

## Morphometric Relationships for the Spiny Lobster (*Panulirus argus*) in Belize

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### ABSTRACT

The spiny lobster (*Panulirus argus*) fishery is the most valuable in Belize. Management measures to promote the long term sustainability of the fishery include minimum size limits for harvested individuals. The regulations specified a minimum carapace length of 83 mm (3.25 in.) and a minimum tail weight of 113.4 g (4.0 oz.). Fishermen had indicated that these two size specifications were inconsistent with each other. Historically, this was not an issue as the fishery landed the tails only, however there has been a recent development of a market for whole lobsters. It was claimed that lobsters landed whole and rejected as undersized, based on carapace length, were being tailed off and sold as the tails were over the minimum tail weight requirement.

The Belize Fisheries Department undertook a study to investigate appropriate size limits that were consistent with each other. Morphometric data was collected from lobsters being landed at two of the largest fishermen's cooperatives in Belize. The data were analysed and length/weight relationships were determined for a variety of body regions. The results supported the fishermen's observation that the size specifications in the existing fisheries regulations were inconsistent with each other. The minimum legal tail weight of 113.4 g corresponded most closely with a carapace length of 71 mm (2.8 in.).

**KEYWORDS:** Belize, length-weight relationships, morphometrics, *Panulirus argus*.

### INTRODUCTION

The fishing industry in Belize is highly lucrative and in 1991 it was the fifth largest foreign exchange earner for the country. The spiny lobster (*Panulirus argus*) accounted for approximately 60%, or US\$6,000,000 of the total fishery revenue. The industry also provides employment for approximately 2,000 full and part-time fishermen (Auil, 1992). Catch peaked in 1985 at 316,000 kg of

lobster tails and since then catches have declined. Although catches have declined, the value has remained relatively constant for the last ten years (Figure 1).

Lobsters are caught, by either traps or diving, along almost the entire length of the barrier reef, from Ambergris Cay in the north to Placentia in the south, and on the three offshore atolls (Figure 2). The traps used are rectangular palmetto traps, normally unbaited, with a funnel entrance on one side, modelled after traps used in Atlantic Canada in the 1920s (Gordon, 1981). The traps are set on the sea grass beds behind the reef crest in depths of three to eight meters. Divers catch the lobsters, either freehand or using a hooked stick, along the reef crest and on the many patch reefs adjacent to the crest. Regulations prohibit the use of SCUBA when diving for lobsters.

Regulations for the lobster fishery were introduced in 1977 and have remained unchanged since then. These set a minimum carapace length (CL) of 8.25 cm (3.25 in) and minimum tail weight (TW) of 113.4 g (4 oz). Catches of soft-shelled or berried lobsters were prohibited and a closed season from March 15 to July 15 was imposed. Permits for export of fish products were restricted to the cooperatives and individuals holding quotas. There is a licensing system for fishermen wishing to fish for lobster and regulations govern the operation of processing plants.

The great majority of lobster landed in Belize is sold to the cooperatives which are owned by the fishermen members. The cooperatives process and market the product, mostly for export to the USA. Until 1991 the co-ops purchased only the tails from the fishermen, however at that time, the National Fishermen's Cooperative began marketing whole cooked lobster which were frozen and exported to Europe. To meet this new market fishermen began landing whole lobsters. It was observed that lobsters which failed to meet the 8.25 cm minimum CL used for whole lobster could be tailed off and exceed the minimum TW of 113.4 g. Concerns raised by the fishermen about this inconsistency in the regulations prompted the Belize Fisheries Department to undertake a study to determine a CL/TW relationship specific to the case in Belize.

## METHODS

### Data Collection

Three distinct sets of morphometric data were collected from lobsters brought in to the two largest cooperatives. At National Fishermen's Cooperative in Belize City, measurements were made daily on a 10% random sample of the whole lobster landings over a three month period. Because data were collected from commercial catches it was not possible to obtain all the relevant measures from any one specimen. The carapace length and tail length (TL) were measured to 0.25 inch accuracy using a standard twelve inch rule and a Manostat caliper.

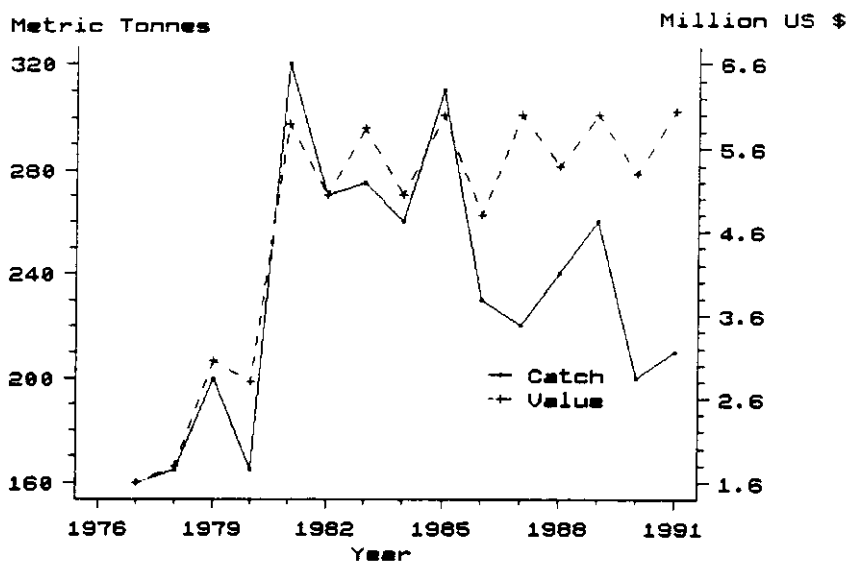


Figure 1. Catch and value of landings of *Panulirus argus* in Belize.

The whole weight (WW) was measured to 0.25 oz. accuracy using a 32 oz. spring scale and the sex was determined as well. In addition, during the same period a daily 20% sample of lobster tail landings were measured, using the same instruments, to determine tail length and tail weight (TW).

Subsequently, there was an opportunity to obtain an additional data set from Northern Fishermen's Cooperative on Caye Caulker, where it was possible to record sex and both carapace length and tail weight on the same specimens. Samples were obtained at the cooperative landing and at sea with fishermen. Sampling at sea permitted access to specimens that were below the legal limits for landing.

#### Data Analysis

All the data were converted from inches and pounds to millimeters and grams. The data were examined graphically and obvious data errors were deleted. In addition, because the relationships between body parts of individuals consistently have very high correlations and outliers are typically rare, data points having large residuals in the morphometric regressions described in the next section were deleted as probable data errors.

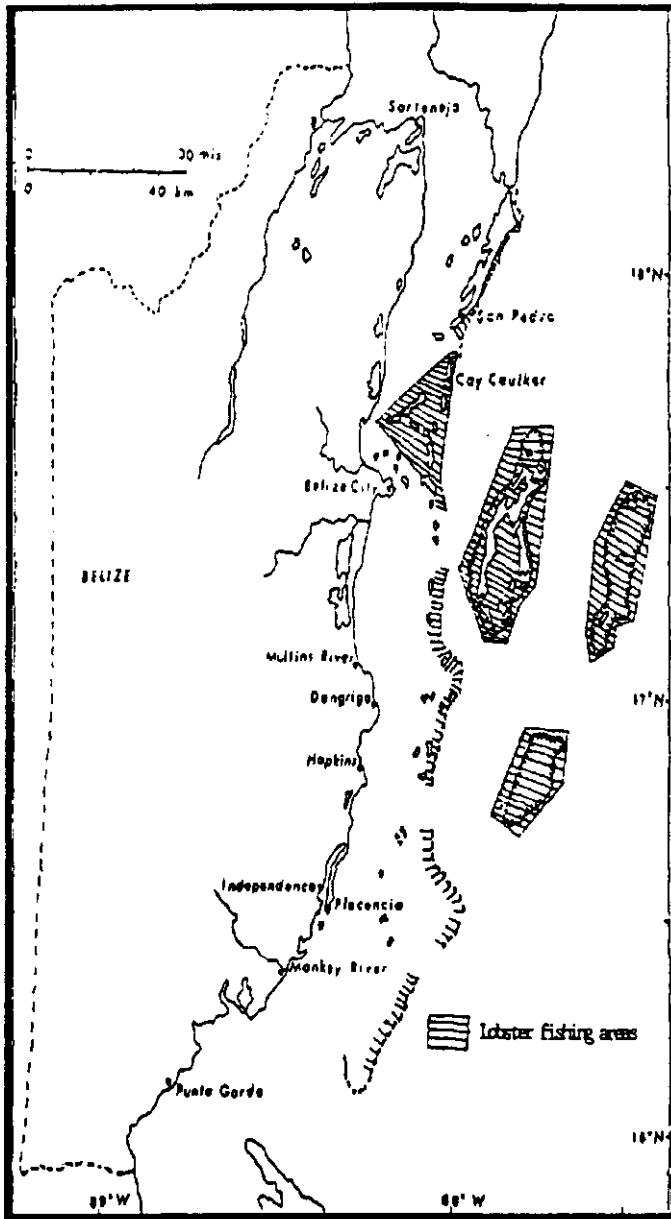


Figure 2. Lobster fishing grounds in Belizean waters.

**Table 1.** Selected morphometric relationships for spiny lobster (*Panulirus argus*) in Belize.

Dependent	Independent	Sex	Intercept	Slope	R <sup>2</sup>	Sample
Total length	Carapace len.	F	26.04	2.49	88.0	National Coop.
		M	19.88	2.48	93.2	
		B	32.08	2.34	87.7	
Car. length	Tail length	F	17.37	0.433	57.2	National Coop.
		M	5.50	0.543	77.0	
		B	11.13	0.489	63.9	
Tail length	Car. length	B	32.08	1.375	70.6	National Coop.
Tail length	Tail weight	B	27.44	0.33	94.0	National Coop.
Tail length	Car. length	B	0.001	2.703	84.1	Caye Caulker
Tail length	Tail weight	B	16.31	0.311	84.1	Caye Caulker

A variety of morphometric relationships were examined (Table 1) using linear regression. Regressions between different length measures were done on untransformed data while multiplicative relationships were used when regressing length with weight data. The particular relationship of interest, CL:TW, could not be estimated directly from the data collected at National Cooperative and was derived instead by combining the CL:TL relationship and the TL:TW relationship. A direct estimate of the CL:TW relationship was estimated from the Caye Caulker data and compared with the indirect estimate.

Spiny lobster has been reported to be sexually dimorphic by various authors including Matthews *et al.* (manuscript) and monomorphic by others (Munro, 1983). Where data were available by sex the morphometric relationships were estimated for the sexes separately and combined. Analysis of covariance was applied to test for significant differences in morphometric relationships between the sexes.

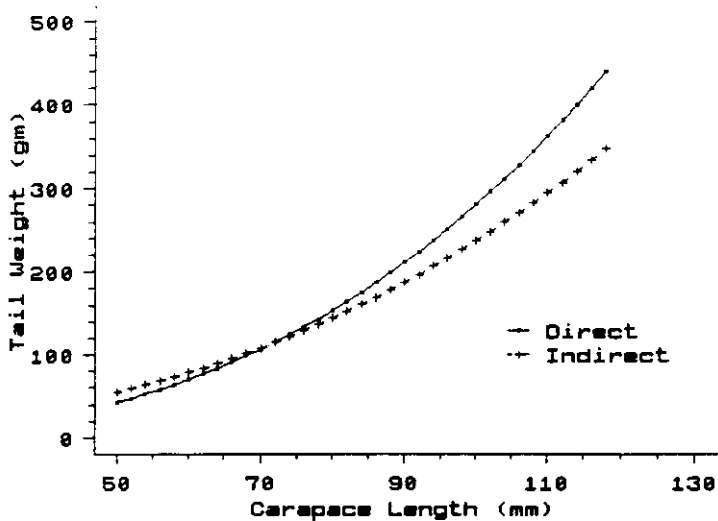
## RESULTS

The basic morphometric relationships calculated are given in Table 1. The main relationship of interest was CL:TW, determined by two different means as follows (Figure 3).

Estimate 1. Direct estimate by regression of measurements from sampling on Caye Caulker (Table 1).

$$CL = 16.31 \times TW^{0.311}$$

$$TW = 0.0012 \times CL^{2.689}$$



**Figure 3.** Predicted morphometric relationship between tail weight and carapace length in Caribbean spiny lobster by two different methods.

Estimate 2. Indirect estimate by relating CL:TL and TL:TW from sampling at National Cooperative (Table 1).

$$CL = 11.13 + 13.418 \times TW^{0.333}$$

$$TW = 0.0012 \times CL^{2.808}$$

These two equations produce the following estimates for the sizes equivalent to those specified in the regulations.

	Carapace Length where Tail Weight is	Tail Weight where Carapace Length is
Current Regulation	82.5 mm (3.25 in)	113.4 g (4.0 oz)
Estimate 1 (Direct)	71.0 mm (2.80 in)	156.6 g (5.5 oz)
Estimate 2 (Indirect)	76.0 mm (3.00 in)	154.0 g (5.4 oz)

The relationships from whole lobsters were calculated separately for male, female, and both sexes. Analysis of covariance indicated that there were significant differences due to sex in the relationship of total length and CL, and

CL:TL. It was not possible to test for sexual dimorphism in other relationships as the sexes were not separated when the data were collected.

#### DISCUSSION

The results of this study confirm the inconsistency between the tail weight and carapace length limits specified in the existing regulations. In spite of the presence of a significant sexual dimorphism in CL:TW and other relationships, it is not practical to establish different standards for regulations on each sex. It was recommended to the Belize Fisheries Department to retain the current carapace length (82.5 mm, 3.25 in) and increase the tail weight to the corresponding limit of 154 g (5.4 oz) as a conservative measure.

These results provide the information to ensure that the length and weight limits chosen are consistent with each other. The current study does not address the important issue of what specific size limits should be established. Additional work is needed to establish the specific fisheries management goals that size limits are intended to meet. The size at maturity and fecundity at size are needed to set a minimum size that will protect an adequate spawning stock. Catch and effort data over time are required to estimate surplus production and set goals in terms of MSY or other target yields.

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