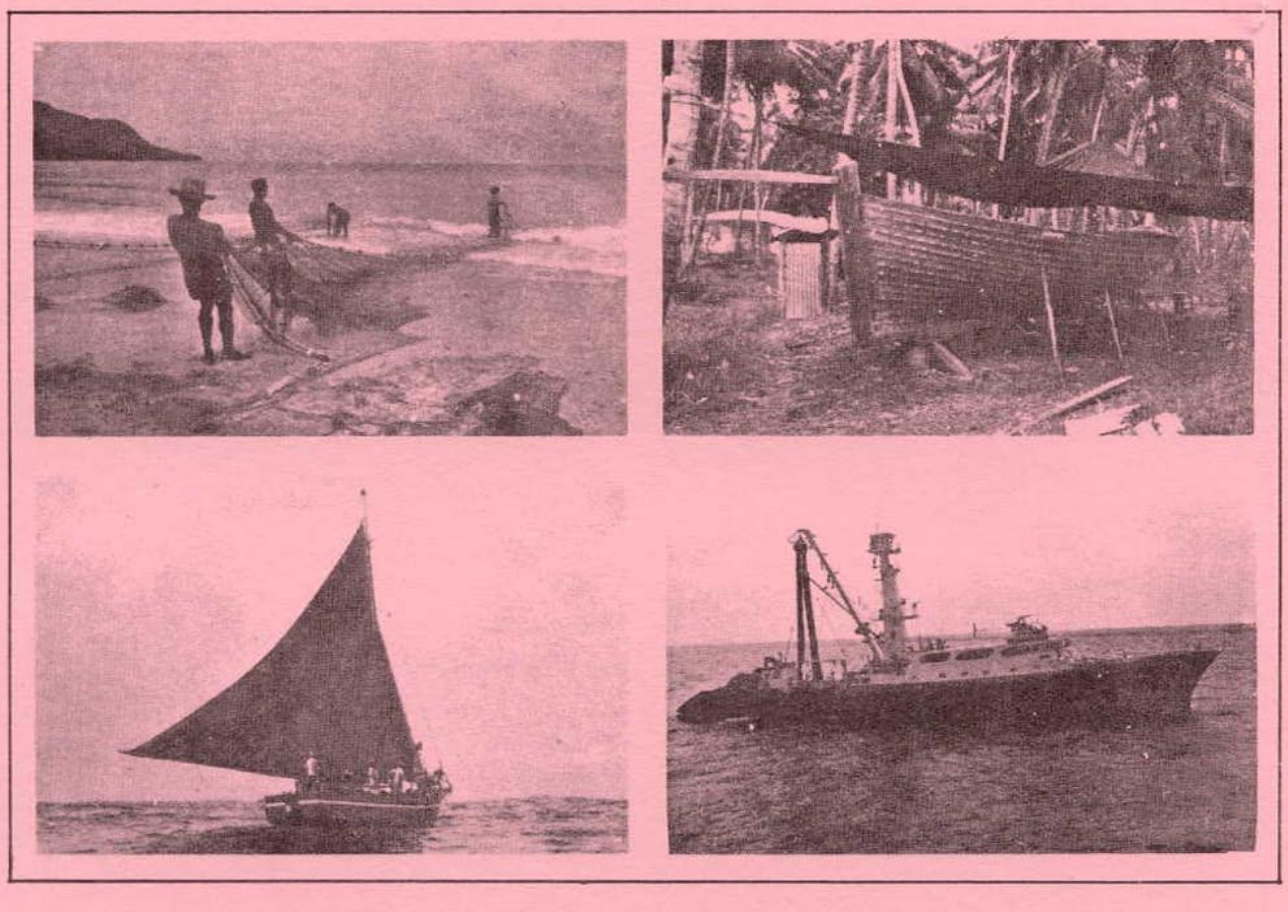
SEYCHELLES FISHING AUTHORITY

TECHNICAL REPORT

Results of a spiny lobster survey around Mahé island during September and October 1991



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Results of a spiny lobster survey around Mahé island during September and October 1991

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ABSTRACT

Spiny lobster fishing in the Seychelles is an artisanal activity done essentially by skin divers operating at night in the shallow waters surrounding the Islands. Because of human population distribution lobster fishing grounds are concentrated on the inner granitic islands.

In September 1991, a random stratified sampling program was set up to gather biological information from the entire granitic Mahé plateau.

Direct census of fishery resources by SCUBA divers swimming underwater transects was selected as the most feasible and expedient means by which to enact the Resource Survey. This report presents partial results, gathered for the survey around Mahé island only and provides an estimate of the Maximum Sustainable Yield for the granitic plateau by extrapolation of the Mahé results.

Around Mahé, three species were found in the catches, *P penicillatus* (P.p.) being the most abundant and caught mainly by skin divers between 2 and 8 meters. *P. longipes* (P.l.) and *P.versicolor* (P.v.) were more rare and often found in deeper water in the SCUBA diving zone. Catch rates were much higher for skin divers than SCUBA divers (4.63 lobsters per man hour against 0.63 for SCUBA divers).

Mean carapace length of each species were respectively for males and females: (P.p.)=95.8, (P.p)=95.9; (P.l.)=86.6, (P.l.)=70.1; (P.v.)=106, and (P.v.)=78.5 mm.

In total, during the two months survey, the percentage of mature females was found to be: (P.p.)=52.9, (P.l.)=55.5 and (P.v.)=25,. Cephalothoracic length at first maturity for females was found to be 79.2 mm for *P. penicillatus* and 74.2 mm for females of *P. longipes*.

The length-weight relationship per species for males and females respectively, were found to be: (P.p.):$W=1.63*L^{2.66}$, (P.p.):$W=2.25*L^{2.25}$. (P.l.):$W=2.03*L^{2.64}$, (P.l.):$W=1.45*L^{2.81}$; (P.v.):$W=-0.688*L^{2.96}$, (P.v.):$W=-0.715*L^{3.3}$ (W = gr, L=cm).

The minimal size at first capture for *P.penicillatus* should be increased from 75 mm to 80 mm of cephalothoracic length.

Maximum Sustainable Yield (MSY) for Mahé island was found to be 1.17 tonnes/year, and simple extrapolation of the Mahé data to the entire granitic plateau gives a MSY of 3.5 tonnes. This MSY is probably a underestimate based on standing stock reather than virgin biomass.

Another estimate of the virgin biomass was done utilising the maximum biomass found in a station for each biotope. This approach lead to an MSY in the Mahé waters of 4.7 tonnes, while for the hole plateau it gives a MSY of 15.5 tonnes.

The fact that only 33.9% of the lobsters caught in the Mahé waters could be retained by a fishery, obliges one to adopt the conservative approach.

The recommendations are the following:

·Further studies should be done to improve the MSY based on accurate estimate of virgin biomass. It is recommended, that in 1992-1993 the research survey on the granitic plateau be finalised and beter estimate of virgin biomass obtained to ascertain the accuravy the estimate of 15.5 tonnes of MSY on the plateau.

- In view of the limited stock, the fishing effort should be limited through the combination of a limited fishing season and a limited issue of fishing licences. The fishing season should be limited to a few months and open when the demand for lobsters is higher and good weather conditions prevails (ie. 3 months at the end of the year, November-January). If the MSY of 15,5 tonnes on the Mahé plateau is confirmed the issue of spiny lobster fishing licences should be limited to a maximum of 14 for the whole Mahé plateau. However in each island the number of licences should be based on the potential of the lobster grounds accessible.

-Before reopening the fishery, a monitoring system should be prepared and implemented.

-In view of the small sizes of individuals lobsters and the poor catch rates observed in deeper waters no SCUBA diving should be authorized.

-It is proposed to have only a professional fishery authorized,

-Licensed fishermen should be authorized to sell their lobsters to hotels and restaurants directly.

-Other recommended measures relative to commercial aspects are:

-Only licensed fishermen should personally be able to sell their catch to hotels and restaurants.

-Licensed fishermen, when fishing and selling lobsters, should carry a specific plastic card identifying the licence number.

-Enforcement patrol should verify at sea if fishermen are licensed.

-In case of offences, legal repressive measures should be defined and action taken.

-For hotels and restaurants a control system should also be established.

-Prevention of lobster fishing in Marine reserves and Park should be enforced.

ACKNOWLEDGMENT

This field survey has been possible thanks to the hard working capacity and active support of certain persons and the contribution of some diving clubs:

Mister Rondolphe PAYET has been following the methodology and was implied in most of the data analysis procedures, he has gained a valuable experience, both practical and theoretical, in the conduct of such field surveys.

A special thank to Madame Rita SAVY for her efficiency in establishing all administrative procedures in the minimal time frame available to set up the project.

The contribution of the fishermen, Mister David CUPIDON, James CUPIDON and Daniel HOUAREAU, has been most useful for the conduct of the research survey.

In Silhouette the team has got full help from Mister Pascal GARNIER and is diving center. His help has been fully appreciated in the difficult moments following the nautical incident.

I also wish to thank the "Marine Divers International" and the "Sheraton dive center", for the facilities and special prices they offered to the Seychelles Fishing Authority to conduct this research. The "Seychelles Underwater Center" also provided good training to members of the team.

TABLE OF CONTENT

1) INTRODUCTION

Four species of spiny lobsters are fished in the shallow coastal waters of the granitic and coral islands of Seychelles, *Panulirus penicillatus*, *Panulirus longipes*, *Panulirus versicolor* and *Panulirus ornatus*.

In Seychelles lobster fishing is an artisanal activity which is historically well established. Due to human population distribution, lobster fishing grounds are essentially limited to the Mahé plateau. Fishing is done in the coastal shallow waters around the main island and on emerging rocks of the plateau (see figure 1). Lobsters are mainly caught by hand and by skin divers operating at night with electrical lamps. The divers operate close to shore or close to a barier reef reached with a small outboard powered boat. While fishing in the shallow waters, the boat maneuvres by paddles to follow the skin divers, so when lobsters are caught by hand, they can be put straight into the boat. The operational range of these boats can be of several kilometers and can include different islands.

From the fishery existing before 1983, no catch and effort data are available for estimation of potential yields and biological information remains limited for the local lobster species.

In 1983 the fishery was closed because of some concern for the resource[1], however no enforcement system existed to control the closure. After five years of official closure, on the basis of some subjective indications of increasing catch rates and mean size of lobsters, the fishery was reopened in 1989, from December to April 1990. During that season 6.9 tonnes were landed at the SMB company. The estimate of total landings including hotels and restaurants is 10 tonnes.

Fishing regulations included:

- A closed season from 1st May to 30th September (corresponding to the South-East monsoon and difficult skin diving conditions).

- A minimum size of capture of 7.5 cm in cephalothoracic length (based on legislation of species from the same family: *Panulirus Argus* in the Caribbean).

- A ban on catching berried females.

- A ban on fishing in marine reserves and parks

- Persons paying a seasonal licence fee of SR 500 to be recommended by SFA and the Ministry of Agriculture and Fishery are authorized to fish. 34 licences were issued, 24 in Mahé, 3 in Praslin and 7 in La Digue.

- All lobsters to be sold alive to the Seychelles Marketing Board.

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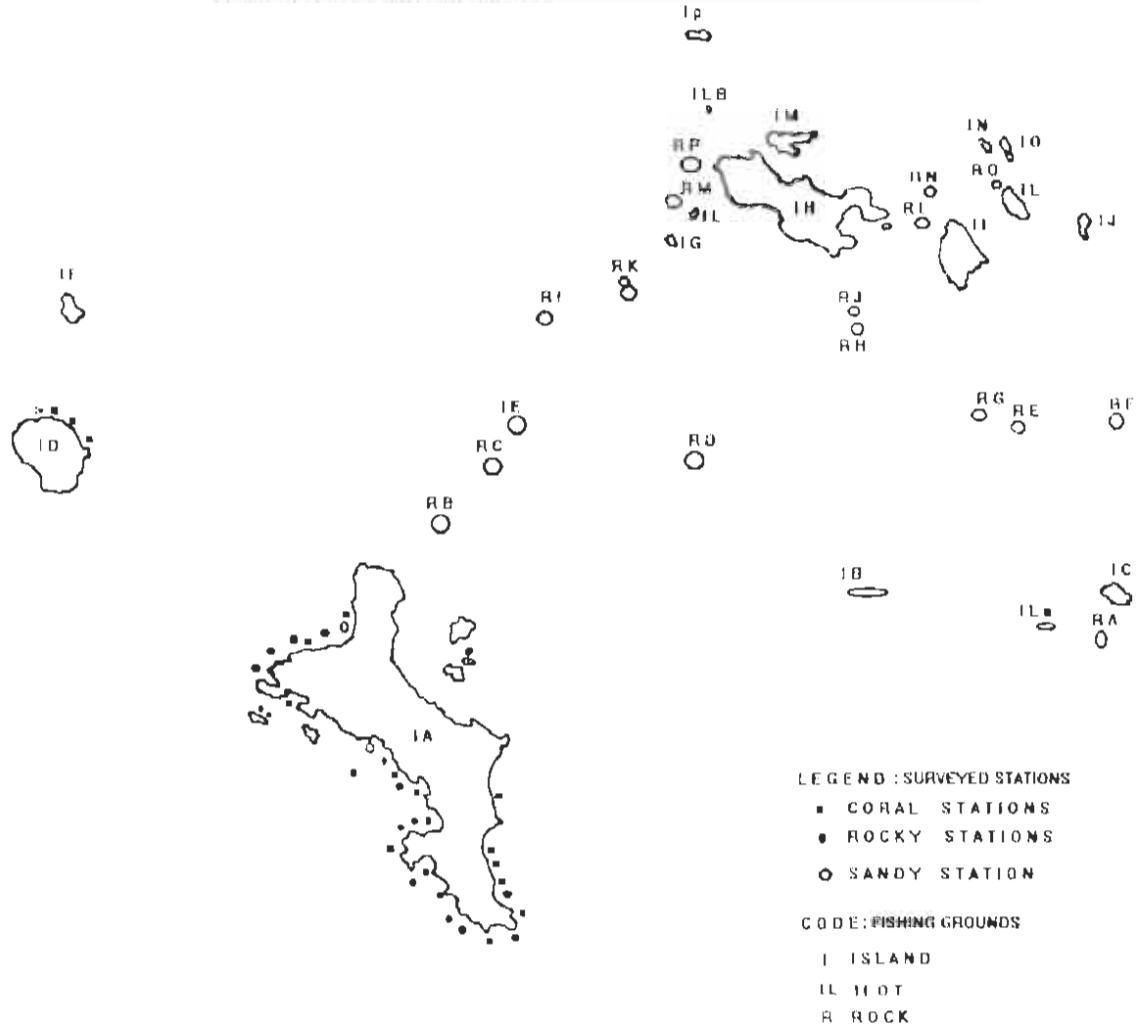
[1] Indication of limited stock size was provided through a preliminary study: Intes et. All (1979): les langoustes coraliennes aux Seychelles, prospection.

Fig. 1.

SPINY LOBSTER FISHING GROUNDS AND SURVEYED STATIONS ON THE GRANITIC PLATEAU.



Abuses in fishing regulations during the 1989/1990 fishing season lead to the following recommendations made by the Seychelles Fishing Authority (SFA) in July 1990:

"It is recommended that the 1990/91 lobster season be closed and no licence issued pending a more indepth study of the problem so as to prepare a better management plan with more stringent enforcement measures. Meanwhile in order to continue biological study on the species it is proposed that SFA carry out a monthly survey of lobster stocks. This will permit a better profile of the lobster population with statistical analysis carried out on all caught specimens".

In September 1991 a random stratified sampling program was set up to gather biological informations from the entire granitic Mahé plateau and generate enough data to asses biomass and Maximum Sustainable Yield of the spiny lobster population (2).

Unfortunately after completing the survey around the Island of Mahé, while the team was operating on Silhouette island, a nautical incident interrupted the project. This paper presents the results gathered around the Mahé Island. These data are however limited and accurate management options should be based on more extensive data collection originating from the entire granitic plateau.

In January 1992, an amendment notice, published by the Ministry of Finance & Information, indicated that under the group 036, crustaceans do not longer fall under Schedule A, items for which no permit will be issued and the import of which will only be undertaken by SMB. The group 036 will fall under Schedule B, restricted goods for which import permits are required.

2) MATERIAL AND METHOD.

Since the potential yield of Seychelles lobster fisheries could not be ascertained through catch per unit effort analysis, a random stratified sampling program using SCUBA assessment techniques was set up for the entire granitic area. Direct census of fishery resources by SCUBA divers swimming underwater transects was selected as the most feasible and expedient means by which to enact the Resources Survey. The coastal areas of the granitic Islands of the Mahé plateau were stratified into three major biotopes: coral reef, rock, and sand. Table 1 below gives the characteristics of the three substrates and table two the length of the lobster fishing grounds around the granitic islands. Coastal Stratification was accomplished using data gleaned from nautical charts. A total of 118 stations were randomly selected within the different biotopes around all the granitic islands. A coded system was set up to facilitate data analysis by computer.

(2) The research survey is detailed in a document by B.BAUTIL (1991)"The development of the lobster fishery in Seychelles".

The results presented here are based only on data collected around Mahé island where 32 randomly selected stations were surveyed. 17 stations were of rock biotope, 14 of coral biotope and 1 of sand biotope. A station was delimited on the surface by a square of 50 meters side. All the delimited sea bottom area was surveyed, at night, by two or three scuba divers and two skin divers. Each station was set as close as possible to the shore. On the West coast of Mahé limited reef barrier formation exists and the biotoe is mainly made of rock, being the continuation of the island granitic foundation. On the East coast in most places, a reef barrier exists, and the stations were set on the "drop off" side of the reef. No stations were set inside a lagoon.

The Mahé survey occurred during September and October 1991. The survey was conducted by utilizing the SFA boat "Kalkal" equipped with all diving facilities and live tanks for lobsters. A zodiac and a mini Mahé were also utilized.

For each station, the location, the date, the time, the biotope type, the moonphase, the water temperature, were recorded. Length frequency, catch and effort data, length-weight data and the presence of eggs under the tail were recorded. All these data were noted on specific forms (see in annexes 1 to 3).

TABLE 1: BIOTOPES CLASSIFICATION

Biotope	Description
Coral	This category include essentially one reef morphology; the barrier reef. The reefs are largely dominated by the stony (scleractinian) corals.
Rock	This biotope is the continuation into the sea of the granitic island foundation of Pre-Cambrian age. Often cut into large boulders, it creates underwater gaps and deep holes between the rocks.
Sand	This biotope is more rarely found and is essentially made of sand partially covered by some small coral formation or rocks.

TABLE 2 LENGTH OF SPINY LOBSTER FISHING GROUNDS AROUND THE INNER GRANITIC AREA

Island name	Rock km	Coral km	Sand km
Mahe	40.7	71.8*	5.35
Praslin	4.73	52.9	0.61
La Digue	4.3	86.6	2.13
Curieuse	4.29	5.99	-
Cousin	-	3.89	-
Cousine	-	3.45	-
Silhouette	4.64	11.03	0.59
Petite Soeur	0.27	3.09	-
Grande Soeur	4.16	1.25	-
Felicite	4.71	4.185	0.15
Marianne	1.93	2.13	-
Fregate	4.00	2.6	-
North Island	7.00	3.5	-
Aride island	3.45	1.00	-
Total	84.8	253.4	9.06
Grand total	347.3 km.		

* Includes length of the reclaimed area which has reduced the reef area by about 5 km.

3) POPULATION CHARACTERISTICS.

The analyses in this section are based on the length frequency forms attached in annexes 1 to 3

3.1) SPECIES COMPOSITION.

In total 127 spiny lobsters were caught and measured in the surrounding waters of Mahé.

The most abundant species was *Panulirus penicillatus* (53%), followed by *P. longipes* (34.7%) and *P. versicolor* (11,8%). Not one individual of *P. ornatus* was observed.

3.2) SEX RATIO.

The sex ratio for *P. penicillatus* was found to be 50% of males and 50% of females.

Sex ratio for *P. longipes* shows 55.5% of females .

Few number of *P. versicolor* were seen (15) and males were predominant (73.3%).

3.3) SIZE DISTRIBUTION.

Figures 2 to 7 indicate the size distribution for each species and sex.

All lengths in the following discussion refer to cephalothoracic length (CL).

For *P penicillatus*, 29 % of the males individuals caught were under the minimal size regulation in force (75 mm CL). For the females 32.3% were under that size limit.

In comparison with other species *P penicillatus* had the highest number of large individuals. Size distribution showed that 44,7 % of males were above 100 mm CL, while for females only 14,7% were above 100 mm CL.

For *P. longipes*, 29.4% of the male were under the size limit, while 63% of the females were under the size limit. For *P. longipes*, no individuals of either sex were observed above 10 mm CL.

For *P.versicolor*, 45.5% of male were under the size limit, while 50% of the females were under the size limit. One individual was above 100 mm CL.

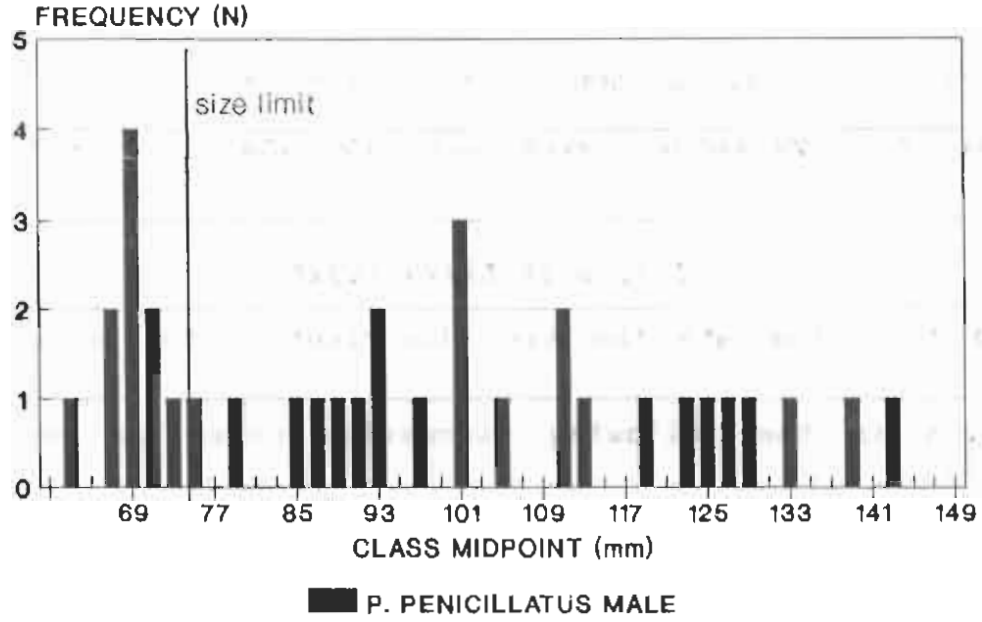
In total, 50 of the caught lobsters were under the size limit. This means that under the prevailing fishery legislation 39.4 % of the lobsters caught were under the size limit and should be released at sea because of their size.

For *P. penicillatus* the mean size of the male population was found to be equal to 95.8 mm, for the female it was found to be 95.9 mm (Annex 4).

For *P. longipes* the mean size of the male population was found to be equal to 86.6 mm, while for the female it was 70.1 mm (Annex 5).

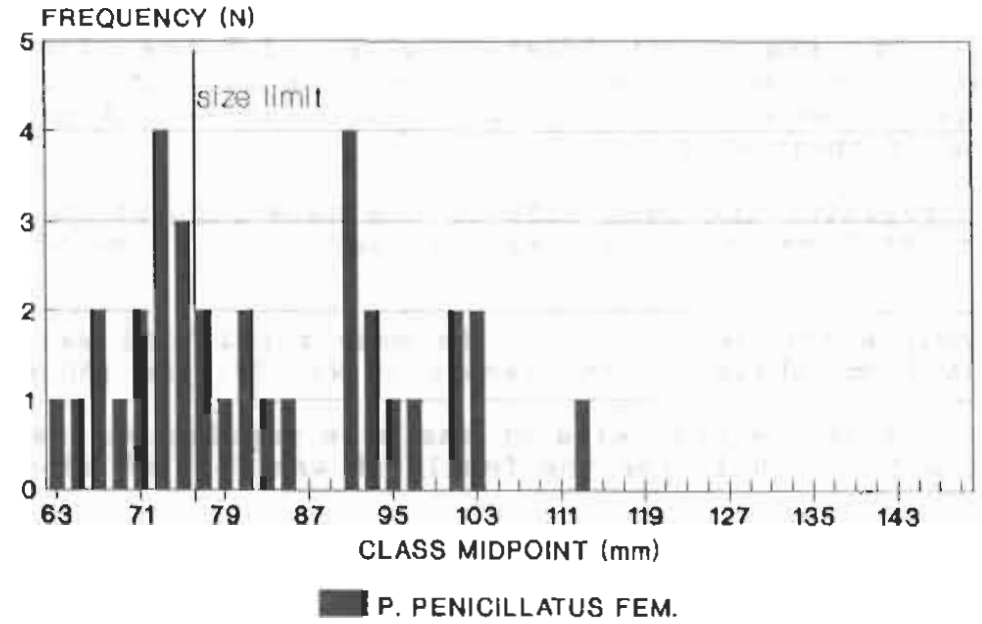
For *P. versicolor* the mean size of the male population was found to be equal to 106.1 mm, while for the female it was 78.5 mm (Annex 6).

Fig 2: Lobster survey: Mahe Sept-Oct 91
Panulirus penicillatus males



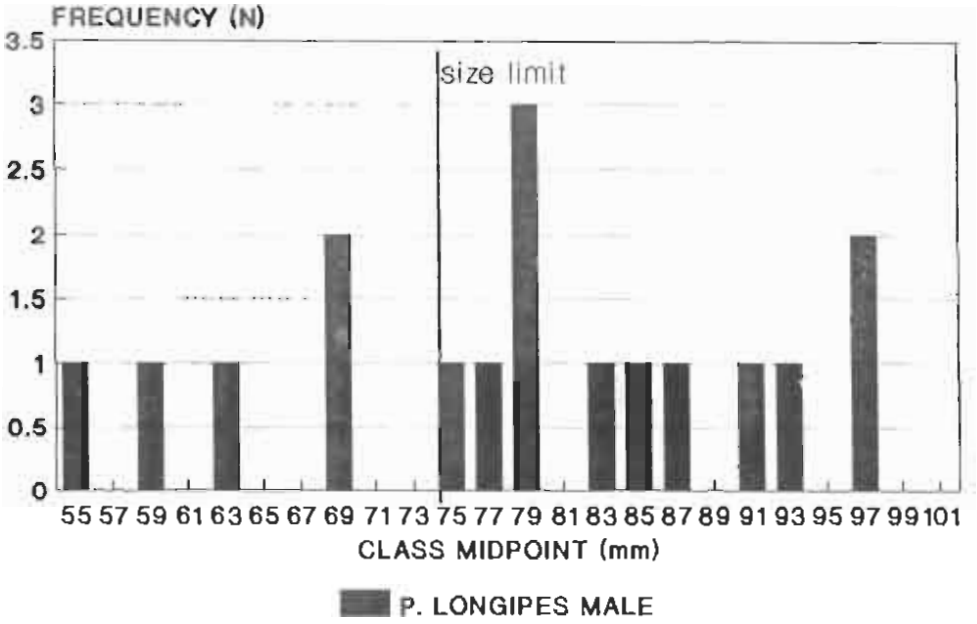
N=34 - Cephalothoracic length

Fig 3: Lobster survey: Mahe Sept-Oct 91
Panulirus penicillatus females



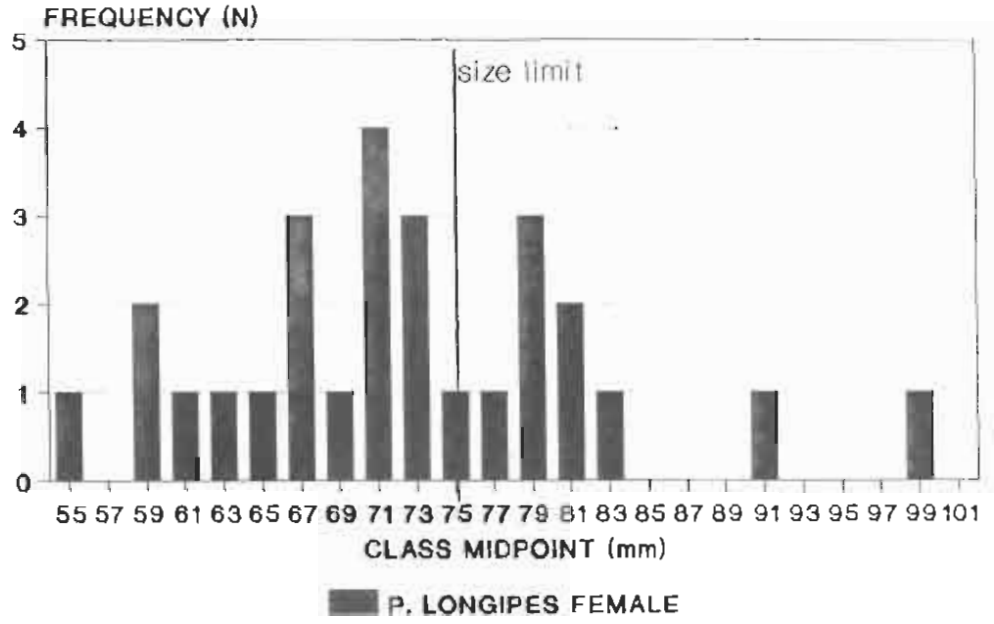
N=34 - Cephalothoracic length

Fig 4 : Lobster survey: Mahe Sept-Oct 91
Panulirus longipes males



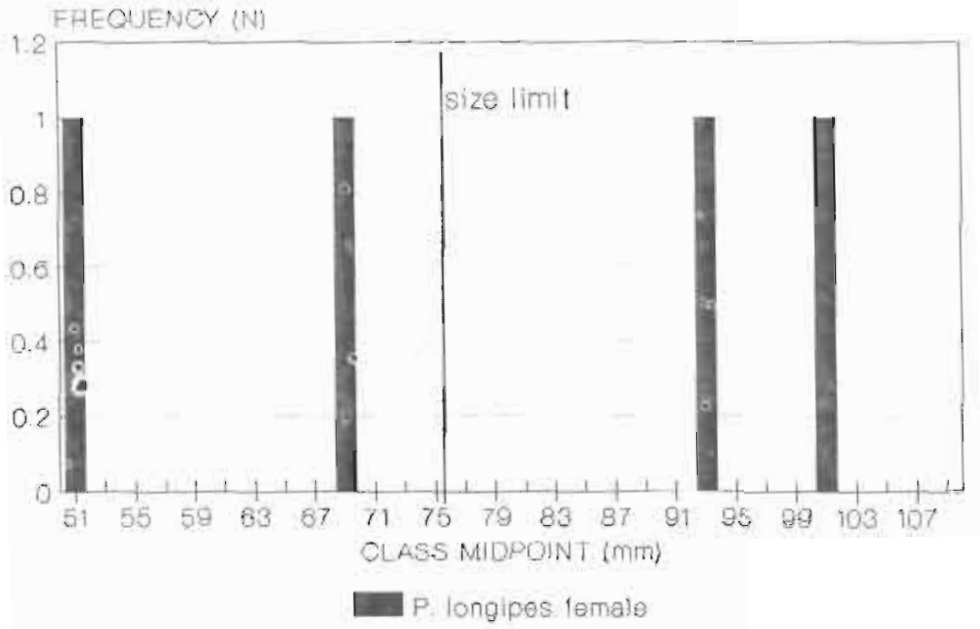
N= 17 - Cephalothoracic length

Fig 5 : Lobster survey: Mahe Sept-Oct 91
Panulirus longipes females



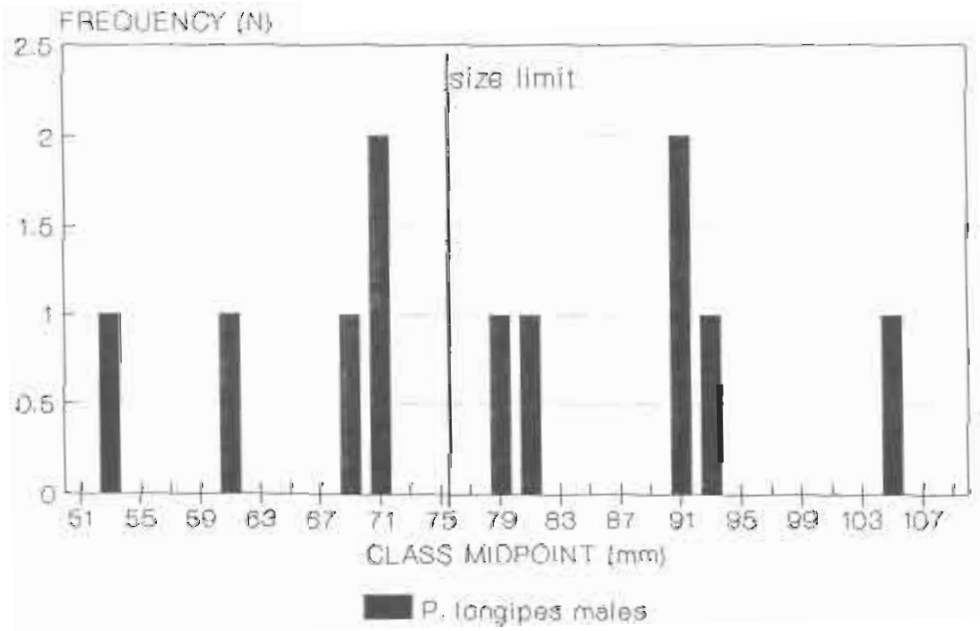
N= 27 - Cephalothoracic length

Fig 6: Lobster survey: Mahe Sept-Oct 91
Panulirus versicolor females



N 4 - Cephalothoracic length

Fig 7: lobster survey: Mahe Sept-Oct 91
Panulirus versicolor males



N 11 - Cephalothoracic length

3.4) PERCENTAGE OF BERRIED FEMALES AND SIZE AT FIRST MATURITY.

Annexes 7 and 8 give the relative and cumulative frequency of berried females.

During the two month survey, 52.9% of the females *of P.penicillatus*, were berried. The smallest female observed to be berried was 65 mm cephalothoracic length. In the Solomon Island, the smallest ovigerous female was 50 millimiters (Prescott Unpbl.).

For *P.longipes*, 55,5% of the females were berried. The smallest female seen to carry eggs was 59 mm CL.

For *P.versicolor*, only 4 females were caught and one only was berried.

In total 34 female individuals were berried. Under the fishery legislation this means that 26.7% of the individuals caught should be released at sea[3] .

Figures 8 and 9 show the sizes at which 50% of females are berried.

For *P. penicillatus*, the size at which 50% of females are mature was found to be 79.2 mm in cephalothoracic length. In Solomon Island the size at sexual maturity for *P. penicillatus* was estimated to be between 75 and 79 millimiter carapace length. In Tonga, Zann found that it was in the 75 to 79 mm size range (PRESCOTT J. 1988).

For *P. longipes*, the size at which 50% of females are mature is 74 mm cephalothoracic length. For *P. versicolor* data are insufficient to say anything.

Table 3 provides a summary of the main characteristics of the lobster population.

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(3) In total during the survey, 66.1% of the lobsters caught around Mahé, were released at sea, either because they were undersized, or because they were berried. It also means that in case of a fishery, only 33.9% of the caught individuals could be retained by fisherman.

Fig. 8

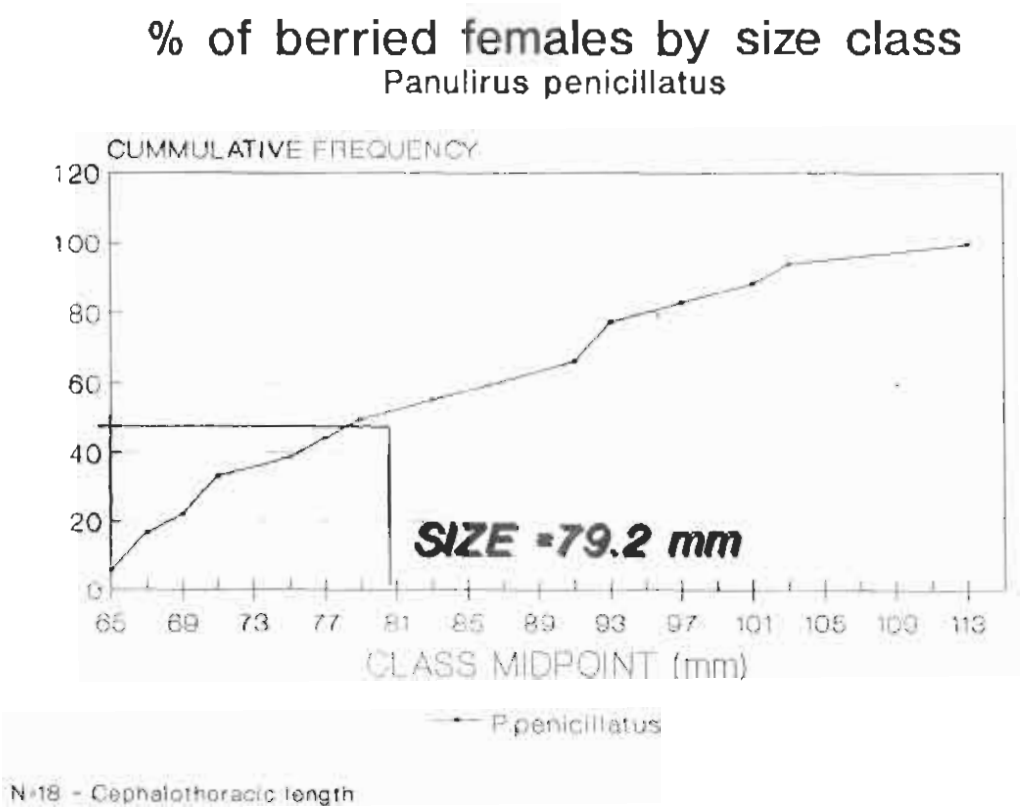
% of berried females by size class
Panulirus penicillatus
CUMMULATIVE FREQUENCY
120
100
80
60
40
20
0
SIZE =79.2 mm
65 69 73 77 81 85 89 93 97 101 105 109 113
CLASS MIDPOINT (mm)
P.penicillatus
N=18 - Cephalothoracic length

Fig. 9

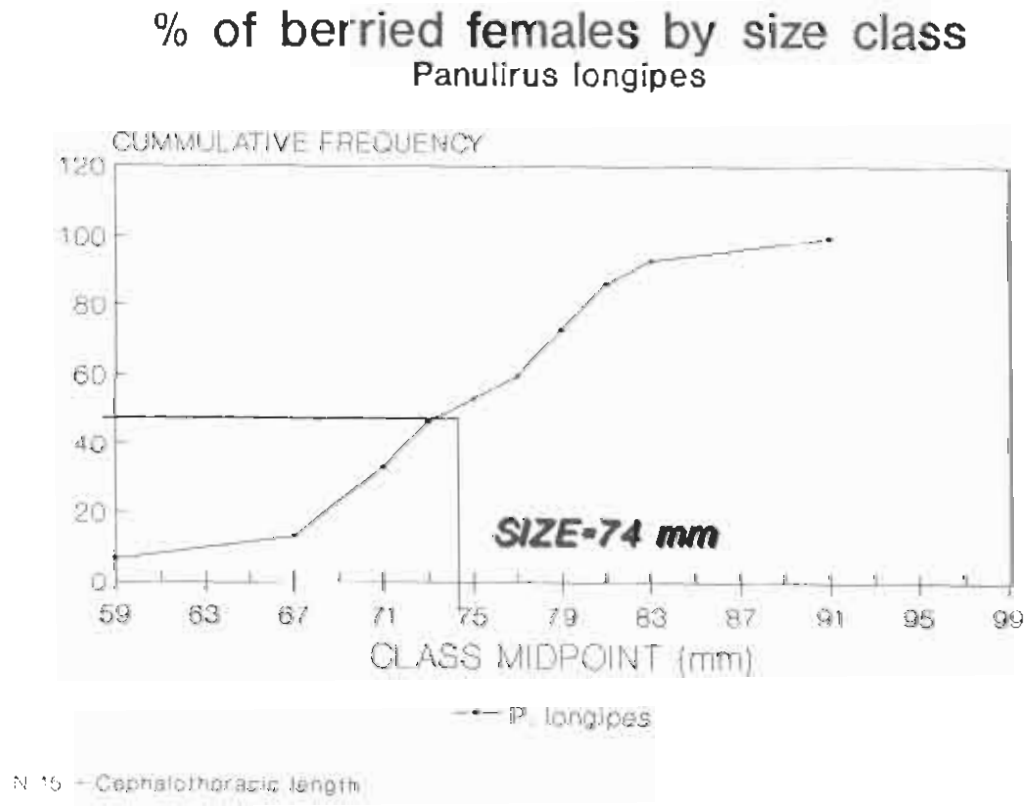
% of berried females by size class
Panulirus longipes
CUMMULATIVE FREQUENCY
120
100
80
60
40
20
0
SIZE=74 mm
59 63 67 71 75 79 83 87 91 95 99
CLASS MIDPOINT (mm)
P. longipes
N=16 - Cephalothoracic length

TABLE 3: MAIN CHARACTERISTICS OF SPINY LOBSTER POPULATION IN SURROUNDING WATERS OF MAHE ISLAND FROM SURVEY DURING SEPTEMBER AND OCTOBER 1991.

Species Number, %	Sex Ratio males %	% of females with eggs	Size at 50% with eggs	% of males C.L. <75 mm	% of fem C.L. <75 mm	Mean size of males	Mean size of females
P.penicillatus 68 53.0	50.0	52.9	79.2	29.4	32.3	95.8	95.9
P.longipes 44 34.7	44.5	55.5	74.0	29.4	63.0	86.6	70.1
P.versicolor 15 11.8	73.3	25.0	*	45.4	50.0	106*	78.5*
Total 127 100%							

NB: All sizes are cephalothorax length and expressed in mm.
*indicates that data are too limited to be significant.

4) LENGTH-WEIGHT RELATIONSHIPS.

The data collected during the Mahé survey were not sufficient to estimate length-weight parameters for the different species. Therefore the data originating from commercial catches during the 1989-1990 season were cumulated. Annexes 9 to 15 give the length and weight data for each species and sex. The data were analysed using the computer programs described in SPARRE P. 1987 (Length based Fish Stock Assessment software). After logarithmic transformation, a linear regression analysis provides the value of the parameters Q and b in the lenght-weight relationship:

$W = Q*L^b$

were W is the total weight in grammes and L is the cephalthoracic length expressed in centimeters.

TABLE 4:LENGTH-WEIGHT RELATIONSHIPS

Species	*P.penicillatus*	N	R	*P.longipes*	N	R	*P.versicolor*	N	R
Male	$W=1.63L^{2.66}$	103	.99	$W=2.03L^{2.64}$	57	.96	$W=-0.688L^{2.96}$	6	.99
Female	$W=2.25L^{2.25}$	73	.99	$W=1.45L^{2.81}$	33	.98	$W=-0.715L^{3.3}$	4	.99

: ABUNDANCE OF LOBSTER PER BIOTOPE

As some lobsters were observed in a station but could not be caught, the observed number of lobsters per station differ from the caught number.

Annex 15 provides the species composition and the number of lobsters observed in each of the surveyed stations around Mahé island. In total 206 lobsters were observed in 32 stations, giving a average number of 6.44 lobsters per station. The predominant species is *Panulirus penicillatus* with 65.5% followed by *Panulirus longipes* with 26.5 and *Panulirus versicolor* with 8 %.

Annex 16 provides the same data for only the rock biotope. It provide the average number of lobsters per rocky station as well as the species composition and the variance. Annex 17 provide the same data for the coral biotope.

The average number of lobster per rock station is higher than for the coral stations (8/5.6). This is true for all species. In both biotopes the predominant species is *Panulirus penicillatus*, *Panulirus longipes* being better represented in the rock biotope than in the coraline one.

6) CATCH-EFFORT PER FISHING METHOD AND PER BIOTOPE.

Annex 18 gives the catch and effort data base for SCUBA divers and "skin" divers around Mahé island. It gives the total number of lobsters observed in each station and additional information on biotope type, maximum depth of the station, water temperature moonphase and some other observations.

From annex 18, of 32 stations surveyed the mean Catch Per Unit of Effort (CPUE) for the SCUBA divers was 0.63 lobsters per man-hour. For the skin divers the mean CPUE was much higher and of 4.75 lobsters per man-hour. Catch rates from skin divers in shallow waters are far better than catch rates from SCUBA diving in deeper waters.

On 32 dives, 13 times the SCUBA divers did not catch any lobsters, while on 24 dives, the skin divers had no catch only 4 times.

Based on annex 18 the following table was produced comparing catch rates and species compositions per biotope and per fishing method.

TABLE 5: CATCH RATES (NUMBER OF LOBSTER/HOUR) AND SPECIES COMPOSITION PER BIOTOPE AND FISHING METHOD.

Biotope	CPUE (SCUBA method)	Species%	CPUE (skin method)	Species%
Rock	0.62	PP= 0.0% PL=69.6% PV=30.4%	4.23	PP=75.4% PL=21.5% PV= 3.0%
Coral	0.65	PP=6.6% PL=86.6% PV=6.6%	6.80	PP=82% PL=14.3% PV=3.6%

The catch rates for skin divers are much higher than for SCUBA divers in each of the two biotopes. On average (all biotope together) the skin divers caught 4.75 lobsters per man-hour compared with 0.62 for the SCUBA divers.

For the skin divers, the catch rate is higher in the coraline biotope than in the rock biotope. Their catch is essentially made of *P. penicillatus* (>75 %).

For the SCUBA divers the catch rates are similar in both biotopes and the main caught species is *P.longipes*.

The differences in species composition per diving method indicates a preferential species distribution by depth. *P. penicillatus* is mostly found in shallow waters between 2 and 8 meters with strong hydrodynamic properties due to the swell breaks. This made it sometimes very difficult for access by skin divers. The species has very long and powerful legs and the cephalothorax is more developed than the other species (may be because of the development of the leg musculature in the carapace).

P. longipes was found in the deeper water zone of the station and constituted most of the catch of the scuba divers.

P. versicolor, the least important species, was often observed in the rock biotope on the west coast of Mahé.

7) STANDING BIOMAS AND MAXIMUM SUSTAINABLE YIELD ESTIMATES

For the island of Mahé, for each biotope, the mean number of lobsters per station was calculated (see Annex 16 and 17). Taking into consideration the species composition observed for each biotope, and the sex ratio from catch and effort data, a mean number for each species and sex has been calculated within a station.

TABLE 6: AVERAGE NUMBER OF LOBSTER PER ROCK AND CORAL STATION FOR EACH SPECIES AND SEX.

	Mean number of lobsters per Rock station =8		
	Mean number per species and sex		
	P.penicillatus	*P.longipes*	*P.versicolor*
Males	2.109	0.76	0.37
Females	2.109	0.94	0.13
	Mean number of lobsters per Coral station = 5.57		
	Mean number per species and sex		
	P.penicillatus	*P.longipes*	*P.versicolor*
Males	2.07	0.51	0.209
Females	2.07	0.63	0.081

For each species and sex, the mean length and the length-weight relationships are known from table 4, so that the mean weight of lobsters in one representative station in Mahé could be calculated. The calculation provides an estimated standing biomass for each of the station type.

TABLE 7: STANDING BIOMASS PER STATION TYPE FROM MAHE DATA

	Mean number of lobsters per Rock station =8		
	Mean number per species and sex		
	P.penicillatus	*P.longipes*	*P.versicolor*
Males Mean weight Females Mean weight	2.109 * 661 gr 2.109 * 685 gr	0.76 606.1 gr 0.94 * 345 gr	0.37 1086.7 gr 0.13 * 641.7 gr
Total	3.2 Kg	1.1 Kg	0.78 Kg = **5.08 kg**
	Mean number of lobsters per Coral station = 5.57		
	Mean number per species and sex		
	P.penicillatus	*P.longipes*	*P.versicolor*
Males Mean weight Females Mean weight	2.07 * 661 gr 2.07 * 685 gr	0.51 606.1 gr 0.63 * 345 gr	0.209 1086.7 gr 0.081 * 641.7 gr
Total	2.786 Kg	0.526 Kg	0.279 Kg = **3.59 kg**

On Mahé the length of the rock biotope is 40.7 km (see table 2 pg 5), while the length of the coral biotope is 71.8 km. However 5 km of coral length should be substracted since the construction of the reclaimed area, giving 66.8 km of coral reef length.

If we assume that the fishing grounds for skin and SCUBA divers are limited to 50 meters offshore, the fishing grounds of rock biotope on Mahé represent an area of 2,035,000 square meters and the coral biotope 3,340,000 square meters. Each station represents a fishing area of 2,500 square meters: the equivalent of 814 stations exist on rock biotope and 1336 stations on coral biotope. The standing stock on the rock biotope is thus equal to 4.1 tonnes (814* 5.08 kg). The standing stock on the coral biotope is equal to 4.7 tonnes (1,336* 3.59 Kg).

Maximum Sustainable yield can be estimated from the Gulland empirical formula:

$$MSY = 0.2 * M * Bv$$

were M is the natural mortality and Bv the virgin biomass.

M was calculated by the Rikther and Efanov's formula:

$$M = 1.51/(T_{m50}^{0.720}) - 0.155 \text{ per year.}$$

were T_{m50} being the age at which 50% of the population is mature.

The size at first maturity for *P.penicillatus* was found to be 79.2 mm, taking the growth parameters identified by J. PRESCOTT (1989) for *P. penicillatus* in Solomon Island (see below), it was found that a size of 79.2 mm corresponds to an age of about 2,35 years.

Growth parameters for *P. penicillatus*

Sex	Linf.	Growth coefficient	to
Males	143.9	0.294	-0.375
Females	113.4	0.499	-0.285

The natural mortality becomes equal to $M = 1.521/(2.35^{0.720}) - 0.155$ per year,

$M = 0.667$.

For the rock biotope on Mahé the MSY becomes 0.2 * 0.667 * 4.1 = 0.547 tonnes per year for Mahé island.

For the coral bictope the MSY becomes 0.2 * 0.667* 4.7 = 0.627 tonnes

In total on Mahé for both biotopes the MSY is equal to:

MSY for Mahé = 1.17 tonnes per year.

However as we could not survey unfished or less fished area for estimate of the virgin biomass, we took the standing stock on Mahé as a figure of virgin biomass. This may underestimate of the virgin biomass as illegal fishing did continued during the 1.3 years of closure before the survey.

Another approach to estimate the virgin biomass would be to consider the stations for which the maximum number of lobsters were found. For the rock biotope, the maximum number of lobsters found was equal to 18 lobsters per 2,500 m^2. For the reef biotope the maximum number of lobster was 30. If we assume that this represents a virgin condition and assigning a mean weight of 650 gr per lobster (9.5 cm mean length CL), we find for a rock station a virgin biomass of 11.7 kg. For a coral station the virgin biomass will be 19.5 kg

In Mahé for the rock biotope (2.035 Km^2) the virgin biomass will be of 9,5 tonnes and for the coral biotope (3.34 km^2) it will be 26 tonnes. In total the virgin biomass on Mahé would be 35.5 tonnes. This biomass then gives a MSY of:

MSY for Mahé = 0.2 * 0.667 * 35.5 = 4.73 tonnes.

Next, to calculate the MSY for the whole of the granitic plateau, if the standing biomass per area found on for the rock biotope on Mahé (5.08 kg/sation) is extrapolated to the entire rock area of the granitic plateau (84.8 km or 4,240,000 m^2, see table 2) representing the equivalent of 1696 stations, it is found that the standing biomass is 8.6 tonnes.

This gives for the hole rock biotope of the granitic plateau a MSY of:

0.2* 0.667* 8.6 = 1.14 tonnes

While for the coral area of the plateau (12,420,000 m^2) equivalent to 4,968 stations for which the standing biomass is 17.8 tonnes, the MSY is equal to :

0.2* 0.667* 17.8= 2.37 tonnes

In total we have:

MSY for both biotope of the plateau = 1.14 t + 2.37 t = 3.5 tonnes

Here again we utilized for extrapolation to the plateau area the standing stock found for Mahé as the virgin biomass underestimating of the real MSY of the plateau.

If for the plateau, we apply for the calculation of the virgin biomass, the logic based on the maximum number of lobsters found per station, we derive a virgin biomass on rocky areas of 19.8 tonnes (11.7 * 1696) while for the reef areas we have 96.8 tonnes (19.5 * 4968). The total virgin biomass would be 116.6 tonnes. In those conditions the MSY becomes :

MSY = 0.2 * 0.667 * 116.6 = 15.5 tonnes per year

Which corresponds to the yearly import of lobsters to supply the local demand in Seychelles.

As no data are available on virgin biomass, a conservative approach is needed for management purposes, the 1.17 tonnes on Mahé and the 3.5 tonnes for the plateau should be retained pending more indepth study of virgin biomass. The conservative approach is also proposed in view of the fact that, as mentioned earlier, only 33.9 % of the caught lobsters could be retained for a fishery.

In view of the limited stock on the granitic plateau the effort will have to be limited through the combination of a limited fishing season and a limited issue of fishing licences. The fishing season should be limited to a few months and open when the demand for lobsters is higher and good weather conditions prevails (ie. 3 months at the end of the year, November-January).

If we take the mean catch per unit of effort for skin divers of 4.75 lobsters per man-hour (Annex 18) and assiging a mean weight of 650 gr per lobster, we find that the weight of the catch is equal to 3.09 kg per man-hour. Assuming a mean fishing time of 6 hours per night per fisherman, the mean catch per night is equal to 18.5 Kg.

The MSY will then be reached by one fisherman afther a fishing effort of 1,170 kg/18.5 kg = 63.2 nights or in about 3.9 months, assuming 16 nights of fishing per month. In these conditions only one fisherman could operate in a 3 months fishing season. In case the second figure of MSY is proven (4.700 kg for Mahé), the MSY will be reached in 254 nights or in about 15.9 months. With a limited fishing season of three months, this give the opportunity for about 5 licences to operate in the surrounding waters of Mahé island.

For the hole plateau the MSY will be reached by one fisherman afther a fishing effort of 3500 kg/ 18.5 kg = 189.2 nights or in about 11 months. If the fishing season is limited to three months this allow the operation for about 4 (3.9) licences on the Mahé plateau. If the second figure of MSY of 12,900 kg for the plateau is proven, the MSY will be reached in 697 nights or in about 43 months by one fisherman. If the season is limited to 3 months a year, some 14 lobster fishermen could operate in the waters of the surrounding waters of the granitic island of the Mahé plateau.

8) MANAGEMENT OPTIONS

In Seychelles existing supporting biological material for spiny lobster management purposes remains limited and limited biological data are available to the resource manager in order to propose adequate management options for the fishery. The research program designed for the granitic area has not been completed and data generated by this study remain limited and should be refined, in particular:

- The MSY obtained for the granitic area is based on the standing stock and not on the virgin biomass. Virgin biomass should be determined from survey in unfished areas. The MSY is also based on the simple extrapolation of the Mahé results, and further studies should provide more accurate MSY.

- Seasonality of reproduction and reproductive potential of the population is not well known and should be determined to ascertain best fishing season and establish accurate minimal size limits. Size at first maturity should be confirmed based on more data

- Growth parameters for Seychelles lobsters should be determined (possibly by tagging experiments).

In view of the limited stock available on the granitic fishing grounds, and the limited amount of data gathered so far, it is recommended that the survey SFA has started on the granitic area should be completed, in order to define adequate management options before reopening the fishery.

To monitor properly the fishery, experience gained by managing lobster fisheries worldwide since the 1950's, may be applied to provide some guiding principles which need to be followed:

(1) Precise catch and effort, and length-frequency data are required for a first understanding of the effect of increasing fishing pressure on the population,

(2) The setting of a legal minimum size with adequate inspection and legislative backing is needed;

(3) Fishing effort restriction which may be combined with catch quotas, are needed to assist in obtaining maximum benefit from a spiny lobster resource;

(4) An effective and continuing communication system with the professional spiny lobster fishermen needs to be established to ensure that the objectives of management and methods employed are well understood.

(5) The effect of high exploitation rates on the stock/recruitment relationship is not well understood, and long run data on indices of recruitment success should be collected and analyzed. J.S.COBB and B.F.PHILLIPS (1980).

9) GENERAL CONCLUSION.

Maximum Sustainable Yield (MSY) for Mahé island was found to be 1.17 tonnes/year, and simple extrapolation of the Mahé data to the entire granitic plateau gives a MSY of 3.5 tonnes. This allows only one licensed fisherman to operate during a three months season. For the entire Mahé plateau only 4 licences could be issued. Further studies should be done to improve that estimate. It is recommended, that in 1992-1993 the research survey on the granitic plateau be finalised and better estimate of virgin biomass obtained to ascertain the MSY of 15.5 tonnes and the issue of 14 fishing licences for the plateau.

Before reopening the fishery, a monitoring system shoulcenced be prepared and implemented. This system should include a data collection system on length frequency, catch-effort and biometric data. A data analysis system should also be created.

In view of the small sizes and the poor catch rates observed in deeper waters no SCUBA diving should be authorized. It is proposed to have only a professional fishery authorized, no amateur fishery should be allowed. This will protect a portion of the population living in the deeper waters and contribute to the quality of tourism diving in the Seychelles. Licensed fishermen should be authorized to sell their lobsters to hotels and restaurants directly. A quota system could be established and the monitoring of catches and effort could be done directly through the fishermen, or via the hotels and restaurants.

The measures for limitation of the fishing effort should be accompanied by other measures on commercial aspects: Only licensed fishermen should be authorized to fish for spiny lobsters. Only licensed fishermen should be able to sell their catch personally to hotels and restaurants. Licensed fishermen, when fishing and selling lobsters, could carry a specific plastic card identifying the licence number. Enforcement patrols should verify at sea if fishermen are licensed. In case of offences, legal repressive measures should be defined and action be taken. For hotels and restaurants a control system should also be established. A ban of lobster fishing in Marine reserves and Park should be enforced.

Minimal size for *P.penicillatus* should be increased from 7.5 cm CL to 8 cm CL.

10) REFERENCES

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FORM No 1

LENGHT FREQUENCY DISTRIBUTION (CL)
AND PRESENCE OF EGGS FOR SPINY LOBSTERS

Annex 1

Species name: P. VERSICOLOR Name of station place: MAHE Station code: I A

Date: SEPTEMBER + OCTOBER 1991
Weight of catch: Moonphase: Time:

	MALES		FEMALES				MALES		FEMALES		
CL (mm)	Number of Males	Total	Nb of fem. without eggs	Nb of fem. with eggs	Total	LC (mm)	Nb of Males	Total	Nb.of fem. without eggs	Nb.of fem. with eggs	Total
22-<24						86-<88		0			0
24-<26						88-<90		0			0
26-<28						90-<92	11	2			0
28-<30						92-<94	1	1		1	1
30-<32						94-<96		0			0
32-<34						96-<98		0		1	0
34-<36						98-<100		0			0
36-<38						100-<102		0	1		1
38-<40						102-<104		0			
40-<42						104-<106	1	1	3		4
42-<44						106-<108					
44-<46						108-<110		11			
46-<48						110-<112					
48-<50						112-<114					
50-<52			1		1	114-<116					
52-<54	1	1			0	116-<118					
54-<56		0			0	118-<120					
56-<58		0			0	120-<122					
58-<60		0			0	122-<124					
60-<62	1	1			0	124-<126					
62-<64		0			0	126-<128					
64-<66		0			0	128-<130					
66-<68		0			0	130-<132					
68-<70	1	1	1		1	132-<134					
70-<72	11	2			0	134-<136					
72-<74		0			0	136-<138					
74-<76		0			0	138-<140					
76-<78		0			0	140-<142					
78-<80	1	1			0	142-<144					
80-<82	1	1			0	144-<146					
82-<84		0			0	146-<148					
84-<86		0			0	148-<150					

FORM No 1

LENGHT FREQUENCY DISTRIBUTION (CL)
AND PRESENCE OF EGGS FOR SPINY LOBSTERS

Species name: P. PENICILATUS Name of station place: MAHE Station code: I A

Date: SEPTEMBER + OCTOBER 1991
Weight of catch: Moonphase: / Time: /

	MALES		FEMALES				MALES		FEMALES		
CL (mm)	Number of Males	Total	Nb of fem. without eggs	Nb of fem. with eggs	Total	LC (mm)	Nb of Males	Total	Nb.of fem. without eggs	Nb.of fem. with eggs	Total
22-<24						86-<88	I	1			
24-<26						88-<90	I	1			
26-<28						90-<92	I	1	II	II	4
28-<30						92-<94	II	2		II	2
30-<32						94-<96		0	I		1
32-<34						96-<98	I	1		I	1
34-<36						98-<100		0			0
36-<38						100-<102	III	3	I	I	2
38-<40						102-<104		0	I	I	2
40-<42						104-<106	I	1			0
42-<44						106-<108		0	16		0
44-<46						108-<110		0			0
46-<48						110-<112	II	2			0
48-<50						112-<114	I	1		I	1
50-<52						114-<116		0			
52-<54						116-<118		0		18	34
54-<56						118-<120	I	1			
56-<58						120-<122		0			
58-<60						122-<124	I	1			
60-<62						124-<126	I	1			
62-<64	I	1	I		1	126-<128	I	1			
64-<66		0		I	1	128-<130	I	1			
66-<68	II	2		II	2	130-<132		0			
68-<70	IIII	4		I	1	132-<134	I	1			
70-<72	II	2		II	2	134-<136		0			
72-<74	I	1	IIII		4	136-<138		0			
74-<76	I	1	II	I	3	138-<140	I	1			
76-<78		0	I	I	2	140-<142		0			
78-<80	I	1		I	1	142-<144	I	1			
80-<82		0	II		2	144-<146		/			
82-<84		0		I	1	146-<148		34			
84-<86	I	1	I		1	148-<150					

FORM No 1

LENGHT FREQUENCY DISTRIBUTION (CL)
AND PRESENCE OF EGGS FOR SPINY LOBSTERS

Species name: P. LONGIPES | Name of station place: MAINE | Station code: I A

Date: SEPTEMBER + OCTOBER | Moonphase: | Time:

Weight of catch:

	MALES		FEMALES				MALES		FEMALES		
CL (mm)	Number of Males	Total	Nb of fem. without eggs	Nb of fem. with eggs	Total	LC (mm)	Nb of Males	Total	Nb.of fem. without eggs	Nb.of fem. with eggs	Total
22-<24						86-<88	1	1			0
24-<26						88-<90		0			0
26-<28						90-<92	1	1		1	1
28-<30						92-<94	1	1			0
30-<32						94-<96		0		15	0
32-<34						96-<98	11	2			0
34-<36						98-<100			1		1
36-<38						100-<102		17			
38-<40						102-<104			13		
40-<42						104-<106					
42-<44						106-<108					
44-<46						108-<110					
46-<48						110-<112					
48-<50						112-<114					
50-<52						114-<116					
52-<54						116-<118					
54-<56	1	1	1		1	118-<120					
56-<58		0			0	120-<122					
58-<60	1	1	1	1	1	122-<124					
60-<62		0	1		1	124-<126					
62-<64	1	1	1		1	126-<128					
64-<66		0	1		1	128-<130					
66-<68	1	1	11	1	3	130-<132					
68-<70	11	2	1		1	132-<134					
70-<72		0	1	111	4	134-<136					
72-<74		0	1	11	3	136-<138					
74-<76	1	1		1	1	138-<140					
76-<78	1	1		1	1	140-<142					
78-<80	111	3	1	11	3	142-<144					
80-<82		0		11	2	144-<146					
82-<84	1	1		1	1	146-<148					
84-<86	1	1			0	148-<150					

ANNEX 4: Mean size of males and females *P. penicillatus*

Class midpoint L_j	Frequency of Males (F_j)	$L_j * F_j$ Males	Frequency of Females F(j)	$L_j * F_j$ Females
5	0	0	0	0
57	0	0	0	0
59	0	0	0	00
61	0	0	0	0
63	1	63	1	63
65	0	0	1	65
67	2	134	2	134
69	4	276	1	69
71	2	142	2	142
73	1	73	4	292
75	1	75	3	225
77	0	0	2	154
79	1	79	1	79
81	0	0	2	162
83	0	0	1	83
85	1	85	1	85
87	1	87	0	0
89	1	89	0	0
91	1	91	4	364
93	2	186	2	186
95	0	0	1	95
97	1	97	1	97
99	0	0	0	0
101	3	303	2	202
103	0	0	2	206
105	1	105	0	105
107	0	0	0	0
109	0	0	0	0
111	2	222	0	222
113	1	113	1	113
115	0	0	0	0
117	0	0	0	0
119	1	119	0	119
121	0	0	0	0
123	1	123	0	0
125	1	125	0	0
127	1	127	0	0
129	1	129	0	0
131	0	0	0	0
133	1	133	0	0
135	0	0	0	0
137	0	0	0	0
139	1	139	0	0
141	0	0	0	0
143	1	143	0	0
145	0	0	0	0
Total	34	3,258	34	3,262
Mean size: Males=95.8 mm CL			Females=95.9 mm CL	

ANNEX 5: Mean size of *P. longipes*

Class midpoint L_j	Frequency of Males F_j	L_j*F_j Males	Frequency of Females F_j	L_j*F_j Females
55	1	55	1	55
57	0	0	0	0
59	1	59	2	118
61	0	0	1	61
63	1	63	1	63
65	0	0	1	65
67	2	134	3	201
69	0	69	1	69
71	0	0	4	284
73	1	73	3	219
75	1	75	1	75
77	3	231	1	77
79	0	0	3	237
81	1	81	2	162
83	1	83	1	83
85	1	85	0	0
87	1	87	0	0
89	0	0	0	0
91	1	91	1	91
93	1	93	0	0
95	0	0	0	0
97	2	194	0	0
99	0	0	1	99
101	0	0	0	0
103	0	0	0	0
105	0	0	0	0
107	0	0	0	0
109	0	0	0	0
111	0	0	0	0
113	0	0	0	0
115	0	0	0	0
117	0	0	0	0
119	0	0	0	0
Total	17	1,473	27	1,894
Mean size: Males=86.6 mm CL			Females= 70.1 mm CL	

ANNEX 6: Mean size of *P.versicolor*

Class midpoint L_j	Frequency of Males F_j	L_j* F_j Males	Frequency of Females F_j	L_j* F_j Females
51	0	0	1	51
53	1	53	0	0
55	0	0	0	0
57	0	0	0	0
59	0	0	0	0
61	1	61	0	0
63	0	0	0	0
65	0	0	0	0
67	2	134	0	0
69	1	69	0	69
71	2	142	0	0
73	0	0	0	0
75	0	0	0	0
77	0	0	0	0
79	1	79	0	0
81	1	81	0	0
83	0	83	0	0
85	0	85	0	0
87	0	0	0	0
89	0	0	0	0
91	2	182	0	0
93	1	93	1	93
95	0	0	0	0
97	0	0	0	0
99	0	0	0	0
101	0	0	1	101
103	0	0	0	0
105	1	105	0	0
107	0	0	0	0
109	0	0	0	0
111	0	0	0	0
113	0	0	0	0
115	0	0	0	0
117	0	0	0	0
119	0	0	0	0
Total	11	1,167	4	314
Mean size: Males= 106.1 mm CL			Females= 78.5 mm CL	

ANNEX 7: FREQUENCY DISTRIBUTION OF FEMALES *P.PENICILLATUS* CARRYNG EGGS UNDER THEIR TAILS. N=18.

Class midpoint	Relative frequency	Cummulative frequency
65	5.5	5.5
67	11.1	16.6
69	5.5	22.1
71	11.1	33.2
73	0.0	0.0
75	5.5	38.7
77	5.5	44.2
79	5.5	49.7
81	0.0	0.0
83	5.5	55.2
85	0.0	0.0
87	0.0	0.0
89	0.0	0.0
91	11.1	66.3
93	11.1	77.4
95	0.0	0.0
97	5.5	82.9
99	0.0	0.0
101	5.5	88.4
103	5.5	93
105	0.0	0.0
107	0.0	0.0
109	0.0	0.0
111	0.0	0.0
113	5.5	99.4

ANNEX 8: FREQUENCY DISTRIBUTION OF FEMALES *P.LONGIPES* CARRYNG EGGS UNDER THEIR TAILS.N=15.

Class midpoint	Relative frequency	Cummulative frequency
59	6.6	6.6
61	0.0	6.6
62	0.0	6.6
63	0.0	6.6
64	0.0	6.6
65	0.0	6.6
67	6.6	13.2
69	0.0	13.2
71	20.0	33.2
73	13.3	46.5
75	6.6	53.1
77	6.6	59.7
79	13.3	73.0
81	13.3	86.3
83	6.6	92.9
85	0.0	92.9
87	0.0	92.9
89	0.0	92.9
91	6.6	99.5

ANNEX 9

Panulirus penicillatus males

i	X(i)	Y(i)	N(i)
1	6.6800	250.0000	1.0000
2	6.8900	274.0000	1.0000
3	6.9000	290.0000	1.0000
4	6.9200	207.0000	1.0000
5	6.9800	294.0000	1.0000
6	7.1400	300.0000	1.0000
7	7.1600	313.0000	1.0000
8	7.4400	310.0000	1.0000
9	7.5600	330.0000	1.0000
10	7.6000	330.0000	1.0000
11	7.7000	355.0000	1.0000
12	7.9800	410.0000	1.0000
13	8.0600	430.0000	1.0000
14	8.1000	400.0000	1.0000
15	8.1400	440.0000	1.0000
16	8.2200	420.0000	1.0000
17	8.2700	430.0000	1.0000
18	8.3600	420.0000	1.0000
19	8.4000	520.0000	1.0000
20	8.4800	450.0000	1.0000
21	8.5400	480.0000	1.0000
22	8.5500	460.0000	1.0000
23	9.0700	600.0000	1.0000
24	9.2000	620.0000	1.0000
25	9.2100	640.0000	1.0000
26	9.2200	620.0000	1.0000
27	9.2200	650.0000	1.0000
28	9.3500	680.0000	1.0000
29	9.3800	645.0000	1.0000
30	9.5000	620.0000	1.0000
31	9.6000	650.0000	1.0000
32	9.7000	720.0000	1.0000
33	9.7700	730.0000	1.0000
34	9.8100	740.0000	1.0000
35	9.8600	570.0000	1.0000
36	9.9200	780.0000	1.0000
37	10.0000	800.0000	1.0000
38	10.2000	820.0000	1.0000
39	10.2500	780.0000	1.0000
40	10.2800	780.0000	1.0000
41	10.3300	770.0000	1.0000
42	10.3700	850.0000	1.0000
43	10.4300	860.0000	1.0000
44	10.6100	940.0000	1.0000
45	10.6700	930.0000	1.0000
46	10.6100	940.0000	1.0000

47	11.1000	1030.0000	1.0000
48	11.1100	1042.0000	1.0000
49	11.2600	1050.0000	1.0000
50	11.4300	1070.0000	1.0000
51	11.4500	1050.0000	1.0000
52	11.5000	900.0000	1.0000
53	11.5300	1150.0000	1.0000
54	11.5700	1220.0000	1.0000
55	11.6300	1090.0000	1.0000
56	11.6400	1200.0000	1.0000
57	11.6800	1110.0000	1.0000
58	11.9000	1370.0000	1.0000
59	12.0000	1250.0000	1.0000
60	12.0800	1380.0000	1.0000
61	12.3200	1350.0000	1.0000
62	12.3300	1350.0000	1.0000
63	12.3600	1360.0000	1.0000
64	12.3700	1260.0000	1.0000
65	12.4000	1350.0000	1.0000
66	12.4700	1170.0000	1.0000
67	12.5900	1400.0000	1.0000
68	12.6200	1600.0000	1.0000
69	12.6700	1550.0000	1.0000
70	12.7000	1440.0000	1.0000
71	12.7100	1352.0000	1.0000
72	12.7500	1430.0000	1.0000
73	12.7600	1555.0000	1.0000
74	12.8100	1420.0000	1.0000
75	13.0600	1450.0000	1.0000
76	13.1100	1500.0000	1.0000
77	13.1900	1700.0000	1.0000
78	13.3200	1700.0000	1.0000
79	13.3600	1550.0000	1.0000
80	13.3800	1950.0000	1.0000
81	13.7000	1520.0000	1.0000
82	13.7000	1830.0000	1.0000
83	13.9100	1930.0000	1.0000
84	13.9600	1350.0000	1.0000
85	14.1200	1900.0000	1.0000
86	14.2000	1280.0000	1.0000
87	14.3000	2100.0000	1.0000
88	14.4500	1970.0000	1.0000
89	14.5000	2100.0000	1.0000
90	14.5800	1900.0000	1.0000
91	14.6700	2200.0000	1.0000
92	14.7200	1620.0000	1.0000
93	14.8300	1600.0000	1.0000
94	14.9000	2200.0000	1.0000
95	14.9200	1900.0000	1.0000
96	14.9600	2000.0000	1.0000
97	15.0000	2040.0000	1.0000
98	15.2700	2450.0000	1.0000
99	15.3500	2350.0000	1.0000
100	15.4500	2550.0000	1.0000
101	15.4800	2407.0000	1.0000
102	15.5700	1970.0000	1.0000
103	16.0000	2750.0000	1.0000

ANNEX 10

Panulirus penicillatus females

i	X(i)	Y(i)	N(i)
1	6.3500	250.0000	1.0000
2	6.3800	261.0000	1.0000
3	6.5500	278.0000	1.0000
4	6.8000	323.0000	1.0000
5	6.8300	309.0000	1.0000
6	7.1000	301.0000	1.0000
7	7.4400	340.0000	1.0000
8	7.5000	340.0000	1.0000
9	7.5000	341.0000	1.0000
10	7.5000	370.0000	1.0000
11	7.6000	429.0000	1.0000
12	7.7700	390.0000	1.0000
13	7.7800	390.0000	1.0000
14	7.8100	430.0000	1.0000
15	7.8600	410.0000	1.0000
16	7.8900	370.0000	1.0000
17	7.9800	420.0000	1.0000
18	7.9800	430.0000	1.0000
19	8.0000	410.0000	1.0000
20	8.0500	410.0000	1.0000
21	8.0700	440.0000	1.0000
22	8.0800	424.0000	1.0000
23	8.1200	482.0000	1.0000
24	8.1500	440.0000	1.0000
25	8.2400	440.0000	1.0000
26	8.2400	490.0000	1.0000
27	8.2500	460.0000	1.0000
28	8.2600	450.0000	1.0000
29	8.2600	470.0000	1.0000
30	8.4300	480.0000	1.0000
31	8.4400	480.0000	1.0000
32	8.4400	480.0000	1.0000
33	8.4500	450.0000	1.0000
34	8.4600	480.0000	1.0000
35	8.4800	520.0000	1.0000
36	8.5000	500.0000	1.0000
37	8.5800	510.0000	1.0000
38	8.6000	506.0000	1.0000
39	8.6000	510.0000	1.0000
40	8.6300	550.0000	1.0000
41	8.7200	560.0000	1.0000
42	8.7400	550.0000	1.0000
43	8.8000	560.0000	1.0000
44	8.9100	580.0000	1.0000
45	8.9500	550.0000	1.0000
46	8.9500	560.0000	1.0000

47	8.9600	550.0000	1.0000
48	8.9900	570.0000	1.0000
49	9.0000	622.0000	1.0000
50	9.0300	600.0000	1.0000
51	9.1000	603.0000	1.0000
52	9.1500	610.0000	1.0000
53	9.3000	670.0000	1.0000
54	9.3100	650.0000	1.0000
55	9.3400	630.0000	1.0000
56	9.3800	737.0000	1.0000
57	9.5000	660.0000	1.0000
58	9.5500	690.0000	1.0000
59	9.6000	690.0000	1.0000
60	9.6200	740.0000	1.0000
61	9.6400	650.0000	1.0000
62	9.7000	790.0000	1.0000
63	9.7400	700.0000	1.0000
64	9.7800	720.0000	1.0000
65	9.8000	740.0000	1.0000
66	9.8400	750.0000	1.0000
67	9.9300	770.0000	1.0000
68	9.9600	780.0000	1.0000
69	10.1200	780.0000	1.0000
70	10.4900	880.0000	1.0000
71	10.5000	870.0000	1.0000
72	11.5000	1000.0000	1.0000
73	12.0800	1250.0000	1.0000

ANNEX II

Panulirus longipes males

i	X(i)	Y(i)	N(i)
1	5.5200	185.0000	1.0000
2	6.3800	264.0000	1.0000
3	6.7000	285.0000	1.0000
4	6.8500	271.0000	1.0000
5	6.8900	262.0000	1.0000
6	7.1500	350.0000	1.0000
7	7.2000	360.0000	1.0000
8	7.2700	360.0000	1.0000
9	7.6000	420.0000	1.0000
10	7.6400	460.0000	1.0000
11	7.7100	440.0000	1.0000
12	7.7600	450.0000	1.0000
13	7.7900	500.0000	1.0000
14	7.8000	440.0000	1.0000
15	7.8400	420.0000	1.0000
16	7.9300	500.0000	1.0000
17	8.0000	520.0000	1.0000
18	8.0600	400.0000	1.0000
19	8.0600	550.0000	1.0000
20	8.0700	540.0000	1.0000
21	8.1000	550.0000	1.0000
22	8.1100	510.0000	1.0000
23	8.1100	550.0000	1.0000
24	8.1300	550.0000	1.0000
25	8.1300	570.0000	1.0000
26	8.2100	550.0000	1.0000
27	8.2600	600.0000	1.0000
28	8.3000	600.0000	1.0000
29	8.3500	570.0000	1.0000
30	8.4500	600.0000	1.0000
31	8.5600	520.0000	1.0000
32	8.6000	620.0000	1.0000
33	8.6500	540.0000	1.0000
34	8.7300	630.0000	1.0000
35	8.7400	600.0000	1.0000
36	8.8400	680.0000	1.0000
37	8.9300	660.0000	1.0000
38	9.0100	667.0000	1.0000
39	9.0500	750.0000	1.0000
40	9.1000	790.0000	1.0000
41	9.1300	750.0000	1.0000
42	9.1500	610.0000	1.0000
43	9.2000	633.0000	1.0000
44	9.2200	750.0000	1.0000
45	9.3500	700.0000	1.0000
46	9.3800	800.0000	1.0000

47	9.4000	720.0000	1.0000
48	9.4100	700.0000	1.0000
49	9.4500	779.0000	1.0000
50	9.5200	750.0000	1.0000
51	9.5400	790.0000	1.0000
52	9.5900	825.0000	1.0000
53	9.6000	700.0000	1.0000
54	9.6700	900.0000	1.0000
55	9.7500	810.0000	1.0000
56	10.0000	850.0000	1.0000
57	11.3300	890.0000	1.0000

ANNEX 12

Panulirus longipes females

i	X(i)	Y(i)	N(i)
1	5.5200	177.0000	1.0000
2	5.8000	207.0000	1.0000
3	6.0000	236.0000	1.0000
4	6.1700	220.0000	1.0000
5	6.2000	255.0000	1.0000
6	6.2100	270.0000	1.0000
7	6.2400	250.0000	1.0000
8	6.3000	240.0000	1.0000
9	6.5000	262.0000	1.0000
10	6.6600	270.0000	1.0000
11	6.6900	279.0000	1.0000
12	6.7300	370.0000	1.0000
13	6.8200	136.0000	1.0000
14	6.9800	320.0000	1.0000
15	6.9900	350.0000	1.0000
16	7.0300	340.0000	1.0000
17	7.1200	338.0000	1.0000
18	7.1800	350.0000	1.0000
19	7.2000	274.0000	1.0000
20	7.2600	450.0000	1.0000
21	7.3300	302.0000	1.0000
22	7.4700	370.0000	1.0000
23	7.5800	469.0000	1.0000
24	7.6000	430.0000	1.0000
25	7.6600	440.0000	1.0000
26	7.9200	456.0000	1.0000
27	7.9400	450.0000	1.0000
28	7.9400	525.0000	1.0000
29	7.9500	510.0000	1.0000
30	7.9800	505.0000	1.0000
31	8.0100	474.0000	1.0000
32	8.2100	540.0000	1.0000
33	8.2300	550.0000	1.0000
34	8.2700	600.0000	1.0000
35	8.4900	570.0000	1.0000
36	8.6000	520.0000	1.0000
37	9.0800	720.0000	1.0000

ANNEX 13

Panulirus versicolor males

i	X(i)	Y(i)	N(i)
1	5.3800	150.0000	1.0000
2	7.0000	269.0000	1.0000
3	7.0000	274.0000	1.0000
4	8.0000	469.0000	1.0000
5	9.0500	670.0000	1.0000
6	9.1400	675.0000	1.0000

ANNEX 14

Panulirus versicolor females

i	X(i)	Y(i)	N(i)
1	5.0800	116.0000	1.0000
2	6.8300	255.0000	1.0000
3	9.2500	775.0000	1.0000
4	10.1800	1160.0000	1.0000

ANNEX 15 TOTAL NUMBER OF LOBSTER OBSERVED IN STATION AROUND MAHE ISLAND.

Station Location	Date in 1991	Time	Moon-phase	Total observed				Biotope type	Maximum depth	t_o	Observations
				PP	PL	PV	T.....	....			
Anse major	30/08	8.30	1	0	0	0	0	R	8.1	27	depleted?
Vista Do Mar	04/09	9.00	3/4	2	6	3	11	R	10.8	27	
Sunset	04/09	11.30	3/4	1	0	0	1	S	6	27	
Northolme	05/09	9.17	1	?	?	?	9	R	7.1		
Mare Anglaise	09/09	10.30	0	0	0	0	0	C	3.9	27	depleted?
Bel Ombre	09/09	8.40	1/2	0	0	1	1	R	4.7	27	
Auberge club	11/09	10.35	3/4	1	1	0	2	C	10.7	27	
Danzil	11/09	8.30	3/4	8	10	0	18	R	6.9	27	
Danzil	18/09	8.35	3/4	9	1	1	11	R	10	27	
Concep-tion	13/09	8.55	1/4	5	1	1	7	R	15	26.5	
Concep-tion	13/09	10.20	1/4	7	1	1	9	R	13.9	27	
Iles aux vaches	23/09	9.00	1	0	0	0	0	R	11.3	26.5	
Port Launay	26/09	10.15	3/4	0	0	1	1	R	14	27	
Cap Ternay	26/09	12.55	3/4	1	0	0	1	C	18	27	
Anse Cime-tiere	07/10	21.20	0	2	1	0	3	R	5.1	26.5	
Barbaron	07/10	20.30	0	7	0	0	7	C	10	26.5	
Pti Boileau	09/10	8.30	0	4	0	3	7	R	6		

Anse Louise	09/10	10.00		0	1	0	1	C	10	
Ile chauve Souris	11/10	8.55	1/4	4	2	1	7	R	11	
Anse à la Mouche	11/10	10.05	1/4	3	2	0	5	R	4	
Petite Anse	14/10	10.00	1/2	0	3	0	3	C		seen one turtle
Anse à la Mouche	14/10	1.15		0	3	0	3	C	12.7	
Anse Intendance	16/10	8.30	1/2	10	3	1	14	C	7.5	
Baie Lazare	21/10	11.05	1	29	0	1	30	C	5.9	
Roche Mancienne	21/10	8.50	1	7	5	0	12	R	8.5	
Petite Louise	23/10	10.45	1	9	1	0	10	R	10.8	
Anse Marie Louise	23/10	9.30	1	2	2	1	5	C	8	
Police Bay	25/10	10.30	3/4	11	6	0	17	R	10.4	
Anse Bougainville	29/10	1.20	0	0	0	0	1	1	C	10.6
Anse Parnel	28/10	10.15	0	8	0	0	8	C	13.2	
Anse aux Pins	29/10	9.30	0	0	3	0	3	C	8.5	
Anse Royale	29/10	11.00	0	0	0	0	0	C		
Total				129	52	16	206			
Species composition %				65.5	26.4	8.1				
Avg/station				4.2	1.7	0.5	6.4			

ANNEX 16 TOTAL NUMBER OF LOBSTER OBSERVED IN ROCK STATIONS AROUND MAHE ISLAND.

Station Location	Date in	Time	Moon-phase	Total observed				Biotope type	Maximum depth	t_o	Observations
				PP	PL	PV	T.....			....	
Anse major	30/08	8.30	1	0	0	0	0	R	8.1	27	depleted?
Vista Do Mar	04/09	9.00	3/4	2	6	3	11	R	10.8	27	
Northolme	05/09	9.17	1	?	?	?	9	R	7.1		
Bel Ombre	09/09	8.40	1/2	0	0	1	1	R	4.7	27	
Danzil	11/09	8.30	3/4	8	10	0	18	R	6.9	27	
Danzil	18/09	8.35	3/4	9	1	1	11	R	10	27	
Conception	13/09	8.55	1/4	5	1	1	7	R	15	26.5	
Conception	13/09	10.20	1/4	7	1	1	9	R	13.9	27	
Iles aux vaches	23/09	9.00	1	0	0	0	0	R	11.3	26.5	
Port Launay	26/09	10.15	3/4	0	0	1	1	R	14	27	
Anse Cimetiere	07/10	21.20	0	2	1	0	3	R	5.1	26.5	
Pti Boileau	09/10	8.30	0	4	0	3	7	R	6		
Ile chauve Souris	11/10	8.55	1/4	4	2	1	7	R	11		
Anse à la Mouche	11/10	10.05	1/4	3	2	0	5	R	4		
Roche Mancienne	21/10	8.50	1	7	5	0	12	R	8.5		
Petite Louise	23/10	10.45	1	9	1	0	10	R	10.8		
Police Bay	25/10	10.30	3/4	11	6	0	17	R	10.4		
Total				71	36	12	128				
Species Composition %				59	30	10					
Avg/station				4.4	2.2	0.7	7.5				
Variance				3.7	2,9	1	5.5				

ANNEX 17 TOTAL NUMBER OF LOBSTER OBSERVED IN CORAL STATIONS AROUND MAHE ISLAND.

Station Location	Date in	Time	Moon-phase	Total observed				Biotope type	Maximum depth	t_o	Observations
				PP	PL	PV	T.....			....	
Mare Anglaise	09/09	10.30	0	0	0	0	0	C	3.9	27	depleted?
Auberge club	11/09	10.35	3/4	1	1	0	2	C	10.7	27	
Cap Ternay	26/09	12.55	3/4	1	0	0	1	C	18	27	
Barbaron	07/10	20.30	0	7	0	0	7	C	10	26.5	
Anse Louise	09/10	10.00		0	1	0	1	C	10		
Petite Anse	14/10	10.00	1/2	0	3	0	3	C			seen one turtle
Anse à la Mouche	14/10	1.15		0	3	0	3	C	12.7		
Anse Inten-dance	16/10	8.30	1/2	10	3	1	14	C	7.5		
Baie Lazare	21/10	11.05	1	29	0	1	30	C	5.9		
Anse Marie Louise	23/10	9.30	1	2	2	1	5	C	8		
Anse Bou-gainville	29/10	1.20	0	0	0	1	1	C	10.6		
Anse Parnel	28/10	10.15	0	8	0	0	8	C	13.2		
Anse aux Pins	29/10	9.30	0	0	3	0	3	C	8.5		
Anse Royale	29/10	11.00	0	0	0	0	0	C			
Total				58	16	4	78				
Species composition%				74	20.5	5					
Avg/station				4.1	1.1	0.3	0.57				
Var				7.9	1.3	0.47	8				

ANNEX 18: CATCH-EFFORT DATA BASE FROM SURVEY AROUND MAHE ISLAND.

Station location	Date in 91	Time	Moon-phase	Effort Scuba divers	Catch Scuba divers				CPUE Scuba divers	Effort Skin divers	Catch Skin divers				CPUE Skin divers
					PP	PL	PV	T			PP	PL	PV	T	
Anse major	30/08	8.30	1	2.25	0	0	0	0	0	2.25	0	0	0	0	0
Vista Do Mar	04/09	9.00	3/4	3.35	0	3	1	4	1.2	0.66	2	3	2	7	21.2
Sunset	04/09	11.30	3/4	0.7	0	0	0	0	0	0.33	1	0	0	1	3.03
North-olme	05/09	9.17	1	1.86	0	1	0	1	0.54	1.16	1	1	0	2	1.72
Mare Anglaise	09/09	10.30	0	1.75	0	0	0	0	0	0.3	0	0	0	0	0
Bel-Ombre	09/09	8.40	1/2	1.98	0	0	0	0	0	1.2	0	0	0	0	0
Auberge club	11/09	10.35	3/4	2.25	0	0	0	0	0	0.66	1	1	0	2	3.03
Danzil	11/09	8.30	3/4	2.8	0	3	0	3	1.07	1.06	4	5	0	9	8.49
Danzil	18/09	8.35	3/4	1.75	0	1	1	2	1.14	1.33	5	0	0	5	3.75
Concep-tion	13/09	8.55	1/4	1.56	0	1	1	2	1.28	1.1	5	0	0	5	4.5
Concep-tion	13/09	10.20	1/4	1.7	0	1	1	2	1.18	0.66	7	0	0	7	10.6
Iles aux vaches	23/09	9.00	1	3.84	0	1	0	1	0.26	1	1	0	0	1	3.84
Port Launay	26/09	10.15	3/4	2.2	0	0	1	1	0.45	0.16	0	0	0	0	0
Cap-Ternay	26/09	12.55	3/4	1.25	0	0	0	0	0	0	0	0	0	0	0
Anse Cime-tiere	07/10	21.20	0	2.25	0	0	0	0	0	0.66	2	1	0	3	4.54
Bar-baron	07/10	20.30	0	2.49	0	0	0	0	0	0.66	4	0	0	4	6.06
Pti Boil-eau	09/10	8.30	0	1.16	0	0	1	1	0.86	0.33	2	0	0	2	6.06

Anse-Louise	09/10	10.00		0.83	0	0	0	0	0	0.16	0	1	0	1	6.25
Ile chauve Souris	11/10	8.55	1/4	1.5	0	0	1	1	0.66	0.82	3	0	0	3	3.66
Anse à la Mouche	11/10	10.05	1/4	0.4	0	0	0	0	0	0.5	1	1	0	2	2.5
Petite Anse	14/10	10.00	1/2	1.96	0	3	0	3	1.53	0	0	0	0	0	0
Anse à la Mouche	14/10	1.15	0	1.83	0	2	0	2	1.09	0	0	0	0	0	0
Anse Intendance	16/10	8.30	1/2	2.2	1	1	0	2	0.91	0.66	2	2	0	4	6.06
Baie Lazare	21/10	11.05	1	1.85	0	0	0	0	0	1	14	0	0	14	14
Roche Mancienne	21/10	8.50	1	3.9	0	0	0	0	0	0.83	6	2	0	8	9.64
Petite Louise	23/10	10.45	1	2.15	0	1	0	1	0.46	0.82	3	0	0	3	3.6
Anse Marie Louise	23/10	9.30	1	0.65	0	1	0	1	1.54	0.66	2	0	1	3	4.54
Roche Sud	25/10	10.30	3/4	2.13	0	4	0	4	1.87	0.83	5	0	0	5	2.67
Anse Bougainville	29/10	1.20	0	1.5	0	0	1	1	0.66	0	0	0	0	0	0
Anse Parnel	28/10	10.15	0	1.32	0	3	0	3	2.27	0	0	0	0	0	0
Anse aux Pins	29/10	9.30	0	1.90	0	3	0	3	1.58	0	0	0	0	0	0
Anse Royale	29/10	11.00	0	0.66	0	0	0	0	0	0	0	0	0	0	0
TOTAL/AVG				59.92	1	29	8	38	0.63	19.8	73	18	3	94	4.75