# Length Frequency Analysis of Caribbean Spiny Lobster (*Panulirus argus*) Sampled by the Puerto Rico Commercial Trip Interview Program (1980 – 2003)

by

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## ABSTRACT

Length data for Caribbean spiny lobster (*Panulirus argus*) sampled by the Trip Interview Program (TIP) was analyzed for trends with regard to the year caught, the season (quarter) caught, the region of Puerto Rico where they were landed, and the gear used for capture. The data were cleaned by removing outliers and by standardizing the length units to carapace length and the weight units to total weight. The results of a multi-way ANOVA conducted on the length data for the years, regions, and gear types with a high sampling level indicated a significant effect of year and region on mean lobster length, though all interaction terms were also significant, indicating that gear may also represent a significant factor. An analysis was also conducted on the percentage of undersized spiny lobsters sampled in Puerto Rico by TIP. Percent undersize was found to vary by gear and region but not by season (quarter). Further, the initial analysis showed a decreasing trend in percent undersize over the years sampled by TIP, from a level of around 40% – 50% in the 1980's to near 15% between 2000 and 2003. In order to rule out the possibility that sampling had shifted from fishing centers with relatively high percentages of undersized catch to others with relatively low percentages of undersized catch, sampling levels for municipalities sampled between 1983 and 1987 were calculated for the years after 1987. Therefore, no sampling bias appeared to be present. This allowed for the expansion of the percent undersize trends to the total landings of spiny lobster in Puerto Rico by year available from NOAA landings data. This was further refined by expanding the percent undersize trends to only the landings from municipalities represented in TIP for any given year. The results of both of these analyses confirm a decreasing trend in percent undersize catch of spiny lobster in Puerto Rico over the time period sampled by TIP.

## INTRODUCTION

The Trip Interview Program (TIP) conducted by the National Oceanographic and Atmospheric Administration (NOAA) collects biostatistical samples for spiny lobster (*Panulirus argus*) through port sampling of commercial fish landings at the 42 coastal Municipalities of Puerto Rico. The data contain length and weight information for a proportion of the sampled catch as well as information on the fishing date, area fished, and gear fished. These data have been used for the years 1980 through 2003 to conduct a length frequency analysis of the spiny lobster landings in Puerto Rico in order to gauge changes in lobster size over this sampling period, gear selectivity, regional differences in lobster populations, as well as yearly recruitment patterns.

## DATA PREPARATION

### Unit Conversions

The TIP data was found in multiple units for both length and weight for spiny lobster. All length data was converted to carapace length (CL) and weight data were converted to total weight in grams. In cases where lengths were reported as total length, the following relationship for Cuban lobsters greater 110 mm in total length (Arce & de León, 2001) was used to calculate carapace length:

$$L_C = 0.3838 L_T - 11.6569$$

where $L_C$ = Carapace Length and $L_T$ = Total Length. Further, lengths reported as "fork length" were treated as carapace lengths and lengths reported as "core lengths" were treated as total lengths. Weights reported as or assumed to be tail weights were estimated as total weights using the following relationship for Cuban lobsters (Arce & de León, 2001):

$$W_T = 0.0046\, L_C^{\,2.630}$$

where $W_T$ = total weight and $L_C$ = carapace length. Records missing either length data or weight data were also estimated using this relationship.

### Cleaning the Data

Following the standardization of the length and weight measurements, a length weight relationship was calculated for spiny lobster in Puerto Rico. The plots were analyzed in order to remove outliers that may represent misreported data. First, all records lacking both length and weight data were removed. Next, records with carapace lengths greater than 250 mm and weights greater than 5000 g were removed. Finally, records that either appeared to represent different length or weight units than those reported in the database, or records that were a significant distance from the main curve were removed.

**Assigning Regions and Combining Gears**

Samples were grouped into regions based on county or sampling center from which they were reported. The regions were assigned by coast and divided into North (1), East (2), South (3), West (4), and Unknown (0).

Gear codes were grouped by category. Hooka, spear, and "by hand" were grouped as DIVE, Fish pots and traps and combined pots and traps were grouped as FISHTRAPS, lobster pots were considered by themselves as LOBTRAP, gill nets and trammel nets were grouped as GILLTRAMM, hand lines, troll lines, and rod and reel were grouped as HANDTROLL, and all other unknown or insignificant gears were grouped as OTH (Other).

## DATA ANALYSIS - METHODS AND RESULTS

**Length Frequency Analysis**

Once the cleaning of the data was complete, length frequency analysis was conducted for the data by year, gear, region and season (quarterly) (Table 1). Length frequencies were found to be univariate for all factors considered with a mode roughly equal for each iteration; between 90 and 95 mm Carapace Length (CL) (See Appendix), which is slightly above the legal minimum carapace length of 3.5 inches or 89 mm. Due to these findings, a statistical test was conducted in order to ascertain the differences between mean lengths by year, gear, region, and season. Further, the percentage of undersize lobsters was calculated for the TIP landings with regard to each factor.

**Multi-way ANOVA of carapace length by year, gear, and region**

A multi-way analyses of variance (MANOVA) was calculated on length data in order to determine the significance between mean values for the following strata: year, gear, region, and the interactions between year and region, year and gear, region and gear, and those between all three factors. To conduct the analysis, the data were constrained in order to obtain a more balanced design, and as a result, the analysis was done using TIP data from years with more than 1000 samples of lobster, for the two most prominent gear types, diving and fish pots, and for the three regions with the most samples, the East, South, and West. Those years containing greater than 1000 samples were well spread throughout the time series, and were thus representative of the time series as a whole. These data showed no clear trends in mean lengths prior to MANOVA analysis (Figures 1). Using the MANOVA, it was determined that the interactions were significant for all three two-way interactions (year and region, year and gear, and region and gear) and for the three-way interaction term. In addition, mean length was found to vary significantly by year and region, though the presence of significant interaction terms may indicate significant differences by gear as well (Table 2).

**a)**

| | Size Range | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 - 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 110 | 110 - 120 | 120 - 130 | 130 - 140 | 140 - 150 | 150 - 160 | 160 - 170 | 170 - 180 | 180 - 190 | 190 - 200 | Total | Undersized | % Undersized |
| 1980 | | | | | | | 22 | 87 | 168 | 174 | 104 | 42 | 13 | 2 | | | | | | | 612 | 251 | 41.013% |
| 1981 | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0.000% |
| 1982 | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0.000% |
| 1983 | | | | | | 4 | 7 | 30 | 55 | 76 | 60 | 25 | 14 | 3 | | | | | | | 274 | 90 | 32.847% |
| 1984 | | | | | | 21 | 133 | 263 | 412 | 427 | 366 | 189 | 64 | 41 | 9 | 2 | 3 | 1 | | | 1931 | 758 | 39.254% |
| 1985 | | | | | | 17 | 117 | 283 | 497 | 443 | 288 | 120 | 58 | 16 | 6 | 6 | 4 | 3 | | | 1858 | 818 | 44.026% |
| 1986 | | | | | | 1 | 57 | 174 | 308 | 216 | 133 | 89 | 39 | 21 | 6 | 2 | 2 | 1 | | 1 | 1050 | 493 | 46.952% |
| 1987 | | | | 3 | 4 | 12 | 53 | 126 | 175 | 200 | 131 | 68 | 22 | 13 | 6 | | | | | | 813 | 373 | 45.879% |
| 1988 | | | | | | | | 3 | 11 | 10 | 13 | 4 | 4 | 3 | 2 | | 2 | | | | 52 | 9 | 17.308% |
| 1989 | | | | | 3 | 26 | 86 | 239 | 344 | 265 | 148 | 80 | 26 | 7 | 5 | 5 | 2 | 1 | 1 | 1 | 1239 | 670 | 54.076% |
| 1990 | | | | | | | 14 | 150 | 233 | 252 | 143 | 83 | 29 | 7 | 8 | 1 | | | | | 920 | 377 | 40.978% |
| 1991 | | | 1 | | | | 52 | 336 | 451 | 449 | 244 | 121 | 52 | 29 | 7 | 4 | 3 | 2 | | | 1751 | 801 | 45.745% |
| 1992 | | | | 1 | | 1 | 46 | 214 | 329 | 342 | 222 | 119 | 41 | 17 | 5 | 1 | 3 | | | | 1341 | 560 | 41.760% |
| 1993 | | | 1 | | | | 11 | 109 | 249 | 225 | 161 | 91 | 46 | 19 | 6 | 6 | 2 | 1 | 2 | | 929 | 343 | 36.921% |
| 1994 | | | | | | | 16 | 19 | 78 | 92 | 63 | 39 | 8 | 5 | 2 | 2 | 1 | 1 | 1 | | 327 | 103 | 31.498% |
| 1995 | | | | | 1 | 2 | 12 | 54 | 219 | 237 | 174 | 119 | 46 | 23 | 18 | 6 | 0 | | | | 911 | 255 | 27.991% |
| 1996 | | | | | | 2 | 20 | 90 | 169 | 258 | 125 | 76 | 41 | 11 | 11 | | 1 | | | | 804 | 254 | 31.592% |
| 1997 | | | | | | | 9 | 39 | 95 | 117 | 51 | 29 | 8 | 7 | 2 | | | | | | 357 | 130 | 36.415% |
| 1998 | | | | | | | 11 | 31 | 173 | 290 | 180 | 101 | 23 | 15 | 13 | 4 | 1 | | | | 842 | 155 | 18.409% |
| 1999 | | | 1 | | 11 | 18 | 20 | 28 | 226 | 463 | 268 | 141 | 64 | 31 | 22 | 10 | | 1 | 1 | | 1305 | 226 | 17.318% |
| 2000 | | | | | | | 1 | 10 | 133 | 365 | 216 | 112 | 49 | 26 | 13 | 2 | | | | | 927 | 104 | 11.219% |
| 2001 | | | | | | | | 6 | 206 | 541 | 362 | 205 | 79 | 36 | 18 | 5 | | | | | 1458 | 142 | 9.739% |
| 2002 | | | | | | 1 | 2 | | 139 | 263 | 193 | 76 | 37 | 14 | 9 | 4 | 2 | 2 | | | 742 | 81 | 10.916% |
| 2003 | | | 1 | | | | | 5 | 312 | 636 | 411 | 225 | 77 | 44 | 28 | 1 | 2 | | | | 1742 | 257 | 14.753% |

**b)**

| | Size Range | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | 0 - 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 110 | 110 - 120 | 120 - 130 | 130 - 140 | 140 - 150 | 150 - 160 | 160 - 170 | 170 - 180 | 180 - 190 | 190 - 200 | Total | Undersized | % Undersized |
| North | | | | | 3 | 6 | 60 | 211 | 564 | 725 | 539 | 213 | 93 | 34 | 24 | 8 | 5 | 4 | 2 | 1 | 2492 | 691 | 27.728732% |
| East | | | 2 | | 1 | 37 | 159 | 434 | 1025 | 1573 | 951 | 592 | 236 | 112 | 80 | 13 | 7 | 1 | 1 | 1 | 5225 | 1480 | 28.325359% |
| South | | | 2 | 3 | 15 | 45 | 272 | 1195 | 2256 | 2612 | 1525 | 744 | 263 | 120 | 37 | 15 | 7 | 4 | | | 9115 | 3452 | 37.871640% |
| West | | | | 1 | | 10 | 140 | 323 | 917 | 1228 | 876 | 516 | 208 | 100 | 39 | 21 | 8 | 4 | 2 | | 4393 | 1230 | 27.999089% |

**c)**

| | Size Range | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | 0 - 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 110 | 110 - 120 | 120 - 130 | 130 - 140 | 140 - 150 | 150 - 160 | 160 - 170 | 170 - 180 | 180 - 190 | 190 - 200 | Total | Undersized | % Undersized |
| 1 | | | | 4 | 6 | 38 | 199 | 538 | 1277 | 1700 | 1163 | 673 | 272 | 132 | 62 | 23 | 8 | 4 | 2 | 1 | 6102 | 1867 | 30.596526% |
| 2 | | | 2 | | | 25 | 192 | 537 | 1123 | 1431 | 1057 | 573 | 216 | 103 | 51 | 15 | 10 | 4 | 2 | | 5341 | 1702 | 31.866692% |
| 3 | | | 1 | | | 8 | 157 | 562 | 1193 | 1345 | 799 | 420 | 176 | 77 | 32 | 11 | 3 | 4 | | | 4788 | 1706 | 35.630744% |
| 4 | | | 1 | | 13 | 34 | 141 | 659 | 1389 | 1865 | 1037 | 488 | 176 | 78 | 51 | 12 | 7 | 1 | 1 | 1 | 5954 | 1961 | 32.935841% |

**d)**

| | Size Range | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gear | 0 - 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 110 | 110 - 120 | 120 - 130 | 130 - 140 | 140 - 150 | 150 - 160 | 160 - 170 | 170 - 180 | 180 - 190 | 190 - 200 | Total | Undersized | % Undersized |
| DIVE | | | 2 | 1 | 6 | 13 | 174 | 941 | 2397 | 3507 | 2241 | 1236 | 478 | 239 | 129 | 37 | 10 | 5 | 2 | 1 | 11419 | 3138 | 27.480515% |
| FISHTRAPS | | | 2 | 3 | 12 | 33 | 101 | 260 | 636 | 701 | 363 | 200 | 74 | 28 | 16 | 9 | 4 | 2 | 1 | 1 | 2446 | 914 | 37.367130% |
| LOBTRAP | | | | | | | 5 | 31 | 119 | 204 | 139 | 54 | 26 | 10 | 5 | 2 | | | 1 | | 596 | 116 | 19.463087% |
| GILLTRAM | | | | | | | 2 | 10 | 50 | 92 | 61 | 24 | 8 | 7 | 2 | 1 | | | | | 257 | 55 | 21.400778% |
| LINES | | | | | | | 2 | 25 | 41 | 100 | 63 | 30 | 4 | 4 | 4 | 2 | 3 | 1 | 1 | 0 | 280 | 61 | 21.785714% |
| OTH | | | | | 1 | 59 | 405 | 1029 | 1739 | 1737 | 1189 | 610 | 250 | 102 | 40 | 10 | 11 | 5 | | | 7187 | 2952 | 41.074162% |

**Table 1: Length Frequencies for Caribbean spiny lobster by a) year, b) region of Puerto Rico, c) season (quarter), and d) gear from the length data collected by TIP in Puerto Rico.**

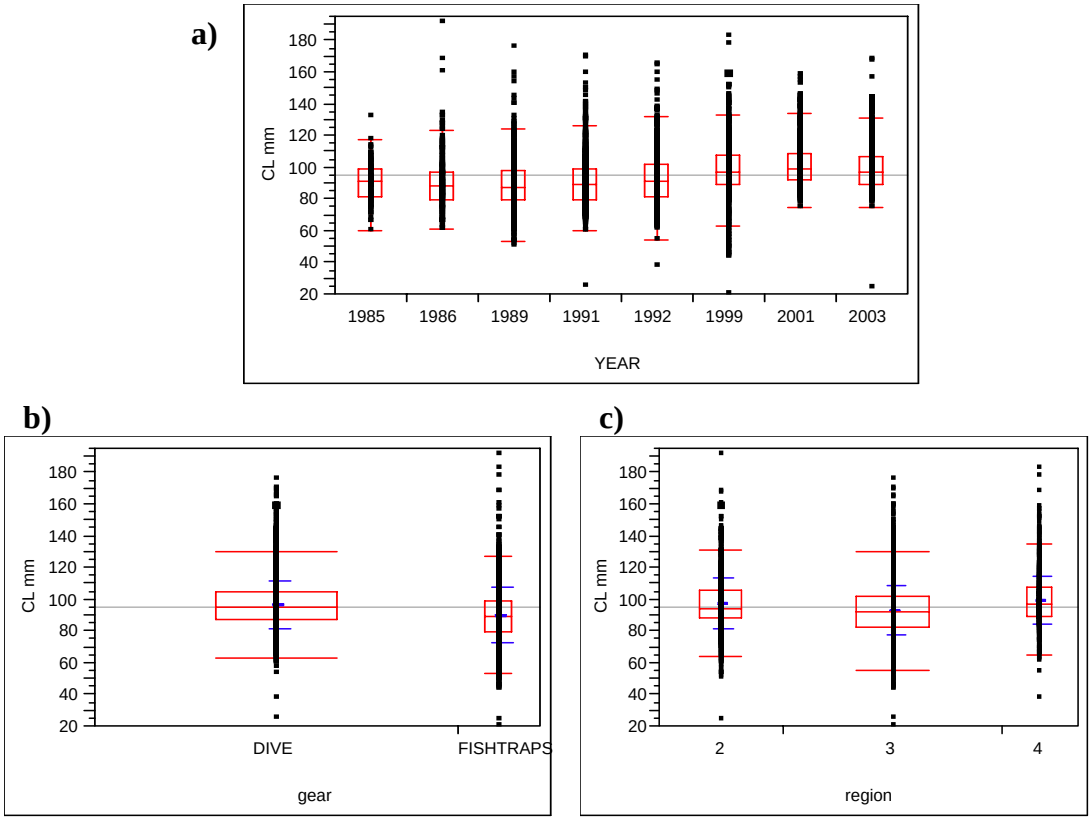


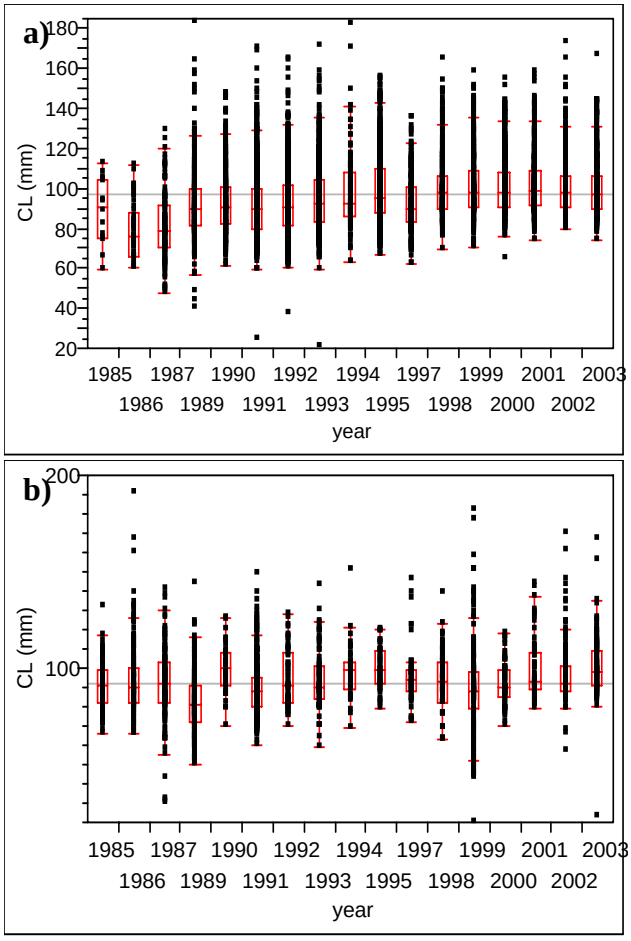

**Figure 1: Significance of year (a), gear (b) and region (c) on spiny lobster length data collected by TIP. Red boxes constraining the plotted observed data illustrates the 95% confidence interval while the red lines constraining the observed plotted data illustrate the 50% confidence interval of the length data. The grey line located at 95 mm carapace length represents the overall mean carapace length for all individuals included in this analysis. Blue lines constraining the data represent the standard deviation.**

**MANOVA Model CL by YEAR GEAR and REGION**

| Test | Value | Exact F | NumDF | DenDF | Prob>F |
|---|---|---|---|---|---|
| MODEL | 0.1638712 | 42.9288 | 30 | 7859 | <.0001 |
| YEAR | 0.0217382 | 28.4735 | 6 | 7859 | <.0001 |
| REGION | 0.0005476 | 4.3036 | 1 | 7859 | 0.0381 |
| GEAR | 0.0003798 | 2.9845 | 1 | 7859 | 0.0841 |
| YEAR*REGION | 0.0167755 | 11.9853 | 11 | 7859 | <.0001 |
| YEAR*GEAR | 0.0159545 | 17.9124 | 7 | 7859 | <.0001 |
| REGION*GEAR | 0.0057412 | 22.5602 | 2 | 7859 | <.0001 |

**Table 2: Multiple way analyses of variance for spiny lobster for year, gear and region.**

Given this result, the three most prominent gears, dive, fish traps, and lobster traps respectively, and all regions were analyzed by year using the original unconstrained data set in order to determine whether mean lengths of lobsters caught by each gear in each region changed over the sampling period of TIP by year. These results indicate that the mean length has significantly increased for dive gear over the sampling period, though no trend is evident for fish traps or lobster traps (Figure 2). No regional trend was evident over time (Figure 3).



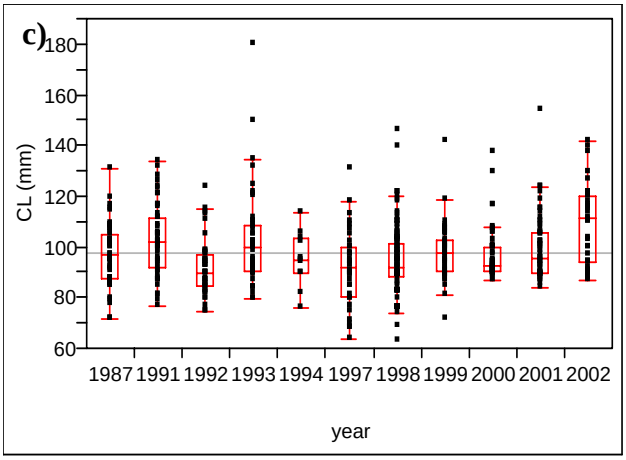
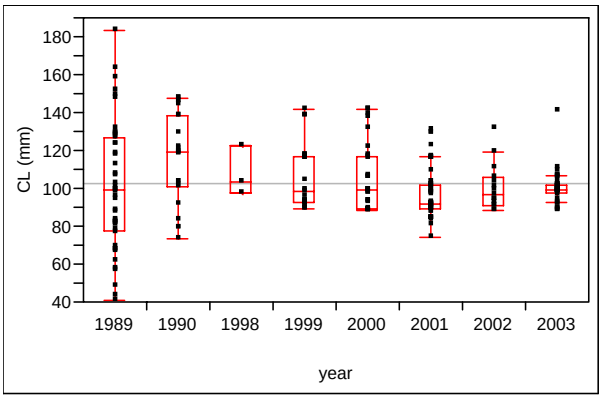





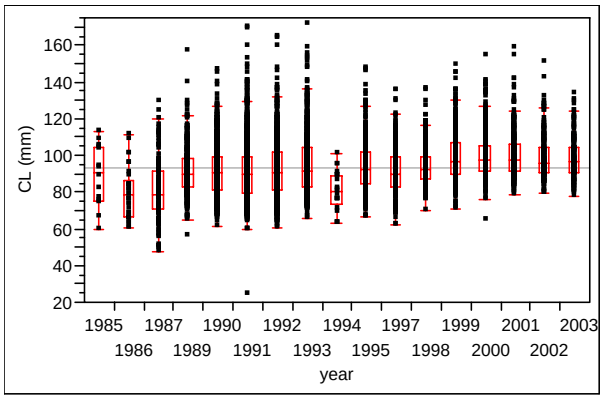


**Figure 1: Significance of diving (a), lobster traps (b), and fish traps (c) by year for spiny lobster lengths collected by TIP. Red boxes constraining the plotted observed data illustrates the 95% confidence interval while the red lines constraining the observed plotted data illustrates the 50% confidence interval of the length data. The grey line located at 95 mm carapace length represents the overall mean carapace length for all individuals included in this analysis.**

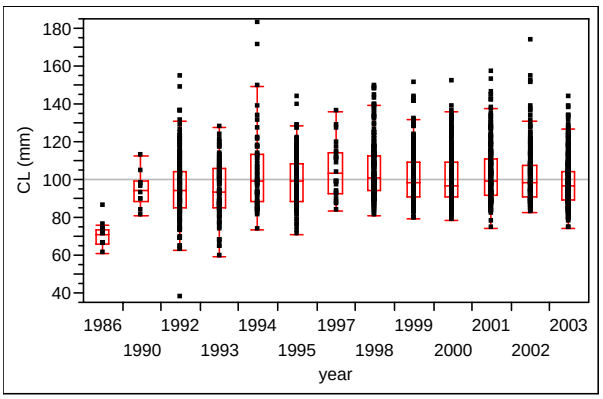
**a) North**




**b) South**




**c) East**




**d) West**

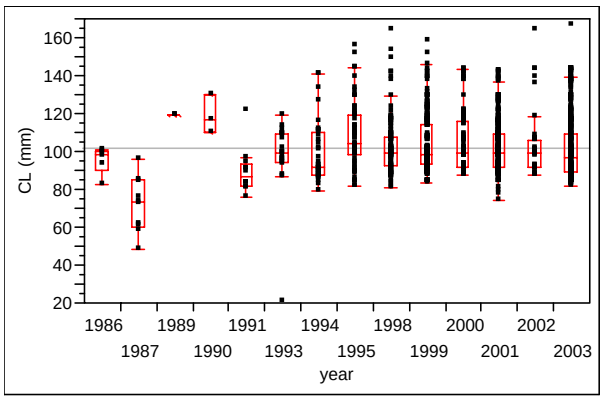



**Figure 3: The significance of each year on spiny lobster length frequencies at each region, a) North, b) South, c) East, and d) West of Puerto Rico. Red boxes constraining the plotted observed data illustrates the 95% confidence interval while the red lines constraining the observed plotted data illustrate the 50% confidence interval of the length data. The grey line located at 95 mm carapace length represents the overall mean carapace length for all individuals included in this analysis.**

## Analysis of the Percentage of Undersized Lobsters in the Commercial Catch

An analysis of the undersized proportion of the landings sampled by TIP was carried out by year, gear, region, and season (quarter). Samples were considered to be undersized if their reported carapace length was less than the legal limit of 3.5 inches or 88.0 mm. This analysis showed that the percent of undersized lobsters making up the TIP samples varied by gear and by region, but not by quarter (Figure 4). Further the analysis showed a decline in percent undersize by year from roughly 40% during the 1980's around 10 -15% after 2000 (Figure 5). Discussion among the SEDAR 8 data assessment group questioned whether the TIP percentages would remain accurate when expanded to the total landings for Puerto Rico due to a potential bias in TIP sampling at the municipality level. It was further hypothesized that the reduction in the number of undersized landings may represent a shift in TIP sampling from municipalities that reported a high percentage of undersized catch toward others that showed a lower percentage, thus invalidating the decreasing trend in percentage over the sampled years.

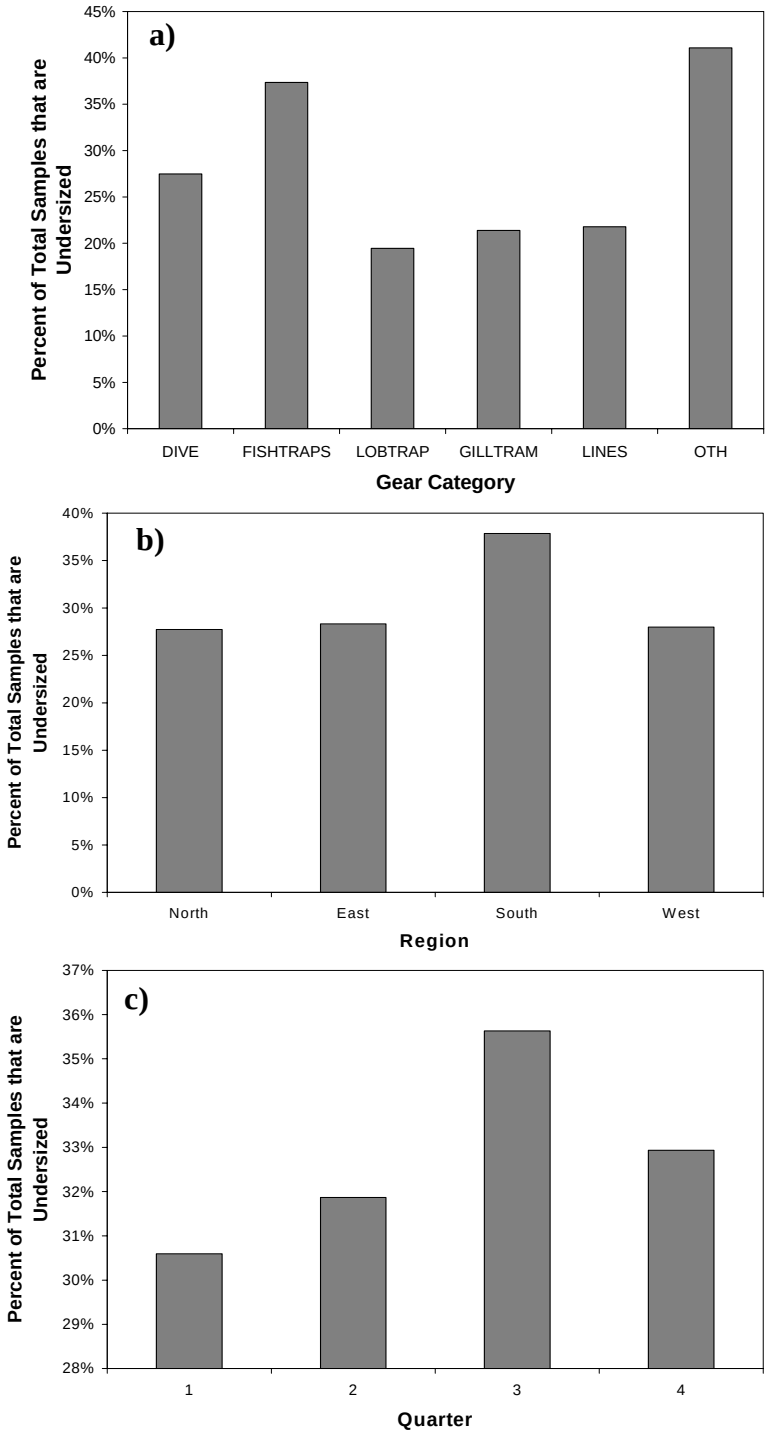



**Figure 4: The percentage of total individuals sampled by TIP found to be undersized by gear (a), region (b) and quarter (c).**

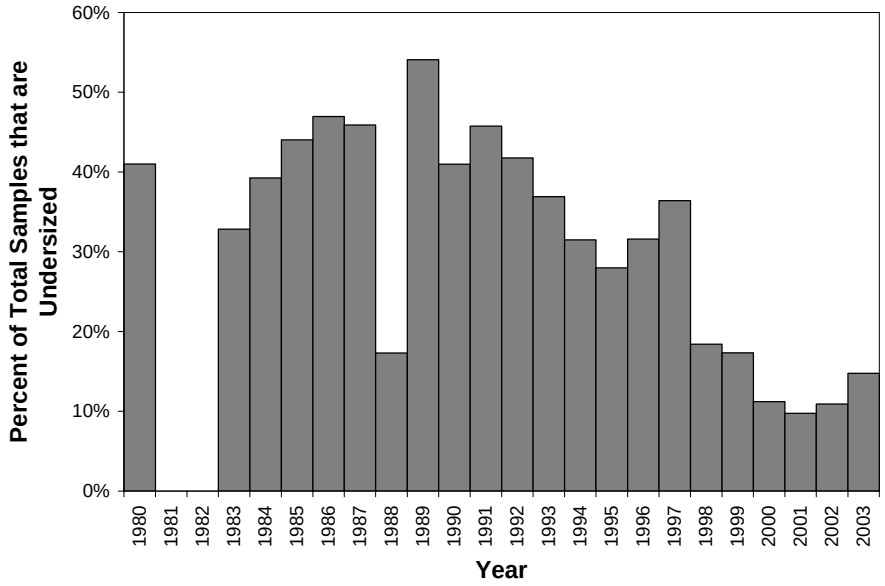



**Figure 5: The percentage of total individuals sampled by TIP found to be undersized by year.**

In order to ascertain whether the TIP database may be biased by the sampling pattern at the municipal level, an analysis was run to look at sampling history with respect to the percentage of undersized lobsters reported each year. To do this, the municipalities were placed into three groups:

- Municipalities not sampled in the first five years of TIP (1983 – 1987)
- Municipalities with a high initial percentage of undersized lobsters for the first five years of TIP
- Municipalities with a low percentage of undersized lobsters for the first five years of TIP

For the second two groups, the highest single year measurement over this five year period (1983 – 1987) was taken and the 20 municipalities that fell into this category were ranked; the ten highest were considered to have a high number of reported undersized lobsters while the ten lowest were considered to have a low number of reported undersized lobsters. These data were plotted by year, and no obvious trend was observed in the sampling level by group (Figure 6). The total number of samples for each group were then compared for the years after 1987 in order to determine if any change had occurred in the sampling levels between groups. The results indicate that both the low and high groups were equally sampled after 1987 (Figure 7). These data were then broken down by year, but showed no trend in sampling effort (Figure 8). Further, the data for the high percentage group showed a trend toward decreasing percent undersize, which correlates to the decline in percentages by year in the TIP data (Figure 9). Therefore, the percentage undersize values calculated in TIP for each year should be expandable to Total Landings.

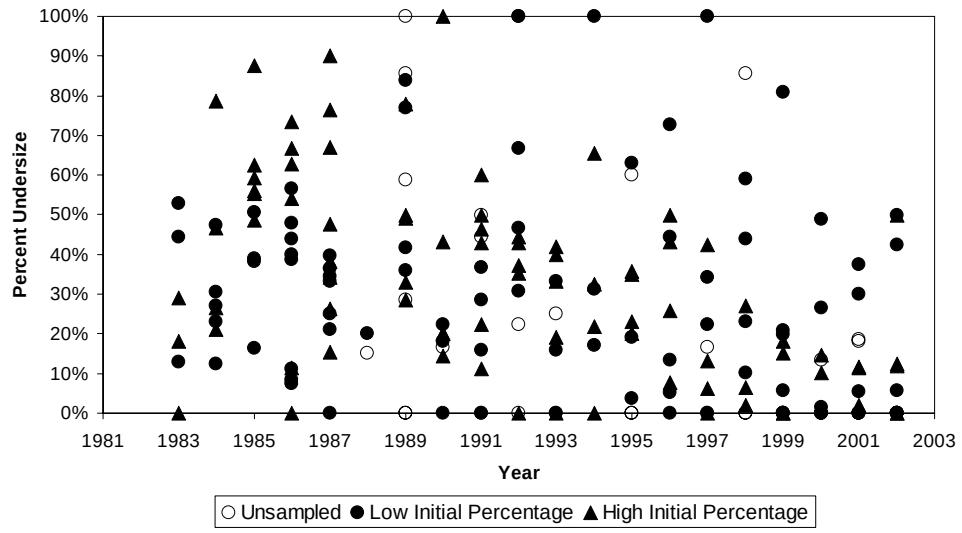



**Figure 6: The percentage of undersized lobsters sampled by year for each municipality.**

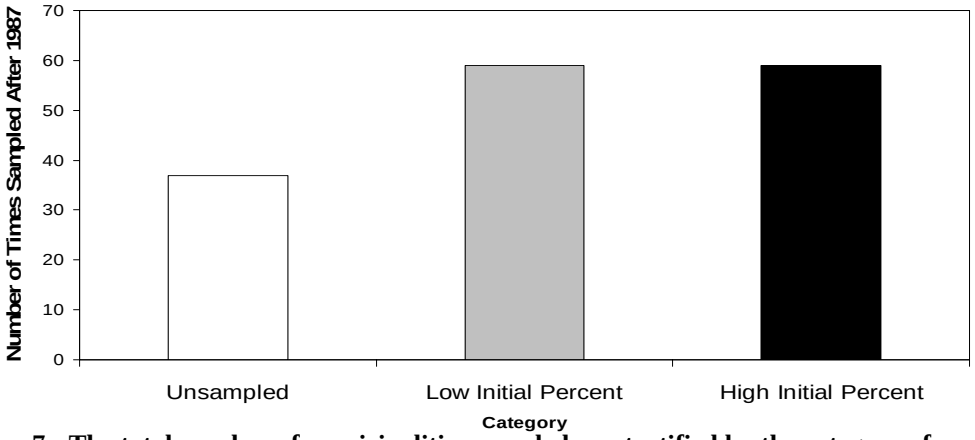



**Figure 7: The total number of municipalities sampled, as stratified by the category of undersized lobsters sampled.**

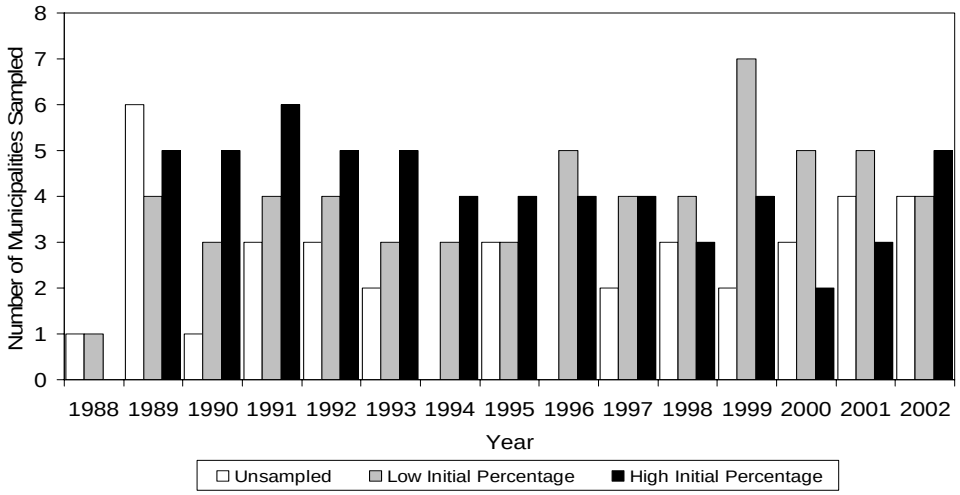



**Figure 8: Stratification of the number of municipalities sampled each year by the category of immature lobsters that were landed.**

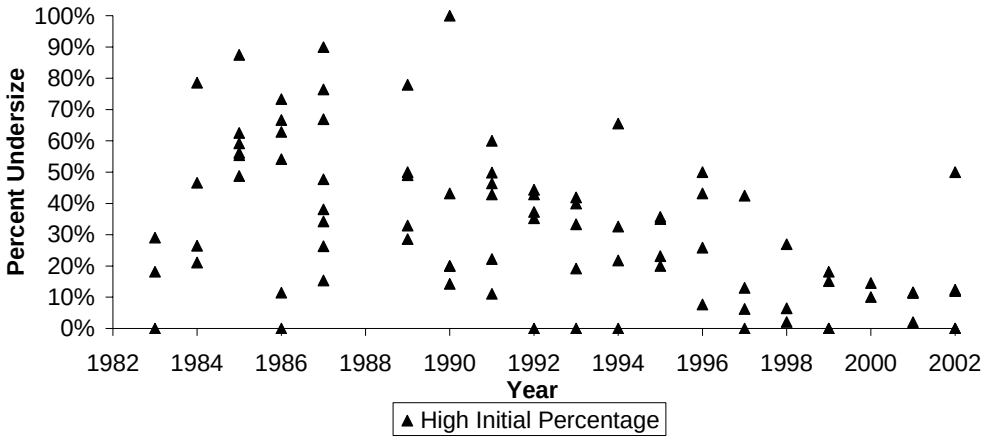



**Figure 9: The percentage of lobsters undersized each year for those municipalities in the category of landing a high percentage of lobsters undersized.**

## Expanding Percent Undersize to Total Landings

The percentages of undersize lobster calculated by year were then expanded only to the landings represented in those municipalities that were sampled by TIP for any given year. These truncated landings were used so as to provide a more accurate expansion due to a lack of sampling at many municipalities on a yearly basis. The percentage of the total landings covered by these municipalities remained at roughly 50% over the sampling period (Figure 10) and the percentage of those landings sampled by TIP remained at roughly 0.2% over the period (Figure 11). When expanded to these landings, the percentage of undersized landed over time showed a decreasing trend (Figure 12), corroborating the trend in the percentages seen in the TIP data. Due to this similarity in trend, we can make the assumption that the TIP data represents a random sampling of the landings data throughout time and without bias, and thus the TIP data can be expanded to the total landings data. The TIP percentages were then expanded to total landings and also showed a decrease from 50% in the middle 1980's to around 15% after 2000 (Figure 13).

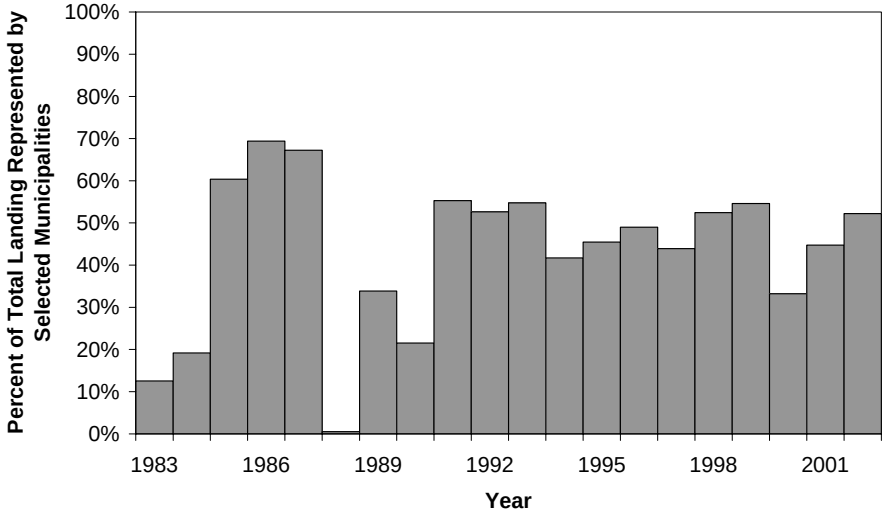



**Figure 10: The percentage of total landings represented by municipalities selected for analysis.**

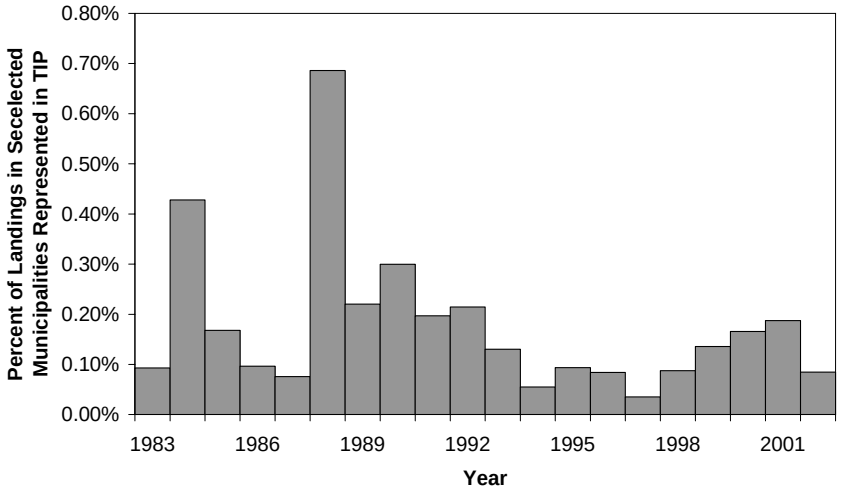



**Figure 3: The percent of the selected municipalities that are represented in TIP.**

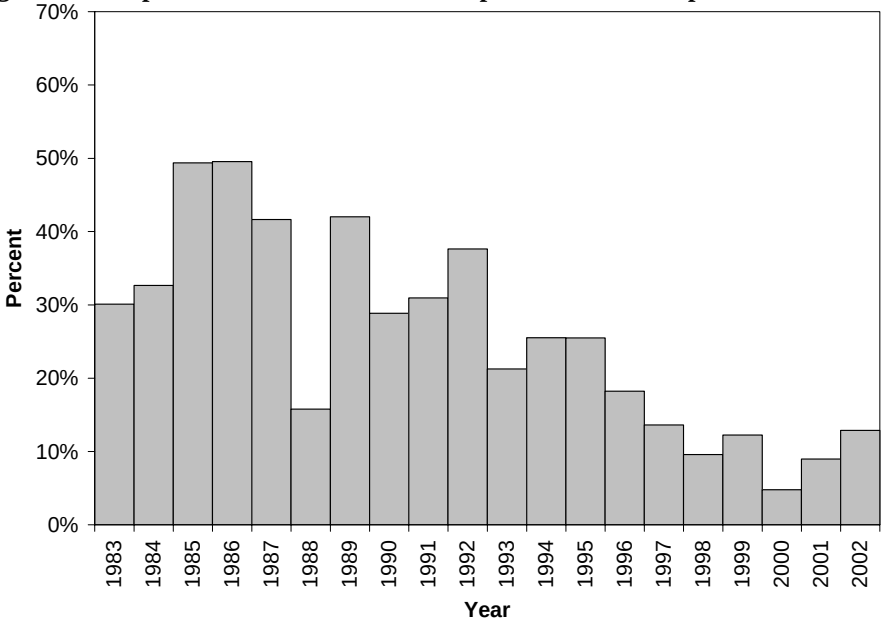



**Figure 2: The percentage of undersized lobsters by year expanded by total landings.**

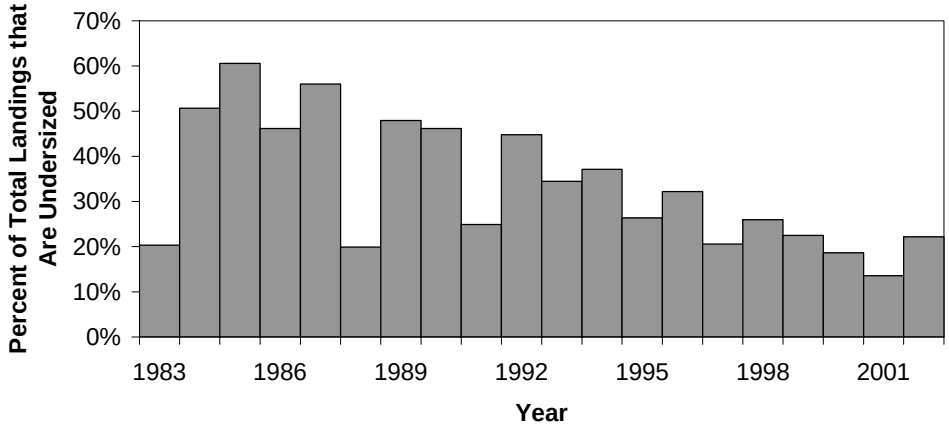



**Figure 13: The percentage of undersized lobsters found to be in the landings data from Puerto Rico calculated by expanding the TIP data to the expanded landings.**

## CONCLUSIONS

Length frequencies were analyzed from TIP data between 1980 and 2003 in order to gauge changes in lobster size over the time period, gear selectivity, regional differences in lobster populations, yearly recruitment patterns. The univariate nature of the length frequencies when considering each of four factors, year, gear type, region, and season (quarter), did not indicate either any change in size frequency over the sampling period, gear selectivity by size, regional difference in size frequencies, or any pattern of recruitment on a seasonal basis. The results of the MANOVA indicate that the mean length of lobster sampled by TIP varies by year and by region, and significant interactions in the model may indicate significant differences between gears. The analysis of gear types and regions by year indicated a rise in mean length of lobsters taken by dive gear.

The analysis of the levels of undersize catch conducted by gear, region, and season (quarter) indicate significant differences only between gear and region. The yearly trend in percent undersize indicate a decreasing trend over the sampling period, from 1980 to 2003. The analysis of TIP sampling over the sampling period with respect to percent undersize indicates no bias towards sampling municipalities with a lower percentage of undersized catch. This allows for the expansion of the calculated percent undersize from TIP to the landings from TIP sampled municipalities and then to Total Landings. These analyses both show a decreasing trend and corroborate the trend toward a decreasing level of undersized lobster landings in Puerto Rico.

## LITERATURE CITED

Arce, A. M., M. E. de León. 2001. "Biology." Report on the FAO/DANIDA/CFRAMP/ WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (Panulirus argus). Belize City, Belize, 21 April - 2 May 1997; Merida, Mexico, 1-12 June 1998. FAO Fish. Rep. (619): 17-25.

# Appendix I - Length Frequency Analysis of TIP data for Spiny Lobster in Puerto Rico

## Appendix I-A - Sample sizes for each factor considered in the length frequency analysis

### 1). Number of Lobsters Sampled for Each Quarter of Each Year and Each Full Year

| Year | Q1 | Q2 | Q3 | Q4 | Total |
|---|---|---|---|---|---|
| 1980 | 0 | 0 | 0 | 612 | 612 |
| 1981 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 77 | 0 | 0 | 197 | 274 |
| 1984 | 596 | 751 | 233 | 351 | 1931 |
| 1985 | 1858 | 419 | 724 | 451 | 3452 |
| 1986 | 140 | 31 | 743 | 136 | 1050 |
| 1987 | 306 | 69 | 291 | 147 | 813 |
| 1988 | 0 | 52 | 0 | 0 | 52 |
| 1989 | 414 | 288 | 239 | 298 | 1239 |
| 1990 | 233 | 227 | 166 | 294 | 920 |
| 1991 | 512 | 489 | 320 | 430 | 1751 |
| 1992 | 407 | 324 | 310 | 300 | 1341 |
| 1993 | 428 | 214 | 109 | 178 | 929 |
| 1994 | 166 | 116 | 45 | 0 | 327 |
| 1995 | 199 | 371 | 164 | 177 | 911 |
| 1996 | 330 | 221 | 22 | 231 | 804 |
| 1997 | 96 | 87 | 94 | 80 | 357 |
| 1998 | 186 | 270 | 141 | 245 | 842 |
| 1999 | 426 | 367 | 236 | 276 | 1305 |
| 2000 | 280 | 145 | 183 | 319 | 927 |
| 2001 | 423 | 335 | 339 | 361 | 1458 |
| 2002 | 211 | 193 | 182 | 156 | 742 |
| 2003 | 408 | 372 | 247 | 715 | 1742 |

### 2). Number of Lobsters Sampled for Each Gear Type

| GEAR TYPES | CODES | GEAR NAME | NUMBER |
|---|---|---|---|
| DIVE | 760, 943, 955 | Diving | 11419 |
| FISHTRAPS | 300, 345 | Fish Pots and Traps | 2446 |
| LOBTRAP | 355 | Lobster Traps | 596 |
| LINES | 600, 610, 611, 660 | Hand and Troll Lines | 280 |
| GILLTRAM | 425, 530 | Gill and Trammel Nets | 257 |
| OTH | 000, 009, 030, 755, 999 | Other | 7187 |

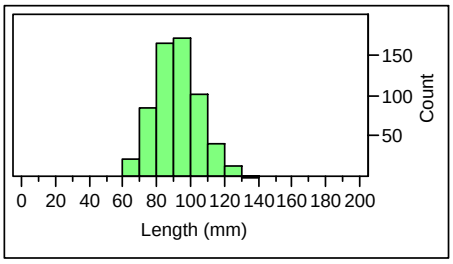
**3). Number of Lobsters Sampled for Each Region**

| Region | Samples |
|---|---|
| 0 | 960 |
| 1 | 2492 |
| 2 | 5225 |
| 3 | 9115 |
| 4 | 4393 |

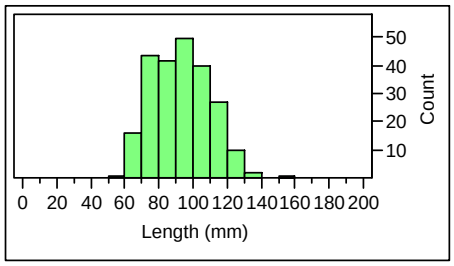
# Appendix I-B - Length Frequency Charts

## 1). Length Frequency for Puerto Rican Spiny Lobster by Year and Quarter

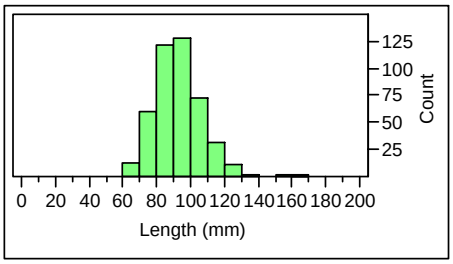
**Year=1980, Quarter=4**



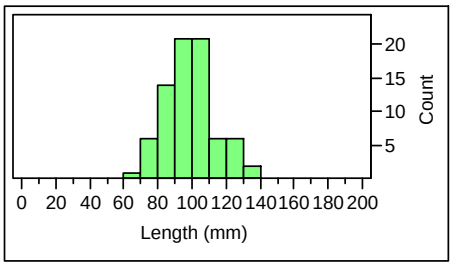

**Year=1984, Quarter=3**



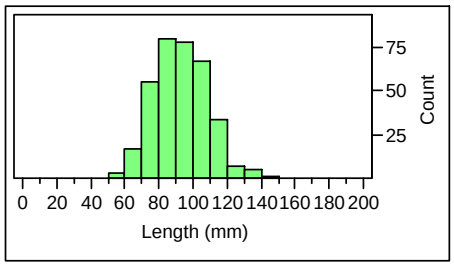

**Year=1985, Quarter=4**



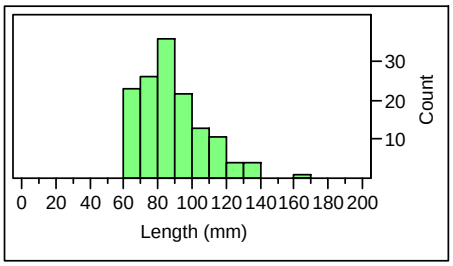

**Year=1983, Quarter=1**



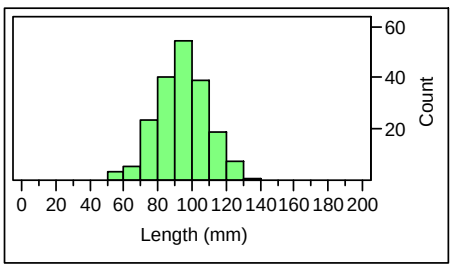

**Year=1984, Quarter=4**



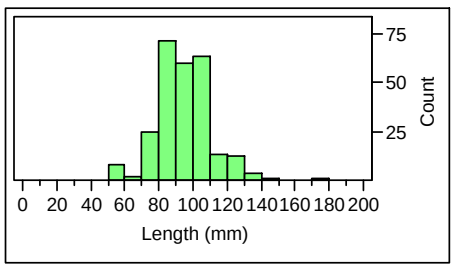

**Year=1986, Quarter=1**



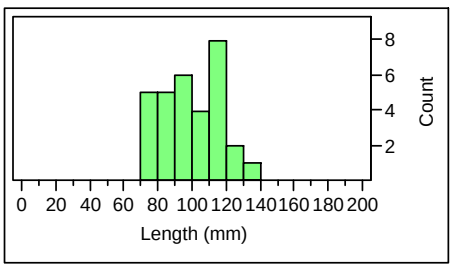

**Year=1983, Quarter=4**



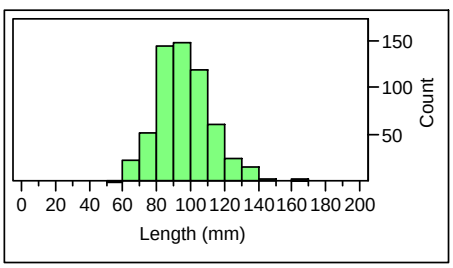

**Year=1985, Quarter=1**



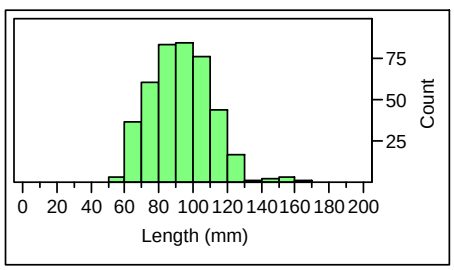

**Year=1986, Quarter=2**



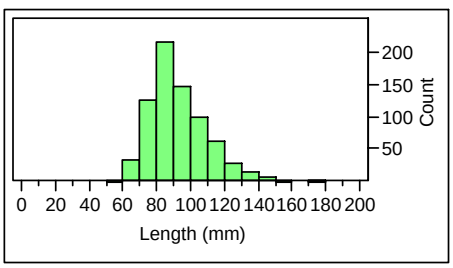

**Year=1984, Quarter=1**



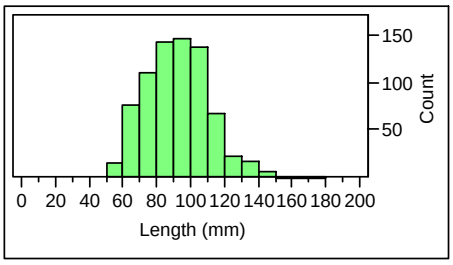

**Year=1985, Quarter=2**



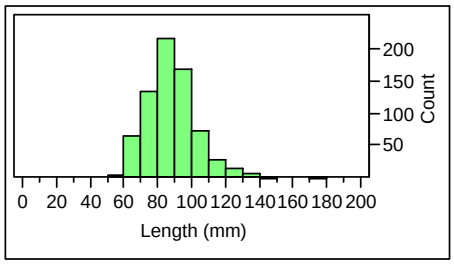

**Year=1986, Quarter=3**




**Year=1984, Quarter=2**




**Year=1985, Quarter=3**

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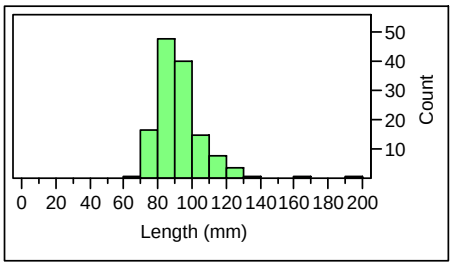
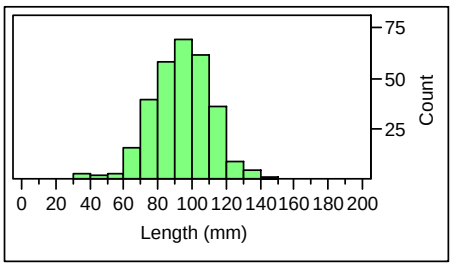
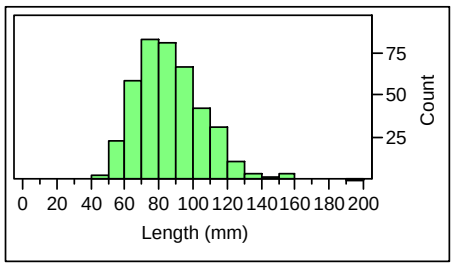


**Year=1987, Quarter=1**




**Year=1989, Quarter=1**

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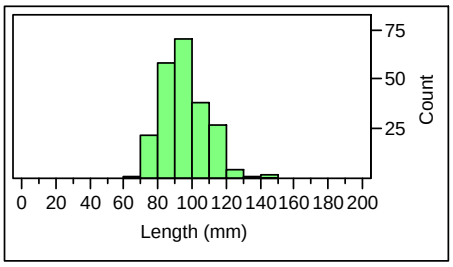


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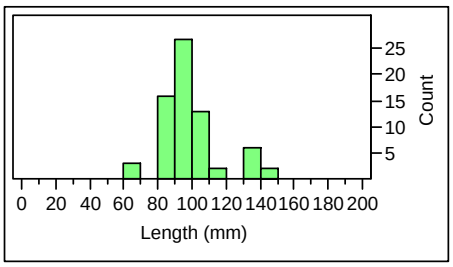


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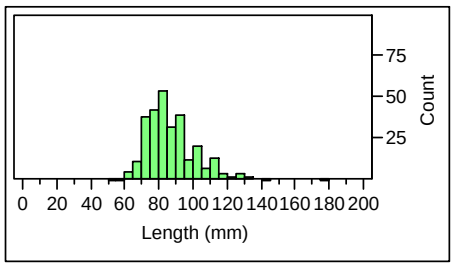


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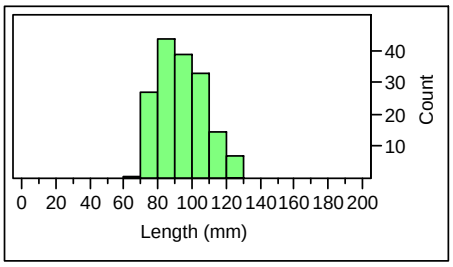


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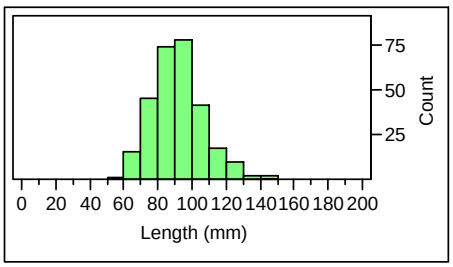


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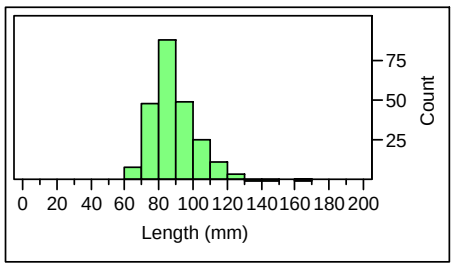


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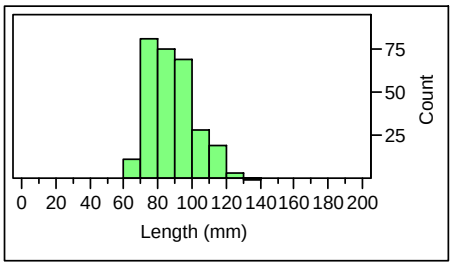


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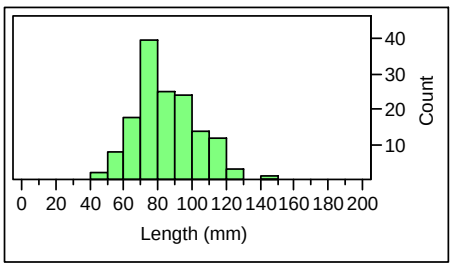


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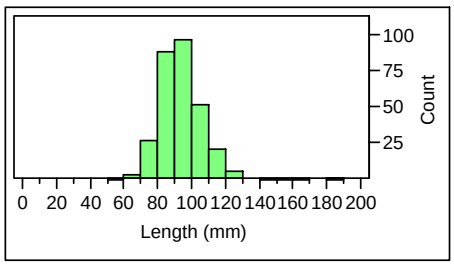


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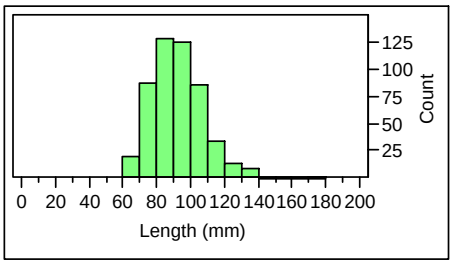
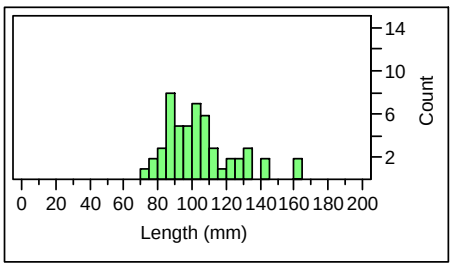



**Year=1988, Quarter=2**

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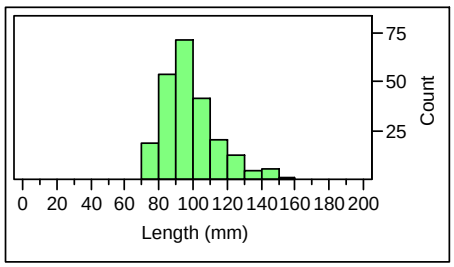


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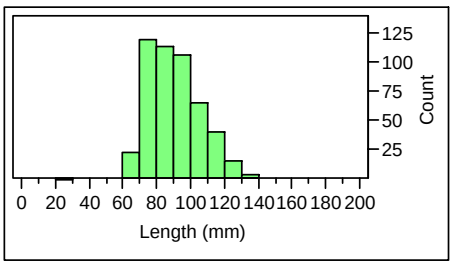

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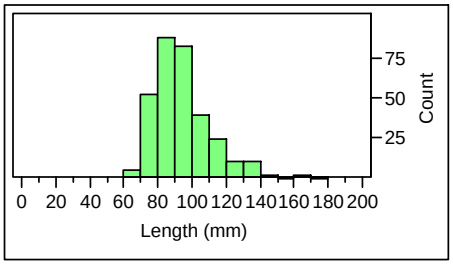


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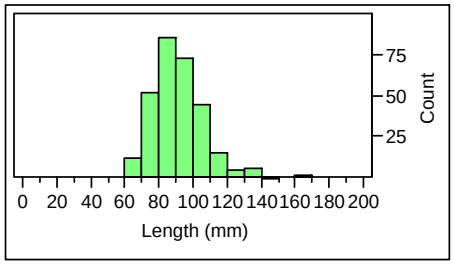
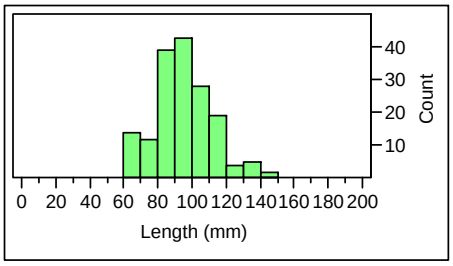
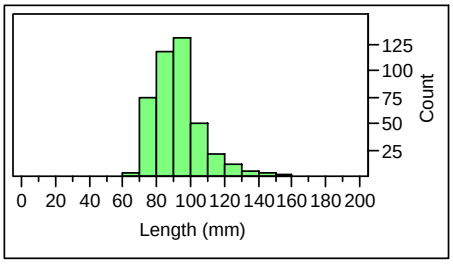



**Year=1994, Quarter=1**




**Year=1991, Quarter=4**

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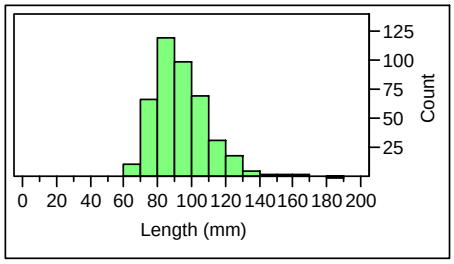


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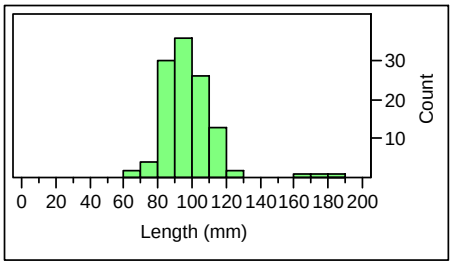


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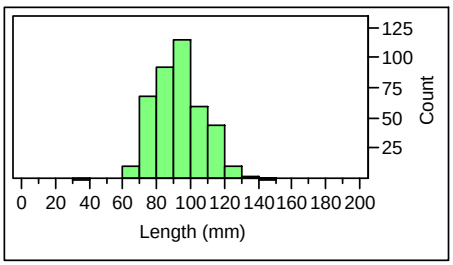


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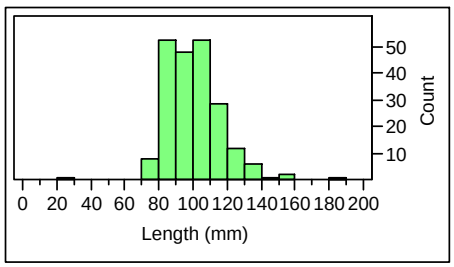


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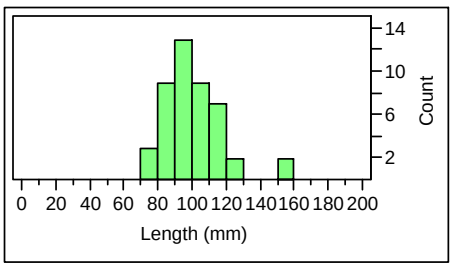
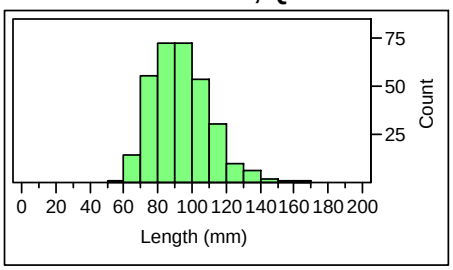
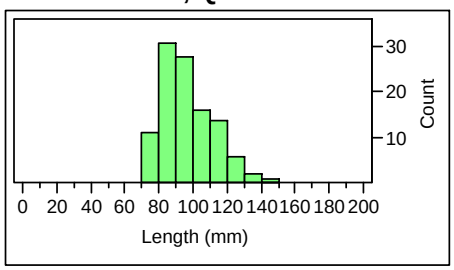


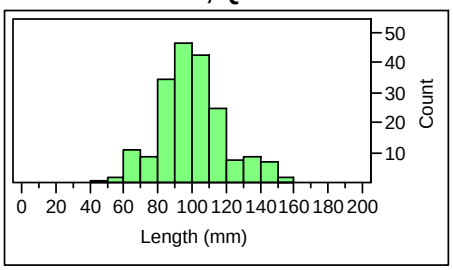

**Year=1992, Quarter=2**



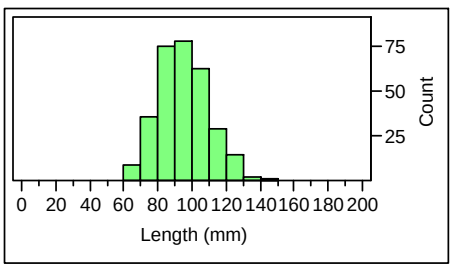

**Year=1993, Quarter=3**



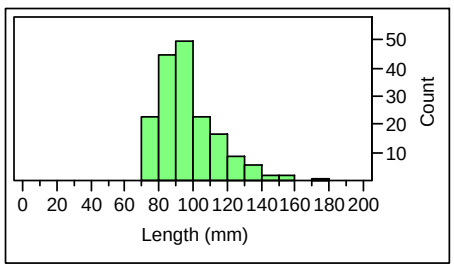

**Year=1995, Quarter=1**



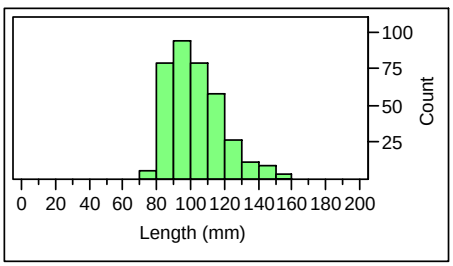

**Year=1992, Quarter=3**



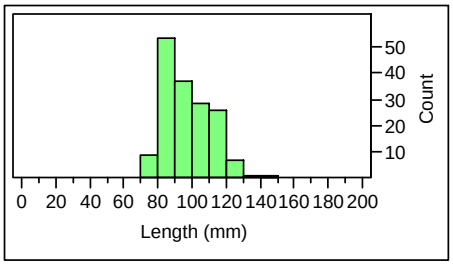

**Year=1993, Quarter=4**



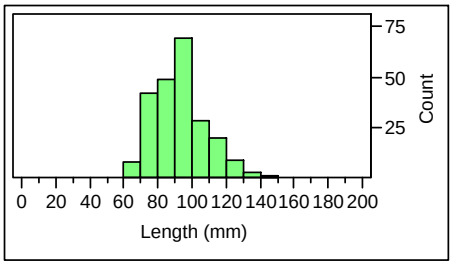

**Year=1995, Quarter=2**



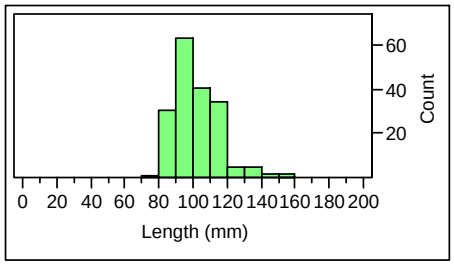
**Year=1995, Quarter=3**



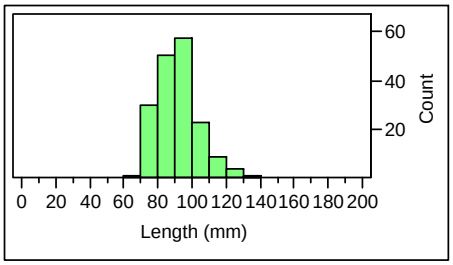

**Year=1996, Quarter=4**



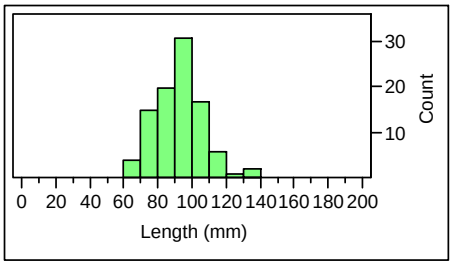

**Year=1998, Quarter=1**



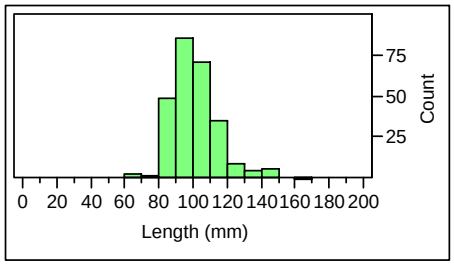

**Year=1995, Quarter=4**



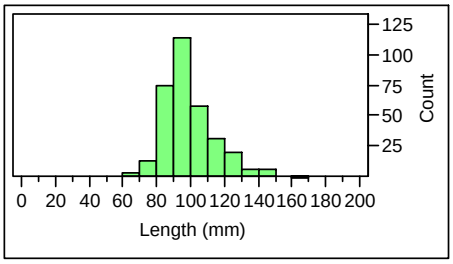

**Year=1997, Quarter=1**



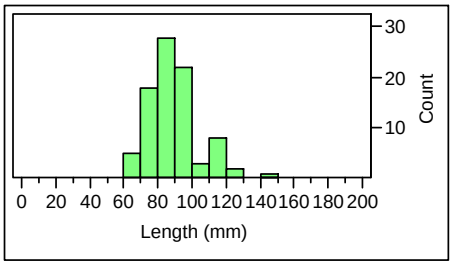

**Year=1998, Quarter=2**



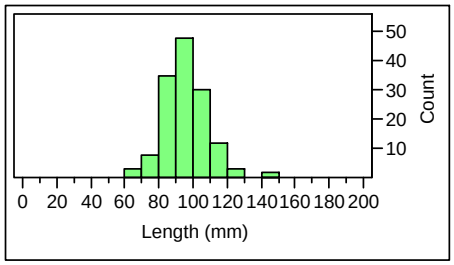

**Year=1996, Quarter=1**



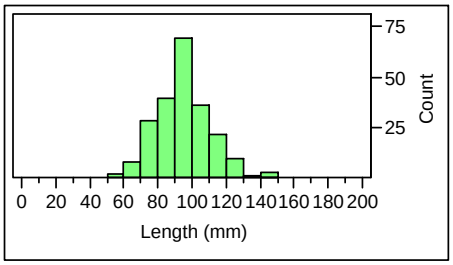

**Year=1997, Quarter=2**



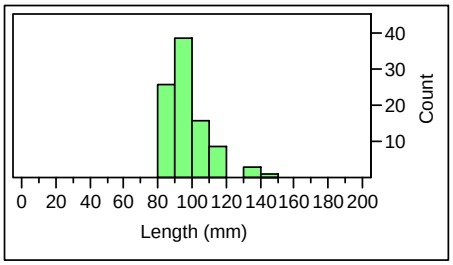

**Year=1998, Quarter=3**



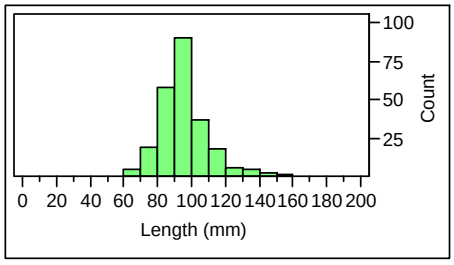

**Year=1996, Quarter=2**



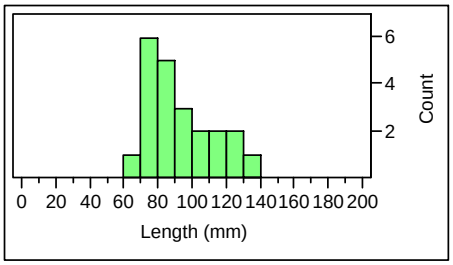

**Year=1997, Quarter=3**



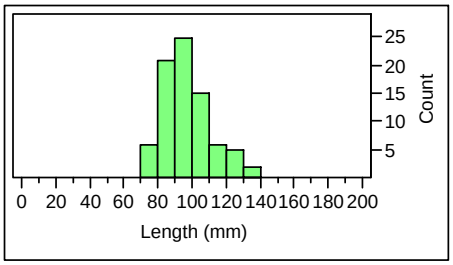

**Year=1998, Quarter=4**



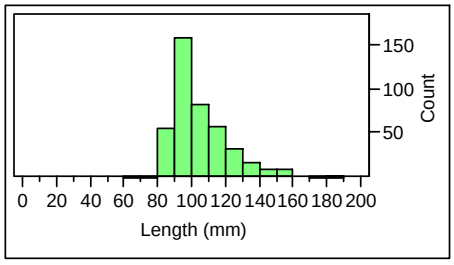

**Year=1996, Quarter=3**



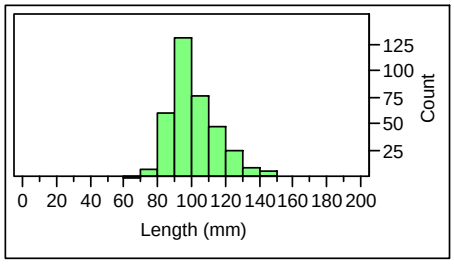

**Year=1997, Quarter=4**



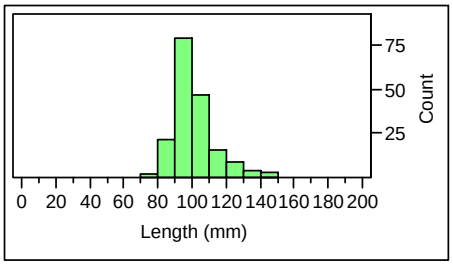

**Year=1999, Quarter=1**



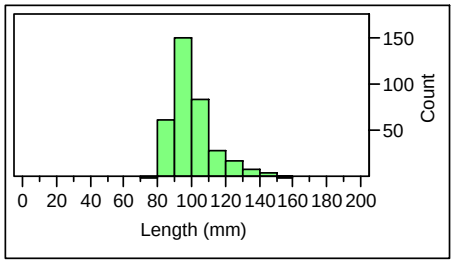
**Year=1999, Quarter=2**



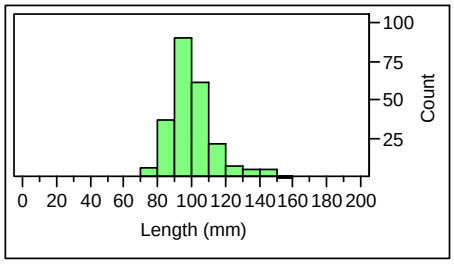

**Year=2000, Quarter=3**



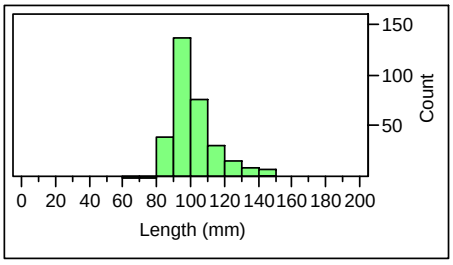

**Year=2001, Quarter=4**



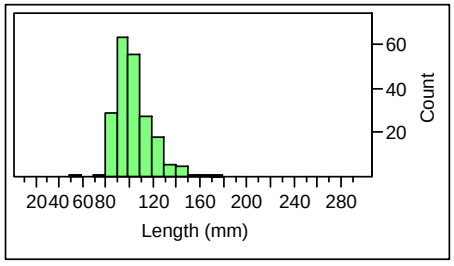

**Year=1999, Quarter=3**



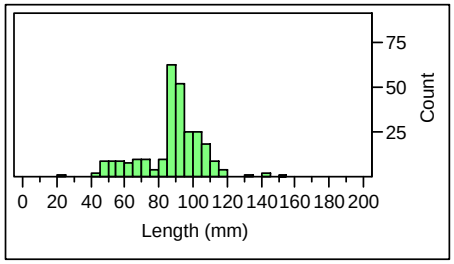

**Year=2000, Quarter=4**



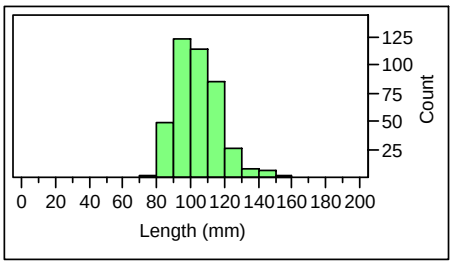

**Year=2002, Quarter=1**



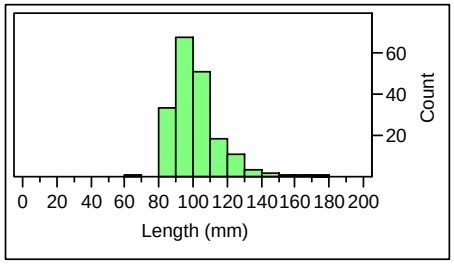

**Year=1999, Quarter=4**



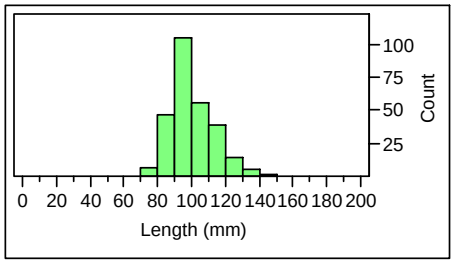

**Year=2001, Quarter=1**



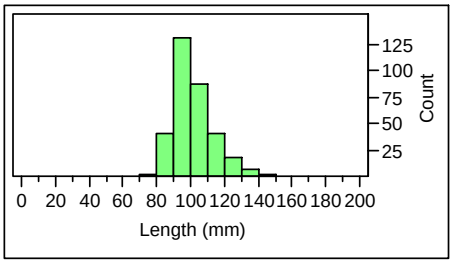

**Year=2002, Quarter=2**



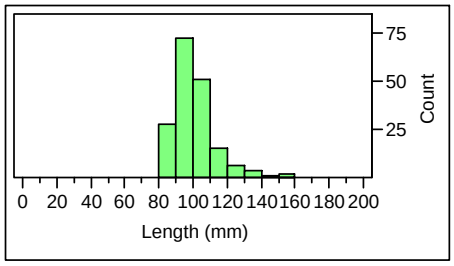

**Year=2000, Quarter=1**



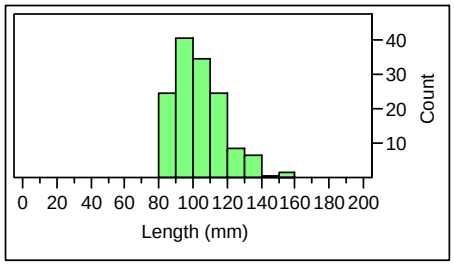

**Year=2001, Quarter=2**



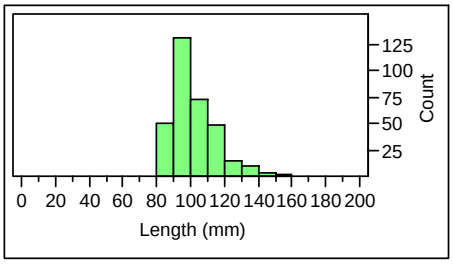

**Year=2002, Quarter=3**



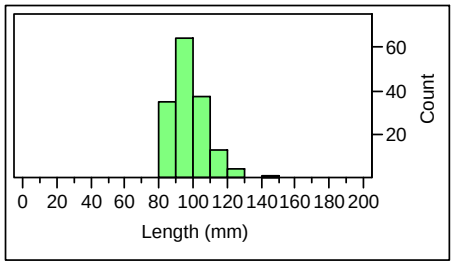

**Year=2000, Quarter=2**



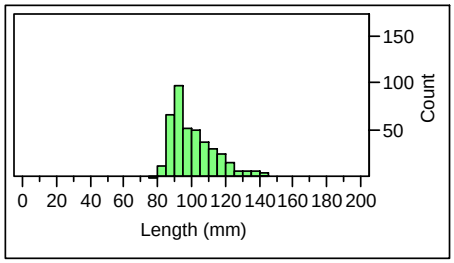

**Year=2001, Quarter=3**



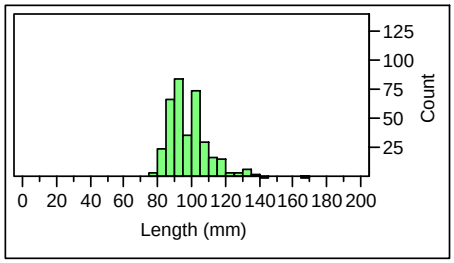

**Year=2002, Quarter=4**



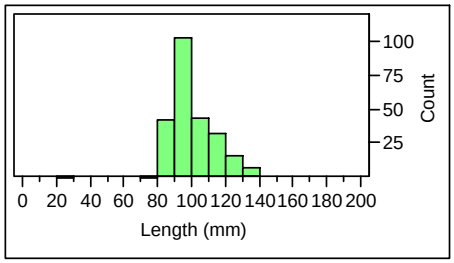
**Year=2003, Quarter=1**



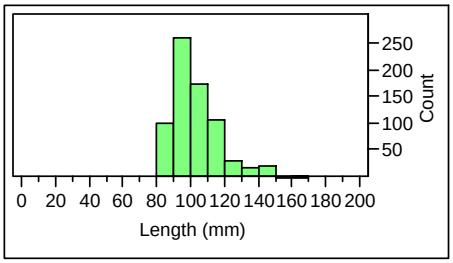

**Year=2003, Quarter=2**




**Year=2003, Quarter=3**

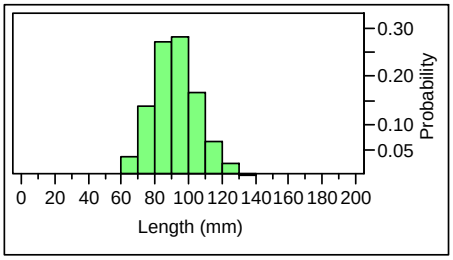



**Year=2003, Quarter=4**

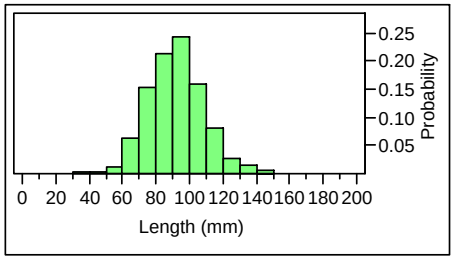


## 2) Length Frequency for Puerto Rican Spiny Lobster by Year

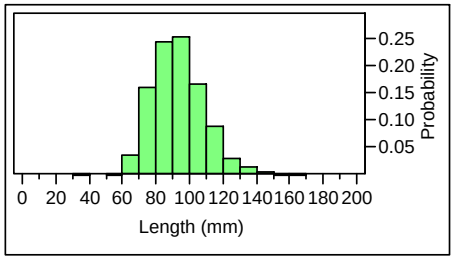
**Year=1980 N = 612**



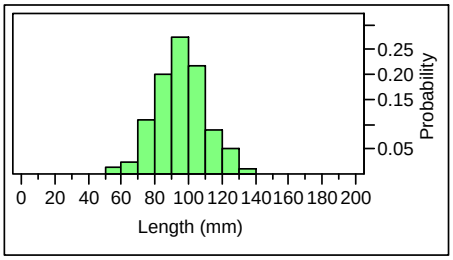

**Year=1987 N = 813**



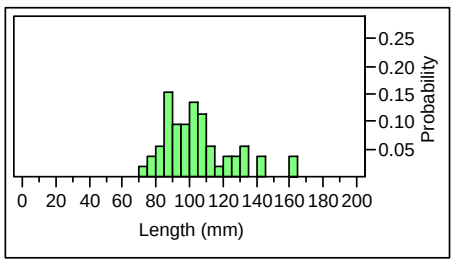

**Year=1992 N = 1341**



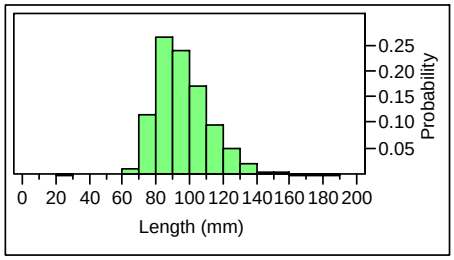

**Year=1983 N = 274**



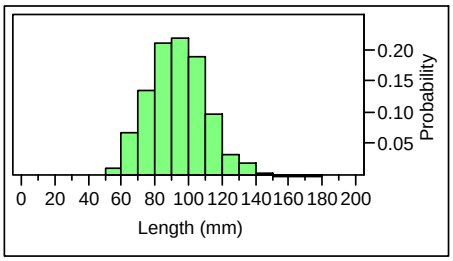

**Year=1988 N = 52**



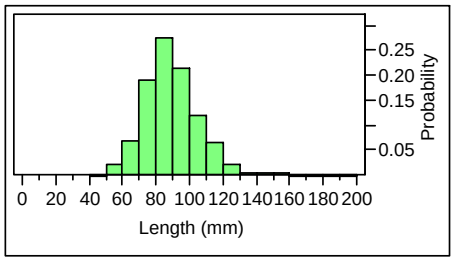

**Year=1993 N = 929**



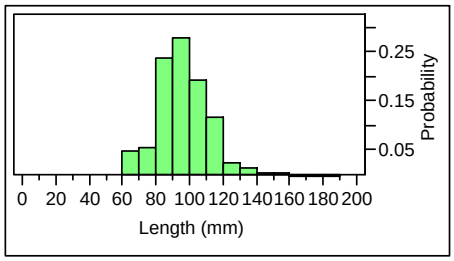

**Year=1984 N = 1931**



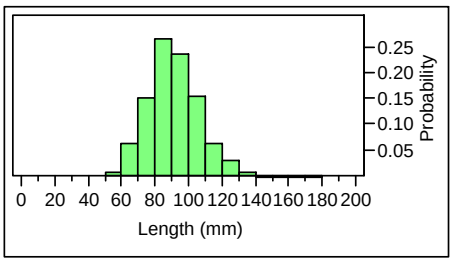

**Year=1989 N = 1239**



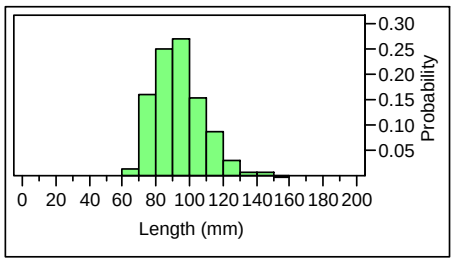

**Year=1994 N = 327**



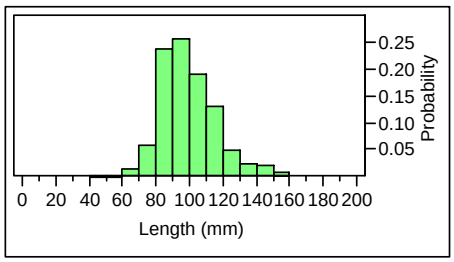

**Year=1985 N = 3452**



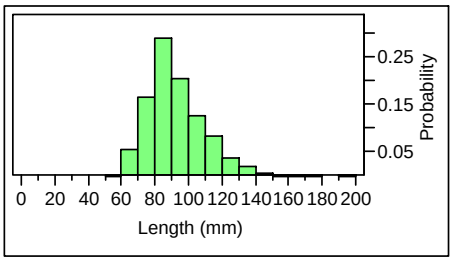

**Year=1990 N = 920**



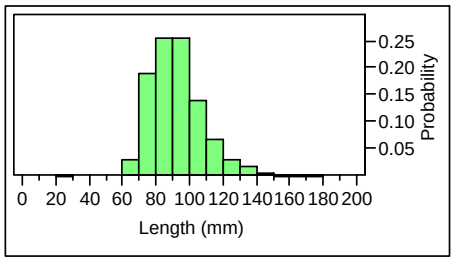

**Year=1995 N = 911**



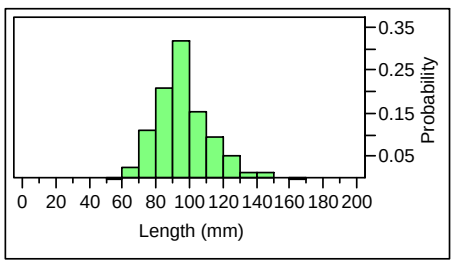

**Year=1986 N = 1050**



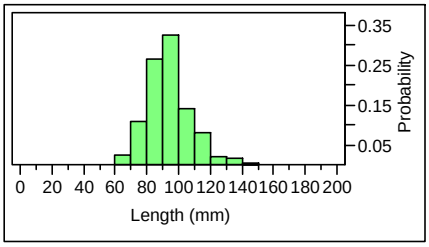

**Year=1991 N = 1751**



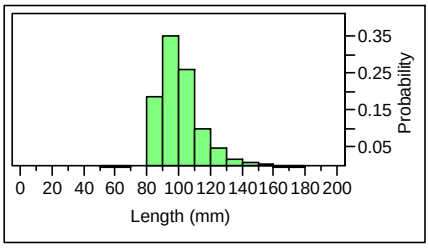

**Year=1996 N = 804**



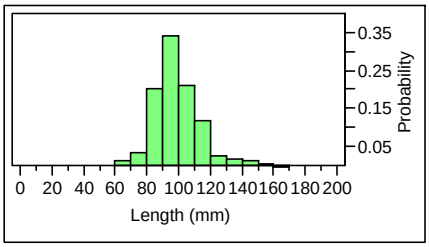
**Year=1997 N = 357**



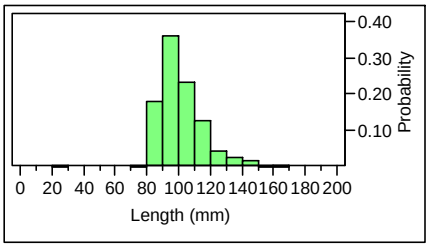

**Year=2002 N = 742**



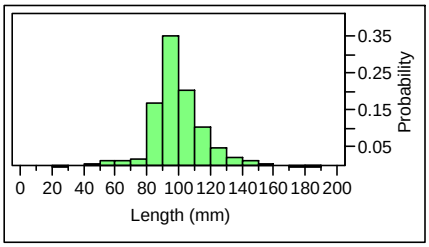

**Year=1998 N = 842**



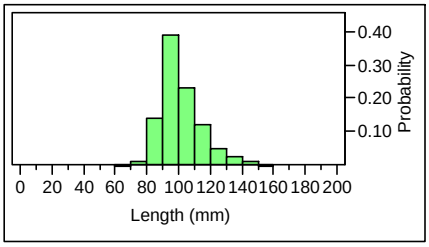

**Year=2003 N = 1742**



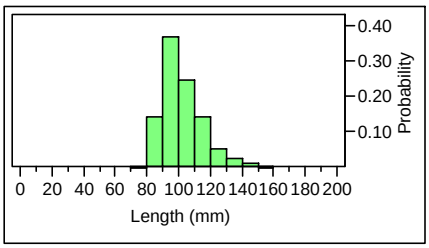

**Year=1999 N = 1305**




**Year=2000 N = 927**

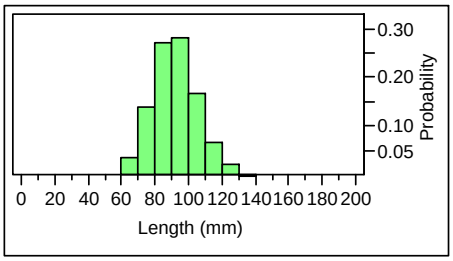



**Year=2001 N = 1458**

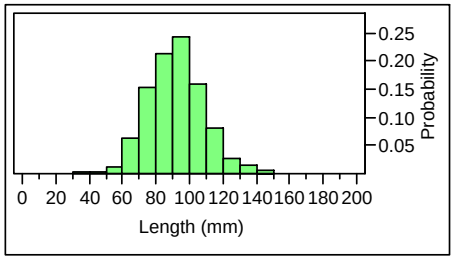


## 2) Length Frequency for Puerto Rican Spiny Lobster by Year

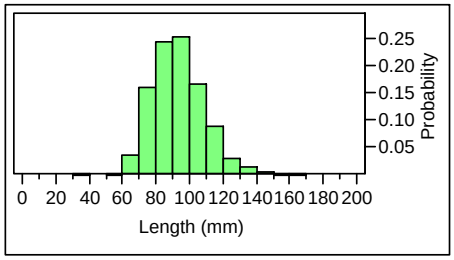
**Year=1980 N = 612**



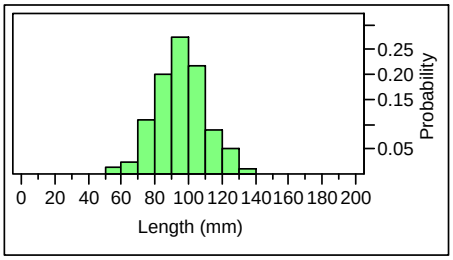

**Year=1987 N = 813**



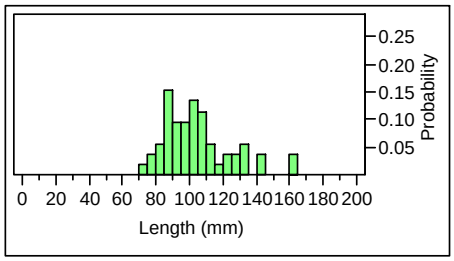

**Year=1992 N = 1341**



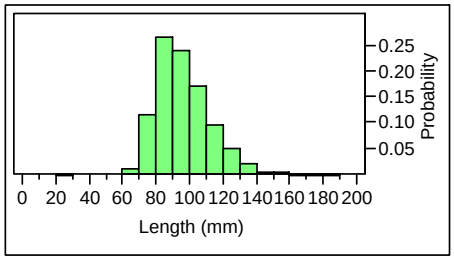

**Year=1983 N = 274**



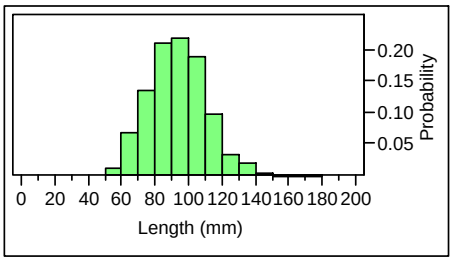

**Year=1988 N = 52**



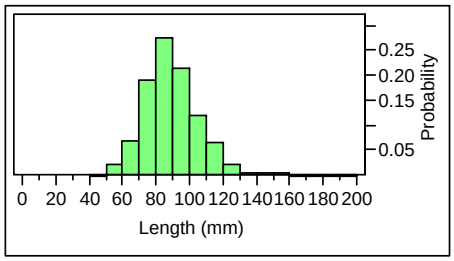

**Year=1993 N = 929**



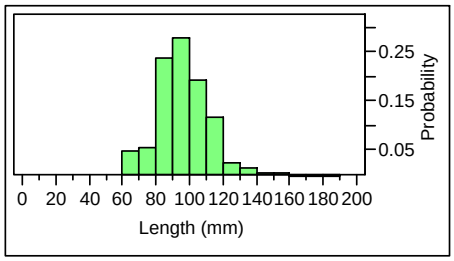

**Year=1984 N = 1931**



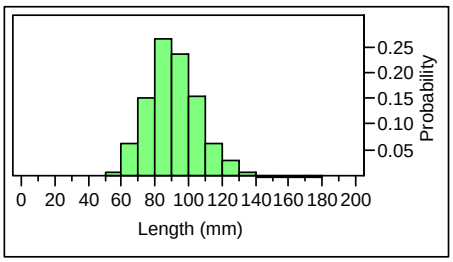

**Year=1989 N = 1239**



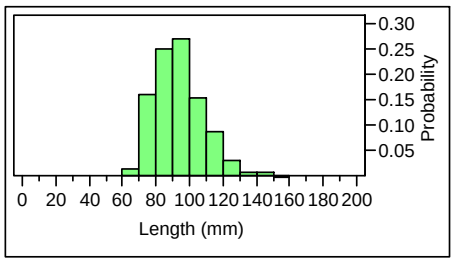

**Year=1994 N = 327**



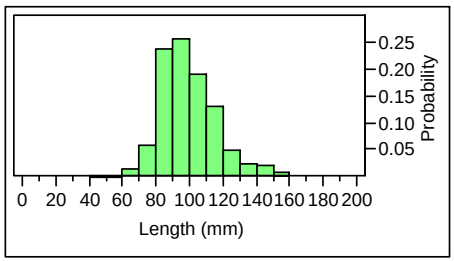

**Year=1985 N = 3452**



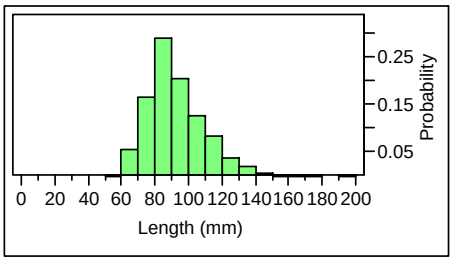

**Year=1990 N = 920**



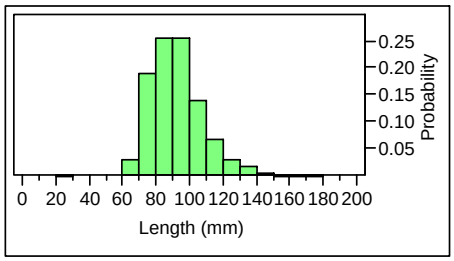

**Year=1995 N = 911**



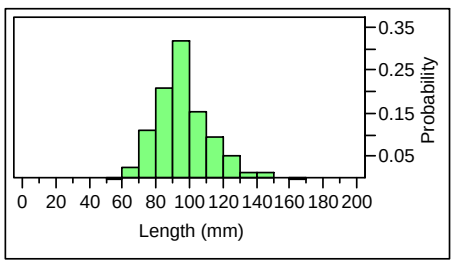

**Year=1986 N = 1050**



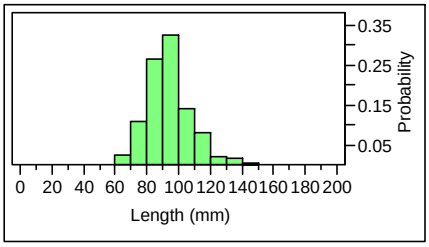

**Year=1991 N = 1751**



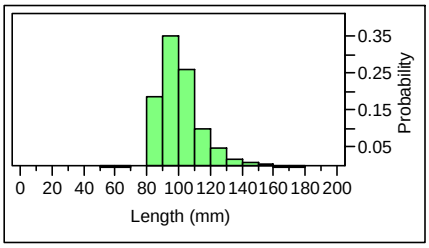

**Year=1996 N = 804**



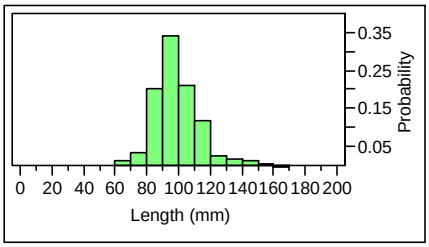
**Year=1997 N = 357**



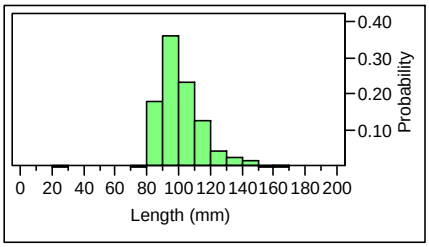

**Year=2002 N = 742**



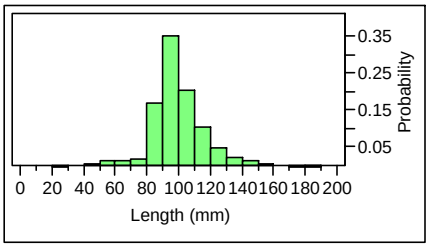

**Year=1998 N = 842**



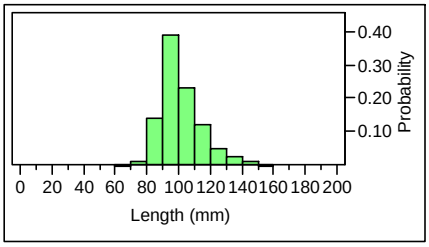

**Year=2003 N = 1742**



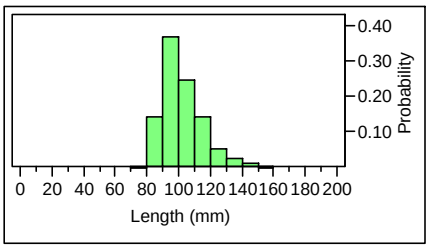

**Year=1999 N = 1305**




**Year=2000 N = 927**

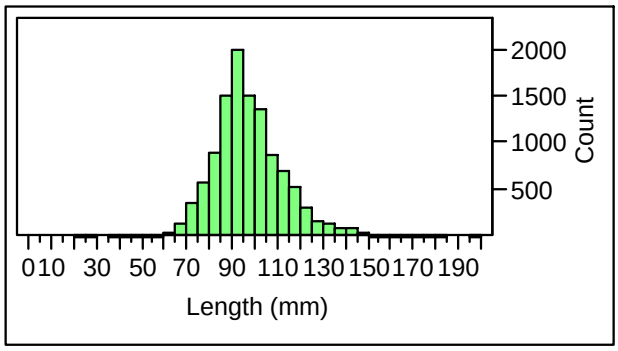



**Year=2001 N = 1458**

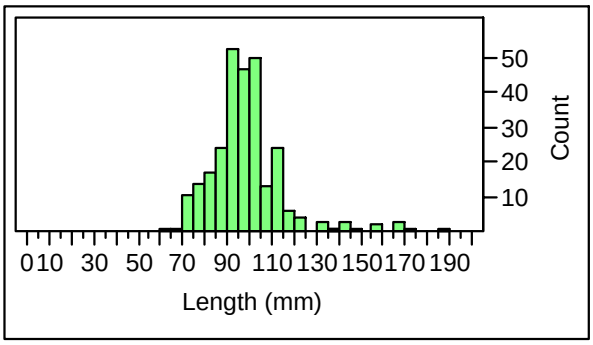


## 4.) Length Frequency for Puerto Rican Spiny Lobster by Gear Type

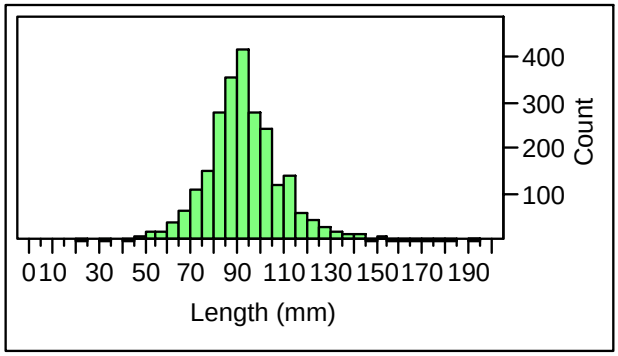
**GEAR CODE=DIVE**
N = 11419



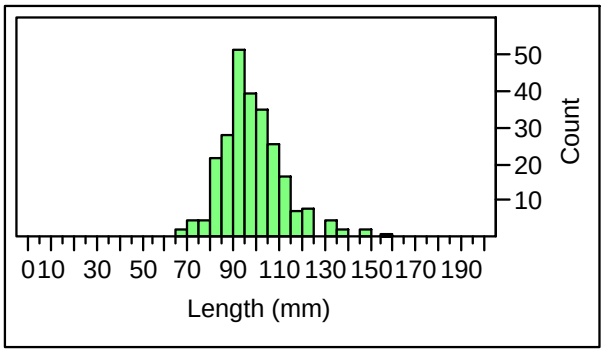

**GEAR CODE=HANDTROLL**
N = 280



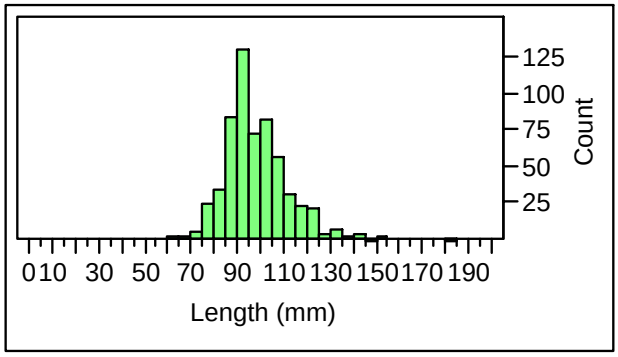

**GEAR CODE=FISHTRAPS**
N = 2446



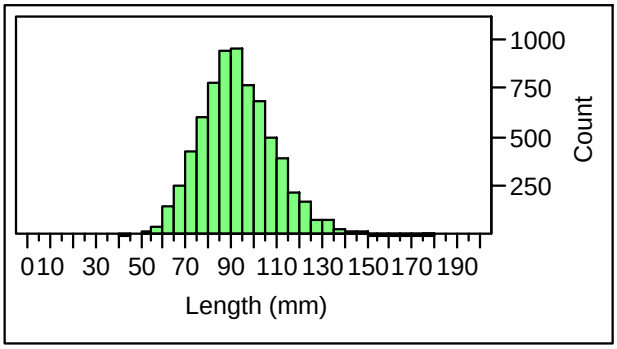

**GEAR CODE=GILLTRAMM**
N = 257




**GEAR CODE=LOBTRAP**
N = 596

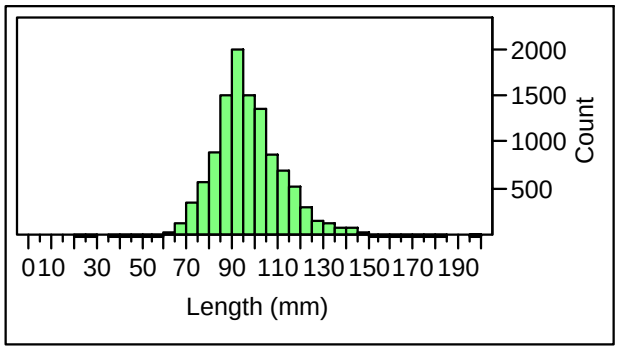



**GEAR CODE=OTH**
N = 7187

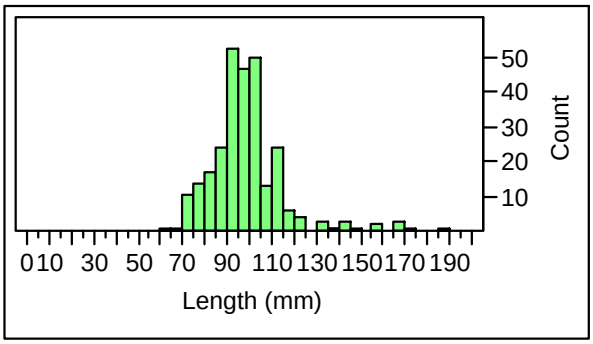


## 4.) Length Frequency for Puerto Rican Spiny Lobster by Gear Type

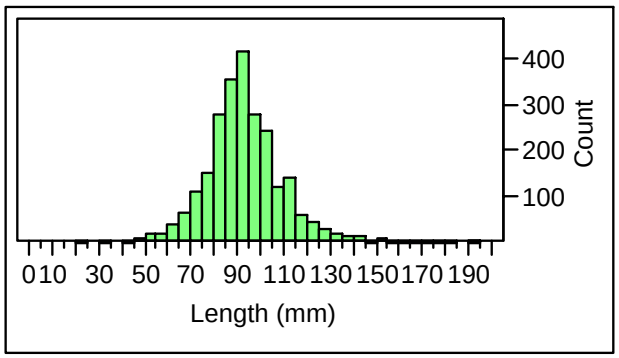
**GEAR CODE=DIVE**
N = 11419



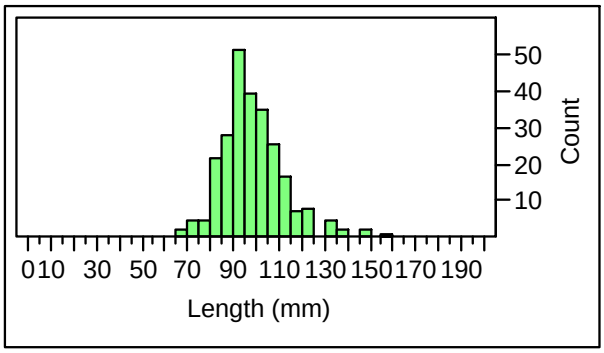

**GEAR CODE=HANDTROLL**
N = 280



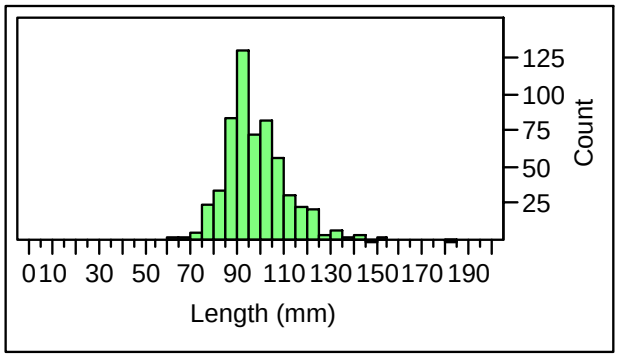

**GEAR CODE=FISHTRAPS**
N = 2446




**GEAR CODE=GILLTRAMM**
N = 257




**GEAR CODE=LOBTRAP**
N = 596




**GEAR CODE=OTH**
N = 7187