Chapter 5.2
A Review of the Spiny Lobster Fishery in the Tolagnaro (Fort-Dauphin) Region

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Abstract

The spiny lobster fishery is currently the most important economic activity in the Tolagnaro region. In 2004, the closing season for catching these animals shifted from January - March to October - December, the time of the reproductive cycle. It is assumed that this shift will offset increasing pressure on the spiny lobster resource, which has been over-exploited for some time. The status of the spiny lobster fishery in the Tolagnaro region is examined, based on governmental documents and our own surveys carried out in 2005. A trend analysis based on catch per unit effort and indicators of over-exploitation, such as the number of under-sized individuals captured, shows that the resource may collapse within the next 10 years, and may already be beyond recovery.

Résumé

Revue de l'activité de pêche de la langouste dans la région de Tolagnaro (Fort-Dauphin) à Madagascar. L'activité de pêche de la langouste est actuellement l'activité économique la plus importante de la région de Tolagnaro. La fermeture de la saison de pêche de ces animaux a été récemment revue pour l'ensemble de l'île en 2004 pour passer de la période comprise entre les mois de janvier à mars à celle définie du 1er octobre au 31 décembre (saison de reproduction). Il est prévu que ce décalage excentrera la pression de pêche, à court terme, sur les langoustes qui ont été surexploitées pendant un certain temps. Le statut de la pêche locale à la langouste est examiné ici à partir de documents gouvernementaux et de nos propres investigations menées en 2005. Une analyse des tendances à partir des captures par unité d'effort et d'autres indicateurs d'une surexploitation tels que le nombre d'individus capturés n'atteignant pas la taille requise, prouvent que la ressource peut s'effondrer au cours des 10 années à venir et pourrait déjà se trouver à un point de non retour.

Introduction

The spiny lobster fishery is the most important economic activity in the Tolagnaro (Fort Dauphin) region of southeastern Madagascar. Regional exploitation of these animals accounts for approximately 70% of the country's spiny lobster fishery production (Rabarison 2000). There are five spiny lobster species exploited in the Tolagnaro region: *Panulirus homarus, P. penicillatus, P. ornatus, P. versicolor*, and *P. longipes*. These species all belong to the Family Palinuridae and are principally found in coastal areas on rocky shoals or reefs at a depth of 1 to 45 m. Holthuis (1991) provides synopses of the biology, reproduction, and geographical distribution of each species.

The Tolagnaro region, as defined by several authors (Rabarison 2000, Bautil 2002, Raharimanana 2003), extends approximately 450 km from Androka, which is southwest of Toliara, to Sandravinany, north of Sainte Luce. Tolagnaro has become the core of the spiny lobster fishing industry with the establishment of several seafood processing plants. The region is economically disadvantaged, whereby the fishermen practice their trade according to traditional methods using local materials, and technical expertise is passed on from one generation to the next.

Several methods are used to capture spiny lobsters including traps, nets, and by hand while snorkeling. In the Tolagnaro region, fishermen predominantly use lobster traps (measuring approximately 0.5 m wide x 0.4 m long x 0.25 m high) made of

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vahipiky (*Flagellaria indica*), a creeper plant occurring locally (see Rabenantoandro *et al*. Chapter 6.7). Lobster traps are generally baited with mussels or oysters, and rocks are used to weight them down. Hence, all materials, including the canoes, used in the spiny lobster fishery are indigenous and obtained locally. Lobster traps are used to the north of Tolagnaro, while nets and snorkeling are the prefered fishing techniques to the south.

There are several seafood processing plants in Tolagnaro that buy spiny lobster from fishermen for exportation to Europe, Japan, and other Asian destinations. A review of the data obtained from the "Chef de Circonscription de la Pêche et des Ressources Halieutiques de Tolagnaro" (the local fishery officer) for the years 1990 to 2005 showed that the processing plants handled approximately 250 to 300 metric tons of spiny lobsters per year, which averages 279.6 metric tons (Table 1). For a few years, for example from 1991 to 1993 and for 1999, spiny lobster catches were less than 250 metric tons per year. Conversely, for 1994, 1998, 2001, and 2003, annual captures exceeded 300 metric tons. *Panulirus homarus* constitutes the majority of the catch, and, depending on the year, it can account for up to 70% of the spiny lobster landings (Rabarison 2000, Bautil 2002).

Table 1. Spiny lobster (genus *Panulirus*) production for the Tolagnaro region from 1990 to 2005.

Year	Production (kg)
1990	257,248
1991	236,815
1992	206,436
1993	238,776
1994	302,058
1995	266,760
1996	280,663
1997	274,651
1998	317,114
1999	223,840
2000	273,167
2001	358,987
2002	292,002
2003	385,823
2004	Data not available
2005	280,776
Average	279,674

These catches of approximately 250 to 300 metric tons per year make Tolagnaro the most important spiny lobster production center in Madagascar. In addition, the contributions of about 30 villages in the Tolagnaro region constitute 70% of the total national production (Rabarison 2000). According to our review, two thirds of the catches are fished north of Tolagnaro, of which Sainte-Luce is the most important sector, while the remaining one third of the catches are taken from waters south of Tolagnaro.

The goal of this chapter is to extrapolate from catch data aspects of the development of the Tolagnaro region lobster fishery, and the population dynamics of the local lobster populations. The results are then used to forecast potential consequences of present fishing activities.

Methods

A monitoring program to collect baseline spiny lobster fishery data was initiated in 2005 prior to the construction and operation of a new port. This new port is to be located adjacent to the Ehoala Peninsula and immediately southwest of Tolagnaro (Fig. 1). The following landing sites (i.e., sites where fishery processing plant representatives meet with fishermen to buy their lobster catch) were surveyed: 1) Ehoala Peninsula - sites of Bevava and Somatraha, and 2) Tolagnaro Peninsula - sites of Libanona, Ampotatra (west of the Miramar Hotel), and the existing Tolagnaro Port. Each individual landing site was surveyed to obtain spiny lobster catch statistics. Fishermen using these landing sites fish within the Fausse Baie des Galions and off the Ehoala and Tolagnaro promontories.

A questionnaire and data sheet was developed and QMM field staff was trained by Jacques Whitford Ltd. personnel to carry out the surveys. Depending on the site, a number of days were spent interviewing fishermen and recording statistics (such as spiny lobster species, number of individuals per species, sex of individuals, sub-sample of weight and length of lobsters, method of catch, time spent fishing, etc.) for each of the fishermen's catch. These data were then used to calculate an average Catch per

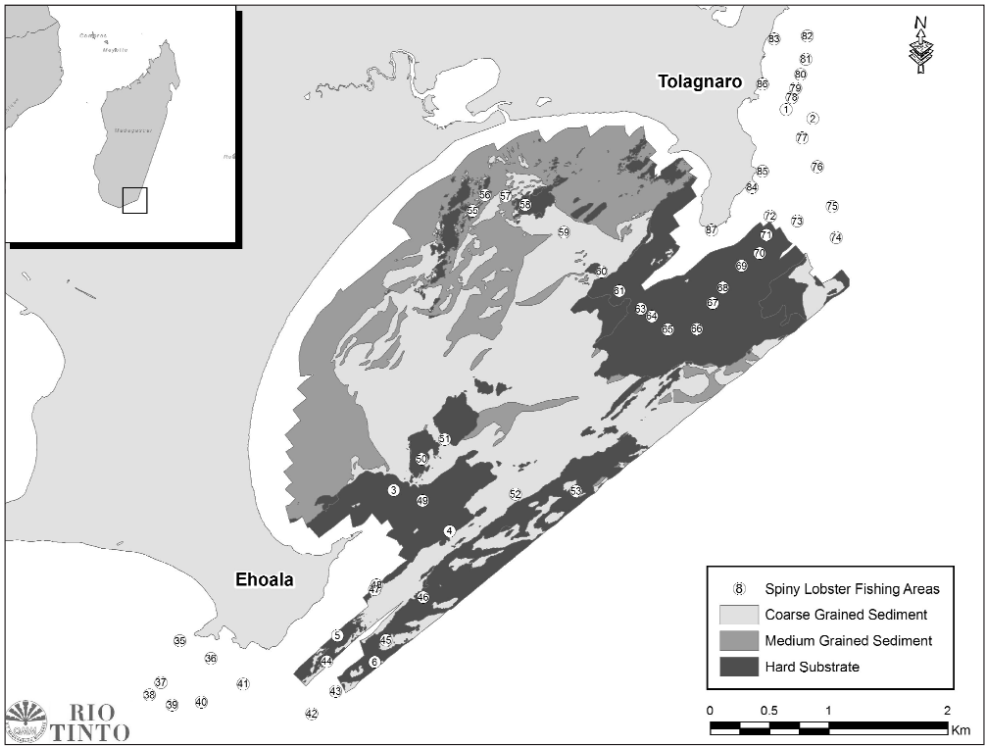

Figure1. Map of the lobster fishing areas in the immediate area of Tolagnaro.

Unit of Effort (CPUE) for each landing site. The total catch of spiny lobster for each individual fisherman was obtained from the processing plant collectors. In addition, the Shannon-Weaver diversity index (H') was calculated for each landing site ($H' = -\sum [(Ni/N) \times \log_2 (Ni/N)]$, where Ni = number of individuals of a given species, and N = total number of individuals) to get an idea of species diversity.

Three surveys were carried out at the landing sites noted above in 2005. They covered the time periods of January 10 - February 18, April 14 - 18, and June 20 – 23. The January/February 2005 survey was by far the most comprehensive. It coincided with the first month of the open lobster fishing season. Furthermore, because of logistical constraints, it was not possible to survey all landing sites during the three survey periods, and therefore, only the January/February survey is presented below. However, the CPUE summary for 2005 is based on all three survey periods. These data were then used to create a regression analysis along with data obtained from the literature for other years. The regression was calculated with SYSTAT® statistical computer software (version 10.2).

Various government documents produced by local experts and the Food and Agriculture Organization (FAO) discussing the status of the spiny lobster fishery were reviewed (Mara 1993, Raharimanana 2002, Rakotozanany 2002, Harris and Rakotomavo 2003, MAEP 2003, 2004a, 2004b).

Results

January/February 2005 fisheries survey

Somatraha and Bevava (Ehoala) Landing Sites

During this survey, approximately 211 fishermen coming from 113 families used the Somatraha and Bevava landing sites of Ehoala. Of the 73 fishermen counted at Somatraha, only 60 were surveyed. It was found that fishermen use 6-7 traps each (average = 6.6 traps; standard deviation (SD) ± 2.9 traps) when fishing for spiny lobsters. As is the case here, and for the other landing sites, traps are usually set in the afternoon or evening and retrieved in the early morning of the following day. Traps were set in about 17 offshore areas at an average depth of approximately

21 m (20.9 ± 10.3 m) for approximately 19 hours of fishing time (19h15 ± 2h50).

Fishermen using traps caught an average of 901.5 g (± 757.7 g) of lobster during an average fishing time of approximately 19h. Extrapolating for a 24h fishing period yields 1138.7 g/fisherman/day when using 6-7 traps, which is the equivalent of a CPUE of 172.5 g/trap/day (1138.7 g divided by 6.6 traps per fisherman). Each fisherman using nets caught, on average, 1753.2 g (± 988.2 g) during an average fishing time of approximately 16.5h. Extrapolation of a 24-h fishing period results in 2250 g/fisherman/day. The average number of nets used by each fisherman is unknown. Only two divers were present during this survey period. One diver caught 2100 g during a 5-h diving period, while the other caught a 650 g spiny lobster during a 1.5-h diving period. This represents a CPUE of 426.6 g/hour. During this survey at this site, 51.9% of all spiny lobsters caught were male and 48.1% were female. Among the females, 38.5% were egg-bearing.

Libanona landing site

Approximately 63 fishermen from 48 families used this landing site, and 59 of which were surveyed. It was found that each fisherman used, on average, seven traps (7 ± 2.6 traps) when fishing for spiny lobsters. Traps were set offshore in 14 areas at an average depth of approximately 32 m (± 17 m) for approximately 18.5 hours of fishing time (18h20 ± 4h10). One trap was recorded as having been set for 88 h;and was excluded from the calculations because it could not be determined whether this was a transcription error.

Fishermen using traps each caught an average of 808.7 g (± 734 g) of lobster during an average fishing time of approximately 18.5 h. Extrapolating for a 24-h fishing period yields a CPUE of 1049.3 g/fisherman/day for this site when using an average of 7 traps. This is equal to a CPUE of 149.9 g/trap/day. Only two fishermen were surveyed using nets, and the average catch was 850 g/fisherman for an average fishing time of 15.5 h. However, the number of nets is unknown. This equates to a CPUE of 1316.1 g/fisherman/day. At this site, diving (snorkeling) is practiced extensively. Fifty divers were surveyed between January 19 and February 10. Fishermen spent an average of approximately 90 minutes diving (92 ± 60 min) at an average depth of approximately 12 m (± 3.3 m). Fishermen caught, on average, 978.1 g (± 776.8 g) of spiny lobster while snorkeling for an average of only 90 minutes. This yields a CPUE for a 24-h fishing period of 15,649 g (or 15.65 kg) of spiny lobster with an average size of 18.1 cm. This represents a CPUE of 652.1 g/hour. During this site survey, 49.7% of all spiny lobsters caught were male and 50.3% were female. Among the females, 64.5% were egg-bearing.

Tolagnaro Port landing site

Approximately 92 fishermen from 82 families used this landing site, and 56 of which were surveyed. Fishermen working out of this landing site tended to use more traps during their outings. In addition, they generally do not snorkel to fish for spiny lobsters. Indeed, it was found during this survey that the local fishermen use, on average, 17.7 traps (± 7.2 traps), with some fishermen using as many as 30-40 traps. Traps were set offshore in 6 areas at an average depth of 26.2 m (± 4.70 m) for approximately 27 h of fishing time (26h45 ± 1h10). Fishermen using traps each caught an average of 1026.1 g (± 471.2 g) of lobster during an average fishing time of approximately 27 h. Extrapolating for a 24-h fishing period yields a CPUE of 912 g/fisherman/day for this site. Using an average of about 18 traps, the CPUE is calculated at 50.6 g/trap/day. During this site survey, 46.9% of all spiny lobsters caught were males and 53.1% were females. Among the females, 47% were egg-bearing.

Summary

The average CPUE for fishermen using traps during the January/February 2005 survey based on the three landing sites (1138.5, 1049.3, and 912.0 g/fisherman/day) is 1.03 kg/fisherman/day, with an average of 11 traps/fisherman. The average CPUE of fishermen using traps for all landing sites during the different survey periods was: January/February 2005 survey - average CPUE = 1.03 kg/fisherman/day (average of 11 traps/fisherman); April 2005 survey - average CPUE = 1.54 kg/fisherman/day (average of 11 traps/fisherman); and July 2005 survey - average CPUE = 0.54 kg/fisherman/day (average of 8 traps/fisherman). Thus, the overall CPUE is 1.035 kg/fisherman/day based on an overall average of 10 traps/fisherman.

Species diversity of captured spiny lobster

Five species of spiny lobster were captured by fishermen. A total of 2059 individuals were caught during the survey from 10 January to 18 February 2005. Table

Table 2. Number of spiny lobster and species caught by fishermen at the three landing sites in Tolagnaro in January/February 2005 (Sylvestre 2005).

Species	Landing Site			Total
	Libanona	Ehoala	Tolagnaro Port	
Panulirus longipes	691	350	343	1384
P. homarus	185	231	140	556
P. penicillatus	74	33	9	116
P. versicolor	2	0	0	2
P. ornatus	1	0	0	1
Total number of individuals	953	614	492	2059
Species Diversity Index (H')	1.11	1.22	0.98	

2 summarizes the number of spiny lobster caught by species and by fishermen at the Libanona, Ehoala, and Tolagnaro Port landing sites, along with the Shannon-Weaver diversity index (H').

Panulirus longipes was the most abundant species caught at all three landing sites, and accounted for 67.2% of the total catch. *Panulirus homarus* made up 27.0% and *P. penicillatus* 5.6% of the catch, while *P. versicolor* and *P. ornatus* both made up less than 1% of the total. *P. homarus* has the largest range of capture in the Tolagnaro region (over 450 km). In some years, it accounts for up to 70% of the spiny lobster landings (Rabarison 2000, Bautil 2002). Based on this survey, however, it would appear that *P. longipes* is the most abundant species caught at the Tolagnaro landing sites.

In Table 2, the index for species diversity is slightly higher for Ehoala compared to the two other sites. It should be noted that the index for diversity is based on spiny lobster species captured, and does not necessarily reflect the diversity in natural habitats. The majority of fishermen use traps to capture spiny lobster and *P. versicolor* is reported not to enter traps (DeBruin 1962, Pichon 1964, Prescott 1988). Similarly, *P. ornatus* is also fished throughout, but often in small quantities (Holthuis 1991) because apparently it too does not enter traps (Chittleborough 1974, Juinio and Gomez 1986, Prescott 1988, Phillips and Trendall 1989).

Our study area covers only a portion of the spiny lobster fishing zone in the region of Tolagnaro. It is likely that the conclusions may change with data from additional areas of the fishing zones of the region. The diminishing supply and scarcity of mussels in the region, the preferred bait for traps set to capture *P. homarus* according to local fishermen, may be the cause for the decreased capture of this species. In the absence of mussels, local fishermen currently rely on sea urchins and shells from other animals as bait in their traps. Abiotic environmental conditions such as temperature, salinity, turbidity, currents, depth, and type of shelter (rock, coral, sand, or mud) determine the preferred habitat of each species (Pichon 1964, Berry 1971, George 1974, Holthuis 1991). Therefore, it is possible that the environmental conditions in Fausse Baie des Galions are more favorable for *P. longipes* than for other spiny lobster species.

Catch size of spiny lobster

Because of national legislation, it is illegal to keep a spiny lobster with a total length below 20 cm (measured from the rostrum to the telson) and to keep egg-bearing females. Theoretically, if captured, these lobsters must be released. Surveys carried out in villages north and south of Tolagnaro showed that most captured spiny lobster were under the legal size of 20 cm. Various government documents reviewed (Rabarison 2000, Bautil 2002) state that although the 20 cm minimum catch size is to be respected, a minimum size of 16 cm is now tolerated. The panel of experts producing these surveys and reports suggested that the 16 cm length should be raised to at least 18 cm. It is speculated that the reason the legal size is not respected is that small spiny lobsters are preferred for exportation. The data listed in Table 3 show the percentage of individual spiny lobsters under the legal catch size for various years based on available data. This information was obtained from Bautil (2002) from surveys and reports carried out in an inconsistent and haphazard fashion by various scientists, researchers, and government bodies.

During our survey, however, only 19.7% of the spiny lobsters caught at the three landing sites were found to be less than 18 cm in length (Sylvester 2005). On average, animals measured 20.3 cm at the

Table 3. Percentage of captured spiny lobsters (genus *Panulirus*) under the legal catch size for various years based on data presented in Bautil (2002).

Year	Percent of catch under legal size of 20 cm
1989	57% of male and 62.4% of female of *P. homarus*
1990	75% of females *P. homarus* (no data for males)
1994	63% of all captured *P. homarus*
1995	57% of all captured *P. homarus*
1999	80% of all spiny lobster species
2000	80% of all spiny lobster species
2002	93% of male and 90% of female of *P. homarus*

Ehoala landing site, 19.8 cm at Libanona, and 19.0 cm at Tolagnaro Port. At Ehoala, only 10.6% of lobsters caught measured less than 18 cm, while this figure is 17.1 % at the Tolagnaro Port and 28.7% at Libanona (Fig. 2). In addition to the problem of being under-sized, a large proportion of the collected *P. homarus* females (in years when data are available) were egg-bearing: 29.3% in 1989; 58.7% in 1999, and 71.3% in 2000 (Bautil 2002). Our survey of unidentified lobsters carried out at the three landing sites during January/February 2005, found that egg-bearing females made up 38.5% at Ehoala and 64.5% at Libanona.

Trend of the spiny lobster fishery

Further evidence that the spiny lobster fishery is being acutely over-exploited is provided by two surveys carried out at Evatraha, just north of Tolagnaro. These surveys revealed that in 1989 there were, on average, 3.5 traps being used by each local spiny lobster fishermen, but that by 2002 this had increased to 10.5 (Bautil 2002). This latter figure is in agreement with our survey, which found that the average number of traps per fisherman for all three landing sites is 10.

Although this trend of increasing the number of traps and fishing effort may only be occurring locally, anecdotal information suggests that, over the years, fishermen have increased the number of traps used and the amount of geographic area covered by them. In addition, several spiny lobster fishermen interviewed, especially those at Libanona Beach adjacent to Tolagnaro, were found to be abandoning the use of traps in favor of snorkeling. A survey of several fishermen from this area showed that those snorkeling less than 1.5 hours were able to obtain approximately the same quantity of spiny lobster as individuals using seven traps over 15 to 19 hours. The lobster fishermen association of the Sainte Luce area has agreed to ban the use of snorkeling techniques in spiny lobster fishing.

Although fishermen from the Tolagnaro region might be increasing the number of traps, as the Evatraha data and this survey suggests, there is no corresponding increase in the number of animals being captured. Bautil (2002) reported that in 1989, fishermen were catching 2.33 kg/fisherman/day, in 2000 the catch decreased to 1.35 kg/fisherman/day, and in 2002 the catch had fur-

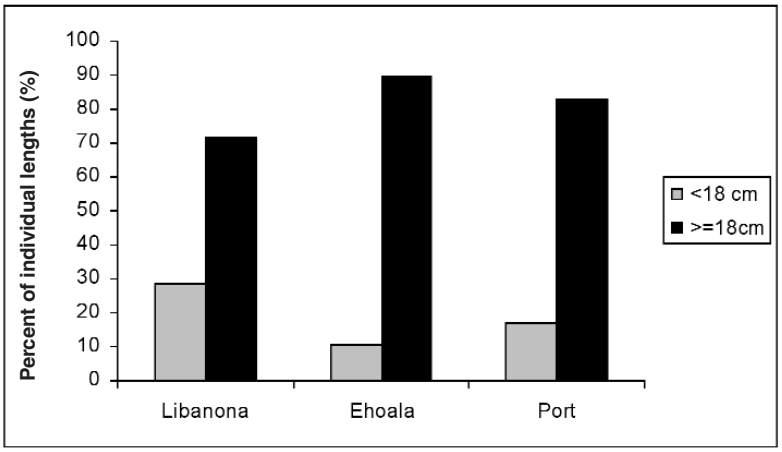

Figure 2. Percent distribution of the length of spiny lobster (genus *Panulirus*) fished in Tolagnaro during the January/February 2005 survey (from Sylvestre 2005).

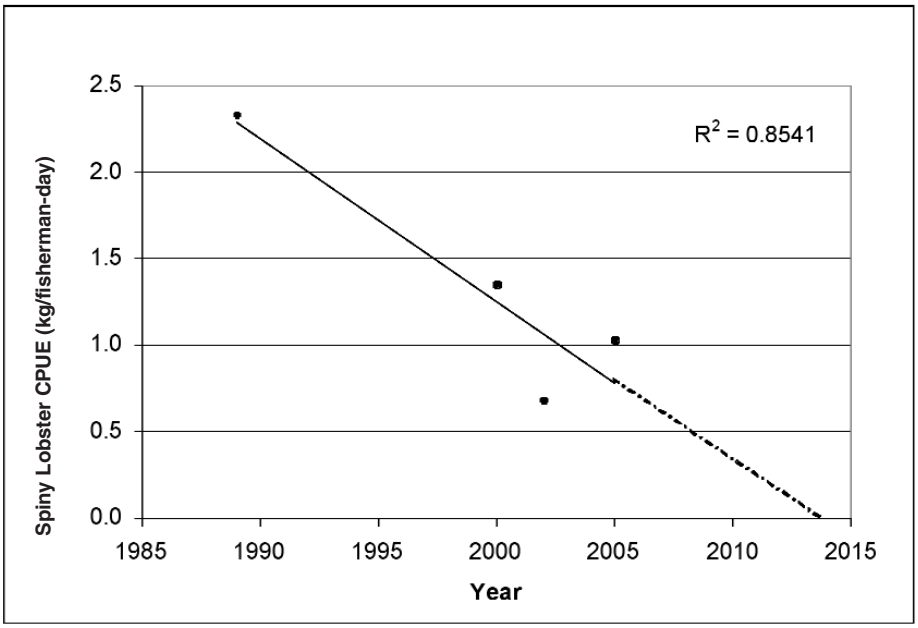

Figure 3. Trend of spiny lobster Catch per Unit of Effort (CPUE) in the Tolagnaro region.

ther declined to 0.68 kg/fisherman/day. Our survey in 2005 shows the average catch to be 1.03 kg/fisherman/day for all three landing sites and all survey periods of the fishing season.

It was not possible to determine whether the varying numbers of lobster traps used throughout the years was considered in the determination of the catch per unit effort (CPUE) data listed above by Bautil (2002). Regardless, a least square linear regression plot of CPUE measured as kilograms of spiny lobster caught per fisherman per day against year shows a declining trend in CPUE (Fig. 3). The regression equation is: spiny lobster CPUE = 189.34 - 0.0940 * year (R^2 = 0.85, p = 0.07). The standard error of the coefficient for the constant (189.34) and for the slope (-0.0940) are ± 54.93 and ± 0.0274, respectively. Despite the small sample size, the regression might reflect a meaningful tendency with respect to CPUE. If the extrapolation is correct, the CPUE for spiny lobster may reach zero kg/fisherman/day in 2014-2015 (Fig. 3).

Discussion

The analysis presented here of the trend of the collapsing spiny lobster fisheries of the Tolagnaro region is only based on four data points (Fig. 3). However, several other points help to support the poor future prospects of these fisheries: data on the elevated illegal size catches for various years (Table 3), the elevated catches of egg-bearing females (especially for the years 1999 and 2000), the increasing number of lobster traps being used (as suggested by the Evatraha data), the increase in the use of snorkeling, at least to the west of Tolagnaro, and the fact that in 1987 there were 1470 fishermen counted in the region, but by 1998 that number had increased to 2038, a 39% increase (Bautil *et al.* 2002). These combined data suggest that unless local fishing practices are changed it is highly likely that the spiny lobster fishery in the Tolagnaro region will collapse within 10 years.

Prior to 1962, the closure of the lobster fishing season was between October and January. From 1962 until 2003, this close had been shifted to be between January and March by the Ministère de l'Agriculture, de l'Elevage, et de la Pêche, Direction de la Pêche et Ressources Halieutiques de Madagascar. The closure of the spiny lobster fishing season was based on weather conditions not on the spiny lobster reproduction cycle, as the period between January and April is cyclone season. Beginning in 2004, the closure of the season was shifted back to be between 1 October to

31 December. The authorities have concluded that by shifting the closure back to be between October and January, not only is the spiny lobster reproduction cycle favored, but, given there are reduced fishermen activities between January and April associated with sea conditions, the spiny lobster fishery theoretically has a double chance of recovery. However, the off-season should to be extended beyond December. More importantly, the results from the January/February survey show that half of the females caught were still egg-bearing at this time of the year.

In addition to the recommendation of the season shift, the panel of local and FAO experts also recommended: the closure of the spiny lobster fishery for two years with appropriate government economic support for fishermen, incentive for fishermen to observe legal size of catch, and adding openings in traps to allow undersized spiny lobsters to escape.

Considering that 2004 was the first year that the spiny lobster season had been shifted, it is too early to assess the effect of this change on local lobster population dynamics. More complete and standardized data are needed on the reproductive cycle of the spiny lobster to develop appropriate management strategies, which will aid in the determination of the appropriate parameters for the season and for the minimum catch size. Finally, the willingness of the fishermen themselves to follow these regulations and a law enforcement group to enforce them when the former is absent are both needed to allow the local fisheries to recover. Given the economic importance of spiny lobster fisheries on local and national scales, measures need to be taken and enforced to enhance their recovery.

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