Completion Report to National Marine Fisheries Service
Reproductive Cycle of Queen Snapper (*Etelis oculatus*) and the Wenchman (*Pristipomoides macrophthalmus*)

By

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Abstract

Gonads and otoliths were collected from January 8, 2005 to June 19, 2006 for a total of 425 queen snappers (*Etelis oculatus*) and 432 wenchman (*Pristipomoides macrophthalmus*) to determine the size of 50% maturation, reproductive season and age and growth. Samples were collected from deep water fishers from Rincón. The catch method was buoying a main line with several hooks tied up to a buoy and left to drift with the current. In any given fishing trip up to three buoys are set to drift at determined fishing ground simultaneously for an hour.

The mean fork length of collected queen snappers was 312.05 mm ± 66.65 and a mean weight of 554.04 g ± 475.58. Of the total individuals, 187 (44.0%) were females, 208 (48.9%) males, and 30 (7.1%) were undetermined. The obtained males to females ratio was 1M:1.11F, roughly one to one. From the gonadosomatic index (GSI) of females it was observed that queen snapper reproduce in all sampled months with a peak during October to November.

Sampled wenchman had a mean fork length of 297.98 mm ± 51.67, mean weight of 549.39 g ± 290.33. Of total sampled individuals, 199 were females (46.1%) and 228 were males (52.8%) and 5 (1.16%) were undetermined. The obtained males to females ratio was 1M:1.15F, roughly one to one. The obtained GSI for wenchman showed that the species reproduces in all sampled months with two peaks. The first corresponded to March 2005 (53%) and the second during December (2005).

It was not possible to plot the age growth curve for sampled queen snappers and wenchman. Results for the number of otoliths ring versus fork length yielded a non-linear relationship.

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All mistake and misinterpretation of the results are my own.

Table of Content

Introduction

The Lutjanidae family, commonly known as snappers has a circumtropical and subtropical distribution. The family comprises 17 genera and approximately 185 species; eleven of these are represented in the Western Atlantic (Rivas, 1970). Most of these species are substrate oriented, are carnivores and are found at depths that range from shallow water to depths of the magnitude of 340 fathoms (640 m's or 2,100 feet) (Anderson, 1967). Snappers are a group of high commercial importance along their wide distribution.

Deepwater snappers constitute the most important commercial species of finfish in Puerto Rico fisheries. Among the deep water snapper complex the silk snapper and the blackfin snappers (*Lutjanus vivanus* and *L. buccanella*) represented the most important species in the commercial landings until the 1990's. Commercial landings collected by the Fisheries Research Laboratory (FRL) showed that 8.1% of total catch was comprised mostly by these two species. Of these two species the silk snapper was the most seek snapper. Over the last five years data collected at the FRL have shown an increase reporting of the queens' snapper (*Etelis oculatus*), while silk snappers' landings decreased. Matos (2002) reported that deep water snappers comprised 9% (mainly *L. vivanus* and *Etelis oculatus*) of total landed finfishes. Although the exact composition of the landed deep water snappers is not known, the fact that there is a change in the two main species comprising this fish group is a signal of problems with this fishery. Besides a change in the species composition of the group, there is also a change in the fishing method involved and the depths targeted. These two factors are indication of over exploitation of the deep water snapper's group.

It's important to remark that the deep water snapper group usually consisted of the following species: the silk snapper (*L. vivanus*), blackfin snapper (*L. bucannella*), vermillion snapper (*Rhomboplites aurorubens*), queen snapper (*E. oculatus*), and wenchman (*Pristipomoides macrophthalmus*) (Erdman, 1983). Another species that is usually caught but seldom reported is the black snapper (*Apsilus dentatus*). The percentage of any of this species to the fisheries depends on the depth at which are caught since there is an apparent stratification by depth. Another factor that influenced the composition is the gear used. The traditional deep water snapper group landed in Puerto Rico until mid 1990's was composed mainly of the silk and blackfin snappers, mainly caught with fish traps and those captured with hook and line involved snappers' reels. Vermillion snappers were also part of this group. This fishery was mainly at depths that ranged from 40 fm. to 175 fm. (80 m to 350 m) (Boardman and Weiler, 1979; Silvester *et al*., 1980). These species caught at 40 fm. (80 m) are usually juveniles. The present deep water snappers are mainly composed of the queens' snapper and the wenchman that are caught mainly 100 fm. to 200 fm. (200 m to 400 m) depths. The blackfin snapper are also

caught at these depths toward, shallower depths and might overlap with the silk snapper. Allen (1985) reported the depth ranges for these species to be 100 m to 450 m. The most common used gear to catch these species is hook and line, either with snapper's reels or buoying.

Regardless of the importance of this resource there is very little knowledge of the reproductive biology of the deep water snappers. This fact is alarming considering the decreasing trend on some of these species in our landings. There are a few studies done on the reproduction of the silk snapper, blackfin snapper and vermillion snapper in Puerto Rico. Since late 1970's Boardman and Weiler, (1979) reported that 90% of the silk snapper landed in Puerto Rico are juvenile. Matos, (2000) reported that 97% of landed silk snapper during 1994-97 were under the minimum maturity size of 410 mm FL reported by Figuerola (1991).

On the other hand, of the deeper species such as the queen and black snapper and the wenchman there is very few data or knowledge from Puerto Rico since their importance in our fisheries is very "recent", due to the decreasing population of the silk snapper.

The distribution of all the species mention before in the western Atlantic is from North Carolina Gulf of Mexico southward through the Caribbean to Brazil, particularly abundant in the Bahamas and the Antilles. Their vertical distribution varies according to the geographical area (Grimes *et al*., 1977).

The information on the reproduction of the queen snapper is very limited. Murray *et al*., (1992) reported spawning for the queens' snapper in March and August in St. Lucia water. There is not information available for the wenchman spawning strategy.

It's important to understand the life history of these species in order to determine the best management strategy for these species. All the mentioned species are included in the Caribbean Fishery Management Council's (CFMC) Reef Fish Management Plan and lack stock assessment data. In November 2005 the CFMC implemented the Sustainable Fisheries Act which amends all FMP's in place. Among the approved management measures it was established a close season to protect the silk snapper population. The present study was undertaken to provide information on the reproductive cycle of these species, which is much needed to evaluate the status of the species.

Objective:

The primary aim of this study will be to describe the reproductive strategy and the age and growth of the deep water snappers, the queens' snapper, and the wenchman. The parameters that will be determine will be the minimum size of maturation, the percentage of mature individuals of both sexes at each size class using histological

analysis and the reproductive seasons for each species. Growth curves for both species will be fitted to the length-at-age data by using the von Bertalanffy growth model. Data on catch per unit of effort will be determined for buoying fishing.

Approach:

The methodology used consisted in collect 25 samples per month of gonads and otoliths covering a wide size range for a period of 18 months. Samples were collected from deep water fishers from Rincón. The catch method was buoying a main line with several hooks tied up to a buoy and left to drift with the current. In any given fishing trip up to three buoys are set to drift at determined fishing ground simultaneously for an hour. Every line consists of a buoy, monofilament (200 to a 300-lb. test); weight (10 to 15 lbs.), with forty hooks (size 10 to 12 tuna hooks) baited with squid and/or little tunny. For each individual size, weight, date, gear used and location of capture were recorded. Upon collection gonads were weighed, fixed in Davidson's fixative (Yevixch and Barszcz, 1981), embedded in Paraplast, sectioned at eight μ and stained with hematoxylin and eosin. Gonads are classified according to their maturity stage (Table 1). Analysis and classification of gonads histology maturation followed Sadovy *et al*.,(1994); Moe (1969) and Hunter and Macewicz (1985). The annual reproductive cycle is described by the percentage of each maturity class/month and the average gonadosomatic index (GSI=100[ovary weight + somatic weight]) plotted against month of collection. To determine size of maturity (defined as the smallest size class in which 50% of the individuals are sexually mature) a maturity curve is developed. GSI was calculated using the relationship described by de Vlaming et al (1982) GSI = GW x 100/FW – GW,

where GW = gonad weight (g), and
FW = fish weight (g)

To determine the smallest size class in which 50% of individuals were sexually mature (size-at-maturity), a maturity curve of the percent of fish of maturity classes ≥ 2 was developed.

Otoliths were measured, weighed, mounted with silicone glue, sectioned to .5 mm or 500μ and read. Generally, the left sagitta is used for age determination. If the left otolith is lost or broken, the right otolith is sectioned. For sectioning, otoliths were mounted on a small card with glue, using a hot glue gun, and sectioned through the core with a 7.2 cm diameter low concentration diamond blade on a Buehler Isomet low speed saw. From each otolith, three sections of 0.5 mm were mounted on glass slides using Protocol mounting medium. Sections are read under a dissecting microscope (10-70X) with transmitted light. Only sexed fish were used for age determination. Terminology follows that of Wilson et al (1983).

Otoliths were sectioned and opaque bands counted by two readers under transmitted light. Marginal increment analysis will be performed to determine if opaque zones are annual and when they are formed. Growth curves will be fitted to the length-at-age data by using the von Bertalanffy growth model: $L_t = L_\infty(1-e^{-K[t-t0]})$, where L_t = the expected length at age t years; L_∞ = the asymptotic maximum length; K = the von Bertalanffy growth constant; and t_0 = the theoretical age at zero length.

Results

Etelis oculatus

Although the methodology was to collect a minimum of 25 samples per months it was not possible to collected gonads and otoliths for all due to the bad conditions of some of the supplied individuals. Table 2 summarizes by month the number of samples processed. Even thus not all samples were used to establish the reproductive season and maturity of the species. That's why total sampled individuals in Table 2 is not equal to that of other tables presented for the species. Gonads and otoliths were collected from January 8, 2005 to June 19, 2006 from a total of 425 individuals.

On Table 3 is shows descriptive statistics of the sampled queen snappers. The mean fork length of collected queen snappers was 312.05 mm ± 66.65 and a mean weight of 554.04 g ± 475.58. For the total sample class distribution the modal class corresponded to 280 mm (Figure 1). The modal class of the obtained distribution by sex (Figure 2) was 270 mm for males and 290 mm for females. Observed differences between the size frequency of males and females yielded statistically significant results (Kolmogorov-Smirnov, $d << D_{.05}$, 0.063 << 0.101) (Sokal and Rohlf, 1981).

Of the total individuals, 187 (44.0%) were females, 208 (48.9%) males, and 30 (7.1%) were undetermined. Males had a mean fork length of 311.51 mm ± 71.43 and 565.54 g ± 545.96 (Table 4a). Sampled females had a mean fork length of 316.26 mm ± 63.63 and 563.91 g ± 417.62 (Table 4b). The obtained males to females ratio was 1M:1.11F, roughly one to one. On Figure 3 is displayed the obtained length-weight relationship of sampled queen snappers.

Figure 4 shows the size frequency distribution of sampled queen snappers by port agents around Puerto Rico during January to December 2005. A total of 583 queen snappers were sampled by port agents. Table 5 displays descriptive statistics of this sample. This sample mean size was 498.42 mm ± 130.52. The observed differences between size distribution of queen snappers sampled during this study and those sampled by port agents yielded statistically non significant results (Kolmogorov-Smirnov, $d >> D_{.05}$, 0.802 >> 0.088) (Sokal and Rohlf, 1981).

Sexual Maturation Size

There were no size classes with immature individuals, therefore we cannot provide a minimum size of sexual maturation for females as well for males. Of total sampled females 48.4% were mature, meanwhile 75.0% of males were mature. Figures 5 and 6 display the obtained percent maturation size for females and males, respectively. The 50% maturation size for females corresponded to 310 mm FL, which also corresponds to the size class that have the 50% mature individuals. For males the size class that have the 50% mature individuals corresponds to 220 mm, 50% size is 220 mm FL. All females and males were mature at 370 mm FL size class.

The distribution of the percent sexual stages by months for females is shown in Figure 7. It can be observed that ripe individuals were caught in all sampled months (F2 to F5 stages). From the gonadosomatic index (GSI) of females shown in Figure 8 it can be seen that queen snapper reproduce in all sampled month with a peak during October to November. With a decrease in reproductive activity from January to June. The only month in which no a single queen snapper was collected corresponded to July.

Age and Growth

Of the 425 sampled queen snapper 402 otoliths were prepared for examination. Opaque and translucent zones were detectable in most otoliths sections. When zones lacked sufficient definition for focus-to-opaque zone measurements, the otoliths were not use for age determination. Otolith radius (length) does not showed a linear relationship with FL ($N = 402$; $r^2 = 0.767$) (Figure 9).

It was not possible to plot the age growth curve for sampled queen snappers. In Figure 10 it can be observed the variation in the number of otoliths rings versus the fork length ($N = 402$; $r^2 = 0.156$).

Pristipomoides macrophthalmus

A total of 432 wenchman were sampled from January 8, 2005 to June 19, 2006 for which gonads and otoliths were collected. Table 6 shows descriptive statistics of sampled wenchman. The mean fork length for total sampled of this species was 297.98 mm ± 51.67, mean weight of 549.39 g ± 290.33 and modal class of 310 mm (Figure 11). The modal class of the obtained distribution for males had a modal class of 300 mm and 270 mm for females (Figure 12), respectively. Observed differences between the size frequency of males and females yielded statistically non significant results (Kolmogorov-Smirnov, $d > D_{.05}$, $0.138 > 0.135$) (Sokal and Rohlf, 1981).

Mean fork length of males was 303.54 mm ± 51.42 and 573.44 g ± 299.35 mean weight (Table 7a). Females mean fork length was 289.55 mm ± 50.21 and 506.61 g ± 262.12 mean weight (Table 7b). Of total sampled individuals, 199 were females (46.1%) and 228 were males (52.8%) and 5 (1.16%) were undetermined. The obtained males to females ratio was 1M:1.15F, roughly one to one. The obtained length-weight relationship for sampled wenchman is display in Figure 13.

Figure 14 shows the size frequency distribution of sampled wenchman by port agents around Puerto Rico during January to December 2005. A total of 44 individual were sampled by port agents. Table 8 displays descriptive statistics of this sample. This sample mean size was 359.57 mm ± 55.95. The observed differences between size distribution of queen snappers sampled during this study and those sampled by port agents yielded statistically non significant results (Kolmogorov-Smirnov, d >> D.05, 0.263 >> 0.221) (Sokal and Rohlf, 1981).

Sexual Maturation Size

As was the case for sampled queen snappers there were no size classes with immature wenchman, therefore we cannot provide a minimum size of sexual maturation for females as well for males. Figures 15 and 16 display the obtained percent maturation size for females and males, respectively. The 50% maturation size for females corresponded to 170 mm FL, which also corresponds to the size class that have the 50% mature individuals. For males the size class that have the 50% mature individuals corresponds to 200 mm, 50% size is 220 mm FL. All females were mature at 170 mm FL and males were mature at 320 mm FL size class.

The distribution of the percent sexual stages by months for females is shown in Figure 17. It can be observed that ripe individuals were caught in all sampled months (F2 to F4 stages). From the gonadosomatic index (GSI) of females shown in Figure 18 it can be seen that wenchman reproduce in all sampled month with two major peaks. The first corresponded to March 2005 (53%) and the second during December (2005). The lowest GSI were recorded during April and August 2005.

Age and Growth

Of the 432 sampled wenchman 381 otoliths were prepared for examination. Opaque and translucent zones were detectable in most otoliths sections. When zones lacked sufficient definition for focus-to-opaque zone measurements, the otoliths were not use for age determination. Otolith radius (length) does not showed a linear relationship with FL (N = 402; r^2 =0.891) (Figure 19).

It was not possible to plot the age growth curve for sampled queen snappers. In Figure 20 it can be observed the variation in the number of otoliths rings versus the fork length (N = 402; $r^2 = 0.263$).

Discussion

Etelis oculatus

Queen snapper has become a major part of the commercial landings in Puerto Rico in the last decade, with declining catches of silk snappers. Regardless of their commercial value this study is the first study undertaken on the reproduction of this species in Puerto Rico. Therefore we do not have any past reference to compare our results on the reproduction of this species, as well as for the wenchman.

The maximum reported size for the queen snapper in the literature is 100 cm TL (males) by Cervigon, 1993. Maximum reported weight is 5,300 kg (Allen, 1985). The maximum size of individuals sampled in this study was 715 cm FL with a maximum weight of 4,394 kg. Maximum size of queen snappers sampled by port agent was 882 cm FL.

It was noted a tendency of females to be of higher size than males. There was a statistically significant results between the size distribution of males and females. This might suggest a real tendency of females be bigger than males.

Size at maturity and age at first maturity are estimated as 53.6 cm TL and 1 year, respectively (SFA, 2004). In this study the 50% of sexual maturity for females was determined 50% of the sample was 310 mm, while for males it was 220 mm. Nonetheless, we must keep in mind that we do not have any immature individual corresponding to the smaller class sizes. If we were to fit the distribution of the sampled queen snapper by port agents with the obtained the sexual maturation data from this study assuming that those corresponding to 220 mm size class and lower were all females it will yield 0.34% of immature individuals. Likewise assuming that those corresponding to the 310 mm size class were all males it will yielded 5.31% of immature sampled individual. A tendency to capture bigger and mature individuals will definitively will help the queen snapper population. Zhao and Mc Govern (1997) report that smaller size at maturity of females suggests an increase in fishing pressure, so females are maturing at smaller sizes. In the queen snapper we have individuals maturing at a fairly big size, which might indicate that fishing pressure is not affecting this species at present time. If the size of sexual maturation is related to the exploited populations (Garrat, 1985) is evident that *E.oculatus* is not being exploited by the fisheries before reaching the sexual maturity.

The reported spawning season for queen snappers have been reported to have to peaks corresponding in March and August in St. Lucia (Murray et al, 1992). The obtained results are not consistent with those reported. Although they reproduce year round there is an isolated peak in November (GSI = 42%). July was the only month in which was not recorded mature individuals. There is no management measure in place to protect this species at the present time. But if the need arise to protect the population a close season during the months around the peak of reproduction will be a good management measure.

The obtained results in this study for the age and growth are were consistent with other studies undertaken for another specie of deep water snapper, the silk snapper (*L. vivanus*). Although these researchers were able to identify rings, they were not able to fit a growth curve. A most discouraging result those and this, but it's clear that traditional methods of using otoliths is not the way to calculate the age and growth for this species, as well as for the silk snapper.

Pristipomoides macrophthalmus

Wenchman is exploited together with the queen snapper at similar depths, although is less popular within the general population and commercial fishers. As for the queen snapper this is the first study undertaken on is reproduction, and therefore we lack past reference.

The maximum reported size for wenchman in the literature is 50.0 cm TL by Allen, 1985. The maximum size of individuals sampled in this study was 457 cm FL with a maximum weight of 1,710 kg. Maximum size of queen snappers sampled by port agent was 560 cm FL.

Although there was a statistically significant results between the size distribution of males and females both distribution are basically equal.

Thompson and Munro (1983) reported the size at maturity as 180 mm FL for Jamaica. We were not able to find any report in the literature regarding age at first maturity for wenchman. In this study the 50% of sexual maturity for females was determined 50% of the sample was 170 mm, while for males it was 200 mm. As was the case of the queen snappers we did not have any immature individual corresponding to the smaller class sizes. If we were to fit the distribution of the sampled queen snapper by port agents with the obtained the sexual maturation data from this study assuming that those corresponding to 170 mm size class and lower were all females it will yield 0.0% of immature individuals. Likewise assuming that those corresponding to the 220 mm size class were all males it will yielded 0.0% of immature sampled individual. A word of caution on this pertain the size sample of the port agents data for 2005. This might not reflect the population of this species caught around Puerto Rico.

We were not able to find any spawning season reports for wenchman in the literature. Our results suggest a year round spawning. There were two distinct peaks one in March 05 (53%) and a second one in November (GSI = 56%). Samples collected in 2006 tend to confirm a reproduction peak between February and March. There was not a single month without mature individuals. August was the month with the lowest GSI (14%). As for the queen snapper there is no management measure in place to protect this species at the present time. But if the need arise to protect the population a close season during the months around the peak of reproduction will be a good management measure.

The obtained results in this study for the age and growth are consistent other studies undertaken for another specie of deep water snapper, the silk snapper (*L. vivanus*) with unpublished data collected by Boardman and Weiler, 1979a, Collazo, 1982. Although these researchers were able to identify rings, they were not able to fit a growth curve. A most discouraging result those and this, but it's clear that traditional methods of using otoliths is not the way to calculate the age and growth for this species, as well as for the silk snapper.

Recommendation

Although the present study provide a much needed information on the reproduction of the queen snapper and wenchman, it was not possible to plot the age growth curve. Since we have the otoliths collected for this two species, it is recommend to pursue other methods beside the one used in this study. We are more than willing to provide these samples to any investigator that might want to used them in some other method to plot the age growth curve.

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Tables

Table 1. Microscopic description of sexual maturation of male and females gonads.

Stage of Maturation	Microscopic description
Ovaries	
F1 (Inmature)	Early stages of oogenesis predominate (oocytes in stages 1 and 2) Stage 3 oocytes absent or very few. Compact gonad. Thin muscular tunica. No evidence of previous spawning (thick tunica, ovary with empty areas, post ovulatory follicles and atretic bodies present.
F2 (Inactive mature)	Oocytes in stages 1, 2 and 3 present, but stages 3 do not predominate. Oocytes in stage 4 absent or very few. Thin tunica, except in spent individuals.
F3 (Active mature)	Oocytes in stages 2, 3, 4 present. Advanced stages of 4 oocytes absent. Thin tunica, except in spent individuals.
F4 (Ripe)	Oocytes in stages 2, 3, 4 and rarely 5 present. Advanced stages predominate. Thin tunica, except in spent individuals.
F5 (Spent)	Post-ovulatory follicles and atretic bodies present. Thick tunica. Ovary with empty areas.
Testes	
M1 (Inmature)	Early stages of spermatogenesis, gonad small and compact with gonia and seminiferous tubules.
M2 (Mature)	All stages of spermatogenesis present, or later stages dominate. Post-spawning testes are disorganized with empty lumina.

Table 2. Catch summary by month of sampled queen snapper (Etelis oculatus) and wenchman (Pristipomoides machrophtalmus) in 2005.

Date	Queen snapper	Wenchman
January 05	25	22
February 05	32	30
March 05	18	19
April 05	21	23
May 05	20	25
June 05	23	25
July 05	15	22
August 05	25	24

Table 2. Catch summary by month of sampled queen snapper (Etelis oculatus) and wenchman (Pristipomoides machrophtalmus) in 2005.

Date	Queen snapper	Wenchman
September 05	26	23
October 05	25	23
November 05	23	25
December 05	25	23
January 06	25	22
February 06	25	25
March 06	23	25
April 06	21	25
May 06	25	26
June 06	28	25
Total	425	432

Table 3. Descriptive statistics of sampled queen snapper during January2005 to June 2006.

Fork length (mm)		*Weight (g)*	
Mean	312.05	Mean	554.04
Standard Error	3.23	Standard Error	23.07
Median	296	Median	427
Mode	295	Mode	293
Standard Deviation	66.65	Standard Deviation	475.58
Variance	4,442.00	Variance	226,180.44
Kurtosis	7.98	Kurtosis	29.29
Skewness	2.20	Skewness	4.71
Range	504	Range	4246
Minimum	211	Minimum	148
Maximum	715	Maximum	4394
Sum	132,620	Sum	235,468
Count	425	Count	425
Confidence Level(95.0%)	6.34	Confidence Level(95.0%)	45.21

Table 4a. Descriptive statistics by sex of sampled queen snapper during January 2005 to June 2005; a) males, b) females.

Fork length (mm)		*Weight (g)*	
Mean	316.26	Mean	563.91
Standard Error	4.65	Standard Error	30.54
Median	300	Median	435
Mode	265	Mode	392
Standard Deviation	63.63	Standard Deviation	417.62
Sample Variance	4,048.65	Sample Variance	174,404.15
Kurtosis	4.24	Kurtosis	19.58
Skewness	1.69	Skewness	3.67
Range	412	Range	3,470
Minimum	211	Minimum	162
Maximum	623	Maximum	3,632
Sum	59,141	Sum	105,452
Count	187	Count	187
Confidence Level(95.0%)	9.18	Confidence Level(95.0%)	60.25

Table 4b. Descriptive statistics by sex of sampled queen snapper during January 2005 to June 2005; a) males, b) females.

Fork length (mm)		*Weight (g)*	
Mean	316.26	Mean	563.91
Standard Error	4.65	Standard Error	30.54
Median	300	Median	435
Mode	265	Mode	392
Standard Deviation	63.63	Standard Deviation	417.62
Sample Variance	4,048.65	Sample Variance	174,404.15
Kurtosis	4.24	Kurtosis	19.58
Skewness	1.69	Skewness	3.67
Range	412	Range	3,470
Minimum	211	Minimum	162
Maximum	623	Maximum	3,632
Sum	59,141	Sum	105,452
Count	187	Count	187
Confidence Level(95.0%)	9.18	Confidence Level(95.0%)	60.25

Table 5. Descriptive statistics of sampled queen snapper by port samplers around Puerto Rico during January to December 2005.

Fork length (mm)	
Mean	498.42
Standard Error	5.41
Median	495
Mode	520
Standard Deviation	130.52
Variance	17,034.32
Kurtosis	-0.44
Skewness	0.15
Range	702
Minimum	180
Maximum	882
Sum	290,581
Count	583
Confidence Level(95.0%)	10.59

Table 6. Descriptive statistics of total sampled wenchman (Pristipomoides machrophtalmus) during January 2005 to June 2006.

Fork length (mm)		*Weight (g)*	
Mean	297.98	Mean	549.39
Standard Error	2.65	Standard Error	14.89
Median	298	Median	502
Mode	305	Mode	246
Standard Deviation	51.67	Standard Deviation	290.33
Variance	2,670.26	Variance	84,290.24
Kurtosis	(0.16)	Kurtosis	1.33
Skewness	0.35	Skewness	1.15
Range	285	Range	1,603
Minimum	172	Minimum	107
Maximum	457	Maximum	1,710
Sum	113,231	Sum	208,768
Count	380	Count	380
Confidence Level(0.95)	5.20	Confidence Level(0.95)	29.19

Table 7a. Descriptive statistics by sex of total sampled wenchman (Pristipomoides machrophtalmus) during January 2005 to June 2006; a) males; b) females.

Fork length (mm)		*Weight (g)*	
Mean	303.54	Mean	573.44
Standard Error	3.41	Standard Error	19.87
Median	302	Median	513
Mode	232	Mode	509
Standard Deviation	51.42	Standard Deviation	299.35
Variance	2,643.95	Variance	89,611.37
Kurtosis	(0.27)	Kurtosis	1.29
Skewness	0.40	Skewness	1.16
Range	257	Range	1,551
Minimum	200	Minimum	159
Maximum	457	Maximum	1,710
Sum	68,903	Sum	130,172
Count	227	Count	227
Confidence Level(0.95)	6.69	Confidence Level(0.95)	38.94

Table 7b. Descriptive statistics by sex of total sampled wenchman (Pristipomoides machrophtalmus) during January 2005 to June 2006; a) males; b) females.

Fork length (mm)		*Weight (g)*	
Mean	289.55	Mean	506.61
Standard Error	3.57	Standard Error	18.63
Median	285	Median	449.5
Mode	270	Mode	256
Standard Deviation	50.21	Standard Deviation	262.12
Variance	2,520.91	Variance	68,705.84
Kurtosis	(0.04)	Kurtosis	1.27
Skewness	0.26	Skewness	1.06
Range	281	Range	1,391
Minimum	172	Minimum	99
Maximum	453	Maximum	1,490
Sum	57,330	Sum	100,309
Count	198	Count	198
Confidence Level(0.95)	6.99	Confidence Level(0.95)	36.51

Table 8. Descriptive statistics of sampled wenchman (Pristipomoides machrophtalmus) by port samplers around Puerto Rico during January to December 2005.

Fork length (mm)	
Mean	359.57
Standard Error	8.43
Median	363.50
Mode	382
Standard Deviation	55.95
Variance	3,130.07
Kurtosis	2.92
Skewness	0.69
Range	308
Minimum	252
Maximum	560
Sum	15,821
Count	44
Confidence Level(0.95)	16.53

Figures

Figure 1. Size frequency distribution of total sampled queen snapper during January 2005 to June 2006.

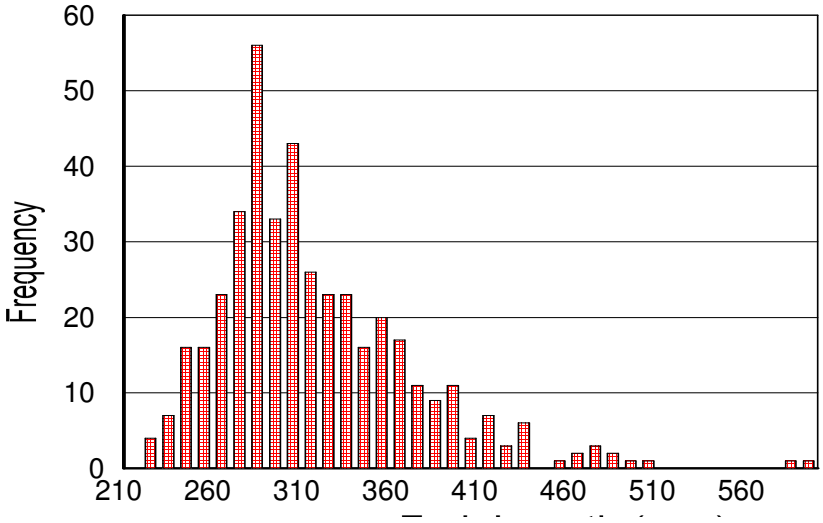

Figure 2. Size frequency distribution of sampled females and males queen snappers.

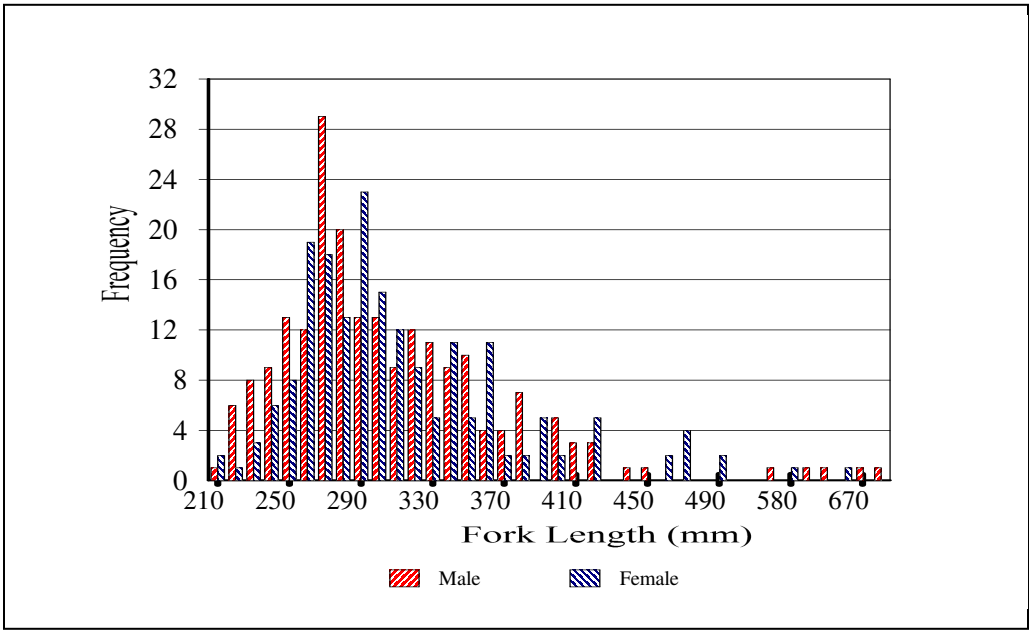

Figure 3. Length-weight relationship of sampled queen snappers. Log W = -4.40 + 2.84 Log FL; N = 419, r = 0.99.

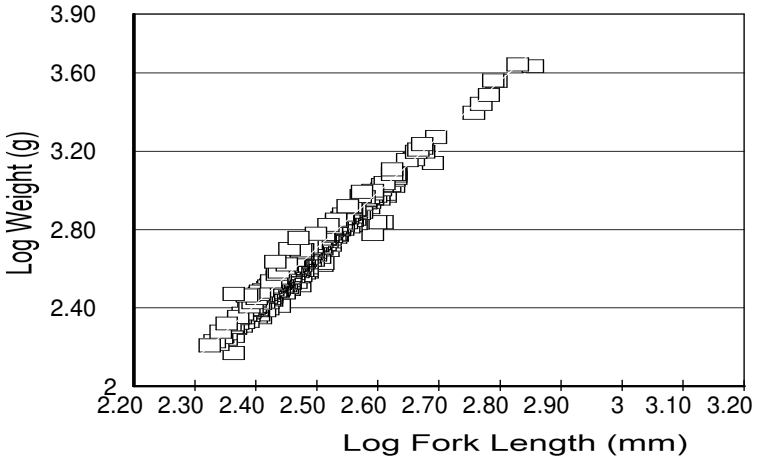

Figure 4. Size frequency distribution of queen snappers sampled by port agents during January to December 2005.

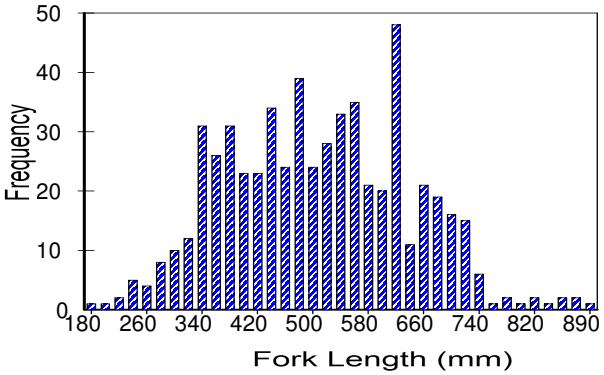

Figure 5. Fifty Percent sexual maturation of sampled females queen snappers during January 2005 to June 2006.

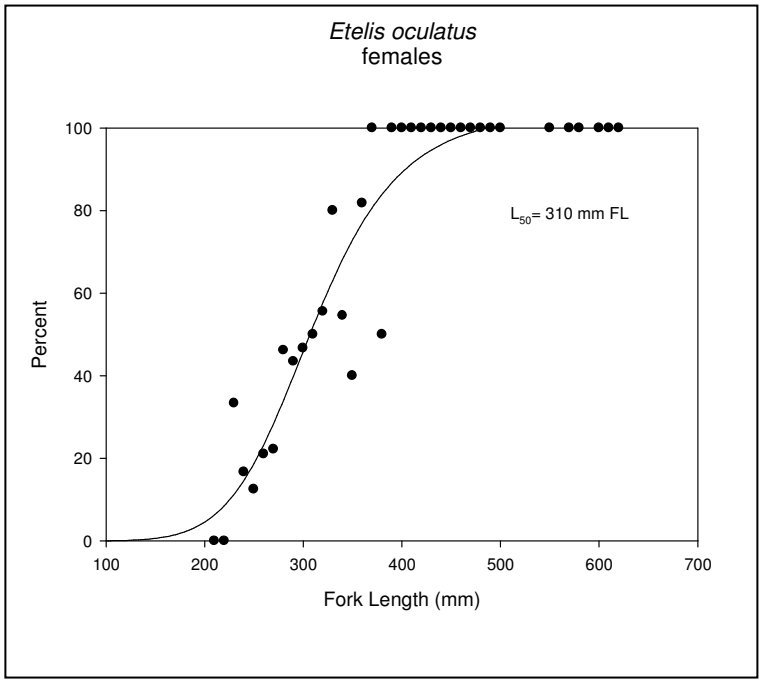

Figure 6. Fifty percent sexual maturation of sampled males queen snappers.

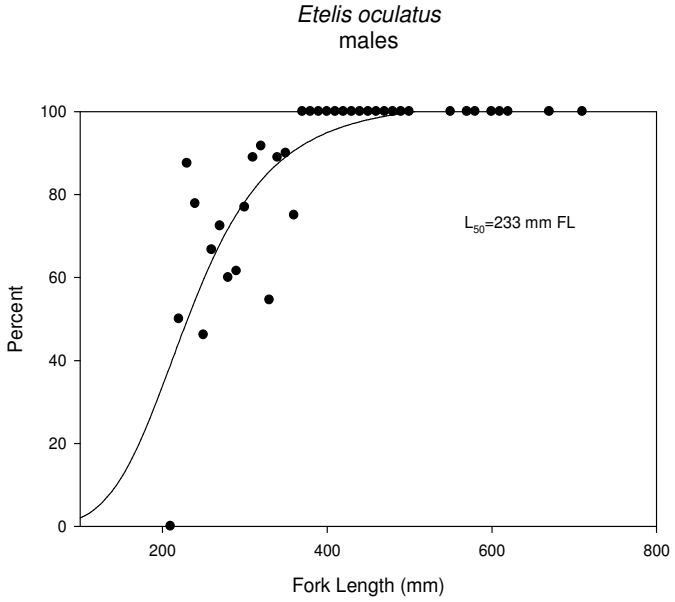

Figure 7. Percent of sexual maturation stage by months of sampled females queen snappers.

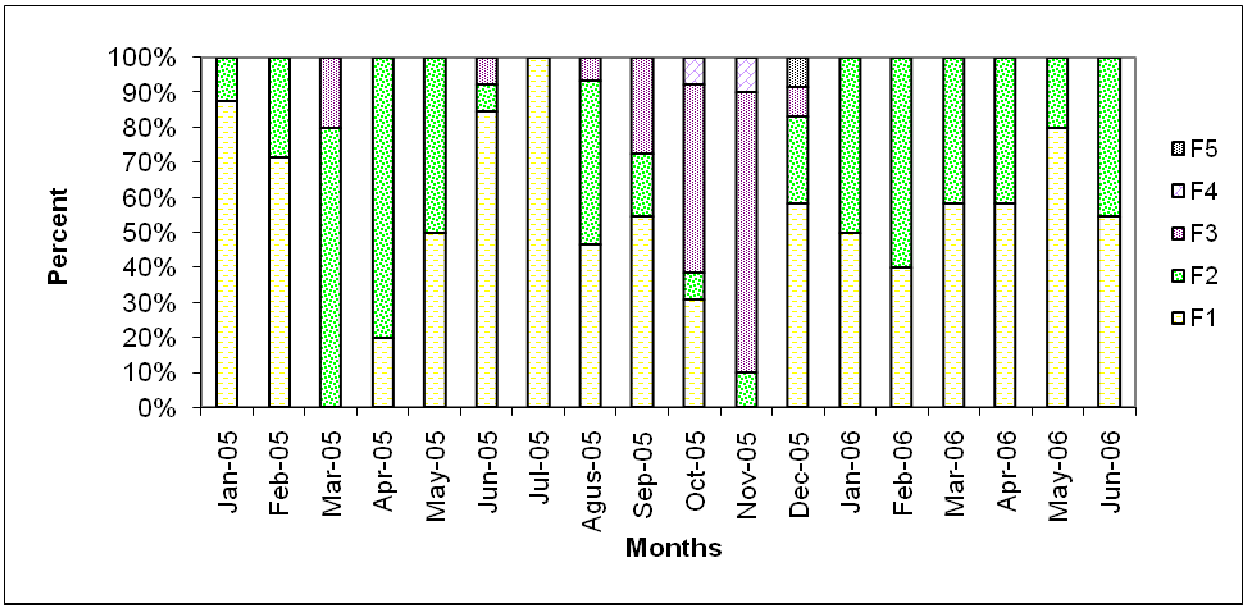

Figure 8. Gonadosomatic Index of sampled females queen snappers by months.

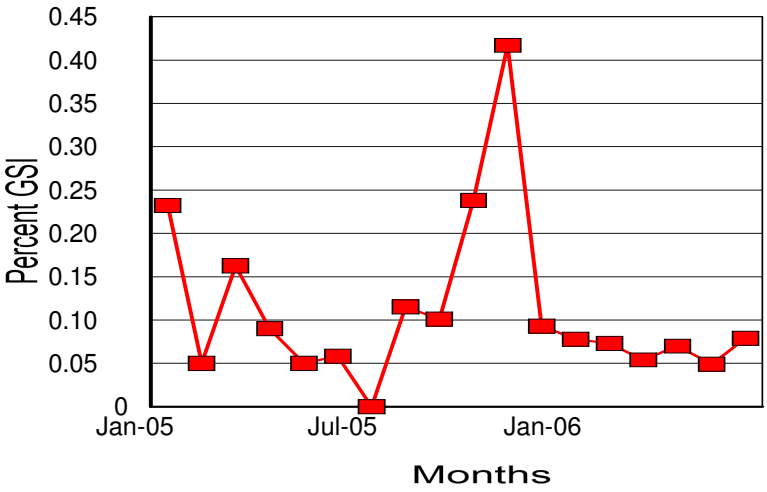

Figure 9. Relationship of fork length vs. otolith length of sampled queen snappers.

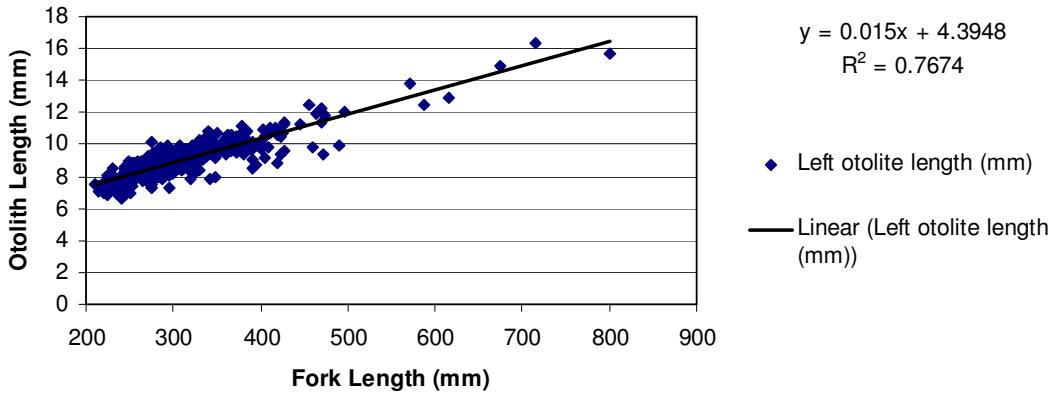

Figure 10. Fork length vs. number of otolith rings of sampled queen snappers.

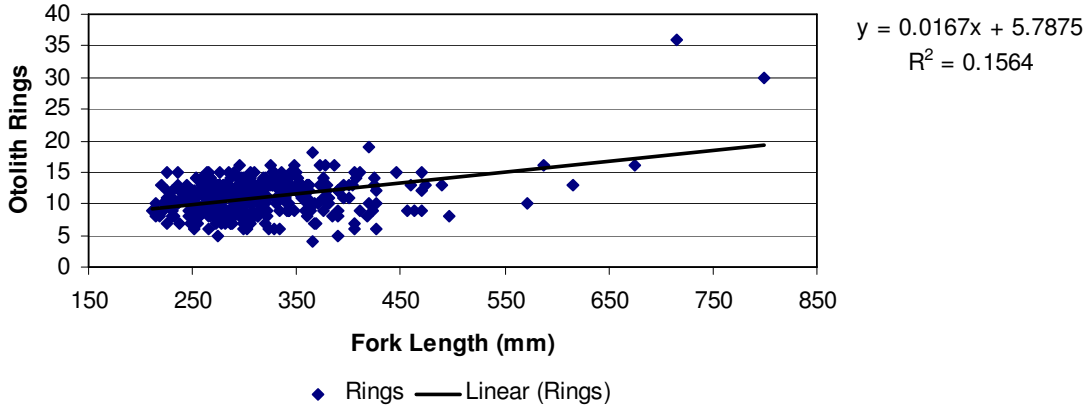

Figure 11. Size frequency distribution of total sampled wenchman from January 2005 to June 2006.

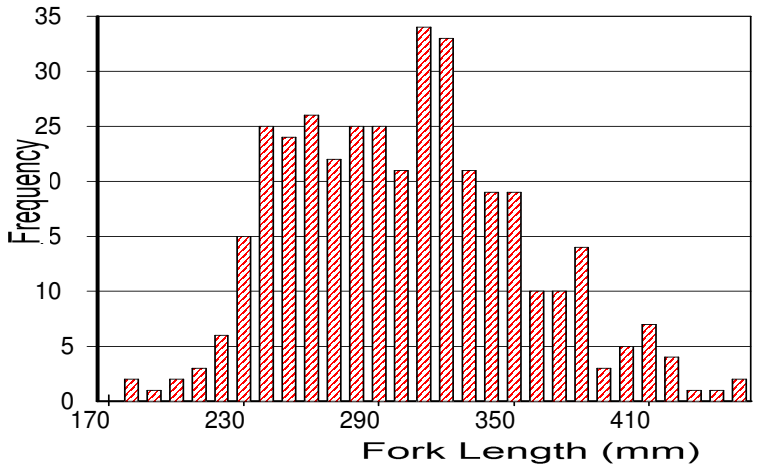

Figure 12. Size frequency distribution of sampled wenchman (Pristipomoides macrophthalmus) by sex.

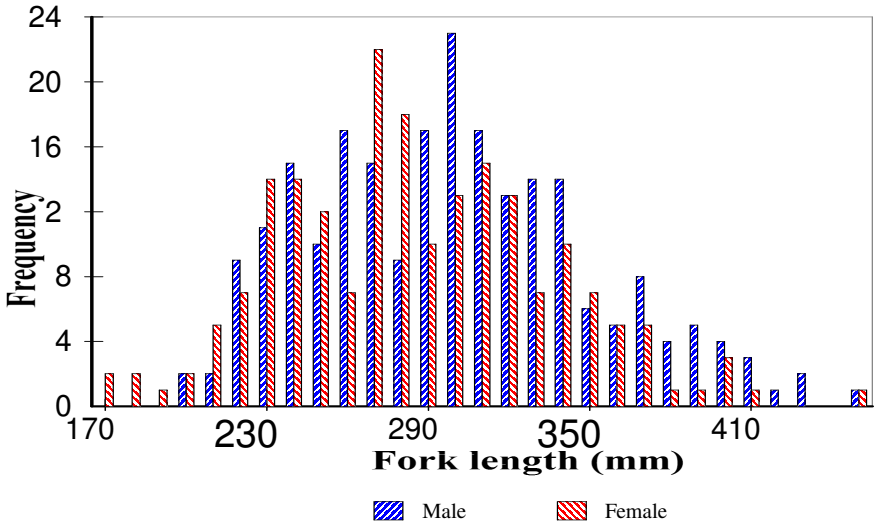

Figure 13. Length-weight relationship of sampled wenchman. Log W = -4.59 + 2.95 Log FL; N = 380, r = 0.98.

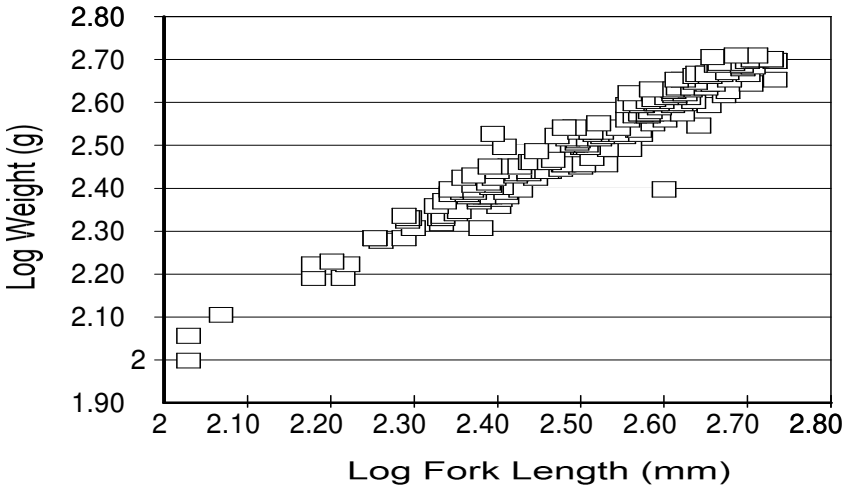

Figure 14. Size frequency distribution of sampled wenchman by port agents during January to December 2005. N = 44.

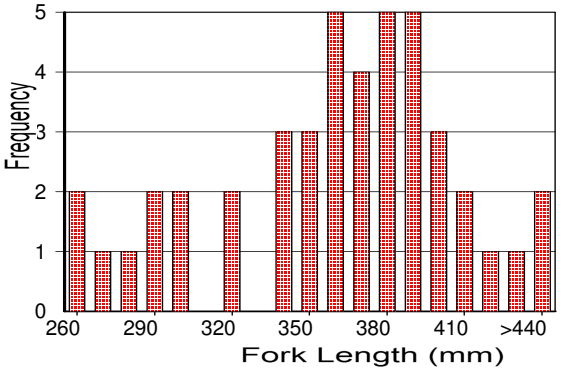

Figure 15. Percent maturation data of sampled females wenchman from January 2005 to June 2006.

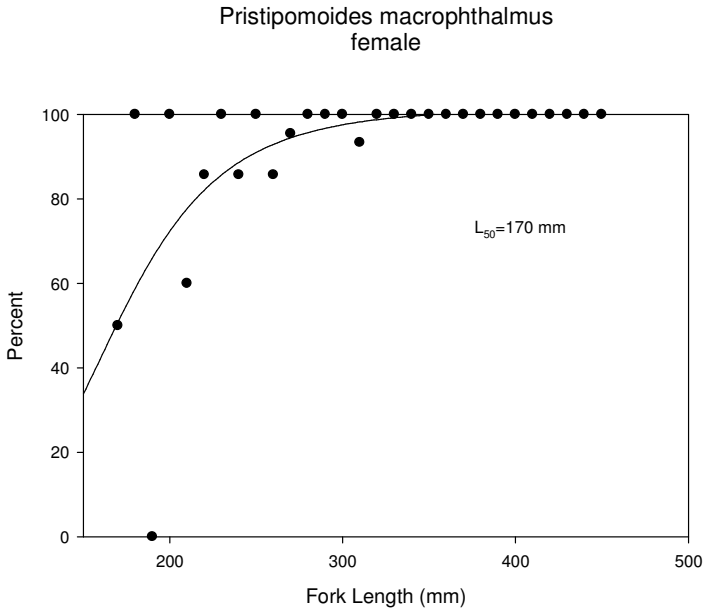

Figure 16. Percent maturation of sampled males wenchaman.

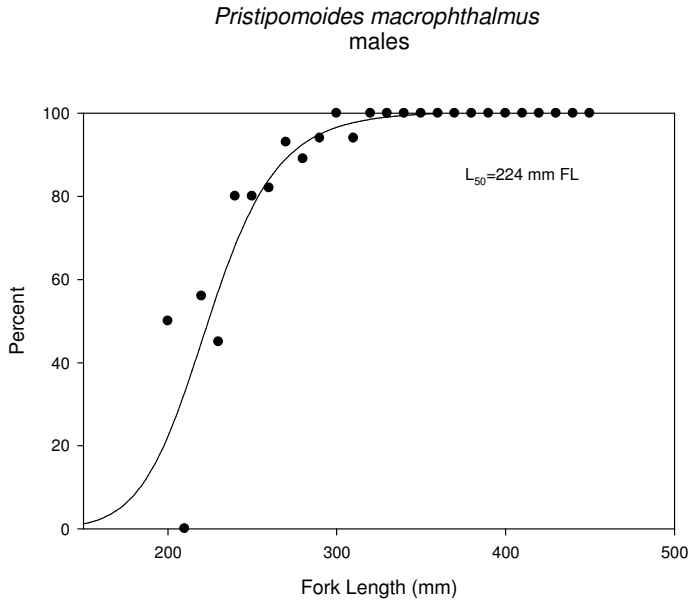

Figure 17. Females stages of sexual maturation for sampled wenchman, from January 2005 to June 2006.

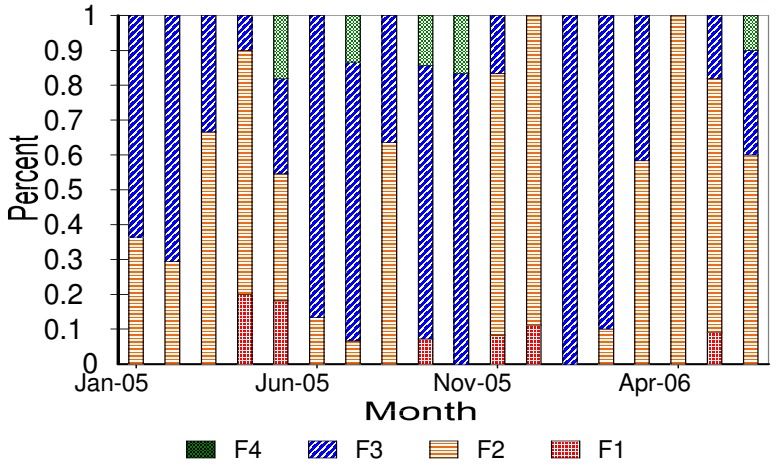

Figure 18. Gonadosomatic index of sampled females wenchman from January 2005 to June 2006.

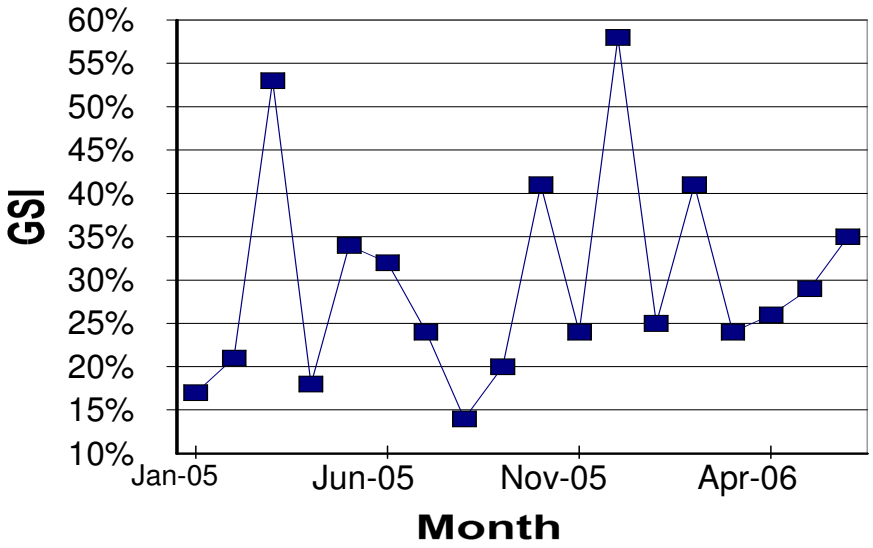

Figure 19. Relationship of fork length vs otolith length of sampled wenchman.

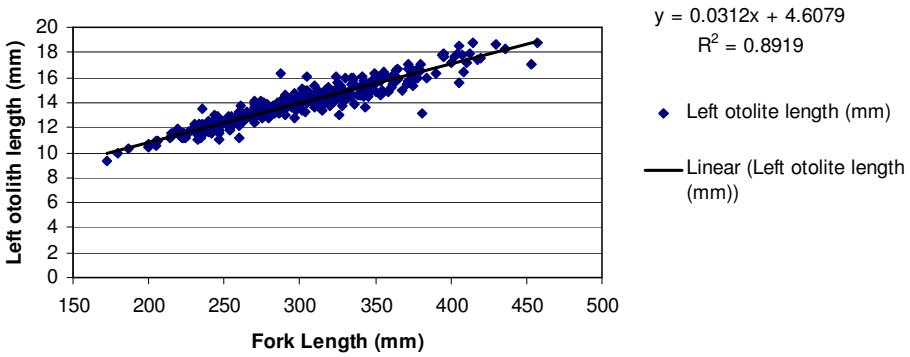

Figure 20. Fork length vs. number of otolith rings for sampled wenchman.