1970. Fish behavior studies from an undersea habitat. *Com. Fish. Rev.* 31-37.

Juhl, R. 1969. Exploratory fishing surveys and gear test in Puerto Rico. Contr. Agrop. Pesq. Fish Wildl. Div. Dept. Agric. Puerto Rico 1(1): 1-39.

Juhl, R. 1972. A report on exploratory fishing and gear tests in Puerto Rico from 1969 to 1972. Contr. Agrop. Pesq. Dept. Agric. Puerto Rico 4(3): 1-63.

Juhl, R., and J.A. Suarez-Caabro. 1972. A report on exploratory fishing survey and gear test in Puerto Rico from 1967 to 1972. Cont. Agrop. Pesq. P.R. Dept. Agric. 4(3):1-63.

Juhl, R. and J.A. Suarez-Caabro. 1973. Fish pot fisheries in Puerto Rico. Contr. Agrop. Pesq. Dept. Agric. Puerto Rico 5(4): 1-18.

Kawaguchi, K. 1974. Handline and longline fishing explorations for snapper and related species in the Caribbean and adjacent waters. *Mar. Fish. Rev.* **36**(9): 8-31.

Luckhurst, B. and J. Ward. 1987. Behavioral dynamics of coral reef fishes in Antillean fish traps in Bermuda. *Gulf Caribb. Fish. Inst.* **38**: 528-546.

Matos, D. 1990. History and current status of the commercial fishery in Puerto Rico, 1988-1989. First Symposium of the Coast. Sea Grant. Technological College Ponce, Puerto Rico. 1: 1-16.

Matos, D. 1991. Comparison of size of capture using hook and line, fish traps and gill nets of five commercial fish in Puerto Rico during 1988-90. *Gulf Caribb. Fish. Inst.* **44**: in press.

Matos, D. 1992. Fisheries Research Laboratory/NMFS Cooperative Statistics Program for 1991-92. Mayagüez, Puerto Rico. Laboratorio de Investigaciones Pesqueras.

Matos, D. 1993. Fisheries Research Laboratory/NMFS Cooperative Statistics Program for 1992-93. Mayagüez, Puerto Rico. Laboratorio de Investigaciones Pesqueras.

Matos, D., and Y. Sadovy. 1990. Overview of Puerto Rico' small-scale Fisheries Statistics 1988-1989. CODREMAR. Tech. Rep. 1(4): 1-17.

Matos, D., and Z. Torres. 1989. Comprehensive census of the fishery of Puerto Rico, 1988. CODREMAR. Tech. Rep. 1(3): 1-55.

Miller, R.J. and W. Hunte. 1989. Effective area fished by Antillean fish traps. Unpublished.

Miller, R.J. 1989. Traps as a survey tool for animal density. *Gulf Caribb. Fish. Inst.* **39**: 331-339.

Munro, J.L., P.H. Reeson and V.C. Gaut. 1971. Dynamics factors affecting the performance of the Antillean fish trap. *Gulf Caribb. Fish. Inst.* **23**: 184-194.

Munro, J.L. 1974a. The composition and magnitude of line catches in Jamaican waters. Part 4. *The biology, ecology, exploitation and management of Caribbean reef fishes.* ODA/UWI fisheries ecology research project. Res. Rep. Zoo. Dep. Univ. West Indies. 4: 26-32

Munro, J.L. 1974b. The composition and magnitude of trap catches in Jamaican waters. Part 5. *The biology, ecology, exploitation and management of Caribbean reef fishes.* ODA/UWI fisheries ecology research project. Res. Rep. Zoo. Dep. Univ. West Indies. 5: 33-49

Munro, J.L. 1974c. The mode of operation of Antillean fish traps and the relationship between ingress, escapement, catch and soak. *J. Cons. Int. Explo. Mer.* **35**: 337-350.

Munro, J.L. 1983. Coral reef fish and fisheries of the Caribbean Sea. *ICLARM Stud. Rev.*, **7**: 9 p.

Sadovy, Y. 1993b. Spawning biomass per recruit: *Epinephelus guttatus* (Puerto Rico). Report to the Caribbean Management Council. May 1993, 20 p.

Sadovy, Y. 1994. Grouper stocks of the western central Atlantic: the need for management and management needs. *Gulf Caribb. Fish. Inst.* **43**: 43-64.

Sadovy, Y., and M. Figuerola. 1992. The status of the red hind fishery in Puerto Rico and St. Thomas, as determined by yield-per-recruit analysis. *Gulf Caribb. Fish. Inst.* **42**: in press.

Sadovy, Y. and P. L. Colin. 1995. Sexual development and sexuality in the Nassau grouper, *Epinephelus striatus* (Pisces, Serranidae). *J. Fish. Biol.* 46:961-976.

Sadovy, Y., M. Figuerola and A. Román. 1992. Age and growth of red hind, *Epinephelus guttatus*, in Puerto Rico and St. Thomas. *Fish. Bull.* 90:516-528.

Sadovy, Y, A. Rosario, and A. M. Román. 1994a. Spawning dynamics in an aggregating grouper, the red hind, *Epinephelus guttatus. Env. Biol. Fish.* 41: 269-286.

Sadovy, Y. P. L. Colin and M. Domier. 1994b. Aggregation and spawning of the tiger grouper, *Mycteroperca tigis* (Pisces: Serranidae). *Copeia* 1994:511-516.

Shapiro, D.Y. 1987a. Inferring larval recruitment strategies from the distributional ecology of settled individuals of a coral reef fish. *Bull. Mar. Sci.* 41: 289-295.

Shapiro, D.Y. 1987b. Reproduction in groupers. Pages 295-328 in: J. J. Polovina and S. Ralston, (eds.) *Tropical snappers and groupers: biology and fisheries management. Westview Press, Boulder, Colorado.*

Shapiro, D.Y., Y. Sadovy, M.A. McGehee. 1993a. Size, composition, and spatial structure of the annual spawning aggregation of the red hind, *Epinephelus guttatus* (Pisces:Serranidae). *Copeia* 1993:367-374.

Shapiro, D.Y., Y. Sadovy, M.A. McGehee. 1993b. Periodicity of sex change and reproduction of the red hind grouper, *Epinephelus guttatus*, a protogynous grouper. *Bull. Mar. Sci.* 53:1151-1162.

Sinoda, M. and T. Kobayasi. 1969. Studies of the fishery of Zuwai crab in the Japan Sea-VI. Efficiency of the toyoma kago (a kind of crab trap) in capturing beni-zuwai crab. *Bull. Jap. Soc. Sci. Fish.* **35**: 948-956.

Smith, S.G. and J.S. Ault. 1993. Statistical sampling design analysis of the 1991-1992 Puerto Rico shallow-water reef fish monitoring survey. The Rothschild\Ault\Group final report for SEAMAP-Caribbean Program. unpublished 1-74.

Stevenson, D.K. 1978. Management of a tropical fishery for maximum sustainable yield. *Gulf Caribb. Fish. Inst.* **30**: 386-397.

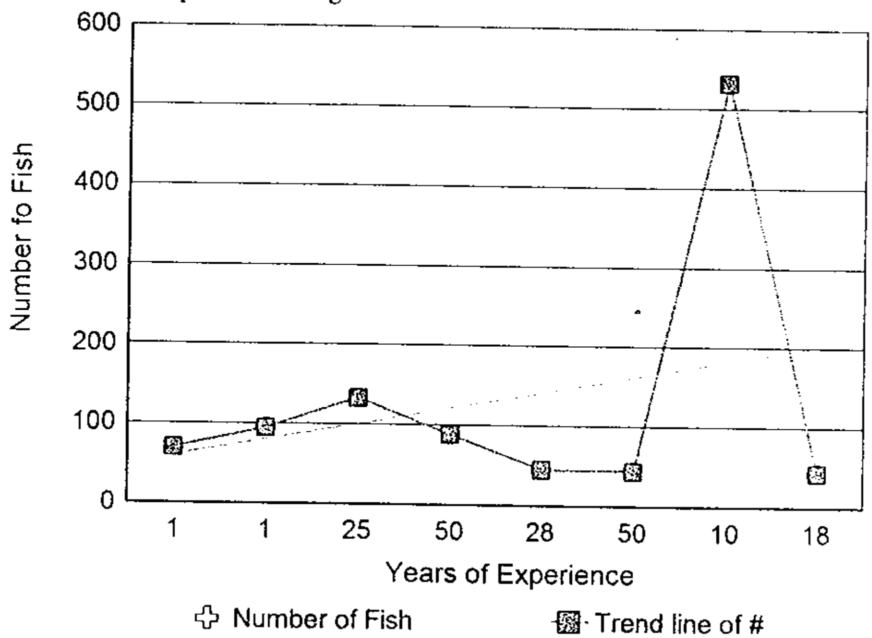
Stevenson, D.K. and P. Stuart-Sharkey. 1980. Performance of wire fish traps on the western coast of Puerto Rico. *Gulf Caribb. Fish. Inst.* **32**: 173-193.

Sutherland, D.L., J.A. Bohnsack, D.E. Harper, C.M. Holt, M.W. Hulsbeck, and D.B. McClellan. 1987. Preliminary report: Reef fish size and species selectivity by wire fish traps in south Florida waters. A report to the Gulf of Mexico Fishery Management Council, September 1987. U.S. Dep. Commer., NOAA/NMFS/SEFC, Miami Lab., Coast Resource. Div. 86/87-33.

Thompson, R. and J.L. Munro. 1974. The biology, ecology and bionomics of the hinds and groupers, Serranidae. Part 7. The biology, ecology, exploitation and management of Caribbean reef fishes. ODA/UWI fisheries ecology research project. Res. Rep. Zoo. Dep. Univ. West Indies. 3: 59-81.

Figures

Figure 2. Trend of number of fish caught with hooks per number of year of experience fishing.



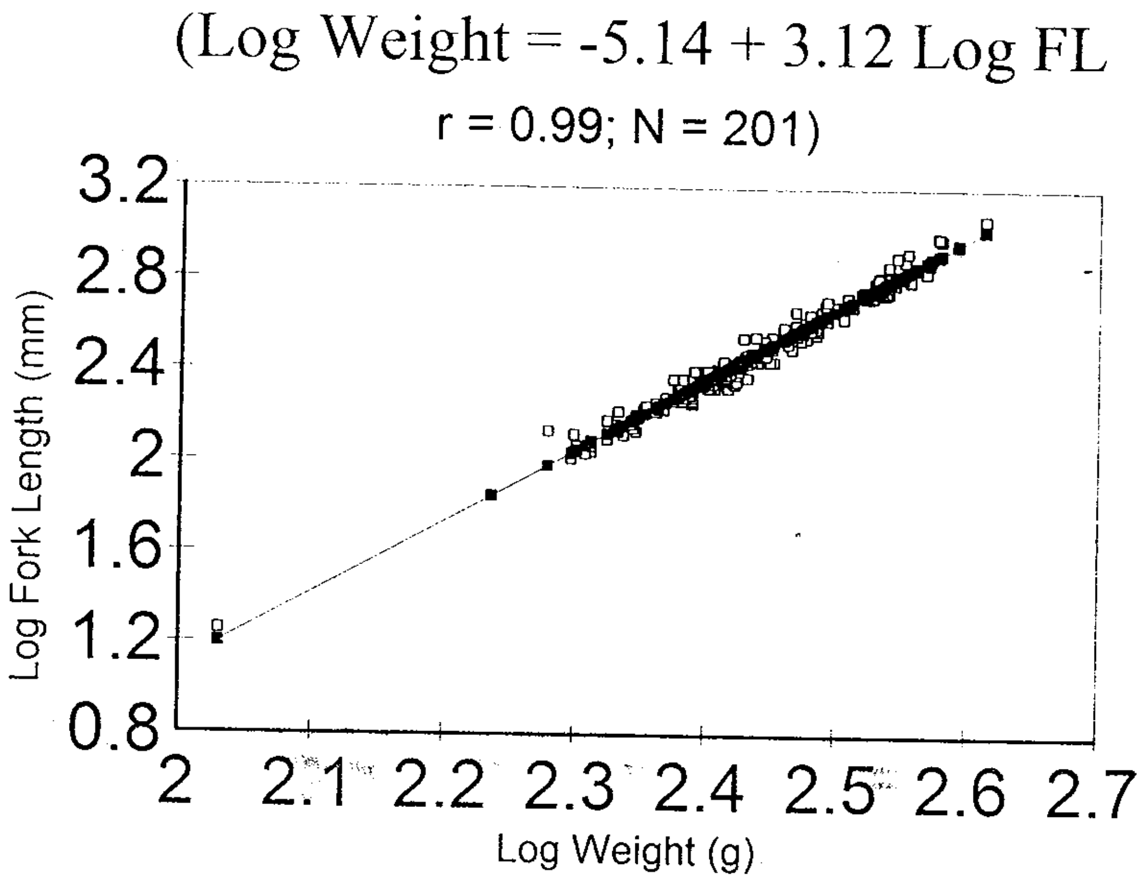


Figure 5. Length-weight relationship of sampled red hinds with hook April 2000 to March 2001.

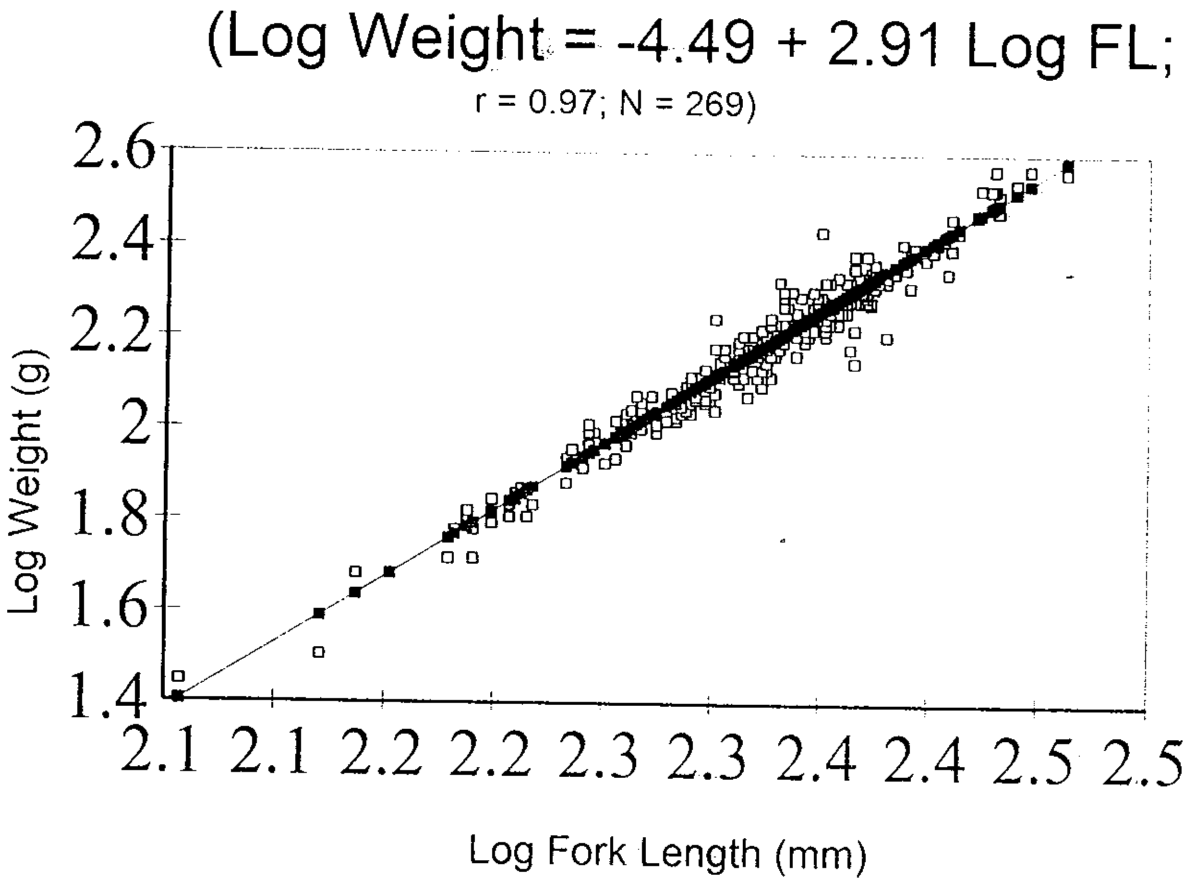


Figure 7. Length-weight relationship of sampled coneys with hooks during

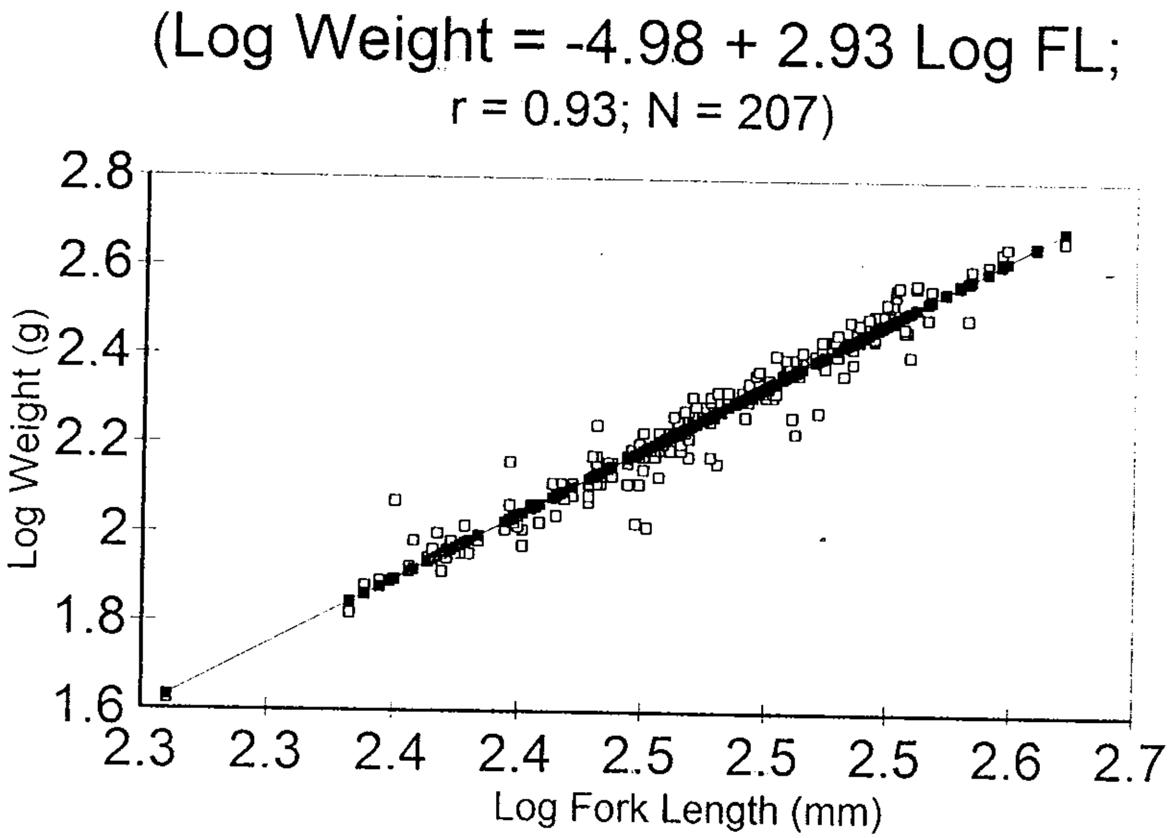


Figure 9. Lenght-weight relationship of sampled sand tilefish with hooks April 2000 to March 2001.

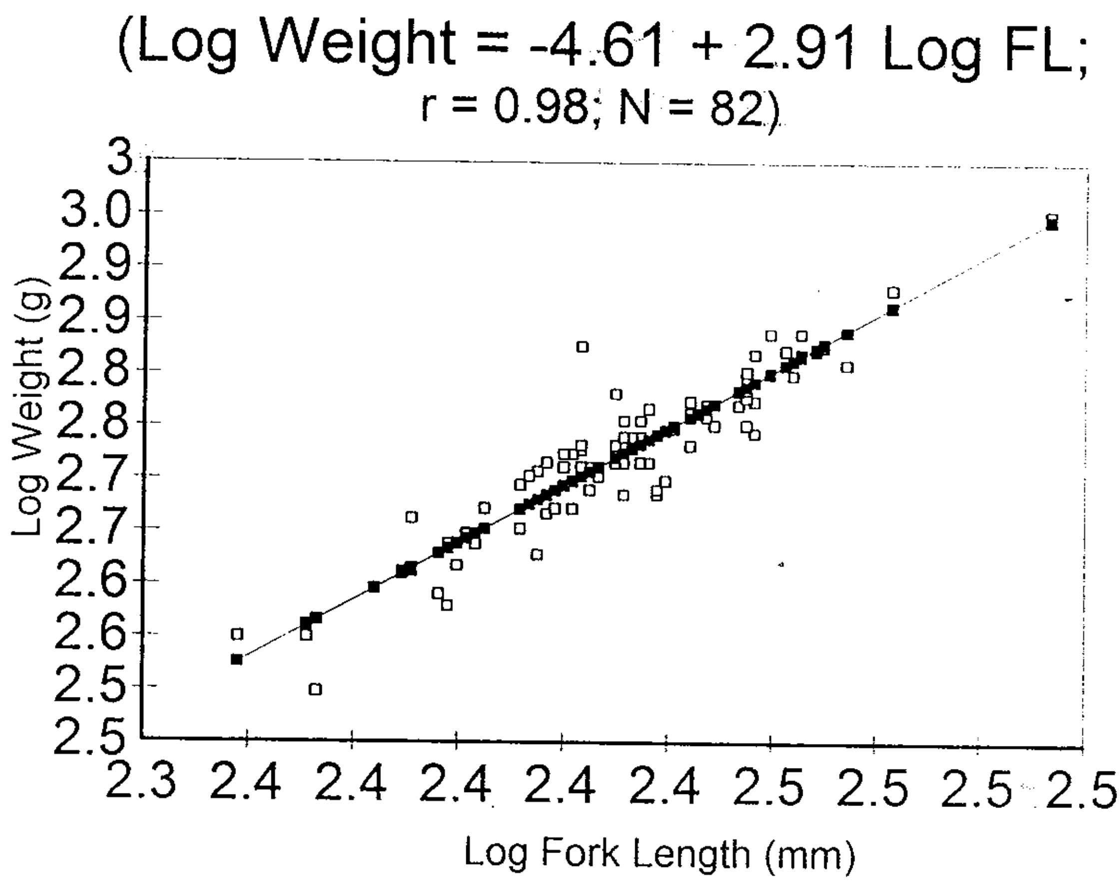


Figure 11. Lenght-weight relationship of sampled black dungon with hooks April 2000 to March 2001.

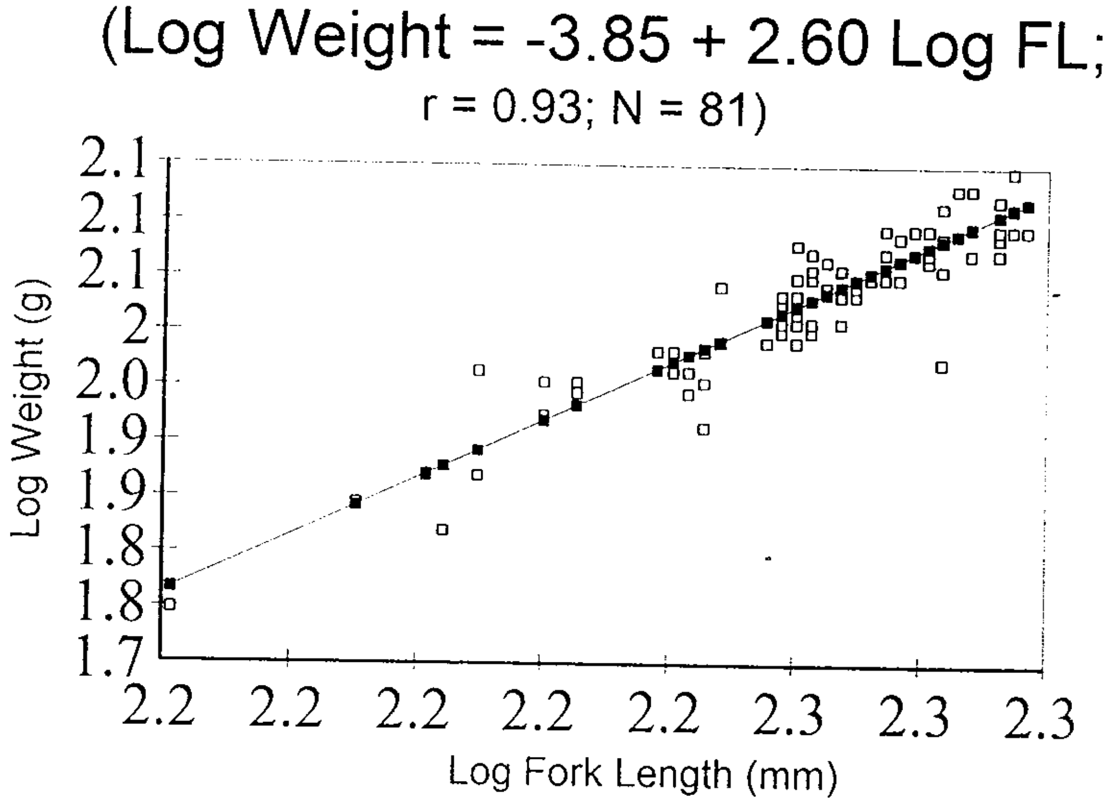


Figure 13. Length-weight relationshipof sampled longspine squirrelfish with hooks during sampling period of April 2000 to March 2001.

Figure 23. Size frequency distribution of sampled longjaw squirrelfish by sex during sampling period of April 2000 to March 2001.

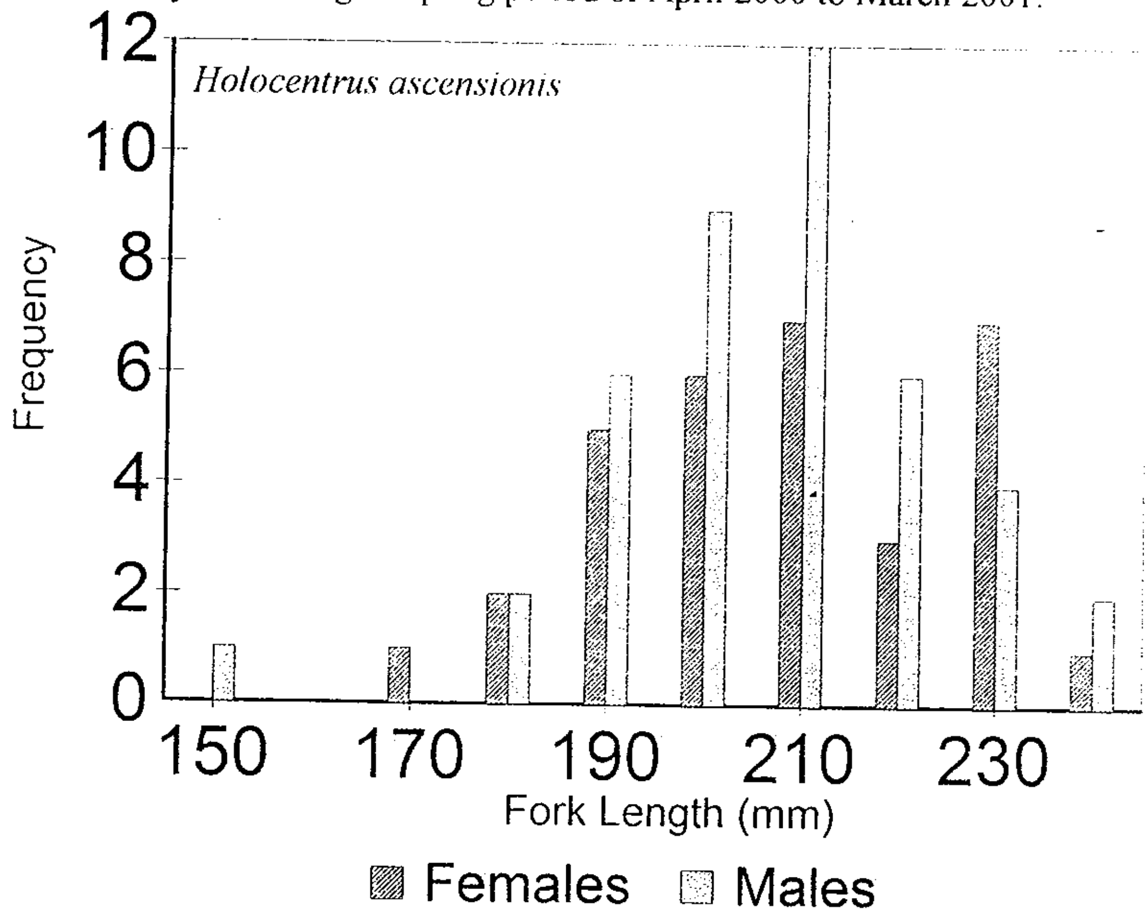


Figure 19. Size frequency distribution by sex of sampled coney during April 2000 to March 2001.

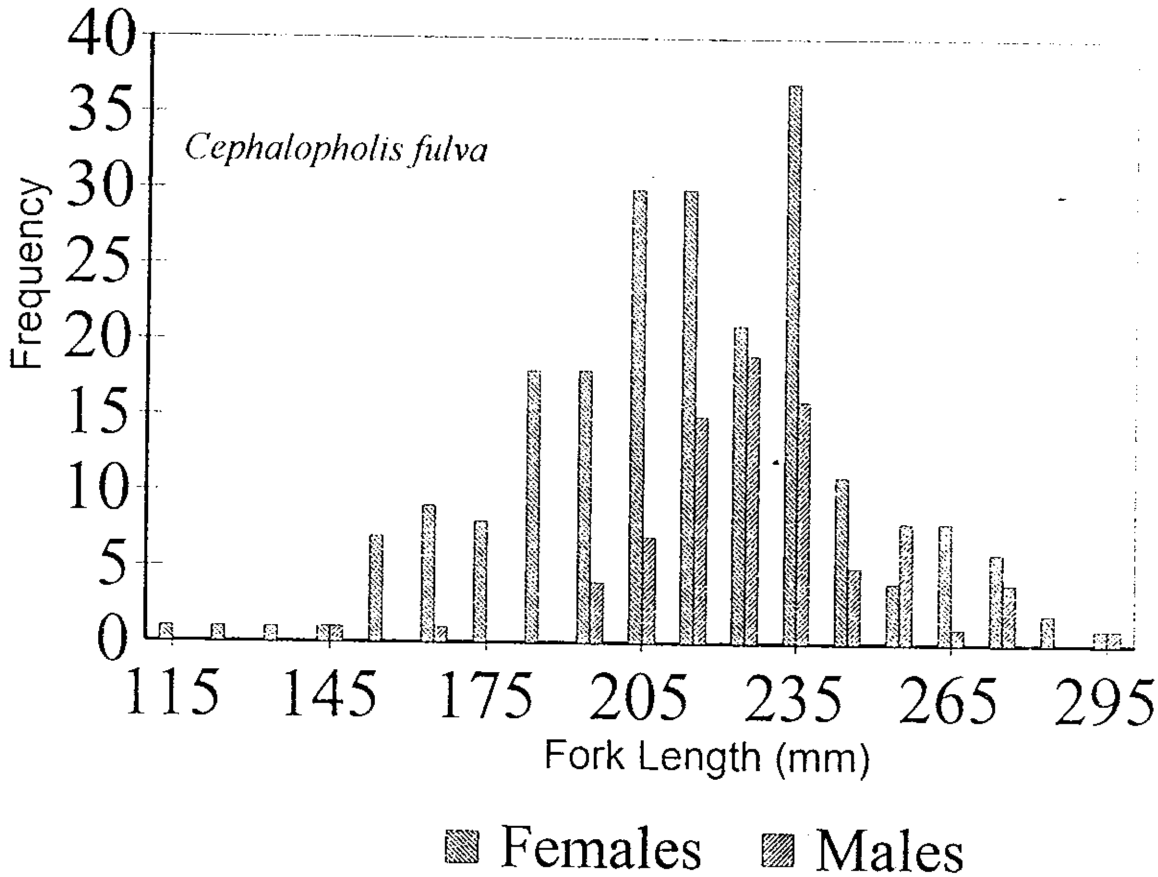


Figure 21. Size frequency distribution by sex of sampled black dungon during April 2000 to March 2001.

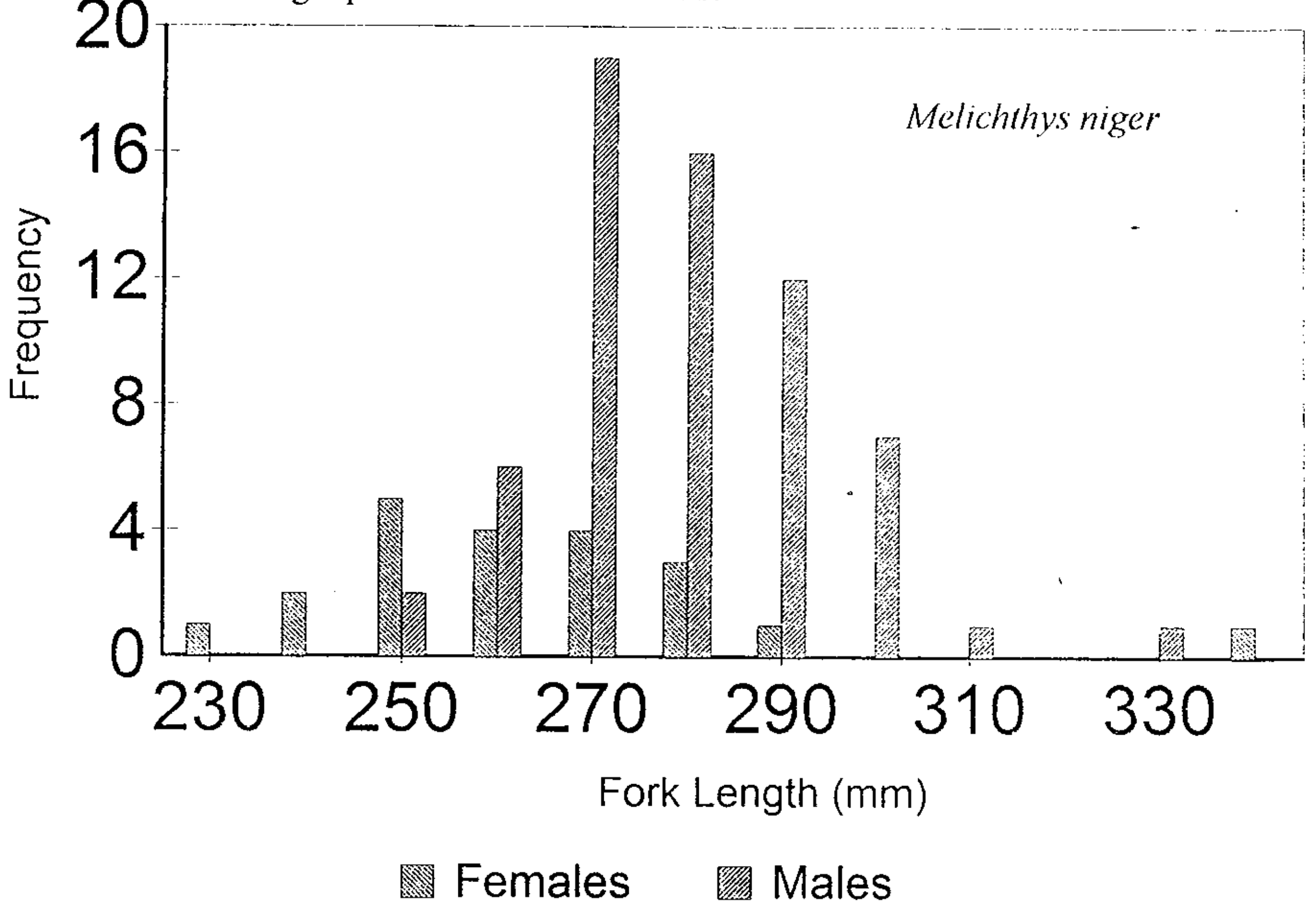


Figure 21. Size frequency distribution by sex of sampled black dungon during April 2000 to March 2001.

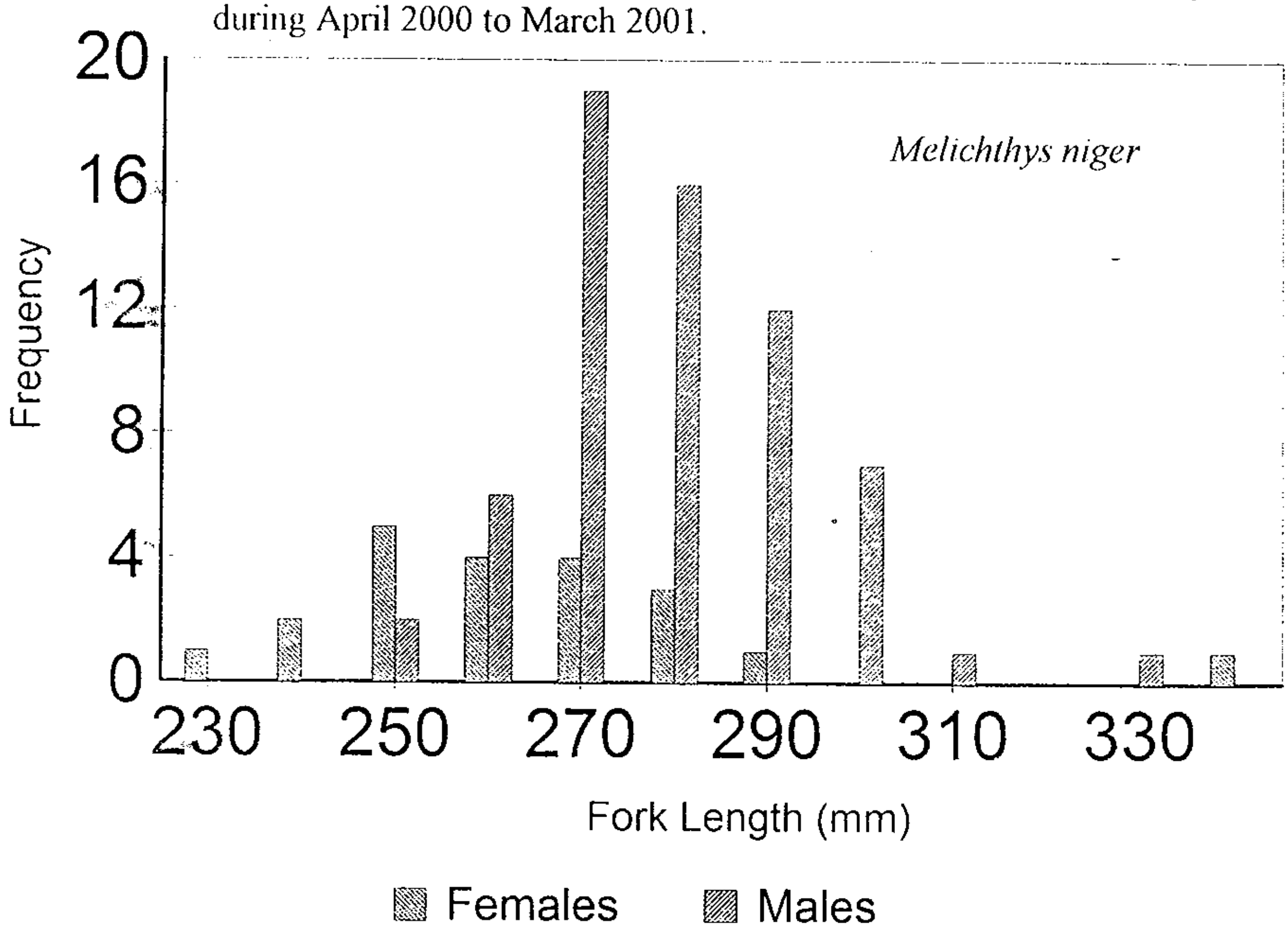


Figure 23. Size frequency distribution of sampled longjaw squirrelfish by sex during sampling period of April 2000 to March 2001.

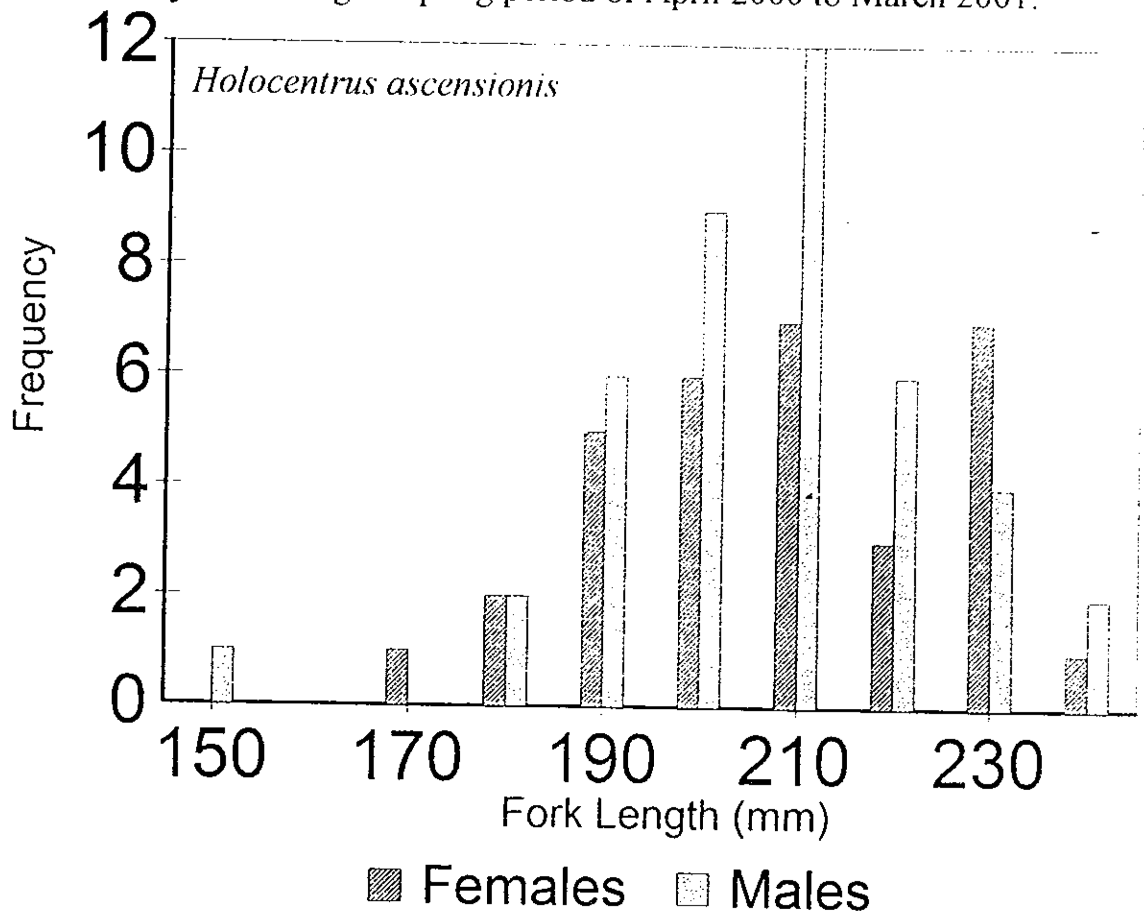


Table 2. Catch summary, by date and station, for the sampling period of April 1, 2000 to March 31, 2001.

Station	Date	#Fish	Weight	#Line	Hook hrs	DEPTH	g/hook hrs	g/line day
59	Apr-00	21	6,624	3	14.01	14	472.81	2,208.00
78	Apr-00	16	4,172	5	15.75	11	264.89	834.40
89	Apr-00	11	2,634	3	15	20	175.60	878.00
96	Apr-00	16	6,894	3	13.5	24.5	510.67	2,298.00
49	May-00	13	3,769	3	13.5	20.5	279.19	1,256.33
7	May-00	14	3,011	3	11.25	11.5	267.64	1,003.67
69	May-00	5	1,730	3	11.1	22.5	155.86	576.67
49	Jun-00	30	10,083	3	14.49	20.5	695.86	3,361.00
47	Jun-00	5	1,100	3	11.49	16.5	95.74	366.67
69	Jun-00	7	5,528	3	14.49	19.5	381.50	1,842.67
59	Jun-00	36	8,224	4	15	8.5	548.27	2,056.00
95	Oct-00	40	17,614	3	15	30	1,174.27	5,871.33
59	Oct-00	42	11,214	3	15	25	747.60	3,738.00
59	Oct-00	26	5,425	3	15	25	361.67	1,808.33
96	Nov-00	34	10,465	3	15	18	697.67	3,488.33
59	Nov-00	70	15,246	4	15	18	1,016.40	3,811.50
80	Nov-00	46	7,877	3	15	18	525.13	2,625.67
59	Nov-00	27	6,440	3	15	18	429.33	2,146.67
9	Dec-00	31	5,244	3	15	11	349.60	1,748.00
59	Dec-00	11	3,450	2	15	18	230.00	1,725.00
59	Dec-00	3	705	2	15	18	47.00	352.50
59	Jan-01	33	7,826	3	15	18	521.73	2,608.67
59	Jan-01	23	4,877	3	15	14	325.13	1,625.67
59	Jan-01	28	4,489	3	15	14	299.27	1,496.33
59	Jan-01	28	5,491	3	15	14	366.07	1,830.33
59	Jan-01	25	5,565	3	15	14	371.00	1,855.00
59	Feb-01	51	20,686	5	14.49	14	1,427.61	4,137.20
59	Feb-01	45	12,557	7	15	14	837.13	1,793.86
59	Feb-01	16	4,174	4	15	14	278.27	1,043.50
79	Feb-01	23	4,970	4	16.74	14	296.89	1,242.50
59	Feb-01	37	10,832	5	14.25	14.5	760.14	2,166.40
59	Feb-01	34	11,558	5	14.25	14	811.09	2,311.60
59	Feb-01	39	11,460	6	14.25	14	804.21	1,910.00
79	Feb-01	20	4,649	3	14.25	14	326.25	1,549.67
59	Mar-01	14	3,710	3	12.24	14	303.10	1,236.67
79	Mar-01	19	2,985	3	15.99	12.5	186.68	995.00
59	Mar-01	47	10,847	4	14.25	14	761.19	2,711.75
96	Mar-01	46	19,353	4	13.5	15.5	1,433.56	4,838.25
95	Mar-01	17	5,258	3	12	19.5	438.17	1,752.67
39	Total	1,049	288,736	136	560.79		514.87	2,123.06
	Avg.	26.90	7,403.49	3.49	14.38	16.67	512.16	2,079.53
	Std. dev.	14.67	4,794.87	1.01	1.23	4.42	331.29	1,186.41
	Var.	215.12	22,990,748.87	1.02	1.51	19.53	109,750.34	1,407,559.32

Table 4. Catch summary, by station and fisher, for the sampling period of April 1, 2000 to March 31, 2001.

Station Code	Fisher #1 #	Wt	Fisher #2 #	Wt	Fisher #6 #	Wt	Fisher #13 #	Wt
7	0	0	4	366	*	*	7	2,196
9	2	333	5	660	*	*	*	*
47	0	0	2	540	*	*	1	235
49	0	0	15	3,808	*	*	10	3,815
59	43	12,287	67	20,331	67	23,627	14	4,251
69	2	950	5	1,450			3	4,398
78	1	250	*	*	*	*	0	0
79	3	1,010	4	658	7	2,287	*	*
80	1	180	*	*	*	*	0	0
89	1	210	*	*	*	*	5	1,445
95	5	2,080	17	8,744	*	*	*	*
96	12	4,315	14	6,974	14	5,051	5	1,544
# Trips	70	21,615	133	43,531	88	30,965	45	17,884
Mean #/trip	5.83		11.08		8.00		3.75	
std. dev.	11.65		17.82		19.14		4.44	
Mean Weight/trip	1,801.25		3,627.58		2,815.00		1,490.33	
std. dev.	3,380.76		5,762.15		6,754.20		1,699.61	
Years Experience	3		>25		>50		>25	

Station Code	Fisher #20 #	Wt	Fisher #21 #	Wt	Fisher #26 #	Wt	Fisher #28 #	Wt
7	*	*	3	449	*	*	*	*
9	*	*	*	*	*	*	*	*
47	25	4,251	*	*	*	*	*	*
49	*	*	2	325	*	*	*	*
59	*	*	18	6,229	*	*	*	*
69	358	80,145	2	1,116	23	7,674	83	21,969
78	*	*	2	460	*	*	*	*
79	*	*	3	884	*	*	12	3,038
80	47	8,649	*	*	*	*	*	*
89	45	7,697	0	0	*	*	*	*
95	*	*	5	979	*	*	*	*
96	15	4,278			20	7,770	*	*
# Trips	42	14,023	9	4,805				
Mean #/trip	532	119,043	44	15,247	43	15,444	95	25,007
std. dev.	44.33		3.73		3.91		8.64	
Mean Weight/trip	96.36		5.21		8.32		23.77	
std. dev.	9,920.25		1,345.27		1,404.00		2,273.36	
Years Experience	21,620.50		2,028.97		2,978.40		6,288.64	
	10		>50		17		0 to 2	

Table 6. Catch summary, by sampled stations of selected species with hooks April 1,2000 to March 31, 2001 .

Stations	#Trips	A) Red hinds #Fish	Weight	g/lnday	g/hk hrs	B) Coneys #Fish	WEIGHT	g/lnday	g/hk hrs	C) Sand tilefish #Fish	WEIGHT	g/lnday	g/hk hrs
7	1	3	1,650	550.00	146.67	9	1,066	355.33	94.76				
9	1	0	0	0.00	0.00	13	2,131	710.33	142.07				
47	1	0	0	0.00	0.00			0.00	0.00				
49	2	23	9,316	1,552.67	166.42	15	2,429	404.83	43.39				
59	21	117	34,117	437.40	5.28	156	23,302	298.74	3.61	168	33,193	425.55	5.14
69	2	6	2,305	384.17	45.04			0.00	0.00	2	405	67.50	7.91
78	1	0	0	0.00	0.00	6	1,511	302.20	95.94			0.00	0.00
79	3	2	528	52.80	3.75	14	1,763	176.30	12.51	20	3,482	348.20	24.71
80	1	2	515	171.67	34.33	8	1,056	352.00	70.40	9	1,245	415.00	83.00
89	1	5	1,650	550.00	110.00	4	574	191.33	38.27			0.00	0.00
95	2	36	14,295	2,382.50	264.72	10	2,408	401.33	44.59	5	1,075	179.17	19.91
96	3	14	5,515	551.50	43.77	36	7,044	704.40	55.90	7	1,750	175.00	13.89
TOTAL	39	208	69,891	513.90	3.20	271	43,284	3,897	601	211	41,150	1,610	155
Avg.	3.25	17.33	5,824.25	707.20	20.49	27.10	4,328.40	324.73	50.12	35.17	6,858.33	201.30	19.32
Std. Dev.	5.40	31.86	9,529.60	1,257.26	25.17	43.79	6,553.34	215.78	42.63	59.67	11,815.32	164.95	25.48
Var.	29.19	3,518.46	375,274,856.25	1,580,705.54	633.36	6,659.47	164,458,481.79	948,994.01	23,259.25	6,837.63	263,648,770.12	220,294.15	2,383.07

Stations	#Trips	D) Black dungon #Fish	WEIGHT	g/lnday	g/hk hrs	E) Longjaw squirrelfish #Fish	WEIGHT	g/line day	g/hook hrs	F) Longspine squirrelfish #Fish	WEIGHT	g/line day	g/hook hrs
7	1							0.00	0.00			0.00	0.00
9	1							0.00	0.00	12	1,238	412.67	82.53
47	1					1	195	65.00	16.97			0.00	0.00
49	2	1	625	104.17	11.16			0.00	0.00	1	108	18.00	1.93
59	21	51	26,624	341.33	4.12	35	5,690	72.95	0.88	56	6,135	78.65	0.95
69	2			0.00	0.00	2	265	44.17	5.18			0.00	0.00
78	1			0.00	0.00			0.00	0.00	1	132	26.40	8.38
79	3			0.00	0.00	5	722	72.20	5.12	7	684	68.40	4.85
80	1			0.00	0.00	18	3,105	1,035.00	207.00	3	270	90.00	18.00
89	1			0.00	0.00	1	200	66.67	13.33			0.00	0.00
95	2	3	1,550	258.33	28.70	1	190	31.67	3.52			0.00	0.00
96	3	29	16,095	1,609.50	127.74	1	60	6.00	0.48	2	223	22.30	1.77
TOTAL	39	84	44,894	330.10	2.05	64	10,427	76.67	0.48	82	8,790	64.63	0.40
Avg.	3.25	21.00	11,223.50	257.04	19.08	8.00	1,303.38	116.14	21.04	11.71	1,255.71	59.70	9.87
Std. Dev.	5.40	20.54	10,802.91	493.29	39.45	11.57	1,908.40	278.62	56.32	18.45	2,026.70	111.06	22.49
Var.	29.19	972.64	274,754,754.64	219,477.79	1,426.68	428.62	11,458,628.10	71,769.34	2,958.41	838.25	9,802,811.50	11,386.76	473.19

Table 8. Catch summary by sampled months during April 1. 2000 to March 31, 2001.

Date	# Trips	# Fish	Weight	Hook hours	#Line	g/hook hours	g/line day
April	4	64	20,324	233.04	14	87.21	1,451.71
May	3	32	8,510	107.55	9	79.13	945.56
June	4	78	24,935	221.88	13	112.38	1,918.08
October	3	108	34,253	45.00	9	761.18	3,805.89
November	4	177	40,028	60.00	13	667.13	3,079.08
December	3	45	9,399	45.00	7	208.87	1,342.71
January	5	137	28,248	375.00	15	75.33	1,883.20
February	8	265	80,886	945.84	39	85.52	2,074.00
March	5	143	42,153	339.90	17	124.02	2,479.59
TOTAL	39	1,049	288,736	11,842.59	317	24.38	910.84

Table 10. Descriptive statistics of selected sampled species with hook and line for April 1, 2000 to March 31, 2001.

A. Epinephelus guttatus

LENGTH		WEIGHT	
Mean	275.48	Mean	336.01
Standard Error	3.45	Standard Error	13.24
Median	266.50	Median	270.00
Mode	252.00	Mode	230.00
Standard Deviation	49.82	Standard Deviation	190.92
Variance	2,481.93	Variance	36,451.01
Kurtosis	1.46	Kurtosis	2.18
Skewness	0.59	Skewness	1.40
Range	387	Range	1,152
Minimum	107	Minimum	18
Maximum	494	Maximum	1,170
Sum	57,300	Sum	69,891
Count	208	Count	208
Confidence Level(0.95)	6.77	Confidence Level(0.95)	25.95

B. Cephalopholis fulva

LENGTH		WEIGHT	
Mean	211.41	Mean	159.72
Standard Error	1.77	Standard Error	3.80
Median	213.00	Median	160.00
Mode	235.00	Mode	190.00
Standard Deviation	29.15	Standard Deviation	62.49
Variance	849.85	Variance	3,904.92
Kurtosis	0.63	Kurtosis	1.19
Skewness	-0.30	Skewness	0.72
Range	176	Range	342
Minimum	114	Minimum	28
Maximum	290	Maximum	370
Sum	57,291	Sum	43,284
Count	271	Count	271
Confidence Level(0.95)	3.47	Confidence Level(0.95)	7.44

C. Malacanthus plumieri

LENGTH		WEIGHT	
Mean	298.46	Mean	195.02
Standard Error	2.93	Standard Error	5.78
Median	294.00	Median	180.00
Mode	270.00	Mode	155.00
Standard Deviation	42.53	Standard Deviation	83.96
Variance	1,808.62	Variance	7,048.92
Kurtosis	-0.20	Kurtosis	0.52
Skewness	0.17	Skewness	0.88
Range	236	Range	423
Minimum	182	Minimum	42
Maximum	418	Maximum	465
Sum	62,975	Sum	41,150
Count	211	Count	211
Confidence Level(0.95)	5.74	Confidence Level(0.95)	11.33

D. Melychthis niger

LENGTH		WEIGHT	
Mean	272.00	Mean	534.45
Standard Error	2.33	Standard Error	10.94
Median	270	Median	530
Mode	285	Mode	520
Standard Deviation	21.36	Standard Deviation	100.28
Variance	456.05	Variance	10,056.76
Kurtosis	12.57	Kurtosis	1.36
Skewness	2.30	Skewness	0.31
Range	167	Range	615
Minimum	228	Minimum	280
Maximum	395	Maximum	895
Sum	22,848	Sum	44,894
Count	84	Count	84
Confidence Level(0.95)	4.57	Confidence Level(0.95)	21.45

E. Holocentrus rufus

LENGTH		WEIGHT	
Mean	181.70	Mean	107.20
Standard Error	1.19	Standard Error	2.20
Median	183.00	Median	108.00
Mode	182.00	Mode	118.00
Standard Deviation	10.79	Standard Deviation	19.89
Variance	116.51	Variance	395.42
Kurtosis	1.19	Kurtosis	5.61
Skewness	-1.00	Skewness	0.89
Range	53	Range	146
Minimum	145	Minimum	56
Maximum	198	Maximum	202
Sum	14,899	Sum	8,790
Count	82	Count	82
Confidence Level(0.95)	2.34	Confidence Level(0.95)	4.30

F. Holocentrus ascensionis

LENGTH		WEIGHT	
Mean	201.27	Mean	162.92
Standard Error	2.25	Standard Error	4.14
Median	202	Median	170
Mode	202	Mode	170
Standard Deviation	18.02	Standard Deviation	33.11
Variance	324.83	Variance	1,096.36
Kurtosis	3.92	Kurtosis	0.74
Skewness	0.65	Skewness	-0.60
Range	125	Range	170
Minimum	150	Minimum	60
Maximum	275	Maximum	230
Sum	12,881	Sum	10,427
Count	64	Count	64
Confidence Level(0.95)	4.42	Confidence Level(0.95)	8.11

Table 13. Descriptive statistics by sex of selected sampled species for sampling period of April 1, 2000 to March 31, 2004

A. Epinephelus guttatus

Females

Length		*Weight*	
Mean	269.53	Mean	303.37
Standard Error	3.34	Standard Error	11.31
Median	264.00	Median	257.50
Mode	252.00	Mode	230.00
Standard Deviation	44.86	Standard Deviation	151.78
Variance	2,012.59	Variance	23,037.82
Kurtosis	2.61	Kurtosis	0.88
Skewness	1.01	Skewness	1.16
Range	322	Range	765
Minimum	172	Minimum	70
Maximum	494	Maximum	835
Sum	48,515	Sum	54,606
Count	180	Count	180
Confidence Level(0.9500	6.55	Confidence Level(0.9500	22.17

Males

Length		*Weight*	
Mean	306.00	Mean	480.82
Standard Error	7.32	Standard Error	37.44
Median	296	Median	410
Mode	270	Mode	215
Standard Deviation	49.07	Standard Deviation	251.17
Variance	2,408.18	Variance	63,088.83
Kurtosis	-0.81	Kurtosis	-0.05
Skewness	0.21	Skewness	0.86
Range	205	Range	985
Minimum	205	Minimum	185
Maximum	410	Maximum	1170
Sum	13,770	Sum	21,637
Count	45	Count	45
Confidence Level(0.95)	14.34	Confidence Level(0.95)	73.39

B. Cephalopholis fulva

Females

LENGTH		*WEIGHT*	
Mean	209.42	Mean	156.66
Standard Error	2.09	Standard Error	4.52
Median	210.00	Median	150.00
Mode	235.00	Mode	190.00
Standard Deviation	30.53	Standard Deviation	66.19
Variance	932.03	Variance	4,381.66
Kurtosis	0.33	Kurtosis	1.31
Skewness	-0.18	Skewness	0.85
Range	174	Range	387
Minimum	114	Minimum	28
Maximum	288	Maximum	415
Sum	44,815	Sum	33,526
Count	214	Count	214
Confidence Level(0.9500	4.09	Confidence Level(0.9500	8.87

Males

LENGTH		*WEIGHT*	
Mean	224.16	Mean	186.50
Standard Error	2.53	Standard Error	6.01
Median	224	Median	177.5
Mode	215	Mode	165
Standard Deviation	22.95	Standard Deviation	54.41
Variance	526.60	Variance	2,960.67
Kurtosis	2.61	Kurtosis	1.36
Skewness	-0.33	Skewness	0.66
Range	153	Range	317
Minimum	137	Minimum	48
Maximum	290	Maximum	365
Sum	18,381	Sum	15,293
Count	82	Count	82
Confidence Level(0.95)	4.97	Confidence Level(0.95)	11.78

C. Malacanthus plumieri

Females

LENGTH		*WEIGHT*	
Mean	264.95	Mean	131.27
Standard Error	3.16	Standard Error	4.40
Median	270	Median	130
Mode	270	Mode	130
Standard Deviation	25.70	Standard Deviation	35.72
Variance	660.72	Variance	1,276.26
Kurtosis	0.61	Kurtosis	0.61
Skewness	-0.71	Skewness	0.35
Range	140	Range	193
Minimum	182	Minimum	42
Maximum	322	Maximum	235
Sum	17,487	Sum	8,664
Count	66	Count	66
Confidence Level(0.95)	6.20	Confidence Level(0.95)	8.62

Males

LENGTH		*WEIGHT*	
Mean	314.90	Mean	225.99
Standard Error	3.25	Standard Error	6.90
Median	314	Median	210
Mode	311	Mode	150
Standard Deviation	38.86	Standard Deviation	82.55
Variance	1,510.02	Variance	6,814.66
Kurtosis	-0.03	Kurtosis	0.24
Skewness	-0.04	Skewness	0.62
Range	203	Range	399
Minimum	215	Minimum	66
Maximum	418	Maximum	465
Sum	45,030	Sum	32,316
Count	143	Count	143
Confidence Level(0.95)	6.37	Confidence Level(0.95)	13.53

D. Melichthys niger

Females

LENGTH		*WEIGHT*	
Mean	262.62	Mean	442.38
Standard Error	7.34	Standard Error	14.91
Median	254	Median	435
Mode	250	Mode	470
Standard Deviation	33.64	Standard Deviation	68.35
Variance	1,131.35	Variance	4,671.55
Kurtosis	12.87	Kurtosis	-0.46
Skewness	3.24	Skewness	0.18
Range	167	Range	255
Minimum	228	Minimum	315
Maximum	395	Maximum	570
Sum	5,515	Sum	9,290
Count	21	Count	21
Confidence Level(0.95)	14.39	Confidence Level(0.95)	29.23

Males

LENGTH		*WEIGHT*	
Mean	275.13	Mean	563.42
Standard Error	1.78	Standard Error	11.31
Median	273	Median	550
Mode	285	Mode	515
Standard Deviation	14.23	Standard Deviation	99.49
Variance	202.56	Variance	8,188.28
Kurtosis	1.48	Kurtosis	2.88
Skewness	0.65	Skewness	0.44
Range	81	Range	615
Minimum	245	Minimum	28[illegible]
Maximum	326	Maximum	895
Sum	17,608	Sum	36,059
Count	64	Count	64
Confidence Level(0.95)	3.49	Confidence Level(0.95)	22.17

Table 14. Sexual stage description of selected sampled species with both gears from April 1, 2000 to March 31, 2001.

A. Epinephelus guttatus

Stage	# Fish	W (g)	Mean X	Std Dev.	Var.	Mean WT	Std Dev.	Var.	Min X	Max X	Min Wt	Max Wt	Tot Fem	Tot mal	F:M
F1	24	7,840	278.08	41.42	1,715.91	326.67	152.80	23,347.22	172.00	360.00	70.00	720.00			
F2	39	10,385	261.15	27.47	754.54	266.28	103.06	10,621.43	199.00	346.00	130.00	730.00	180	45	4
F3	38	10,064	257.13	53.18	2,828.32	264.84	144.96	21,013.82	190.00	494.00	102.00	835.00			
F4	79	26,317	277.03	46.03	2,118.94	333.13	165.26	27,311.98	190.00	370.00	78.00	685.00			
M1	9	4,890	328.44	32.83	1,077.80	543.33	179.26	32,133.33	283.00	379.00	275.00	860.00			
M2	6	2,095	280.00	36.18	1,309.33	349.17	158.12	25,003.47	237.00	351.00	185.00	665.00			
M3	22	8,852	291.50	38.40	1,474.34	402.36	196.37	38,561.87	241.00	378.00	190.00	972.00			
M4	8	5,800	340.13	64.65	4,179.61	725.00	303.47	92,093.75	205.00	410.00	230.00	1,170.00			
Unk	5	1,213	242.80	69.45	4,823.36	242.60	116.73	13,625.04	107.00	297.00	18.00	345.00			
Total	230	77,456	276.08	48.63	2,364.69	336.77	188.20	35,420.79	107.00	494.00	18.00	1,170.00			

B. Cephalopholis fulva

Stage	# Fish	W (g)	Mean X	Std Dev.	Var.	Mean WT	Std Dev.	Var.	Min X	Max X	Min Wt	Max Wt	Tot Fem	Tot mal	F:M
F1	12	2,314	212.42	46.53	2,165.41	192.83	99.05	9,811.31	117.00	288.00	48.00	415.00			
F2	22	2,922	196.55	19.19	368.25	132.82	38.11	1,452.60	162.00	236.00	72.00	220.00	214	82	2.60976
F3	44	4,804	188.00	32.72	1,070.32	109.18	49.34	2,434.47	114.00	280.00	28.00	310.00			
F4	136	23,486	218.16	24.71	610.34	172.69	61.49	3,780.45	155.00	279.00	34.00.	370.00			
M1	3	545	219.67	19.87	394.89	181.67	50.39	2,538.89	198.00	246.00	130.00	250.00			
M2	8	1,515	221.50	14.97	224.25	189.38	33.02	1,090.23	202.00	250.00	135.00	235.00			
M3	35	6,835	228.89	14.28	203.82	195.29	36.07	1,301.35	205.00	268.00	140.00	310.00			
M4	36	6,398	220.53	29.42	865.80	177.72	69.19	4,786.59	137.00	290.00	48.00	365.00			
Unk	2	550	245.00	24.00	576.00	275.00	95.00	9,025.00	221.00	269.00	180.00	370.00			
Total	298	49,369	213.71	29.38	863.04	165.67	65.23	4,255.04	114.00	290.00	28.00	415.00			

C. Malacanthus plumieri

Stage	# Fish	W (g)	Mean X	Std Dev.	Var.	Mean WT	Std Dev.	Var.	Min X	Max X	Min Wt	Max Wt	Tot Fem	Tot mal	F:M
F1	6	624	249.50	18.62	346.58	104.00	17.51	306.67	218	278	76	130			
F2	12	1,808	262.67	32.09	1,029.56	150.67	44.89	2,015.39	207	322	88	235	66	143	0.46154
F3	44	5,748	267.43	24.03	577.38	130.64	32.02	1,025.32	182	300	42	200			
F4	4	484	267.75	18.10	327.69	121.00	24.51	600.50	237	283	90	145			
M1	25	3,687	273.44	31.19	973.13	147.48	47.88	2,292.81	215	317	66	225			
M2	62	13,551	313.66	33.99	1,155.48	218.56	73.10	5,343.63	251	396	102	450			
M3	52	13,918	334.33	29.59	875.84	267.65	72.39	5,240.15	286	418	135	465			
M4	4	1,160	340.50	43.58	1,899.25	290.00	102.96	10,600.00	301	407	190	450			
Unk	2	170	229.00	6.00	36.00	85.00	7.00	49.00	223	235	78	92			
Total	211	41,150	298.46	42.43	1,800.05	195.02	83.76	7,015.51	182	418	42	465			

D. Melichtys niger

Stage	# Fish	W (g)	Mean X	Std Dev.	Var.	Mean WT	Std Dev.	Var.	Min X	Max X	Min Wt	Max Wt	Tot Fem	Tot mal	F:M
F1	2	765	247.00	11.00	121.00	382.50	67.50	4,556.25	236	258	315	450			
F2	2	775	246.00	4.00	16.00	387.50	7.50	56.25	242	250	380	395	21	64	0.32813
F3	9	3,985	272.67	45.04	2,028.89	442.78	55.68	3,100.62	235	395	355	520			
F4	8	3,765	259.38	16.05	257.48	470.63	67.75	4,590.23	228	285	355	570			
M1	3	1,575	272.00	2.16	4.67	525.00	50.17	2,516.67	270	275	455	570			
M2	23	13,175	276.65	13.10	171.71	572.83	81.63	6,662.67	252	304	445	760			
M3	33	18,689	275.67	15.45	238.77	566.33	98.52	9,705.68	245	326	280	895			
M4	5	2,620	266.40	9.44	89.04	524.00	63.67	4,054.00	260	285	475	625			
Total	85	45,349	272.04	21.11	445.42	533.52	99.47	9,893.52	228	395	280	895			

Table 15. Catch summary of sampled red hinds by moon phase and gonad development stage for sampling period of April 2000 to March 2001.

Red hind Date	Sex Moon phase	Unk	F1	F2	F3	F4	M1	M2	M3	M4	TOTAL
04-Apr	NM					11			1		12
18-Apr	FM					5					5
27-Apr	LQ					7					7
02-May	LQ					7				1	8
09-May	NM					2				1	3
23-May	FM					3				1	4
06-Jun	NM					13				2	15
16-Jun	FM					3					3
20-Jun	FM		1			2					3
19-Oct	FM		20			14	8				42
25-Oct	LQ		1	24				2			27
27-Oct	NM	1	1			6				1	9
01-Nov	NM			2				1	1		4
02-Nov	NM			3			1				4
15-Nov	FM			1				1			2
16-Nov	FM			2							2
14-Dec	FM			1							1
15-Jan	FM				1				1		2
16-Jan	LQ				2						2
17-Jan	LQ	1			2						3
19-Jan	LQ	1									1
07-Feb	FQ			1	8				3		12
08-Feb	FM				10			1	4		15
09-Feb	FM	1		3	3			1	6		14
14-Feb	FM				7	2			4		13
15-Feb	LQ			2	2						4
16-Feb	LQ		1		3	1			1		6
22-Feb	LQ								1		1
15-Mar	FM	1									1
21-Mar	LQ					2				1	3
30-Mar	NM					1				1	2
TOTAL		5	24	39	38	79	9	6	22	8	230

Table 17. Catch summary by month and sexual maturation stage of selected sampled species. Sexual maturation stage is define as follows: 1 = resting gonad, 2 = developing, 3 = ripe, 4 = spent gonad and unk = unknown.

A. *Malacanthus plumieri*

Month	Sexual Maturation Stage									
	unk	F1	F2	F3	F4	M1	M2	M3	M4	TOTAL
Apr	0	0	0	0	0	0	1	1	0	2
May	0	0	0	0	0	0	1	0	0	1
Jun	0	0	1	4	1	0	12	2	1	21
Jul	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0
Oct	0	0	1	0	0	5	3	0	0	9
Nov	1	5	9	8	0	9	12	6	0	50
Dec	0	1	0	0	0	2	2	0	0	5
Jan	1	0	1	11	2	3	11	9	2	40
Feb	0	0	0	14	0	3	6	24	0	47
Mar	0	0	0	7	1	3	14	10	1	36
Total	2	6	12	44	4	25	62	52	4	211

B. *Melichtys niger*

Month	Sexual Maturation Stage								
	F1	F2	F3	F4	M1	M2	M3	M4	TOTAL
Apr	0	0	2	0	0	0	1	0	3
May	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	1	1	2	4
Jul	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	2	0	2
Nov	1	1	3	1	0	5	3	0	14
Dec	0	0	0	0	1	1	0	1	3
Jan	0	0	0	1	0	4	1	1	7
Feb	1	1	0	3	2	8	10	1	26
Mar	0	0	4	3	0	4	15	0	26
Total	2	2	9	8	3	23	33	5	85

C. *Holocentrus rufus*

Month	Sexual Maturation Stage					
	F2	F3	F4	M2	M3	M4	TOTAL
Apr	0	0	1	0	0	0	1
May	0	0	2	0	0	0	2
Jun	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0
Oct	2	0	0	0	2	1	5
Nov	0	1	1	0	5	0	7
Dec	3	1	2	3	3	0	12
Jan	0	1	7	1	6	6	21
Feb	0	4	6	0	16	2	28
Mar	0	0	3	1	1	2	7
Total	5	7	22	5	33	11	83

D. *Holocentrus ascensionis*

Month	Sexual Maturation Stage							
	F2	F3	F4	M1	M2	M3	M4	TOTAL
Apr	0	0	1	0	0	1	0	2
May	0	0	0	0	0	0	1	1
Jun	0	0	2	0	0	0	0	2
Jul	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0
Oct	1	0	1	0	1	0	1	4
Nov	2	7	1	0	4	14	0	28
Dec	0	0	0	0	0	0	0	0
Jan	1	1	2	0	1	3	2	10
Feb	0	4	5	1	1	5	3	19
Mar	0	1	3	0	2	1	1	8
Total	4	13	15	1	9	24	8	74