EVALUATION OF THE WHITE SHRIMP (*Penaeus schmitti*) STOCK WITHIN THE ORINOCO DELTA AND GULF OF PARIA REGION

by

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1. JUSTIFICATION

A common approach for evaluating shrimp resources in areas where information is scant, usually having only data on catch and effort, has been the use of surplus production models (e.g. Fox, 1970). Notwithstanding their valuable contribution to management of marine shrimp fisheries, these types of models make gross assumptions about the dynamics of the population under analysis. Since they treat all individuals in a similar way, they are unsuitable for evaluating, for instance, the variations undergone by different stages within the life cycle of a shrimp species. The information currently available on the shrimp species within the region of the Guyana – Brazil shelf has improved significantly in recent years. In addition to the catch and effort data already available in most countries, processing plants within the region can provide a large amount of information on catch received by month, and how it was converted to catch per size class. Furthermore, there have been numerous studies on the regional species of shrimp covering aspects of growth, reproduction and maturation, morphometry, distribution of life stages, recruitment, natural mortality and stock assessment (see review by Lum Young *et al*., 1992).

Considering the available, albeit still limited, information the working group on *Penaeus schmitti* decided to perform a first assessment of this species using virtual population analysis (VPA). It is expected to serve as an introduction of this methodology in the progressive evaluation of other regional shrimp resources, which may become possible in the near future as more information accrues.

2. DESCRIPTION OF STOCK AND FISHERIES

The white shrimp, *Penaeus schmitti,* occurs in shallow waters throughout the Gulf of Paria and the marine border of the Orinoco delta. Its distribution encompasses the Caribbean Sea and the eastern coast of South America, to southern Brazil (Holthuis, 1980). It seems that within the Trinidad - Brazil shelf region, important landings of this species are only made from Venezuelan waters.

Catches of juvenile *P. schmitti* are made by artisanal fishermen in shallow areas within the Gulf of Paria and in the mouths of the rivers throughout the Orinoco delta region (Figure 1). There is an artisanal fishery for this species in the northern coast of the Gulf of Paria (Irapa to Soro), in which fishermen use beach seines in very shallow water (Altuve *et al*. 1995; Altuve 1997). There is also an artisanal trawl fishery, composed of fishers from Venezuela and Trinidad-Tobago, who operate in the mouths of the rivers of the northern Orinoco delta. Venezuelan fishers operate in the northern sector of Point Bombeador, whereas Trinidad fishers do it in the southern sector, near Cocuina Island. *P. schmitti* represents most of the landings from the Venezuelan fleet, but only 69% of the Trinidad landings; the other 31% in the latter landings are made up of *P. subtilis* (Trinidad and Tobago Fisheries Division, 1996).

Adult *P. schmitti* are trawled in offshore waters close to the mouths of major rivers in the Gulf of Paria and the Orinoco River. The Venezuelan industrial fleet harvests *P. schmitti* in the Gulf of Paria and the Columbus Channel (statistical areas 10621, 10612, 09614, 09613, 09604, 09601, 08594 and 08593; Marcano *et al.*, 1996) while the Trinidad industrial fleet does not make large landings of this species.

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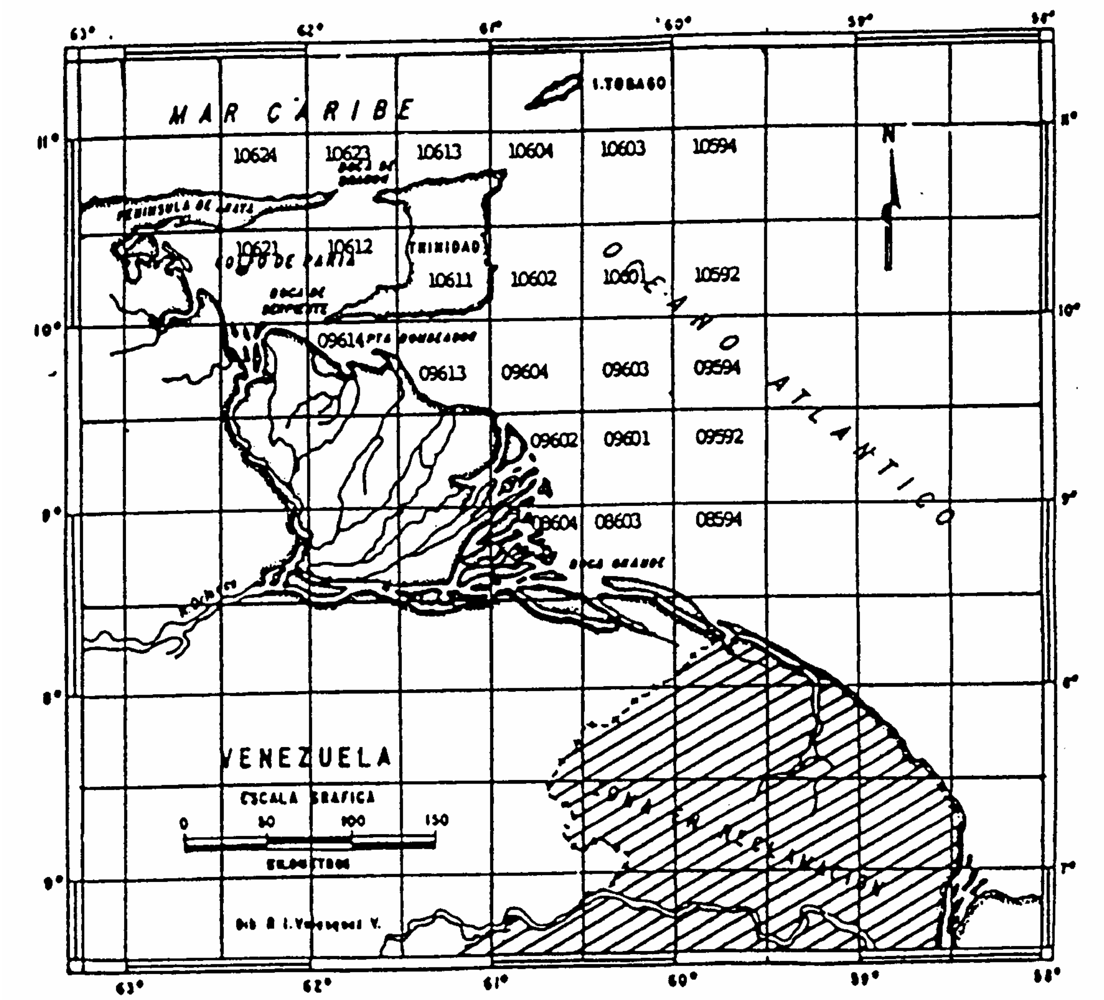

Figure 1. Distribution of *P. schmitti* in the Gulf of Paria and northern delta of the Orinoco River as indicated by the distribution of fishing effort

Landings of *P. schmitti* by numerous gears in the artisanal fleets can amount to up to 100 t per year (Altuve, 1997), having increased in recent years after the incorporation of the artisanal trawl fleet. The average annual landings of this species in the industrial trawl fleet have been 200 t, with values varying between 160 and 370 t per year during the last 9 years (Figure 2). In spite of the significant increase in effort levels deployed by the industrial fleet in recent years, landings of this species have not followed a similarly increasing trend, probably because the species is not normally targeted by the fleet. *P. schmitti* represents about 20% of the total shrimp landings, but its importance relies on its reaching the largest sizes among all shrimp species in the area (Marcano *et al.*, 1997).

For the purpose of this assessment we assumed the existence of a single stock of *P. schmitti* within the area of the Gulf of Paria and the Orinoco delta.

3. METHODS

3.1 Data on Catch and Size Structure

Total monthly landings of *P. schmitti* for the period July 1996 to February 1997 (Table 1) were obtained from logbook information provided by the Venezuelan industrial fleet and from information gathered by observers on board. This data gathering system was explained in the case study of *P. subtilis* in this volume (Alió *et al.*, 1997). Information pertaining to size structure of *P. schmitti* in the landings was obtained at industrial processing plants located in Güiria and Cumaná. These processing plants provided: 1) data on bulk shrimp that entered the plants from boats landing in the location, and 2) resulting number of boxes by commercial categories (in 5 lb. boxes of tails or 1 kg boxes whole shrimp; Table 2).

Table 1: Total landings of *Penaeus schmitti* by month, reported by the Venezuelan trawl fleet operating in the Gulf of Paria and the Orinoco River delta

	July 96	Aug. 96	Sept. 96	Oct. 96	Nov. 96	Dec. 96	Jan. 97	Feb. 97
Landings (kg)	20513	13441	19166	7229	11403	21503	14212	20845

Table 2: No. of boxes (5 lb. tails) of *P. schmitti* per month, reported by processing plants in Cumaná and Güiria during the period July 96 to Feb. 97. A 5 lb. box of tails would be equivalent to a 7 lb. box whole shrimp (tail weight + 40%). The sample size was calculated by the formula: Spl. = No. Boxes tails * 7 lb. * 0.459 kg/lb. The monthly weighting factor was calculated by dividing the landings by the sample size from Table 1

Comm. cat.	July	August	Sept.	Oct.	Nov.	Dec. 96	Jan. 97	Feb. 97
U-10	0	15	0	0	1	30	0	0
U-12	2	155	5	1	6	36	0	25
U-15	3	220	5	2	11	125	25	82
16-20	3	430	6	3	13	196	120	288
21-25	1	335	5	3	21	360	180	588
26-30		160	4	1	16	360	140	245
31-35		70			2	130	85	65
36-40		10			1	95	105	20
41-50						70	100	15
51-60						50	80	
61-70							30	
71-100							100	
Total	9	1395	25	10	71	1452	965	1328
Sample size (kg)	29	4429	79	32	225	4610	3064	4217
Weighting factor	717.8	3.0	241.5	227.7	50.6	4.7	4.6	4.9

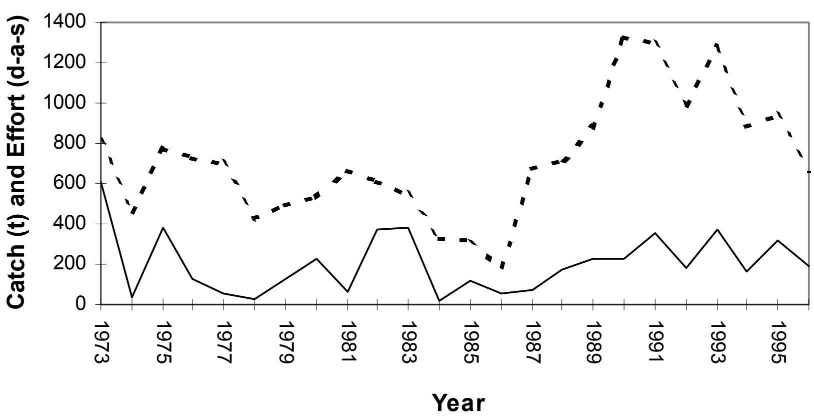

Figure 2: Trends in the landings of *P. schmitti* (continuous line) and general effort (dashed line) of the Venezuelan trawl fleet operating in the Gulf of Paria and delta of the Orinoco River (after Marcano *et al.*, 1997)

Table 3: No. of tails per 5 lb. box for the different commercial categories (after Cadima, *et al.,* 1972, Table 2)

Comm. Cat.	U-10	U-12	U-15	16-20	21-25	26-30	31-35	36-40	41-50	51-60	61-70	71-100
N	50	65	80	95	120	145	170	200	245	290	335	404

Table 4: Percentage of each size class (TL) for different commercial categories (tails) of *P. schmitti* landed by the Venezuelan trawl fleet operating in the Gulf of Paria and Orinoco delta. Length of tail was converted to total length by the equation: $TL=-11.3575 + 1.7457L_{tail}$ (after Marcano *et al*., 1997, Table 11)

Total Length (mm)	U-10	U-12	U-15	16-20	21-25	26-30	31-35	36-40	41-50	51-60	61-70	70 - 100
90												6.1
100												52.2
110							0.5		2.0	12.2	14.8	38.9
120							0.0	1.1	26.0	43.0	70.4	2.8
130						0.2	0.5	7.8	57.0	37.8	12.8	
140					0.5	0.7	10.9	23.9	15.0	4.1		
150					4.1	23.6	34.8	52.2	1.1	2.4		
160				0.5	23.0	62.0	46.7	13.9				
170	2.3		0.3	13.0	47.8	13.0	6.0	1.1				
180	0.0		6.8	42.1	22.1	0.5	0.5					
190	0.0	0.7	32.1	35.7	1.8							
200	0.0	7.3	36.2	7.0	0.5							
210	15.9	21.9	23.2	1.5	0.0							
220	18.2	40.4	1.5	0.0	0.0							
230	43.2	23.9		0.3	0.5							
240	6.8	5.3										
250	11.4	0.0										
260	2.3	0.7										

The parameters for the von Bertalanffy growth equation for *P. schmitti* (both sexes combined) were obtained from Pérez *et al.* (1980), which were estimated for the population of La Broa Sound, Cuba. These authors provide L_∞ values that best approximate the observed maximum sizes observed in the population of *P. schmitti* in the Gulf of Paria. L_∞ values, given by these authors as total length (postorbital notch – sixth abdominal segment, TL'), were converted to total length (rostrum – telson, TLrt) using the conversion equation provided by Giménez *et al.,* (1980):

$$TLrt = 1.359 * TL' - 0.751$$

Values of L_∞ and K for both sexes combined were obtained by averaging values for females and males: K= 0.35.mth^{-1} (K females = 0.31 mth^{-1}; K males = 0.39 mth^{-1}). Likewise, L_∞ (TLrt) = 253 mm (L_∞ females = 275 mm; L_∞ males = 232 mm).

The total length (mm) vs. weight (g) relationship for the species (both sexes combined) was obtained from Marcano *et al*. (1997):

$$\text{Weight} = 1.21 * 10^{-6}\ TL^{3.3856}$$

3.2 Preparation of Data Sets

The sample size of *P. schmitti* processed in the region every month (St) was estimated as:

$$St\ (kg) = \Sigma B_{it} * 7 * 0.4569 \qquad (1)$$

where B_{it} is the number of 5-lb tail boxes processed of the commercial category "i" during month "t"; 7 is the weight (lb.) of a box carrying whole shrimp (adding 40% in weight corresponding to the heads) and 0.4569 is the number of pounds in one kilogram.

The number of *P. schmitti* (N_{it}) in a commercial category "i" every month "t" was estimated as:

$$N_{it} = B_{it} * A_i \qquad (2)$$

where A_i is the number of animals in the commercial category "I".

Finally, the number of animals in a given size class for the monthly samples (C_{jt}) was estimated as:

$$C_{jt} = (\Sigma N_{it} * P_j) * L_t/S_t \qquad (3)$$

where P_j is the proportion of the size class "j" in the commercial category "i"; L_t/S_t is a weighting factor which incorporates the total landings in a month and the sample size for that month. The addition is taken over all commercial categories.

The estimated size structure (total number of shrimps per size class) in the monthly catches (Table 5), was used to calculate Z and F values using a linearized catch curve ("Length Converted Catch Curve" procedure, prepared in Excel by Ehrhardt & Legault, 1996). The mortality rate for every month was assumed constant and equal to 0.2. The values for Z, F and the length interval where the catch curve becomes linear are shown in Table 6. In order to verify the relationship between the changes in F value and the variation of fishing effort by the industrial fleet of trawlers, monthly means and standard errors were plotted for the available period (1992-94; L. Marcano, unpublished results).

The mean number of shrimp at sea by month (Table 7 and Figure 5) were estimated using Length Cohort Analysis (Jones 1984; see also Sparre and Venema, 1995, chapt. 5). In this case, a tuning procedure implemented in Excel and developed by Ehrhardt and Legault (1996) was used. This algorithm permits the tuning of the F-estimates by age (size) class to be performed, based on the estimated F-value and the interval of size classes used in its calculation in the length converted catch curve routine.

Problems in the tuning procedure were encountered in application of VPA in some months (Oct., Dec. 96; Jan., Feb. 97). In these cases the Goal Seek routine of Excel could not converge, forcing a lower weighted F (F_w) value to be used in the calculations of the mean number of animals at sea, instead of the F value calculated from the linearized catch curve (F_l). Trying to overcome this problem, the size of the interval used in the calculation of F_l was restricted and forced towards the largest size classes. The lower F_l value thus obtained was used in recalculating the length cohort analysis. If convergence was still not obtained, several F_l values were tested, obtained by choosing different size intervals within the linearized catch curve. The one providing the smallest difference between F_l and F_w values was chosen.

Monthly average biomass in the sea was estimated by multiplying the mean number of shrimp at sea times the mean weight per size class (Table 8 and Figure 6). Biomass of recruits per month was estimated from data on Table 8, considering that the recruits to the fishery would be animals in the 90-100 mm TL length interval (Figure 3). Biomass of parental stock per month (Figure 8) was estimated as the biomass of all animals larger than 160 mm, which was considered a mean size of maturation for female *P. schmitti* (range 128-181 mm TL, Pérez-Farfante, 1969).

Table 5: Estimated total number of *P. schmitti* in the monthly catch from the Venezuelan trawl fleet operating in the Gulf of Paria and delta of the Orinoco River

Total length (cm)	July 96	Aug. 96	Sept. 96	Oct. 96	Nov. 96	Dec. 96	Jan. 97	Feb. 97
90	0	0	0	0	0	0	11457	0
100	0	0	0	0	0	0	97916	0
110	0	195	0	0	93	10406	95588	657
120	0	67	0	0	112	50867	114926	4941
130	0	836	336	79	1162	79155	119510	12603
140	388	6424	1646	603	5693	49746	53078	16200
150	3489	37270	38889	11104	44098	150183	104246	85058
160	20809	90032	120833	39629	111828	258227	126542	218017
170	68166	85892	105470	51941	85516	146495	72027	210462
180	116869	83297	97156	48051	58110	85920	45826	137294
190	130354	63725	83167	36391	38972	49621	23634	64961
200	83792	30750	50914	19155	22475	24638	7498	23329
210	63497	21314	41656	12673	15995	15640	2949	11321
220	40233	13550	33122	6514	9084	6367	136	3722
230	23193	9146	19743	4067	6535	6752	583	3827
240	4946	1776	4159	784	1218	1056	0	426
250	616	512	518	98	475	1026	0	53
Totals	556352	444786	597609	231089	401366	936099	875916	792871

Table 6: Monthly estimates of total mortality (Z), fishing mortality (F) and size interval (TL) utilized within the linear portion of the catch curve, following the procedure by Ehrhardt & Legault (1996). Natural mortality was assumed to be 0.2. Fishing mortality values were employed in the Length Cohort Analysis procedure (Ehrhardt & Legault, 1996). In the two cases when no convergence was obtained in the latter procedure (using Goal Seek routine of Excel), the F weighted values used are shown in parenthesis

Month	Z	F	Size Interval (mm)
July 96	0.8	0.6	200 – 230
Aug.	1.07	0.87	190 - 220
Sep.	0.74	0.54	190 - 220
Oct.	0.92	0.72	200 – 230
Nov	1.03	0.83	190 - 220
Dec.	1.43	1.23 (1.13)	180 – 210
Jan 97	1.78	1.58	160 - 190
Feb	1.85	1.65 (1.58)	170 - 220

4. RESULTS

Total mortality (Z), and fishing mortality (F), values showed important variations for the different months for which they were estimated (Table 6, Figure 3). Minimum values, in the range 0.7 – 0.8, were observed in July and September, while values larger than 1 were found in August and towards the final and earlier months of the year. A progressive trend in Z values was observed in between these two periods.

The period August – October shows the greatest stability of effort by the industrial fleet of trawlers operating in the region (Figure 4). It is preceded and followed by two months of reduced activity, corresponding to partial closures imposed by the Venezuelan Government to reduce the general

Table 7: Estimated monthly number ($*10^5$) of *Penaeus schmitti* at sea, by size categories (mean total length) as result of the Tuned Length Cohort Analysis (Ehrhardt & Legault, 1996)

Size (mm)	Jul-96	Aug. 96	**Sep. 96**	Oct. 96	Nov. 96	Dec. 96	Jan. 97	Feb. 97
90	1.92	1.27	1.92	0.68	1.11	2.34	1.95	2.08
100	1.97	1.31	1.97	0.70	1.14	2.40	1.91	2.13
110	2.03	1.35	2.03	0.72	1.17	2.46	1.77	2.19
120	2.09	1.39	2.09	0.75	1.21	2.48	1.61	2.26
130	2.17	1.44	2.16	0.77	1.25	2.41	1.39	2.31
140	2.25	1.48	2.24	0.80	1.28	2.34	1.23	2.36
150	2.33	1.48	2.28	0.82	1.27	2.17	1.07	2.32
160	2.40	1.36	2.14	0.78	1.09	1.65	0.77	1.97
170	2.37	1.13	1.87	0.66	0.82	1.06	0.48	1.36
180	2.15	0.88	1.59	0.51	0.59	0.69	0.29	0.78
190	1.75	0.61	1.31	0.36	0.42	0.44	0.16	0.39
200	1.34	0.42	1.07	0.25	0.30	0.28	0.09	0.20
210	1.01	0.30	0.88	0.17	0.21	0.18	0.07	0.11
220	0.72	0.20	0.68	0.11	0.13	0.12	0.06	0.06
230	0.49	0.10	0.51	0.08	0.07	0.06	0.00	0.03
240	0.38	0.03	0.44	0.05	0.02	0.01	0.00	0.01
Total	27.4	14.7	25.2	8.2	12.1	21.1	12.9	20.6

trawlers fishing effort, 15 June – 15 July and 15 December – 15 January. During the Easter period in April there is a self-imposed absolute closure by crewmembers, resulting in an appreciable reduction in the effort level. Effort increases above mean values preceding the partial closure periods in June and November. No significant correlation was found between changes in the fishing mortality and the fishing effort ($r=0.34$, $P>0.05$).

The estimated number of *P. schmitti* at sea showed wide fluctuations during the year, with a declining trend during the period July to October, changing to an increasing trend towards November – February (Figure 5). A similar trend is observed in the variation of total biomass during the year (Figure 6). The greatest amount of animals at sea, as well as the greatest biomass, occurs during the period July – September.

The biomass of recruits shows two periods of greater abundance, July – September, and Dec. – Feb (Figure 7). However, when the proportion of recruits in the population structure is considered, a slow but increasing trend from 14% in July to a peak 30% in January is observed (Figure 3). The minimum biomass of recruits is reached during the month of October. Parental stock biomass is less variable, showing the largest values towards mid year, with a progressive decline until January after which it shows a progressive increase (Figure 8).

There is a strong correlation ($r=0.83$, $P<0.025$) between the fishing mortality values and the proportion of recruits in the population (Figure 3).

Table 8: Estimated biomass (t) of *Penaeus schmitti* in the study region, by size categories (mean total length), calculated from the N at sea (Table 6) and the common equation Weight (g) = $1.21*10^{-6}$ * TL(mm) $^{3.38}$ (after Marcano *et al*., 1997, Table 11). Recruits are considered animals smaller than 110 mm TL. Parental stock is assumed formed by animals larger than 150 mm TL

Size (mm)	July 96	Aug. 96	Sep. 96	Oct. 96	Nov. 96	Dec. 96	Jan. 97	Feb. 97
90	0.9	0.6	0.9	0.3	0.5	1.1	1.0	1.0
100	1.4	0.9	1.4	0.5	0.8	1.7	1.3	1.5
110	2.0	1.3	2.0	0.7	1.1	2.4	1.7	2.1
120	2.7	1.8	2.7	1.0	1.6	3.2	2.1	2.9
130	3.7	2.4	3.7	1.3	2.1	4.1	2.4	3.9
140	4.9	3.2	4.9	1.7	2.8	5.1	2.7	5.1
150	6.4	4.1	6.2	2.2	3.5	5.9	2.9	6.4
160	8.2	4.6	7.3	2.6	3.7	5.6	2.6	6.7
170	9.9	4.7	7.8	2.8	3.4	4.4	2.0	5.7
180	10.9	4.4	8.1	2.6	3.0	3.5	1.5	4.0
190	10.7	3.7	8.0	2.2	2.6	2.7	1.0	2.4
200	9.7	3.0	7.7	1.8	2.2	2.0	0.7	1.4
210	8.6	2.5	7.5	1.5	1.8	1.6	0.6	0.9
220	7.2	2.0	6.8	1.1	1.3	1.2	0.6	0.6
230	5.7	1.2	5.9	0.9	0.8	0.8		0.4
240	5.1	0.5	5.9	0.7	0.2	0.2		0.1
TOTAL	98	41	87	24	31	45	23	45
Biomass of Recruits	2	2	2	1	1	3	2	2
Biomass of Parental stock	76	27	65	16	19	22	9	22

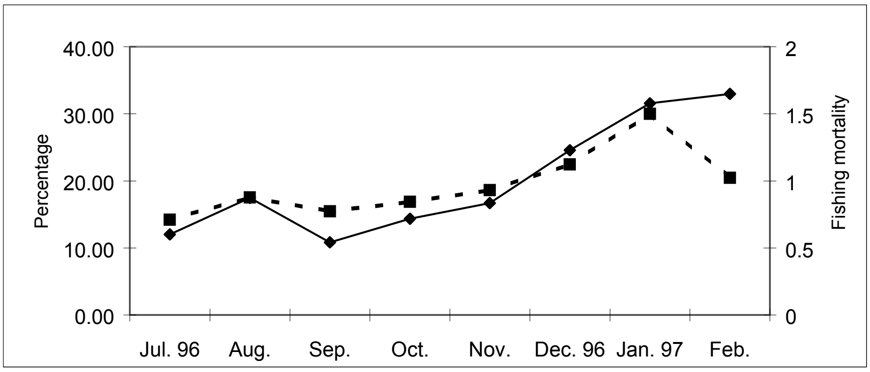

Figure 3: Monthly fishing mortality (F) values in the fishery of *P. schmitti* within the Gulf of Paria and northern delta of the Orinoco River (continuous line). Estimated values for monthly percentage of recruits (animals with 90 – 110 mm TL) in the *P. schmitti* population as a result of the Length Cohort Analysis (dashed line)

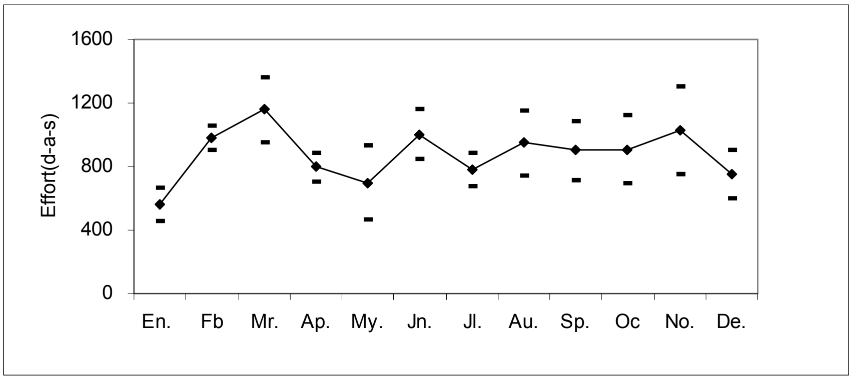

Figure 4: Average monthly effort (bounded by standard error) for the trawl fleet operating in the Gulf of Paria and delta of the Orinoco River during the period 1992-94 (after Marcano, unpublished results)

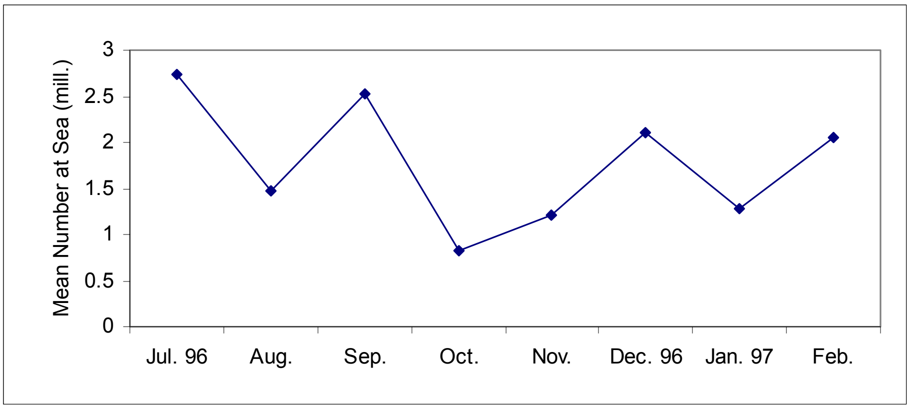

Figure 5: Estimated variation of the mean number of *P. schmitti* at sea by month, in the Gulf of Paria and northern delta of the Orinoco River

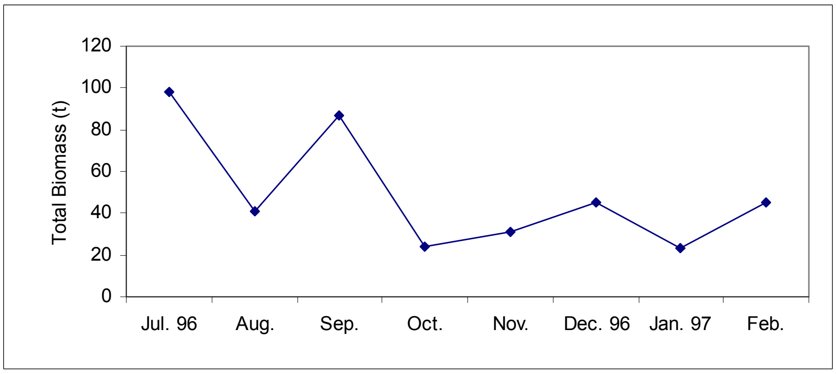

Figure 6: Estimated variation of the total biomass of *P. schmitti* by month, in the Gulf of Paria and northern delta of the Orinoco River

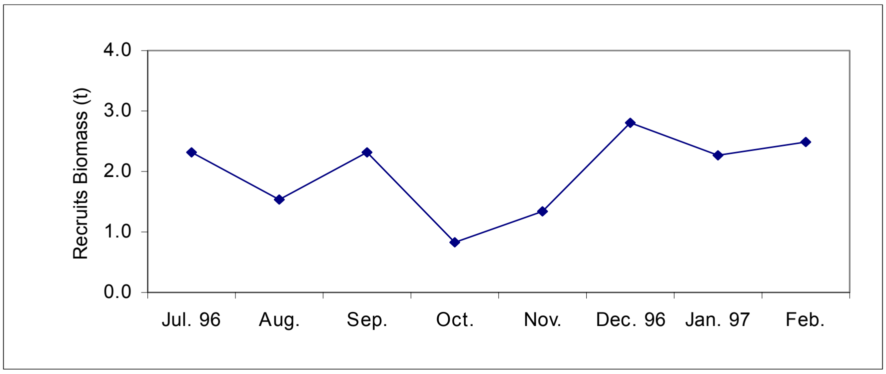

Figure 7: Estimated variation of the biomass of recruits of *P. schmitti* to the trawl fishery grounds in the Gulf of Paria and northern delta of the Orinoco River

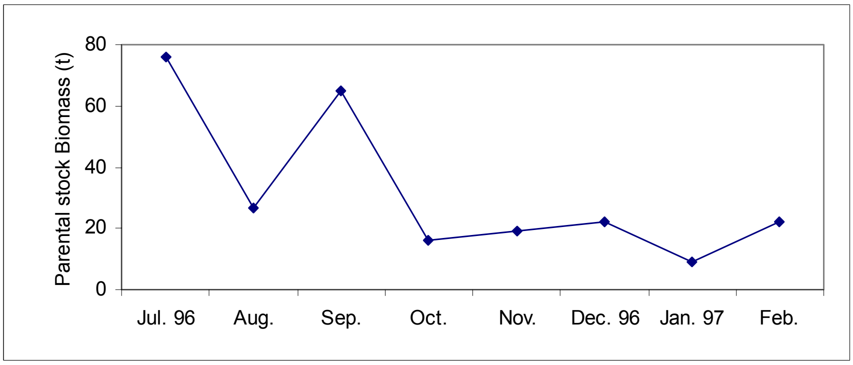

Figure 8: Estimated variation of the parental stock biomass of *P. schmitti* by month, in the Gulf of Paria and northern delta of the Orinoco River

5. DISCUSSION

Large fluctuations in monthly total mortality values were observed, amounting to a 200% variation between the smallest value in September and the largest in February. They could not be correlated to actual variation in fishing effort, but there is a significant positive correlation with the proportion of recruits in the population. It seems that the impact of the fishing gear on the population is greater when there are proportionally more juveniles in the field.

It seems that the recuperation in the shrimp density towards the end of the year is related to a progressive incorporation of recruits to the fishing grounds.

The estimated changes in the biomass of the stock of *P. schmitti* in the region indicate that the period July - October would represent the time of the year where the largest biomass of the parental stock is observed, thus becoming a time of increased potential reproduction. This phenomenon is possibly associated with the fact that 6 months afterwards, towards the beginning of the following year, there is an observable increase in the amount of recruits in the fishing ground. The results of Alió *et al.* (1990), reporting two periods of greater density of postlarvae of *P. schmitti* in the area (Feb.-March and July-Sept.) support this reproductive trend.

The shrimp fisheries in Venezuela have two 1-month closed seasons in the year, as a measure to reduce the trawl effort nation wide. The choosing of the current periods was not necessarily based on biological, but on practical reasons; since the fleet normally stops operating during Christmas time, the setting of a mid year closed season seemed reasonable. Nevertheless, the timing of the seasons could be changed to include periods when the largest amount of recruits is found in the fishing grounds, thus allowing for an increase in the size of the animals and the value of the catch. From the analyses performed herein it appears that the current closed seasons coincide with moments of greater abundance of juveniles in the fishing grounds, so their maintenance is supported. Furthermore, considering that a large number of recruits is still present during February, it is recommended that if the closed season were to be extended, it be done to include February in the current late year season. These recommendations necessarily require a reevaluation when a more complete data base is obtained, which should include information on the exploited population structure during March to June.

Samples of shrimp processed for this study not only did not include the entire year, but sample sizes for some months (July, Sept., and Oct. 96) were very small, so the results obtained for these periods in the present report can only be considered as preliminary. In fact, both the linearized catch curve and length cohort analyses seem to be sensitive to the amount of information on which they are based. It can be observed that abundance of shrimp during the year (Figure 5) shows wider fluctuations during the months when sample sizes are smaller. In spite of these limitations, the working group considered that current limitations could be overcome and it is important to adopt VPA stock assessment algorithms to frame data gathering and more extensive future assessments following similar methods.

As a consequence of the preparation of the information for this workshop, it was found that many industries save the information related to the amount of shrimps processed every month and the resulting number of boxes by commercial category. This valuable information had not been provided to the government, but it is now being requested from the processing plants in order to allow for further population studies of the different penaeid shrimp species in the country.

6 REFERENCES

Alió, J. J.; M. Boada; D. Altuve; L. Briceño; J. Marcano; F. Tineo & L. Granadillo 1990. Disponibilidad de postlarvas de camarones peneidos en la region oriental de Venezuela. Informe final de la Actividad. FONAIAP Sucre, Cumaná.

Alió, J.; D. Die; L. Ferreira; K. Goriesingh; S. Kurivilla; L. Maharaj; L. Marcano; I. Ramnarine & A. Richardson-Drakes, 1997. Evaluation of the binational fishery of *Penaeus subtilis* in the Gulf of Paria and the Columbus Channel. CFRAMP/FAO/DANIDA Stock Assessment Workshop on the shrimp and groundfish fishery on the Guyana - Brazil Shelf, Port of Spain, Trinidad & Tobago, 7 - 18 April, 1997. This volume.

Altuve, D. E. 1997. The artisanal fishery of *Penaeus schmitti* in the northern Gulf of Paria. MSc Thesis. Instituto Oceanográfico de Venezuela, Universidad de Oriente, Cumaná.

Altuve, D. E.; J.J. Alió & L.A. Marcano 1995. Preliminary results on the artisanal fishery of penaeid shrimps in the Northeastern coast of the Gulf of Paria, Venezuela. Third Workshop on the biological and economical modeling of the shrimp and groundfish resources on the Guyana-Brazil Shelf. Paramaribo, Suriname, June, 1992. *FAO Fish. Rep*. No. 526 (Supplem.):128-188.

Cadima, E.; J.J. Ewald; H. Montesinos; W. Diaz; D. Novoa; E. Racca & C. Godoy. (1972). La pesquería de camarones en el occidente de Venezuela. Ministerio de Agricultura, Caracas, Venezuela. Proyecto MAC-PNUD-FAO. Inf. Tec. No. 52, 45 p.

Ehrhardt, N. M. and C. M. Legault, 1996. Crustacean stock assessment techniques incorporating uncertainty. Report of the FAO/CFRAMP Stock Assessment Workshop, Port of Spain, Trinidad & Tobago, 8-12 January, 1996. *FAO Fisheries Report* 544, Supplement 111-131.

Fox, W. W. (1970). An exponential surplus-yield model for optimizing exploited fish populations. *Trans. Am. Fish. Soc.*, 99:80-8.

Giménez, E.; J. Páez & B. Guitart 1980. Relaciones morfométricas de algunos peneidos de la plataforma Guyanesa. In: Jones, A.C. & L, Villegas (eds) 1980. Proceedings of the Workshop Group on shrimp fisheries on the northern South America. Panama City, Panama, 23 – 27 April, 1979. Contributions WECAFC Rep. No. 28 pp:197-214.

Holthuis, L. B. 1980. FAO Species catalogue. Vol. 1. Shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. *FAO Fish. Synopsis* No. 125, Vol. 1:261 p.

Jones, R., 1984. Assessing the effects of changes in exploitation pattern using length composition data (with notes on VPA and cohort analyses). *FAO Fish. Tech. Pap*., (256):118 p.

Lum Young, P.; L. Ferreira & L. Maharaj 1992. Stock assessment parameters for five species of western tropical shrimp. Technical Report of the Project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/UNDP:TRI/91/001/TRI.

Marcano, L., J. J. Alio, and D.E. Altuve, 1996. National Report of Venezuela. Prepared for CFRAMP Shrimp and Groundfish Subproject Specification Workshop and Fourth Meeting of the WECAFC *ad hoc* Shrimp and Groundfish Working Group on the Guyana-Brazil Continental Shelf. Port of Spain, Trinidad and Tobago, 8-12 January, 1996. *FAO Fisheries Report* No. 544. Supplement. 96-110.

Marcano, L.; J. J. Alio & D. E. Altuve, 1997. National Report of Venezuela, with data to 1996. Prepared for CFRAMP/FAO/DANIDA Stock Assessment Workshop on the Shrimp and Groundfish Fishery on the Guyana - Brazil Shelf. Port of Spain, Trinidad and Tobago, 7-18 April, 1997. *FAO Fisheries Report*. (600):This volume.

Pérez, A.; G. Venta & R. Puga 1980. Crecimiento del camarón rosado, *Penaeus notialis* y el camarón blanco, *Penaeus schmitti* en la ensenada de La Broa, Cuba. *Rev. Cub. Inv. Pesq.* 5(1):66-83.

Pérez-Farfante, I. 1969. Western Atlantic shrimp of the genus *Penaeus*. U.S. Fish and Wildlife Service, Washington (USA). *US. Fish Widl. Ser. Fish. Bull.* 67(3):489-493.

Sparre, P. & S. C. Venema 1995. Introducción a la evaluación de recursos pesqueros tropicales. Parte 1. Manual. *FAO Doc. Tec. Pesca* 306.1. Rev. 1. Roma, 420 p.

Trinidad and Tobago Fisheries Division (1996). The shrimp and groundfish fishery of Trinidad and Tobago. National Report. Prepared for CFRAMP Shrimp and Groundfish Subproject Specification Workshop and Fourth Meeting of the WECAFC *ad hoc* Shrimp and Groundfish Working Group on the Guyana-Brazil Continental Shelf. Port of Spain, Trinidad and Tobago, 8-12 January, 1996. *FAO Fisheries Report* No. 544. Supplement.