Standardized catch rates of Spiny Lobster from the St. Thomas and St. John commercial fish trap fishery, 2000-2024

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Executive Summary

During the Caribbean Fisheries Management Council (Council) meeting in April 2026, the Council requested that the NOAA Fisheries Southeast Fisheries Science Center (SEFSC) explore developing a fishery-dependent index of abundance for the SEDAR 91 St. Thomas and St. John (STTJ) assessment. This document describes the development of a standardized index of abundance based on fishery catch-per-unit-effort (CPUE) using data from the commercial fish trap fishery of SSTJ. Following outlier removal and exclusion of trips with missing effort data, an index of abundance was constructed from 2000 to 2024 using fish trap data. CPUE was modeled using the delta-generalized linear model (GLM) approach. Results of the analyses found a slight increasing trend from 2000 to 2018 followed by a decline up to 2021 in spiny lobster abundance in STTJ.

Caribbean Commercial Logbook Program (CCL) Overview

Landings and fishing effort of commercial vessels in STTJ were obtained from self-reported fisher logbook data collected through the Caribbean Commercial Logbook Program (CCL), a collaboration between the U.S. Virgin Islands Department of Planning and Natural Resources and the NOAA Fisheries SEFSC. Commercial fishery landings data for spiny lobster in STTJ were available for the years 1974-2024, however, several major changes in the reporting forms throughout the program history have affected the data (Southeast Fisheries Science Center, 2026). Logbook reporting began in 1974, initially recording landings by gear type and broad categories (snapper/grouper or other finfish) through 1995 (Valle-Esquivel and Díaz 2004). Reporting transitioned to specific species groups and gear types between 1996 and 1997, becoming standardized for all commercial data by 2000 in STTJ. Lastly, species-specific reporting was implemented in July 2011, establishing 2012 as the first complete year of species-specific data.

For each fishing trip, the CCL recorded a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings by species. Fishing effort data available for fish traps included number of traps hauled and the length of the fishing trip in hours.

Background

The Council during their April, 2026 meeting requested the SEFSC to evaluate the feasibility of constructing a standardized index of abundance for STTJ spiny lobster using commercial logbook data. The request is informed by the successful development of a fishery-dependent index of abundance for the SEDAR 91 Puerto Rico assessment. Nominal CPUE had been calculated for the SEDAR 91 and 46 spiny lobster assessments, but no fishery dependent indices were recommended for use in those stock assessments.

Data Description

A standardized index of abundance for spiny lobster landed with fish traps was developed using CPUE data from CCL logbooks, with CPUE defined as whole weight per fish trap hauled. The size range of lobsters included in the indices were, therefore, the same as the size composition of landings from the commercial fish trap fleet. Those size data were available in the Trip Interview Program dataset and were included in the models developed during the assessment process. An index using lobster trap data was not developed due to the very high proportion of positive trips (>95% of trips with reported lobster landings), likely due to successful targeting of spiny lobsters. Such effective targeting by the fishery could lead to hyperstability in any index developed from lobster trap data and would not reflect changes in relative abundance of the population.

Outlier removal

Extreme values occur more frequently in self-reported data than in scientific survey data because there are limited opportunities to validate self-reported data. Identification of possible data errors followed the methods used in recent SEDAR stock assessments in other regions of the southeastern US mainland. Values at the extreme tails of the distribution of effort data in self-reported fishery-dependent data sets were identified. Effort data exceeding the 97.5th percentile were excluded from the analysis.

Data exclusions and assumptions

Data were restricted to include only those records with landings, effort data, and exclusively fish trap gear reported for individual trips. Trips with missing landings or insufficient effort data were removed. Effort data were considered sufficiently detailed if the number of fish traps hauled were reported for a trip. Trip hours were also reported, but were not considered informative for quantifying fishing effort as trip hours may have indicated trap soak time or the duration of a particular trip.

Time period

During the years 1974 to 1999, different versions of CCL forms were in use. Some were gear-based (e.g., “pot fish”, “net fish”, etc.) while other versions of the reporting forms were species-group based (e.g., snappers, groupers, etc.). In many years, both versions of the forms were in use. Beginning in 2000, only forms collecting species-group data were used. After July, 2011, data were reported by species. A classification analysis was used to identify presumptive fish trap trips for the period 2000 to June, 2011 (CFB, 2026). Additionally, the terminal year was updated from 2023 (used in SEDAR 91) to 2024. The full time series of data used to construct the index was 2000-2024.

Index Development

Evaluation of Explanatory Variables

The following variables were examined for inclusion in the delta-GLM submodels:

YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 2000-2024.

SEASON – Season included two levels: (December-April, dry season; May-November, wet season).

TOTAL FISH TRAPS HAULED – Trip total fish traps hauled as a four-level factor pooled into quartiles of the data, examined for use in the Bernoulli submodel only.

Standardization

CPUE was modeled using the delta-GLM approach (Lo, Jacobson, and Squire 1992; Dick 2004; Maunder and Punt 2004). This approach combines two separate GLMs, one to describe presence/absence of the focal species, and one to describe catch rates of successful trips (trips that caught the focal species). Estimates of variance were based on 1000 bootstrap runs where trips were chosen randomly with replacement (Efron and Tibshirani 1993). All analyses were programmed in R, with much of the code adapted from Dick (2004).

Bernoulli submodel

The Bernoulli component of the delta-GLM is a logistic regression model designed to predict the presence/absence (i.e., availability to be caught) of spiny lobster on any given trip. Initially, all explanatory variables were included in the model as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. The final model was:

CPUE ~ YEAR + SEASON + GEAR_QUANTITY

Positive CPUE submodel

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. For both distributions, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was used to eliminate those variables that did not improve model fit. The two distributions were compared using AIC. Based upon AIC scores, the lognormal model outperformed the gamma model, and was therefore applied in the final delta-GLM. The final lognormal model was:

CPUE ~ YEAR + SEASON

Results and Discussion

The annual proportion of positive spiny lobster trips was sufficiently high (~30–50%, except for the first two years at ~20%) to preclude further data subsetting (Table 1). Lobster trap data were not combined with fish trap data due to differing targeting strategies between the two gears.

Because most reported trips included effort data as fish trap hauls, minimal data were excluded from the final data set due to missing effort information (Figure 1A and B).

Residuals of the final model indicated no issues with the selected variables regarding data skewness or other patterns that would suggest a poor model fit (Figure 2). Diagnostic plots of log CPUE and Q-Q plots of residuals from the fitted lognormal submodel indicate that the data are suitable for the analysis (Figure 3), although the data remain slightly skewed from a normal distribution.

The fish trap standardized index followed a similar pattern to its nominal index (Figure 4, Table 1). However, the increase in the nominal index for 2024 was driven by a few high-CPUE trips. CV values were low, ranging from 4% to 10% across all years (Table 1). The general trend showed a slight increase from 2000 to 2018, followed by a decline through 2021. Notably, the decrease in CPUE from 2019 to 2021 cannot be explained by a low sample size; furthermore, these years do not show a change in the proportion of fish trap trips with spiny lobster landings (Table 1). The highest standardized index values occurred during 2017 and 2018.

The development of a standardized index of abundance for STTJ spiny lobster represents a significant advancement in the information available to inform regional stock assessments. Incorporating these indices allows dynamic recruitment to be integrated into the assessment model, enabling the estimation of annual recruitment. Without indices as model inputs, recruitment pulses cannot be estimated, and assessment models must assume a constant, average recruitment across all years.

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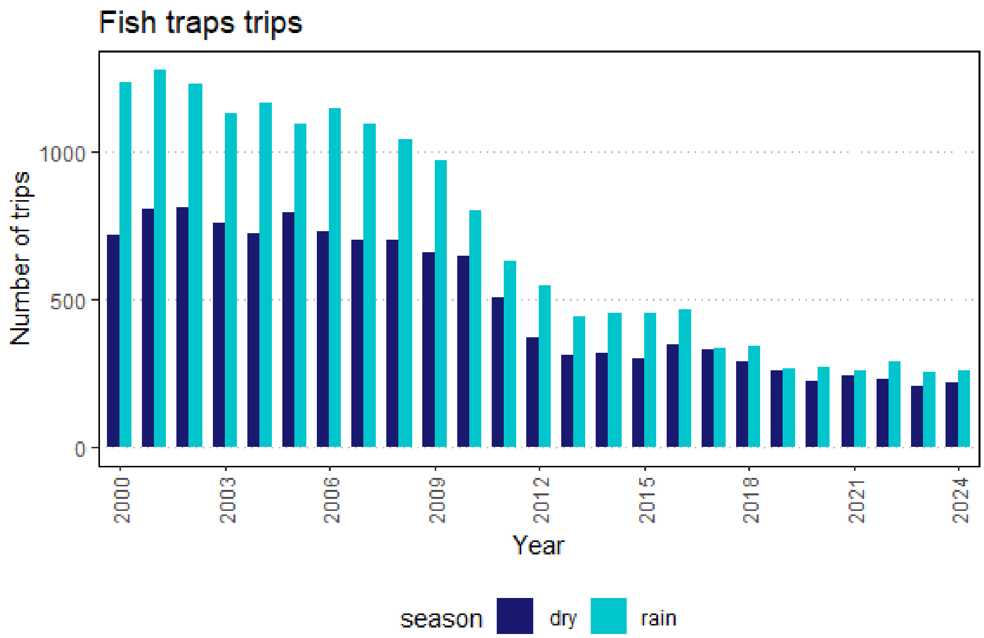
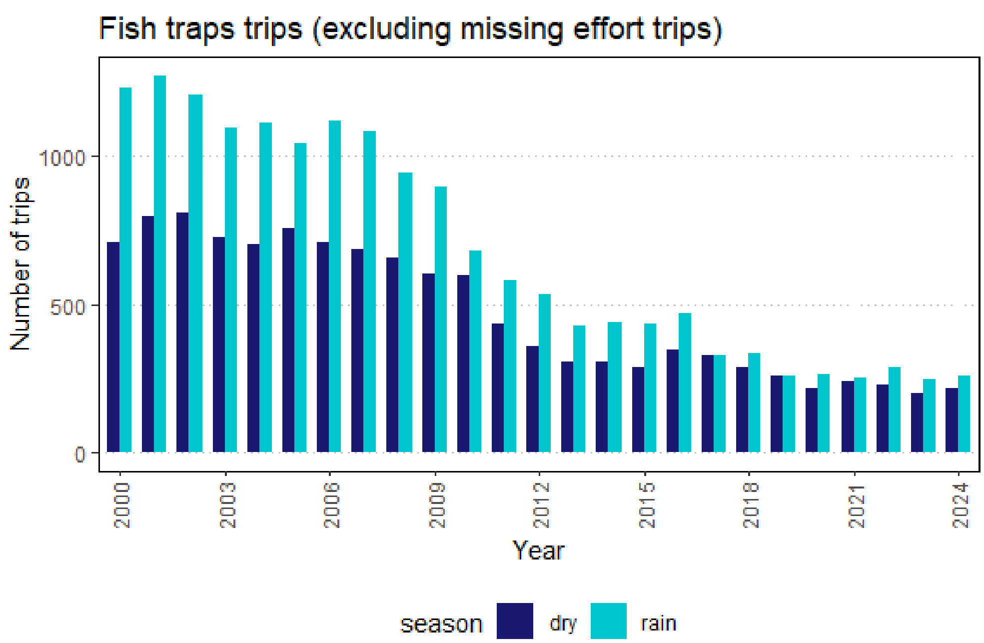
Table 1: Standardized index of abundance of St. Thomas and St. John spiny lobster using fish trap fishery reported data.

Year	N	Nominal CPUE	Relative Nominal	Standardized CPUE	Proportion Positive	CV
2000	1,935	0.0707	0.3919	0.5005	23%	0.0539
2001	2,069	0.0836	0.4630	0.6245	25%	0.0478
2002	2,014	0.1134	0.6286	0.7813	30%	0.0447
2003	1,824	0.1105	0.6124	0.7817	30%	0.0470
2004	1,816	0.1466	0.8125	1.0052	37%	0.0448
2005	1,802	0.1564	0.8665	1.0495	33%	0.0464
2006	1,827	0.1680	0.9309	0.9391	29%	0.0507
2007	1,773	0.1490	0.8255	0.9600	33%	0.0506
2008	1,597	0.1651	0.9149	1.0390	32%	0.0521
2009	1,502	0.1465	0.8117	0.9192	29%	0.0560
2010	1,279	0.1173	0.6498	0.7362	27%	0.0675
2011	1,015	0.1106	0.6131	0.6553	31%	0.0698
2012	889	0.1526	0.8456	0.8437	41%	0.0611
2013	728	0.1582	0.8767	0.9045	46%	0.0690
2014	742	0.2374	1.3153	1.2851	49%	0.0664
2015	723	0.2312	1.2814	1.4354	48%	0.0630
2016	809	0.2259	1.2515	1.2867	47%	0.0602
2017	654	0.2818	1.5615	1.6377	50%	0.0676
2018	625	0.3359	1.8615	1.7258	45%	0.0783
2019	511	0.2027	1.1230	1.1602	52%	0.0710
2020	476	0.1914	1.0606	0.8303	50%	0.0798
2021	491	0.1298	0.7193	0.6860	42%	0.0872
2022	510	0.1651	0.9150	0.7846	43%	0.0912
2023	449	0.2365	1.3103	1.1743	47%	0.0905
2024	472	0.4254	2.3575	1.2543	46%	0.0954

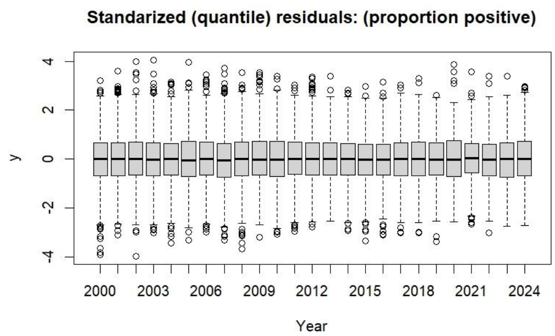


A.

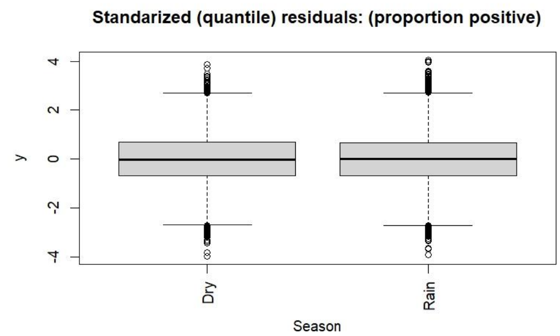


B.

Figure 1: The number of fish trap trips by year identified in the data (A). Number of trips by year for the period 2000-2024 following removal of trips missing effort data (B).



A.



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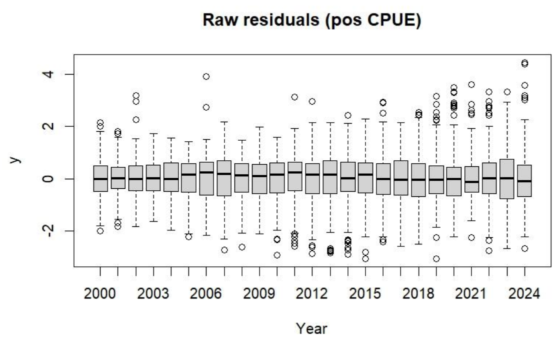

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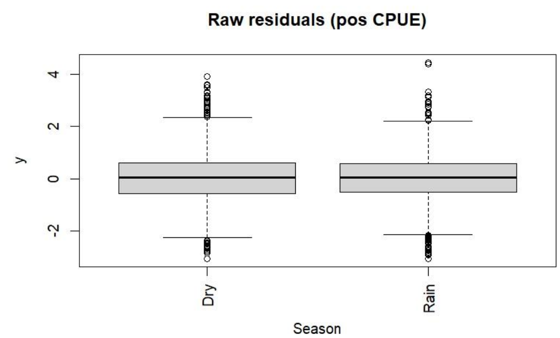

D.

Figure 2: Fish trap index diagnostics of lognormal submodel fits to binomial data (Plots A-B). Fish trap index diagnostics of lognormal submodel fits to positive CPUE data (Plots C-D). Box and whisker plots give first, second (median) and third quartiles, as well as limbs that extend to approximately one interquartile range beyond the nearest quartile, and outliers (circles) beyond the limbs.

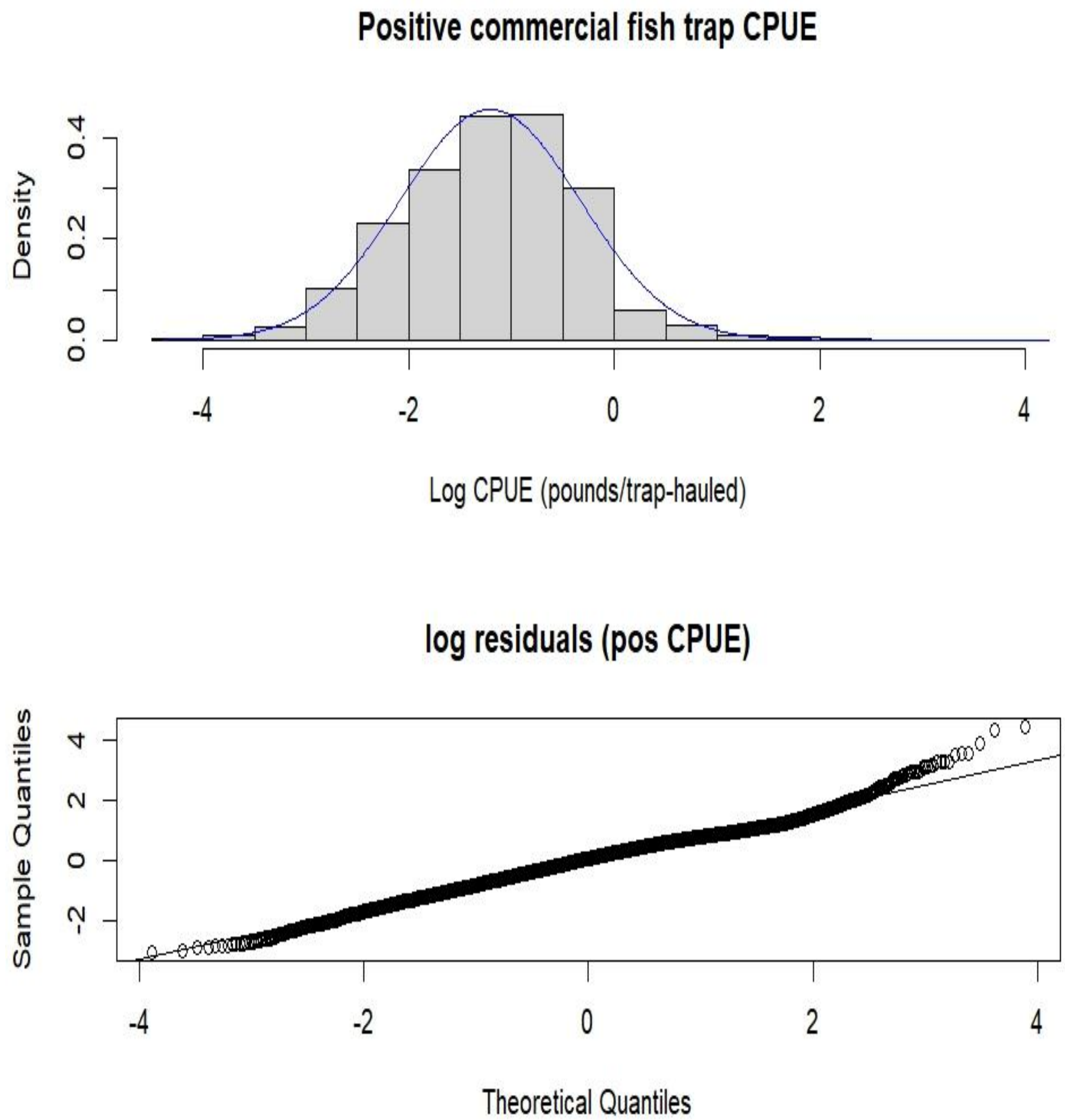

Figure 3: Histogram of empirical CPUE from the fish trap data, with the lognormal distribution overlaid. Quantile-quantile plot of residuals from the fitted lognormal submodel to the positive CPUE catch.

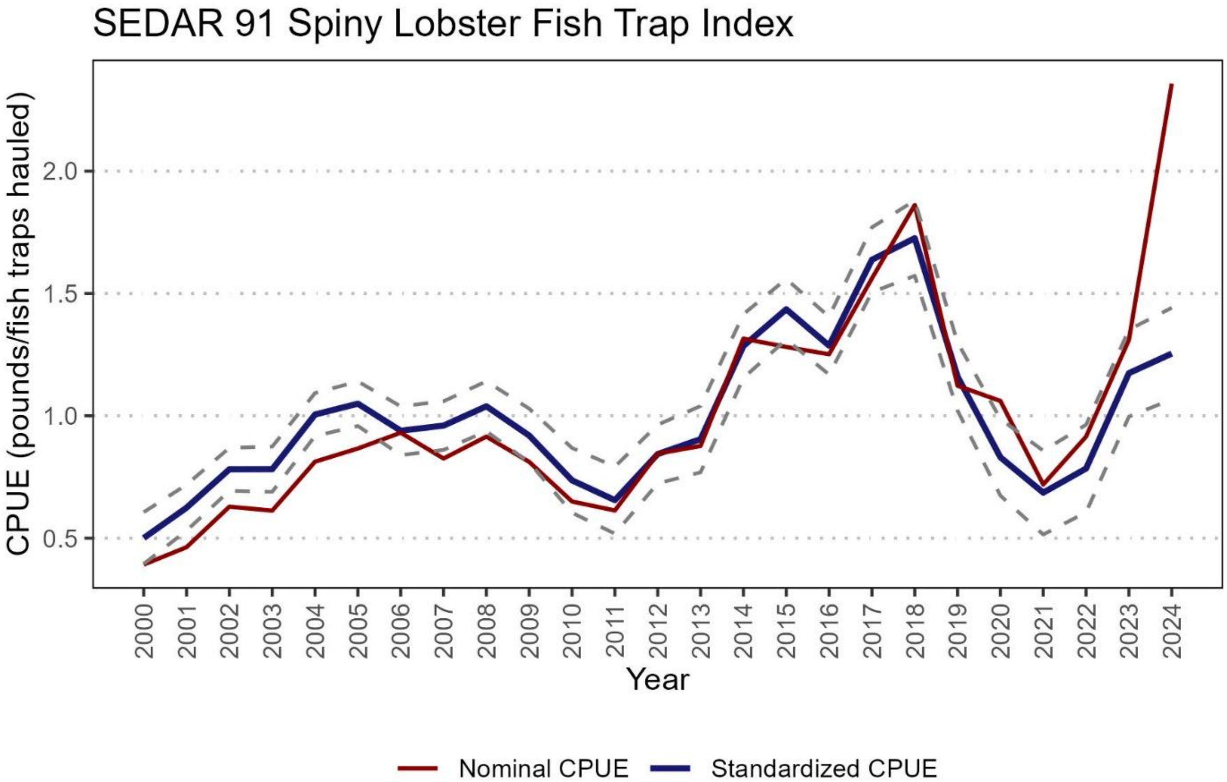

Figure 4: Standardized index of spiny lobster abundance in St. Thomas and St. John from commercial fish trap CPUE data. CPUE is pounds of spiny lobster per fish trap hauled reported by trip. Nominal CPUE and upper and lower confidence intervals of the standardized index are also provided.