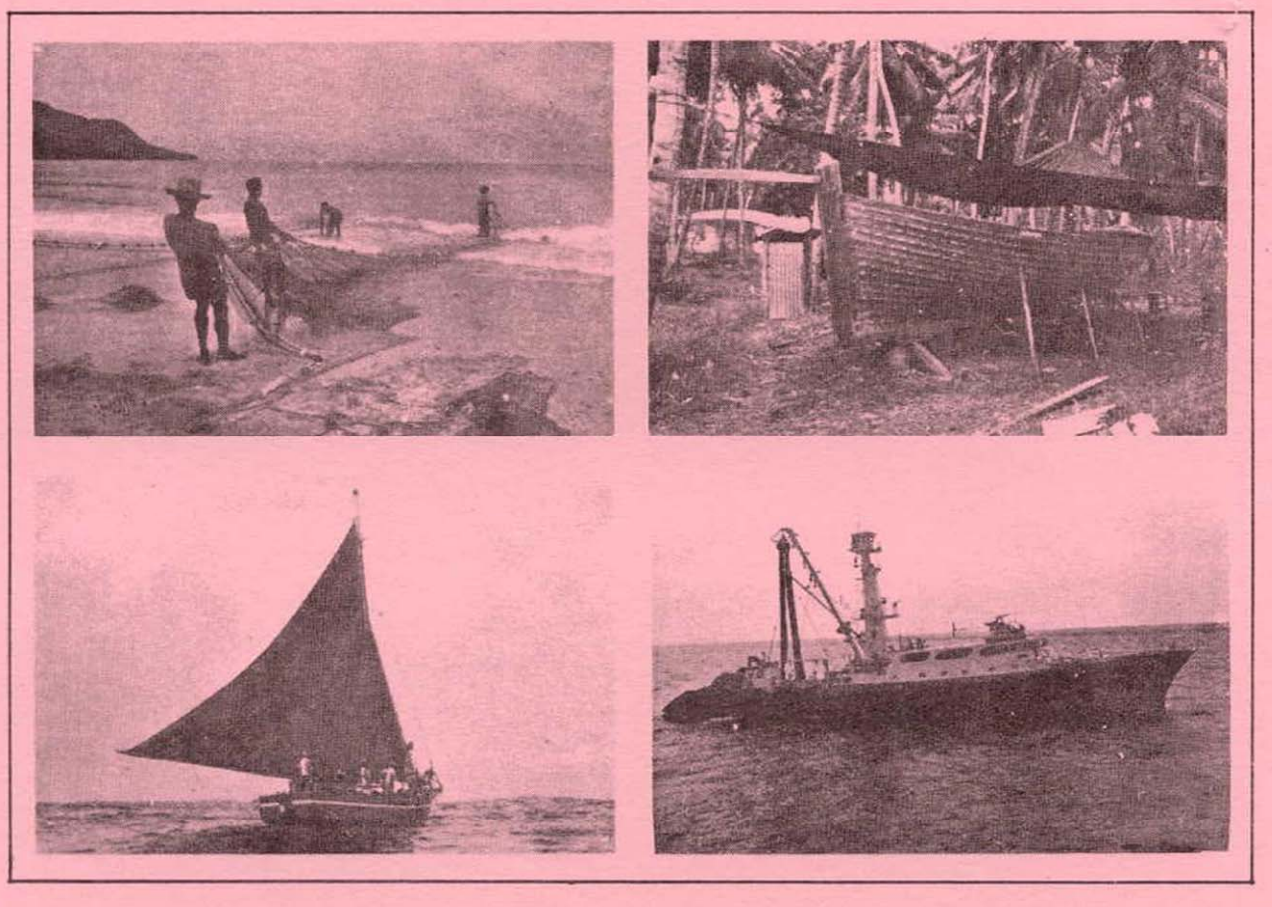
SEYCHELLES FISHING AUTHORITY

TECHNICAL REPORT

SEYCHELLES KRAB ZIRAF (Ranina ranina) FISHERY: THE STATUS OF THE STOCK



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SFA/R&D/030

SEYCHELLES KRAB ZIRAF (*Ranina ranina*) FISHERY: THE STATUS OF THE STOCK

D. P. BOULLÉ

(1995)

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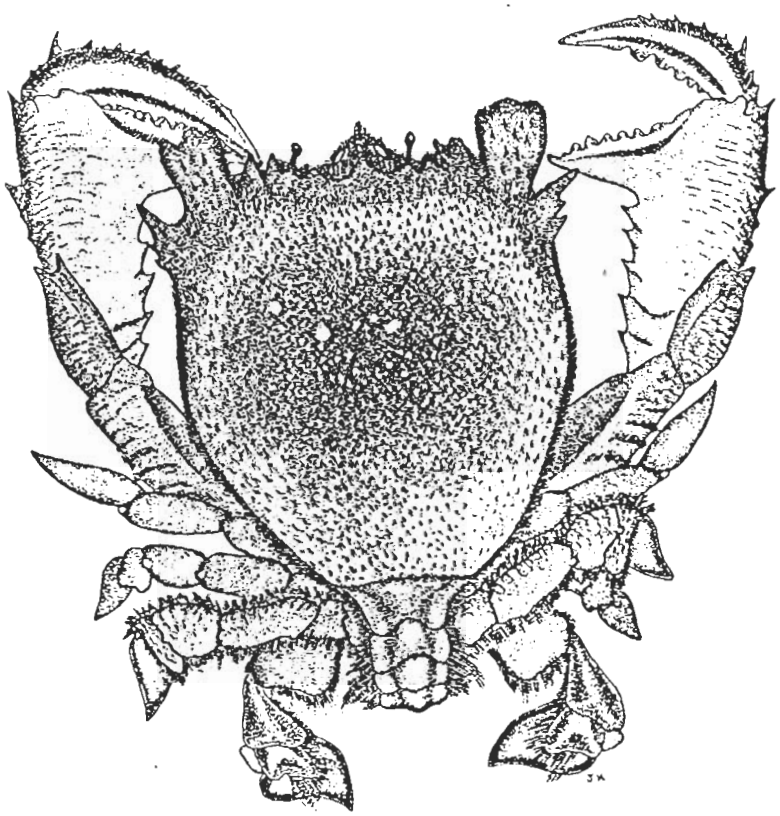

Ranina ranina (Linnaeus)

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ACKNOWLEDGMENTS

I would like to thank firstly the crew of the Seychelles Fishing Authority research vessel *Etelis* who persevered during the research stock prospection cruises. Secondly I wish to thank the SFA Research Technicians who were responsible for the basic data collection for this resource survey.
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Finally I would like to thank Mrs. J. Confait and Mr. R. Azemia for their help in the production of this report

David Boullé
20/04/1995

ABSTRACT

The local commonly used kreol name for *Ranina ranina* is krab ziraf.
The krab ziraf fishery in Seychelles started functioning as a commercial fishery in 1986 when the resource was identified as potentially viable. Prior to this time these crab stocks were unexploited. In keeping with the Seychelles Fishing Authority (SFA) policy of monitoring catch and effort in new fisheries a research programme was implemented to assess the state of the Seychelles Stock and determine the viability of the fishery as a whole.

The objective of this report is to provide an indication of the state of the crab stock at the present fishing levels and give estimates of the standing stock biomass and the potential yield of the fishery.

The biomass estimates give a range of between 2460 tonnes and 4486 tonnes for the Mahé plateau. For the calculations of the potential yield these figures were used to derive MSY estimates. The MSY estimates range between 381.36 tonnes and 695.44 tonnes taken as the most conservatively calculated estimates.

Given that only an approximate 30 tonnes of krab ziraf are caught per annum the MSY estimates would suggest that the stocks has the potential to be more intensively exploited.

THE SEYCHELLES KRAB ZIRAF (*Ranina ranina*) FISHERY

INTRODUCTION

1. Historical Overview

Prior to 1974 krab ziraf (*Ranina ranina*) was unknown as a fishery resource in Seychelles. It was during the preliminary fishing investigations of 1973-1976 off the west coast of Mahé conducted by Mr. C. Ratcliffe (1976) a fisheries advisor in 1976 attached to the then Seychelles Fisheries Division. Experimental fishing trials were conducted using, amongst other gear types, bottom set gillnets and trammel (tangle) nets. It was by using these two gear types that resulted in the subsequent discovery and bycatch of 44 kilograms of krab ziraf.

No further stock prospection for krab ziraf was carried out until 1984 when a comprehensive programme of prospection on the Mahé and Amirantes plateaus was initiated. This programme was started by two expatriate biologists, G. De Moussac and M. de San, attached to the Seychelles Fishing Authority (SFA) under the EEC Technical Assistance Programme. This programme also heralded the beginning of commercial exploitation of this fishery by a local fisherman Mr. Maxime Michel who worked hand in hand with the biologists.

This programme was established to determine the CPUE and biological parameters of the potential krab ziraf fishery on the Mahé plateau as well as investigate potential fishing locations. The fishing gear type used was hoop tangle nets (locally known as kalé) strung along a tripline and baited. The gear in use was adopted from the Mauritian fishery for these crabs. This method has proved to be the most successful and is still in use today. At the culmination of the project 9.4 tons of crab had been caught and the results prompted the entry into the fishery of two commercial vessels. Proposals were also submitted for further stock prospection, a more comprehensive stock assessment programme and for the catches to be monitored.
At the culmination of this programme the technology was passed on to Mr. Michel who, with technical assistance from SFA, continued to pursued the krab ziraf fishery on a commercial scale.

In 1989 the Seychelles Fishing Authority (SFA) re-implemented the krab ziraf programme conducting stock prospection from the *R/V Etelis*. This data collection programme was run for approximately three years. During this time one of the commercial vessels dropped out of the fishery due to economic constraints. At present (Dec. 1994) there is only one vessel operating in the crab ziraf fishery, the *F/V St. Michel*. The Seychelles Marketing Board (SMB) Fish Division has been the major retailing organization for the local sale and exportation of krab ziraf and to a certain extent controls the fishery in that it requests a certain amount to be landed per month. With the establishment of private fishery product entrepreneurs the demand for krab ziraf may rise as new international markets are explored.

The catch of krab ziraf in Seychelles over the last two years has been approximately 30 tons per annum. This figure of 30 tons is only a reflection of the present, mostly local, market requirements.

2. Fishing Methodology

Krab ziraf (spanner crab - Australia; kona crab - Hawaii; crabe girafe - Reunion) are commonly caught using tangle or trammel nets however they are noted as a small bycatch of bottom set gillnets in Seychelles. The tangle nets are constructed of a double layer of 3 - 5cm stretched mesh multi- or monofilament nylon netting. The netting is stretched over a metal hoop (approx. 1m in diameter) and a trip line is attached to the hoop leading to the main line. In normal fishing conditions between 200 to 300 hoop nets are attached to the main line, the main line is held on the surface by a flagged marker buoy and held in place on the seabed by two anchor systems (Fig. 1).

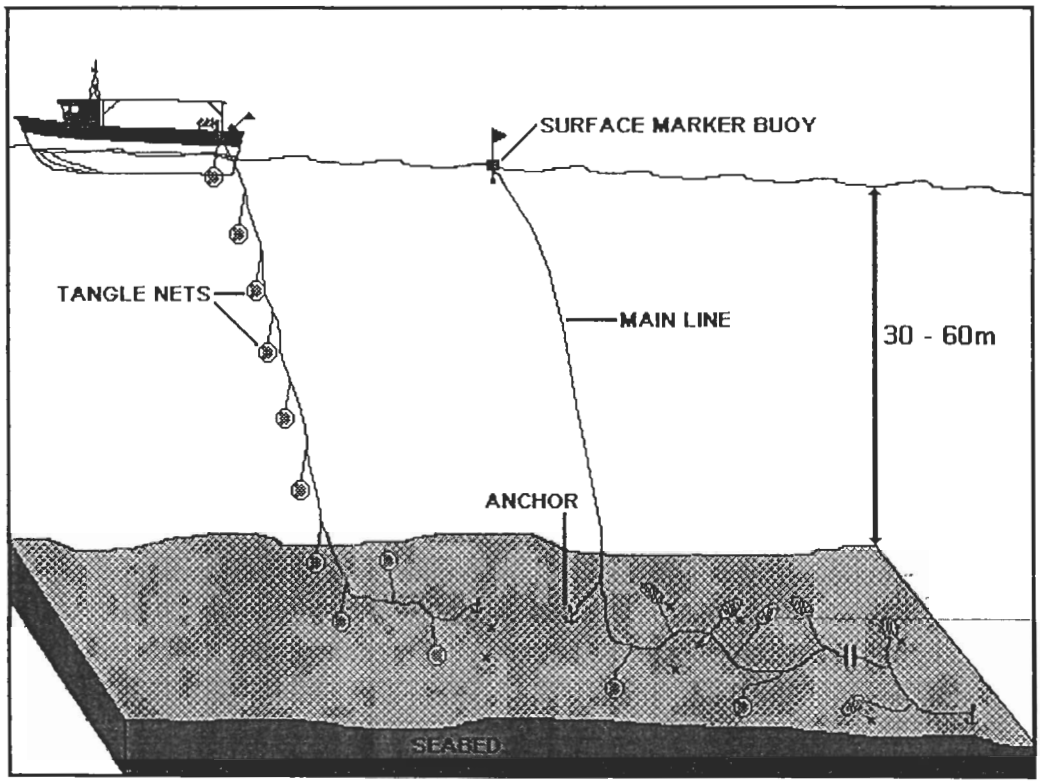


Figure 1. Diagrammatic representation of the current fishing method for krab ziraf.

The hoop nets are evenly spaced at 3 - 4m along the length of the main line and baited prior to setting. The fishing vessel will generally hold 3 - 5 sets of this type of fishing gear on board. When an appropriate type of fishing ground is found the first set will be shot followed by the rest of the sets. Usually, once the last rig has been shot, the fishing vessel will return to the first rig and commence hauling. Fishing only occurs during the daylight hours, however night fishing has been attempted, however no catch was recorded (M. Michel, pers. comm.). Crab fishing also seems to be the most productive during the new moon period this is in keeping with catch observations made in the Australian crab fishery.

The crabs, once brought to the surface, are carefully untangled and stored on ice. Although no regulations are as yet in place for the krab ziraf fishery it is generally accepted by the fishers that all crabs less than 7cm carapace length (7cm is the smallest acceptable market size) and berried females are returned.

3. Fishing Grounds and Crab Distribution

In Seychelles krab ziraf is found only on the Mahé plateau, research cruises to the Amirantes group have not revealed the presence of any crabs. Stock prospection cruises were undertaken by the SFA Research Section between 1990 and 1992 on board *R/V Etelis* (Fig. 2). These were planned in such a way so as to cover as much of the plateau area as possible. The cruises mostly took place during the inter- and North-West monsoon seasons (October to April) during which time fishing conditions are more favourable. This period is also representative of the actual period of the fishery itself.

From this information as well as information received from local fishers the approximate extent of the krab ziraf distribution pattern for the Mahé plateau has been determined (Fig. 3). The distribution pattern has been refined further by taking into account catch rates per tangle net from research stock prospection as well as commercial catches (Fig. 4).

In Seychelles it is recognized that krab ziraf are found to inhabit relatively flat predominantly sandy seabed areas interspersed with coral and seagrasses at depths of between 30m to 70m. Areas that fit this description are fairly extensive on the Mahé plateau and the potential exploitable seabed area for krab ziraf is estimated (Table 1) using a planimeter to be approximately 17332 km^2 compared with the total fishable area of the Mahé plateau of 26500 km^2 (Mees, 1992).

SECTOR	CATCH RATE (NUMBER OF CRABS PER TANGLE NET)	FISHABLE AREA (SQ. KM)
A	20 - 30	4108 km^2
B	10 - 20	1961 km^2
C	5 - 10	5512 km^2
D	0 - 5	5751 km^2
TOTAL FISHABLE AREA		17332 km^2

Table 1. Area of the krab ziraf fishing grounds on the Mahé plateau (from Fig. 4)

The distribution pattern of crab stock density tends to increase southwards along the Mahé plateau. An outline of predominant oceanographic conditions over the Mahé plateau can be seen in Table 2.
Given that *Ranina ranina* are relatively sedentary animals in that they do not tend to forage very far from their burrows, the predominant currents over the plateau (southerly) may explain the distribution to some extent as crab larvae dispersion would be directly influenced by the currents.

Table 2. A Summary of Oceanographic Conditions over the Mahé Plateau (adapted from Mees, 1992)

DETAILS	OCTOBER	NOVEMBER	DECEMBER	MARCH	APRIL	JULY	AUG-SEP
CLIMATE	End of the SE Trade Winds.	NW Monsoon Begins.	NW Monsoon.	End of NW Monsoon.	Inter- monsoon period.	SE Trade Winds begin.	SE Trade Winds.
SEA SURFACE CURRENT	North to eastwards over the surface of the plateau.	Predominantly eastwards, but northern flowing components over S of plateau.	Easterly counter - current in N, NW monsoon pushes counter current southward in S of plateau.	Predominantly E and SE.	Plateau washed by Eastward equatorial counter current. Clockwise circulation occurs SE of plateau.	Southerly, modified to SE/SW by the edges of the plateau. A localised circulation in S of plateau.	The southerly current now swings to the East. Flowing from SE.
UPWELLING / NUTRIENTS	In S and SE nutrient rich water is carried by counter current from intensive upwelling S of plateau.	Continues along S and SE edges of plateau. Algal blooms occur.	Nothing special reported.	Nothing special reported.	Upwelling associated with circulation in SE occurs. Enriched water is carried over the S surface of the plateau.	Cold water with low oxygen levels leaks over S edge of plateau.	Upwelling occurs along S and SE edges of the plateau.
THERMOCLINE	20m - 30m. A cold water dome occurs S of plateau.	Over plateau between 18-27m.	~ 30 - 40m weak temperature gradient.	No definite thermocline.	~ 40m still a weak gradient.	Well defined thermocline at 75-100m N and E of plateau and <35m S and W.	Thermocline stabilises at 35-40m.
SURFACE TEMPERATURE	26 - 28^{o}C	26 - 28^{o}C	27 - 28^{o}C	28.5 - 31^{o}C	29 - 31^{o}C	26^{o}C	25^{o}C
TEMPERATURE AVERAGE AT 30m - 70m	24^{o}C	24^{o}C	24^{o}C	26.3^{o}C	~27^{o}C	24.1^{o}C	24^{o}C

Figure 2. Stock prospection cruises by *R/V Etelis* on the Mahé plateau for crab girafe (1990 - 1992)

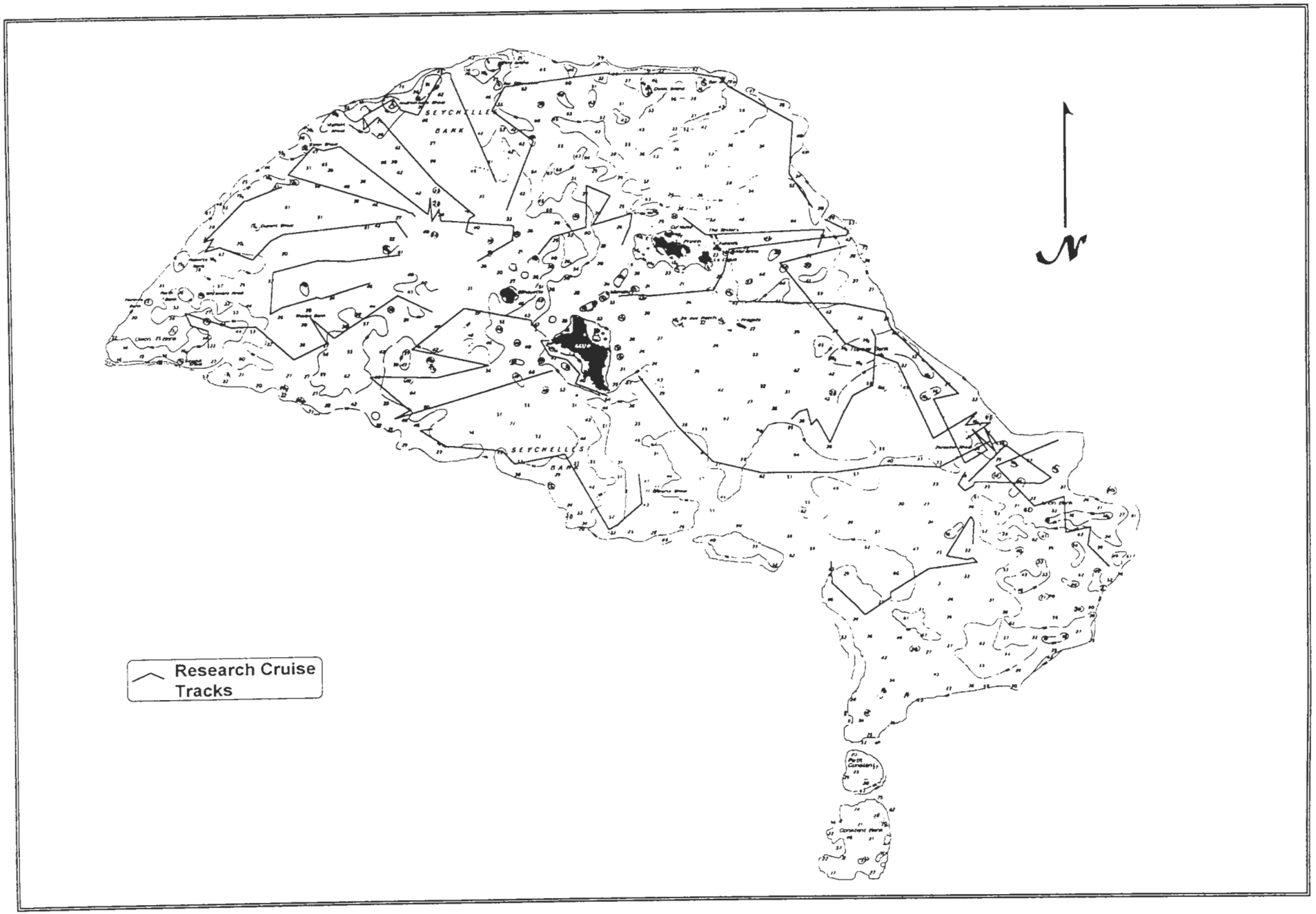


Figure 3. Approximate distribution of Krab Girafe on the Mahé plateau.

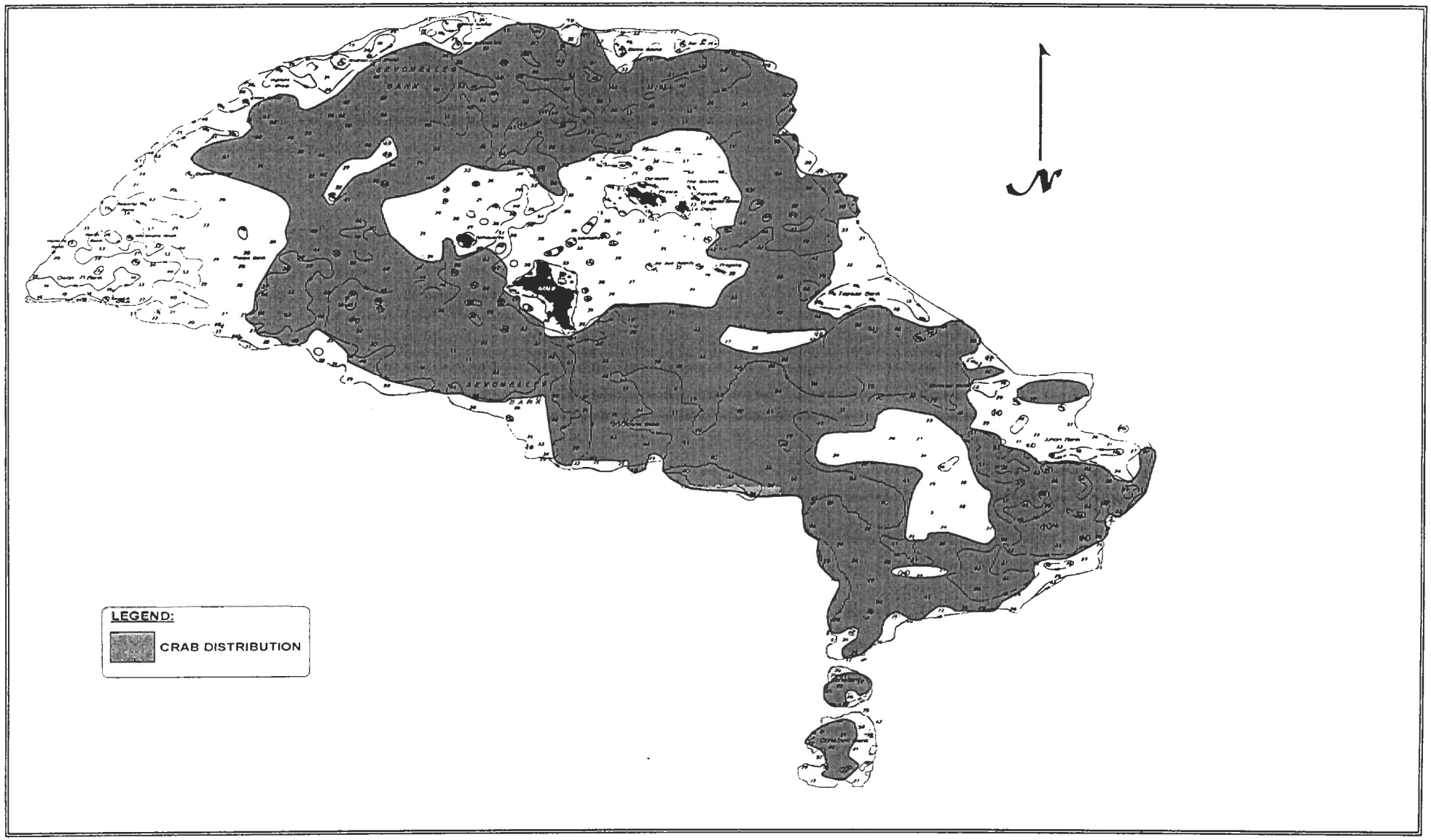
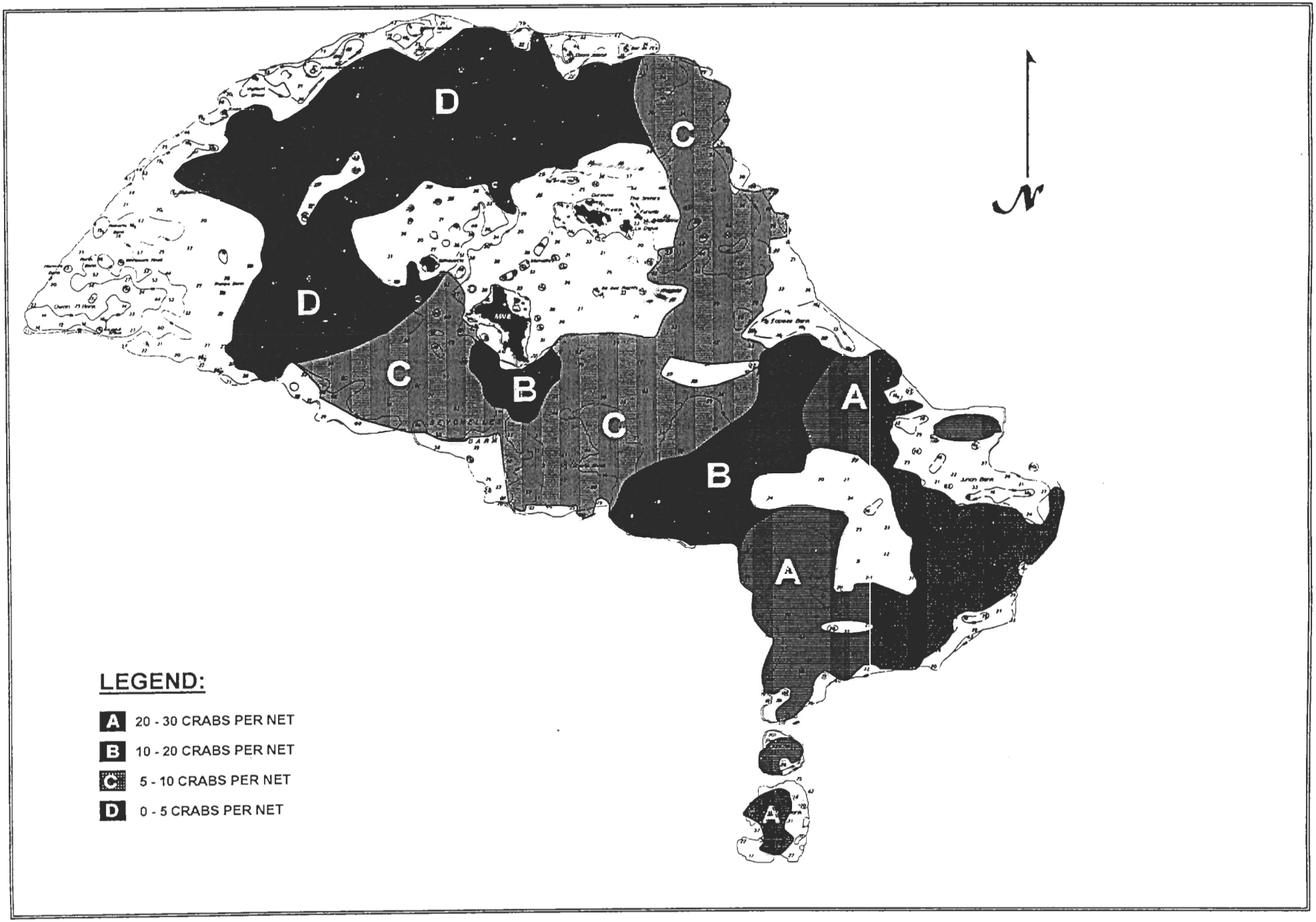


Figure 4. Distribution of crab girafe on the Mahé plateau relating to catch rates



CRAB BIOLOGY

In order to gather information on the biology of *Ranina ranina* in Seychelles waters, crabs caught during the research cruises were measured and weighed. In addition to this information was gathered on substrate type, crab density (by site in terms of crabs per net), specific oceanographic conditions and time of capture.
Crabs were sampled from the research cruise catches, the numbers sampled equal 2101 crabs, the landed number of crabs equals 2683 which represents 78.3 percent of the catch sampled by measuring carapace length (CL) for length frequency analysis. A total of 722 crabs were sampled randomly for the length weight and stock assessment analysis.

Data was analysed using Quatro Pro ver. 5.0, Statgraphics ver. 5.0, Marine Resource Assessment Group (MRAG) software packages - LFDA (Length Frequency Distribution Analysis) and CEDA (Catch and Effort Data Analysis).

RESULTS

1. Habitat

During the research cruises information was gained regarding the substrate types from various location where krab ziraf were found. The substrate sampling was done using various dredges including an Eckmann dredge and a small mollusc dredge. Any substrate material, plants or animals caught in the tangle nets were also noted. Table 3 shows the divisions of substrate type, the depths at which they were encountered and the percentage of the krab ziraf catch by substrate type.

SUBSTRATE TYPE	DEPTH RANGE (m)	PERCENTAGE CATCH
SAND	34 - 48	9.3
SEA GRASS	34 - 48	13.7
SAND + SEA GRASS	34 - 48	20.2
CORAL RUBBLE	32 - 50	1.3
CORAL + SAND	32 - 48	23.8
CORAL	32 - 48	31.7

Table 3. Krab ziraf substrate type association on the Mahé plateau

From Australian surveys (Brown, 1986. Skinner and Hill, 1986) krab ziraf are known to prefer bare sandy areas, however in Seychelles the crabs have a tendency towards sandy areas associated with other substrate types such as corals and seagrass beds. Given that the crabs' preferred diet is one of urchins (Echinoidea) and small bivalve molluscs (Atlas Aus. Fish. Res. 1993), it is more likely that the prey will be encountered in areas other than bare sand.

Krab ziraf are mostly encountered between depths of 30 - 70 metres but have been found in the intertidal zone as well as at depths greater than 100 metres.

2. Reproduction

2.1. Females with Eggs

Table 4 represents all (12) gravid female crabs caught during the research cruises. No gravid females are landed by the commercial fishing vessels as it is a common practice to return the gravid females to the sea by the fishers.

SEX	LENGTH (mm)	WEIGHT (kgs)
FE	65	0.16
FE	72	0.17
FE	84	0.25
FE	86	0.27
FE	90	0.3
FE	91	0.3
FE	94	0.35
FE	100.4	0.36
FE	100.4	0.36
FE	100.4	0.38
FE	106	0.5
FE	115	0.56

Table 4. Female crabs collected with eggs.

From the table the smallest gravid female was 65 mm carapace length (CL), the largest 115 mm CL.
All of the berried females were caught between the months of November and February. Moussac (1987) suggests a main breeding period between December and January. The catch results indicate that this period should be extended from November to February.
The possible reason behind such a low catch rate of berried females is that the females will tend to bury themselves for long periods to incubate and protect the eggs (Brown, 1986). Large female krab ziraf (>90cm CL) are known to produce at least two broods per season and the eggs will remain attached to the female for 4 - 5 weeks before hatching (Aus. Fish. Res. 1993).

2.1. Sex Ratio

From the catches made during the research cruises 413 males and 317 females were sampled, which was representative of the various catches made. This represents a sex ratio of **1.3:1.0** males to females.

Annex 1a,b and c shows the sample groups of males, females and females with eggs.

3. Length and Weight Frequency Distribution

Data from Annexes 1a, b and c was used to determine length frequency distributions for krab ziraf (Figures 5 and 6) as well as length relationships for all crabs, males and females in total (Figures 7and 9) and by year (Figures 8 and 10) respectively.

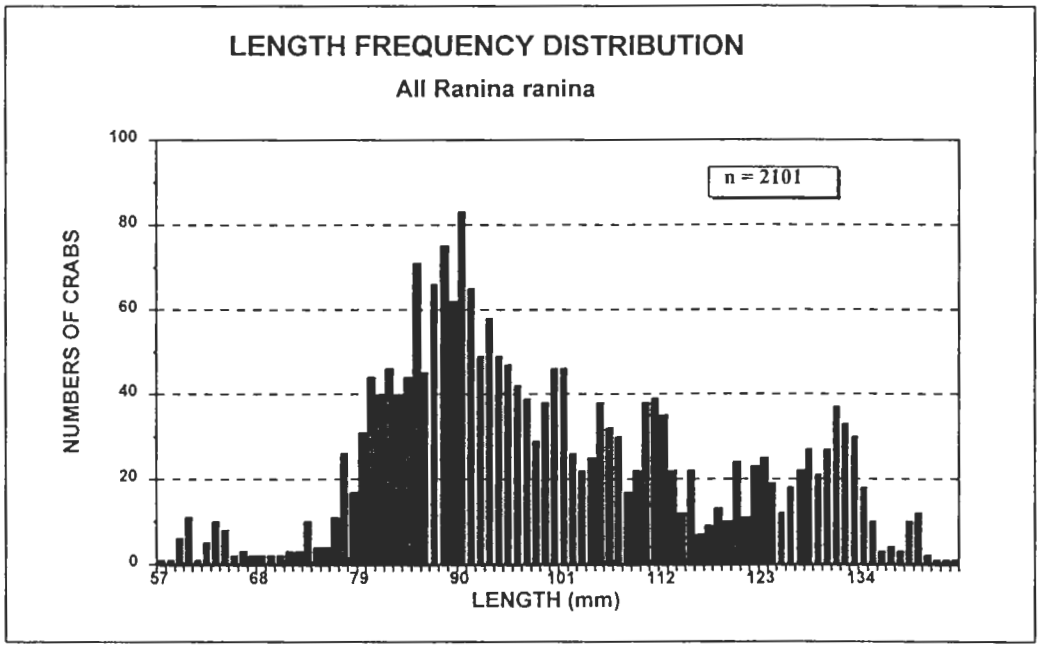


Figure 5. Length frequency distribution for all krab ziraf.

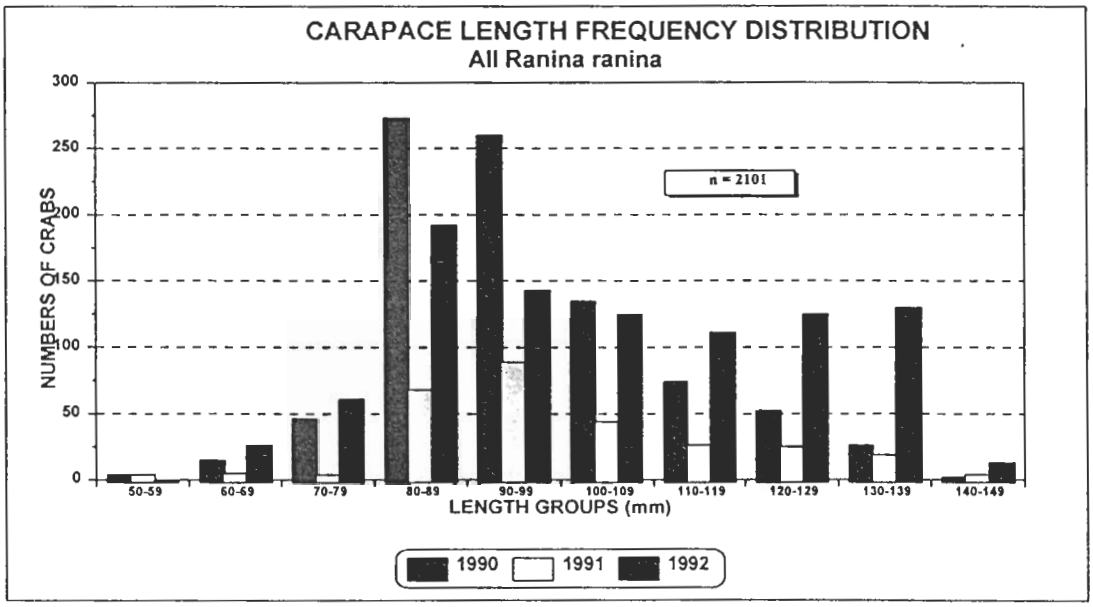


Figure 6. Length frequency distribution for all krab ziraf by year.

Figures 5 and 6 show the length frequency distributions for all Krab ziraf for all years

sampled (1990 - 1992) and by year respectively. For the <u>total</u> sample CL_{min} = 57.0 mm; CL_{max} = 144.6 mm. The mean carapace length for all crabs was 102.1mm.

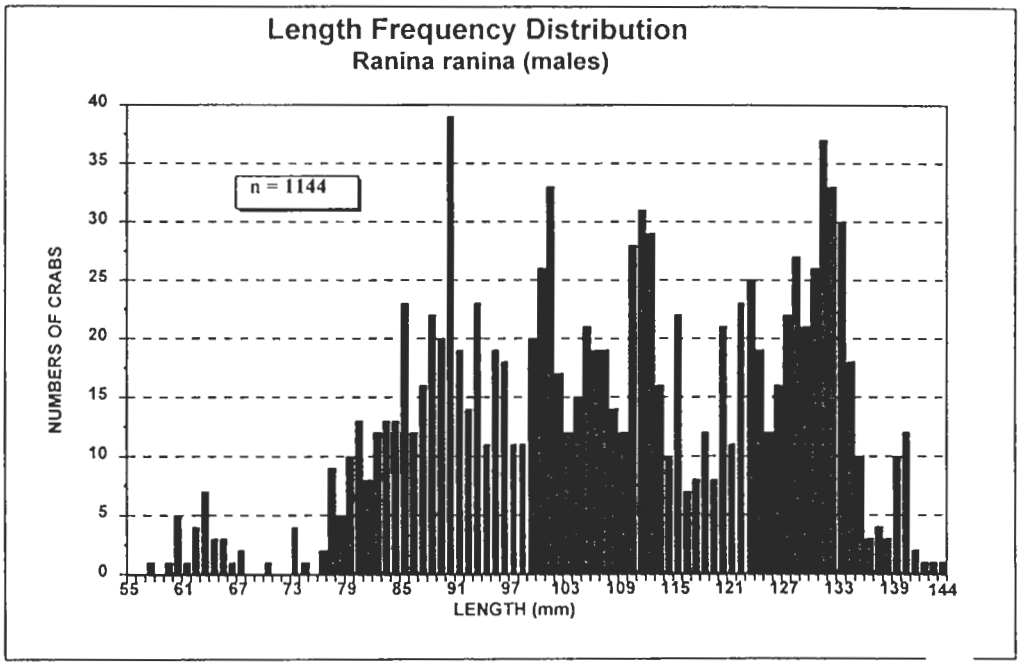


Figure 7. Length frequency distribution for all krab ziraf males.

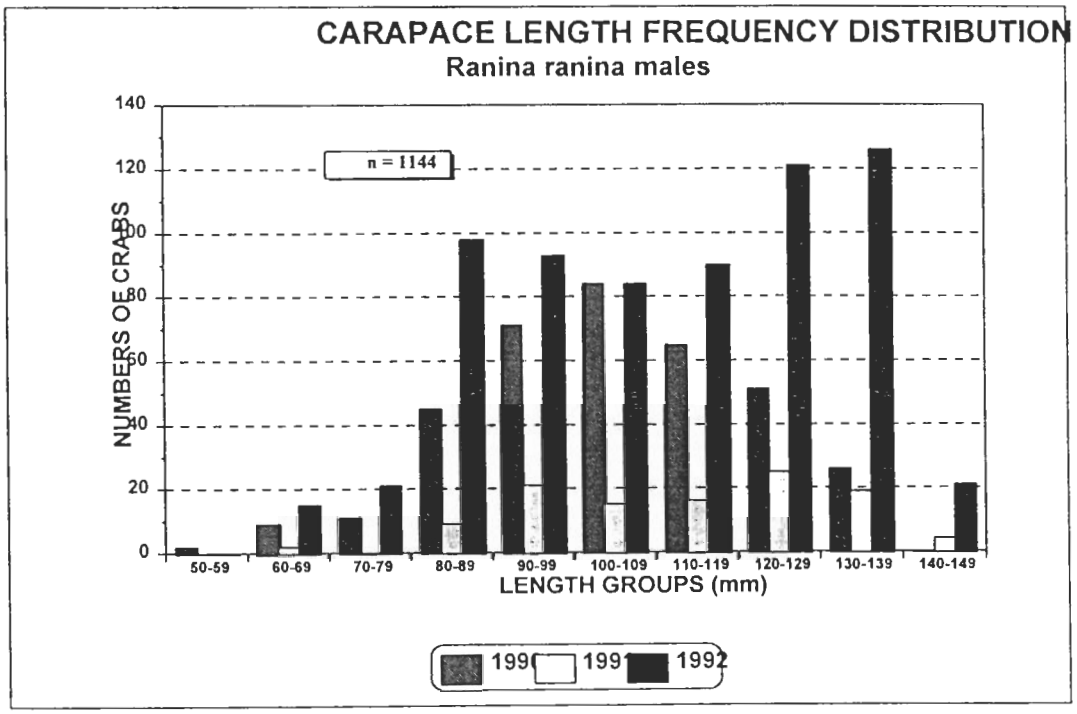


Figure 8. Length frequency distribution for all krab ziraf males by year.

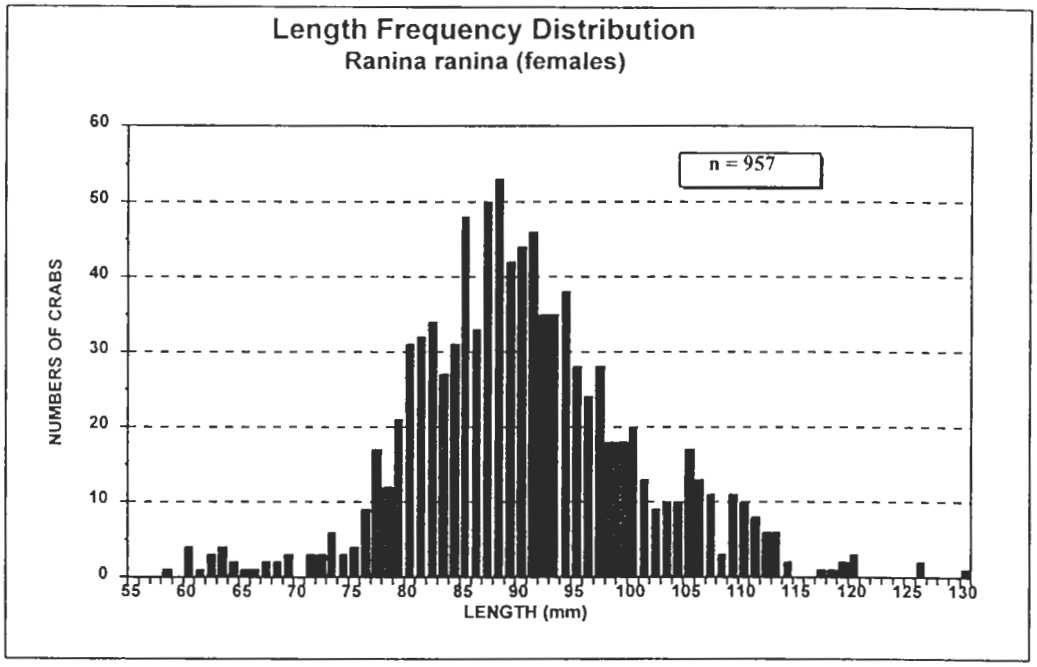


Figure 9. Length frequency distribution for all krab ziraf females.

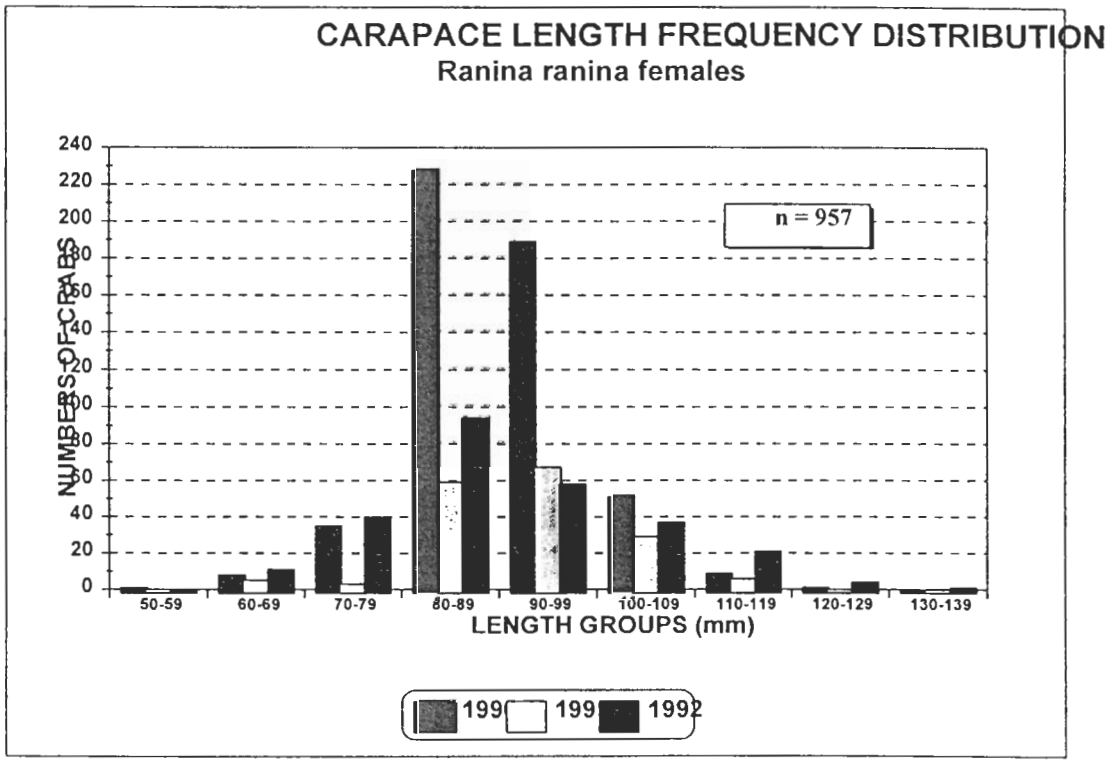


Figure 10. Length frequency distribution for all krab ziraf females by year.

Figures 7 and 9 show the length frequency distributions for krab ziraf males and females, respectively, for all years sampled (1990 - 1992). Figures 8 and 10 show length frequency distributions by year respectively.

For the male sample CL_{min} = 57.0 mm; CL_{max} = 144.6 mm. The mean carapace length for male crabs was 111.2mm.
For the female sample CL_{min} = 60.1 mm; CL_{max} = 130.6 mm. The mean carapace length for female crabs was 93.6mm.

The samples of males and females are significantly different (Kolmogorov-Smirnov two-sample test, DN = 0.50072). This can largely be explained as a factor of catchability i.e. more male crabs are caught when the females are gravid as the females tend to remain in their burrows when carrying eggs. It can also be hypothesized that the larger overall size of captured males may be a result of the tendency of males to generally grow larger than females and possibly the large males may exclude (dominate the trap) other crabs from feeding in the same area.

Data from Annexes 2a, b and c was used to determine length-weight relationship distributions for all crabs and males and females (Figures 11, 12 and 13) respectively.

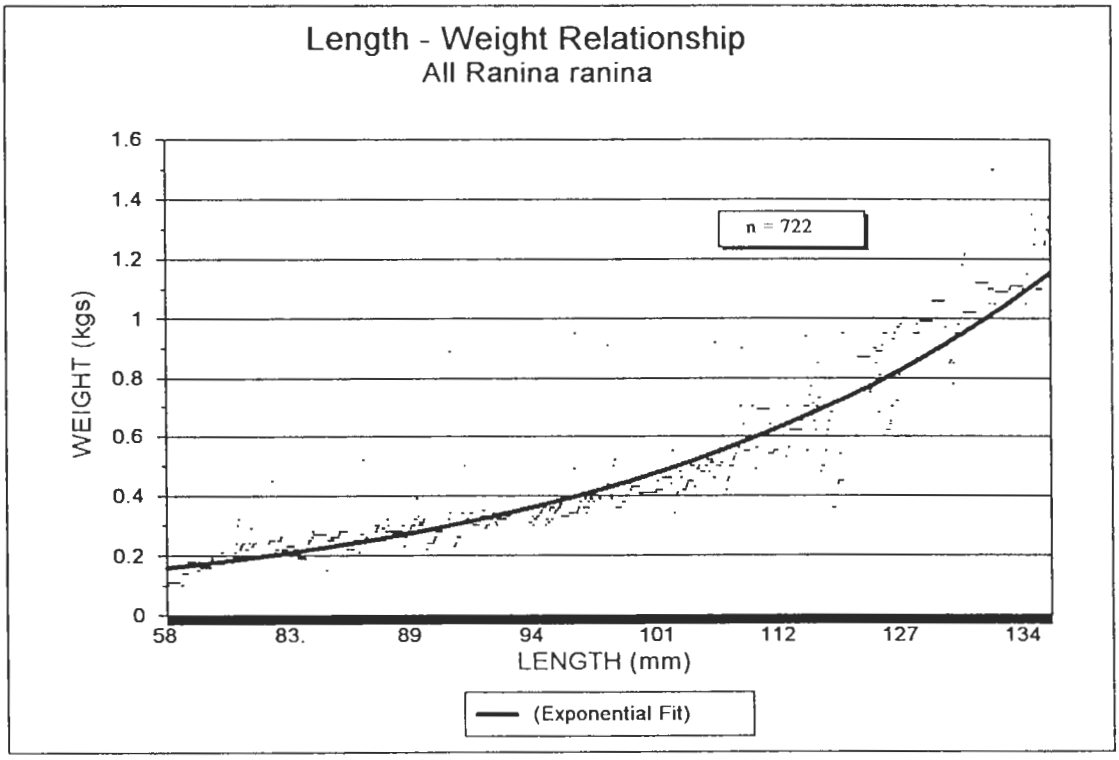


Figure 11. Length weight curve for all krab ziraf.

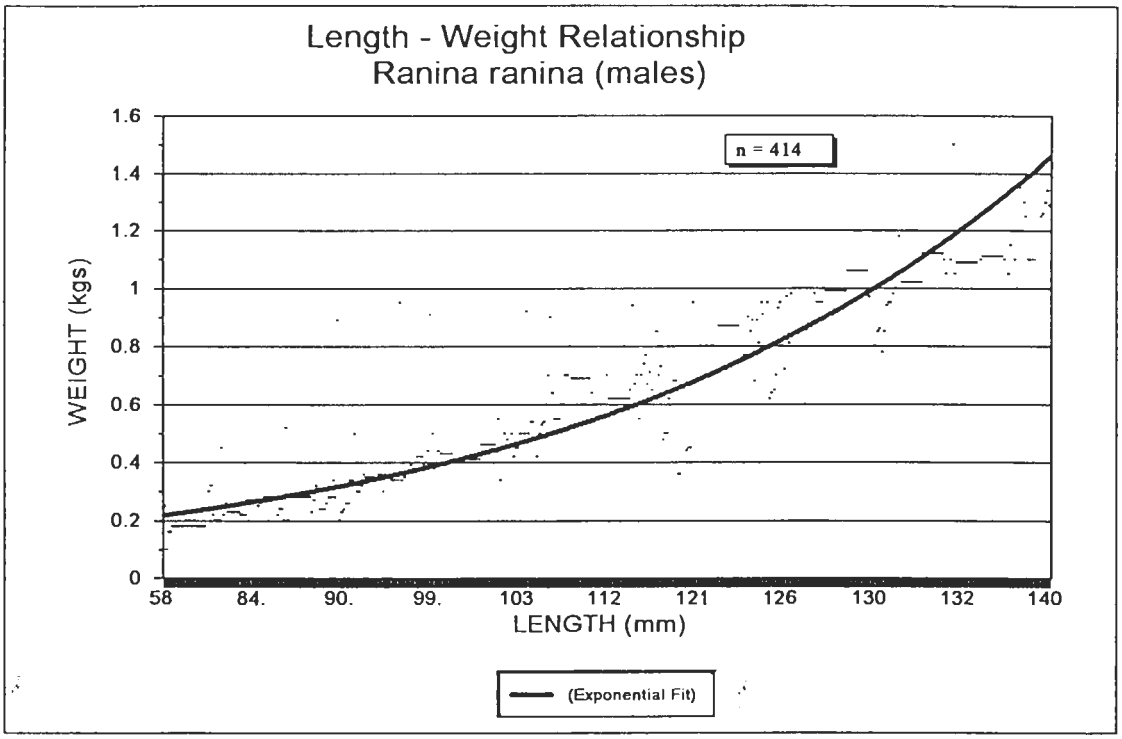


Figure 12. Length weight curve for krab ziraf males.

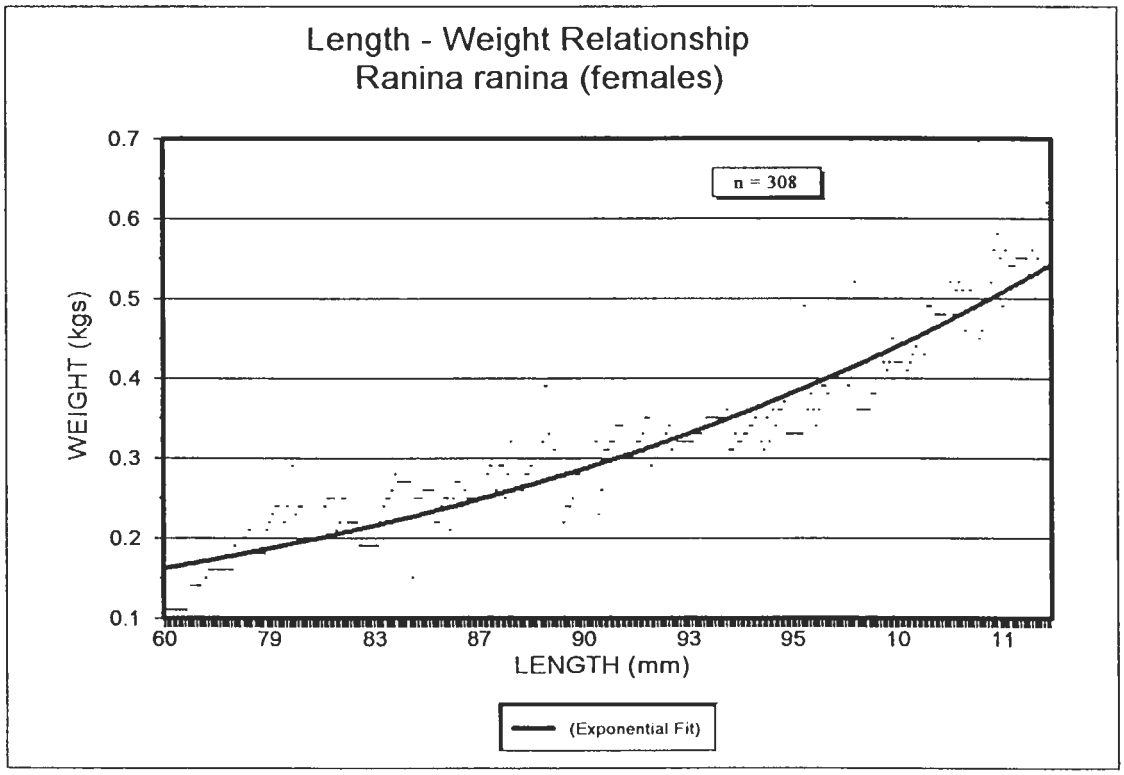


Figure 13. Length weight curve for krab ziraf females.

For the total sample $WEIGHT_{min}$ = 0.10 kgs; $WEIGHT_{max}$ = 1.34 kgs. The mean weight for all crabs was 0.51 kgs.
For the male sample $WEIGHT_{min}$ = 0.10 kgs; $WEIGHT_{max}$ = 1.34 kgs. The mean weight for male crabs was 0.66 kgs.
For the female sample $WEIGHT_{min}$ = 0.10 kgs; $WEIGHT_{max}$ = 0.80 kgs. The mean weight for female crabs was 0.32 kgs.

The relationships of length to weight as given by lines of exponential regression are as follows, for:-

Fig. 11 (all crabs) - $\ln y = -3.88 + 0.029x$, $r^2 = 93.0\%$;

Fig. 12 (males) - $\ln y = -3.70 + 0.028x$, $r^2 = 90.4\%$;

Fig. 13 (females) - $\ln y = -3.94 + 0.03x$, $r^2 = 91.8\%$.

4. Population Dynamics

Recent (1990-1992) data was analysed using LFDA to determine K, L_∞, t_o population parameters. LFDA also provides a module for estimating Z from the estimates of K and L_∞ and the first 100% exploited length as input parameters. The first 100% exploited level was taken to be 112 mm.
This data was also compared to similar estimates derived by de Moussac (1987) using the NORMSEP program developed by Hasselblad (Pauly, et.al. 1986).
Table 5 shows a comparison of the parameters derived by Moussac and this study. Moussac's data was also entered into the LFDA program for a comparison of the two methods.

	NUMBER OF OBSERVATIONS	L_∞	K (per year)	t_o	SCORE *
LFDA - this report *ALL CRABS*	2101	145.34	0.545	-0.36	0.3694
NORMSEP - Moussac (1987) *MALES*	39	151.00	0.3	0.35	N/A
FEMALES	53	134.00	0.14	0.42	N/A
LFDA - Moussac data *ALL CRABS*	5782	141.22	0.578	-0.58	0.3189

Table 5. Estimations and comparisons of derived von Bertalanffy growth parameters for *Ranina ranina* in Seychelles.

where:- L_∞ = mean length of the oldest crabs.
K = growth rate.
t_0 = time at which length of crabs equals 0.

* SCORE - this denotes the value of the maximised "score function" derived from the von Bertalanffy growth parameters i.e. a measure of the goodness of fit. Taken between 0 and 1, where 0 = poorest fit and 1 = best fit.

Annex 3 shows the combined data from Moussac (1987) which was used to derive the parameters in Table 5.

From the data, the parameters derived using the LFDA programme gave similar results for both this reports data set and that of Moussac's. The parameters derived by Moussac using the NORMSEP programme are different, however it gives a more conceivable value for the L_∞ for male crabs than when analysed using LFDA.

5. Standing Stock Biomass

Table 6 shows the potential exploitable weights for the areas of the fishable sectors[1] on the Mahé plateau for krab ziraf. The columns "weight min.", "wt. avg." and "wt. max." indicate the minimum, mean and maximum weights in grams of crabs caught by sector per tangle net or kale.

Sector	weight min. (g)	weight mean (g)	weight max. (g)
A	10.20	12.75	15.3
B	5.10	7.65	10.2
C	2.55	3.83	5.10
D	0.51	1.28	2.55

Table 6. Potential exploitable weights per tangle net by sectors on the Mahé plateau.

Table 7 shows the estimations of the areas of the fishable sectors on the Mahé plateau for krab ziraf. The column "net area" indicates the area (m^2) potentially exploited by a single tangle net i.e. the area around the tangle net in which a crab is most likely to be attracted to that baited tangle net.

[1] For the sector areas and locations see Table 1 and Figure 4.

The ranges for the column "net area" (10m; 16m; 25m; 28m) are derived by estimating the length of the main rig line of the set and the number of traps attached (see Fig. 1). The variation of the rigs gives the selected ranges. The ranges are determined by the proximity of one tangle net to its nieghbour i.e. where there are a lot of nets set on a rig line the individual net catch range will be small ($10m^2$).

net area (m^2)	Sector Area (m^2)			
	A	B	C	D
10m	410800000	196100000	551200000	575100000
16m	256750000	122562500	344500000	359437500
25m	164320000	78440000	220480000	230040000
28m	146714286	70035714	196857143	205392857

Table 7. Estimations of the areas of the fishable sectors on the Mahé plateau by net catch range.

The following formula for the calculation of fishable area was used:

- for example; Sector A = 4 108 km^2

x 1 000 000 = 4 108 000 000 m2

$$\frac{\text{Area A}}{\text{net area } (m^2)} = \text{fishable area}$$

$$\frac{4\ 108\ 000\ 000\ m^2}{28\ m^2} = 146\ 714\ 286\ m^2 \text{ fishable area A}$$

Table 8 shows the biomass estimates for each sector. These figures were derived by using the "net area" value of 28m from Table 7 and multiplying this by the corresponding "weight min.", "wt. avg." and "wt. max." values for each sector. The value of 28m was chosen as the net catch range as it is the most likely combination given the structure of the rigs set for fishing. The figures in Table 8 indicate the range of estimated biomass of krab ziraf by sector and the biomass of the Mahé plateau as a whole in tonnes.

BIOMASS EST. FOR SECTOR A		BIOMASS EST. FOR SECTOR C		
WT. MIN.	1496.49t	WT. MIN.	501.99t	**BIOMASS ESTIMATE FOR THE FISHABLE AREA OF THE MAHÉ PLATEAU**
WT. AVG.	1870.61t	WT. AVG.	753.96t	
WT. MAX.	2244.73t	WT. MAX.	1003.97t	
BIOMASS EST. FOR SECTOR B		**BIOMASS EST. FOR SECTOR D**		WT. MIN. 2460.40t
WT. MIN.	357.18t	WT. MIN.	104.75t	WT. AVG. 3423.25t
WT. AVG.	535.77t	WT. AVG.	262.90t	WT. MAX. 4486.82t
WT. MAX.	714.36t	WT. MAX.	523.75t	

Table 8. Estimates of the biomass of krab ziraf by sectors on the Mahé plateau (in tonnes).

The following formula for the calculation of biomass by area was used:

- for example;

fishable area x minimum estimated catch weight (kg) = min. est. Biomass

146 714 286 m^2 fishable area A x 0.0102 kg = 1496.48 kg

= 1496 tonnes

6. Potential Fishery Yields

6.1 Fishing Effort and Catch per Unit of Effort

Figures 14, 15 and 16 show the total catch, the total effort and the catch per unit of effort (CPUE) by fishing trip respectively. The data was collected from SMB Fish Division and relates to the commercial fishing trips made by *F/V St. Michel* between November 1990 and December 1993. Effort was estimated by taking into account the number of days fished and the number of actual traps deployed. During an average day fishing for krab ziraf 260 to 300 traps will be deployed.

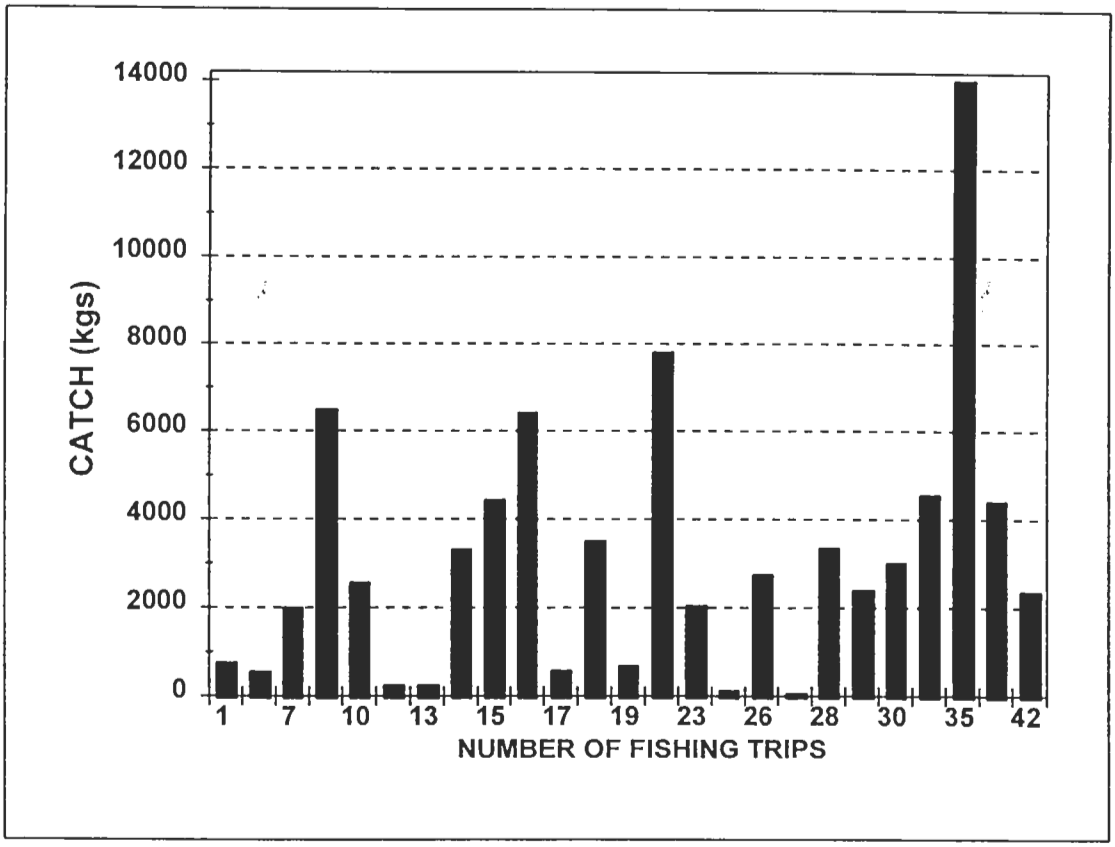


Figure 14. Total catch of krab ziraf by fishing trip for *F/V St. Michel* from November 1990 to December 1993.

As can be seen from Fig. 16 the CPUE is more or less directly proportional to the total catch (Fig. 14) and the total effort (Fig. 15). If the trend were to express an inversely proportional relationship i.e. as more effort is applied the CPUE tends to decrease (which is not apparent) then the assumption could be made that stock depletion was occurring at high levels of effort. The data represented here would, however, lead to the assumption that a positive increase, i.e. more vessels operating in the fishery, in effort could be applied in this particular crab fishery in Seychelles.

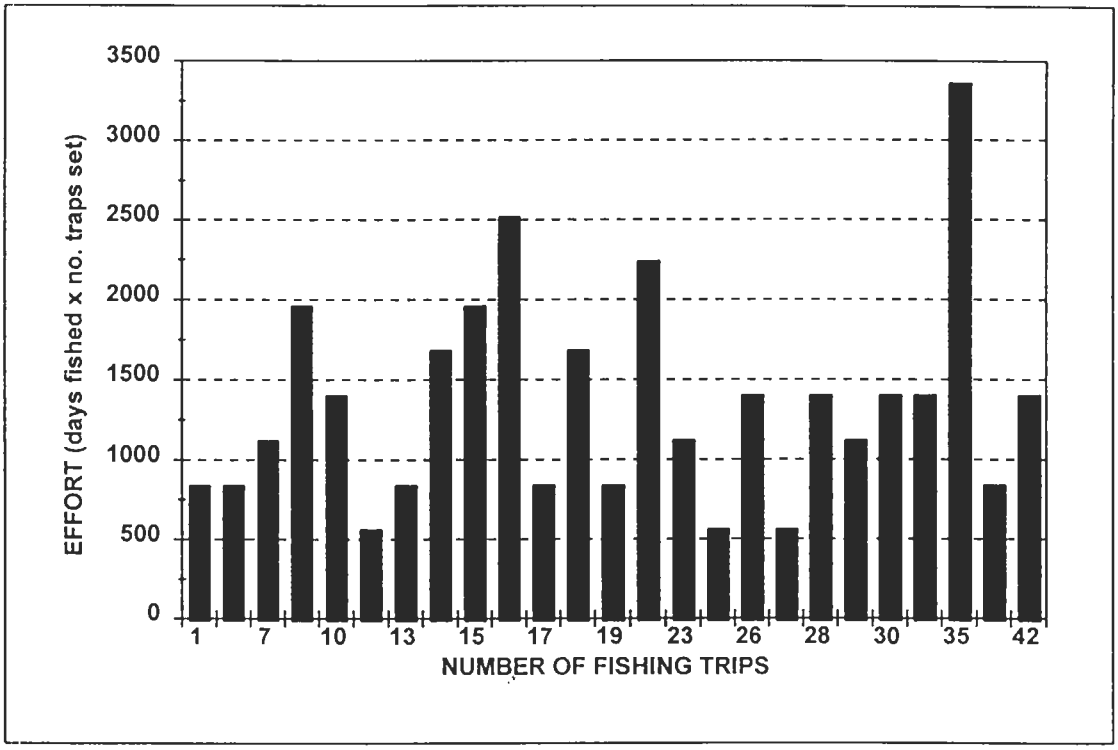


Figure 15. Total effort used in the krab ziraf fishery by fishing trip for *F/V St. Michel* from November 1990 to December 1993.

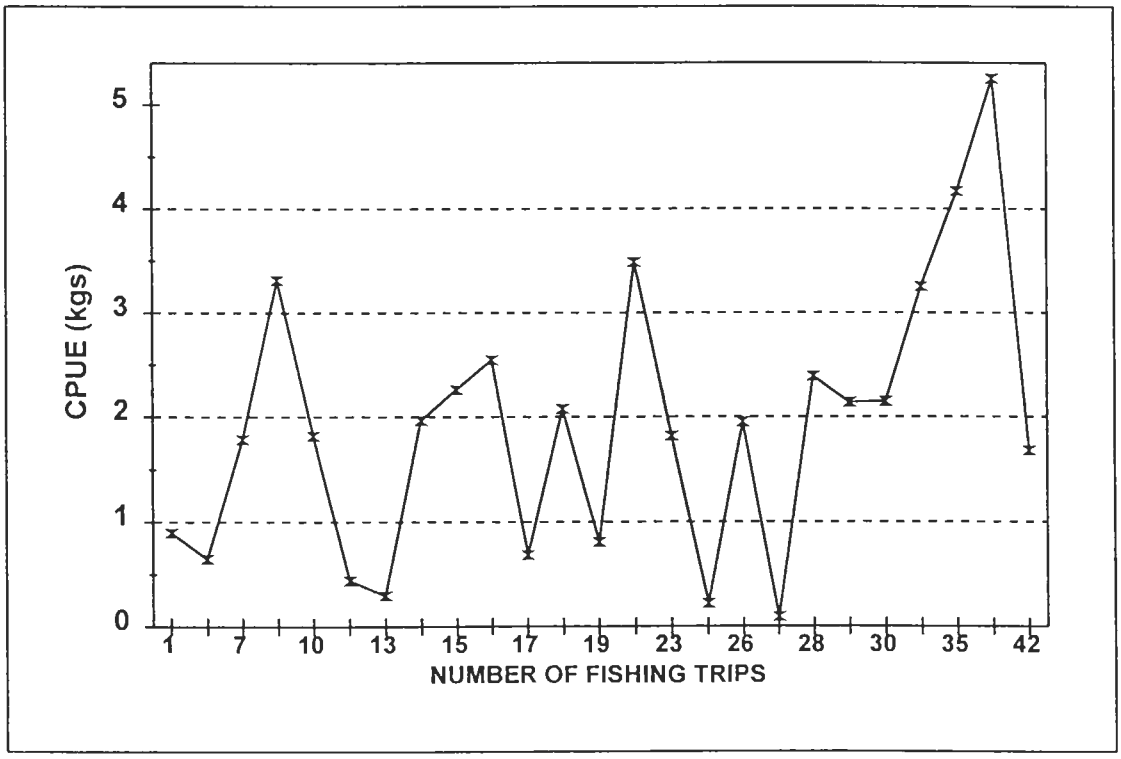


Figure 16. Catch per unit effort (CPUE) of krab ziraf by fishing trip for *F/V St. Michel* from November 1990 to December 1993.

6.2 Maximum Sustainable Yield

The CEDA software package offered by MRAG is a system for the analysis of catch and effort data. These data are then used to give estimates of current and unexploited stock sizes (MRAG, 1992). However, the models included in the CEDA package (Constant recruitment, Schaefer production, Fox production and Pella-Tomlinson production models) are dependent on the data showing stock depletion. As noted above there seems to be no depletion of crab stocks at the present levels of fishing effort, thus the deterministic aspect of this package could not be used.

In order to obtain an estimate of the maximum sustainable yield (MSY) of the krab ziraf fishery the formula:-

$$MSY = \tfrac{1}{2}MB_0$$

is used. Where:-

M = coefficient of natural mortality
B_0 = estimated biomass of the stock

In using this formula it must be noted that the MSY has been shown to give inflated estimates and, conversely, depending on the parameters used, also give under estimates of the yield (Beddington & Cooke, 1983).
As mentioned earlier LFDA also provides a module for estimating Z from the estimates of K and L_∞ and the first 100% exploited length as input parameters. This produced a value for Z of 1.28.
For calculating the natural mortality (M) the total mortality (Z) estimate of 1.28 (standard deviation = 0.47) and a constant fishing mortality (F) of 0.87 were used for MSY estimates. These gave the value for:- M = 0.31 at minimum biomass and M = 0.41 at mean biomass.

The two values were applied to the above formula to determine the MSY estimates. Table 9 shows the MSY estimates by sector for the Mahé plateau by minimum, mean and maximum MSY's. The MSY estimates where M = 0.31 shows more conservative figures as expected. Throughout this document the most conservative figures are preferentially used. This will be the case until either the fishery is expanded or further stock assessment research is conducted by SFA.

	M = 0.31			M = 0.41		
SECTOR	MSY MIN.	MSY AVG.	MSY MAX.	MSY MIN.	MSY AVG.	MSY MAX.
A	231.95t	289.94t	347.93t	306.78t	383.47t	460.16t
B	55.36t	83.04t	110.72t	73.22t	109.83t	146.44t
C	77.80t	116.86t	155.61t	102.90t	154.56t	205.81t
D	16.24t	40.75t	81.18t	21.47t	53.89t	107.36t
TOTAL FOR MAHÉ PLATEAU	381.36t	530.60t	695.45t	504.38t	701.76t	919.80t

Table 9. Maximum sustainable yield (MSY) estimates in tonnes by sector for the Mahé plateau for M = 0.31 and M = 0.41.

MANAGEMENT OF THE KRAB ZIRAF FISHERY

1. Past Landings

Tables 10 and 11 show the values of landed catch at SMB by weight (kg) and rupees (SR) respectively. The catch was predominantly landed at the Seychelles Marketing Board's (SMB) Fish Division and the catch mainly originated from *F/V St. Michel* with a small contribution by the SFA research vessel *Etelis*.
The areas in the table represented by a dash (-) indicate that no crabs were landed and thus sold to SMB during those months.

	1991	1992	1993	1994
Jan	-	-	-	4412.00
Feb	754.70	248.00	124.00	-
Mar	-	3309.50	2740.00	-
Apr	547.00	4432.50	53.00	-
May	-	6417.60	3344.00	-
June	-	576.00	2401.00	-
July	-	3496.00	3010.00	2356.00
Aug	2000.50	678.00	-	*
Sep	6496.50	-	4554.00	*
Oct	-	-	-	*
Nov	2555.00	7812.00	-	*
Dec	245.50	2042.00	14027.00	*
TOTAL	**12599.20**	**29011.60**	**30253.00**	**6768.00**

* = no information available

Table 10. Landings of krab ziraf in kilograms at SMB.

	1991	1992	1993	1994
Jan	-	-	-	57356.00
Feb	12075.30	3968.00	2480.00	-
Mar	-	66190.00	54800.00	-
Apr	8760.00	88414.00	1060.00	-
May	-	128352.00	66880.00	-
June	-	11520.00	48020.00	-
July	-	69920.00	60200.00	47120.00
Aug	32008.00	13560.00	-	*
Sep	103944.00	-	91080.00	*
Oct	-	-	-	*
Nov	40880.00	156240.00	-	*
Dec	3928.00	40840.00	280533.00	*
TOTAL	**201,595.30**	**579,004.00**	**605,053.00**	**104,476.00**

* = no information available

Table 11. Sales value (SR) of landed catch to SMB.

Tables 12 and 13 show the values of sales made to the private sector by weight (kg) and cost (SR). There is a noticeable difference in monthly distribution between the weight tables (9 and 11) this is due to SMB's policy of retaining a certain amount of crabs in freezers for constant distribution throughout the year.

	1991	1992	1993	1994
Jan	1669.10	1939.70	1205.50	2068.20
Feb	1205.00	637.60	1469.70	2041.50
Mar	1211.10	771.40	1967.60	2721.90
Apr	1511.70	2702.00	1768.70	1945.90
May	547.50	1321.40	1810.00	1845.60
June	945.80	1733.30	1488.50	1993.90
July	1360.40	1834.60	2210.00	1455.60
Aug	1717.40	2359.50	2880.50	*
Sep	2002.40	1932.40	1693.20	*
Oct	2048.10	831.00	1606.00	*
Nov	1424.30	2003.40	1647.70	*
Dec	2405.40	2277.60	4393.90	*
TOTAL	**18048.20**	**20343.90**	**24141.30**	**14072.60**

* = no information available

Table 12. Sales (kg) by SMB.

	1991	1992	1993	1994
Jan	4988.60	58084.60	38444.00	42325.60
Feb	36281.10	19032.80	47000.40	42313.00
Mar	36245.90	44537.00	62927.20	55808.00
Apr	46030.90	84679.80	56550.00	37615.60
May	8760.00	39388.00	58304.40	34484.60
June	28196.90	51897.00	47610.40	37508.00
July	40700.40	57915.20	71588.00	43924.50
Aug	51485.30	75356.80	96183.20	*
Sep	47870.80	61764.80	54082.40	*
Oct	62131.20	26711.20	55889.00	*
Nov	42669.40	63929.60	57603.50	*
Dec	70304.10	72373.20	108776.40	*
TOTAL	**475,664.60**	**655,670.00**	**754,958.90**	**293,979.30**

* = no information available

Table 13. Value of sales (SR) by SMB.

Table 14 shows the price variation (SR) per kilogram of crab bought and sold by the SMB Fish Division.

YEAR	PURCHASE (SR/kg)	RETAIL (SR/kg)
1991	SR16.00	SR26.00
1992	SR20.00	SR32.00
1993	SR20.00	SR32.00
1994*	SR16.00	SR22.00

* - provisional

Table 14. Krab ziraf landed and retail prices.

At present the annual catch stands at approximately 30 tonnes. This catch is being provided by a single vessel fishing for approximately 6 to 7 months of the year. At present only the local market is being supplied with minimal crabs allocated to the export market.

2. Management Recommendations

At present there is no management of the krab ziraf fishery, however, there is a minimum size limit of 7cm carapace length (CL) which has been set by the fishers in collaboration with SMB. This size represents the minimum size which is marketable. This size limit should be retained given that the smallest berried female was found to be 6.5cm CL.

The retaining of berried females in the catch is also presently discouraged by fishers. This practice should be retained for as long as possible even though it has been shown that survival rates for these crabs returned to the sea is low (Kennelly et. al. 1990).

Should the fishery expand a minimum carapace length of 7.5cm to 8cm could be introduced to further ensure that a stronger section of the reproductively mature stock remains.

The MSY estimates are shown in terms of the minimum, mean and maximum ranges due to the relative paucity of information gleaned from the population dynamics assessment.
If a management strategy is to be formulated for the krab ziraf fishery and if this strategy is to be derived from the results of the MSY estimates then the most conservative approach should be employed.
From the results obtained in section 6 the minimum MSY estimate for the entire Mahé plateau stands at 381.36 metric tonnes. It is of the author's opinion that this figure should be used as the target MSY, until further assessments can be made, should the decision be made to further develop this fishery.

As mentioned in Section 7.1 there is very little of the crab catch being exported. If more international market research was conducted and the product given more exposure, then the fishery would be stimulated. At present SMB will only purchase enough krab ziraf to keep the local market supplied, and this amount or quota per se is satisfied by the present single vessel fishery.
Unless the fishery is stimulated there is no call for the krab ziraf stocks to be managed at the presently exploited levels.
The author, whilst in South Africa (one of Seychelles major trading partners), had discussions with several fish mongers and fishery product importers and exporters. When these persons were shown pictures of the krab ziraf they all expressed a high degree of interest, noting that the natural orange-red colour of the crabs would generate consumer interest as a fresh non-cooked product.

Again, if there is to be any management then it should be directed at increasing the output of the fishery. This can be done by stimulating both the local and international markets. As always the fishery will have to be continuously monitored in terms of the landed catch and effort to further refine the yield estimates.

GENERAL CONCLUSIONS

The Seychelles krab ziraf fishery seems to be healthy in terms of the state of the stock. It is presently under utilised in terms of both the fishing grounds being harvested and the effort being employed in the fishery.

In terms of the product, any type of crustacean harvested from the sea is generally considered to be of high economic value, one has to look no further than a restaurant menu to realise this.
Here it must stressed that a market survey should be conducted to fully realise the potential for supply.

At present only the landed catch of krab ziraf is being monitored, and unless the fishing effort is increased, this policy will remain as there seems no need to do otherwise.

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Annex 1a. Length - weight data for *Ranina ranina* (males).

SEX	LENGTH (mm)	WEIGHT (kgs)
M	58	0.25
M	60	0.1
M	60.1	0.16
M	60.1	0.16
M	63	0.18
M	63	0.18
M	63	0.18
M	63	0.18
M	63	0.18
M	63	0.18
M	66	0.2
M	73.1	0.18
M	76	0.2
M	77	0.18
M	77	0.2
M	78.4	0.18
M	78.4	0.18
M	78.4	0.18
M	78.4	0.18
M	78.4	0.18
M	79.6	0.24
M	79.6	0.3
M	79.6	0.32
M	80	0.22
M	82	0.2
M	82	0.2
M	82	0.2
M	82.6	0.45
M	83	0.22
M	83	0.26
M	83.4	0.23
M	83.4	0.23
M	83.4	0.23
M	83.4	0.23
M	83.4	0.23
M	83.4	0.23
M	83.8	0.22
M	83.8	0.22
M	83.8	0.22
M	84.9	0.27
M	84.9	0.27
M	84.9	0.27
M	84.9	0.27
M	84.9	0.27
M	85	0.25
M	85	0.26
M	85.4	0.27
M	85.4	0.28
M	85.4	0.28
M	85.4	0.28
M	85.4	0.28
M	85.4	0.28
M	85.4	0.28
M	85.6	0.22
M	85.6	0.24
M	85.6	0.24
M	86	0.2
M	86	0.52
M	88	0.2
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	88.6	0.28
M	89	0.23
M	89	0.27
M	89.5	0.32
M	89.5	0.31
M	90	0.24
M	90	0.24
M	90	0.24
M	90	0.26
M	90	0.28
M	90	0.28
M	90	0.34
M	90	0.28
M	90.3	0.89
M	90.5	0.2
M	90.5	0.23
M	90.5	0.24
M	90.5	0.26
M	90.5	0.26
M	90.8	0.34
M	90.8	0.34
M	90.8	0.5
M	91	0.3
M	92	0.3
M	93	0.32
M	93	0.36
M	93	0.35
M	93	0.35
M	93	0.35
M	93	0.35
M	93	0.35
M	93	0.35
M	94	0.36
M	94	0.36
M	94	0.3
M	94.4	0.36
M	95	0.35
M	95	0.35
M	95.4	0.34
M	95.4	0.34
M	95.4	0.34
M	95.4	0.34
M	95.9	0.95
M	96	0.34
M	96	0.35
M	96	0.4
M	96.2	0.4
M	96.7	0.39
M	97	0.38
M	97.8	0.4
M	98.5	0.42
M	99	0.4
M	99	0.42
M	99	0.39
M	99	0.4
M	99.2	0.44
M	99.3	0.91
M	100	0.5
M	100.4	0.38
M	100.4	0.4
M	100.4	0.44
M	100.5	0.43
M	100.5	0.43
M	100.5	0.43
M	100.5	0.43
M	100.5	0.43
M	100.5	0.43
M	101	0.4
M	101	0.4
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101	0.41
M	101.3	0.46
M	101.3	0.46
M	101.3	0.46
M	101.3	0.46
M	101.3	0.46

Annex 1a. (cont.)

SEX	LENGTH (mm)	WEIGHT (kgs)
M	101.3	0.46
M	101.3	0.46
M	101.7	0.44
M	101.7	0.55
M	102	0.34
M	102	0.4
M	102.3	0.5
M	102.6	0.48
M	102.8	0.46
M	102.8	0.5
M	103	0.42
M	103	0.45
M	103	0.45
M	103.4	0.5
M	104.7	0.4
M	106	0.5
M	107.7	0.92
M	108	0.5
M	108	0.54
M	108.7	0.54
M	109	0.6
M	110	0.42
M	110	0.5
M	110	0.53
M	110	0.54
M	110	0.6
M	110.2	0.7
M	110 2	0.9
M	110.5	0.64
M	110.6	0.55
M	110.6	0.55
M	110.6	0.55
M	110.6	0.6
M	110.6	0.6
M	110.6	0.7
M	110.6	0.7
M	110.8	0.8
M	111	0.69
M	111	0.69
M	111	0.69
M	111	0.69
M	111	0.69
M	111	0.69
M	111	0.69
M	111	0.69
M	111.8	0.64
M	112.2	0.6
M	112.2	0.6
M	112.2	0.6
M	112.2	0.6

SEX	LENGTH (mm)	WEIGHT (kgs)
M	112.2	0.6
M	112.2	0.6
M	113	0.7
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.62
M	114	0.65
M	115	0.94
M	115	0.67
M	115	0.7
M	115.1	0.55
M	115.5	0.7
M	115.7	0.74
M	115.8	0.77
M	117.8	0.67
M	118.5	0.71
M	118.6	0.65
M	119	0.62
M	119	0.85
M	119	0.7
M	119.8	0.73
M	120	0.48
M	120	0.5
M	120	0.5
M	120	0.62
M	120	0.65
M	120	0.68
M	120	0.68
M	120.3	0.36
M	120.3	0.36
M	120.3	0.4
M	120.3	0.4
M	120.3	0.44
M	120.3	0.45
M	120.7	0.45
M	121.5	0.95
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8
M	121.8	0.8

SEX	LENGTH (mm)	WEIGHT (kgs)
M	121.8	0.8
M	121.8	0.8
M	122	0.6
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.1	0.87
M	122.3	0.75
M	122.3	0.76
M	122.3	0.77
M	122.3	0.77
M	122.7	0.9
M	123	0.85
M	123	0.89
M	123.3	0.68
M	123.8	0.89
M	123.8	0.81
M	124	0.95
M	124	0.91
M	124.2	0.8
M	125.8	0.95
M	126	0.62
M	126	0.64
M	126	0.65
M	126	0.7
M	126	0.93
M	126.8	0.95
M	127	0.8
M	127.4	0.72
M	127.4	0.97
M	127.7	0.81
M	127.7	0.98
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.2	1
M	128.3	0.98
M	128.3	0.95
M	128.3	0.95

Annex 1a. (cont.)

SEX	LENGTH (mm)	WEIGHT (kgs)
M	128.5	0.95
M	128.6	1
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.3	0.99
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	129.4	1.06
M	130	0.97
M	130.2	1
M	130.4	0.8
M	130.4	0.8
M	130.4	0.85
M	130.4	0.86
M	130.6	0.78
M	130.6	0.85
M	130.6	0.94
M	130.6	0.95
M	130.6	0.95
M	130.6	0.98
M	130.6	1
M	130.6	1

SEX	LENGTH (mm)	WEIGHT (kgs)
M	130.6	1.18
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.02
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.2	1.12
M	131.3	1.1
M	131.5	1.05
M	131.7	1.2
M	132	1.1
M	132.6	1.5
M	132.7	1.05
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	132.9	1.09
M	133.6	1.2
M	132.9	1.09

SEX	LENGTH (mm)	WEIGHT (kgs)
M	132.9	1.09
M	132.9	1.09
M	133.8	1.1
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.3	1.11
M	134.4	1.1
M	134.5	1.2
M	135	1.05
M	136	1.15
M	136.7	1.2
M	137	1.1
M	138.3	1
M	139.5	1.35
M	140	1.2
M	140	1.3
M	140	1.25
M	140.1	1.1
M	140.1	1.1
M	140.1	1.1
M	140.1	1.1
M	140.1	1.2
M	140.1	1.2
M	140.1	1.25
M	140.1	1.26
M	140.1	1.3
M	140.1	1.34
M	144.6	1.2

Annex 1b. Length - weight data for *Ranina ranina* (females).

SEX	LENGTH (mm)	WEIGHT (kgs)
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	60.1	0.11
F	63	0.1
F	63	0.14
F	63	0.14
F	63	0.14
F	63	0.14
F	68	0.2
F	73.1	0.16
F	73.1	0.16
F	73.1	0.16
F	73 1	0.16
F	73.1	0.16
F	73.1	0.16
F	73.1	0.16
F	73.1	0.16
F	73.1	0.16
F	76	0.19
F	77	0.18
F	77	0.18
F	78	0.2
F	78	0.2
F	78	0.21
F	78.4	0.18
F	78.4	0.18
F	78.4	0.18
F	78.4	0.18
F	78.4	0.18
F	79	0.21
F	79.6	0.22
F	79.6	0.23
F	79.6	0.24
F	79.8	0.24
F	80	0.2
F	80	0.22
F	80	0.24
F	81	0.2
F	81	0.29
F	81.5	0.23
F	81.7	0.24
F	81.8	0.24
F	82	0.2
F	82	0.2
F	82	0.2
F	82	0.2
F	82	0.2
F	82	0.2
F	82	0.24
F	82	0.25
F	82.5	0.25
F	82.8	0.25
F	83	0.21
F	83	0.22
F	83	0.25
F	83	0.25
F	83.4	0.22
F	83.4	0.22
F	83.4	0.22
F	83.4	0.22
F	83.8	0.19
F	83.8	0.19
F	83.8	0.19
F	83.8	0.19
F	83.8	0.19
F	83.8	0.19
F	83.8	0.19
F	84	0.22
F	84	0.24
F	84.4	0.25
F	84.4	0.26
F	84.5	0.28
F	84.9	0.27
F	84.9	0.27
F	84.9	0.27
F	84.9	0.27
F	85	0.15
F	85	0.25
F	85	0.25
F	85.2	0.25
F	85.4	0.26
F	85.4	0.26
F	85.4	0.26
F	85.4	0.26
F	85.6	0.22
F	85.6	0.22
F	85.6	0.24
F	85.6	0.25
F	85.6	0.25
F	86	0.21
F	86	0.25
F	86	0.27
F	86	0.27
F	86.3	0.24
F	86.3	0.26
F	86.6	0.25
F	87	0.25
F	87	0.25
F	87	0.25
F	87	0.25
F	87	0.3
F	87.5	0.28
F	87.5	0.29
F	87.8	0.3
F	88	0.26
F	88	0.29
F	88	0.29
F	88.4	0.25
F	88.4	0.28
F	88.4	0.32
F	88.5	0.3
F	88.7	0.3
F	88.8	0.3
F	89	0.26
F	89	0.28
F	89	0.28
F	89	0.29
F	89	0.3
F	89	0.3
F	89	0.3
F	89	0.32
F	89	0.39
F	89.3	0.33
F	89.4	0.3
F	89.4	0.31
F	89.5	0.3
F	89.7	0.28
F	90	0.22
F	90	0.24
F	90	0.24
F	90	0.25
F	90	0.28
F	90	0.28
F	90	0.3
F	90	0.3
F	90	0.3
F	90	0.3
F	90	0.3
F	90	0.32
F	90.5	0.23
F	90.5	0.26
F	90.6	0.31
F	90.8	0.31
F	90.8	0.32
F	90.8	0.32

Annex 1b. (cont.)

SEX	LENGTH (mm)	WEIGHT (kgs)
F	90.8	0.34
F	90.8	0.34
F	90.8	0.34
F	91	0.3
F	91	0.3
F	91	0.3
F	91	0.32
F	91	0.32
F	91	0.33
F	91	0.35
F	91	0.35
F	91.5	0.29
F	91.9	0.3
F	92	0.3
F	92	0.32
F	92	0.32
F	92	0.33
F	92.2	0.34
F	92.7	0.31
F	93	0.3
F	93	0.32
F	93	0.32
F	93	0.32
F	93	0.32
F	93	0.32
F	93	0.32
F	93	0.33
F	93	0.33
F	93	0.33
F	93	0.34
F	93	0.35
F	93	0.35
F	93	0.35
F	93	0.35
F	93	0.35
F	93	0.35
F	93	0.35
F	93	0.36
F	93.2	0.31
F	93.4	0.31
F	93.6	0.33
F	94	0.32
F	94	0.32
F	94	0.33
F	94	0.33
F	94	0.34
F	94	0.34
F	94.2	0.3
F	94.2	0.32
F	94.3	0.31
F	94.4	0.35
F	94.8	0.32
F	94.9	0.36
F	95	0.34
F	95	0.36
F	95	0.36
F	95	0.37
F	95.4	0.33
F	95.4	0.33
F	95.4	0.33
F	95.4	0.33
F	95.4	0.33
F	95.4	0.33
F	95.8	0.49
F	96	0.36
F	96	0.38
F	96.6	0.36
F	97	0.34
F	97	0.36
F	97	0.39
F	97	0.39
F	98	0.38
F	98	0.4
F	98.3	0.4
F	98.7	0.4
F	99	0.4
F	99	0.4
F	99.3	0.4
F	100	0.39
F	100	0.4
F	100	0.52
F	100.4	0.36
F	100.4	0.36
F	100.4	0.36
F	100.4	0.38
F	100.4	0.4
F	100.4	0.4
F	100.5	0.42
F	100.6	0.41
F	101	0.42
F	101	0.45
F	101.1	0.42
F	101.1	0.42
F	101.1	0.42
F	102	0.4
F	102	0.41
F	103	0.42
F	103	0.43
F	103	0.44
F	103.7	0.45
F	104	0.5
F	104.5	0.43
F	105	0.49
F	105	0.49
F	105	0.5
F	106	0.48
F	106	0.48
F	106	0.48
F	106	0.48
F	106.2	0.52
F	107	0.48
F	107	0.51
F	107	0.52
F	107.4	0.51
F	107.6	0.46
F	109	0.5
F	109	0.51
F	110	0.4
F	110	0.4
F	110	0.45
F	110	0.46
F	110	0.5
F	110	0.5
F	110	0.52
F	110.2	0.56
F	110.2	0.58
F	110.6	0.55
F	111	0.49
F	111	0.56
F	111.7	0.54
F	112	0.54
F	112	0.54
F	112.2	0.55
F	112.2	0.55
F	112.2	0.55
F	112.2	0.55
F	113	0.53
F	114	0.56
F	120	0.5
F	120	0.55
F	120	0.6
F	120.3	0.54
F	126	0.62
F	130.6	0.8

Annex 1c. Length - weight data for *Ranina ranina* (females with eggs).

SEX	LENGTH (mm)	WEIGHT (kgs)
FE	65	0.16
FE	72	0.17
FE	84	0.25
FE	86	0.27
FE	90	0.3
FE	91	0.3
FE	94	0.35
FE	100.4	0.36
FE	100.4	0.36
FE	100.4	0.38
FE	106	0.5
FE	115	0.56

Annex 2a. Length Frequencies for all *Ranina ranina* collected on research cruises.

SEX: ALL LENGTH (mm)	1990				1991		1992		
	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
55									
56									
57	1								1
58					1				1
59	1	1	1		2	1			6
60		1	3	1			2	4	
61								1	
62							1	4	
63				1			3	6	
64	2				2		2	2	
65		1				1			
66	1			1		1			
67	1							1	
68				1	1				
69		1	1						
70		1				1			
71	1							2	
72				1				2	
73	1	1	1				1	6	
74		2	1					1	
75		2						2	
76	3	3		1	1				3
77	7	2					4	4	9
78		2	1	2	1		1	6	4
79	4	4	6			1	2	2	12
80	7	10	1	1	4	1	3	5	12
81	7	8	4	1	3	1		2	14
82	7	10	7	1	2	1	4	8	6
83	7	7	3		2	1	4	13	3
84	8	8	3		4	1	3	13	4
85	7	20	4	1	4	2	9	11	13
86	5	14	4		3	4	5	4	6
87	13	26	7	2	4	2		6	6
88	12	18	12	2	8	2	4	5	12
89	9	14	3		11	8	7	3	7
90	9	17	9	1	8	4	15	1	19
91	10	15	4	1	6	5	5		19
92	6	16	7	2	3	2	2	4	7
93	6	6	6	1	4	10	4	6	15
94	12	7	6	2	9	6	3	1	3
95	8	9	9	1	5	3	3	8	1
96	7	15	4	2	6	1	1	2	4
97	10	9	6		3	3		3	5
98	7	4	5		4		1	2	6
99	6	6	6	3	4	3	3	6	1
100	5	6	6	1	2	2	12	10	2

Annex 2a. (cont.)

SEX: ALL LENGTH (mm)	1990				1991		1992		
	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
101	5	9	6	1	3	2	7	11	2
102	3	7	4	1	4	3	1	2	1
103	5	2	6	1	2	4			2
104	4	4	5		4				8
105	3	5	5		2	1	1		21
106	4	3	6	2	1	4			12
107	2	2	7		3	3		1	12
108	1	3	1	1	2		1	1	7
109	4		4	1	1	1	4	3	4
110	2	3	2	1	2	1	16	8	3
111			3		2	1	13	7	13
112	2	6	2			2		7	16
113	4	1	2	1		1	1	4	8
114	1	3		1		1		5	1
115	5	6	2		7			2	
116	4	2						1	
117	2	3	1		1			2	
118	1	3	4		2			3	
119	1	3	2	1	2		1		
120	1	3	1		1		16	2	
121	1		1		1		4	4	
122	1	2	2		1	1	8	8	
123	2	2	2		3	2	2	5	7
124	4	2	1		3				9
125		4			1				7
126	1	2	1		1	1	5	2	5
127	2	5	2		4	1	1	5	2
128	2		3		5		6	11	
129		4	1				4	10	2
130	3	2	1		3		7	9	2
131	2	3	1		3		12	12	4
132	1	1	2		3		5	9	12
133	1	1			2		6	6	14
134		3			2		1	7	5
135		1				1	1	3	4
136		1			1	1			
137	1		1		1				1
138					1		1		1
139		1			1				8
140					2	1	6		3
141									2
142							1		
143							1		
144					1				
145									

Annex 2b. Length Frequencies for all *Ranina ranina* males collected on research cruises.

SEX: M	1990				1991		1992		
LENGTH (mm)	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
55									
56									
57	1								
58									
59		1							
60	1	1		1			2		
61			1						
62				1			1	2	
63							3	4	
64							2	1	
65		2			1				
66				1					
67	1				1				
68									
69									
70		1							
71									
72									
73		1	1				1	1	
74		1							
75									
76				1					1
77	1						2	2	4
78			1					3	1
79	2	1	1					1	5
80		2			1		3	2	5
81		2	2						4
82		1	2		1		4	4	
83	2	2	1				3	5	
84	1	1					2	7	2
85	1	2	1	1	2		5	6	5
86		2	2		1		3	2	2
87	3	1	5					4	3
88	1		3	2			4	5	7
89	2	3			2	2	6	1	4
90	3	3	2		2	2	10	1	16
91	1	1	1		1		3		12
92	2	3	2	1				2	4
93	3	1	3	1	1		1	3	10
94	2	2	1	1	2	1	1		1
95	4	3	3	1	2		2	4	
96	2	6	1	2	3		1	1	2
97	2	2	1		2			1	3
98	1	2			1			2	5
99	3	3		2	2	2	1	6	1
100	2	4	4	1			7	8	

Annex 2b. (cont.)

SEX: M LENGTH (mm)	1990				1991		1992		
	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
101	3	4	6	1	2	1	6	9	1
102		3	4	1	4	1	1	2	1
103	3		5	1	2	1			
104	2	1	5		1				6
105	1	3	3				1		13
106	2		6	1					10
107	1	2	5		1			1	9
108	1	3	1	1	2			1	5
109	1		2	1			3	3	2
110	1	2	2	1	2	1	8	8	3
111			2		1		11	6	11
112	2	5	2					5	15
113	3		2	1				3	7
114	1	3		1				5	
115	5	6	2		7			2	
116	4	2						1	
117	2	3			1			2	
118	1	3	3		2			3	
119		3	2	1	2				
120	1	3	1		1		13	2	
121	1		1		1		4	4	
122	1	2	2		1	1	8	8	
123	2	2	2		3	2	2	5	7
124	4	2	1		3				9
125		4			1				7
126		2	1		1	1	4	2	5
127	2	5	2		4	1	1	5	2
128	2		3		5		6	11	
129		4	1				4	10	2
130	3	2	1		3		6	9	2
131	2	3	1		3		12	12	4
132	1	1	2		3		5	9	12
133	1	1			2		6	6	14
134		3			2		1	7	5
135		1				1	1	3	4
136		1			1	1			
137	1		1		1				1
138					1		1		1
139		1			1				8
140					2	1	6		3
141									2
142							1		
143							1		
144					1				
145									

Annex 2c. Length Frequencies for all *Ranina ranina* females collected on research cruises.

SEX: F	1990				1991		1992		
LENGTH (mm)	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
55									
56									
57									
58			1						
59									
60								4	
61								1	
62	1							2	
63				1	1			2	
64						1		1	
65					1				
66	1								
67		1						1	
68				1		1			
69		1	2						
70									
71	1							2	
72				1				2	
73	1							5	
74		1	1					1	
75		2						2	
76	3	3			1				2
77	6	2					2	2	5
78		2		2	1		1	3	3
79	2	3	5			1	2	1	7
80	7	8	1	1	3	1		3	7
81	7	6	2	1	3	1		2	10
82	7	9	5	1	1	1		4	6
83	5	5	2		2	1	1	8	3
84	7	7	3		4	1	1	6	2
85	6	18	3		2	2	4	5	8
86	5	12	2		2	4	2	2	4
87	10	25	2	2	4	2		2	3
88	11	18	9		8	2			5
89	7	11	3		9	6	1	2	3
90	6	14	7	1	6	2	5		3
91	9	14	3	1	5	5	2		7
92	4	13	5	1	3	2	2	2	3
93	3	5	3		3	10	3	3	5
94	10	5	5	1	7	5	2	1	2
95	4	6	6		3	3	1	4	1
96	5	9	3		3	1		1	2
97	8	7	5		1	3		2	2
98	6	2	5		3		1		1
99	3	3	6	1	2	1	2		
100	3	2	2		2	2	5	2	2

Annex 2c. (cont.)

SEX: F	1990				1991		1992		
LENGTH (mm)	8/03	22/03	10/07	18/07	16/05	6/08	8/02	12/03	10/04
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
101	2	5			1	1	1	2	1
102	3	4				2			
103	2	2	1			3			2
104	2	3			3				2
105	2	2	2		2	1			8
106	2	3		1	1	4			2
107	1		2		2	3			3
108							1		2
109	3		2		1	1	1	1	2
110	1	1					8		
111			1		1	1	2	1	2
112		1				2		2	1
113	1	1				1	1	1	1
114						1			1
115									
116									
117			1						
118			1						
119	1						1		
120							3		
121									
122									
123									
124									
125									
126	1						1		
127									
128									
129									
130							1		
131									

ANNEX 3. Length - frequency data for all *Ranina ranina* from Moussac (1987).

DATE / LENGTH CLASS (mm)	13/12/86	5/1/87	23/1/87	17/2/87	21/3/87	14/4/87	13/5/87	24/10/87	4/12/87	31/1/88	7/2/88	31/3/88	TOTAL
60	0	0	0	0	5	0	3	3	0	0	0	0	11
64	5	0	1	1	7	2	2	1	0	0	1	0	20
68	2	2	2	0	12	3	3	9	1	6	1	0	41
72	1	2	3	5	37	5	10	18	2	6	5	5	99
76	9	3	2	7	26	5	13	28	5	12	5	6	121
80	24	15	9	27	34	22	33	24	13	16	16	10	243
84	70	43	24	42	58	60	53	22	5	25	15	10	427
88	59	56	67	63	57	99	49	21	15	37	23	28	574
92	65	62	134	56	89	78	41	40	20	51	21	17	674
96	32	29	76	70	51	79	30	53	26	52	15	13	526
100	20	23	34	33	45	56	21	45	15	24	9	6	331
104	11	26	23	30	49	42	22	42	29	24	9	10	317
108	27	15	14	26	40	27	18	79	19	16	11	3	295
112	26	15	17	22	26	35	13	62	22	20	14	15	287
116	14	7	6	23	35	37	20	58	26	14	17	15	272
120	6	7	9	26	16	27	27	20	41	30	38	47	294
124	1	1	14	15	30	31	31	22	42	51	66	84	388
128	0	1	8	8	14	39	35	14	44	55	73	69	360
132	0	0	4	7	5	19	34	10	31	55	39	77	281
136	0	0	0	0	0	10	23	5	5	38	16	60	157
140	0	0	0	0	0	1	14	5	1	13	3	14	51
144	0	0	0	0	0	0	5	0	0	0	2	6	13
TOTAL	372	307	447	461	636	677	500	581	362	545	399	495	5782