Inventory of Fishery-Independent Programs and Survey Data Available for Stock Assessment of Caribbean Spiny Lobster in the US Caribbean

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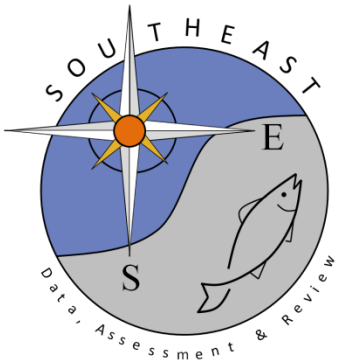

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Introduction

In this paper we identify and summarize relevant fishery-independent data for Caribbean spiny lobster (*Panulirus argus*) in Puerto Rico, St. Thomas/St. John, and St. Croix. Multiple data sources were consulted including the National Centers for Coastal and Ocean Science, the National Coral Reef Monitoring Program (NCRMP), SEAMAP-C, the Puerto Rico Department of Natural and Environmental Resources (DNER), and other funded projects through academic grants. We briefly describe each data source and determine whether available abundance and length data are of sufficient quality to contribute to stock assessment for Caribbean spiny lobster (*Panulirus argus*).

National Ocean Service, National Centers for Coastal and Ocean Science, Center for Coastal Monitoring and Assessment (NCCOS – pre-NCRMP)

Historically, monitoring surveys using belt transects (100 m^2) were implemented in Puerto Rico, St. John/St. Thomas, and St. Croix to characterize the benthic habitats, fish and invertebrate communities. These surveys were stratified by hard, soft, and mangrove habitats and covered depths up to 100 feet. Common information collected includes fish species composition, density, size, benthic cover, and coral density/size/condition. Data collection occurs at stratified random sites where the sampling domain is partitioned by habitat type and depth, sub-regional location (e.g., along-shelf position) and management zone. Three types of surveys are conducted: (1) line point-intercept (LPI), which provides benthic cover estimates for ecologically important cover types/groups (such as spiny lobster); (2) coral demographics, which provides detailed information on coral density, size, and condition; and (3) fish community, which collects species composition, density, size, abundance and derived metrics. Various data caveats have been acknowledged that may limit the continuity of this survey including changes in site selection, definition of habitat strata, and spatial expansion.

Annual surveys were conducted between 2000 and 2012 but at limited spatial and temporal scales (Table 1). Puerto Rico surveys were primarily conducted in the southwestern region during spring and fall, St. Thomas/St. John surveys were sporadically conducted in the East during summer, and St. Croix surveys were conducted during spring and fall primarily in Buck Island and the East End.

Relevance to Caribbean spiny lobster stock assessment

The belt transect surveys method was not specifically designed or optimized to survey spiny lobster. Belt transect surveys (25m x 2m) first started reporting spiny lobster in mid-2003 for all islands, although sampling for macroinvertebrates was sporadic. Overall, annual observations of spiny lobster by island are very low and may not necessarily reflect trends in population abundance (Table 1). Fish and coral demographic data were given higher priority than macro-invertebrates and data were collected by the LPI diver if possible. As a result, spiny lobster were not inventoried at each station, and zero estimates may be due to the absence of lobster or unintentional non-reporting. Their cryptic behavior may also lead to underestimates of spiny lobster.

National Coral Reef Monitoring Program (NCRMP)

Biennial surveys now provide ecological characterization at a broad spatial scale of general reef condition for reef fishes, corals and benthic habitat. Data collection occurs at stratified random sites where the sampling domain is partitioned by habitat type and depth, sub-regional location (e.g., along-shelf position) and management zone. As a result of NCRMP standardization throughout the project's regions (e.g. Florida and Pacific regions), the protocols previously known as the 'LPI Survey Protocols' have been renamed to Benthic Assessment Protocols, and are discussed in detail elsewhere (NCRMP 2017).
Relevance to Caribbean spiny lobster stock assessment

Annual observations of spiny lobster remain low (Table 1) for similar reasons as discussed above. In 2017, the belt transect length was shortened by 10m (15m x 2m). Size composition data are also not collected for lobster. This prevents indices from being generated that reflect exploited size classes, adult size classes, etc.

Southeast Area Monitoring and Assessment Program – US Caribbean (SEAMAP-C)

Various agencies participate in SEAMAP-C including Puerto Rico Sea Grant, Puerto Rico Department of Natural and Environmental Resources, Virgin Islands Department of Fish and Wildlife, Caribbean Fisheries Management Council, United States Fish and Wildlife Service, and NOAA's National Marine Fisheries Service. The intention of lobster surveys supported by SEAMAP-C is to provide information about settlement and juvenile recruitment within the territorial sea of PR and the U.S. EEZ, off the west coast of Puerto Rico. The lobster settlement survey focuses on larval spiny lobster stages (transparent, semi-pigmented, pigmented, and juveniles) and is conducted every five years at fixed sites. Lobster larvae are collected using tow modified Witham collectors per station (see section 4.9 in Fishery-Independent Workshop Report for more details). Artificial structures have also been constructed and surveyed visually during the recruitment survey (see section 4.12 in Fishery-Independent Workshop Report for more details). These shelters consisted of 16 large concrete cement blocks arranged in a two-level quadrangular structure with an open central area (Gordon and Vasques 2004).

Relevance to Caribbean spiny lobster stock assessment

Larval surveys have exhibited different methodologies and have occurred infrequently through time and space (Table 1). In his quality control evaluation of the various studies conducted for the Southwest coast of Puerto Rico, Mateos (2011) documented numerous data gaps due to losses of traps due to weather, fishermen, and changes in trap locations (e.g., deep versus shallow). His conclusion was that longer and more consistent studies are needed to index lobster relative abundance.

PR Department of Natural and Environmental Resources (DNER)

The Puerto Rico Coral Reef Monitoring Program sponsored by NOAA Coral Reef Conservation Program is administered by the PR Department of Natural and Environmental Resources. The monitoring program follows a depth, distance from shore and east-west sampling design and is designed to assess coral reef health and changes in species composition. At each reef, a set of five-10m long transects were surveyed. Transects were positioned non-randomly in areas visually considered to be of optimal coral growth within similar depths (+/- 2m) and reef physiographic zones. Some sites represent permanent transects that have been monitored semi-regularly since 2000. Motile megabenthic invertebrates such as spiny lobster was surveyed by sets of five 10 m long by 3 m wide ($30m^2$) belt-transects centered along the reference line of transects used for sessile-benthic reef characterizations at each reef station. Species outside the transect areas were reported to supplement the taxonomic assessment but were not included in

abundance determinations. Additional details are provided in the various monitoring reports listed in Table 2.

Relevance to Caribbean spiny lobster stock assessment

Spiny lobster was infrequently observed in benthic transects (Table 2). Similar to the transect surveys discussed above, the survey is not designed to sample lobster and therefore may not reflect trends in stock abundance.

Other NOAA funded sources

We reviewed lists of studies funded through NOAA's CRCP and publicly available data and reports curated by the National Centers for Coastal Ocean Science (NCCOS; https://coastalscience.noaa.gov/). Those which included information about spiny lobster were identified (Table 2). Additional contributions are welcome and should be brought to the attention of the SEDAR 57 analysts.

An additional reference document, describing fishery-independent data collection in the U.S. Caribbean is NOAA Technical Memorandum NMFS- SEFSC- 688. Workshop participants should review this document for additional data sources.

Conclusion

Although a variety of fishery-independent data exist for Caribbean spiny lobster, none of the datasets are recommended for use in developing relative abundance or exploring length due to inconsistencies in methodology, limited temporal and spatial scales (i.e., not indexing the lobster population), and low overall sample sizes of Caribbean spiny lobster. Further, the cryptic and nocturnal behavior of spiny lobster has complicated the use of available data in characterizing relative abundance and size trends needed for stock assessment.

There is a clear need for the development of fishery-independent surveys that are specifically designed for spiny lobster. This would require considerable planning regarding data priorities (e.g., relative abundance versus length), the life stage to target (e.g., adult, juveniles, or larvae), type of gear, sampling design, temporal and spatial resolution, and the availability of funds. In addition to discussing field sampling, planning of how best to record and store data would be beneficial to future analyses and stock assessments.

Research aimed at identifying correlations between larval and juvenile abundance from the SEAMAP-C surveys and lobster landings could assist in determining the relationship between juvenile abundance and adult abundance (e.g., Butler et al. 2010). Such an analysis could help address whether surveys aimed at adults or juveniles would be more useful for spiny lobster.

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Table 1. Summarized fishery-independent data collection programs with recommendations for the Caribbean spiny lobster assessment. Numbers in parentheses in Negative Aspects column indicate the range of spiny lobster collected per year.

Series	Reference	Data Source	Area	Years	Season	Data type	Positive Aspects	Negative Aspects
Puerto Rico								
NCCOS	Pittman et al. (2010)	Transects	La Parguera, Guánica (2010+)	2000-2012	Varies	Counts	Non-disruptive	Depth range, changes in sampling, small sample size (1-12 per year), did not measure invertebrates
NCCOS	Bauer et al. (2008); Bauer et al. (2010)	Transects	Vieques	2007	Spring	Counts	Non-disruptive	No lobster reported, depth range, small temporal/ spatial scale
NCCOS	None provided	Transects	Jobos Bay	2009	Spring	Counts	Non-disruptive	No lobster reported, depth range, small temporal/ spatial scale
NCRMP	NCRMP (2015); NCRMP (2017)	Transects	PR	2014, 2016-2017	Spring, Summer, Fall	Counts	Non-disruptive	Biennial, depth range, small sample size (3-11 per year), did not measure invertebrates
SEAMAP-C	Mateos-Molina (2011); Jiménez et al. (2018); Jiménez (2004); Jiménez (2009); Rosario and Figuerola (1999); Rosario and Figuerola (2004); Rosario and Seda (2016)	Postlarval survey	West Coast	1998, 2003-2004, 2007-2009, 2014-2015	Year-round	Counts, lengths	Designed to target larvae; Some length information for juveniles	Data gaps, implementation issues, variable but often small sample size (42-1,337 per year)
University of Puerto Rico	None provided	Postlarval survey	West Coast	2000	Spring, Summer	Counts	Designed to target larvae	Small temporal/spatial scale, small sample size (122), no length data
Fisheries Exploratory Section-FRL	Boardman (1982)	Various gears	West Coast	1980-1981	Year-round	Lengths, tag recapture	Some length information on adults	Small temporal/spatial scale, small sample size (876)
Fisheries Exploratory Section-FRL	Rosario (1988)	Various gears	West, East, South Coasts	1986-1988	Year-round	Lengths, weight, sex	Adults, some effort data	Small sample size (511)

Series	Reference	Data Source	Area	Years	Season	Data type	Positive Aspects	Negative Aspects
St. Thomas/St. John								
NCCOS	Friedlander et al. (2013)	Transects	St. John, St. Thomas (2012)	2001-2012	Summer, occasionally Winter	Counts	Non-disruptive	Depth range, changes in sampling, small sample size (1-11 per year), did not measure invertebrates
NCRMP	NCRMP (2015)	Transects	St. Thomas	2013, 2015	Summer	Counts	Non-disruptive	Biennial, depth range, small sample size (29-50 per year), did not measure invertebrates
SEAMAP-C	Cass-Calay et al. (2016); Kojis et al. (2003)	Postlarval Survey	St. Thomas, St. John	1997-1998, 2014-2015	Year-round	Counts	Designed to target larvae	Limited spatial range, small sample size (0-241 per year)
SEAMAP-C	Gordon and Vasques (2004)	Larval shelter survey	St. Thomas	2002-2003	Year-round	Counts, lengths	Designed to target larvae	Limited spatial range, small sample size (2)
Tropical Discovery Fund	Kojis and Quinn (1997)	Postlarval Survey	St. Thomas	1992-1994	Year-round	Counts, lengths	Designed to target larvae	Overall sample size (422)
St. Croix								
NCCOS	None provided	Transects	St. Croix	2001-2012	Fall, sometimes Winter, Spring	Counts	Non-disruptive	Depth range, changes in sampling, small sample size (2-28 per year), did not measure invertebrates
NCRMP	NCRMP (2015)	Transects	St. Croix	2015	Spring	Counts	Non-disruptive	Biennial, depth range, small sample size (19), did not measure invertebrates
SEAMAP-C	Cass-Calay et al. (2016)	Postlarval survey	Buck Island	1997-1998	Year-round	Counts	Designed to target larvae	Limited spatial range, small sample size (7)
NMFS	Bryan et al. (2013)	Trap survey	St. Croix	2010	Fall	Counts, lengths	Cooperative, targeting lobster	Pilot study, limited spatial/temporal range, small sample size (12)

Table 2. Summarized fishery-independent data collection NOAA grant-driven sources.

Series	Reference	Data Source	Area	Years	Season	Data type	Positive Aspects	Negative Aspects
Characterization of land-based sources of pollution and effects in the St. Thomas East End Reserve	Dennis Apeti	NCCOS website	St. Thomas	2011 - 2014	Spring	Counts	Objective was not necessarily to support stock assessment	Did not measure invertebrates, too short time frame for useful index
Land and Sea Characterization of St. Croix East End Marine Park	Chris Jeffrey	NCCOS website	St. Croix	2010-2013	Fall	Counts	Objective was not necessarily to support stock assessment	Did not measure invertebrates, too short time frame for useful index
Mesophotic Benthic Habitats and Associated Reef Communities	García-Sais et al. (2014a)	Final Report	St. Croix	2013	Summer	Counts	Mesophotic zone sampling	Small sample size, not designed for sampling lobster, cryptic
Characterization of mesophotic benthic habitats and associated reef communities	García-Sais et al. (2007a, 2010a, 2011, 2012b, 2013)	Final report	Puerto Rico	2007, 2010, 2011, 2012-2013	Varies by year	Counts, lengths	Mesophotic zone sampling, some length information	Few lobster observed in transect, not designed for sampling lobster, cryptic
Monitoring of coral reef communities from natural reserves	García-Sais et al. (2001a, 2001b, 2001c, 2001d, 2004a, 2004b, 2005, 2006, 2007b, 2008, 2009, 2010b, 2012a, 2014b, 2015, 2016, 2017)	Final report	Puerto Rico	2001-2012	Varies by year	Counts, lengths	Some length information	Few lobster observed in transect, not designed for sampling lobster, cryptic