MACRODON ANCYLODON STOCK WITHIN THE ORINOCO AND GULF OF PARIA REGION

by

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1. DESCRIPTION OF STOCK AND FISHERIES

The king weakfish (curbinata in Venezuela), *Macrodon ancylodon* (Pisces: Sciaenidae), is a common marine species occurring in shallow waters throughout the Gulf of Paria and the delta of the Orinoco River. Its distribution is restricted to South America, from the Gulf of Venezuela to southern Argentina (Cervigón, 1993). Cousseau (1982) reports to have found individuals of this species down to 37 ° S. Cervigón (*op. cit*.) states that the species is particularly abundant in the Atlantic margin of Venezuela (Gulf of Paria and Orinoco delta), being the predominant component of the trawl catches, between 10 and 35 m depth. Adults perform migratory movements, associated with the reproductive process, away from the trawling fishing grounds. Spawning takes place in the vicinity of mangrove areas, where juvenile fish are common. Juveniles migrate later towards deeper water until they reach maturity, when they migrate back to shallow areas surrounded by mangroves. The trawling fleet therefore tends to capture late juvenile and early adult fish.

M. ancylodon is commonly exploited by all countries in the region. Its landings in the Venezuelan side of the Gulf of Paria have increased significantly during the last 10 years, from 446 t in 1987 to over 4000 t in 1995 (Figure 1). This species is becoming an increasingly larger fraction of the Venezuelan trawl catch from the Gulf and adjacent areas, from 14% in 1987 to over 60 % in 1996 (Figure 2). It has become the most important species in the landings, having displaced other two groups of species (also sciaenids) that used to be the most common species in the catch: the croaker (*Micropogonias furnieri*) and the curvinas (*Cynoscion* spp.; Marcano *et al*, 1997). The CPUE of *M. ancylodon* has shown an almost consistent increase during the period 1987-96, in contrast to that of the other species in the landings (Figure 3). This increasing tendency suggests a progressive targeting of the effort within the trawl fleet towards *Macrodon ancylodon*. The reduction of effort during 1996 has resulted in a decrease in the total landings of all species.

Two fleets of trawlers land *M. ancylodon* and other fish species in the Atlantic zone of Venezuela. The first fleet targets shrimp and fish and is based in Cumaná and Güiria. It is formed by trawlers with 24 m mean length, primarily operating in the Gulf of Paria and the common fishing zone between Trinidad and the Orinoco delta (Marcano *et al*., 1997). The second fleet is composed of larger trawlers (over 30 m in length) based in Cumaná and Puerto La Cruz, which target fish in the southern Orinoco delta. The important increases observed in the landings of *M. ancylodon* in recent years are probably a consequence of the development of the latter fleet which started operating during the late 1980s. However, it is also possibly due to a progressive targeting of effort towards the grounds where this species is abundant. The fish are sold either whole or as frozen fillet in local markets, and because of their small size no exports are made of this species. A large proportion of the catch is processed in industrial plants located in Güiria and Cumaná. The swim bladder is also commercialized as a by-product.

M. ancylodon is most probably distributed continuously as a single stock along the coast from the Northern Gulf of Paria to the Amazon river, so until further evidence is found, it should be considered as a common resource among all countries in this region. However, it should be considered that Yamaguti (1979) found distinct populations for this species in the coast of southern Brazil, within the range 18° 36' and 32 ° 10' S.

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2. DATA ON CATCH, EFFORT AND SIZE STRUCTURE

Data for landings of *M. ancylodon* and fishing effort for the period 1987 - 1996 were obtained from the logbook information provided by the Venezuelan industrial fleet, and from the information gathered by observers on board. Information pertaining to the size structure of the species in the landings (total length and weight) was obtained from measurements made in the laboratory, at the industrial processing plants located in Güiria and Cumaná, as well as by on board measurements made by observers.

3. PREPARATION OF DATA SETS

Two data sets were used in the analyses. Arcia (1996) prepared a data set of 1247 fish during the period January to December 1992, which contained data on sex and measurements of total length, total weight, and weight of gonads and livers. A second data set was prepared with 13407 fish, measured on board and in the processing plants of Güiria and Cumaná between February 1993 and November 1994. The latter contained unsexed data on total length.

The plot of weight vs. total length for males and females for the 1992 data set revealed discrepancies between the data from February - April and the data for other months. The reason of the difference between the two data groups has not been clarified. Since the data excluding Feb.-Apr. provided the larger sample size, they were used for estimating the parameters of the weight vs. length equations. However, average size estimates by sex were based on the total sample. Arcia (1996) also reports that mature females can be found starting at 22 cm TL, and that 50% maturity was reached at 25.4 cm TL.

Parameters for the von Bertalanffy growth equation (L_∞ and K) for *M. ancylodon* were estimated for males and females, using the 1992 data set, with the modal progression analysis routine of FISAT (Gayanilo *et al*., 1995). Due to the paucity of data for males in the database, the analysis for this gender was performed with the monthly data for Feb - June 92, and Nov 92 - Jan. 93, periods when the modes could be recognized. Data for females were more abundant and were grouped in 3-month periods. Battacharya's analysis was performed to split the polymodal length frequencies into normal distributions representing the different annual cohorts within the samples and the results were corrected using the NORMSEP method. A second estimate of L_∞ for females was obtained from the mean length of the larger fish in the 1993-94 database (large animals were those within the upper 6% of the distribution). Total mortality (Z) and fishing mortality (F) were estimated for males (all year) and females (quarterly and for the entire year) using the 1992 database and the "Length Converted Catch Curve by Size Intervals" software (Ehrhardt & Legault, 1996). Furthermore, the 1993/94 database was also used to prepare monthly estimates of Z and F during the period 1993-94 by assuming that the growth parameters for females represent those of the entire exploited population. In these calculations a constant value for the natural mortality (M) was assumed to be 0.3. Since there were not estimates for the value of natural mortality for *M. ancylodon* in the region, it was considered that 0.3 would be an appropriate value as provided by Rikhter & Efanov (1976; in Sparre & Venema 1992, p. 161) for species with a longevity of 5-7 years. *Macrodon ancylodon* is reported to live up to six to seven years (Haimovici, 1988; Leta, 1987).

Estimates of sizes at which *M. ancylodon* recruits to the fishery, is fully captured by the fishing gear and reaches maturity were estimated as 17 cm, 25 cm and 27 cm TL, respectively (Arcia, 1996). The latter estimate coincides with the report of Juras and Yamaguti (1989) who found sizes of first maturity at 21.5 and 27.4 cm TL for males and females, respectively, in southern Brazil. However, Cordo (1986) found that size at first maturity for females was 23.3 cm TL in Argentinian waters.

4. RESULTS OF THE ANALYSES

4.1 Growth

The proportion of sexes in the landings of *M. ancylodon* is very biased towards females, with a ratio close to 4:1 females/males (Table 1). Mean length for males in the sample was significantly smaller than for females (Kolmogorov - Smirnov test, $P<0.001$). The exponential parameter (b) in the growth equation for males is significantly smaller than this parameter for females (Table 2). Young males tend to be slightly larger than females because of their larger coefficient (a). However, females with total length greater than 30 cm TL are heavier than males (Figure 4). Other authors have found no significant differences

between sexes in the coefficients of the length-weight equation of this species (Haimovici, *op. cit.*; Garrido M. J., 1980).

The estimation of parameters L_∞ and K of the growth equation for males can only be considered preliminary, because it was based on few data, leading to a very large value of K (Table 3). Nevertheless, the values of L_∞ and K obtained for females are consistent with the range of values obtained for the species in southern latitudes (L_∞ = 42 cm and K = 0.42; Haimovici, 1988). Individuals would recruit into the trawlers' fishing grounds after 1.4 yr and become sexually mature at 2.7 yr. (Figure 5).

4.2 Mortality

The 1992 data provided a good fit to the catch curve, from where the total (Z) and the fishing (F) mortalities were estimated (Figure 6). Yearly values for males were Z= 2.79 and F= 2.49 (r^2= 0.98). The paucity of data for this gender prevented monthly calculations. Mortality values for females were much smaller and consistent among trimesters, with the exception of the fourth trimester when the total mortality value reached 0.45 (Table 4).

The calculations of the total and fishing mortalities using the larger and unsexed database from 1993/94 provided very poor fits to a linearized catch curve (Figure 7), in spite of the large number of fish measured: 5881 in 1993 and 6795 in 1994. Only the lines that could be drawn through more than two points are shown (Table 5). Curves for the periods June, July and September 93 and October, November 94, and the combined data for 1994, did not show a linear relationship in any portion of the distribution of the catch vs. age plot. Values for Z were also highly variable among different months. This result stresses the problem of trying to use the length-based methods on unsexed samples when the two sexes have markedly different growth rates.

4.3 Per Recruit Calculations

The biomass per recruit (B/R) for *M. ancylodon* during 1992 was estimated using equation (1) below, taken from eq. 8.3.3 of Sparre and Venema (1992). It was assumed that the values for the parameters K, W_∞, Tc, Tr, Z, and F for females shown in Table 6 better represent the portion of the population that is exploited.

$$B / R = \exp[-M * (T_c - T_r)] * W_\infty * \left(\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K} \right\} \quad (1)$$

where

S	= exp[-K*(T_c-t_0)]
B/R	= mean biomass per recruit
M	= instantaneous rate of natural mortality per year
T_c	= age at first capture
T_r	= age at recruitment to the fishing grounds
W_∞	= asymptotic body weight (obtained from asymptotic length $L_\infty$and the length weight relationship)
Z	= F+M = total mortality rate (where F = instantaneous rate of fishing mortality per year)
K	= von Bertalanffy growth parameter
t_0	= von Bertalanffy growth parameter

The yield per recruit was estimated as:

$$Y/R = F * B/R \quad (2)$$

The catchability coefficient (q) of *M. ancylodon* was estimated as the quotient between the fishing mortality F and the effort made by the fleet during a particular period of time (q = F/f.). Considering that during 1992, the effort made by the fleet was 9952 d (Figure 1), and that the estimated value for F during that period is 0.87 (Table 4), q would be $8.77*10^{-5}$.

The level of effort leading to a maximum yield per recruit (f_{MYR}) was estimated from a plot of Y/R vs. F (Figure 8). It was calculated by changing the value of F (actually changing Z) while maintaining the values of the other parameters shown in Table 6. It was considered that f_{MYR} should be in the vicinity of a fishing mortality (F) level of 0.4.

The value of f_{MYR} was then obtained as follows:

$$f_{MYR} = F/q = 4561 \text{ days-at-sea}$$

The biomass of the resource that would be sustained at this level of effort would be around 36% of the virgin biomass (Figure 8), while the biomass of spawners would be close to 34%. Since the size at which 50% of the females are found mature (Tm) was very close to the size when the population starts being fully captured (Tc), the estimated biomass per recruit is close to the biomass of spawners per recruit.

5. DISCUSSION

The effort in the trawl fishery of the region is mainly geared towards shrimps, although there are important incidental landings of groundfish. The contribution to the fish landings by the larger trawlers (which operate with fish nets in the Orinoco delta) is increasing. This means that data on landings and size structure used for the analysis performed in this report come from different fleets, using different gear. However, most of the information probably originates from shrimp trawlers, which represent about 85% of the fleet. In future analysis, a clear separation must be made between the data coming from the two trawl fleets.

Another problem that can affect the quality of the data is the migratory movement of *M. ancylodon*, associated with the reproductive process of the species and which takes place between the spawning grounds and the fishing grounds. The reduction in the proportion of animals “fully recruited to the fishery” (e.g. spawners) in the landings, might be a disrupting factor that prevents good fits in the linearized catch curves tested during the estimations of the total mortality coefficients. Future analyses should consider only those time periods of the year when all age groups exploited by the fishery are estimated to be present on the fishing grounds.

The estimated value of effort that maximizes the yield per recruit of *M. ancylodon* (4560 days-at-sea) is far below the level that has been applied in later years in the area, as well as the one considered adequate for providing the MSY of *Penaeus subtilis* (14000 d-a-s). If this situation continues, there could be a severe depletion of the *M. ancylodon* stocks in the area. The problem could become even more serious because of the progressively higher proportion of this species in the landings of the groundfish fleet, which does not target shrimp. Before any effort control measure can be recommended, it is necessary to perform a better assessment of the level of the biomass of spawners per recruit (Bspw/R) that is expected to remain in the population after a given level of effort is applied.

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Table 1: Total length (TL) and weight (mean ± std. dev. and range) for *M. ancylodon*, by sex, landed by the Venezuelan trawl fleet operating in the Gulf of Paria and the Orinoco River delta during 1992 (data after Arcia, 1996). Data from Feb. to April were excluded (see text)

Sex	N	TL (cm)	Range. TL	Weight (g)	Range. Weight
Males	98	25.4 ± 2.8	20 - 33	147.9 ± 51.9	57.6 – 313.8
Females	805	26.5 ± 3.1	17 - 37	164.4 ± 65.8	32 - 480
Common	901	26.4 ± 3.1	17 - 37	162.6 ± 64.7	32 - 480

Table 2: Parameters a and b, 95% confidence intervals and correlation coefficients for the Total Length vs. Weight equation ($W=a*L^b$), of *M. ancylodon* population, by sex, landed by the Venezuelan trawl fleet operating in the Gulf of Paria and the Orinoco River delta during 1992 (data after Arcia, 1996). Data from February to April were excluded (see text)

Sex	a ($*10^{-4}$)	95% Confidence. Interval for a ($*10^{-4}$)	b	95% Confidence Interval for b	r
Males	75	43 – 131	3.047	±0.172	0.96
Females	36	30 – 43	3.260	±0.028	0.97
Common	40	34 – 48	3.224	±0.054	0.97

Table 3: Estimated values by sex of the parameters for the von Bertalanffy growth equation for *M. ancylodon* landed by the Venezuelan trawl fleet operating in the Gulf of Paria and the Orinoco River delta during 1992 (data after Arcia, 1996). r = correlation coefficient

Sex	L_∞	K	r	n
Males	31.3	2.2	0.99	10
Females	33.2	0.53	0.67	22

Table 4: Estimated total mortality (Z), fishing mortality (F) and coefficient of determination (r^2) of the linearized catch vs. age curve for female *M. ancylodon* landed by the Venezuelan trawl fleet, operating in the Gulf of Paria and the Orinoco River delta during 1992 (data after Arcia, 1996). Natural mortality was assumed constant and equivalent to 0.3. Values for L_∞ and K were 33.15 and 0.53, respectively

Mortality	Trimester I	Trimester II	Trimester III	Trimester IV	All year
Total (Z)	1.16	0.93	1.23	0.45	1.17
Fishing (F)	0.86	0.63	0.93	0.15	0.87
r^2	0.86	0.96	0.99	0.96	0.99

Table 5.: Estimated total mortality (Z) and fishing mortality (F) for *M. ancylodon* landed by the Venezuelan trawl fleet operating in the Gulf of Paria and the Orinoco River delta during 1993 and 94. Natural mortality assumed at 0.3. Values for L_∞ and K were 33.15 and 0.53, respectively. The coefficient of determination (r^2) and the number of points used from the catch curve are also shown

Period	Z	F	r^2	n
Feb. 93	1.01	0.71	0.91	3
Mar	0.34	0.04	0.94	7
Aug	3.0	2.7	0.97	3
General 93	0.82	0.52	0.92	3
Feb 94	0.79	0.49	0.99	3
Mar	0.96	0.66	0.88	4

Table 6: Value of the parameters used to calculate B/R, Bspw/R and Y/R using equation (1). See text for details

Tr (yr)	Tc (yr)	Tm	K (yr^{-1})	W_∞ (g)	Z	F	B/R (g)	Bspw/R (g)	Y/R (g)
1.35	2.6	2.7	0.53	323	1.17	0.87	108	96	95

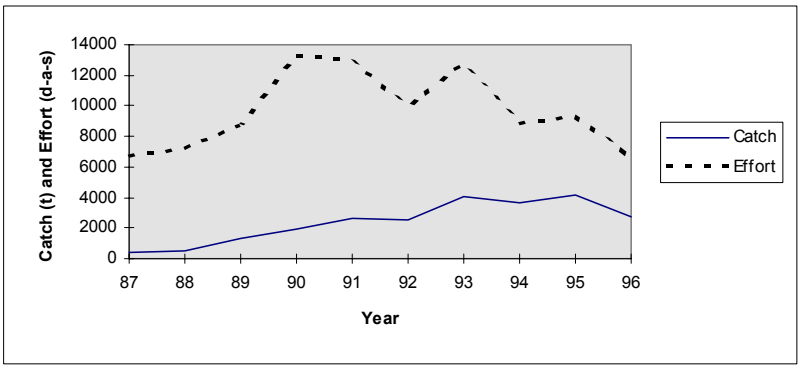

Figure 1: Catch of *M. ancylodon* (solid line) and effort (dashed line) reported by the Venezuelan trawl fleet operating in the Gulf of Paria and Orinoco region during the period 1987-96

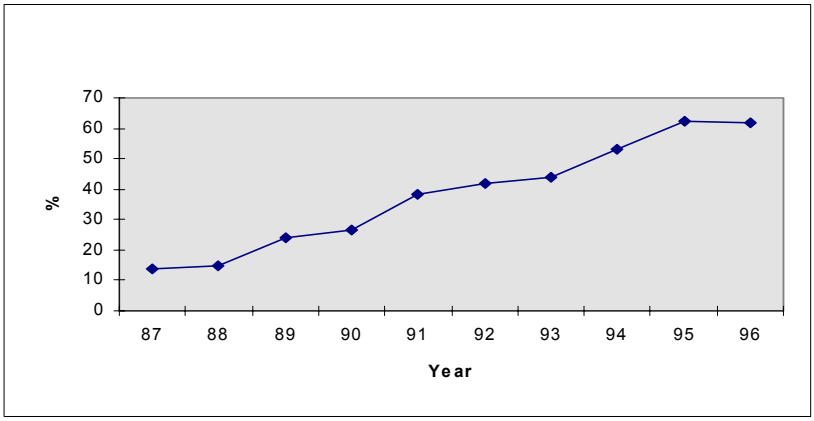

Figure 2: Percent of *M. ancylodon* in the general ground fish catch from the Venezuelan trawl fleet operating in the Gulf of Paria and Orinoco region during the period 1987-96

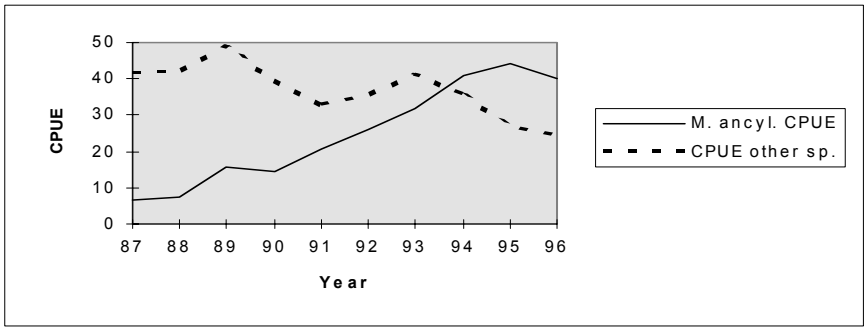

Figure 3: General trend of CPUE for the king weak fish, *M. ancylodon* (solid line) and other ground fish species (dashed line), reported by the Venezuelan trawl fleet operating in the Gulf of Paria and Orinoco region during the period 1987-96

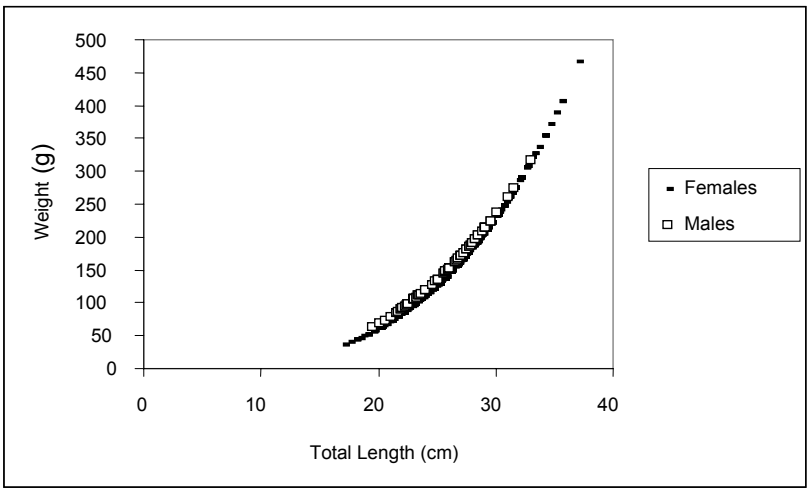

Figure 4. Length : weight relationship for male and female weak fish, *M. ancylodon,* landed by the Venezuelan trawl fleet operating in the Gulf of Paria and Orinoco region during 1992 (data after Arcia, 1996)

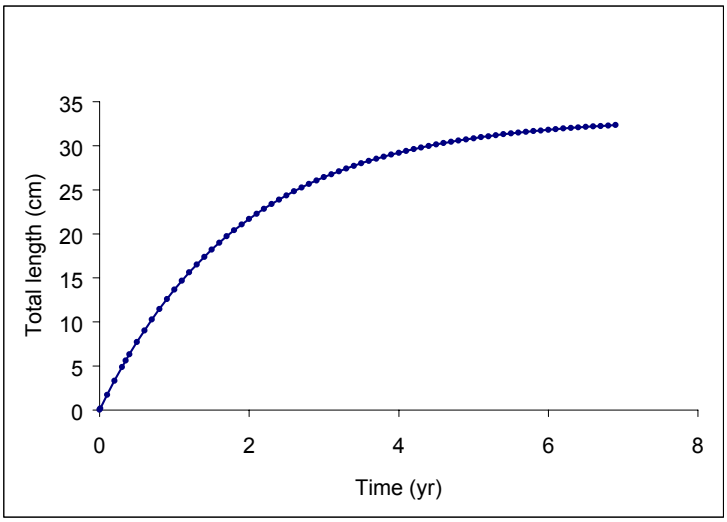

Figure 5: Estimated growth curve of the female king weak fish, *M. ancylodon,* within the Gulf of Paria and Orinoco delta region

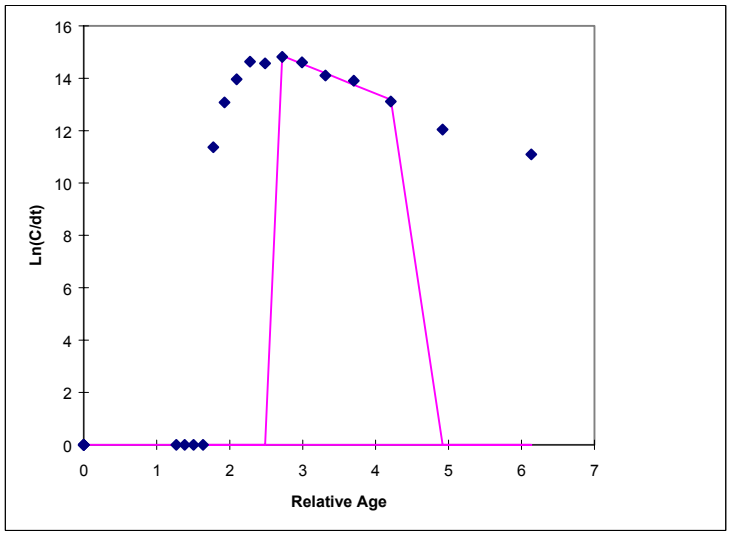

Figure 6: Linearized catch curve for a female sample of *M. ancylodon* landed by the Venezuelan trawl fleet from the Gulf of Paria during August, 1993

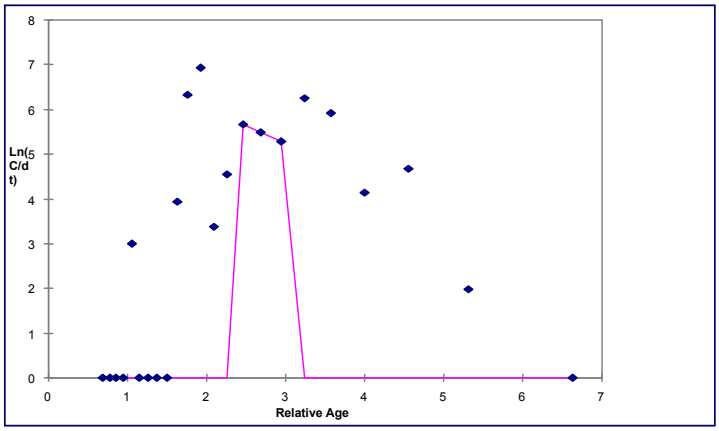

Figure 7: Linearized catch curve for an unsexed sample of *M. ancylodon* landed by the Venezuelan trawl fleet from the Gulf of Paria during February, 1994

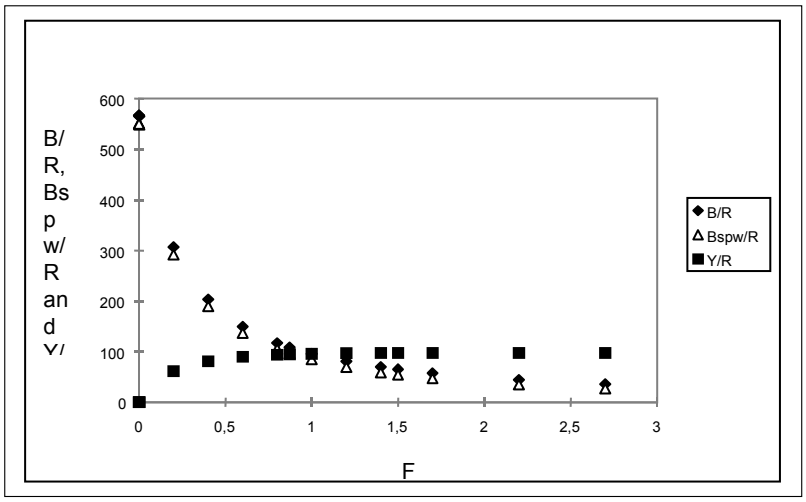

Figure 8: Estimated biomass per recruit (B/R), spawner biomass per recruit (Bspw/R) and yield per recruit (Y/R) against fishing mortality (F) in the king weak fish, *M. ancylodon,* fishery within the Gulf of Paria and Orinoco delta region