# SEDAR

## Southeast Data, Assessment, and Review

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## SEDAR 91

## US Caribbean Spiny Lobster Puerto Rico

## SECTION II: Data Workshop Report

<January 2025>

SEDAR
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# Table of Contents

1. INTRODUCTION ..... 4

**1.1 WORKSHOP TIME AND PLACE ..... 4**

**1.2 TERMS OF REFERNCE ..... 4**

**1.3 LIST OF PARTICIPANTS ..... 4**

**1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS ..... 6**

2. LIFE HISTORY ..... 9

**2.1 Overview ..... 9**

**2.2 Stock Definition and Description ..... 9**

**2.3 Meristic & Conversion factors ..... 9**

**2.4 Natural Mortality ..... 10**

**2.5 Reproduction ..... 10**

**2.6 Age and Growth ..... 10**

3. COMMERCIAL FISHERY STATISTICS ..... 15

**3.1 Biological Sampling ..... 15**

3.1.1 Overview ..... 15

3.1.2 Length Composition Sampling Intensity ..... 15

3.1.3 Length Distributions ..... 15

3.1.4 Adequacy of Size Composition Data for Characterizing Catch ..... 15

**3.2 Commercial Landings ..... 16**

3.2.1 Overview ..... 16

3.2.2 Outlier Analysis ..... 16

3.2.3 Adoption (partial) of Electronic Reporting Since 2020 ..... 16

3.2.4 Expansion Factors and Calculation of Commercial Landings ..... 16

3.2.5 Puerto Rico Caribbean Spiny Lobster Fishery ..... 17

**3.3 Commercial Discards ..... 18**

**3.4 Commercial Effort ..... 18**

4. RECREATIONAL FISHERY STATISTICS ..... 27

5. MEASURES OF POPULATION ABUNDANCE ..... 27

**5. Overview ..... 27**

6. RESEARCH RECOMMENDATIONS ..... 28

**6.1 Life History Research Recommendation ..... 28**

**6.2 Commercial Fishery Statistics** ..... **28**
6.2.1 Length Composition Research Recommendations ..... 28
7. LITERATURE CITED ..... 29

# 1. INTRODUCTION

## 1.1 WORKSHOP TIME AND PLACE

The SEDAR 91 Data Workshop was held November 13-15, 2024, in St Thomas, USVI. In addition to the in-person workshop, a series for webinars were held before (June and October 2024) the meeting.

## 1.2 TERMS OF REFERNCE

**Data Workshop Terms of Reference:**

1. Review available data inputs and provide tables and figures including, but not limited to:
    a. Commercial and recreational catches and/or discards.
    b. Length/age composition data
    c. Life history and ecological information
    d. Indices of abundance
    e. Include data through at least 2022.
2. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on research goals, data to be collected, and how the research will inform stock assessment.
3. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

## 1.3 LIST OF PARTICIPANTS

**Data Workshop Participants**

| | |
|---|---|
| Matt Damiano (Lead Analyst) | NMFS/SEFSC |
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| Maggie Rios | USVI DPNR |
| M. Refik Orhun | NMFS/SEFSC |
| Wilson Santiago Soler | PR Fisheries Liaison |
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Vanessa Ramirez .....
Noemi Peña Alvard ..... PR DNER
Aida Rosario ..... PR DNER

## 1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

| Document # | Title | Authors | Date Submitted |
|---|---|---|---|
| **Documents Prepared for the Data Workshop** | | | |
| SEDAR91-DW-01 | Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the U.S. Virgin Islands lobster fishery | Juan Agar, Mandy Karnauskas, Kelsi Furman, Matt McPherson, Manoj Shivlani | 11/1/2024 |
| SEDAR91-DW-02 | Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the Puerto Rican lobster fishery | Mandy Karnauskas, Juan Agar, Matt McPherson, Kelsi Furman, Manoj Shivlani | 11/1/2024 |
| SEDAR91-DW-03 | PR/DNER/Commercial Fisheries Statistics Program Report Signs of the Abundance of Spiny Lobster Panulirus argus Observed by Commercial Landings Reported during 2014-2023 | Daniel Matos-Caraballo, Jesús León-Fernández, Luis A. Rivera-Padilla, and Wilson Santiago-Soler | 11/15/2024 |
| SEDAR91-DW-04 | SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in Puerto Rico, U.S. Caribbean, 1981-2023 | Katherine Godwin, Adyan Rios | 11/20/2024 |
| SEDAR91-DW-05 | SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in St. Thomas/St. John, U.S. Caribbean, 1981-2023 | Katherine Godwin, Adyan Rios | 11/20/2024 |
| SEDAR91-DW-06 | SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in St. Croix, U.S. Caribbean, 1981-2023 | Katherine Godwin, Adyan Rios | 11/20/2024 |
| SEDAR91-DW-07 | SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus, Panulirus guttatus) | M. Refik Orhun, Katherine Godwin, Kim Johnson, and | 11/24/2024 |

| | | | |
|---|---|---|---|
| | in Puerto Rico, US Caribbean, 1983-2023 | Stephanie Martínez Rivera | |
| SEDAR91-DW-08 | SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus) in St. Thomas and St. John, US Caribbean, 1975-2023 | M. Refik Orhun, Katherine Godwin, Kim Johnson, and Stephanie Martínez Rivera | 11/24/2024 |
| SEDAR91-DW-09 | SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus) in St. Croix, US Caribbean, 1975-2023 | M. Refik Orhun, Katherine Godwin, Kim Johnson, and Stephanie Martínez Rivera | 11/24/2024 |
| **Reference Documents** | | | |
| SEDAR91-RD01 | On the productivity and technical efficiency of the Puerto Rican queen conch Aliger gigas fishery | Juan Agar and Daniel Solis | 10/9/2024 |
| SEDAR91-RD02 | Socio-economic Profile of the Small-scale Dive Fishery in the Commonwealth of Puerto Rico | Juan J. Agar and Manoj Shivlani | 10/9/2024 |
| SEDAR91-RD03 | Determining the age-size relationship of Panulirus argus in the southwest area of Puerto Rico | Ana G. Medina Martinez | 10/9/2024 |
| SEDAR91-RD04 | Annual Juvenile Recruitment of Spiny Lobsters, Panulirus Argus (Decapoda, Palinuridae), in a Shallow Seagrass Bed and a Deeper Hard Bottom off Western Puerto Rico | Nilda M. Jiménez, Ernest H. Williams, Jr. and Aida Rosario | 10/10/2024 |
| SEDAR91-RD05 | Patterns of Spiny Lobster (Panulirus argus) Postlarval Recruitment in the Carribbean: A CRTR Project | Mark J. Butler IV, Angela M. Mojica, Eloy Sosa-Cordero, Marines Millet and Paul Sanchez-Navarro | 10/10/2024 |
| SEDAR91-RD06 | Developing a population assessment for Caribbean spiny lobster *Panulirus argus* in the United States Virgin Islands: lessons learned | Lee Richter[1] and Michael W Feeley[2] | 11/7/2024 |
| SEDAR91-RD07 | Estimate of In-water Size Structure of Spiny Lobsters in St. Thomas | Tyler B. Smith, Sarah L. Heidmann, Rosmin S. Ennis, Viktor W. Brandtneris, | 11/7/2024 |

| | | | |
|---|---|---|---|
| | | Adeline Shelby, Jeremiah Blondeau | |
| SEDAR91-RD08 | Displaced juvenile and subadult Caribbean spiny lobsters show strong orientation toward home dens | Michael J. Childress a,*, Coral Holt a, Rodney D. Bertelsen b | 11/14/2024 |
| SEDAR91-RD09 | Ocean acidification disrupts the orientation of postlarval Caribbean spiny lobsters | Philip M. Gravinese, Heather N. Pag, Casey B. Butler, Angelo Jason Spadaro, Clay Hewett, Megan Considine, David Lankes & Samantha Fisher | 11/14/2024 |
| SEDAR91-RD10 | Relationships between postlarval settlement and commercial landings of Caribbean spiny lobster (Panulirus argus) in Florida (USA) | Emily Hutchinson, Thomas R. Matthews , Gabrielle F. Renchen | 11/14/2024 |
| SEDAR91-RD11 | Gastric mill ossicles record chronological age in the Caribbean spiny lobster (*Panulirus argus*) | Emily Hutchinson, Thomas. R Matthews, Erica Ross, Samantha Hagedorn , Mark J. Butler IV, | 11/14/2024 |
| SEDAR91-12 | Spiny Lobster SEAMAP Program Survey 2021-23 | Department of Natural and Environmental Resources | 11/14/2024 |
| SEDAR91-13 | Progress Report: Independent fishery data collection for lobster (Panulirus argus) and conch (Lobatus gigas) under the SEAMAP-C program | Juan J. Cruz Motta | 11/14/2024 |

# 2. Life History

## 2.1 Overview

No new life history information was available for the SEDAR Panel to discuss during the data workshop. Therefore, sections 2.2-2.8 were carried over from SEDAR 57.

## 2.2 Stock Definition and Description

The Caribbean spiny lobster, *Panulirus argus* (hereafter referred to as spiny lobster), occurs in the Caribbean Sea, the Gulf of Mexico and the Western Central and South Atlantic Ocean. North Carolina marks its northernmost limit whereas Brazil marks its southernmost limit (Bliss 1982). The spiny lobster occurs from the extreme shallows of the littoral fringe to depths exceeding 100 meters (Kanciruk 1980; Munro 1974). CFMC (1981) reports that its distribution off Puerto Rico extends to the edge of the shelf, which is described as the 100−fathom contour (183 meters). Shallow areas with mangroves and seagrass (*Thalassia testudinum*) beds serve as nursery areas where available (Munro 1974). Generally, spiny lobsters move offshore when they reach reproductive size (Phillips et al. 1980). These animals are primarily carnivores, and serve as the major benthic carnivores in some ecosystems (Kanciruk 1980), feeding upon smaller crustaceans, mollusks and annelids (Cobb and Wang 1985).

## 2.3 Meristic & Conversion factors

Length-weight conversions were estimated using the Trip Interview Program (TIP) database. TIP records were filtered according to island platform (Puerto Rico, St. Thomas/St. John, and St. Croix). Records were further filtered such that retained records consisted only of those with paired length-weight measurements that had reported units of measure (e.g., mm or kg) and corresponding measurement type (e.g., carapace length or whole weight). A subsequent evaluation of data entry and/or measurement errors led to the removal of 33 records for Puerto Rico (Table 2.1.)

Length-weight (L-W) relationships were fit as log-linear functions in the R statistical computing software (Quinn and Deriso 1999, R Development Core Team 2012). The relationship for cephalothorax length (CL; mm) to weight (kg whole weight) is:

$$W = aL^b$$

Model fitting was carried out using linear regression on the log transformed equation:

$$log(W) = log(a) + b * \ log(L)$$

Resulting L-W relationships are found in Table 2.2. For Puerto Rico, a total of *n*=22,980 L-W observations were available from TIP (*n* male=12,019; *n* female=10,961) from 1980 to 2016 (Fig. 2.1). The largest individual by length was 196 mm CL, which was also the largest individual by weight (4.536 kg). Cephalothorax length to weight conversions by Island Platform are shown in Table 2.2.

Spatial analysis of Puerto Rico L-W data according to four Caribbean spatial areas suggested that L-W curves were not significantly different (p-value = 1.0; Table 2.3).

### 2.4 Natural Mortality

During SEDAR 8, various sources are referenced with respect to natural mortality, including Olsen and Koblic 1975, Medley and Ninnes 1996, and FAO 2001. Natural mortality was specified at 0.36 for adult lobsters and used for all ages during SEDAR 8. During SEDAR 46 (Spiny lobster St. Thomas/St. John and St. Croix), consideration was given to natural mortality estimates from tagging studies, with estimates typically varying between 0.26 and 0.44 year$^{-1}$ for adult spiny lobster, with the most reliable estimates suggested to be in the range of 0.30 to 0.40 (FAO 2001). A point estimate of 0.34 year$^{-1}$, calculated from a variant of Pauly's equation, is also widely reported (Cruz et al. 1981). Point estimates based on longevity were also considered, but require evidence of maximum age, which is difficult to obtain for lobsters (Kanciruk 1980). This issue is reinforced by additional statements made by Olsen and Koblic (1975). Further discussion about spiny lobster longevity can be found on pg 27, SEDAR 46, Data and Assessment Workshop report (SEDAR 2016). Several spiny lobster stock assessments in the Caribbean have used 0.34 to 0.36 year$^{-1}$ in base model runs (Cruz 2001; Gongora 2010; SEDAR 2005; Babcock et al. 2014). During the SEDAR 57 data workshop, participants identified a mark- recapture dataset from a study undertaken by the St. Thomas Fishermen's Association (Olsen et al. 2017). Analysts determined obtaining an estimate of natural mortality from this study for use in the assessment was not feasible; this was potentially due to an underestimate of reporting practices stated by Olsen et al. (2017), which resulted in an unreasonably high (M > 2.0 year$^{-1}$) estimates of natural mortality (see SEDAR 57 Final Assessment Report).

### 2.5 Reproduction

Die (2005) estimated a logistic maturity curve from TIP prior to 1990, when landing of egg bearing females was permitted. Data from Puerto Rico and St. Thomas/St. John were aggregated for the purpose of model fitting. Two model parameterizations were considered, in both cases, length at 50% maturity were similar being either 91 mm or 92 mm CL.

For SEDAR 8 (2005), fecundity-at-length was obtained for Cuba spiny lobster (FAO 2001):

$E = 0.5911L^{4.5677}$,

where E is number of eggs and L is carapace length in mm.

### 2.6 Age and Growth

During SEDAR 8, von Bertalanffy growth curves for males and females were obtained from Leon et al. (1994) for Cuba (SEDAR 2005). Since SEDAR 8, several additional publications have become available for von Bertalanffy growth curves from regions such as Cuba, Puerto Rico, and Mexico (Table 2.3). Also, during SEDAR 46 (Spiny lobster St. Thomas/St. John & St. Croix), von Bertalanffy growth parameters from Leon et al. (1995) were reviewed, noting similar values used in other stock assessment (i.e., Gongora 2010; Babcock et al. 2014). These point estimates were also compared to a more recent study by Leon et al. (2005) and analyses in SEDAR 46 were based on a single growth curve for both sexes. During the SEDAR 57 data

workshop, participants identified a mark-recapture dataset from a study undertaken by the St. Thomas Fishermen's Association (Olsen et al. 2017). During SEDAR 57, analysts determined that obtaining a growth curve from this study for use in the assessment was not feasible. This was due to an absence of the largest size classes in the data set, though results verified that growth in Puerto Rico (Table 2.3) was generally consistent with growth in St. Thomas/St. John (see SEDAR 57 Final Assessment Report).

**Table 2.1** Records manually removed from Puerto Rico TIP prior to CL-W model fitting.

| CL | W | Sex |
|---|---|---|
| 267 | 0.42 | F |
| 325 | 0.582 | F |
| 340 | 0.846 | F |
| 342 | 0.7 | F |
| 899 | 0.564 | F |
| 162 | 30.6 | F |
| 94 | 7.681 | F |
| 100 | 9.481 | F |
| 90 | 6.116 | F |
| 20.574 | 0.467 | F |
| 10 | 0.531 | F |
| 10 | 0.849 | F |

| CL | W | Sex |
|---|---|---|
| 209 | 0.907 | M |
| 340 | 0.67 | M |
| 340 | 0.498 | M |
| 300 | 0.38 | M |
| 310 | 0.552 | M |
| 514 | 0.83 | M |
| 275 | 0.364 | M |
| 290 | 0.442 | M |
| 262 | 0.33 | M |
| 202 | 1.03 | M |
| 814 | 0.814 | M |
| 952 | 0.64 | M |
| 123 | 11.4 | M |
| 101 | 8.871 | M |
| 1 | 1.142 | M |
| 20.574 | 0.56 | M |
| 20.32 | 0.506 | M |
| 20.574 | 0.59 | M |
| 20.574 | 0.682 | M |
| 60.7 | 4.075 | M |
| 192 | 0.68 | M |

**Table 2.2** Fitted conversion functions from cephalothorax length (mm) to weight (kg whole weight) for Puerto Rico.

| Island platform | Year | n | a | b |
|---|---|---|---|---|
| **Puerto Rico** | | | | |
| Males | 1980-2016 | 12,019 | 6.836E-05 | 2.536 |
| Females | 1980-2016 | 10,961 | 7.612E-05 | 2.521 |
| Males + Females | 1980-2016 | 22,980 | 4.166E-05 | 2.511 |

**Table 2.3** von Bertalanffy growth parameters, noting values used in SEDARs 8 and 46 (i.e., Leon et al. (1995)) and with emphasis on subsequent studies.

| Study | Region/Country | Source | Sex | CL∞ (mm) | K |
|---|---|---|---|---|---|
| Leon et al. (1995) | Cuba | Length frequency | M | 184 | 0.24 |
| | | | F | 155 | 0.22 |
| Leon et al. (2005) | Cuba | Length frequency | Both | 184 | 0.24 |
| Mateo (2004) | Puerto Rico | Length frequency | M (1999) | 197 | 0.24 |
| | | | M (2000) | 195 | 0.24 |
| | | | F (1999) | 191 | 0.25 |
| | | | F (2000) | 185 | 0.23 |
| Velazquez-Abunader et al. (2015) | Mexico, Yucatan | Length frequency | M | 203 | 0.28 |
| | | | F | 189 | 0.34 |

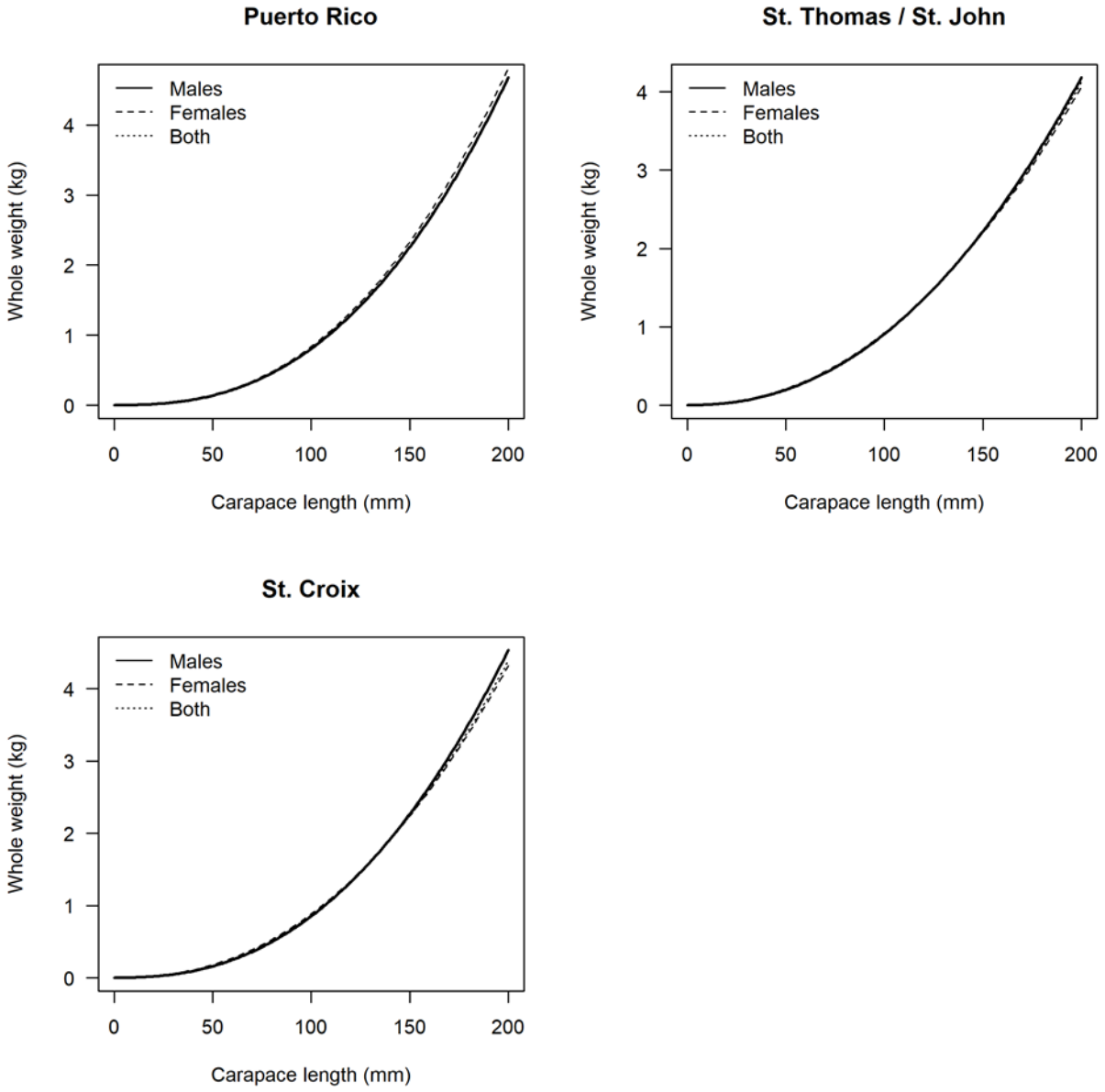


**Figure 2.1** Length-weight curves for spiny lobster of Puerto Rico, St. Thomas/St. John, and St. Croix.

# 3. Commercial Fishery Statistics

## 3.1 Biological Sampling

### *3.1.1 Overview*

The NOAA Fisheries, Southeast Fisheries Science Center Trip Interview Program (TIP) collects length and weight data from fish landed by commercial fishing vessels, along with information about fishing area and gear. Data collection began in the 1980s with frequent updates in best practices; the latest being in 2017. Data are collected by trained shore-based samplers (Beggerly et al., 2022).

### *3.1.2 Length Composition Sampling Intensity*

The TIP data pertaining to Caribbean Spiny Lobster in Puerto Rico consists of 69,212 length observations across 7,894 unique port sampling interviews (Figure 3.1.1). Of the Caribbean spiny lobster measured, 69,065 were CL observations (99.8%). Plots and summary statistics of the currently available CL frequency data of Caribbean spiny lobster sampled from the predominant gears in Puerto Rico are included in the working paper (Godwin et al. 2024).

### *3.1.3 Length Distributions*

A variety of fishing gears were used by Puerto Rico commercial fishers to catch Caribbean spiny lobster. A generalized linear mixed model (GLMM) was fit to TIP data to compare mean CL composition among gear types. The purpose of the analysis was to identify gear groups among the commercial fishing gears with groups based upon Caribbean spiny lobster size composition. Gears with size compositions that were not significantly different were assigned to the same gear group. The analysis identified no difference in mean size composition among gear specific size compositions and the gears with confidential data are provided in Table 3.1.1. Summary statistics produced by the GLMM analysis of the available length frequency data from 1981 to 2023 are also included in Table 3.1.1. Gear groups were identified based on GLMM analysis using a gamma-distributed dependent variable and a covariate to account for changes in mean CL over time. Random effects for interview ID and categorical year were included to account for non-independence of observations.

The aggregated density plot for all gears combined of Caribbean spiny lobster CL collected across the time series 1981-2023 are summarized in Figure 3.1.2. Aggregated density plots of Caribbean spiny lobster landed by nonconfidential gears are summarized in Figure 3.1.3.

### *3.1.4 Adequacy of Size Composition Data for Characterizing Catch*

Due to reasonable levels of available data throughout the time series, TIP data can be considered to inform selectivity and annual population trends in the SEDAR 91 assessment. A weight-length analysis was not conducted to identify outliers in the TIP data. A cutoff of 2.5cm minimum and 25cm maximum CL was implemented to remove notable outliers in the TIP dataset (Godwin et al 2024).

**Decisions:**

- Consider TIP data to inform selectivity and annual population trends in the SEDAR 91 assessment.
- Compare SEAMAP-C data and data from two pilot studies (MER Consultants at sea size composition and HJR Reefscaping at sea CL composition studies) with TIP data.
- Supply complete TIP time series for use in SEDAR 91 analyses.

## 3.2 Commercial Landings

### *3.2.1 Overview*

Commercial fishery landings in Puerto Rico, were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL). Commercial fishery landings data for Caribbean Spiny Lobster in Puerto Rico were available for the years 1983-2023.

### *3.2.2 Outlier Analysis*

An outlier analysis was conducted by using a mean and standard deviation method. If the landings of Caribbean Spiny Lobster reported on a trip were greater than three standard deviations from the mean (i.e., 99.73% quantile), they were marked for removal from the dataset. Outliers were identified for each gear group across all years. Total landings with and without outliers are shown in Figure 3.2.1 and the percent change in landings with outliers removed is shown in Table 3.2.1.

**Decisions**:

- SEDAR 91 Panel decided to define as outliers trips with landings of 1,000 pounds or more. Reports from those trips should be investigated and if found errant, remove them from the commercial landings' series for Puerto Rico.
- The panel recommended that the lead analyst be given the freedom to explore the assessment start year, tentatively recommending 1985. Members of the panel suggested that landings reported prior to 1985 may have included catches from outside of Puerto Rico's EEZ.

### *3.2.3 Adoption (partial) of Electronic Reporting Since 2020*

Starting in 2020, commercial fishers have had an electronic reporting option for reporting landings on their fishing trips. According to DRNA the adoption rate of electronic reporting is estimated to be around 40%. Due to differences in variable names and other database issues, integration of those electronically reported data into the CCL, and ultimately the Accumulated Landing System (ALS), has been difficult and has necessitated many labor-intensive adjustments to integrate these to the landings datasets for each year since its adoption.

### *3.2.4 Expansion Factors and Calculation of Commercial Landings*

Expansion factors to account for known underreporting and to better estimate commercial landings in Puerto Rico have been in use since landings data collection began in 1983. Port samplers go to a fishing landings center and record the landings of all vessels at that location.

The port sampler observed landings at each location/day are compared to the commercial logbooks with reported landings at the same location/day combination. The ratio of reported landings to observed landings, across all locations within a coast (as defined by DRNA) is the expansion factor for that coast. Expansion factors are not species specific. Expansion factors are usually smaller than 1, meaning not all landings observed by port agents are reported by the fisher:

$$\text{Expansion Factor} = \text{Sum of Reported Landings} / \text{Sum of Observed Landing}$$

The landings are then expanded by the inverse of the expansion factor (aka the expansion factor):

$$\text{Expansion Factor} = 1 / \text{Expansion Factor}$$

From 1983 to 2002, one expansion factor was used for all of Puerto Rico to expand the reported commercial landings. Starting in 2003 expansion factors by coast were adopted; i.e., separate expansion factors estimated and used for North, East, South and West Coast, Figure 3.2.2 shows Municipalities of Puerto Rico. A more detailed map of the municipalities and Fishing Landings Centers is shown in Appendix 1.

Since the beginning of electronic reporting, data accessibility, and calculation of expansion factors has been challenging. To provide expansion factors for the years 2020-23 (years of electronic reporting), the mean coast specific expansion factors calculated over the years 2014-2019 were used to calculate the expanded landings.

### *3.2.5 Puerto Rico Caribbean Spiny Lobster Fishery*

Commercial fishery landings in Puerto Rico were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL) that are mailed or delivered to the Puerto Rico Department of Natural and Environmental Resources (DNER or DRNA in Spanish). Commercial landings were reported by species, fishing gear, and the fishing center where the catch was landed.

Commercial fishery landings data for Caribbean Spiny Lobster in Puerto Rico were available for the years 1983-2023. The gear grouping followed the recommendations of the prior Caribbean Spiny Lobster assessment and its update (SEDAR 57, 2019; SEDAR 57 Update, 2022) shown in Orhun et al. (2024) with the addition of "NETS" as separate gear group. The commercial landings were presented in pounds by year and fishing gear groups are shown in Table 3.2.2.

**Decision**:

- The SEDAR 91 panel decided to combine all net gears; i.e., cast net, gill net and trammel net as a separate "NETS" gear group. The panel also decided to give the lead analyst freedom to explore fleet structure in the assessment model.

### 3.3 Commercial Discards

Species-specific commercial discard reporting was not established in Puerto Rico for Caribbean Spiny Lobster during the period 1983-2023.

### 3.4 Commercial Effort

Commercial trips with reported Caribbean Spiny Lobster landings per year and gear group were compiled from 1983 to 2023 (Table 3.4.1).

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**Table 3.1.1** GLMM analysis summary results for Puerto Rico TIP Caribbean Spiny Lobster CL (cm) from 1981 to 2023. The column titled "group" indicates the group(s) where mean CL are not statistically different from other gears with matching group number(s). The "n" column indicates the number of unique lengths recorded for each gear. The "Percentage" column indicates the percent of the total recorded lengths for each gear. Only nonconfidential data shown.

| Gear | Mean (cm) | Estimated Marginal Mean | LCL | UCL | Group | Lobster (n) | Interview (n) | Percentage |
|---|---|---|---|---|---|---|---|---|
| BY HAND; DIVING GEAR | 10.14 | 2.30 | 2.30 | 2.31 | 1 | 48,772 | 5,977 | 71.59 |
| POTS AND TRAPS; FISH | 9.79 | 2.32 | 2.30 | 2.33 | 1 | 10,801 | 1,020 | 15.85 |
| POTS AND TRAPS; SPINY LOBSTER | 9.92 | 2.29 | 2.28 | 2.31 | 1 | 4,370 | 304 | 6.41 |
| TRAMMEL NETS | 10.21 | 2.31 | 2.29 | 2.32 | 1 | 1,775 | 221 | 2.61 |

**Table 3.2.1** Comparison expanded landings before and after outlier removal of commercial landings of Caribbean Spiny Lobster in pounds for Puerto Rico.

| Year | Expanded Landings (lbs.) | Expanded Landings outlier analysis (lbs.) | Difference (%) |
|---|---|---|---|
| 1983 | 448,508 | 447,524 | 0.2 |
| 1984 | 420,343 | 418,530 | 0.4 |
| 1985 | 376,525 | 374,344 | 0.6 |
| 1986 | 279,757 | 260,191 | 7.0 |
| 1987 | 205,821 | 181,639 | 11.7 |
| 1988 | 252,020 | 240,642 | 4.5 |
| 1989 | 363,939 | 338,746 | 6.9 |
| 1990 | 329,415 | 302,116 | 8.3 |
| 1991 | 414,945 | 379,740 | 8.5 |
| 1992 | 268,317 | 237,424 | 11.5 |
| 1993 | 281,659 | 249,645 | 11.4 |
| 1994 | 300,095 | 286,801 | 4.4 |
| 1995 | 392,427 | 375,510 | 4.3 |
| 1996 | 392,777 | 371,898 | 5.3 |
| 1997 | 363,096 | 336,134 | 7.4 |
| 1998 | 381,511 | 339,054 | 11.1 |
| 1999 | 417,854 | 370,992 | 11.2 |
| 2000 | 449,641 | 415,172 | 7.7 |
| 2001 | 411,429 | 398,978 | 3.0 |
| 2002 | 349,237 | 313,213 | 10.3 |
| 2003 | 395,962 | 361,077 | 8.8 |
| 2004 | 476,493 | 471,092 | 1.1 |
| 2005 | 298,688 | 291,249 | 2.5 |
| 2006 | 276,402 | 271,272 | 1.9 |
| 2007 | 265,615 | 254,987 | 4.0 |
| 2008 | 330,029 | 294,887 | 10.6 |
| 2009 | 323,143 | 312,692 | 3.2 |
| 2010 | 289,630 | 264,583 | 8.6 |
| 2011 | 273,018 | 269,733 | 1.2 |
| 2012 | 384,059 | 378,357 | 1.5 |
| 2013 | 275,421 | 274,367 | 0.4 |
| 2014 | 296,806 | 293,023 | 1.3 |
| 2015 | 417,579 | 406,909 | 2.6 |
| 2016 | 445,733 | 434,089 | 2.6 |
| 2017 | 281,905 | 275,150 | 2.4 |
| 2018 | 518,331 | 496,520 | 4.2 |
| 2019 | 488,196 | 475,101 | 2.7 |
| 2020 | 298,750 | 292,654 | 2.0 |
| 2021 | 416,528 | 411,649 | 1.2 |
| 2022 | 534,147 | 499,588 | 6.5 |
| 2023 | 616,177 | 560,874 | 9.0 |
| Total | 15,001,928 | 14,228,146 | 5.2 |

**Table 3.2.2** Commercial landings of Caribbean Spiny Lobster in pounds by gear group that reported Caribbean Spiny Lobster landings in Puerto Rico. 'Expanded Lbs' are the total landings of Caribbean Spiny Lobster in pounds estimated by applying the expansion factors. *Data are not confidential.

| YEAR | EXPANDED DIVING ALL LBS | EXPANDED NETS LBS | EXPANDED POTS AND TRAPS ALL LBS | EXPANDED TOTAL LBS |
|---|---|---|---|---|
| 1983 | 411,599 | 207 | 36,702 | 448,508 |
| 1984 | 377,932 | 109 | 42,302 | 420,343 |
| 1985 | 135,604 | 11,271 | 229,650 | 376,525 |
| 1986 | 103,758 | 7,147 | 168,852 | 279,757 |
| 1987 | 63,963 | 3,942 | 137,916 | 205,821 |
| 1988 | 112,287 | 12,473 | 127,260 | 252,020 |
| 1989 | 132,658 | 13,485 | 217,796 | 363,939 |
| 1990 | 119,915 | 10,595 | 198,905 | 329,415 |
| 1991 | 157,496 | 31,938 | 225,511 | 414,945 |
| 1992 | 96,077 | 20,794 | 151,446 | 268,317 |
| 1993 | 122,488 | 22,096 | 137,075 | 281,659 |
| 1994 | 123,167 | 17,009 | 159,919 | 300,095 |
| 1995 | 165,732 | 32,725 | 193,970 | 392,427 |
| 1996 | 174,057 | 24,704 | 194,016 | 392,777 |
| 1997 | 151,841 | 26,728 | 184,527 | 363,096 |
| 1998 | 176,607 | 24,306 | 180,598 | 381,511 |
| 1999 | 169,835 | 33,766 | 214,253 | 417,854 |
| 2000 | 228,922 | 19,000 | 201,719 | 449,641 |
| 2001 | 200,313 | 11,377 | 199,739 | 411,429 |
| 2002 | 175,330 | 7,015 | 166,892 | 349,237 |
| 2003 | 162,356 | 27,797 | 205,809 | 395,962 |
| 2004 | 211,980 | 21,675 | 242,838 | 476,493 |
| 2005 | 135,117 | 9,094 | 154,477 | 298,688 |
| 2006 | 136,014 | 10,046 | 130,342 | 276,402 |
| 2007 | 153,650 | 8,168 | 103,797 | 265,615 |
| 2008 | 209,971 | 11,713 | 108,345 | 330,029 |
| 2009 | 199,276 | 6,323 | 117,544 | 323,143 |
| 2010 | 168,271 | 26,834 | 94,525 | 289,630 |
| 2011 | 172,693 | 3,942 | 96,383 | 273,018 |
| 2012 | 224,069 | 10,270 | 149,720 | 384,059 |
| 2013 | 177,514 | 15,684 | 82,223 | 275,421 |
| 2014 | 175,756 | 23,536 | 97,514 | 296,806 |
| 2015 | 236,900 | 22,221 | 158,458 | 417,579 |
| 2016 | 237,239 | 25,657 | 182,837 | 445,733 |
| 2017 | 163,971 | 14,150 | 103,784 | 281,905 |
| 2018 | 321,863 | 22,634 | 173,834 | 518,331 |
| 2019 | 279,995 | 29,248 | 178,953 | 488,196 |
| 2020 | 151,397 | 17,657 | 129,696 | 298,750 |
| 2021 | 222,740 | 16,936 | 176,852 | 416,528 |
| 2022 | 281,371 | 29,344 | 223,432 | 534,147 |
| 2023 | 354,023 | 32,621 | 229,533 | 616,177 |
| Total | 7,775,747 | 716,237 | 6,509,944 | 15,001,928 |

**Table 3.4.1** Number of commercial trips reported by gear group that included Caribbean Spiny Lobster landings in Puerto Rico. *Data are not confidential.

| YEAR | TRIPS DIVING | TRIPS NETS | TRIPS POTS AND TRAPS | TRIPS GRAND TOTAL |
|---|---|---|---|---|
| 1983 | 23,265 | 37 | 1,128 | 24,430 |
| 1984 | 22,786 | 36 | 1,651 | 24,473 |
| 1985 | 6,626 | 840 | 11,718 | 19,184 |
| 1986 | 4,933 | 604 | 5,812 | 11,349 |
| 1987 | 2,834 | 305 | 4,898 | 8,037 |
| 1988 | 3,740 | 372 | 4,448 | 8,560 |
| 1989 | 3,507 | 294 | 6,273 | 10,074 |
| 1990 | 2,914 | 903 | 6,841 | 10,658 |
| 1991 | 4,971 | 1,138 | 8,824 | 14,933 |
| 1992 | 3,359 | 870 | 4,701 | 8,930 |
| 1993 | 4,866 | 1,222 | 5,400 | 11,488 |
| 1994 | 5,939 | 1,111 | 6,731 | 13,781 |
| 1995 | 8,744 | 1,607 | 10,996 | 21,347 |
| 1996 | 9,629 | 1,898 | 12,320 | 23,847 |
| 1997 | 8,756 | 1,647 | 9,522 | 19,925 |
| 1998 | 9,749 | 1,051 | 9,361 | 20,161 |
| 1999 | 10,216 | 1,667 | 11,708 | 23,591 |
| 2000 | 8,500 | 1,181 | 8,931 | 18,612 |
| 2001 | 9,158 | 1,042 | 8,672 | 18,872 |
| 2002 | 9,104 | 677 | 8,600 | 18,381 |
| 2003 | 5,319 | 607 | 4,732 | 10,658 |
| 2004 | 5,744 | 592 | 3,764 | 10,100 |
| 2005 | 5,166 | 414 | 3,063 | 8,643 |
| 2006 | 5,340 | 742 | 2,669 | 8,751 |
| 2007 | 5,544 | 522 | 1,934 | 8,000 |
| 2008 | 5,375 | 488 | 1,714 | 7,577 |
| 2009 | 5,856 | 293 | 2,218 | 8,367 |
| 2010 | 4,712 | 411 | 2,028 | 7,151 |
| 2011 | 6,872 | 237 | 2,062 | 9,171 |
| 2012 | 7,417 | 482 | 2,533 | 10,432 |
| 2013 | 8,191 | 712 | 2,276 | 11,179 |
| 2014 | 8,379 | 968 | 2,518 | 11,865 |
| 2015 | 8,253 | 909 | 2,976 | 12,138 |
| 2016 | 7,409 | 892 | 2,998 | 11,299 |
| 2017 | 5,217 | 536 | 1,872 | 7,625 |
| 2018 | 8,149 | 798 | 1,952 | 10,899 |
| 2019 | 8,665 | 933 | 2,718 | 12,316 |
| 2020 | 4,593 | 665 | 1,979 | 7,237 |
| 2021 | 6,716 | 635 | 2,425 | 9,776 |
| 2022 | 7,449 | 991 | 2,683 | 11,123 |
| 2023 | 8,448 | 855 | 2,575 | 11,878 |
| Total | 302,410 | 32,184 | 202,224 | 536,818 |

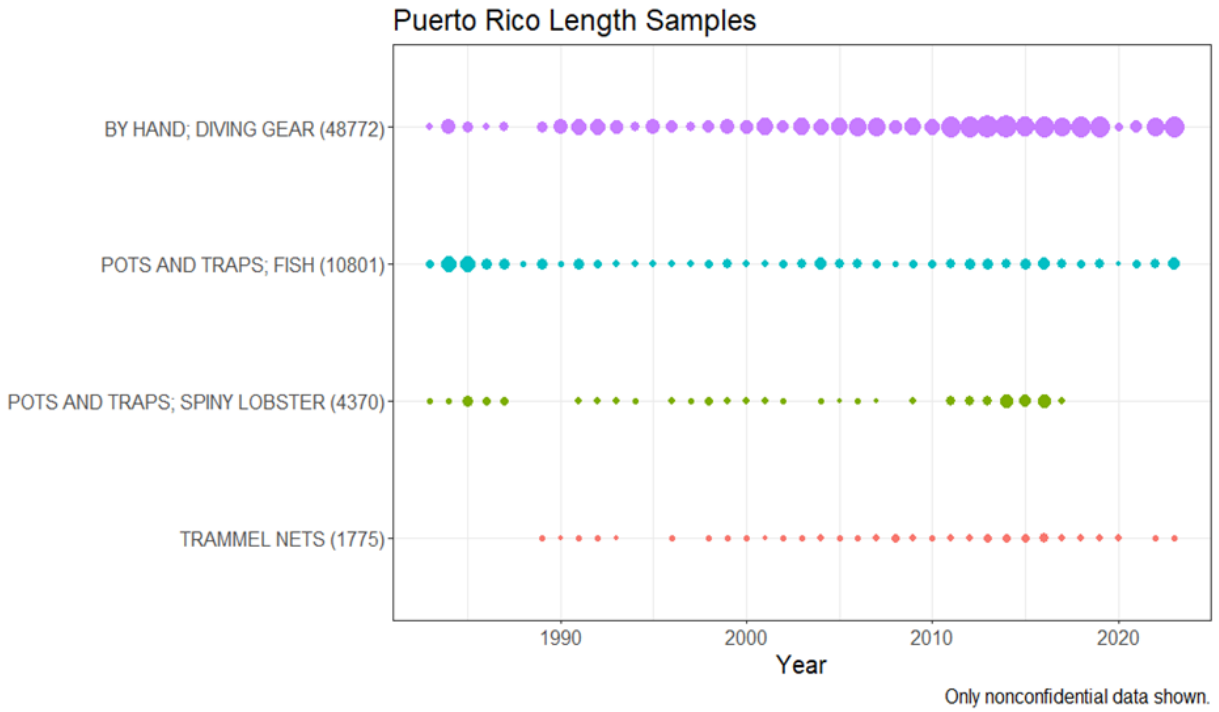


**Figure 3.1.1** Plot showing relative number of Caribbean Spiny Lobster CL in Puerto Rico across time collected. Each point is color specific to the gear it represents. Gears are arranged from most to least abundant.

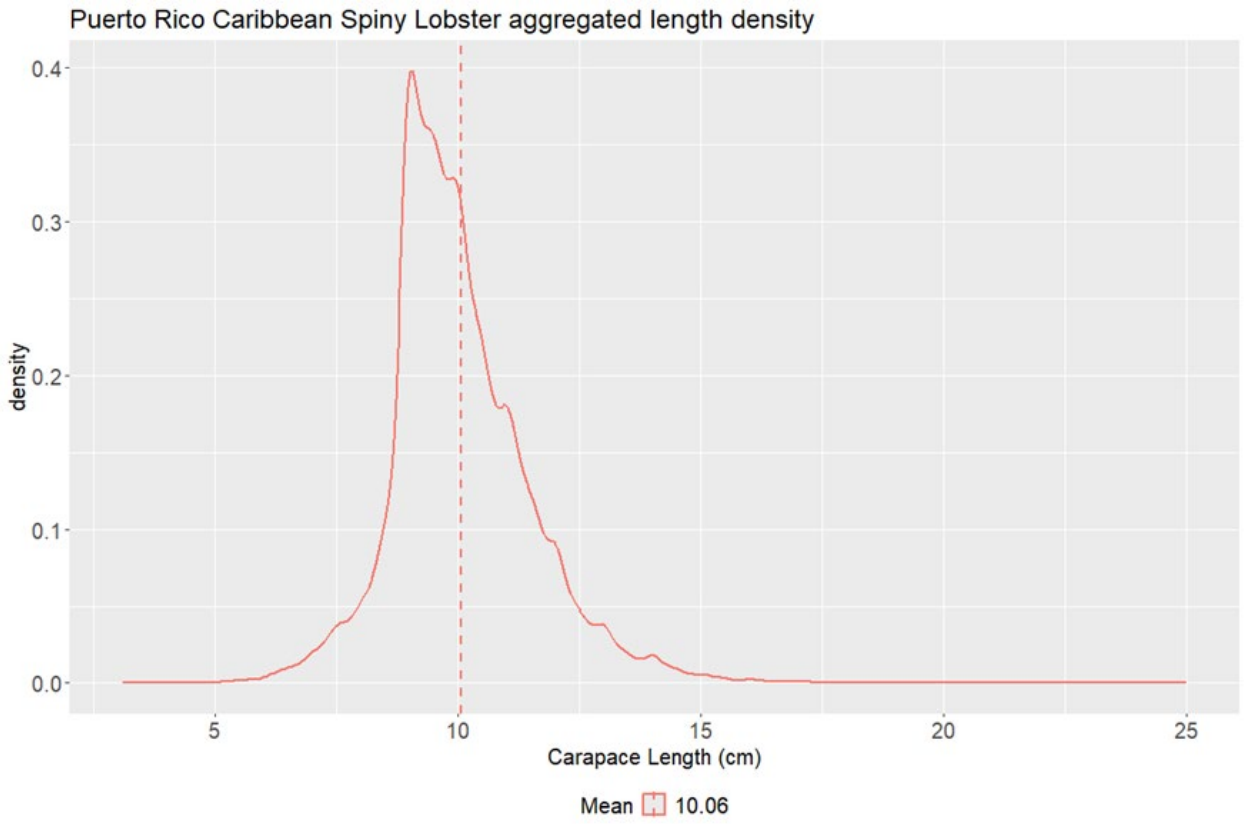


**Figure 3.1.2** Aggregated density plot of cephalothorax lengths (cm) of Caribbean Spiny Lobster in Puerto Rico, all gears combined. Dotted line represents mean CL.

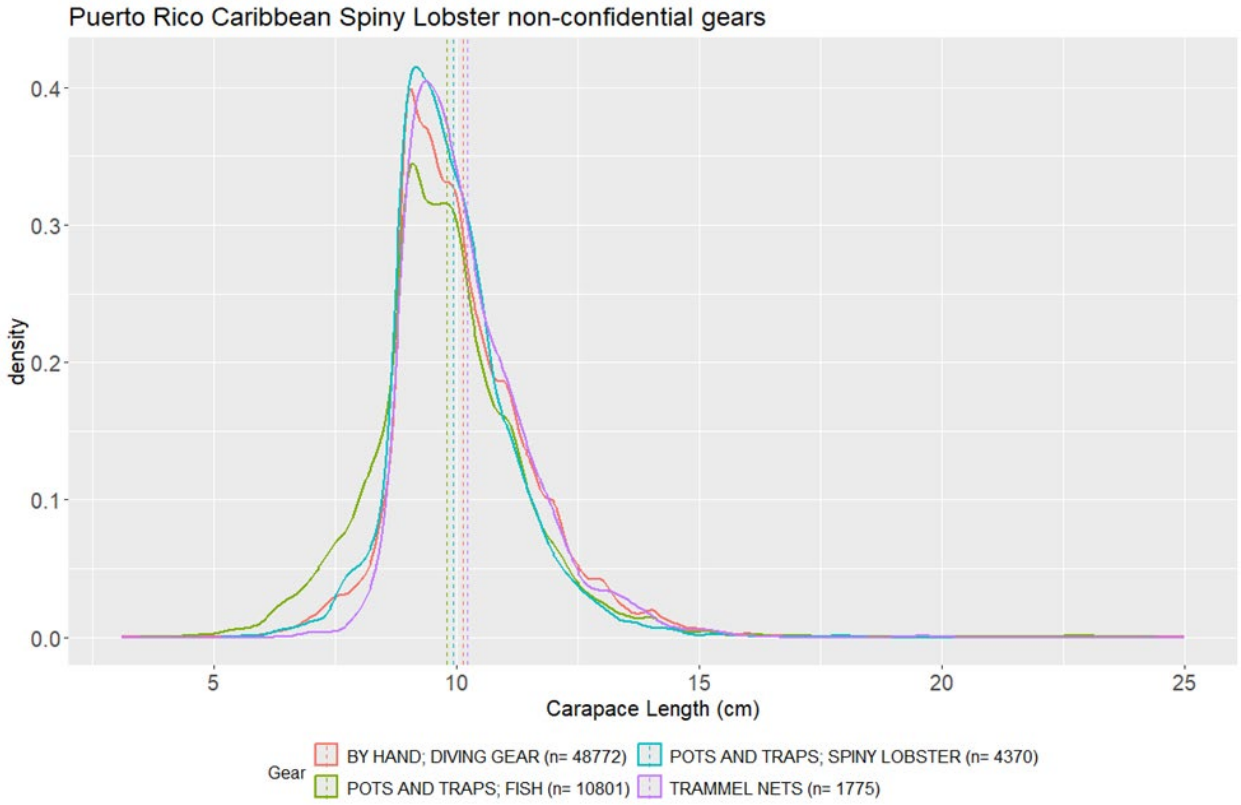


**Figure 3.1.3** Aggregated density plot of cephalothorax length (cm) of nonconfidential gears recorded for Caribbean Spiny Lobster in Puerto Rico from 1981 to 2023. Dotted line represents mean CL. Mean lengths can be found in **Table 3.1.1**.

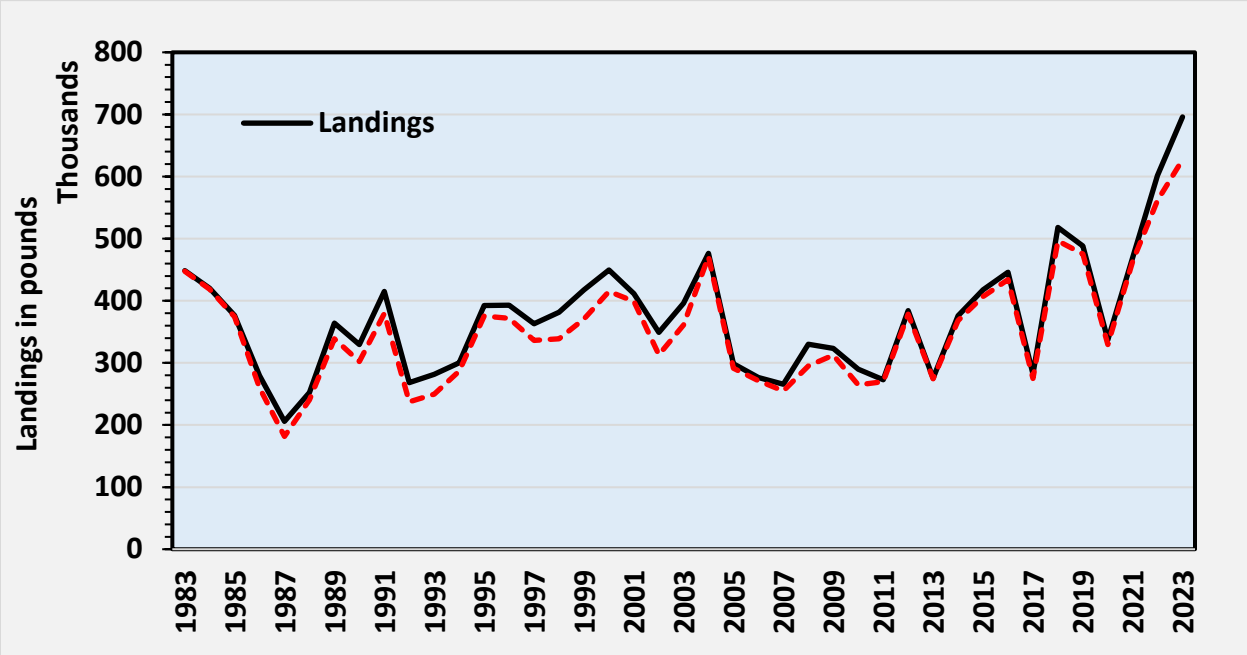


**Figure 3.2.1** Commercial landings (pounds) of Caribbean Spiny Lobster of Puerto Rico with and without the outliers removed.


**Figure 3.2.2** Map of the Municipalities of Puerto Rico.

## 4. Recreational Fishery Statistics

There are currently no data available on recreational landings in Puerto Rico.

## 5. Measures of Population Abundance

### 5.1 Overview

The panel was presented with a summary of the fishery-independent research conducted by SEAMAP-C during 2021-2023 (RD-12). Concerns were raised about using the data for an index of relative abundance, principally due to short time series and unequal sample sizes among years. The panel recommended that the data not be considered for use as an index of relative abundance in the PR assessment model, but noted that the CL composition data from all three years were substantive and warrant consideration for model-fitting.

Concerning fishery-dependent information, rising landings and decreasing or flat effort trends in the self-reported commercial logbook data demonstrated potential signs of hyperstability in catch-per-unit-effort. Members of the panel noted that the number of trips is likely not the best measure of effort for trap fisheries, for which effort is best measured in number of traps, for trips reporting that gear. The panel discussed possible alternative explanations for the patterns in landings and effort, including years of potentially high recruitment. The panel discussed the feasibility of standardizing a fishery-dependent index of relative abundance using the landings divided by the number of traps. However, the panel agreed that although there may be consistent trap effort reporting in logbooks, there is no such means for dive fisheries or nets, and the mechanism(s) that would explain the trend are not likely to be discernable, even though standardization.

**Decision:**

- No data were recommended for use in constructing an index of abundance for spiny lobsters in Puerto Rico.

## 6. Research Recommendations

- When developing new research projects, consider how those projects can be designed to include data collection and/or analyses that would inform ecosystem models and analyses. The original objectives of the project should not be compromised, however.

### 6.1 Life History Research Recommendation

- Life history studies focused on the US Caribbean – generate region-specific parameters for growth, fecundity, natural mortality.
- Look for ongoing growth/aging work via SEAMAP-C and DNER who is involved in doing histology for reproductive analyses.
- Merge selectivity studies, life history data collection, and fishery-independent survey frameworks to determine how to get best data for stock assessment.

### 6.2 Commercial Fishery Statistics

#### *6.2.1 Length Composition Research Recommendations*

- Compare SEAMAP-C, HJR Reefscaping, and MER Consultants CL composition to TIP size composition.

#### 6.1.1 Commercial Landings Research Recommendations

- Track number of fishers/year in relation to annual landings- how does it vary?
- Support connectivity studies – consider spiny lobster as one stock vs. by island (metapopulation).
- Investigate weak/lack of correlation between TIP and landings data
- Demand analysis: look at price per pound (survey), market preferences, trends and correlation with landings, and for all islands.
- Investigate species associations with spiny lobster.
- Investigate recruitment connectivity between island platforms; e.g., STX seeding PR and other “hypotheses”.
- Increase funding for port samplers to improve TIP data collection in PR.
- Increase IT support for automated expansion factors calculation for the landings.

#### 6.2.3 Discards and Discard Mortality Research Recommendations

- Discard information in the catch reports does not allow data on length or sex in current reporting schema.

### 6.3 Indices Research Recommendations

- There were no recommendations from the panel regarding use of fishery-independent data in the Puerto Rico assessment model. However, the panel recommended that analysts not explore standardization of fishery-dependent data for use as an index of relative abundance.

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## Appendix – Fishing Landing Center Naming Conventions

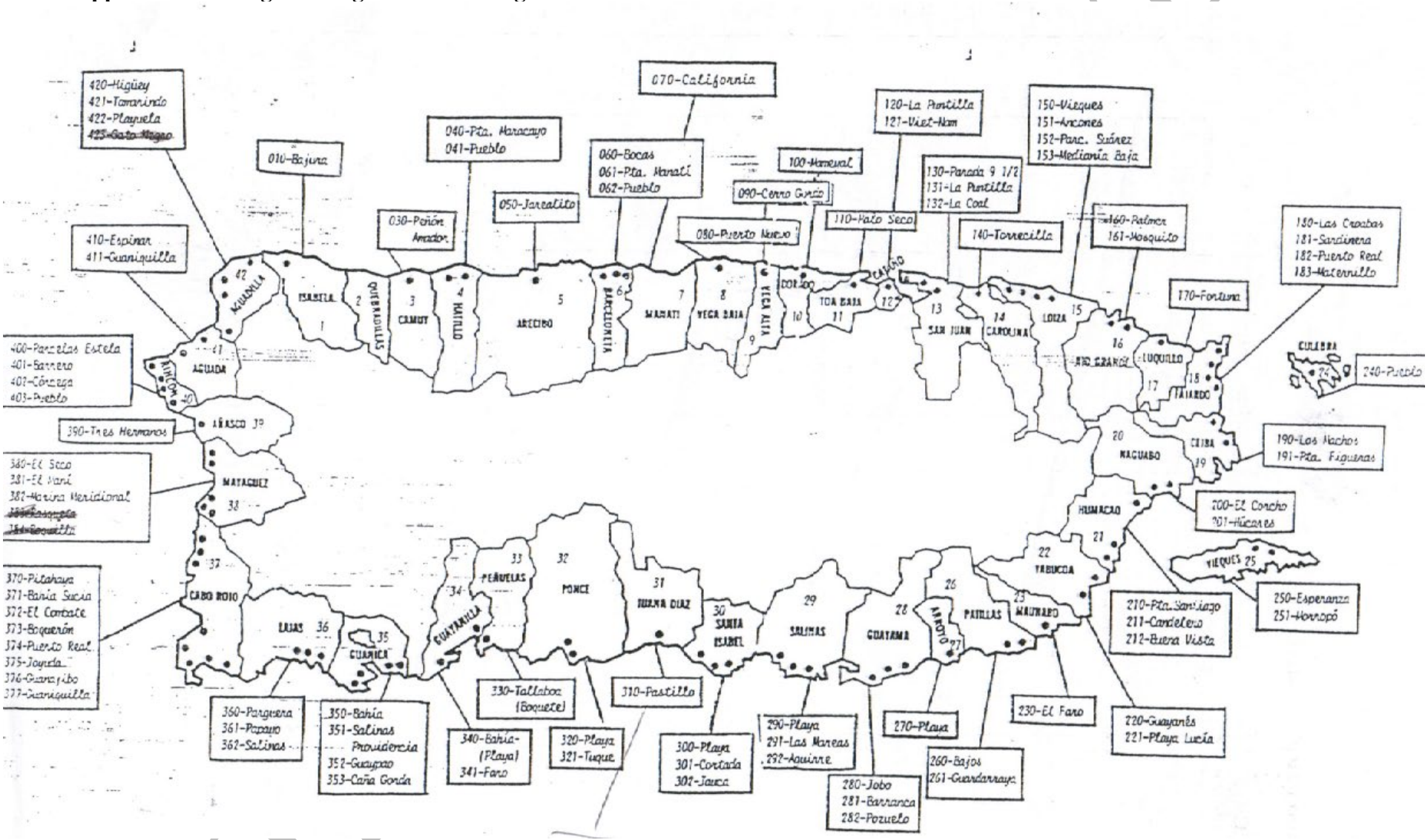


Figure Appendix 1. Map of Fishing Landing Centers in the Municipalities of Puerto Rico.