Caribbean Fisheries Data Evaluation

SEDAR Procedures Workshop 3

January 26 – 29, 2009

San Juan, Puerto Rico

Executive Summary

The Council-Federal cooperative SEDAR process provides stock assessments for fisheries resources of the National Marine Fisheries Service's Southeast Region. Regional assessment priorities are typically based upon management needs or perceptions of management or population problems. Data availability is seldom explicitly considered when setting such priorities. As a result, despite several attempts, no acceptable quantitative assessments have been developed for Caribbean stocks because data to support traditional stock assessment methods simply do not exist for the species considered so far. Several SEDAR peer review panels suggested reviewing basic data availability and evaluating alternative assessment methods before again assigning scarce resources to produce more traditional assessments that are unlikely to provide informative results. Identifying and evaluating available data sources across all managed species is a strong first step that is consistent with peer review and assessment report recommendations. Further, alternative methods need to be developed that will allow assessing Caribbean fisheries resources in a manner that is consistent with the information content of the available data sources that will therefore withstand independent peer review.

SEDAR convened a procedural workshop from January 26-29, 2009 in San Juan, Puerto Rico, to evaluate Caribbean data sources, including the Puerto Rico and Virgin Island platforms. Participants included representatives from Federal agencies, territorial governments, non-governmental organizations, Council technical and constituent advisors, and university researchers. Prior to the workshop Federal and territorial agency representatives summarized and cataloged basic data sources and explored alternative assessment methods. During the workshop, participants reviewed these initial efforts and discussed each data source and potential method in detail.

The workshop began with a presentation by Clay Porch of the SEFSC which provided an overview of the MSRA requirements for fishing level recommendations and the information provided by stock assessments to support those recommendations. Next, Puerto Rican fishermen Gregg Engstrong, Eugenio Pinero, and Nelson Crespo provided an history and overview of primary changes in the Puerto Rico fisheries. This was followed by descriptions of the USVI fisheries provided by Jose Sanchez and Tom Daly. Territorial agency representatives then presented information on data availability and collection programs, with Daniel Matos addressing Puerto Rico commercial statistics, Toby Tobias addressing USVI commercial statistics, and January Murray addressing USVI recreational statistics. The first day concluded with presentations on catch records and adjustment factors by Steve Turner and Nancie Cummings of the SEFSC. The group had considerable discussion over this controversial yet important data component. A sub-group of SEFSC, agency representatives, and local fishermen agreed to meet during the week to try and resolve questions related to expansion factors.

Tuesday opened with Ron Hill of SEFSC summarizing available sources of fishery-independent data and Nilda Jiminez of PR DNER addressing SEAMAP. During the discussion several additional fishery-independent data sources were identified. Todd Gedamke of SEFSC then presented a length based assessment method with application to several Puerto Rico stocks. This approach may provide a means of quantitatively assessing Caribbean stocks, but it requires considerable assumptions and robust data. Some additional length data sources were suggested. The remainder of the day was spent discussing CPUE analyses, with example applications to USVI parrotfish provided by Kevin McCarthy, SEFSC, and to Puerto Rico Queen and silk snappers by Nancie Cummings of SEFSC. Developing the analyses and interpreting CPUE trends is particularly problematic in this region due to deficiencies in data reporting and the challenges posed by a highly variable, multi-species fishery.

On Wednesday the panel began with a presentation on several approaches to evaluating management complexes using landings records provided by Nick Farmer of SERO. The group noted several unexpected associations which may be an artifact of landings records that include multiple trips and suggested comparing species associations identified here with those identified in the CPUE analysis. The group then received presentations on other assessment methods by Paul Medley of the CIE who reviewed the ParFish approach and Todd Gedamke of SEFSC who presented an overview of several alternatives. Also, Caribbean SSC representative Jim Berkson provided an overview of the recent National SSC meeting, with emphasis on ACL recommendations. The panel held a work session Wednesday afternoon to begin drafting the workshop report, and then ended the session for the day by discussing responses to the Terms of Reference.

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1. INTRODUCTION

1.1. Workshop Time and Place

The SEDAR Procedural Workshop III – Caribbean Data Evaluation I was held January 26 – 29, 2009, in Old San Juan, Puerto Rico

1.2. Terms of Reference

1) Review available data and develop recommendations regarding their accuracy and reliability for use in assessing U.S. Caribbean fish stocks. Provide complete tables documenting the quantity and quality of data by stock and area.

2) Review the basis for existing stock complexes and evaluate whether adjustments to these complexes are suggested based on available data.

3) Recommend species or stock complexes for which informative SEDAR benchmark assessments may be feasible.

4) Review alternative methods for estimating mortality rates and abundance trends that might be useful for those species or stock complexes for which data are deemed sufficient.

5) Review the research and monitoring recommendations from the previous assessments in the U.S. Caribbean. Note any which have been completed, make any necessary additions or clarifications, and prioritize data and research needed to successfully complete benchmark stock assessments.

6) Provide guidance on developing ACLs given data accuracy and reliability recommendations and comment on issues that should be considered by the Council and its committee's when making ACL determinations.

1.3. List of Participants

Workshop Panel

Josh Bennet..NMFS SEFSC Miami
Jim Berkson ....NMFS/ Virginia Tech/CFMC SSC
Nelson Crespo...Commercial Fisher Rincon PR
Zulena Cortes...PR DNER/MRFSS
Nancie Cummings...NMFS SEFSC Miami
Tom Daley ....Commercial Fisher St Croix (traps)
Greg Engstrong...Commercial Fisher Rincon PR
Nick Farmer ....NMFS SERO
Jorge (Reni) Garcia-Sais...UPRM/HAP CFMC
Todd Gedamke...NMFS SEFSC Miami
Ron Hill...NMFS SEFSC Galveston
Staci Hudy...Virginia Tech
Nilda Jimenez..PR DNER/FRL
Walter Keithly...LSU/SSC CFMC
Joe Kimmel ....NMFS SERO
Jesus Leon..PR DNER/FRL Port Agent
Hector Lopez..PR DNER/FRL Port Agent
Craig Lyliestrom ....PR DNER MRFSS
Gerson Martinez...Commercial Fisher St. Croix
Daniel Matos ....PRDNER/FRL
Kevin McCarthy...NMFS SEFSC Miami
Paul Medley ....CIE
Julian Magras ....STFA Commercial Fisher St. Thomas
Andres Maldonado...Commercial Fisher Cabo Rojo PR
January Murray ....USVI/DPNR/FWS
David Olsen ....STFA/St Thomas
Noemi Peña...PR DNER/FRL
Eugenio Pineiro...Commercial Fisher Rincon PR
M. Valdez-Pizzini ....UPRM/Sea Grant/SSC CFMC
Clay Porch..NMFS SEFSC Miami
Luis A. Rivera..PR-DNER/FRL Port Agent
Yamitza Rodriguez ....PR DNER/FRL
Aida Rosario ....PR DNER/FRL
Jason Rueter ....NMFS SERO
José A. Sanchez ....Commercial Fisher St. Croix
Christy Pattengill-Semmens...REEF
Tyler Smith ....UVI
William Tobias..USVI/DPNR/DFW
Steve Turner...NMFS SEFSC Miami

Staff

John Carmichael..SAFMC

Graciela García-Moliner .... CFMC
Patrick Gilles .... NMFS Miami
Julie Neer .... SEDAR
Iris N. Oliveras .... CFMC
Miguel Rolon .... CFMC

1.4. List of Workshop Working Papers

Document Number	Title	Author
SP3-01	Preliminary Evaluation of Available US Caribbean Fisheries - Length-Frequency Data and Spatial Changes in the Fisheries.	Todd Gedamke, Staci Hudy, Kevin McCarthy
SP3-02	United States Virgin Islands Fisheries Description and Available Data: Preliminary Evaluation.	Kevin McCarthy and Todd Gedamke
SP3-03	A multi-pronged approach to evaluating managed species groups in Puerto Rico from reported landings.	Nick Farmer and Andy Strelcheck
SP3-04	Management History for Reef Fish Resources	Jason Rueter
SP3-05	Map of closures	Jason Rueter
SP3-06	Not received	
SP3-07	Consolidated Caribbean SEDAR Research Recommendations	Edited by Julie A. Neer
SP3-08	Quick Reference to the Fishing Regulations History in the US Caribbean	Graciela García-Moliner

1.5. List of Workshop Reference Papers

Document Number	**Title**	**Author**
SP3-R1	Length-based assessment of sustainability benchmarks for coral reef fishes in Puerto Rico	JERALD S. AULT, STEVEN G. SMITH, JIANGANG LUO, MARK E. MONACO AND RICHARD S. APPELDOORN
SP3-R2	Evaluation of average length as an estimator of exploitation status for the Florida coral-reef fish community	Jerald S. Ault, Steven G. Smith, and James A. Bohnsack
SP3-R3	SEDAR 8 SAR1 Caribbean Yellowtail Snapper	SEDAR
SP3-R4	SEDAR 8 SAR2 Caribbean Lobster	SEDAR
SP3-R5	SEDAR 14 SAR1 Caribbean Yellowfin Grouper	SEDAR
SP3-R6	SEDAR 14 SAR2 Caribbean Mutton Snapper	SEDAR
SP3-R7	SEDAR 14 SAR3 Caribbean Queen Conch	SEDAR

SP3-R8	SEDAR 4 Data Workshop Report	SEDAR
SP3-R9	Report of a National Workshop on Developing Best Practices for SSCs	Witherell, D., and P. Dalzell (editors)
SP3-R10	Estimating Mortality from Mean Length Data in Nonequilibrium Situations, with Application to the Assessment of Goosefish	Todd Gedamke and John M. Hoenig
SP3-R11	Notes Relating to the Commercial Fisheries in Puerto Rico	Nancie J. Cummings and Daniel Matos-Caraballo

2. Workshop Findings

2.1. TOR 1. Data Review

Review available data and develop recommendations regarding their accuracy and reliability for use in assessing U.S. Caribbean fish stocks. Provide complete tables documenting the quantity and quality of data by stock and area.

2.1.1. Territorial Data and Collection Programs

Representatives of Puerto Rico DNR and the USVI DFW provided overview presentations of data collection programs, including information available and changes in programs over time.

2.1.2. Catch Data and Expansion Factors

2.1.2.1. Recreational Catches

A review of recreational fisheries in the US Caribbean was presented in SEDAR 14; it stated:

> "The recreational harvest of marine species in the US Caribbean is thought to be large, but until recently there have been very few surveys to document the recreational catch and effort. Apparently recreational effort is particularly high during holidays such as Easter week and summer vacations when large numbers of families camp along the shore and harvest fish and shellfish in near shore waters".
>
> "In the year 2000 the Marine Recreational Fisheries Statistical Survey (MRFSS) was initiated in Puerto Rico by the Department of Natural and Environmental Resources and by a private contractor in the U.S. Virgin Islands. The sampling efforts were unsuccessful in the Virgin Islands and were not continued in subsequent years in that area. Sampling in Puerto Rico has continued since 2000. The MRFSS collects catch information on finfish, but generally does not include invertebrates such as conch and lobster. However a special survey to record the number of participants in the recreational conch fishery was conducted by MRFSS in May through September of 2000; it estimated that there were 50,000 participants in the recreational fishery for conch in Puerto Rico and the Virgin Islands during that four month period".

SEDAR 14 research recommendations included: 1) increasing the dockside sampling of recreational fishing trips in Puerto Rico to reduce the uncertainty in the catch estimates and 2) extending / initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches. In addition, recreational effort for conch and lobster should be included in the MRFSS project in the US Caribbean.

2.1.2.2. Commercial Landings Overview

Puerto Rico Commercial Landings

Matos (2008) and Cummings and Matos-Caraballo (SP3-R11) summarized available information pertaining to the commercial fisheries in Puerto Rico. From 1967 through 2004, records of the sales of marine fish and shellfish in Puerto Rico have been collected from voluntary reports by fishers, from fishing associations (i.e., cooperatives) and from dealers; starting in 2005 reporting became mandatory. Landings data are available by species in electronic form for Puerto Rico since 1983. Figure 1 presents reported commercial landings by year for 1971-2007. Table 1 presents the percentage weight landed by gear and year for all species groups combined, 1983-2007.

US Virgin Island Commercial Landings.

McCarthy and Gedamke (SP3-2) provided a brief description of US Virgin Islands commercial fisheries, and identified the types and quantity of data that exist to describe trends in the commercial fisheries (landings and length). Of interest in particular, is that species specific data are not available for the US Virgin Islands. Logbook records exist since 1974 for the two platforms, St. Thomas/St. John, and St. Croix. During the early years (1974- 1996) fishermen were requested, to report catches by major gear types, these categories included: netfish, hook fish, potfish, and spear fish. Beginning around 1996, fishers were requested to stratify the gear specific catches by the species groups captured (e.g., snappers, groupers, parrotfishes, surgeonfishes, etc.). Conch, lobster and a number of pelagic species (wahoo, dolphin) were always recorded separately on the logbook records (Figures 2 and 3).

2.1.2.3. Commercial Landings Expansion Factor Issues

Expansions factors are used with for Puerto Rico and the US Virgin Islands to calculate total landings from partial landings statistics. In Puerto Rico not all fishermen have provided landings reports; expansion factors have been used to adjust for the un-sampled fishermen. In the Virgin Islands expansion factors have been used to account for non-reporting fishermen and also to adjust for missing reports by fishermen who reported for part of the year. This working group agreed that it was important to refine the expansion factors used for the Virgin Islands landings for SEDAR 14 (see below)

The working group considered it important to provide indications of the uncertainty about the calculated total landings caused by the use of expansion factors. Additionally the working group recognized that there were additional uncertainties in the calculated total landings due to mis-reporting (underreporting, over reporting) and also due to non-reporting (also referred to as un-reported landings).

Expansion Methods for Puerto Rico Commercial Landings

Two methods have been used historically in Puerto Rico to correct (expand) the reported commercial landings for mis-reporting and unreported landings. Correction factors exist from 1971-1987 however the methods used to calculate those factors are not well described (Matos-Caraballo 1990). From around 1988 through 2002, fisher reported landings (accumulated from sales receipts) were expanded by the ratio of active fishers to licensed fishers. This procedure is referred to henceforth as the Fisher Based Correction Factor (FBCF) method. Port agents conducted port sampling collections and the periodic annual census's and developed lists of active fishers. Using this information correction fisher based factors (FBCF's) were calculated. Since 2003, correction factors were calculated on a weight based system referred to herein as the Weight Based Correction Factors (WBCF). Reported commercial landings have been corrected (expanded) since 2003 by the ratio of reported landings (in weight) by coast to the port sampler observed landings by coast. As Matos-Caraballo and earlier investigators pointed out (Matos Caraballo and Sadovy 1990) the two procedures are not comparable. The historical time series of corrections factors (CF's) used to adjust Puerto Rico's commercial landings are presented in Table 2.

The working group reviewed alternative estimates of expansion factors (Cummings and Matos-Caraballo 2009, draft document) derived from analyses of port sampler surveys conducted during 2006 and 2007. They provided information on the uncertainty around the total non-reporting and mis-reporting (i.e., the WBCF) developed form the survey data and also evaluated alternative stratification strategies for estimation. The Caribbean SEDAR Procedural Panel found that the confidence intervals about the stratified estimates and the existing expansion factors overlapped. It was recommended to use the existing expansion factors however the group recommended that the DNER consider using stratified expansion approaches in the future. Tables 3 through 5 present stratified mean estimates for the recent 2006 and 2007 Weight Based Correction Factors and 80%, 90% and 95% confidence intervals for the WBCF's. Estimates of total non + mis reporting (Non+Mis) were calculated as stratified mean estimates of the total fisher reported weight (reported to DNER, CSP) divided by the total port sampler observed weight.

In addition, Cummings and Turner (draft document) developed estimates of mis-reporting from the 2006 and 2007 survey observations. Estimates of mis-reporting were calculated similarly to the WBCF's using all surveys in which the number of trips reported equaled the number of port sampler observed trips (assuming that they were the same trips). Stratified mean estimates of mis-reporting from the 2006 and 2007 survey data were calculated for each year (Table 6) and for both years combined (Table 7). Additional information is provided by year and major coast in Table 8. Sample sizes for stratifications of mis-reporting rates on a year by coast basis and on a year basis were quite low, so Cummings and Turner considered those estimates to have low reliability. Sample sizes for the mis-reporting rates calculated across both years were considered to be sufficient to provide reasonable estimates.

The working group also recommended that the uncertainty in the annual reported landings be characterized by computing the variance of the expansion factors and confidence intervals about the calculated total landings. The 2006 and 2007 port sampler data and the resulting estimates of non – reporting and mis reporting were used to calculate the amount of uncertainty in the year by coast expansion factors. It was assumed that the 2006-2007 non-reporting and/or mis-reporting rates applied to earlier years; the validity of this assumption could not be tested.

Tables 9 and 10 present the reported Puerto Rican landings by year and species.

2003 and earlier landings:

The reported landings were expanded for two factors:

1) non-reporting based on the annual FBCF's of Matos-Caraballo and XXX

2) mis-reporting based on the 2006-2007 survey data. For this report, the 2006 and 2007 estimates of mis-reporting were averaged and applied to the reported landings from 2002 and prior.

Variability about the total landings for 2002 and earlier was also calculated.

1) The variance in annual landings of the reporting fishermen who could be identified was calculated; that variance was used in computing confidence intervals about the calculated landings of the non-reporting fishers.
2) The variability associated with mis-reporting was calculated from the 2006-2007 data; that variance was assumed to apply to earlier years and was used in calculating the confidence intervals about the landings from all fishers (reporting and non-reporting).

The 2003-2005 landings

Reported landings were expanded to total landings using the year specific WBCFs. Variability about the 2003-2005 annual WBCFs was not available, so the variability about 2006-2007 WBCFs was also used in computing confidence intervals about the 2003-2005 total landings.

Further work should be done to obtain the individual port sampler survey observations for 2003-2005 to quantify the variability associated with the annual WBCFs for those years. .

The 2006 and 2007 landings

The WBCFs for each year were used to calculate total landings.

The variance around those annual factors was used in calculating the confidence intervals.

Table 11 and Figures 4 through 6 present the reported and calculated total landings across all species groups by year with 80%, 90% and 95% confidence bounds.

2.1.2.4. US Virgin Islands Expansion Procedures

The work group concluded that improvements could be made to the procedures used to calculate the Virgin Island expansion factors for SEDAR 14. It was felt that the SEDAR 14 procedures may have overestimated the landings.

The Virgin Islands expansion factors have historically taken into account two factors: 1) fishermen who did not report and 2) fishermen who reported in only some months. For SEDAR 14 it was assumed that all license holders fished and that non-reporters fished in the same manner as the reporting fishers. It was also assumed that if a fisher reported in any month, then he fished in every month. Apparently there are incentives for people to obtain fishing licenses even though they do not intend to fish. Additionally some fishers fish part of the year and may not actively fish in other parts of the year.

The working group recommended that for 1990-present (when the Virgin Islands Division of Fish and Wildlife was responsible for issuing fishing licenses) it should be assumed that non-reporting fishers did not fish. The working group also recommended that a fisher's history be used in calculating how to handle months when he submitted no fishing reports. It was recommended that it be assumed that if a fisher reported at least once in a year, that he fished at least the average number of months he fished in most years.(see below for specific details).

The SEDAR14 expansion procedures were:

(1) Expansion of individual landings where fishers did not report all months within a year by the ratio of 12 (months) over number of months reported, and

(2) Expansion of total landings by the ratio of total permit holders$_2$ over reporting permit holders; thus allowing for landings from the permit holders not reporting at all.

The revised procedures for partially reporting fishers accounts for the reporting tendencies of the individual by using the mean number of reports submitted over the year ranges (1980-81 to 1989-90 for St Thomas/St John and 1983-84 to 1989-90 for St. Croix) and (1990-91 to 2006-07).

SEDAR14 Procedure:

Example: Fisher reported 4 months in a given fishing year landing 100 lbs.

100 lbs reported landings x 12 months/4months = 300 lbs estimated landings for that year.

Revised Procedure:

Example: Fisher reported 4 months in a given fishing year but averages 6 reporting months a year over the range of years

100 lbs reported landings x 6 months/4 months = 150 lbs estimated landings for that year.

The revised procedures for non-reporting fishers allows for fishers who have reported during at least 2 fishing years and whose catch report's show fishing years of no reporting that lie between or among the reporting years. These years of non-reporting are now presumed to be years where no fishing occurred because:

1. The fisher is familiar with reporting requirements.
2. The fisher likely kept the permit active and so is part of the total number of permit holders.

For fishing-years outside the range of reporting-years the fisher is considered in-active in the fishery and so is not part of the total number of permit holders.

SEDAR14 Procedure:

Example: All reporting fishers landed 1,000,000 total lbs in a year. The number of reporters is 200, the number of total permit holders is 300

1,000,000 lbs x 300 total permit holders/ 200 reporters = 1,500,000 lbs

Revised Procedure:

Example: All reporting fishers landed 1,000,000 total lbs in year X. The number of reporters for that year is 200, the number of total permit holders is 300. There are 50 fishers who provided reports in years before and after year X who did not report in year X.

1,000,000 lbs * (300 total permit holders – 50)/200 = 1,250,000 lbs

Reported and total expanded landings for all species combined are provided in Table 12 for St. Thomas / St. John and Table 13 for St. Croix. The expanded landings were calculated using the revised procedures described above.

Stakeholder Opinion Regarding U.S. Virgin Island Expansion Procedure:

Review of US Virgin Islands reporting frequency reveals that 47% of the St. Croix fishermen and 57% of the St. Thomas fishermen file 12 fishing reports annually. Both of these numbers exceed estimates of the number of "full time" fishermen on each district.

Additionally, during a normal fishing year, it is highly likely that boat breakdowns, health problems and bad weather can easily eliminate one to two months each year. Coupled with these reasons for non-reporting, the US Virgin Islands have been hit by 10 hurricanes since 1974. Experience has shown that these storms can eliminate fishing activities (and reporting) for up to six months and, in fact, have led to significant shifts in methods employed.

For these reasons it is likely that the best estimates of landings are provided by the unexpanded data and that expansion simply distorts signals which currently exist.

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2.1.2.5. US Virgin Islands Commercial Discards

In the Virgin Islands feasibility studies for measuring bycatch in a pilot observer program were conducted in 2005-2006 and showed that considerable numbers of finfish were being discarded. A size limit was established for conch in 1988 in St. Croix and in 1994 in St. Thomas / St. John, but because conchs are primarily harvested by hand (divers), it is thought that nearly all are of legal sizes.

Results for the recent MARFIN US VI bycatch studies by MRAG Americas were summarized here again as in SEDAR 14. Observers and fisher captain samples from gill and trammel nets (13 trips), hook and lines (13 trips), bottom long lines, traps (12 trips) and dive operations (12 trips) provided information on the number and weight of retained and discarded catch (50 trips St. Croix, 73 trips St. Thomas).

St. Croix

In St. Croix discarded catch represented 19.6 % of the total catch across all trips by number and 14.3 % by weight. Many species discarded also appeared in the retained catch. Blue tang, jacks (horse eye, bar), ocean surgeon fish, houndfish, moray eels, needlefishes, parrotfishes (redband, queen, princess, redfin, redtail, and stoplight with redtail and stoplight dominating), trunkfish, coney, and ballyhoo were among the discards. Generally, species discarded were caught in low numbers. For example, blue tang comprised 15% of the overall discards but represented only 7% of the retained catch. However, occasionally discards occurred in high numbers also. Ocean surgeon fish represented 34% of the total bycatch (by number) but less than 1% of the retained catch. Ballyhoo and redtail parrotfish comprised 10.5% and over 25% of the retained catch but less than 1% of the discards. Trammel nets and pots and traps had the highest bycatch, followed by hook and line with dive trips having the lowest bycatch. Blue tang and surgeon fish were the most frequently caught species in the trammel net bycatch. Blue tang and trunkfish were the most frequently caught species in the pot and trap bycatch. Pots/traps also discarded spiny lobster, grunts, doctorfish, and cowfish. Hook and line trips frequently discarded jacks, sand tilefish, and coney. Bottom long line trips discarded greater amberjack, beardfish and lizardfish. Dive trips discarded the fewest number of species and also the lowest numbers of individuals and lowest total weight. Species discarded on dive trips included barracuda, spiny lobster, and parrotfish. Table 14 presents a summary of discard data for St. Croix.

St. Thomas

MRAG Americas evaluated the feasibility of placing observers on reeffish vessels operating off St. Thomas, US Virgin Islands to quantify bycatch/discards. In general success was very low in that vessels are generally smaller than 25 feet, making it difficult for observers to work on these vessels. Vessels averaged 24.7 feet across all fisheries (24.9 ft fish trap vessels, 31.2 lobster boats, 22.5 hand line skiffs, 17.6 seine net skiffs, 32.0 long line vessels). Trap vessels presented the most difficulty when attempting to place observers onboard due to the space required for handling traps which restricted the remaining available space for the observer to adequately collect data on bycatch. In order to obtain bycatch information from vessels that were space restricted, observers trained captains to retain bycatch samples for later dockside/shore sampling by the observer.

Forty two percent (21) of the 50 full time St Thomas fishers participated in the MRAG bycatch/discard project yielding 45 captain samples and 28 observer trips. Comparisons between captain samples and observer samples did not suggest differences in bycatch retention rates by number.

Reasons for discarding included ciguatera risk, market size, and non-marketable species. Ciguatera affected nearly 14% of the finfish bycatch with the species composition including jacks, a variety of snappers- (schoolmaster dominating the snapper bycatch, also including blackfin, gray, mahogany, dog), mackerels, and barracuda. Finfish were also discarded due to market size considerations with some 78% of the finfish bycatch being smaller than the desired size (often referred to as ‘plate’ size) - these species included box fish or surgeon fish. Discarded species are due to market size concerns included: surgeon fishes, jacks, and several groupers (red hind, coney, and rock hind). Tables 15 and 16 present a summary of finfish discard data for St. Thomas.

Daily catch reports

In addition to the above studies in the Virgin Islands, a MARFIN funded pilot project was carried out to determine the feasibility of collecting daily catch reports from fishers with species specific information on landings and discards have recorded mutton snapper discards off St. Thomas / St. John (MRAG 2007a); both mutton snapper and yellowfin grouper are also known to be discarded off St. Thomas / St. John primarily in the southeast section off those islands and to decreasing extent further west (Olsen, pers comm.). During a comparable study on St. Croix (MRAG 2006b), discards of sub-adult mutton snapper were recorded but no yellowfin grouper were observed in catches or discards. As in Puerto Rico, recent species specific area closures off the Virgin Islands are thought to have increased discarding (Olsen,pers. comm.). Ongoing research by the St. Thomas Fishermen's Association from 1500 trips and 80,000 trap hauls, indicates a discard rate of approximately 2 fish per trap haul. That survey indicates high discard rates of mutton snapper and some discarding of yellowfin grouper. The main reasons for discarding include the size of the fish being too small, the lack of a commercial market for the species or the presence of Ciguatera in the members of that species from the capture area. This finding is in agreement with observations from the MRAG bycatch study.

2.1.2.6. Puerto Rico Comercial Discards

SEDAR 14 summarized commercial discard information for Puerto Rico. "Matos *et al*. (2007) indicated that conch, mutton snapper and yellowfin grouper were all discarded in Puerto Rico. In the relatively small number of trips reported on in Matos *et al* mutton snapper were observed being discarded in trammel net and trap fisheries, and Matos (pers. comm.) noted that discarding of mutton snapper may have increased in recent years, because of recent management measures including a closed season for several snappers. No conch or yellowfin grouper were observed being discarded in the beach seine, hook and line, trammel net and trap fishing observed by Matos *et al*.. Conch are thought to be released alive (Matos pers. comm.)

2.1.2.7. References

MRAG, Americas, Inc., 2006a. Final Report: A pilot program to assess methods of collecting bycatch, discard, and biological data in the commercial fisheries of the US Caribbean. A Cooperative Research Program Report Submitted to Southeast Regional Office National Marine Fisheries Service Grant No. NA04NMF4540214, 59 pp.

MRAG, Americas, Inc. 2006b. Final Report (Revised). A pilot program to assess methods of collecting bycatch, discard, and biological data in the commercial fisheries of St. Thomas, U.S. Caribbean A Cooperative Research Program Report Submitted to Southeast Regional Office National Marine Fisheries Service Grant No. NA05NMF4540042, 80 pp

Matos-Caraballo, Daniel, M. Cartagena-Haddock, and N.. PEÑA-Alvarado. 2007. Bycatch Study of the Puerto Rico's Marine Commercial Fisheries. Proceedings of the 58th GCFI, 9pp.

Matos-Caraballo, Daniel and Yvonne Sadovy.

Matos 2008 GCFI

Table 1: Proportion of reported commercial landings of finfish and shellfish in Puerto Rico, 1983-2007 by major gear, from fisher sales tickets (% by weight). 2007 is preliminary. Estimated correction factors for non-reporting ranged from 0.50 to 0.75 over the period. Taken from Cummings and Matos-Caraballo 2009 (SP3-R11).

	agear										
	Bottom Line	*Cast Net*	*Dive, Spear, Scuba*	*Fish Pot*	*Lobster Pot*	*Net*	*Other*	*Rod and Reel*	*Seine*	*Vertical Line*	*All*
CYEAR											
1983	11	0	21	40	0	11	0	11	5	1	100
1984	11	1	21	43	1	11	0	7	5	1	100
1985	20	1	16	39	1	13	0	6	4	1	100
1986	24	1	13	36	1	14	0	7	4	0	100
1987	20	1	13	37	1	15	0	9	6	1	100
1988	20	0	18	29	1	13	1	12	5	1	100
1989	22	0	14	35	1	10	0	11	5	1	100
1990	21	0	12	32	1	12	0	16	4	1	100
1991	24	1	12	30	1	13	0	14	5	1	100
1992	29	1	11	27	0	7	0	19	4	1	100
1993	31	1	14	24	0	10	0	15	4	1	100
1994	30	1	13	26	0	12	0	14	3	1	100
1995	34	1	14	22	1	8	0	16	4	1	100
1996	31	1	15	22	1	10	0	16	3	1	100
1997	29	1	13	22	1	12	0	16	3	2	100
1998	27	1	18	21	1	12	0	16	2	2	100
1999	29	1	17	20	1	14	0	14	2	2	100
2000	29	1	20	18	1	13	0	12	2	4	100
2001	31	1	18	22	1	13	0	10	2	2	100
2002	29	1	20	21	1	14	0	10	3	2	100
2003	32	1	17	22	1	11	0	12	3	1	100
2004	29	1	25	19	2	9	0	12	4	1	100
2005	35	1	24	15	2	6	0	13	1	1	100
2006	34	0	27	16	2	5	1	13	2	2	100
2007	35	1	31	12	1	5	0	12	1	1	100
All	26	1	17	27	1	11	0	12	3	1	100

Table 2: Puerto Rico's Historical Correction Factor as estimated by the FBCF or the WBCF methods: The correction factor to estimate the mis and/or non- reported landings data in Puerto Rico have been used since the beginning of the Commercial Fisheries Statistics Program in 1971.

	Commercial Landings Reported in Puerto Rico		
YEAR	**TOTAL LANDINGS POUNDS**	**Correction factors**	**Correction Factor Method**
1971	4,900,000	0.60	FBCF
1972	4,700,000	0.60	FBCF
1973	4,500,000	0.60	FBCF
1974	4,600,000	0.60	FBCF
1975	5,200,000	0.60	FBCF
1976	6,090,000	0.60	FBCF
1977	6,300,000	0.60	FBCF
1978	7,100,000	0.68	FBCF
1979	7,400,000	0.75	FBCF
1980	6,500,000	0.75	FBCF
1981	5,900,000	0.75	FBCF
1982	5,350,000	0.75	FBCF
1983	3,929,608	0.61	FBCF
1984	3,155,385	0.59	FBCF
1985	2,839,361	0.56	FBCF
1986	2,666,925	0.75	FBCF
1987	2,149,255	0.75	FBCF
1988	2,020,000	0.56	FBCF

Table 2: Continued.

1989	2,305,000	0.51	FBCF
1990	2,186,435	0.51	FBCF
1991	2,463,018	0.51	FBCF
1992	2,044,207	0.60	FBCF
1993	2,509,441	0.60	FBCF
1994	2,714,402	0.64	FBCF
1995	3,708,999	0.71	FBCF
1996	3,617,039	0.71	FBCF
1997	3,895,980	0.78	FBCF
1998	3,501,895	0.78	FBCF
1999	3,337,486	0.78	FBCF
2000	3,362,722	0.57	FBCF
2001	3,389,010	0.68	FBCF
2002	3,272,812	0.86	FBCF
2003	2,388,761	0.56	WBCF
2004	1,864,680	0.61	WBCF
2005	1,569,035	0.50	WBCF
2006	1,338,924	0.52	WBCF
2007	1,242,002	0.59	WBCF

FBCF: Correction factor calculated as number active fishers divided by the number of registered Fishers; adjusts for non-reporting.

WBCF: Correction factor calculated as total pounds registered by active fishers divided by total pounds observed by port samplers, at the most productive fishing centers; adjusts for non-reporting and mis-reporting.

Table 3: Stratified mean estimates for total non-reporting and mis-reporting (i.e., WBCF) and 95% Confidence Interval by year and region in Puerto Rico. WBCF (weight based correction factor) calculated as stratified mean estimates with each year, fishing center survey a stratum. Estimates of WBCF = Weight (pounds) reported by fisher to CFSP (all coasts) divided by Weight (pounds) observed port sampler for a unique year, survey observation. N=number surveys.

Year	Region	N	Mean	Std Error of Mean	95% CL for Mean	
	E	21	0.61	0.26	0.08	1.14
	N	35	0.43	0.30	-0.19	1.04
	S	37	0.72	0.11	0.50	0.95
2006	W	40	1.16	0.22	0.71	1.61
	E	15	0.53	0.22	0.06	0.99
	N	20	0.27	0.08	0.11	0.43
	S	24	0.80	0.19	0.40	1.19
2007	W	28	0.79	0.06	0.67	0.92

Table 4: Stratified mean estimates for total non-reporting and mis-reporting (i.e., WBCF) and 90% Confidence Interval by year and region in Puerto Rico. WBCF (weight based correction factor) calculated as stratified mean estimates with each year, fishing center survey a stratum. Estimates of WBCF = Weight (pounds) reported by fisher to CFSP (all coasts) divided by Weight (pounds) observed port sampler for a unique year, survey observation. N=number surveys.

Year	Region	N	Mean	Std Error of Mean	90% CL for Mean	
	E	21	0.61	0.26	0.17	1.05
	N	35	0.43	0.30	-0.08	0.94
	S	37	0.72	0.11	0.53	0.91
2006	W	40	1.16	0.22	0.79	1.53
	E	15	0.53	0.22	0.14	0.91
	N	20	0.27	0.08	0.14	0.40
	S	24	0.80	0.19	0.47	1.13
2007	W	28	0.79	0.06	0.69	0.90

Table 5: Stratified mean estimates for total non-reporting and mis-reporting (i.e., WBCF) and 80% Confidence Interval by year and region in Puerto Rico. WBCF (weight based correction factor) calculated as stratified mean estimates with each year, fishing center survey a stratum. Estimates of WBCF = Weight (pounds) reported by fisher to CFSP (all coasts) divided by Weight (pounds) observed port sampler for a unique year, survey observation. N=number surveys.

Year	Region	N	Mean	Std Error of Mean	80% CL for Mean	
	E	21	0.61	0.26	0.27	0.95
	N	35	0.43	0.30	0.03	0.82
	S	37	0.72	0.11	0.58	0.86
2006	W	40	1.16	0.22	0.87	1.45
	E	15	0.53	0.22	0.23	0.82
	N	20	0.27	0.08	0.17	0.37
	S	24	0.80	0.19	0.54	1.05
2007	W	28	0.79	0.06	0.71	0.88

Table 6: Stratified mean mis-reporting rates for Puerto Rico commercial landings by year, all coasts combined.

Year	# Surveys	Mis- Reporting Rate
2006	28	0.80582
2007	17	0.87192

Table 7: Estimated stratified mean mis-reporting rate and 95, 90 and 80 % Confidence Intervals derived from 2006-2007 survey data. N=number surveys.

Calculated mis-reporting Rate for Puerto Rico commercial landings for 2006 and 2007 combined and 95%, 90%, and 80% Confidence Intervals.

Mean	N	U95 CI	L95 CI	U90 CI	L90 CI	U80 CI	L80CI
0.94	45	1.19	0.69	1.15	0.73	1.1	0.78

Table 8: Summary information for mis-reporting for 2006 and 2007 Puerto Rico commercial landings by major coast. N=45 survey observations total. SmpLbs is the observed pounds recorded by port samplers; FishLbs is the reported pounded recorded by fishermen on trip tickets.

Year	Region	NSurveys	SmpLbs	FishLbs	MisRep_Ratio
2006	E	6	313	226.5	0.72
2006	N	5	730	23	0.03
2006	S	11	1645.5	1756	1.07
2006	W	6	789	796.75	1.01
2007	E	2	296	351	1.19
2007	N	1	30.5	10	0.33
2007	S	8	796.15	563.05	0.71
2007	W	6	2208	1980	0.90

Table 9: Reported Puerto Rico commercial landings of by species, 1983-1995.

	CYEAR												
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT	TOT_WT
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
COMMON_NAME													
AMBERJACK,GREATER	0	0	0	0	884	1732	1929	1075	1160	902	598	366	1763
ANCHOVIES	0	0	0	0	0	10	0	0	0	0	0	0	0
ANCHOVY,STRIPED	0	0	0	0	0	0	0	0	0	0	0	0	0
ANCHOVY,WHALEBONE	0	0	0	0	0	0	0	0	0	200	0	0	0
ANGELFISH,GRAY	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGELFISH,QUEEN	0	0	0	0	0	0	82	0	0	0	0	28	0
BALLYHOO	22167	11268	18666	9195	9584	449	5495	14903	27880	22951	29726	32239	56786
BARBU	0	0	0	0	0	46	61	393	150	88	83	179	45
BARRACUDA,GREAT	0	0	0	0	0	0	0	0	75	0	0	15	24
BARRACUDAS	25553	10889	9441	18893	19517	10843	15816	7123	21289	9508	8948	13016	17756
BASS,CHALK	0	0	0	0	0	0	0	0	0	0	3	0	0
BASS,PEACOCK	0	0	0	0	0	0	0	0	0	0	0	0	11
BASS,REDEYE	0	0	0	0	0	10	5	0	0	0	0	0	0
BATFISH,SHORTNOSE	0	0	0	0	0	0	10	0	50	0	50	0	0
BATFISHES	0	0	0	0	0	0	0	0	0	0	0	0	15
BEARDFISH	0	0	0	0	0	8	0	0	0	0	0	0	0
BEARDFISHES	0	0	0	0	0	41	25	0	0	0	0	0	0
BIGEYE	0	0	0	0	2	0	0	176	265	371	375	0	360
BIGEYES	0	0	0	0	0	0	0	0	32	0	0	0	30
BLUEGILL	0	0	0	0	833	75	0	61	153	483	204	1073	523
BONEFISH	0	0	0	0	0	24	545	1374	612	347	164	65	107
BONEFISHES	0	0	0	0	0	27	89	0	0	11	0	2	0
BOXFISHES	40376	38547	34103	36154	36116	58	3136	24001	33063	39138	53955	52611	66618
BROTULA,BEARDED	0	0	0	0	0	160	0	0	0	0	0	0	0
BUMPER,ATLANTIC	0	0	0	0	8248	109	1006	563	1662	1047	1477	2200	1412
BUTTERFISH	0	0	0	0	6	0	0	0	37	48	15	0	10
BUTTERFISHES	0	0	0	0	5	0	0	0	0	7	0	60	7
BUTTERFLYFISH,BANDED	0	0	0	0	0	0	0	0	0	0	0	0	0

BUTTERFLYFISH,FOUREYE	0	0	0	0	0	0	0	14	0	0	0	0	52
BUTTERFLYFISH,SPOTFIN	0	0	0	0	0	0	0	0	0	0	0	0	0
BUTTERFLYFISHES	0	0	0	0	7	0	0	0	79	40	0	0	19
CARDINALFISHES	0	0	0	0	0	0	12	0	382	0	0	0	0
CARPS AND MINNOWS	0	0	0	0	0	10	0	0	0	0	0	0	0
CATFISH,BERMUDA	0	0	0	0	4	0	0	0	0	0	0	0	0
CATFISH,CHANNEL	0	0	0	0	0	0	0	0	0	0	0	0	0
CATFISH,WHITE	0	0	0	0	15	0	0	0	6	0	30	0	20
CATFISHES,BULLHEAD	0	0	0	0	0	0	0	0	0	0	12	0	0
CHROMIS,BROWN	0	0	0	0	0	0	0	0	0	0	0	0	0
CHUB,BERMUDA	0	0	0	0	0	153	344	190	0	12	0	36	6
CHUB,YELLOW	0	0	0	0	0	0	100	0	1280	7	6	0	0
CICHLIDS	0	0	0	0	0	0	0	0	11	0	7	0	4
CLAMS	0	0	0	113	97	173	0	58	5	0	13	1619	795
COBIA	0	0	0	0	0	0	10	0	0	0	0	0	27
COBIAS	0	0	0	0	0	0	0	31	0	47	12	34	0
CONCH,QUEEN	399880	294773	260825	188360	142994	230702	160247	107964	108084	90947	164590	170802	214231
CONEY	0	0	0	10	3758	4449	6745	5815	9142	6793	6013	5522	9788
CONGER EELS	0	0	0	0	0	4	0	0	0	0	0	0	0
CONGER,MANYTOOTH	0	0	0	0	0	38	0	3	0	0	5	9	9
CORNETFISH,BLUESPOTTE	0	0	0	0	0	25	0	0	0	0	0	0	16
CORNETFISHES	0	0	0	0	0	0	0	0	0	0	0	0	0
COTTONWICK	0	0	0	0	0	0	0	0	0	42	0	0	0
COWFISH,HONEYCOMB	0	0	0	0	0	0	10	0	0	0	0	0	0
CRAB,BLUE LAND	2060	1409	1235	1184	2063	2571	4731	1979	5650	2640	1793	2014	5730
CRAB,FLAME BOX	0	0	0	0	0	0	0	0	0	0	0	0	0
CRAB,MARINE	2	0	0	13	0	36	7	3	38	20	55	0	868
CRAB,SPECKLED SWIMMIN	0	0	0	0	70	0	0	0	85	79	97	1460	719
CREOLE FISH	0	0	0	0	0	0	0	0	0	0	0	0	0
CROAKER,REEF	0	0	0	0	6291	1473	139	2134	4382	1360	2098	5112	5769
CUSK-EELS	0	0	0	0	0	238	35	0	0	0	0	0	0
CUTLASSFISH,ATLANTIC	0	0	0	0	40	21	44	67	321	322	897	140	0
CUTLASSFISHES	0	0	630	0	0	17	0	0	273	40	58	222	57
DAMSELFISHES	0	0	0	0	0	0	7	0	0	0	3	0	0
DOLPHIN,POMPANO	0	0	0	0	0	27	43	48	22	0	0	2	45

DOLPHINFISH	167	0	0	0	0	69286	69195	32033	14823	4548	1279	664	1847
DOLPHINS	42170	14867	19246	33098	28620	0	126	66041	54887	80640	73942	90456	195674
DRUM,SAND	0	0	0	0	0	0	0	0	0	0	27	0	0
DRUM,SPOTTED	0	0	0	4	0	0	0	0	0	0	0	0	0
DRUMMER,GROUND	0	0	0	0	0	0	50	0	68	192	0	0	10
DRUMMER,MONGOLAR	0	0	0	0	0	5	10	0	346	3	0	0	12
DRUMMER,WHITEMOUTH	0	0	0	0	0	982	2000	1903	614	69	547	33	141
DRUMS	0	0	0	0	0	324	402	548	84	0	171	16	14
DURGON,BLACK	0	0	0	0	0	12	163	18	40	0	0	0	20
EAGLE RAY,SPOTTED	0	0	0	0	120	40	0	924	1018	853	895	4556	5862
EAGLE RAYS	0	0	0	0	53	105	0	317	210	600	111	8	232
EEL,AMERICAN	0	0	0	0	0	0	0	0	0	0	0	0	30
EELS,FRESHWATER	0	0	0	0	0	0	0	0	0	0	0	0	18
FILEFISH,ORANGE	0	0	0	0	0	0	0	0	0	0	0	0	0
FILEFISH,ORANGESPOT	0	0	0	0	0	1188	257	0	112	15	127	29	269
FIRST CLASS	0	0	7750	122526	91518	113306	214797	178726	193239	164653	186088	173074	238771
FLAMEFISH	0	0	0	0	0	0	0	43	0	938	0	0	0
FLYING GURNARD	0	0	0	0	0	59	0	0	0	0	0	0	10
FLYING GURNARDS	0	0	0	0	0	16	0	0	0	0	0	233	0
FLYINGFISH,ATLANTIC	0	0	0	0	0	13	92	37	0	0	0	0	0
FLYINGFISHES	0	0	0	0	0	834	0	0	0	0	0	0	2
FROGFISHES	0	0	0	0	0	0	0	8	0	0	0	20	0
GOATFISH,SPOTTED	0	0	0	0	239	6113	8296	11423	13633	6178	7284	8635	12627
GOATFISH,YELLOW	0	0	0	0	5	753	1221	2064	2068	1272	748	1390	1799
GOATFISHES	163010	125610	58723	19871	9696	160	0	62	0	31	96	12	103
GOBIES	0	0	0	0	0	0	0	0	0	0	0	0	0
GOBY,FRILLFIN	0	0	0	0	0	0	0	0	0	0	0	0	0
GOBY,RIVER	0	0	0	0	0	0	0	0	23	0	0	0	0
GOBY,SIRAJO	0	0	0	0	3602	364	705	171	118	484	140	0	170
GOBY,VIOLET	0	0	0	0	0	0	0	0	0	0	0	12	0
GRAYSBY	0	0	0	0	0	0	0	0	0	0	0	0	3
GROUPER,BLACK	0	0	0	0	0	0	0	217	0	7	0	0	0
GROUPER,MARBLED	0	0	0	0	0	0	700	0	0	0	0	0	200
GROUPER,MISTY	0	0	0	0	0	0	26	2662	2784	5106	3885	4988	5941
GROUPER,NASSAU	0	0	0	57	320	2022	2047	2341	4352	6612	5018	7735	7772

GROUPER,RED	0	0	0	0	0	0	0	0	0	535	0	0	125
GROUPER,TIGER	0	0	0	0	0	0	0	0	0	0	0	0	151
GROUPER,YELLOWFIN	0	0	0	0	78	460	1249	558	1701	920	1482	447	827
GRUNT,BARRED	0	0	0	0	0	0	55	15	0	18	0	0	0
GRUNT,BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0
GRUNT,BLUE STRIPED	0	0	0	0	0	5	35	0	20	16	6	651	82
GRUNT,BURRO	0	0	0	0	106	0	0	5	0	160	0	3	0
GRUNT,CAESAR	0	0	0	0	0	0	0	0	0	0	0	0	0
GRUNT,FRENCH	0	0	0	0	0	0	0	200	0	0	0	0	18
GRUNT,SMALLMOUTH	0	0	0	0	0	0	20	34	47	16	22	6	4
GRUNT,SPANISH	0	0	0	0	0	0	46	0	0	0	0	10	0
GRUNT,TOMTATE	0	0	0	0	0	13	0	71	0	0	0	65	0
GRUNT,WHITE	404972	330470	274970	182185	158111	88126	78146	117946	140590	117416	161077	141856	142445
GRUNTS	0	0	0	0	360	1749	1266	1237	2822	618	1287	409	1382
GUANCHANCHE	0	0	0	0	164	0	60	659	136	73	703	388	698
GUPPY	0	0	0	0	0	0	0	0	0	0	0	0	0
HALFBEAK,SILVERSTRIPE	0	0	0	500	87	31704	22088	15494	8070	2058	176	184	60
HAMLET,BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0
HAMLET,MUTTON	0	0	0	0	0	30	55	0	0	0	0	0	0
HARVESTFISH,SOUTHERN	0	0	0	0	0	0	0	0	0	0	0	5612	0
HERRING,ATL THREAD	0	0	0	0	12	18	2215	2598	4215	1228	2365	981	1654
HERRING,DWARF	0	0	0	0	0	0	0	0	0	0	0	0	0
HERRING,SPINY-TOOTH	0	0	0	0	0	0	0	0	0	0	0	0	41
HERRINGS	21366	19150	20344	12593	23327	7913	12103	7370	20274	17152	14695	24651	26594
HIND,RED	0	0	0	442	11465	28790	37921	39383	55515	42014	40389	28669	42190
HIND,ROCK	0	0	0	0	0	18	1100	15	0	0	0	17	0
HOGFISH	72696	70980	41814	37668	36543	30146	25543	21660	30943	21171	21166	32263	49439
HOGFISH,SPANISH	0	0	0	0	56	46552	49734	49111	23502	7865	14138	8933	1399
HOUNDFISH	0	0	0	0	0	88	572	630	690	980	352	91	156
JACK,ALMACO	0	0	0	0	0	5	0	0	0	30	0	0	0
JACK,BAR	0	0	0	0	2486	387	1340	6225	4921	2705	4392	4155	9699
JACK,BLACK	0	0	0	0	46	5	40	115	6	3	0	0	18
JACK,CREVALLE	0	0	0	0	0	0	0	0	4	0	5	12	0
JACK,HORSE EYE	0	0	0	0	119	375	1010	207	16	0	70	141	121
JACK,YELLOW	0	0	0	0	0	0	1253	1341	751	1478	913	24	71

JACKKNIFE-FISH	0	0	0	0	0	0	0	0	0	0	0	130	0
JACKS	42525	30008	34700	44616	33484	24440	29202	22043	34369	22758	28581	38965	52903
JENNY,SILVER	0	0	0	0	0	10	100	0	10	0	44	14	122
JEWFISH	0	0	0	0	475	6382	3543	1515	1813	288	42	0	395
LADYFISH	0	0	0	0	1773	108	9	385	708	593	682	133	190
LEATHERJACK	0	0	0	0	0	1	0	6	0	0	0	72	0
LIZA	0	0	0	0	1293	463	4	70	286	202	70	1247	196
LIZARDFISH,SAND DIVER	0	0	0	0	0	0	0	0	0	89	0	4	10
LIZARDFISHES	0	0	0	0	0	0	0	0	0	0	0	46	225
LOBSTER,CARIB0 SPINY	273679	248019	211082	210071	153407	141275	185777	168654	211588	160530	168910	192148	279171
LOBSTER,SPANISH SLIP0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOBSTER,SPOTTED SPINY	0	0	0	0	887	0	0	0	2	298	163	67	0
MACKEREL,BULLET	0	0	0	0	0	0	15	0	0	0	0	0	15
MACKEREL,CERO	0	0	0	0	1339	310	1092	15385	15358	8878	10454	24221	34023
MACKEREL,KING	223716	159565	131426	115040	85074	80017	95686	82055	90323	61061	107230	97003	153807
MACKEREL,SNAKE	0	0	0	0	0	36	17	0	0	146	0	0	0
MACKERELS & TUNAS	189126	65051	69377	78223	108535	113791	104698	40188	28011	22662	30920	58978	77286
MAN-OF-WAR FISH	0	0	0	0	0	0	0	0	0	0	0	47	0
MANTA,ATLANTIC	0	0	0	0	0	451	26	39	355	421	88	607	379
MANTAS	0	0	0	0	201	0	0	0	63	110	85	376	972
MARGATE	0	0	0	15	247	567	898	828	2130	969	494	2314	2821
MARGATE,BLACK	0	0	0	0	455	41	43	578	728	420	433	424	148
MARLIN,BLUE	0	0	0	0	22	10602	6017	5024	6042	5044	6393	2607	1000
MARLIN,WHITE	0	0	0	0	31	0	0	0	0	55	0	31	0
MARLINS	11385	9107	10825	12559	6122	102	0	0	45	0	0	0	10
MINNOW,FATHEAD	0	0	0	0	0	0	0	0	0	0	0	0	0
MOJARRA,RHOMBOID	0	0	0	0	154	0	40	0	10	0	0	63	0
MOJARRA,STRIPED	0	0	0	0	0	6	171	461	78	75	0	12	0
MOJARRA,YELLOWFIN	0	0	0	0	0	5	32	168	12	15	1607	156	611
MOJARRAS	10979	9782	9004	9887	9018	17744	11554	14827	20106	19708	17924	28607	31327
MOONFISH,ATLANTIC	0	0	0	9	1530	436	4093	3422	8180	2240	3696	6730	6805
MORAY,GREEN	0	0	0	0	0	0	0	18	8	0	0	0	0
MORAY,VIPER	0	0	0	0	0	0	0	0	0	0	10	0	0
MORAY,WHITE SPOTTED	0	0	0	0	0	0	0	0	0	0	11	0	50
MORAYS	0	0	0	0	0	0	0	0	0	0	0	0	0

MOSQUITOFISH	0	0	0	0	0	0	0	0	0	0	0	0	0
MULLET,HOG NOSE	0	0	0	0	0	0	0	0	3	0	32	0	60
MULLET,MOUNTAIN	0	0	0	0	0	23	0	257	13	0	80	0	19
MULLET,WHITE	55218	39220	44575	32794	29167	26595	19318	21328	32258	25865	26529	29541	57368
MULLETS	0	0	0	0	79	279	15	0	0	13	24	92	91
NEEDLEFISH,FLAT	0	0	0	0	0	0	0	0	0	0	0	0	0
NEEDLEFISHES	0	0	0	0	0	47	0	0	0	0	0	0	0
OCTOPUS,G:OCTOPUS	19702	16732	30331	11795	8896	15653	16438	24745	19962	12755	20692	25781	19387
OILFISH	0	0	0	0	0	0	0	0	0	7	0	0	2854
OTHER FISHES	178751	148621	190269	202772	126101	55724	35769	2050	3772	1756	5333	8645	42188
OYSTER,MANGROVE CUPED	49364	46247	29358	541	99	1140	165	516	400	202	129	2889	6830
PALOMETA	0	0	0	0	0	3	25	3	9	281	5	19	207
PARROTFISH,BLUE	40	0	0	0	0	0	0	0	0	0	0	300	4
PARROTFISH,MIDNIGHT	0	0	0	0	0	0	0	0	0	200	0	0	0
PARROTFISH,RAINBOW	0	0	0	0	0	0	0	0	0	0	0	0	251
PARROTFISH,REDTAIL	0	0	0	0	0	0	0	0	0	0	0	0	0
PARROTFISH,STOPLIGHT	0	0	0	0	0	0	0	0	0	0	14	0	77
PARROTFISHES	233579	231387	221378	105546	76852	12208	4278	36848	68051	91918	160181	115723	79860
PERCH,CONGO	0	0	0	0	0	0	20	40	0	0	0	0	0
PERCH,DWARF SAND	0	0	0	0	0	19	0	24	20	16	0	24	4
PERMIT	0	0	0	0	737	377	441	720	951	293	651	604	877
PLATYFISH,SOUTHERN	0	0	0	0	0	0	0	0	0	0	0	0	0
POMPANO,AFRICAN	0	0	0	0	0	174	491	347	433	627	282	29	65
PORCUPINEFISH	0	0	0	0	0	0	156	0	0	0	0	2	15
PORCUPINEFISHES	0	0	0	0	0	0	16	20	0	19	56	27	1
PORGIES	83621	66907	22075	18071	10653	9063	9721	9125	12923	9993	10956	11013	18611
PORGY,G:CALAMUS	0	0	0	0	0	0	0	0	0	0	0	0	0
PORGY,JOLTHEAD	0	0	0	0	0	0	0	0	0	42	5	52	123
PORGY,PLUMA	0	0	0	0	0	97	0	5	0	0	0	0	0
PORGY,SAUCEREYE	0	0	0	0	0	0	0	0	0	0	0	0	0
PORGY,SHEEPSHEAD	0	0	0	0	0	0	0	0	2	0	0	0	0
PORKFISH	0	0	0	0	0	0	43	0	0	0	0	0	0
PUDDINGWIFE	0	0	0	0	0	0	55	0	0	0	0	0	5
PUFFER,BANDTAIL	7	0	0	0	0	0	0	0	0	0	0	0	83
PUFFER,SMOOTH	0	0	0	0	0	0	10	0	0	0	0	0	0

PUFFERS	0	0	0	0	0	0	0	0	0	0	0	0	0
REMORA	0	0	0	0	0	0	0	0	0	0	0	0	0
REMORAS	0	0	0	0	0	10	0	12	0	100	96	0	570
RUNNER,BLUE	0	0	0	0	685	991	3683	482	1464	1333	5432	6039	4178
RUNNER,RAINBOW	0	0	0	0	0	613	579	431	357	300	286	141	127
SAILFISH	0	0	0	0	40	0	96	78	197	187	40	154	18
SARDINE,REDEAR	0	0	0	0	220	16	0	0	128	0	0	0	365
SARDINE,SCALED	0	0	0	0	0	110	100	140	225	16	0	80	0
SARGASSUMFISH	0	0	0	0	0	0	0	908	140	457	200	0	48
SCAD,BIGEYE	0	0	0	0	21	2588	8134	8211	7933	5146	4177	2386	11272
SCAD,MACKEREL	0	0	0	0	0	0	472	0	0	0	0	31	0
SCAD,ROUND	0	0	0	0	0	29	470	443	0	0	33	155	70
SCHOOLMASTER	0	0	0	0	0	88	0	12	0	423	0	35	0
SEA BASSES	332414	318648	304294	194886	132005	61229	88106	59146	78405	69244	81964	80643	93105
SEA BREAM	0	0	0	0	0	0	11	221	36	0	197	0	8
SEA CHUBS	0	0	0	0	0	367	22	19	137	314	138	1036	51
SEAHORSE,LONGSNOUT	0	0	0	0	0	0	0	0	0	0	0	109	0
SECOND CLASS	0	0	0	135645	142422	124467	161398	146772	138116	94717	93418	143463	132724
SENNET,SOUTHERN	0	0	0	0	987	2285	1000	151	2212	427	2308	601	1664
SERGEANT MAJOR	0	0	0	0	0	0	0	0	0	0	0	16	0
SHARK,BIGEYED SIXGILL	0	0	0	0	0	1	0	0	25	0	0	0	0
SHARK,BLUE	0	0	0	0	0	0	0	0	0	0	16	0	0
SHARK,CARIBBEAN REEF	0	0	0	0	0	0	0	0	0	0	0	0	0
SHARK,COW	0	0	0	0	0	0	0	0	0	0	0	11	0
SHARK,DUSKY	0	0	0	0	0	0	0	0	0	0	0	0	0
SHARK,FLORIDA SMOOTH0	0	0	0	0	0	0	0	0	2	0	0	0	0
SHARK,HAMMER0SCALOPED	0	0	0	0	0	0	65	0	60	0	0	0	0
SHARK,LEMON	0	0	0	0	0	0	0	600	0	0	0	0	0
SHARK,NURSE	0	0	0	0	0	0	0	48	437	0	0	0	9002
SHARK,SEVEN GILL	0	0	0	0	0	0	0	0	84	0	0	0	0
SHARK,SHORTFIN MAKO	0	0	0	0	0	0	0	0	0	0	0	7	219
SHARK,SMOOTH DOGFISH	0	0	0	0	0	0	0	0	0	0	0	0	0
SHARK,TIGER	0	0	0	0	0	0	0	0	0	0	0	0	0
SHARK,WHALE	0	0	0	0	0	0	326	0	0	0	0	0	52
SHARKS,CARPET	0	0	0	0	0	0	0	0	812	0	1361	1348	0

SHARKS,HAMMERHEAD	0	0	0	0	0	0	0	30	0	0	78	0	15
SHARKS,MACKEREL	0	0	0	0	0	0	0	0	0	0	2	0	0
SHARKS,REQUIEM	0	0	0	0	13373	27623	29797	40020	46054	35577	37270	36187	74585
SHARKS,WHALE	0	0	0	0	0	0	0	9811	0	0	0	0	0
SHARKSUCKER	0	0	0	0	0	0	0	0	0	0	0	0	0
SHELLFISH,OTHER	3915	3397	3675	4873	1945	6217	3690	1606	1636	917	3157	6547	6014
SHRIMP,PENAEID UNC0	0	0	63	648	331	120	0	233	780	128	779	1857	531
SILVERSIDE,HARDHEAD	0	0	0	0	0	10	0	0	0	0	0	0	0
SILVERSIDES	0	0	0	0	0	0	0	0	0	0	0	0	0
SLEEPER,BIGMOUTH	0	0	0	0	75	100	60	0	0	0	0	0	335
SLEEPER,SPINYCHEEK	0	0	0	0	0	53	0	0	0	0	0	9	0
SLEEPERS	0	0	0	0	269	60	0	0	5	0	0	0	15
SNAIL,WEST INDIAN TOP	0	0	0	0	0	0	0	0	54	72	70	168	357
SNAPPER,BLACK	0	0	0	0	0	1447	449	596	156	219	698	32	0
SNAPPER,BLACKFIN	0	0	0	0	0	25	13	109	107	72	1986	0	89
SNAPPER,CARDINAL	0	0	0	0	0	0	204	84	0	288	1	0	0
SNAPPER,CUBERA	0	0	0	0	0	36	0	46	760	62	20	121	119
SNAPPER,DOG	0	0	0	0	0	38	5	0	160	58	357	291	48
SNAPPER,GLASSEYE	0	0	0	0	0	48	0	0	0	0	8	0	0
SNAPPER,GRAY(GREY)	0	0	0	0	0	0	32	29	37	15	118	767	1180
SNAPPER,LANE	167173	152406	119138	80672	60091	80035	109495	112789	138774	91020	90927	135416	241803
SNAPPER,MAHOGANY	0	0	0	0	0	85	1665	0	0	45	39	88	362
SNAPPER,MUTTON	65141	53086	45633	30338	20031	21536	31754	25175	42100	32484	29327	39694	79888
SNAPPER,QUEEN	0	0	0	0	4378	14759	15405	11379	17763	25260	32310	27731	34114
SNAPPER,SILK	396343	357156	371827	356898	206976	169954	245912	176783	167085	207830	243962	338664	363134
SNAPPER,SOUTHERN RED	0	0	0	0	0	0	0	0	0	0	0	0	0
SNAPPER,VERMILION	0	0	0	0	2423	1418	1427	1888	4147	5920	5561	7505	18240
SNAPPER,YELLOWTAIL	167867	134184	140451	93804	92319	77232	91028	106978	148564	149058	183079	186350	291769
SNAPPERS	65870	36215	32953	28950	23453	21425	22642	34333	50927	44700	43837	39549	48789
SNOOK,COMMON	681	0	0	0	0	44	28	0	38	0	49	0	0
SNOOK,FAT	0	0	0	0	0	18	0	0	0	0	41	0	967
SNOOK,SWORDSPINE	0	0	0	0	0	112	35	0	0	0	0	0	0
SNOOK,TARPON	0	0	0	0	0	0	0	0	0	0	0	0	0
SNOOKS	41697	25138	22625	24820	29530	29188	24397	19970	32329	28990	28179	34624	48070
SOAPFISH,GREATER	0	0	0	0	0	0	0	0	0	0	0	0	0

SOAPFISHES	0	0	0	0	0	0	0	0	0	0	0	0	0
SOLDIERFISH,BLACKBAR	0	0	0	0	0	32	0	0	0	0	0	1	0
SPADEFISH,ATLANTIC	0	0	0	0	0	0	3	0	0	0	0	0	0
SPADEFISHES	0	0	0	0	0	0	10	57	36	0	40	134	0
SPANISH FLAG	0	0	0	0	0	0	0	0	0	0	0	0	8
SQUIRRELFISH	0	0	0	0	4	4394	5235	4587	4396	1348	684	263	1032
SQUIRRELFISHES	19152	12539	15931	12487	3943	145	550	1850	4654	4713	6798	8730	13095
STINGRAY,SOUTHERN	0	0	0	0	0	52	50	67	40	22	886	1299	1066
STINGRAYS	0	0	0	0	1155	0	0	10	14	100	0	0	55
SUNFISH,REDBREAST	0	0	0	0	0	0	0	0	0	0	0	0	0
SUNFISHES	0	0	0	0	0	0	0	0	0	0	0	0	0
SURGEON,OCEAN	0	0	0	0	0	0	0	0	198	102	0	0	0
SURGEONFISHES	0	0	0	0	29	0	0	0	41	0	0	0	7
SWORDFISH	0	0	0	0	0	5854	2	9415	0	0	41	11	7
SWORDFISHES	0	0	0	0	0	6	0	0	0	0	16	0	88
SWORDTAIL,GREEN	0	0	0	0	0	0	0	0	0	0	0	0	0
TARPON	0	0	0	0	12583	3347	4807	6319	6229	3175	4732	4654	1795
TARPONS	0	0	0	0	0	1366	612	876	1036	1828	500	47	1351
TATTLER	0	0	0	0	0	28	100	0	0	0	0	0	0
THIRD CLASS	0	0	0	25995	27207	51666	60785	51358	63175	38679	69290	39754	87627
THREADFINS	0	0	0	0	61	0	0	0	0	3	0	34	8
TILAPIA,BLUE	0	0	0	0	0	0	0	2	0	0	0	0	0
TILAPIA,MOZAMBIQUE	0	0	0	0	0	0	0	0	0	0	68	0	0
TILAPIA,NILE	0	0	0	0	0	0	0	0	0	0	0	0	0
TILAPIA,REDEYE	0	0	0	0	0	82	0	0	0	0	0	0	0
TILEFISH,BLACKLINE	0	0	0	0	0	33	0	12	0	18	35	247	337
TILEFISH,SAND	0	0	0	0	44	62	31	40	81	17	43	13	0
TILEFISHES	0	0	0	0	0	0	0	0	100	0	12	0	0
TOBACCOFISH	0	0	0	0	0	0	0	0	0	362	0	25	16
TONGUEFISHES	0	0	0	0	0	0	0	0	0	0	0	0	0
TRASH FISH	0	0	0	9533	6467	5553	3343	7806	7067	5382	4386	922	2706
TRIGGERFISH,GRAY	0	0	0	0	0	0	0	67	0	0	0	0	0
TRIGGERFISH,OCEAN	0	0	0	0	0	0	0	3	0	0	0	11	0
TRIGGERFISH,QUEEN	89865	72920	46348	31034	38347	27578	33027	28507	30919	27700	38127	46605	69013
TRIGGERFISH,SARGASS	0	0	0	0	0	8	0	0	0	0	0	64	23

TRIGGERFISHES	56	0	0	0	70	3	35	0	6	16	16	20	60
TRIPLETAIL	0	0	0	0	0	0	322	33	0	13	0	168	314
TRIPLETAILS	0	0	0	0	0	0	145	0	0	0	0	55	50
TRUMPETFISH	0	0	0	0	0	0	115	0	0	0	0	0	0
TRUNKFISH	0	0	0	0	1	36914	46867	23424	16146	967	1850	853	1871
TULIP,TRUE	0	0	0	0	0	0	0	0	0	40	0	0	0
TUNA,ALBACORE	189	0	0	0	0	67	103	111	33	15	0	2694	188
TUNA,BLACKFIN	0	0	0	0	1473	1333	3442	6996	6808	7738	12042	12269	13256
TUNA,SKIPJACK	0	0	0	0	2745	10228	12949	14096	16295	7109	4072	5663	5880
TUNA,YELLOWFIN	214	0	0	0	0	10995	3715	68521	52744	26352	26734	2457	1659
TUNNY,LITTLE	0	0	0	0	1207	5049	5089	3672	8146	6102	13986	8718	16851
WAHOO	0	0	0	0	744	633	448	163	279	81	1560	1274	1041
WARMOUTH	0	0	0	0	0	4	0	8119	112	25	5	0	91
WRASSES	0	0	0	0	0	213	0	0	22	44	36	53	2
All	3916688	3154298	2855085	2535388	2081941	2013691	2290865	2179705	2458664	2043970	2495161	2708878	3687150

Table 10: Reported commercial landings in Puerto Rico by species, 1996-2007.

	CYEAR												
	1996	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*All*
	TOT_WT	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*	*TOT_WT*
	Sum	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*	*Sum*
COMMON_NAME													
AMBERJACK,GREATER	1205	802	270	151	7	8	213	9	245	31	0	0	13346
ANCHOVIES	42	86	0	95	0	0	0	0	0	0	0	0	233
ANCHOVY,STRIPED	0	0	0	0	1	0	1	0	0	0	14	0	16
ANCHOVY,WHALEBONE	0	6	0	0	0	0	0	0	0	0	0	0	206
ANGELFISH,GRAY	0	0	0	0	333	0	0	0	0	0	0	0	333
ANGELFISH,QUEEN	0	0	8	0	4	0	13	0	0	0	0	0	135
BALLYHOO	57695	55734	49407	50647	56376	60539	68045	41094	26789	14879	15874	18857	777241
BARBU	0	12	0	0	0	0	0	0	0	0	0	0	1056
BARRACUDA,GREAT	288	69	215	496	1102	846	172	0	1	0	0	0	3303
BARRACUDAS	20769	26176	33475	24078	24591	18588	23771	11086	6614	4927	4970	1944	389578
BASS,CHALK	0	0	0	0	0	0	0	0	0	0	0	0	3
BASS,PEACOCK	0	0	0	0	0	0	0	28	0	0	0	0	39
BASS,REDEYE	0	0	0	0	0	0	0	0	8	0	0	5	28
BATFISH,SHORTNOSE	50	0	150	0	0	0	30	100	0	0	0	0	440
BATFISHES	0	0	0	0	0	0	0	0	0	0	0	0	15
BEARDFISH	0	0	4001	0	0	0	0	0	0	0	0	0	4009
BEARDFISHES	0	0	0	0	0	0	0	0	0	0	0	0	66
BIGEYE	633	68	0	0	0	0	0	0	0	20	0	0	2268
BIGEYES	15	5	59	0	49	1	6	78	13	0	0	0	288
BLUEGILL	1609	101	169	789	51	467	912	168	724	340	98	369	9200
BONEFISH	692	113	23	0	75	522	752	684	1688	181	319	1349	9634
BONEFISHES	0	0	27	0	0	0	0	0	0	0	0	0	156
BOXFISHES	64981	80937	90653	83684	83521	75822	79048	58587	52322	42069	39677	31824	1240999
BROTULA,BEARDED	0	17	0	0	0	0	0	0	0	0	0	0	177
BUMPER,ATLANTIC	137	558	1355	76	49	512	299	370	186	257	248	191	21960

BUTTERFISH	0	19	31	0	70	162	0	7	385	1	9	9	809
BUTTERFISHES	0	16	0	0	0	0	2	0	5	0	0	0	102
BUTTERFLYFISH,BANDED	0	0	0	0	0	14	0	0	0	0	0	0	14
BUTTERFLYFISH,FOUREYE	36	0	0	171	602	34	6	0	0	135	8	0	1058
BUTTERFLYFISH,SPOTFIN	0	0	30	0	0	0	0	80	0	0	0	0	110
BUTTERFLYFISHES	151	95	0	0	0	45	4	2	25	0	0	0	467
CARDINALFISHES	0	0	1240	0	0	0	0	0	230	0	0	0	1864
CARPS AND MINNOWS	0	0	130	0	0	0	0	0	0	0	0	0	140
CATFISH,BERMUDA	22	0	68	0	50	0	0	10	0	0	0	0	154
CATFISH,CHANNEL	0	0	0	0	46	0	0	0	0	0	0	0	46
CATFISH,WHITE	0	0	0	0	0	27	0	3	0	0	0	0	101
CATFISHES,BULLHEAD	0	0	0	0	0	0	0	0	0	0	0	0	12
CHROMIS,BROWN	0	0	0	0	12	15	0	0	120	3	139	0	289
CHUB,BERMUDA	46	18	32	52	0	170	34	8	2	0	10	0	1112
CHUB,YELLOW	144	2	0	0	0	0	21	0	0	0	0	0	1560
CICHLIDS	0	239	0	17	0	0	5	0	0	0	0	0	283
CLAMS	120	82	0	7	0	49	5	116	115	0	0	0	3366
COBIA	68	4	0	0	0	38	0	2	22	0	0	0	171
COBIAS	0	28	35	43	0	0	243	0	20	0	0	0	492
CONCH,QUEEN	239817	238619	260905	214044	280658	244806	235608	188021	216040	175957	153018	144156	5126048
CONEY	10960	12101	13868	10253	11536	15648	19038	11002	7858	3903	4940	2710	181851
CONGER EELS	0	0	31	0	0	0	0	0	0	0	0	0	35
CONGER,MANYTOOTH	245	7002	36	0	0	22	0	15	0	0	0	0	7384
CORNETFISH,BLUESPOTTE	83	0	0	5	0	0	0	0	0	0	0	0	129
CORNETFISHES	0	0	0	0	9	0	0	0	0	0	0	0	9
COTTONWICK	0	422	0	0	0	0	0	0	0	0	0	0	464
COWFISH,HONEYCOMB	0	0	0	0	0	0	5	0	0	0	0	0	15
CRAB,BLUE LAND	12878	10065	4604	2600	2074	6305	6459	1617	1400	4268	4988	4451	96766
CRAB,FLAME BOX	0	0	0	250	0	0	140	0	0	0	0	0	390
CRAB,MARINE	161	582	2477	2513	2211	3325	3683	2223	2282	1874	1916	1378	25666
CRAB,SPECKLED SWIMMIN	1719	269	416	226	878	50	333	127	0	216	87	0	6830
CREOLE FISH	0	0	0	0	43	0	256	0	0	0	0	0	299
CROAKER,REEF	1851	2332	2001	4456	1708	2635	3504	3598	2246	73	114	27	53301
CUSK-EELS	0	0	0	0	0	0	11	0	0	0	0	0	284

CUTLASSFISH,ATLANTIC	774	182	308	559	207	31	340	0	717	661	50	0	5679
CUTLASSFISHES	0	58	139	38	74	0	715	146	806	448	108	5	3834
DAMSELFISHES	0	0	0	0	0	0	0	0	0	0	0	0	10
DOLPHIN,POMPANO	60	19	0	0	0	120	0	10	0	0	0	0	396
DOLPHINFISH	667	7865	96	260	9052	45157	45798	54633	69905	33385	44245	51750	556654
DOLPHINS	148490	158417	136936	129700	128628	61071	54823	10204	6422	5002	1714	903	1542076
DRUM,SAND	0	0	0	0	0	0	0	0	0	0	0	0	27
DRUM,SPOTTED	0	0	0	0	0	0	0	0	0	0	0	0	4
DRUMMER,GROUND	0	0	0	0	0	0	0	0	0	0	0	0	320
DRUMMER,MONGOLAR	0	0	0	37	0	910	12	0	0	0	0	0	1335
DRUMMER,WHITEMOUTH	120	79	14	74	17	532	578	582	223	371	209	97	9182
DRUMS	0	0	35	149	8	0	15	9	0	0	0	0	1774
DURGON,BLACK	0	24	0	0	731	0	5	0	0	0	0	0	1012
EAGLE RAY,SPOTTED	3105	198	2034	411	8010	1492	94	0	0	0	0	0	29612
EAGLE RAYS	0	0	0	0	480	172	94	0	0	0	0	122	2504
EEL,AMERICAN	243	0	50	0	0	0	0	0	0	0	0	0	323
EELS,FRESHWATER	59	76	0	0	17	0	0	0	0	0	0	0	170
FILEFISH,ORANGE	0	1002	0	0	0	0	0	0	0	0	0	0	1002
FILEFISH,ORANGESPOT	464	193	65	15	0	30	165	11	30	8	0	0	2978
FIRST CLASS	146975	141472	137855	103248	85585	95703	75302	62918	21956	9216	6073	5290	2576041
FLAMEFISH	0	0	9	370	255	0	0	0	3	0	0	0	1618
FLYING GURNARD	25	1950	34	0	7	32	11	4	0	0	0	0	2132
FLYING GURNARDS	128	335	131	0	6	0	0	0	0	0	0	0	849
FLYINGFISH,ATLANTIC	0	4	0	0	0	0	0	0	0	0	0	0	146
FLYINGFISHES	650	0	0	0	81	0	0	0	0	0	0	0	1567
FROGFISHES	0	0	0	0	0	0	0	0	6	654	619	0	1307
GOATFISH,SPOTTED	18822	14101	11529	22337	16061	15907	13351	8669	6801	4477	3911	2362	212755
GOATFISH,YELLOW	2231	4694	3478	3866	4262	6153	5515	4084	1432	1039	788	713	49572
GOATFISHES	0	6	0	0	101	75	140	30	32	27	27	0	377811
GOBIES	0	0	4	11	0	80	0	0	0	0	0	0	95
GOBY,FRILLFIN	0	0	0	0	0	0	0	0	0	0	141	0	141
GOBY,RIVER	115	0	15	0	0	0	0	0	0	0	0	0	153
GOBY,SIRAJO	0	0	40	30	0	298	328	0	0	40	0	0	6489
GOBY,VIOLET	0	0	11	0	0	0	0	0	29	0	0	0	52

GRAYSBY	6	0	0	25	0	0	30	10	0	0	0	0	73
GROUPER,BLACK	17	0	0	0	0	0	0	0	13	0	0	0	254
GROUPER,MARBLED	0	0	0	0	0	50	350	0	0	0	0	0	1300
GROUPER,MISTY	5462	4347	5557	6717	5246	6183	5679	5860	4786	6308	5581	6486	93602
GROUPER,NASSAU	12594	15457	19070	14966	12940	17572	18698	10217	4229	1850	1673	1137	168676
GROUPER,RED	0	18	0	7	0	28	0	6	27	113	0	0	858
GROUPER,TIGER	2745	0	0	0	0	0	0	0	0	0	0	0	2896
GROUPER,YELLOWFIN	1615	2088	1791	3348	2298	3641	6916	4893	2188	684	975	1017	39174
GRUNT,BARRED	0	0	0	32	150	0	14	30	0	10	14	9	347
GRUNT,BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0
GRUNT,BLUE STRIPED	35	101	28	109	12	5	53	100	0	0	0	0	1258
GRUNT,BURRO	0	33	0	0	0	16	8	0	0	0	0	0	331
GRUNT,CAESAR	0	0	0	0	0	200	0	0	0	0	0	0	200
GRUNT,FRENCH	0	7	0	0	0	0	0	0	0	0	0	0	225
GRUNT,SMALLMOUTH	0	0	0	0	10	12	0	0	5	0	0	0	173
GRUNT,SPANISH	12	17	10	0	0	0	0	0	0	0	0	3	97
GRUNT,TOMTATE	0	0	0	0	0	0	0	0	0	0	0	0	149
GRUNT,WHITE	170124	163995	112651	117060	114981	152370	147099	107566	89313	51438	49244	35081	3649231
GRUNTS	737	190	234	0	57	88	106	19	11	4	11	0	12584
GUANCHANCHE	783	223	84	217	0	29	565	157	682	0	0	108	5729
GUPPY	0	70	0	26	0	0	3	0	0	0	0	0	99
HALFBEAK,SILVERSTRIPE	17	2301	42	0	0	0	0	343	0	0	0	0	83123
HAMLET,BLACK	9	0	0	0	0	0	0	0	0	0	0	0	9
HAMLET,MUTTON	0	0	0	0	0	2	0	0	0	0	0	0	87
HARVESTFISH,SOUTHERN	0	0	35	0	0	0	0	1	0	6	0	0	5654
HERRING,ATL THREAD	1520	120	240	100	0	173	101	17	1	15	0	0	17573
HERRING,DWARF	24	81	19	0	0	0	0	0	0	0	0	0	124
HERRING,SPINY-TOOTH	0	0	0	0	0	0	0	0	0	0	0	0	41
HERRINGS	25810	31828	23213	27050	24261	24650	27931	16605	14263	11180	5814	6182	466318
HIND,RED	53370	60222	54973	65913	60820	68191	81135	48045	43084	27715	21351	17118	928715
HIND,ROCK	18	0	113	0	113	0	0	0	3	0	0	0	1397
HOGFISH	60529	68528	49437	46301	58276	67658	68401	46776	39876	24845	27799	30647	1081104
HOGFISH,SPANISH	671	144	360	218	31	11	285	42	0	0	0	0	203052
HOUNDFISH	35	107	0	20	0	6	73	824	9	837	810	828	7108

JACK,ALMACO	0	0	0	17	0	733	471	509	2466	1930	1706	1514	9380
JACK,BAR	9492	24514	27136	40894	44664	49826	63136	37085	33803	21616	16687	14994	420156
JACK,BLACK	0	0	0	0	0	0	70	21	0	0	18	0	341
JACK,CREVALLE	0	0	0	110	0	0	0	0	0	0	0	0	131
JACK,HORSE EYE	41	1877	6120	5106	7568	6530	4822	4188	1900	1651	996	917	43775
JACK,YELLOW	918	425	3313	2021	2459	3726	3215	827	706	513	250	784	24984
JACKKNIFE-FISH	0	0	0	24	7	54	35	4	0	0	0	0	254
JACKS	48453	55364	35731	29968	29693	35831	30116	22535	13464	7522	6551	4793	758616
JENNY,SILVER	113	9	50	0	0	10	0	0	0	11	0	11	504
JEWFISH	40	85	142	0	27	50	40	476	1149	0	0	0	16460
LADYFISH	102	240	0	108	0	0	67	0	3	0	0	0	5100
LEATHERJACK	0	32	88	0	0	0	48	0	2	0	0	0	249
LIZA	11	105	114	21	154	154	112	18	3	0	0	0	4521
LIZARDFISH,SAND DIVER	0	0	0	0	0	0	0	0	0	0	0	0	103
LIZARDFISHES	0	40	6	0	0	7	0	0	0	0	0	0	324
LOBSTER,CARIB0 SPINY	280642	283293	298431	326766	256612	280641	300440	241910	212226	159494	168233	160123	5573122
LOBSTER,SPANISH SLIP0	5	0	0	0	116	372	168	380	662	438	1278	1096	4515
LOBSTER,SPOTTED SPINY	0	0	3	0	0	0	0	0	0	0	0	0	1420
MACKEREL,BULLET	508	0	0	0	19	148	62	0	0	0	0	0	766
MACKEREL,CERO	63264	98006	71401	63912	53558	82858	53325	35624	19746	29677	23883	15332	721648
MACKEREL,KING	103146	105535	108387	127525	123567	99646	117868	80897	52629	46211	35594	31039	2514048
MACKEREL,SNAKE	11	0	0	0	0	0	0	0	0	0	920	0	1130
MACKERELS & TUNAS	100187	95643	59223	22396	21888	16272	11055	8700	4248	5276	3111	4555	1339397
MAN-OF-WAR FISH	0	0	0	36	0	0	0	0	0	0	0	0	83
MANTA,ATLANTIC	604	44	263	0	12	251	466	178	110	14	136	168	4610
MANTAS	33	0	12604	1509	10	33	110	79	0	254	401	0	16840
MARGATE	4043	3610	2674	990	863	437	27	0	18	32	0	363	24338
MARGATE,BLACK	3	0	6	32	10	5	11	29	16	0	0	0	3382
MARLIN,BLUE	25	32	5	1331	12	0	65	0	0	0	0	0	44221
MARLIN,WHITE	0	0	0	19	0	0	0	0	0	0	0	0	136
MARLINS	77	192	64	0	0	430	40	0	0	5	0	0	50962
MINNOW,FATHEAD	263	0	0	0	0	0	0	0	0	0	0	0	263
MOJARRA,RHOMBOID	0	0	2	0	19	2	37	0	0	3	0	0	329
MOJARRA,STRIPED	6	5	103	0	60	57	59	900	12	3	0	0	2008

MOJARRA,YELLOWFIN	50	20	87	0	0	0	0	0	0	0	0	0	2763
MOJARRAS	25300	23666	19140	22071	18014	18858	20922	16511	6360	3451	1957	2436	389149
MOONFISH,ATLANTIC	771	2065	953	1205	304	740	83	414	406	341	151	198	44770
MORAY,GREEN	0	0	32	0	0	0	7	0	0	0	0	0	65
MORAY,VIPER	0	0	0	0	0	0	0	0	0	0	0	0	10
MORAY,WHITE SPOTTED	0	0	167	0	0	0	0	0	0	0	0	0	228
MORAYS	0	0	0	2	0	0	0	0	0	0	0	0	2
MOSQUITOFISH	0	0	0	0	9	0	0	0	0	0	0	0	9
MULLET,HOG NOSE	0	210	41	14	0	0	0	0	0	0	0	0	360
MULLET,MOUNTAIN	200	0	0	59	53	0	0	0	28	0	0	0	731
MULLET,WHITE	53100	55499	53134	61694	53197	59880	57024	42694	26892	14731	12601	8285	938506
MULLETS	7	23	162	46	20	154	6	135	56	17	0	0	1217
NEEDLEFISH,FLAT	24	0	0	0	0	0	0	0	12	11	0	0	47
NEEDLEFISHES	0	0	0	0	16	0	2	0	0	0	0	0	65
OCTOPUS,G:OCTOPUS	37091	38680	39482	43600	48597	33414	28559	26476	20172	9377	19576	25199	613091
OILFISH	0	0	0	0	0	0	0	0	0	0	0	0	2861
OTHER FISHES	46006	60992	82571	52486	48985	38675	50924	3324	3928	3915	3733	3520	1400808
OYSTER,MANGROVE CUPED	8209	607	1522	1289	2010	1342	372	764	223	243	169	45	154674
PALOMETA	0	0	0	7	0	0	151	0	0	0	0	0	710
PARROTFISH,BLUE	0	5	15	10	0	72	0	12	0	0	0	0	458
PARROTFISH,MIDNIGHT	5	0	0	19	0	0	0	4	0	0	0	0	228
PARROTFISH,RAINBOW	3	0	0	11	0	0	120	407	575	371	146	0	1883
PARROTFISH,REDTAIL	0	0	0	116	0	0	0	0	0	0	0	0	116
PARROTFISH,STOPLIGHT	83	44	61	30	12	9	7	0	0	0	0	0	337
PARROTFISHES	102779	110929	97480	80533	73103	96680	107417	69163	51104	29012	31430	33658	2321094
PERCH,CONGO	0	0	0	0	0	0	8	4	0	0	0	0	72
PERCH,DWARF SAND	0	23	0	0	7	0	0	0	0	0	0	0	137
PERMIT	515	545	1161	818	772	621	1515	456	518	289	111	337	13308
PLATYFISH,SOUTHERN	43	0	0	0	0	0	0	0	0	0	0	0	43
POMPANO,AFRICAN	0	519	27	8	27	11	0	0	28	0	0	0	3066
PORCUPINEFISH	0	0	0	2	0	8	17	0	0	0	26	0	226
PORCUPINEFISHES	0	0	1001	0	5	0	86	0	0	0	18	0	1249
PORGIES	30706	28424	26545	34576	28823	35798	35539	20880	17901	11416	8935	9139	581412
PORGY,G:CALAMUS	0	0	0	0	0	9	0	0	0	0	0	0	9

PORGY,JOLTHEAD	10	0	0	0	10	619	2271	0	0	0	0	0	3131
PORGY,PLUMA	16	0	0	0	30	31	26	6	0	7	28	0	246
PORGY,SAUCEREYE	0	0	0	0	0	7	0	0	0	0	0	0	7
PORGY,SHEEPSHEAD	3	0	0	0	0	0	0	14	0	0	0	0	19
PORKFISH	0	0	0	0	0	0	0	0	8	0	0	0	51
PUDDINGWIFE	0	0	0	0	19	104	32	0	0	9	0	0	224
PUFFER,BANDTAIL	14	0	0	0	0	0	0	0	0	0	0	0	104
PUFFER,SMOOTH	0	0	0	0	0	0	0	0	0	0	0	0	10
PUFFERS	0	0	321	0	0	0	0	0	0	0	0	0	321
REMORA	0	3005	0	0	0	0	0	0	0	0	0	0	3005
REMORAS	0	0	0	0	2	0	0	0	0	0	0	0	790
RUNNER,BLUE	468	86	19	1	0	0	74	0	340	130	0	0	25402
RUNNER,RAINBOW	1942	174	172	39	46	119	101	257	0	55	226	0	5963
SAILFISH	44	180	0	0	0	0	0	0	0	0	0	0	1034
SARDINE,REDEAR	400	148	193	243	141	122	10	298	20	15	0	5	2324
SARDINE,SCALED	129	146	0	132	773	5	10	26	0	0	0	0	1892
SARGASSUMFISH	6	0	0	0	0	0	0	0	0	0	0	0	1759
SCAD,BIGEYE	4183	4972	3559	8506	350	894	933	400	123	17	483	37	74323
SCAD,MACKEREL	0	2655	12530	3	0	0	0	0	0	0	0	0	15692
SCAD,ROUND	101	675	9321	0	57	0	14	0	26	0	0	0	11393
SCHOOLMASTER	84	15	107	146	10	29	0	171	0	0	0	20	1138
SEA BASSES	86597	72582	43115	47832	40455	53124	46826	31212	24374	14575	13148	14780	2382710
SEA BREAM	0	0	6	0	0	0	0	0	0	34	0	0	512
SEA CHUBS	0	66	216	784	121	122	415	0	28	5	51	0	3891
SEAHORSE,LONGSNOUT	0	0	0	0	0	0	5	0	0	0	0	0	114
SECOND CLASS	147670	101845	120049	106771	58462	32688	46974	43090	12026	4208	3905	2034	1992863
SENNET,SOUTHERN	879	1288	10	147	0	108	80	33	65	0	83	16	14344
SERGEANT MAJOR	80	159	0	0	0	0	0	0	0	0	0	0	255
SHARK,BIGEYED SIXGILL	2	41	0	80	1150	0	25	0	0	0	0	0	1324
SHARK,BLUE	0	0	0	0	9	7	10	0	0	15	0	0	56
SHARK,CARIBBEAN REEF	0	0	150	0	0	2	47	0	0	0	901	0	1100
SHARK,COW	25	113	0	2002	0	0	0	0	0	468	256	0	2875
SHARK,DUSKY	0	0	0	0	0	0	8	0	0	0	0	0	8
SHARK,FLORIDA SMOOTH0	0	0	0	5	0	0	0	0	0	0	0	0	7

SHARK,HAMMER0SCALOPED	0	0	0	0	0	0	0	0	0	0	0	0	125
SHARK,LEMON	34	0	0	0	0	0	10	0	0	0	0	0	644
SHARK,NURSE	80	0	70	20	281	0	15	0	0	0	0	0	9953
SHARK,SEVEN GILL	0	0	0	137	0	0	0	0	0	0	0	0	221
SHARK,SHORTFIN MAKO	0	0	0	0	0	9	14	0	0	0	12	0	261
SHARK,SMOOTH DOGFISH	1005	0	0	0	0	0	0	0	0	0	0	0	1005
SHARK,TIGER	15	68	0	0	0	400	0	10	0	0	0	0	493
SHARK,WHALE	9002	5001	25	51	0	0	0	0	504	0	0	0	14962
SHARKS,CARPET	0	0	0	0	0	0	0	0	0	0	0	0	3521
SHARKS,HAMMERHEAD	0	0	0	0	0	0	0	0	0	0	0	0	123
SHARKS,MACKEREL	15	6004	0	0	0	928	0	0	11	0	0	0	6960
SHARKS,REQUIEM	59320	55110	47164	44526	41523	42004	38402	25199	15074	14623	22858	21230	767517
SHARKS,WHALE	0	0	0	0	0	0	0	0	0	0	0	0	9811
SHARKSUCKER	24	24	293	505	2916	39	24	38	0	0	0	0	3863
SHELLFISH,OTHER	5510	4808	14236	9581	8937	10230	5477	3594	1943	5503	3218	2155	122779
SHRIMP,PENAEID UNC0	642	1739	284	683	785	447	814	19	53	16	768	4	11722
SILVERSIDE,HARDHEAD	0	0	0	17	0	0	0	0	0	0	0	0	27
SILVERSIDES	0	20	0	0	0	0	0	0	0	0	0	0	20
SLEEPER,BIGMOUTH	0	0	0	0	0	0	0	0	0	0	0	0	570
SLEEPER,SPINYCHEEK	0	0	0	0	0	0	15	67	0	0	0	0	144
SLEEPERS	0	29	0	0	0	8	0	0	0	0	0	0	386
SNAIL,WEST INDIAN TOP	284	138	532	565	253	1270	1096	906	724	1370	49	90	7998
SNAPPER,BLACK	14	0	207	672	403	20	505	416	10	18	126	0	5987
SNAPPER,BLACKFIN	18	822	3688	4341	10650	9506	9433	9943	3393	2646	3406	873	61118
SNAPPER,CARDINAL	0	542	2302	3644	4952	7165	6197	7233	6278	10066	3887	4760	57603
SNAPPER,CUBERA	59	9	0	0	0	0	0	0	0	72	0	0	1304
SNAPPER,DOG	168	10	0	78	75	1537	120	14	0	0	0	286	3242
SNAPPER,GLASSEYE	0	0	0	10	0	35	0	0	0	0	0	0	101
SNAPPER,GRAY(GREY)	52	0	3	10	85	53	23	1064	21	21	0	0	3509
SNAPPER,LANE	265551	270196	220979	196455	204234	183246	184591	123150	99189	83602	87099	81083	3579114
SNAPPER,MAHOGANY	207	978	274	43	41	7	0	7	0	0	0	0	3839
SNAPPER,MUTTON	76417	76573	77393	96321	84201	88536	91841	79979	47057	32170	24301	27356	1318330
SNAPPER,QUEEN	36671	38770	46070	66682	82825	102137	110058	126999	79544	127879	101748	111125	1213603
SNAPPER,SILK	311207	285637	209255	224684	187530	266547	197985	169825	118866	100650	81797	68273	5824780

SNAPPER,SOUTHERN RED	0	3	0	0	0	0	0	0	0	0	0	0	3
SNAPPER,VERMILION	10184	14016	16580	17226	22374	44795	23136	15835	9548	5364	3096	1535	232215
SNAPPER,YELLOWTAIL	273702	272999	252015	279101	360518	317035	291024	176567	150626	108980	91609	94669	4531526
SNAPPERS	50722	66928	55953	62079	48832	56558	56695	34328	29528	24382	18704	18974	1017324
SNOOK,COMMON	20	10	17	48	394	11697	18179	24833	13585	7815	6796	8935	93167
SNOOK,FAT	12	15	78	0	0	21	9	0	0	0	250	0	1411
SNOOK,SWORDSPINE	0	0	5	90	0	109	0	5	0	0	0	0	356
SNOOK,TARPON	0	5002	0	0	0	0	0	0	0	0	0	0	5002
SNOOKS	49157	52802	44881	49659	39767	34926	26964	12164	5053	3089	2908	1562	712488
SOAPFISH,GREATER	0	130	0	0	0	66	0	0	0	0	0	0	196
SOAPFISHES	0	0	67	0	65	0	0	0	0	0	0	0	132
SOLDIERFISH,BLACKBAR	0	0	0	0	0	0	0	0	0	0	0	0	33
SPADEFISH,ATLANTIC	206	0	0	0	0	0	93	0	0	0	0	44	346
SPADEFISHES	8	56	43	0	7	87	9016	15	3	0	0	0	9511
SPANISH FLAG	25	0	0	14	0	43	0	0	0	0	0	0	90
SQUIRRELFISH	311	184	234	112	127	49	5	32	0	0	2	0	22997
SQUIRRELFISHES	15340	21406	18750	14574	15685	17493	15983	10666	7112	5447	4409	3719	255168
STINGRAY,SOUTHERN	1019	472	1260	767	207	558	252	80	131	0	0	51	8278
STINGRAYS	408	77	0	462	1002	1012	0	0	20	0	0	48	4362
SUNFISH,REDBREAST	0	0	18	0	0	8	58	0	0	0	0	0	84
SUNFISHES	123	112	0	0	0	0	0	0	0	0	0	0	235
SURGEON,OCEAN	8	0	0	9	0	0	6	20	0	0	0	0	343
SURGEONFISHES	217	0	4	4	0	20	0	0	0	0	0	0	322
SWORDFISH	114	28	0	39	63	0	135	23	0	0	0	0	15732
SWORDFISHES	26	0	318	0	665	54	486	54	44	0	0	0	1756
SWORDTAIL,GREEN	0	0	19	0	0	0	0	0	0	0	0	0	19
TARPON	105	2433	1316	2374	354	2186	4420	2436	752	28	32	13	64089
TARPONS	383	55	1027	0	0	7	70	0	2	0	0	0	9159
TATTLER	0	0	0	19	0	0	0	0	0	0	0	0	147
THIRD CLASS	71405	121711	65703	33090	49526	46584	29917	9953	8249	1117	343	1093	954224
THREADFINS	0	0	0	0	0	34	69	3	0	0	8	0	220
TILAPIA,BLUE	0	0	0	0	0	0	0	0	0	0	0	0	2
TILAPIA,MOZAMBIQUE	0	0	0	0	0	0	0	0	0	0	0	0	68
TILAPIA,NILE	0	0	0	0	0	9	0	0	0	0	0	0	9

TILAPIA,REDEYE	0	46	0	0	0	0	5	0	0	0	0	0	133
TILEFISH,BLACKLINE	269	9	156	995	209	105	26	40	14	0	35	0	2540
TILEFISH,SAND	52	463	464	12	18	0	18	4	0	0	0	0	1360
TILEFISHES	0	131	0	0	10	0	0	0	0	173	0	0	426
TOBACCOFISH	0	0	0	9	0	45	28	9	0	0	0	0	494
TONGUEFISHES	0	0	14	246	0	0	0	0	0	0	0	0	260
TRASH FISH	2560	2016	86	475	568	513	791	114	0	72	0	196	60555
TRIGGERFISH,GRAY	0	0	0	0	0	0	0	0	0	0	0	0	67
TRIGGERFISH,OCEAN	34	82	0	293	5	0	0	0	0	0	0	0	427
TRIGGERFISH,QUEEN	63605	73157	64342	49452	40665	59673	53493	41921	43092	30466	27232	21116	1148205
TRIGGERFISH,SARGASS	14	6	15	92	0	18	0	16	0	0	0	0	256
TRIGGERFISHES	55	22	5	28	102	53	53	29	17	0	0	0	645
TRIPLETAIL	18	22	159	47	11	0	0	119	5	0	0	120	1351
TRIPLETAILS	0	207	36	118	31	6	54	0	0	0	0	0	702
TRUMPETFISH	0	28	0	0	0	0	0	0	0	0	0	0	143
TRUNKFISH	2438	898	224	175	0	503	1	0	4	0	0	0	133135
TULIP,TRUE	0	0	0	0	0	0	0	0	0	0	0	0	40
TUNA,ALBACORE	98	8590	24377	24208	16000	9071	9617	6120	4727	2259	899	642	110005
TUNA,BLACKFIN	14309	7001	450	982	3274	23982	27106	34196	29003	20000	18942	21995	266595
TUNA,SKIPJACK	12557	19313	51922	40317	32099	36466	38442	30655	22396	22113	21877	30396	437589
TUNA,YELLOWFIN	603	45516	41653	48915	46673	33042	19303	23467	15554	20966	18531	19970	527581
TUNNY,LITTLE	8792	39718	21069	18309	17172	20139	14820	11704	13452	9553	8037	6073	257656
WAHOO	971	5290	1154	6697	2160	5022	1094	2012	4536	2724	3725	3248	44852
WARMOUTH	5	0	68	0	0	9	4	0	0	0	0	0	8441
WRASSES	38	23	37	0	0	12	145	9139	0	22	0	0	9785
All	3581209	3804030	3452859	3325991	3244005	3387748	3271960	2387974	1864679	1440024	1311981	1254156	60675E7

Table 11: Reported and calculated total commercial landings and 95 %, 90%, and 85 % Confidence intervals for all species groups combined, 1983-2007.

YEAR	Reported Landings	Reported Landings	Expansion Method	Expanded Landings Adjusted for Mis Reporting and Non Reporting	L95 CI + L95 Non CI	U95 CI + U95 CI Non	L90 CI + L90 Non CI	U90 CI + U90 CI Non	L 80 CI + L 80 Non CI	U 80 CI + U 80 CI Non
1971	4,900,000	4,900,000	FBCF + Miss	8,687,943	6,567,196	12,245,277	6,796,729	11,587,571	7,108,952	10,859,873
1972	4,700,000	4,700,000	FBCF + Miss	8,333,333	6,323,596	11,711,591	6,544,519	11,081,490	6,844,873	10,384,367
1973	4,500,000	4,500,000	FBCF + Miss	7,978,723	6,054,456	11,213,297	6,265,976	10,610,006	6,553,547	9,942,547
1974	4,600,000	4,600,000	FBCF + Miss	8,156,028	6,126,274	11,549,397	6,340,548	10,930,753	6,632,267	10,246,218
1975	5,200,000	5,200,000	FBCF + Miss	9,219,858	6,953,765	13,016,470	7,196,870	12,318,016	7,527,655	11,545,210
1976	6,090,000	6,090,000	FBCF + Miss	10,797,872	8,200,264	15,166,229	8,486,725	14,349,980	8,876,140	13,446,919
1977	6,300,000	6,300,000	FBCF + Miss	11,170,213	8,457,453	15,724,646	8,752,998	14,879,456	9,154,926	13,944,341
1978	7,100,000	7,100,000	FBCF + Miss	11,107,635	8,336,768	15,738,126	8,628,383	14,895,397	9,025,438	13,962,899
1979	7,400,000	7,400,000	FBCF + Miss	10,496,454	7,808,968	14,967,884	8,082,393	14,169,381	8,455,130	13,285,722
1980	6,500,000	6,500,000	FBCF + Miss	9,219,858	6,798,892	13,231,071	7,037,191	12,527,811	7,362,437	11,749,466
1981	5,900,000	5,900,000	FBCF + Miss	8,368,794	6,055,542	12,170,144	6,268,251	11,528,208	6,559,335	10,817,571
1982	5,350,000	5,350,000	FBCF + Miss	7,588,652	5,368,214	11,205,836	5,557,283	10,619,930	5,816,839	9,971,146
1983	3,929,608	3,929,608	FBCF + Miss	6,853,171	5,028,464	9,869,630	5,204,811	9,346,111	5,445,668	8,766,663
1984	3,155,385	3,155,385	FBCF + Miss	5,689,479	4,284,272	8,182,527	4,422,744	7,739,973	4,613,572	7,249,785
1985	2,839,361	2,839,361	FBCF + Miss	5,393,923	4,089,244	7,645,633	4,227,316	7,232,853	4,416,042	6,775,951
1986	2,666,925	2,666,925	FBCF + Miss	3,782,872	2,848,819	5,411,526	2,943,178	5,119,567	3,072,712	4,796,294
1987	2,149,255	2,149,255	FBCF + Miss	3,048,589	2,178,105	4,514,427	2,251,220	4,276,211	2,352,271	4,012,355
1988	2,020,000	2,020,000	FBCF + Miss	3,837,386	2,035,709	6,494,765	2,119,293	6,186,454	2,236,693	5,844,530
1989	2,305,000	2,305,000	FBCF + Miss	4,808,093	2,829,074	7,822,630	2,936,748	7,439,279	3,087,243	7,014,258
1990	2,186,435	2,186,435	FBCF + Miss	4,560,774	3,038,399	7,001,226	3,145,685	6,642,753	3,294,377	6,245,532
1991	2,463,018	2,463,018	FBCF + Miss	5,137,710	3,521,206	7,698,146	3,649,342	7,301,604	3,825,222	6,862,514
1992	2,044,207	2,044,207	FBCF + Miss	3,624,480	2,317,353	5,651,107	2,403,430	5,367,042	2,522,537	5,052,308
1993	2,509,441	2,509,441	FBCF + Miss	4,449,363	2,728,349	7,090,105	2,831,084	6,738,458	2,973,915	6,348,713
1994	2,714,402	2,714,402	FBCF + Miss	4,511,971	2,626,305	7,329,057	2,730,587	6,972,563	2,875,553	6,577,459

Table 11: Continued.

YEAR	***Reported Landings***	***Reported Landings***	***Expansion Method***	***Expanded Landings Adjusted for Mis Reporting and Non Reporting***	***L95 CI + L95 Non CI***	***U95 CI + U95 CI Non***	***L90 CI + L90 Non CI***	***U90 CI + U90 CI Non***	***L 80 CI + L 80 Non CI***	***U 80 CI + U 80 CI Non***
1995	3,708,999	3,708,999	FBCF + Miss	5,557,385	2,656,262	9,688,533	2,778,048	9,242,796	2,948,935	8,748,466
1996	3,617,039	3,617,039	FBCF + Miss	5,419,597	3,116,824	8,768,212	3,247,967	8,345,890	3,428,858	7,878,070
1997	3,895,980	3,895,980	FBCF + Miss	5,313,666	2,801,345	8,934,007	2,923,275	8,513,289	3,092,973	8,046,957
1998	3,501,895	3,501,895	FBCF + Miss	4,776,180	2,683,015	7,849,288	2,793,893	7,472,422	2,947,913	7,054,734
1999	3,337,486	3,337,486	FBCF + Miss	4,551,945	2,142,565	7,973,926	2,241,906	7,608,409	2,381,398	7,203,046
2000	3,362,722	3,362,722	FBCF + Miss	6,276,077	3,792,428	9,989,587	3,942,780	9,499,008	4,150,520	8,955,519
2001	3,389,010	3,389,010	FBCF + Miss	5,301,956	2,697,051	9,072,575	2,813,878	8,647,950	2,977,622	8,177,066
2002	3,272,812	3,272,812	FBCF + Miss	4,048,506	3,197,979	5,515,356	2,048,496	6,697,741	2,174,171	6,338,831
2003	2,388,761	2,388,761	WBCF + Total Non + Mis	3,364,452	2,777,629	4,343,202	2,878,025	4,118,553	2,949,088	3,916,002
2004	1,864,680	1,864,680	WBCF + Total Non + Mis	2,626,310	2,168,233	3,390,327	2,246,602	3,214,966	2,302,074	3,056,852
2005	1,569,035	1,569,035	WBCF + Total Non + Mis	2,209,908	1,824,459	2,852,791	1,890,404	2,705,233	1,937,080	2,572,189
2006	1,338,924	1,338,924	WBCF + Total Non + Mis	1,761,742	1,716,569	2,848,774	1,409,394	2,390,936	1,471,345	2,231,540
2007	1,242,002	1,242,002	WBCF + Total Non + Mis	1,971,432	1,254,547	2,388,465	1,634,213	2,484,004	1,701,373	2,343,400

Notes:

1. Mis= mis-reporting rate calculated from DNER port sampler survey observations. 1971-2002 mis rate calculated from the pooled 2006 and 2007 survey data.
2. Total Non + Mis: Stratified year, coast estimates availble for 2006, 2007 DNER port sampler survey observations
2. Variability around non-reporting rate calculated from variance between fishers annual landings, 1983-2002. Estimates for 1971-1982 set equa to 1983.

Table 12: Reported landings and calculated total landings (expanded) for St. Thomas/St. John for all species combined in pounds.

YEAR	reported landings	expanded landings
1990-91	540,097	583,139
1991-92	607,979	699,258
1992-93	807,284	925,287
1993-94	743,122	743,122
1994-95	767,716	804,499
1995-96	561,071	582,417
1996-97	693,752	709,296
1997-98	702,186	749,646
1998-99	591,611	723,424
1999-00	603,573	618,225
2000-01	676,946	691,497
2001-02	797,745	801,067
2002-03	834,806	845,680
2003-04	781,444	832,968
2004-05	785,788	796,687
2005-06	736,534	736,742
2006-07	766,634	800,359

Table 13: Reported landings and calculated total landings (expanded) for St. Croix for all species combined in pounds.

YEAR	reported landings	expanded landings
1990-91	566,867	702,559
1991-92	527,575	570,507
1992-93	549,636	580,665
1993-94	732,239	771,728
1994-95	540,241	573,980
1995-96	413,001	439,372
1996-97	580,075	604,225
1997-98	749,889	768,321
1998-99	610,902	654,605
1999-00	724,153	747,654
2000-01	857,944	871,283
2001-02	1,160,981	1,183,092
2002-03	1,062,545	1,079,731
2003-04	995,635	1,114,414
2004-05	1,021,192	1,119,161
2005-06	1,321,296	1,533,453
2006-07	884,701	1,090,809

Table 14: Sum of Catch and Weight Landed in St. Croix by Species and disposition of catch

	DISP							
	BYCATCH				RETAINED			
	NUMBER		NEW_Weight		NUMBER		NEW_Weight	
	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum
COMMON_NAME								
AMBERJACK,GREATER	3.0	0.2	8.2	0.8				
ANGELFISH,FRENCH					9.0	0.1	19.0	0.3
ANGELFISH,GRAY					6.0	0.1	11.0	0.2
ANGELFISH,QUEEN	2.0	0.1	0.3	0.0	17.0	0.2	16.7	0.3
BALLYHOO					787.0	10.9	149.1	2.4
BARRACUDA,GREAT	1.0	0.1	7.5	0.7	6.0	0.1	16.2	0.3
BEARDFISH	19.0	1.1	7.9	0.8				
BLUE TANG	415.0	23.6	202.4	19.8	296.0	4.1	140.6	2.3
BUTTERFLYFISH,BANDED	146.0	8.3	19.9	1.9				
BUTTERFLYFISH,FOUREYE	40.0	2.3	4.3	0.4				
CHUB,BERMUDA	1.0	0.1	3.6	0.4	2.0	0.0	3.3	0.1
CONCH,QUEEN	2.0	0.1	2.7	0.3				
CONEY	29.0	1.7	4.5	0.4	82.0	1.1	46.7	0.8
COTTONWICK					1.0	0.0	0.6	0.0
COWFISH,HONEYCOMB	6.0	0.3	3.3	0.3	267.0	3.7	165.0	2.7
CRAB,MARINE					1.0	0.0	1.0	0.0
CREOLE FISH	1.0	0.1	0.5	0.1	1.0	0.0	0.4	0.0
DOCTORFISH	38.0	2.2	10.9	1.1	393.0	5.5	264.3	4.3
DURGON,BLACK	17.0	1.0	15.8	1.5	58.0	0.8	43.7	0.7
FILEFISH,ORANGE	26.0	1.5	9.6	0.9	26.0	0.4	29.9	0.5
FILEFISH,ORANGESPOT	15.0	0.9	5.2	0.5				
FILEFISH,PYGMY	1.0	0.1	0.3	0.0				
FILEFISH,SCRAWLED	5.0	0.3	12.6	1.2	4.0	0.1	5.6	0.1
FILEFISH,WHITESPOTTED	11.0	0.6	6.4	0.6	2.0	0.0	2.5	0.0
FLOUNDER,PEACOCK	12.0	0.7	3.5	0.3				
FLYING GURNARD	4.0	0.2	2.7	0.3				

	DISP							
	BYCATCH				RETAINED			
	NUMBER		NEW_Weight		NUMBER		NEW_Weight	
	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum
GOATFISH,SPOTTED					38.0	0.5	13.0	0.2
GOATFISH,YELLOW					11.0	0.2	3.9	0.1
GRAYSBY	5.0	0.3	2.0	0.2	4.0	0.1	2.4	0.0
GROUPER,TIGER					1.0	0.0	1.4	0.0
GRUNT,BLACK					1.0	0.0	1.7	0.0
GRUNT,BLUE STRIPED	3.0	0.2	1.0	0.1	59.0	0.8	34.4	0.6
GRUNT,CAESAR	6.0	0.3	0.7	0.1	36.0	0.5	12.1	0.2
GRUNT,FRENCH	88.0	5.0	19.0	1.9	39.0	0.5	10.8	0.2
GRUNT,SPANISH	8.0	0.5	1.3	0.1				
GRUNT,TOMTATE	10.0	0.6	3.3	0.3	43.0	0.6	15.8	0.3
GRUNT,WHITE	2.0	0.1	0.7	0.1	405.0	5.6	178.9	2.9
HIND,RED					135.0	1.9	97.8	1.6
HIND,ROCK					1.0	0.0	3.6	0.1
HOGFISH,SPANISH	5.0	0.3	0.7	0.1	10.0	0.1	7.1	0.1
HOUNDFISH	8.0	0.5	7.6	0.7	11.0	0.2	13.1	0.2
JACK,BAR	31.0	1.8	17.6	1.7	84.0	1.2	70.0	1.1
JACK,BLACK					1.0	0.0	2.1	0.0
JACK,HORSE EYE	25.0	1.4	96.1	9.4	2.0	0.0	4.4	0.1
JACK,YELLOW					12.0	0.2	10.3	0.2
LIZARDFISH,SAND DIVER	1.0	0.1	0.4	0.0				
LIZARDFISHES	1.0	0.1	4.6	0.4				
LOBSTER,CARIB. SPINY	18.0	1.0	35.2	3.4	213.0	3.0	478.5	7.8
LOBSTER,SPANISH SLIP.					1.0	0.0	1.2	0.0
LOBSTER,SPOTTED SPINY	1.0	0.1	0.6	0.1				
MACKEREL,CERO					2.0	0.0	1.7	0.0
MARGATE					1.0	0.0	1.7	0.0
MARGATE,BLACK					3.0	0.0	4.4	0.1
MOJARRA,YELLOWFIN					7.0	0.1	2.4	0.0
MORAYS	2.0	0.1	7.1	0.7				

	DISP							
	BYCATCH				RETAINED			
	NUMBER		NEW_Weight		NUMBER		NEW_Weight	
	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum
NEEDLEFISHES	6.0	0.3	3.6	0.3				
OTHER FISHES	2.0	0.1	0.9	0.1				
PARROTFISH,PRINCESS	3.0	0.2	2.8	0.3	40.0	0.6	24.0	0.4
PARROTFISH,QUEEN	8.0	0.5	3.6	0.4	53.0	0.7	55.7	0.9
PARROTFISH,REDBAND	18.0	1.0	5.8	0.6	109.0	1.5	71.2	1.2
PARROTFISH,REDFIN					296.0	4.1	289.9	4.7
PARROTFISH,REDTAIL	45.0	2.6	32.7	3.2	1958.0	27.2	1868.8	30.4
PARROTFISH,STOPLIGHT	1.0	0.1	1.2	0.1	317.0	4.4	359.8	5.9
PORCUPINEFISH	15.0	0.9	37.8	3.7				
PORGY,JOLTHEAD					7.0	0.1	5.7	0.1
PORKFISH	1.0	0.1	23.1	2.3	1.0	0.0	0.7	0.0
PUDDINGWIFE	4.0	0.2	5.0	0.5	23.0	0.3	19.5	0.3
PUFFERS	32.0	1.8	17.5	1.7				
ROCK BEAUTY	5.0	0.3	1.5	0.1	2.0	0.0	0.9	0.0
RUNNER,BLUE					7.0	0.1	6.3	0.1
SAILFISH	1.0	0.1	25.0	2.4				
SCAD,MACKEREL					158.0	2.2	46.8	0.8
SCHOOLMASTER	2.0	0.1	5.2	0.5	49.0	0.7	61.6	1.0
SCORPIONFISH,REEF	15.0	0.9	10.2	1.0				
SCORPIONFISH,SPOTTED	1.0	0.1	1.3	0.1				
SCORPIONFISHES,THONYH	1.0	0.1	0.7	0.1				
SENNET,SOUTHERN	2.0	0.1	1.3	0.1	2.0	0.0	1.3	0.0
SHARK,BIGEYED SIXGILL					12.0	0.2	122.0	2.0
SHARK,CARIBBEAN REEF					2.0	0.0	16.4	0.3
SHARK,NURSE	6.0	0.3	114.6	11.2	8.0	0.1	182.2	3.0
SNAPPER,BLACK					5.0	0.1	8.6	0.1
SNAPPER,BLACKFIN					52.0	0.7	45.6	0.7
SNAPPER,CARDINAL					2.0	0.0	1.0	0.0
SNAPPER,DOG	1.0	0.1	0.3	0.0	1.0	0.0	0.8	0.0

	DISP							
	BYCATCH				RETAINED			
	NUMBER		NEW_Weight		NUMBER		NEW_Weight	
	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum	Sum	ColPctSum
SNAPPER,GLASSEYE					1.0	0.0	0.6	0.0
SNAPPER,GRAY(GREY)					5.0	0.1	2.4	0.0
SNAPPER,LANE					11.0	0.2	7.4	0.1
SNAPPER,MAHOGANY	3.0	0.2	0.8	0.1	14.0	0.2	6.5	0.1
SNAPPER,MUTTON	2.0	0.1	0.6	0.1	14.0	0.2	34.4	0.6
SNAPPER,QUEEN					87.0	1.2	154.0	2.5
SNAPPER,SILK					6.0	0.1	11.5	0.2
SNAPPER,VERMILION					2.0	0.0	2.4	0.0
SNAPPER,YELLOWTAIL	6.0	0.3	8.4	0.8	458.0	6.4	502.6	8.2
SPADEFISH,ATLANTIC	5.0	0.3	0.8	0.1	6.0	0.1	15.2	0.2
SQUIRRELFISH,LONGSPIN	44.0	2.5	11.6	1.1	94.0	1.3	34.1	0.6
STINGRAY,SOUTHERN	7.0	0.4	18.2	1.8				
SURGEON,OCEAN	373.0	21.3	97.8	9.6	63.0	0.9	21.4	0.3
TILEFISH,SAND	13.0	0.7	9.7	1.0				
TRIGGERFISH,OCEAN	3.0	0.2	1.1	0.1				
TRIGGERFISH,QUEEN	8.0	0.5	3.8	0.4	86.0	1.2	103.5	1.7
TRUNKFISH	2.0	0.1	0.6	0.1	17.0	0.2	26.7	0.4
TRUNKFISH,SMOOTH	109.0	6.2	43.3	4.2				
TRUNKFISH,SPOTTED	3.0	0.2	0.5	0.0	131.0	1.8	69.1	1.1
TUNA,BLACKFIN					6.0	0.1	14.1	0.2
TUNNY,LITTLE					23.0	0.3	32.0	0.5
WAHOO					1.0	0.0	26.2	0.4
All	1755.0	100.0	1020.7	100.0	7207.0	100.0	6141.0	100.0

Table 15: Finfish discard information for St. Thomas (Taken from MRAG Report).

Species	TIP	Number
Risk of Ciguatera		
Caranx latus	118	8
Caranx lugubris	119	2
Caranx ruber	115	21
Gymnothorax moringa	442	1
Lutjanus apodus	135	118
Lutjanus buccanella	138	3
Lutjanus griseus	132	26
Lutjanus jocu	133	10
Lutjanus mahogoni	137	6
Mulloidichthys martinicus	176	7
Priacanthus arenatus	98	1
Pseudupeneus maculatus	175	2
Scomberomorus regalis	234	5
Seriola rivoliana	111	1
Sphyraena barracuda	203	12
Risk of Ciguatera, Used to Bait Traps		
Lutjanus apodus	135	3
Lutjanus jocu	133	2
Lutjanus mahogoni	137	3
Priacanthus arenatus	98	4
Total		**235 (13.6%)**
Smaller Than Market Size		
Acanthurus bahianus	218	2
Acanthurus chirurgus	651	82

Acanthurus coeruleus	652	201
Balistes vetula	251	52
Calamus pennatula	165	38
Caranx hippos	601	1
Caranx ruber	115	4
Crab,marine	930	1
Epinephelus adscensionis	90	1
Epinephelus cruentatus	82	28
Epinephelus fulvus	80	2
Epinephelus guttatus	88	6
Gerres cinereus	148	1
Haemulon aurolineatum	159	2
Haemulon flavolineatum	157	2
Haemulon melanurum	506	2
Holacanthus ciliaris	184	2
Holacanthus tricolor	575	5
Holocentrus marianus	8810080105	3
Holocentrus rufus	625	32
Lactophrys bicaudalis	702	117
Lactophrys poligonius	701	273
Lactophrys quadricornis	700	149
Lactophrys trigonus	704	81
Lactophrys triqueter	258	41
Lactophrys triqueter	701	100
Lactophrys triqueter	703	33
Lutjanus apodus	135	1
Lutjanus synagris	136	3
Ocyurus chrysurus	140	37

Ostraciidae	256	32
Pomacanthus arcuatus	576	2
Pomacanthus paru	575	8
Priacanthus arenatus	98	1
Scyllarides aequinoctialis	918	1
Total		**1,346 (77.6%)**
Non Marketable Species		
Aluterus monoceros	730	2
Aluterus schoepfi	725	7
Aluterus scriptus	726	11
Bothus lunatus	249	1
Cantherhines macrocerus	727	11
Cantherhines pullus	255	3
Caranx crysos half fish	117	2
Chaetodon striatus	561	14
Chilomycterus antillarum	822	2
Crab,marine	930	2
Diodon holacanthus	820	77
Echeneus naucratis	108	2
Equetus lanceolatus	172	1
Eupomacentrus fuscus		1
Ocyurus chrysurus (shark bite)	140	1
Pomacentridae	185	1
Scorpaena plumieri	244	12
Serranus tabacarius	92	1
Total		**151 (8.7%)**

Too Much in Market		**0**
Used as Bait		
Crab,marine	906	1
Haemulon aurolineatum	159	1
Total		**2 (0.1%)**

Table 16: Lobster discard information for St. Thomas (Taken from MRAG Report).

Species	**TIP**	**Number**	**% of Total**
Spiny Lobsters *Panulirus argus*	901		
Smaller than Legal Size		312	67.5%
Smaller than Legal Size, With Eggs		11	2.4%
With Eggs		139	30.1%
Scyllarides aequinoctia.	918	1	

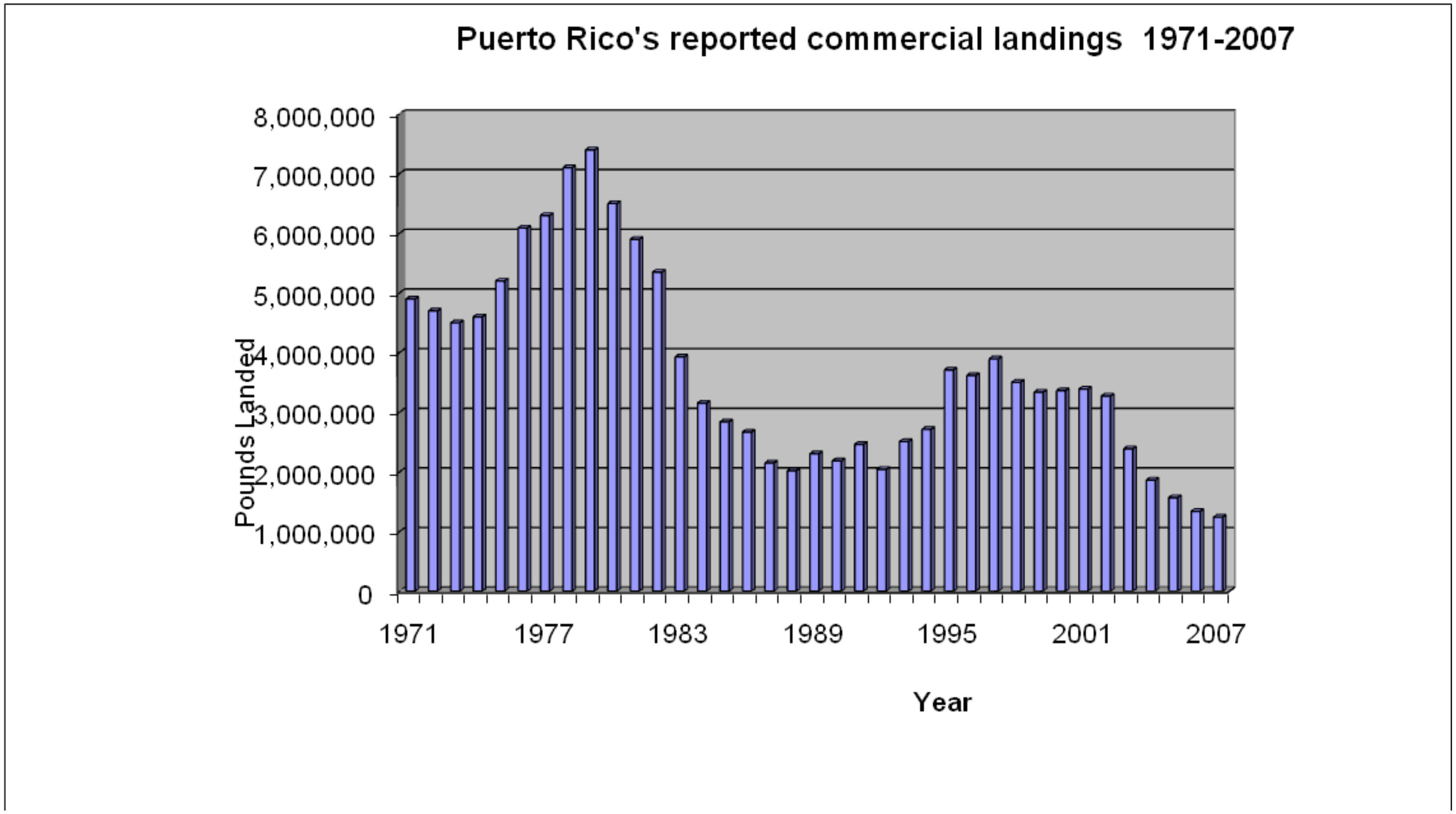

Figure 1: Reported commercial landings in Puerto Rico 1971-2007. Information from DNER, FRL, CSP program. 2007 data Preliminary.

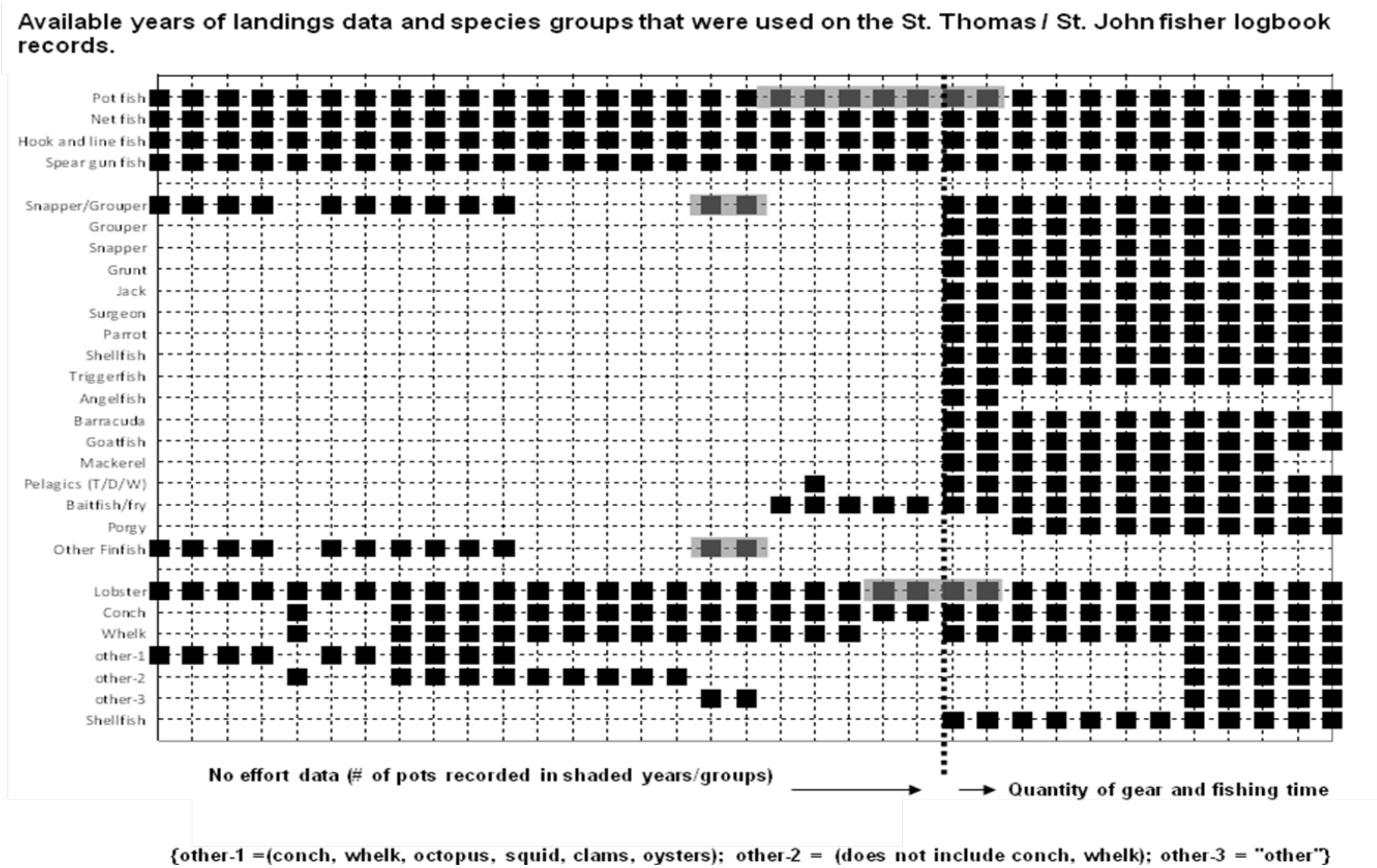

Figure 2: Available number of years of landings data and species and gear category groups used on the St. Thomas/St. John commercial logbook (taken from McCarthy and Gedamke, SP-2).

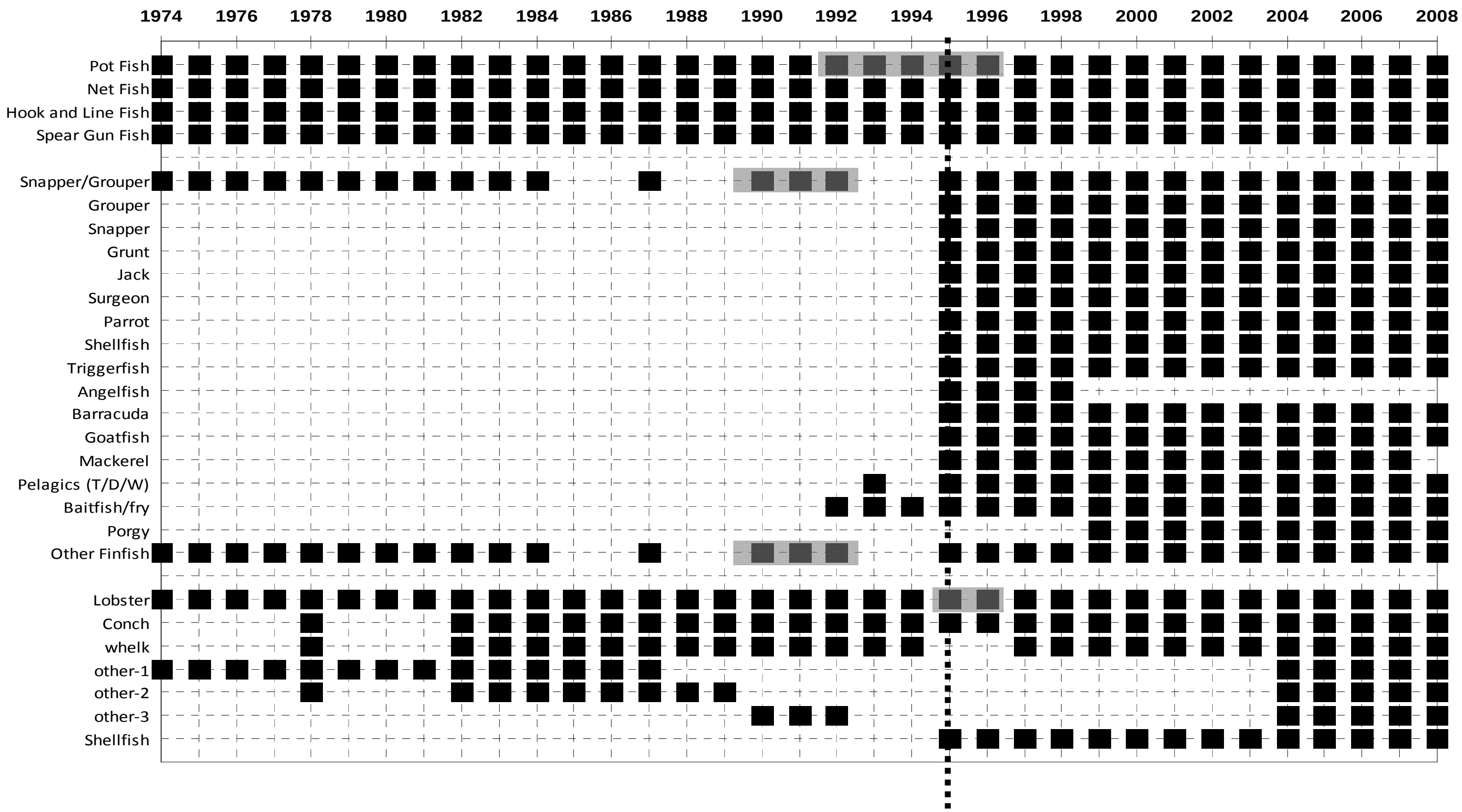

Figure 3: Available years of landings data and species and gear category groups used on the St. Croix commercial logbook (taken from McCarthy and Gedamke, SP-2)

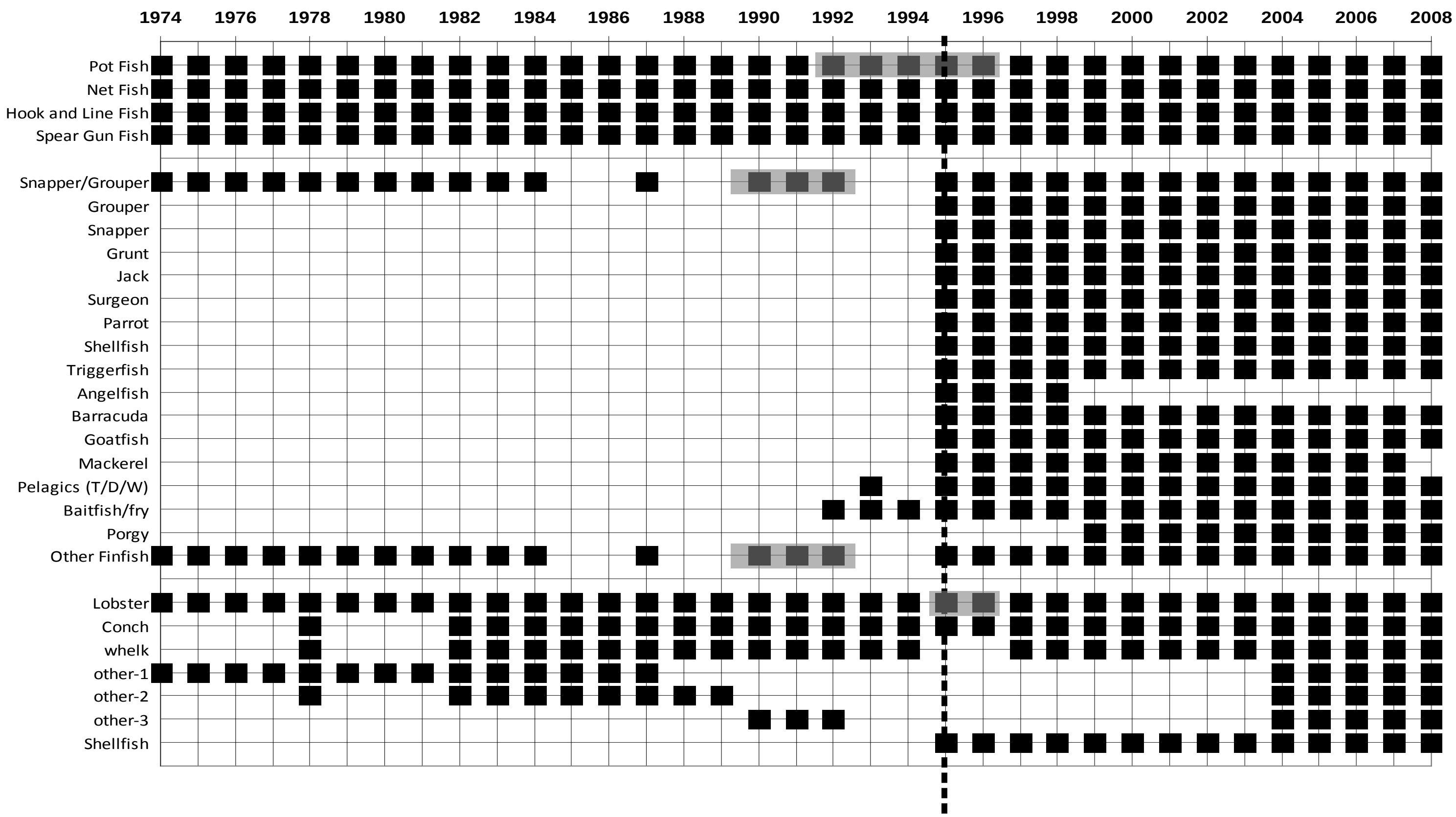

Figure 3: Available years of landings data and species and gear category groups used on the St. Croix commercial logbook (taken from McCarthy and Gedamke, SP-2)

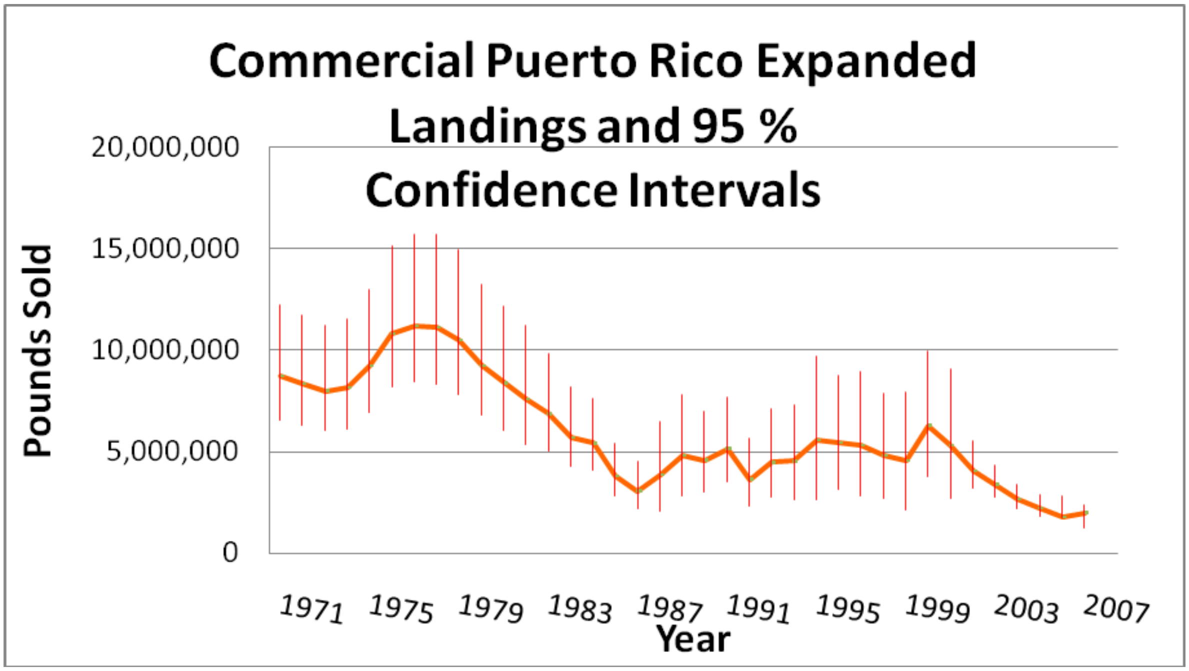

Figure 4: Calculated total commercial landings and 95 % Confidence Interval for all species groups combined, 1983-2007.

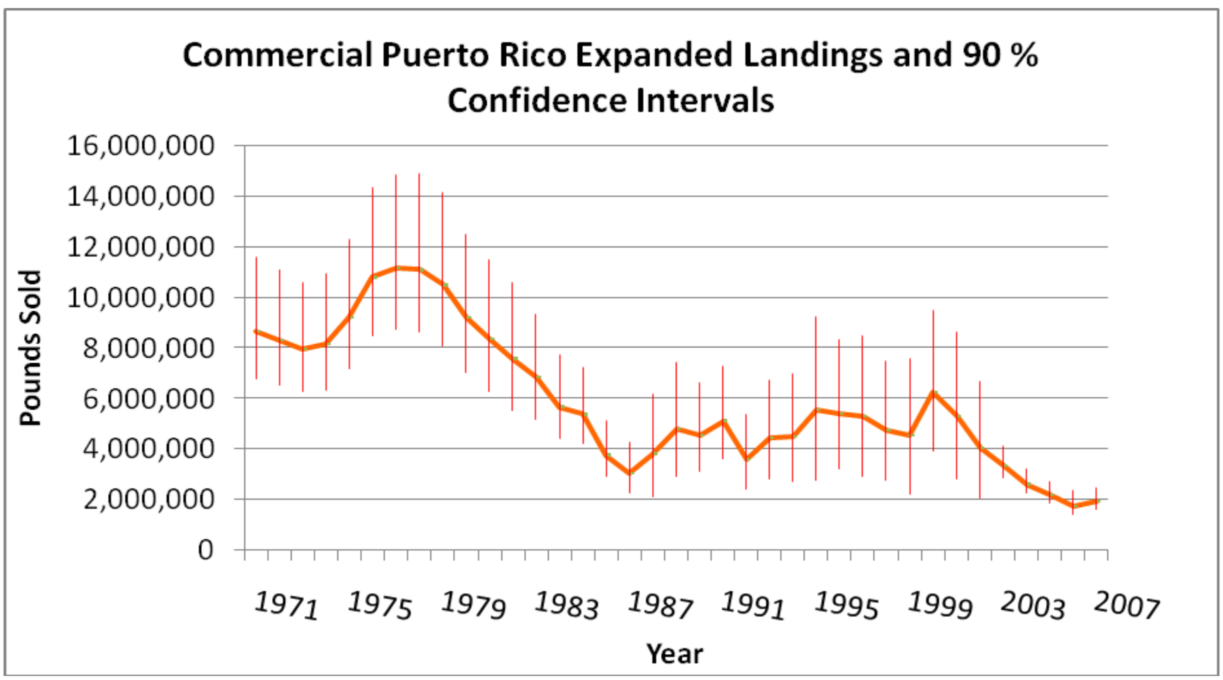

Figure 5: Calculated total commercial landings and 90 % Confidence Interval for all species groups combined, 1983-200

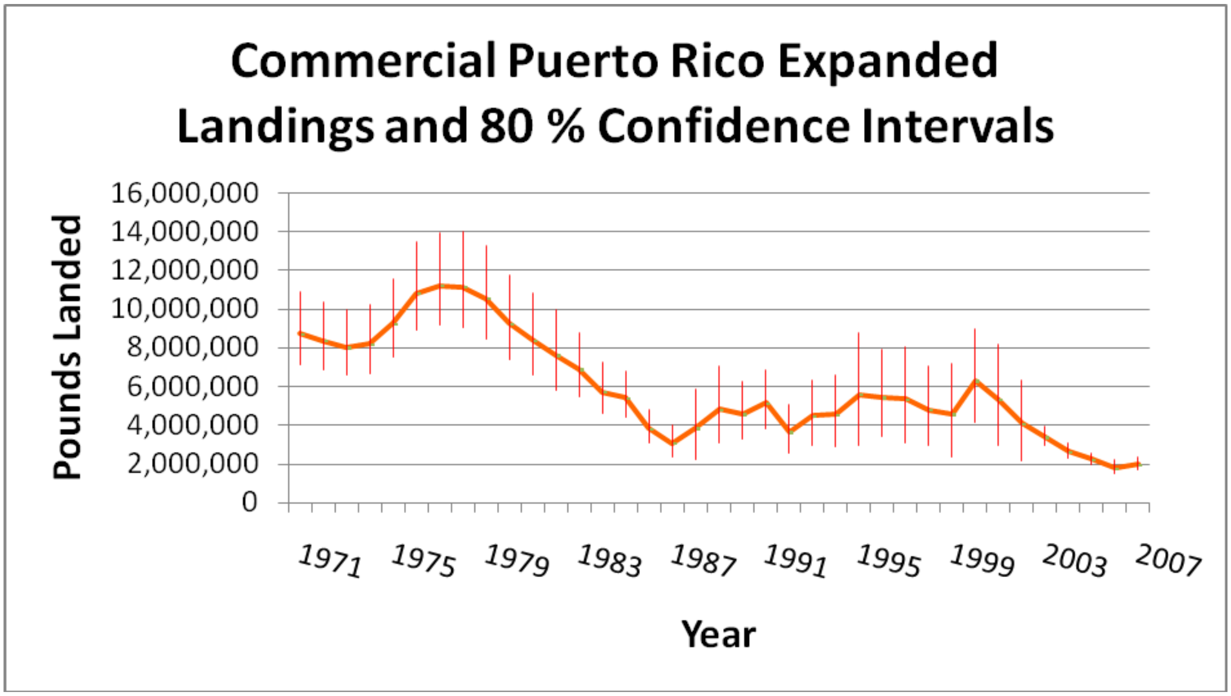

Figure 6: Calculated total commercial landings and 80 % Confidence Interval for all species groups combined, 1983-2007.

2.1.3. Puerto Rico Catch Per Unit of Effort

2.1.3.1. Overview

Stock assessments routinely incorporate information on stock abundance in analyses, this information often derived from rigorous statistical evaluations of commercial catch per unit of effort (CPUE) data. Calculated abundance trends are an integral input in a variety of population models used to quantify stock status (e.g., production models, age (Virtual Population Analyses) or size (length) based models). In addition, CPUE trends can be used to approximate stock biomass in a near or complete un-fished point in time if a sufficiently lengthy time series exists. Previous US Caribbean SEDAR evaluations have attempted, with limited success, to develop standardized CPUE abundance trends from the Puerto Rico and US Virgin Islands commercial landings data (e.g., SEDAR 4 Deepwater Snappers, SEDAR 8 Yellowtail snapper and Spiny Lobster, SEDAR14 Mutton Snapper, Conch, and Yellowfin grouper). Difficulties identified by the analysts and reviewers for those evaluations have included 1) lack of sufficient contrast in resulting indices with which to model changes in stock dynamics, 2) lack of a adequate number of observations temporally or spatially for constructing a time series spanning a reasonable length of time (e.g., 1-2 life spans) which would support evaluation of abundance changes over time, 3) inadequate auxiliary information to use in explaining changes in catch rate over time resulting in indices with weak predictive ability (e.g., location of fishing event, ability to track fishers CPUE trends over time, inability to follow unique vessel trends, etc.,), 4) confounded or lack of clear definition in the units of effort recorded for CPUE resulting in indices that did not reflect abundance likely due to inadequate or non-informative measures of effort (queen conch, SEDAR 14).

Four fishery dependent data sets are currently available from the US Caribbean for use in constructing indices of abundance: 1) Trip interview program (TIP; data available for Puerto Rico and US Virgin Islands) which primarily focus on commercial fishing trips, 2) Puerto Rico commercial sales ticket/trip ticket data, 3) US Virgin Islands commercial landings reports, and 3) MRFSS observations of recreational catch and effort available since 2000 in Puerto Rico. Previous Caribbean SEDAR evaluations found both TIP data and the MRFSS recreational CPUE series to be insufficient for use in constructing abundance indices. The time series available in TIP was generally lacking data in recent years. In addition, there was uncertainty regarding whether complete catches were quantified or whether the catches were simply available to the port sampler, but were not completely sampled. This may be particularly problematic in the US Virgin Islands. Incomplete sampling of catches can introduce an unquantifiable bias into abundance indices constructed using those data. Further fishery dependent data exploration for constructing new indices was limited to the Puerto Rico commercial sales ticket and US Virgin Islands commercial fisher landings reports datasets.

The main focus of this section of the Caribbean Data Evaluation Workshop was to evaluate the potential for calculating from the commercial data series stock abundance trends for US Caribbean Shallow Water Reeffish FMP units: Snapper Unit 1, Grouper Unit 4, and Parrotfish) from the commercial fisheries in the US Caribbean. Both Silk snapper group (Snapper unit 1- Silk, Black, Blackfin, Vermillion snappers) and the Parrotfish resources are complexes for which management has immediate needs for status of stock information as relates to determination of Annual Catch Limits (ACLs) for resources current considered overfished and/or undergoing overfishing. In addition, the Queen Snapper complex (Queen and wenchman snapper) was selected for this evaluation as ongoing stock assessment evaluations are underway using an alternative stock assessment method (ParFish) under a NOAA, Cooperative Research Program research grant.

2.1.3.2. Puerto Rico Single Species Silk Snapper and Queen Snapper Group Analyses

Analysis Approach and Methodology

The goal was to develop standardized abundance trends using General Linear Modeling (GLM) techniques as applied in previous SEDAR assessments. CPUE trends were developed for single species, Silk Snapper and Queen Snapper. SEDAR 14 recommended investigating the development of multispecies CPUE indices of abundance thus multispecies CPUE trends were evaluated for the Silk Snapper Complex (Snapper unit 1).

Available Data for these analyses is characterized briefly as the following:

- Records from commercial sales of reeffish and shellfish in Puerto Rico for 1983-2007 collected by DNER, Fisheries Research Laboratory (FRL), Commercial Statistics Program (CSP).
- Some data exist prior to 1983 but not available electronically.
- Data represented commercial fishing trips from 1983-2007 throughout Puerto Rico from all fishing centers (Figure 7).

Attributes available for the commercial fisher sales records included:

- Date of sale (Year, Month, and Day).
- Location of landing (fishing center- municipality, major coast (North, South, East, West as defined by Matos-Caraballo pers. Comm.).
- Total Pounds Sold by species per sale.
- Hours fished (available for some records)
- Depth in fathoms (minimum, maximum) for some records.
- Trip ticket number (2003- current time).
- 1983-2002: Virtual Tripid designator calculated using a combination of unique variables (year, month, day, fisher identification, fishing center, gear).
- 2003 + Tripid variable placed on the record by DNER

All CPUE analyses for this review were restricted to fishing trips between 1983 and 2007 for the bottom line gear fishery and for which the sale was indicated to represent a single fishing trip (i.e., the ‘Ntrips’ data attribute was coded as ‘1’. Harvest of silk and queen snapper complex by bottom line gear represented the dominant component of removals providing for both complexes and is additional support for restricting the analyses to sales records indicating use of bottom line gear. The exception was from 1983-1985, when harvest of silk snapper group by fish pots dominated removals (Table 17-Silk group harvest by gear; Table 18 - Queen Snapper group harvest by gear).

Stephens and McCall (2004) data reduction analysis was carried out separately for the silk complex and for the queen snapper unit. The Stephens – McCall analysis was used in an effort to identify all trips on which species (that occurred in at least 1% of all Bottom Line trips) were statistically significant in a co-occurrence analysis. This type analysis seeks to identify fishing trips that caught species found in the same habitat as the target species (e.g., Silk Snapper or Queen Snapper group) that did not catch the target group but potentially could have (i.e., identify trips with zero catches of the target).

Single Species CPUE Standardization Steps (Silk and Queen Single Species Models):

Because of the significance of using CPUE to model stock abundance and the assumption that CPUE is proportional to abundance statistical procedures are nearly always used to standardize the raw (nominal) observations of CPUE. Standardization methods are employed in an attempt to remove unexplained variation in CPUE by a variety of factors. General linear modeling (Robson, 1966), is most often carried out to develop the standardized CPUE indices. GLM procedures takes into account variation in CPUE introduced by one or more independent variables such as location of harvest, fishing vessel power, fisher specific characteristics, temporal trends and other factors. For this workshop GLM models were fitted to the lognormal CPUE observations i.e., positive observations of weight landed per trip, incorporating auxiliary information from the attributes listed above (e.g., location of sale, year, month or quarter, municipality). Two type models both were employed to derive the standardized index. Maunder and described the logic behind utilizing the two separate models very nicely as 1) employing the GLM model to describe the CPUE relationship for the positive observations and a separate model for the zero catches. The second model eliminates the problems associated with having strata with positive fishing effort and observations of zero catch for the species of interest. Previous investigators often 1) combined strata to eliminate zeros or 2) added some constant to zero catches and included those in the lognormal model however; more recent workers have handled the problem by assuming a different distribution for the zeros and modeling that component independently. The delta lognormal method (Pennington 1983, 1996; Lo et al. 1992) combines the resulting indices from the lognormal and the binomial models. Thus for this workshop, 1) GLM models were fitted to the lognormal positive CPUE observations and 2) separate binomial models were fitted to the proportion of success observations.

Silk Snapper Results

Table 19 provides a breakdown of the number of total trip observations available for the Silk group analysis. The proportion of positive trips that Silk snapper represented of the total overall bottom line CPUE set ranged from 18% to 43% over the entire period 1983-2007. The proportion of positives ranged from around 35-40% until 1986, then remained at near 25% through 1996 and since that time steadily declined to around 18% (Figure 8). A diagnostic plot of the logged unadjusted CPUE observations presented in Figure 9 illustrates that the logged nominal CPUE observations do not indicate any trend towards non-normality, a basic premise of employing the linear model.

Several models were explored however very few auxiliary variables existed for use in modeling the variation in observed CPUE or in modeling the proportion of positives. The resulting models selected for the final Silk snapper CPUE index were: 1) Silk Lognormal: Year + Fishing center + quarter and 2) Silk binomial model – used to model the proportion of positive observations: Year + Region (i.e., N, S, E, or W coast) + Quarter of the year. Final standardized indices for the combined delta – lognormal procedure are shown in Figure 10 for silk snapper. Figure 10 also presents the nominal (observed) CPUE data and 95% Confidence intervals for the standardized index. Additional diagnostic views are provided for the residual distributions for the fits to both the positive and proportion positive CPUE observations in Figures 11 through 14.

The standardized CPUE trends show an increase in CPUE through 1986 followed by a steep decline around through 1988. Since that time Silk Snapper CPUE has remained stable.

Queen Snapper Results

Table 20 provides the availability of total trip observations for use in developing standardized CPUE trends for the Queen Snapper group. The annual representation of positive queen snapper trips to the overall bottom line fishery, although showing an increase over the entire period, 1987-2007, has remained somewhat low. In particular, during the early years in which annual landings of queen snapper sharply increased (1987-2002) from around 15,000 pounds to 135,000 pounds, the proportion of positives remained steady about 4% annually. In recent years there has been an increasing representation of the number of positive observations of queen snapper in the total CPUE set to the current level of around 12% (Figure 15). This time series also suggests that a sharp reduction in total reported bottom line effort occurred around 2003.

Final models selected for the queen snapper abundance indices were: 1) Queen Lognormal: Year + municipality + quarter and 2) Queen binomial model: Year + municipality

+ quarter. Figure 16 indicates there were no major departures from the normality assumption for the log CPUE observations. Final standardized indices for the combined delta – lognormal procedure are shown in Figure 17. The calculated abundance trends suggest a sharp increase in standardized abundance of Queen Snapper over the period 1987-2007. Additional diagnostic views are provided for the residual distributions for the fits to both the positive and proportion positive CPUE observations in Figures 18 through 21.

Accuracy/reliability determinations

Single species CPUE abundance standardizations were attempted for Snapper unit 1 and also the queen snapper complex using fishery dependent data from the commercial bottom line fishery in Puerto Rico. The data used spanned all available fishing trips over the entire time series and thus represent all the observations of CPUE from these two groups that have been collected by the DNER. Harvest of both groups was dominated by fishing trips using bottom line gear therefore the selection of this fishery for CPUE index develop seems justified.. The exception was during 1983-1985 when silk snapper harvest by fish pots dominated the total catch. Unfortunately, electronic records of commercial sales of silk snapper are unavailable prior to1983 with which to further examine Silk snapper CPUE trends. A sensitivity trial could be conducted using fish pot trips also for the Snapper unit 1. It was noted that the total combined harvest from such commercial trips utilizing either fish pots or hook and line gear on average represents approximately 12 % to 27% annually of the historic production of commercial fishers in Puerto Rico. This effort would represent inshore shallow water shelf fishing effort.

Considerations relating to the Silk Snapper CPUE modeling exercises relate to the uneven of proportion of positives in the data series as well as the overall low level of positives over the entire time series suggesting that inflation of zeros may be present in the data series. This would suggest that a zero inflated model approach might be appropriate. Nonetheless, estimated CPUE trends for both Silk and Queen Snapper were characterized by reasonably narrow confidence intervals.

As relates the Queen snapper predicted index additional work might reveal why the index and the observed trend were divergent in the later part of time series.

2.1.3.3. Puerto Rico Multi-Species CPUE – Silk Snapper Group (Silk, Black, Blackfin, and Vermillion Snappers)

Efforts were also made to further develop CPUE models by using a multispecies approach for the US Caribbean Snapper unit 1 (Silk Snapper unit) using the commercial fisher sales records / trip tickets in Puerto Rico.

Analysis Approach and Methodology

The multinomial index of relative abundance ($I_{s,y}$) was estimated as:

$$I_{s,y} = c_y p_{s,y},$$

Where c_y is the estimate of mean total catch rate (lbs per station id.) for year y; $p_{s,y}$ is the estimate of the mean proportion of the catch made up by species s during year y. In this analysis stations are synonymous with unique tripods.

Both c_y and $p_{s,y}$ were estimated using generalized linear models. Data used to estimate mean total catch rates (c) and species-specific mean proportion of the catch (p_s) were assumed to have a lognormal distribution and a multinomial distribution, respectively, and modeled using the following equations:

1) $\ln(\mathbf{c}) = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$ and

2) $\ln\left(\frac{\mathbf{p}_s}{\mathbf{p}_5}\right) = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$

respectively, where **c** is a vector of the catch rate data, $\mathbf{p}_s$ is a vector of data of the proportion of catch this is made up by species s, **X** is the design matrix for main effects, **β** is the parameter vector for main effects, and **ε** is a vector of independent normally distributed errors with expectation zero and variance σ^2. For the multinomial Silk snapper group model, there were five catch proportion categories: four for each species in the Silk Snapper group (blackfin, silk, black and vermilion snapper) and one for all other species combined (i.e. the rest of the catch). Since the "rest of catch" category comprised the largest proportion of the catch on average, this category (p_5) was treated as the baseline category; the four logit equations then described the log-odds of the rest of the catch being made up of each of the four species in the silk group.

C_y and $p_{s,y}$ were estimated as least-squares means for each year along with their corresponding standard errors, SE(c_y) and SE($p_{s,y}$), respectively. From these estimates, $I_{s,y}$ was calculated and its variance calculated as:

$$V(I_{s,y}) \approx V(c_y)p_{s,y}^2 + c_y^2 V(p_{s,y}) + 2c_y p_{s,y}\mathrm{Cov}(c, p_s)$$

Where

$$\mathrm{Cov}(c, p_s) \approx \rho_{c,p}\left[\mathrm{SE}(c_y)\mathrm{SE}(p_{s,y})\right]$$

and $\rho_{c,p}$ denotes correlation of c and p_s among years.

a) Data used in the multinomial approach

Data used to develop the multinomial Silk Snapper group CPUE indices was identical to that of the single species models that is all the trip observations from the bottom line fishery after data reduction by the Stephens and MacCall method. Table 22 provides the number of total trip observations that were available for analysis.

Models Composition :

As with the single species CPUE standardizations very few auxiliary attributes were recorded for the CPUE observations (year, fishing center, municipality, major region or coast (North, south, east, or west) however these were used in modeling the annual CPUE trends.

1) Multinomial Model used for annual Catch Proportions
    - ln(p(silk group species catch)/p(rest of catch) = Year
2) Lognormal Model for Total Catch per Station
    - Ln(total catch per station id (i.e., trip).) = Year + Quarter + Region + Fishing center

b) Multinomial model results for Silk Snapper group

Table 22 and Figures 22 - 25 presents the estimated annual index and coefficients of variation for each annual index and member of the Silk snapper group from the multinomial model runs. The calculated CPUE trends suggest the following: 1) a decrease in Silk Snapper catch over time, 2) an increase in blackfin and vermilion catch then a subsequent decrease over time, 3) very low CVs for the Silk Snapper index possibly unreasonably low around 3%, and 4) very large and highly variable CV's for both Black and Blackfin snapper species, ranging from 50% to 300% (Black) and 15-100% (Blackfin). Vermillion snapper CPUE indices, the second most frequently caught of the Silk Snapper category was characterized by CV's on the order of 5 % to 40%. Figures 26 and 27 present diagnostic plots of the residuals from the fitted models for the multinomial approach.

Accuracy and Reliability

The multinomial Puerto Rico CPUE analyses utilized the same data as those of the single species analyses thus the same concerns related to choice of data and technical considerations also apply to the multinomial analyses.

2.1.3.4. Puerto Rico Parrotfish Indices

Puerto Rico self reported commercial landings data were used to construct parrotfish indices of abundance as examples of possible analyses that may be conducted using those data.

Analytical approach

Parrotfish trips were identified following the method of Stephens and MacCall (2004), where trips are subset based upon the reported species composition of the landings. This method is intended to identify trips that fished in locations containing parrotfish habitat and, therefore, had the potential of catching parrotfish.

Once the relevant data were identified, the delta lognormal model approach (Lo et al. 1992) was used to construct standardized indices of abundance. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed parrotfish) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM analysis of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(CPUE). The response variable was calculated as: log(CPUE) = ln(pounds of parrotfish/hours fished). All 2-way interactions among significant main effects were examined.

A forward stepwise regression procedure was used to determine the set of fixed factors and interaction terms that explained a significant portion of the observed variability. Each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was $\geq 1\%$. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. Higher order interaction terms were not examined.

Once a set of fixed factors was identified, the influence of the YEAR*FACTOR interactions were examined. YEAR*FACTOR interaction terms were included in the model as random effects. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 log likelihood statistics between successive model formulations (Littell et al. 1996).

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

Available data

Puerto Rico commercial sales/trip ticket data were the only data available for use in constructing indices of abundance. Those data required extensive filtering before any analysis. That process included: removing trips reporting multiple fishing centers where catch was landed, multiple gears fished and those with missing effort (hours fished or trap soak time) or amount of gear fished. In addition, data reported prior to 1989 were also excluded due to concerns that those data may be incomplete or resulted from biased sampling because the landings reporting program was not fully operational in earlier years (see SEDAR 14 data workshop report). Puerto Rico data were further limited to include only those sales/trip tickets which included landings from a single trip and excluded those sales/trip tickets that combined landings from multiple trips.

Once filtered, sufficient data appeared available to explore the construction of four or, perhaps, five indices of abundance (Table 23). Due to time constraints, indices were constructed using data from trap trips, diver trips, and trammel net trips. The yearly number of trips for each gear is provided in Figure 30. The time series for each gear began later than the earliest possible year, 1989, due to small sample sizes in earlier years. Only three factors were considered for their possible affect on cpue: year, coast (Figure 31), and quarter (January-March=1, April-June=2, etc.). In the trap and dive data analyses, trips reported from the north coast were excluded from those analyses due to low sample size. Only south and west coast trammel net trip data were included in the construction of that index. Other possible factors available in the data set had too few observations to be used in the analyses. For example: of 22,719 total parrotfish observations, distance from shore was missing for 16,347 observations.

Results

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips were:

Puerto Rico Traps:

PPT = Year + Coast

LOG(CPUE) = Year

Puerto Rico Dive:

PPT = Coast + Year + Coast*Year

LOG(CPUE) = Year + Coast + Quarter + Year*Quarter + Year*Coast

Puerto Rico Trammel Nets (GLMMIX failed to converge when the binomial component included, therefore a lognormal model only was used to construct the index):

LOG(CPUE) = Coast + Year + Coast*Year

The number of trips, proportion positive trips, and standardized abundance indices are provided in Tables 24 (trap data), Table 25 (dive data), and Table 26 (trammel net data) for Puerto Rico parrotfish. The delta-lognormal abundance indices developed for each gear, with 95% confidence intervals, are shown in Figures 32 to 34.

Plots of the proportion of positive trips per year, nominal cpue, frequency distributions of the proportion of positive trips, frequency distributions of log(CPUE) for positive catch, cumulative normalized residuals, and plots of chi-square residuals by each main effect for the binomial and lognormal models are shown in Figures 35 to 38 (trap), Figures 39 to 42 (dive), Figures 43 to 45 (trammel net). Those diagnostic plots indicate that the fit of the data to the lognormal and binomial models was acceptable. There were some outliers among these data, however, and the frequency distribution of log(CPUE) varied somewhat from the expected normal distribution. Those variations from the expected fit of the data were likely not sufficient to violate assumptions of the analyses.

Accuracy/reliability of data

In the parrotfish example described here, the data appear to meet the assumptions of the analyses conducted. Confidence intervals around the yearly mean CPUEs were quite large for the trap index and during the initial years of the dive index. Additional examination of the indices constructed should be carried out before using those results in any stock assessment. The index constructed from the trammel net data certainly needs further scrutiny, given the very low sample sizes in some years and the large discrepancy between the nominal and standardized mean CPUE in another year. Only a lognormal model could be constructed from the trammel net data. Additional indices may be constructed from data reported by vessels fishing other gears, therefore, the trammel net index may not be the most appropriate index to be included in any parrotfish assessment. Discrepancies between the nominal and standardized mean CPUE were found for some years in the trap index, as well. In addition, the proportion of positive trap trips in recent years was over four times that found in the beginning of the time series and should be investigated. Lengths of the time series were limited by lack of data in early years of data collection (pre-1991) and dive data were unavailable prior to 1998. Even with those limitations, indices were constructed that included 17 years of data. Additional indices may be constructed using gillnet and, possibly, handline data.

At present, only the commercial sales/trip ticket landings data are useful for constructing indices of abundance of Puerto Rico fisheries. In some cases (e.g. parrotfish) separate indices may be constructed using data reported from vessels fishing different gears. Data from vessels reporting multiple gears fished on a single trip should be excluded from those analyses because landings cannot be unambiguously assigned to a gear in those cases. Occasionally, multiple reports of the same species were included in the data from a single trip. Due to uncertainty in interpreting those data, all data from such trips were eliminated from the parrotfish analyses. In addition, the data must be carefully screened to eliminate those records with multiple trips reported, records missing gear information, and records missing effort information. Incompletely reported trips resulted in the exclusion of many records because gear fished was not reported. Those trips with no report of hours fished (the effort measure) were also excluded in the parrotfish example described here, but might be included in an analysis if “trip” were used as the measure of effort.

The “gear amount” information could not be used with any confidence. Those data would have been extremely useful for defining effort, however, there appears to have been no consistent reporting of those data over time. The data were often missing or there was uncertainty in how to interpret the values reported; e.g. for diving, was gear amount the number of divers or the number of tanks? More detailed gear information, such as the number of lines fished and the number of hooks per line, would allow for better measures of effort.

Analyses of Puerto Rico data are limited by the lack of spatial information, including depth data that is often not reported. Reporting area fished, rather than the now reported fishing center where the catch was landed, and depth fished would allow for more detailed analyses in the future.

The single data set currently available for constructing indices of abundance in Puerto Rico must be used cautiously. Results must be carefully reviewed before those results are used in any stock assessment. That review must include the series of data filtering decisions that resulted in the final data set used to construct indices.

2.1.3.5. References

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Table 17: Percentage Composition of Silk Snapper Category harvest by gear category for Puerto Rico commercial fisheries. Units are % by year gear of weight (pounds) landed.

YEAR	Bottom Line	Cast Net	Dive, Spear, Scuba	Fish Pot	Lobster Pot	Net	Rod and Reel	Seine	Vertical Line	All
1983	25	0	0.1	73.4	.	0.6	0.4	0.3	0.1	100
1984	22.4	.	0.2	76.3	.	0.6	0.3	0.2	.	100
1985	61.5	0	0.5	36.5	0	0.8	0.4	0.3	0.1	100
1986	88	0	0.2	10.8	.	0.5	0.3	0.1	0.2	100
1987	78.3	0.1	0.3	18.8	.	0.5	0.6	.	1.3	100
1988	83	0.1	0.4	15	.	0.4	0.9	0.1	0.1	100
1989	80.6	0.1	0.4	15.8	.	1.5	1	0	0.6	100
1990	80.3	.	0.5	16.9	.	0.1	1.4	0.1	0.7	100
1991	74.5	0.2	0.4	23.5	.	0.2	0.8	0	0.4	100
1992	73.2	0.1	0.4	25.5	.	0.4	0.1	0.2	0.1	100
1993	76.9	0.2	0.3	22.2	.	0.1	0.1	0	0.1	100
1994	77	0	0.3	20.8	0.1	0.2	1.1	0.5	0.1	100
1995	83.3	0.3	0.4	14.5	0	0.5	0.9	0.1	0.1	100
1996	83.9	0	0.4	14.6	.	0.1	0.7	0	0.2	100
1997	83.1	0	0.4	13.7	0	0.3	1.6	0.2	0.6	100
1998	68.8	0.1	1.3	22.7	0	0.7	2.2	0.1	4	100
1999	74.5	0	0.4	22.3	0	0.7	0.8	0	1.2	100
2000	60.9	.	1	27.3	0	0.6	0.6	0	9.6	100
2001	55.4	0.2	0.4	40.2	0	0.6	1.7	0.1	1.4	100
2002	71.2	0.1	2.1	22.5	0.1	0.7	1.6	0.2	1.5	100
2003	68.3	.	0.7	29.6	0	0.3	0.5	0.1	0.5	100
2004	78.4	.	1.8	17.5	.	0.2	1	0.9	0.2	100
2005	85.6	.	0.8	9.7	.	0.4	3	0.3	0.3	100
2006	81.1	.	2.3	11.2	.	0.6	4	0.7	0	100
2007	89.5	.	1.7	6.1	0.1	0.1	2.4	.	0.1	100
All	69.2	0.1	0.6	27.7	0	0.5	0.9	0.2	0.9	100

Table 18: Percentage Composition of Queen Snapper Category harvest (weight) by gear category for Puerto Rico commercial fisheries. Units are % by year gear of weight (pounds) landed.

YEAR	Bottom Line	Cast Net	Dive, Spear, Scuba	Fish Pot	Net	Rod and Reel	Seine	Verticcal Line	
1987	77	1	.	23	.	.	.	.	100
1988	88	.	2	0	1	9	.	.	100
1989	82	.	0	1	0	5	.	11	100
1990	91	.	3	4	.	1	.	2	100
1991	96	.	1	1	0	0	.	1	100
1992	88	0	0	11	0	.	.	.	100
1993	86	0	.	10	2	1	1	.	100
1994	89	0	1	7	0	2	0	1	100
1995	92	0	0	6	.	1	.	0	100
1996	84	.	1	12	2	1	.	.	100
1997	89	0	1	2	1	1	0	5	100
1998	68	.	1	2	1	2	2	25	100
1999	79	0	1	2	1	1	0	15	100
2000	38	0	0	1	1	3	0	57	100
2001	77	0	0	4	4	6	0	10	100
2002	88	.	6	3	1	2	.	1	100
2003	95	.	0	2	1	2	0	1	100
2004	96	.	1	0	1	2	0	0	100
2005	74	.	1	0	1	25	.	0	100
2006	77	.	6	0	0	17	.	.	100
2007	81	0	15	0	1	3	.	0	100
All	80	0	3	2	1	6	0	7	100

Table 19: Sample sizes for the Silk Snapper group Bottom Line fishery CPUE analyses.

YEAR	Total Number Trips	# Positive Silk Trips	Proportion Positives
1983	6641	2325	0.35
1984	3774	1389	0.37
1985	3944	1714	0.43
1986	3592	1547	0.43
1987	3861	1366	0.35
1988	5310	1490	0.28
1989	6304	2014	0.32
1990	6051	1602	0.26
1991	8462	2352	0.28
1992	7189	2065	0.29
1993	8686	1992	0.23
1994	8358	2540	0.30
1995	13268	3391	0.26
1996	13407	3328	0.25
1997	12998	3062	0.24
1998	10846	2522	0.23
1999	10286	2379	0.23
2000	11529	2304	0.20
2001	13157	3074	0.23
2002	12443	2848	0.23
2003	13047	3172	0.24
2004	10489	2545	0.24
2005	9416	2071	0.22
2006	8468	1651	0.19
2007	7386	1311	0.18

Table 20: Sample sizes for the Queen Snapper group bottom line fishery CPUE analyses.

YEAR	Total number Trips	# Positive Queen trips	Proportion positives
1987	3892	20	0.01
1988	5382	164	0.03
1989	6382	184	0.03
1990	6100	193	0.03
1991	8565	422	0.05
1992	7214	456	0.06
1993	8782	493	0.06
1994	8443	432	0.05
1995	13375	521	0.04
1996	13602	504	0.04
1997	13253	485	0.04
1998	11047	444	0.04
1999	10424	543	0.05
2000	11719	469	0.04
2001	13333	727	0.05
2002	12552	704	0.06
2003	13134	1451	0.11
2004	10552	995	0.09
2005	9475	928	0.10
2006	8563	802	0.09
2007	7435	925	0.12

Table 21: Reported Queen Snapper group commercial landings in Puerto Rico 1987-2007.

	TOT_WT
	Pounds
CYEAR	
1987	4,378
1988	14,759
1989	15,609
1990	11,463
1991	17,763
1992	25,548
1993	32,311
1994	27,731
1995	34,114
1996	36,671
1997	39,312
1998	48,372
1999	70,326
2000	87,776
2001	109,302
2002	116,255
2003	134,233
2004	85,822
2005	137,945
2006	105,635
2007	115,885
All	127,1206

Table 22: Number of trip observations of CPUE available for use in developing multispecies CPUE trends for the Silk Snapper group from the bottom line fishery in Puerto Rico, 1983-2007. Table also provides CPUE trend (index) and the coefficient of Variation for the estimated CPUE from the multinomial model fit.

Year	*Number of Stations*	*Blackfin Index*	*Blackfin CV*	*Scaled Blackfin Index*	*Silk Index*	*Silk CV*	*Scaled Silk Index*	*Black Index*	*Black CV*	*Scaled Black Index*	*Vermilion Index*	*Vermilion CV*
1983	3595	0.00001	0.14945	0.00007	15.9882	0.03683	1.06248	0	0.53551	0.00016	0	0.0499
1984	1939	0.00003	0.15204	0.00024	23.2806	0.051562	1.54709	0.00001	0.53614	0.00049	0.00002	0.05354
1985	2288	0.00002	0.15141	0.00017	37.4259	0.042575	2.4871	0.00001	0.53599	0.00037	0.00001	0.05288
1986	2126	0.00005	0.15183	0.00035	33.6771	0.043797	2.23798	0.00002	0.53609	0.00074	0.00002	0.05353
1987	2235	0.00002	0.15128	0.00017	16.1789	0.052599	1.07515	0.00001	0.53595	0.00035	0.57242	0.2545
1988	3663	0.00001	0.14931	0.00006	12.1716	0.040957	0.80885	0.05946	0.52917	1.95193	0.30095	0.23638
1989	4095	0.01347	1.00435	0.0932	12.7044	0.036316	0.84426	0.11589	0.34185	3.80424	0.14914	0.30201
1990	3960	0.012	1.22047	0.08308	14.0643	0.039395	0.93463	0.10907	0.40441	3.58047	0.46756	0.19641
1991	4884	0.01738	0.8678	0.1203	12.0893	0.036241	0.80338	0.02892	0.67059	0.94937	0.0963	0.36839
1992	3995	0.06865	0.51518	0.47517	15.0083	0.038345	0.99736	0.08208	0.46819	2.69453	0.37485	0.22016
1993	5561	0.23245	0.23513	1.60892	11.2058	0.036666	0.74467	0.05618	0.47166	1.84427	0.32718	0.19642
1994	4624	0.00001	0.14867	0.00009	19.2427	0.031516	1.27876	0.01179	0.53519	0.38717	0.38086	0.20067
1995	7053	0.00539	1.37798	0.03729	17.0545	0.027366	1.13334	0	0.53505	0.00008	0.85709	0.11019
1996	7788	0	0.14731	0.00002	15.3889	0.027156	1.02265	0.00189	2.19913	0.06204	0.68472	0.11662
1997	7342	0.08904	0.3278	0.61626	13.9856	0.028801	0.9294	0	0.53502	0.00006	0.76776	0.11171
1998	6140	0.27327	0.21292	1.89142	12.8382	0.033767	0.85315	0.01198	0.53501	0.39321	0.99218	0.11119
1999	6289	0.3151	0.19688	2.18099	11.5852	0.035068	0.76988	0.16035	0.27194	5.26371	0.95885	0.11215
2000	5997	0.60454	0.14148	4.18429	11.2821	0.035154	0.74974	0.04153	0.52712	1.36343	1.36879	0.09299
2001	7182	0.40739	0.1561	2.81973	10.6991	0.03285	0.711	0	0.53503	0.00005	0.77237	0.1122
2002	6996	0.37435	0.16746	2.59109	12.2718	0.031692	0.81551	0.00904	0.53496	0.29675	0.86316	0.10932
2003	7553	0.37099	0.143	2.5678	9.8185	0.030107	0.65248	0.06551	0.33343	2.15056	0.46002	0.12672
2004	6896	0.18319	0.20469	1.26792	9.9414	0.030516	0.66064	0.00085	2.95028	0.02801	0.38105	0.14082
2005	6317	0.3036	0.17003	2.10138	10.8976	0.03102	0.72419	0.00352	0.53507	0.11565	0.29164	0.17118
2006	6025	0.26667	0.18108	1.84576	9.0527	0.033758	0.60159	0.00342	0.53509	0.11237	0.10256	0.28751
2007	4777	0.07429	0.39594	0.51421	8.3477	0.040661	0.55474	0	.	0	0.11105	0.322

Table 23. Number of trips by gear fished - Puerto Rico sales/trip ticket landings data.

Gear	Number of Trips
Haul seines	430
Crab pot/traps	1
Fish pot/traps	6,614
Lobster pot/traps	17
Gillnets	3,710
Trammel nets	3,561
Handlines	1,446
Rod and reel	1
Troll lines	44
Longlines	20
Cast nets	3
Spears	4
Diving	6,868
Total	**22,719**

Table 24: Number of trips, proportion positive trips, and standardized abundance index for parrotfish. Index constructed using Puerto Rico trap landings data.

YEAR	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1991	96	0.15625	0.393869	0.051422	3.016871	1.348597
1992	54	0.222222	0.162654	0.016884	1.566973	1.614615
1993	106	0.169811	0.280417	0.04071	1.931545	1.239808
1994	123	0.382114	1.209629	0.301986	4.845254	0.786364
1995	196	0.244898	0.327996	0.08052	1.33608	0.798416
1996	275	0.250909	0.48381	0.144444	1.620508	0.664039
1997	174	0.074713	0.067747	0.006803	0.674665	1.657121
1998	303	0.270627	0.376113	0.120858	1.170469	0.616583
1999	427	0.358314	0.83171	0.341372	2.026355	0.468262
2000	432	0.446759	0.928179	0.416974	2.066116	0.41666
2001	379	0.488127	1.317999	0.607394	2.859956	0.40234
2002	387	0.478036	1.83251	0.826775	4.061676	0.414243
2003	879	0.60182	1.321942	0.7889	2.215148	0.262468
2004	712	0.636236	1.538335	0.927541	2.551345	0.257061
2005	596	0.629195	1.484291	0.848386	2.596835	0.285238
2006	652	0.659509	1.969747	1.255423	3.090512	0.228102
2007	461	0.715835	2.473054	1.566257	3.904849	0.231393

Table 25: Number of trips, proportion positive trips, and standardized abundance index for parrotfish. Index constructed using Puerto Rico dive landings data.

YEAR	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	102	0.441176	2.877067	1.203627	6.877144	0.457238
1999	287	0.33101	1.23848	0.562564	2.726504	0.410434
2000	150	0.4	1.627236	0.691478	3.829329	0.448259
2001	434	0.276498	0.825153	0.377809	1.802174	0.405972
2002	483	0.217391	0.630718	0.262462	1.515669	0.460306
2003	781	0.21767	0.536803	0.232742	1.238097	0.43677
2004	588	0.173469	0.472043	0.18313	1.21676	0.501249
2005	466	0.107296	0.367504	0.107387	1.257683	0.678199
2006	482	0.192946	0.45134	0.17348	1.17424	0.506742
2007	434	0.28341	0.973656	0.445876	2.126167	0.405881

Table 26: Number of trips and standardized abundance index for parrotfish. Index constructed using Puerto Rico trammel net landings data.

YEAR	Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1991	40	1.853138	0.998559	3.439077	0.316698
1992	58	0.689625	0.370554	1.283438	0.318217
1993	5	1.031559	0.433795	2.453033	0.454257
1994	106	1.262051	0.612749	2.599388	0.373384
1995	237	1.281447	0.715252	2.295844	0.297862
1996	189	1.265238	0.703906	2.274208	0.2996
1997	70	1.096878	0.592635	2.030157	0.31526
1998	9	1.278191	0.523957	3.118138	0.469005
1999	45	0.695221	0.310234	1.557961	0.42044
2000	74	0.682398	0.372008	1.251766	0.310463
2001	146	0.854452	0.474771	1.537769	0.30027
2002	245	1.004442	0.55811	1.807715	0.300272
2003	457	0.889651	0.498333	1.588252	0.295971
2004	393	0.920018	0.51504	1.643433	0.296285
2005	207	0.726003	0.403504	1.306257	0.300131
2006	259	0.67699	0.377455	1.214227	0.298446
2007	172	0.792696	0.441375	1.423658	0.29916

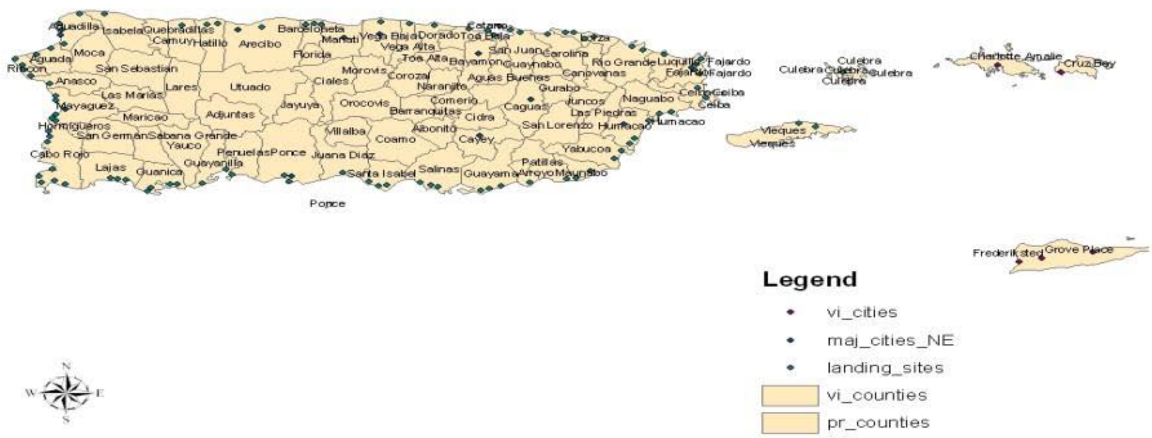


Figure 7: Puerto Rico Commercial Fishing Centers.

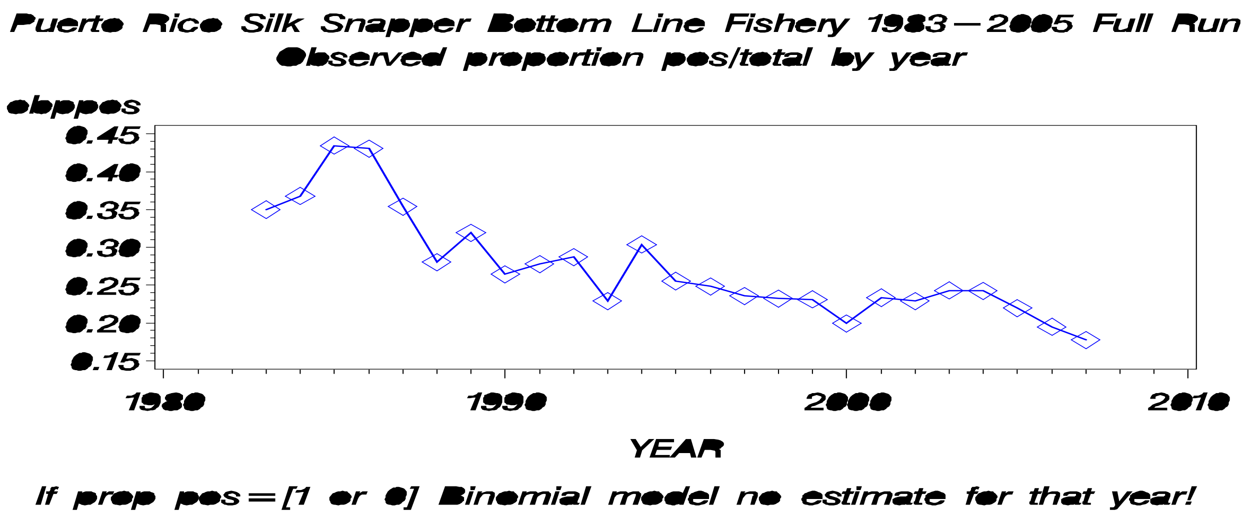


Figure 8: Observed proportion of positives by year for silk snapper CPUE analyses for the commercial bottom line fishery in Puerto Rico for 1983-2007.

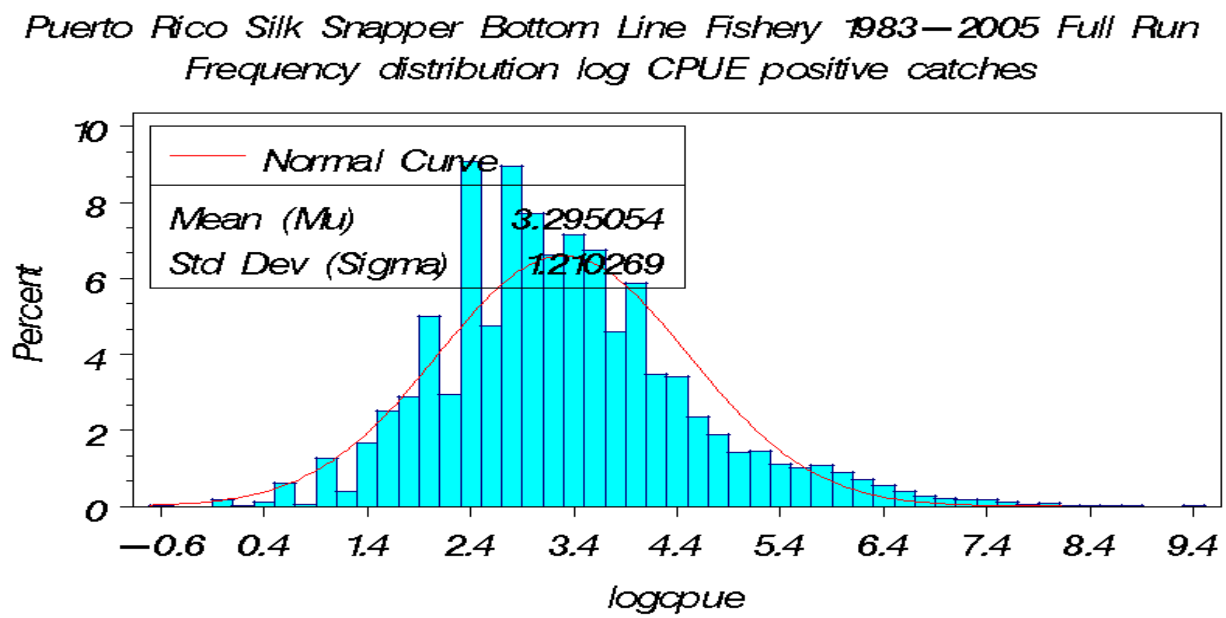


Figure 9: Distribution of logged nominal (unadjusted) CPUE observations for Silk snapper catches form the bottom line fishery in Puerto Rico, 1983-2007.

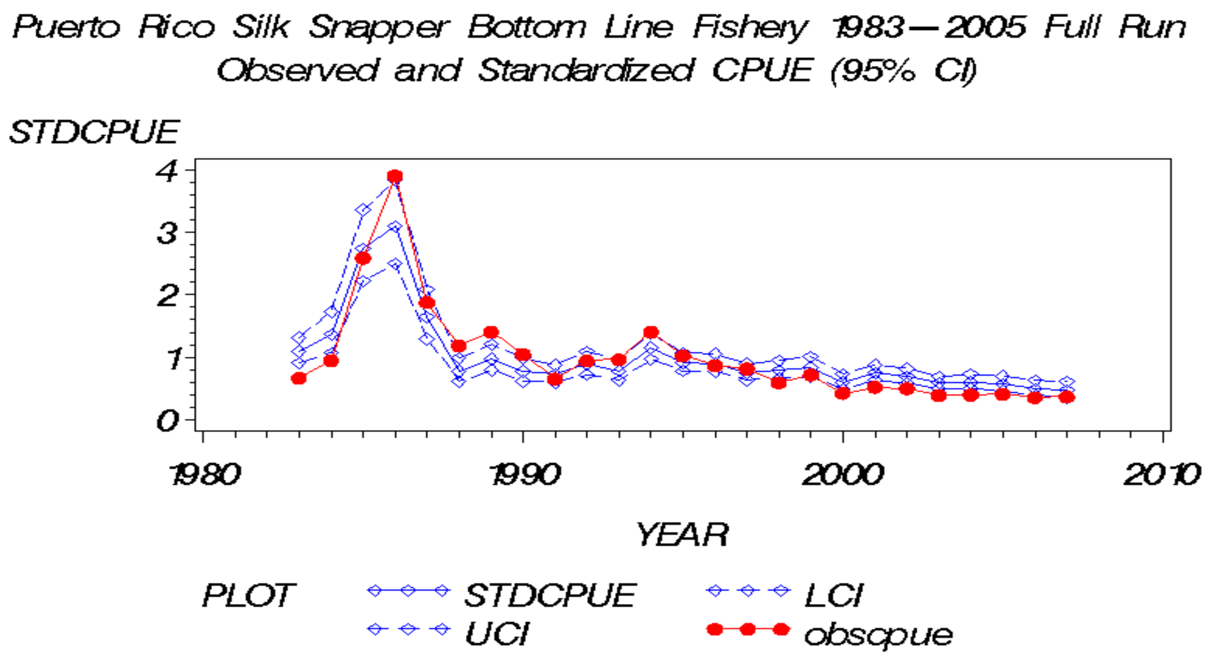


Figure 10: Delta-lognormal standardized, nominal (observed), and 95% Confidence intervals for Silk Snapper CPUE abundance indices for the commercial bottom line fishery in Puerto Rico.

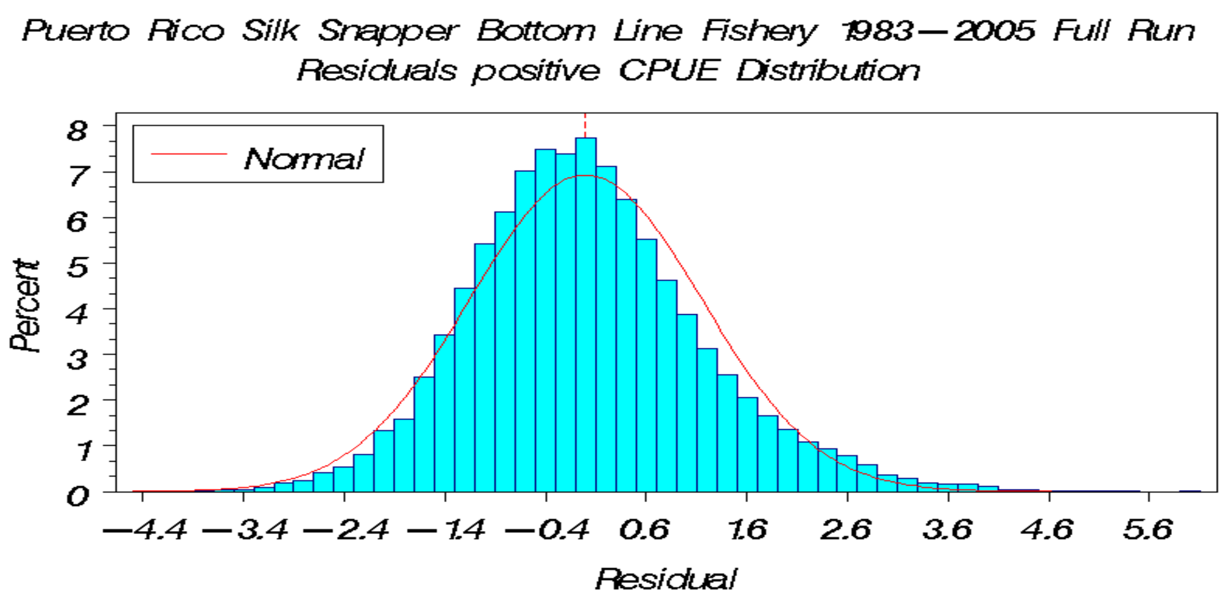


Figure 11: Residual distribution for the fitted logged CPUE observations for the Silk Snapper Bottom line fishery in Puerto Rico 1983-2007.

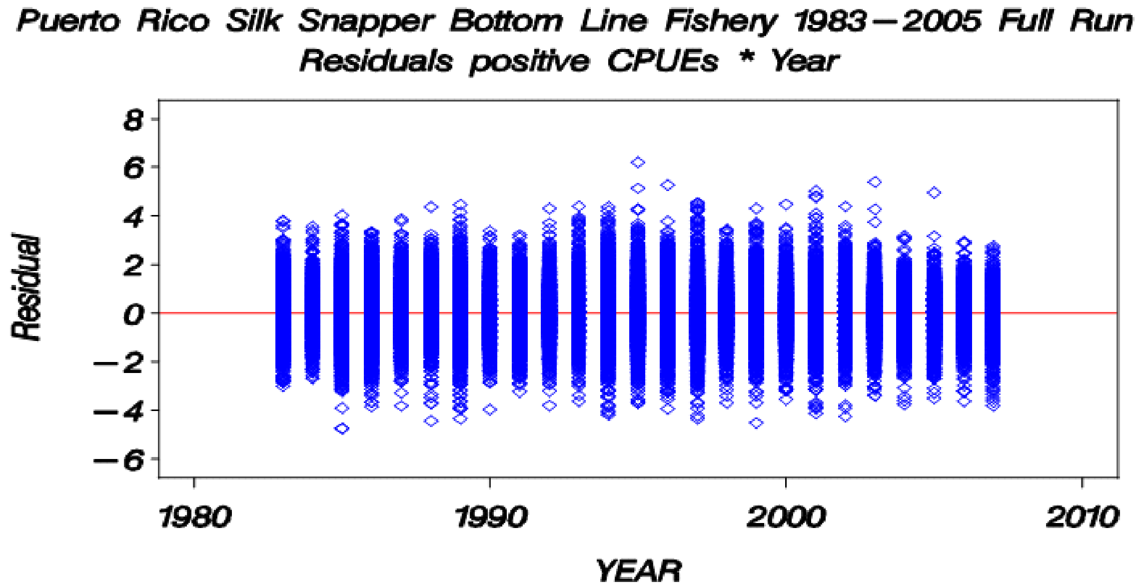


Figure 12: Residual distribution for the fitted logged CPUE observations by year for the Silk Snapper Bottom line fishery in Puerto Rico 1983-2007.

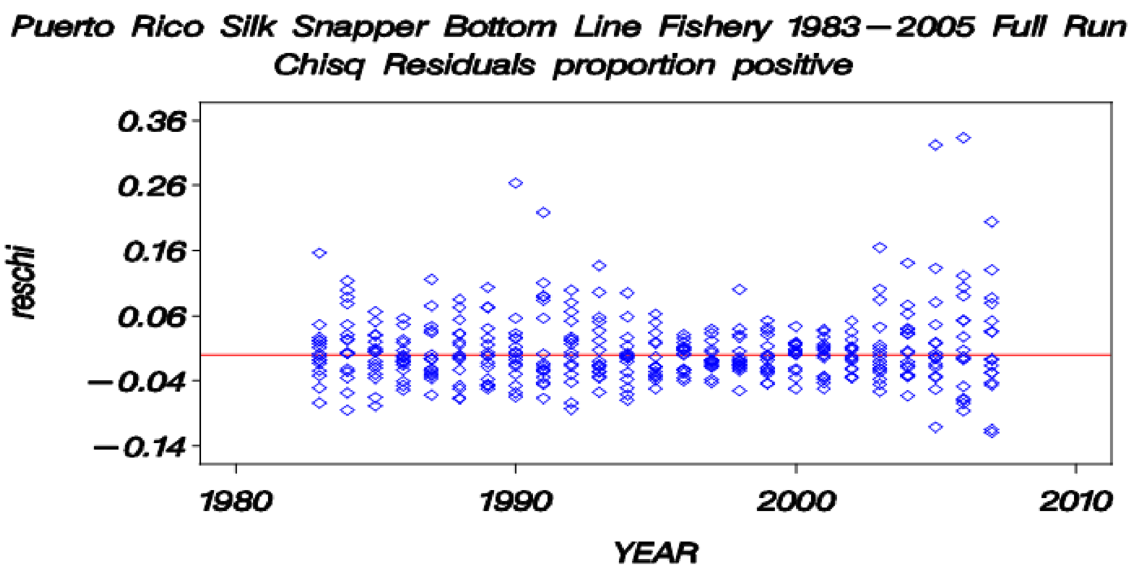


Figure 13: Residual distribution for the fitted proportion of positives success observations for the Silk snapper Bottom line fishery in Puerto Rico.

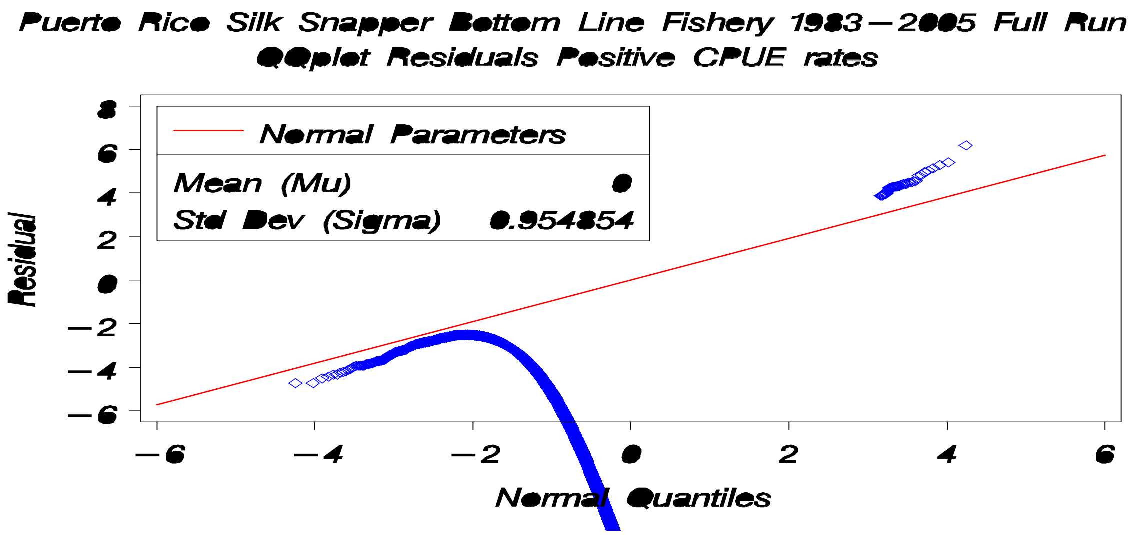


Figure 14: Q-Q Quantile plot of the residuals for the positive CPUE observations for the Silk Snapper Bottom line fishery in Puerto Rico 1983-2007.

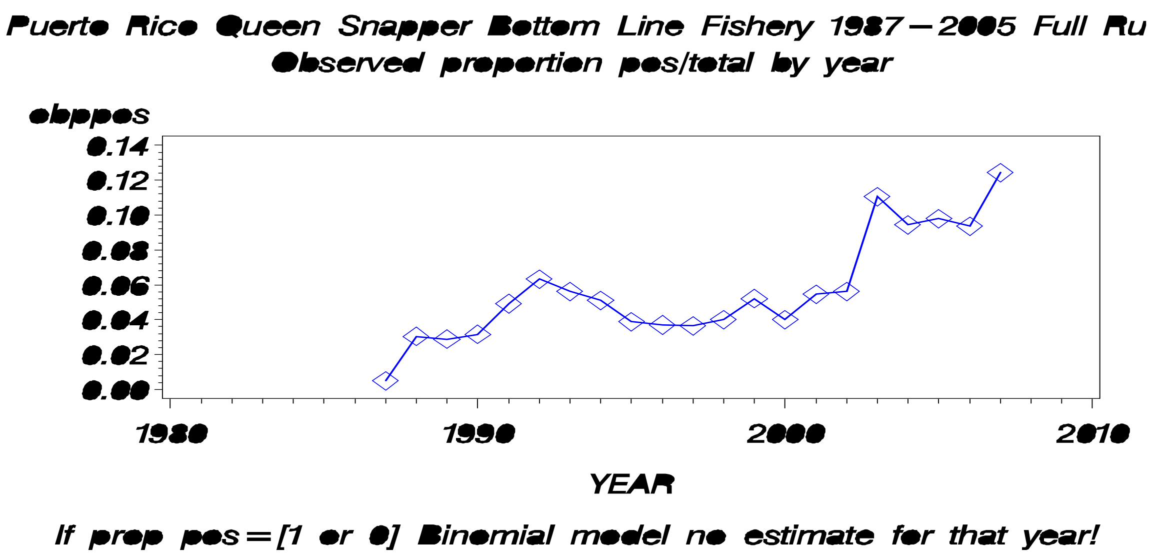


Figure 15: Observed proportion of positives by year for Queen Snapper CPUE analyses for the commercial bottom line fishery in Puerto Rico for 1983-200.

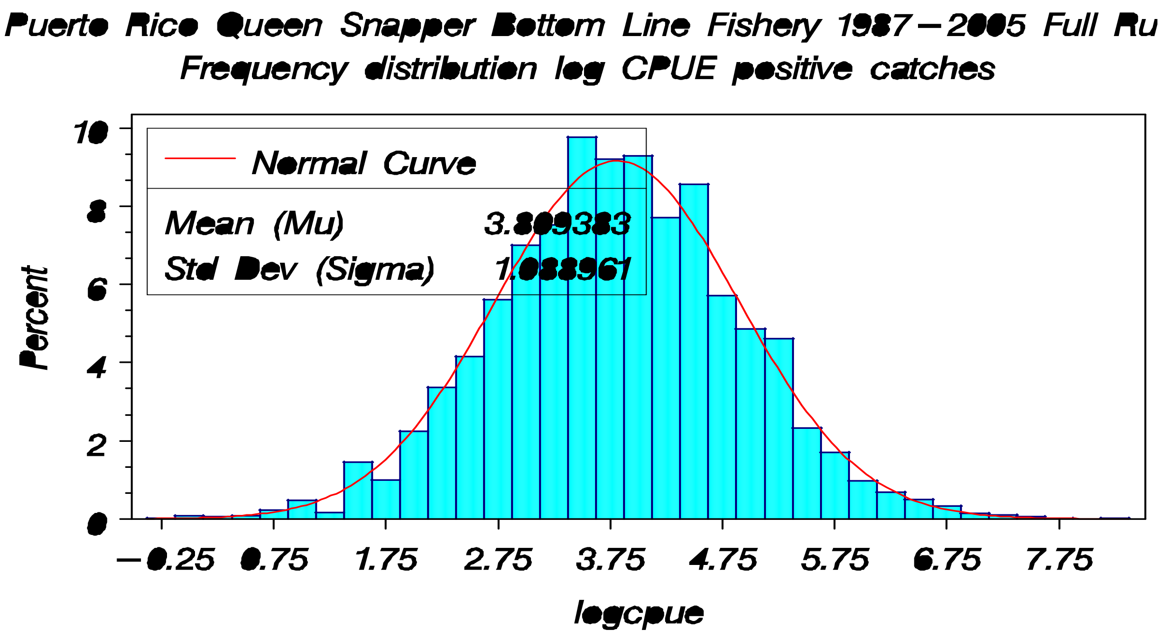


Figure 16: Distribution of logged nominal (unadjusted) CPUE observations for Queen Snapper catches form the bottom line fishery in Puerto Rico, 1983-2007.

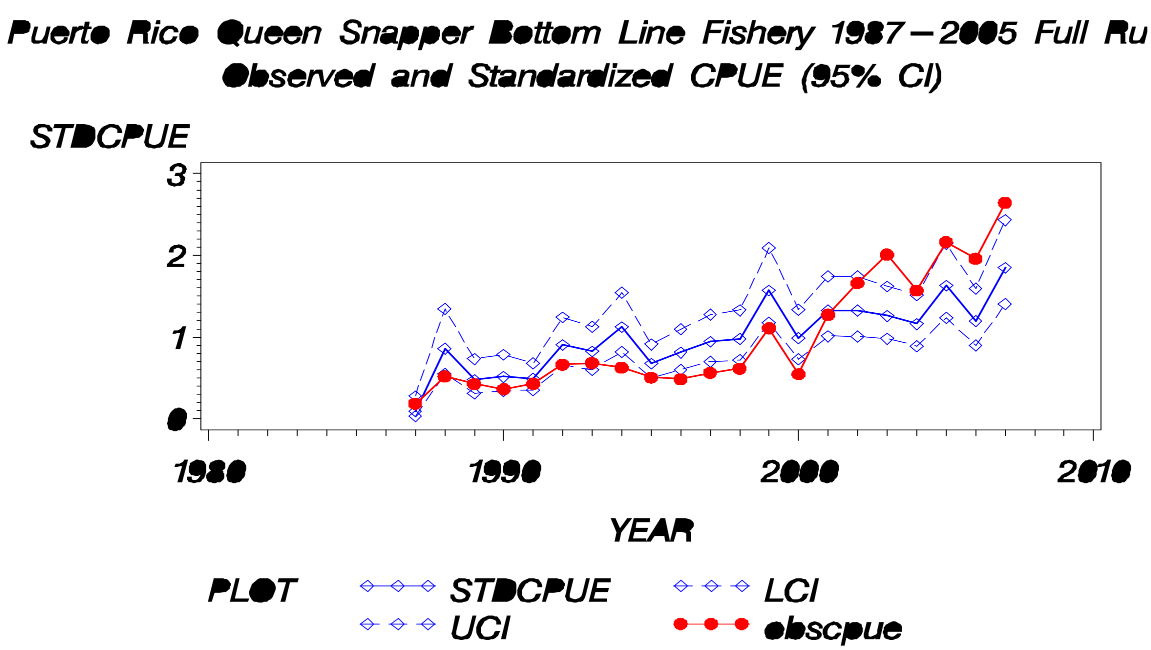


Figure 17: Delta-lognormal standardized, nominal (observed), and 95% Confidence intervals for Queen Snapper CPUE abundance indices for the commercial bottom line fishery in Puerto Rico.

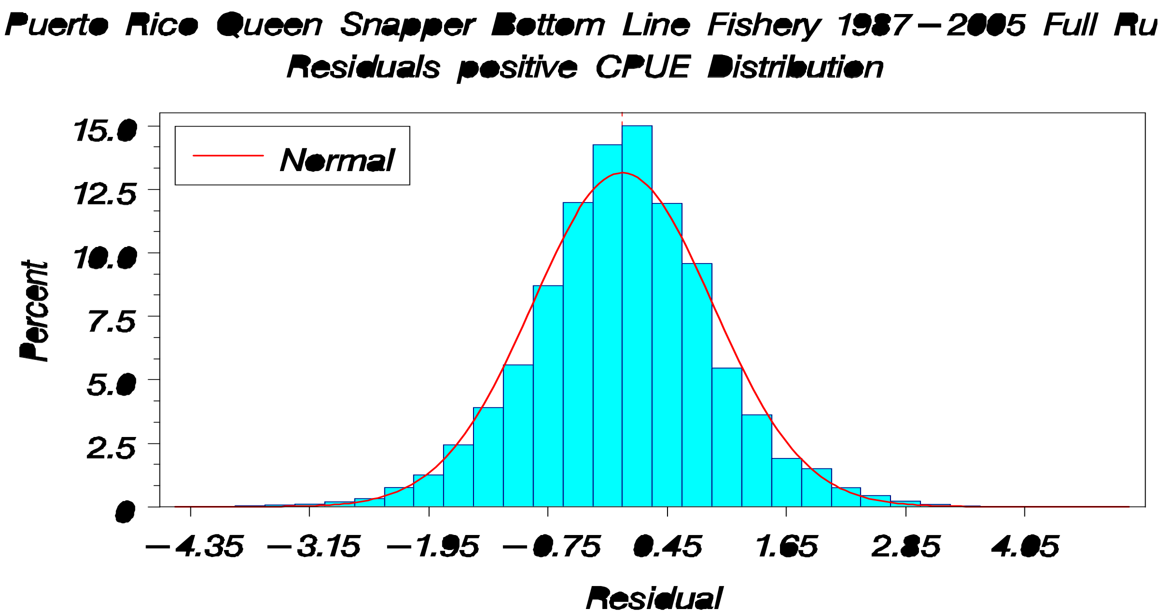


Figure 18: Residual distribution for the fitted logged CPUE observations for the Queen Snapper Bottom line fishery in Puerto Rico 1983-2007.

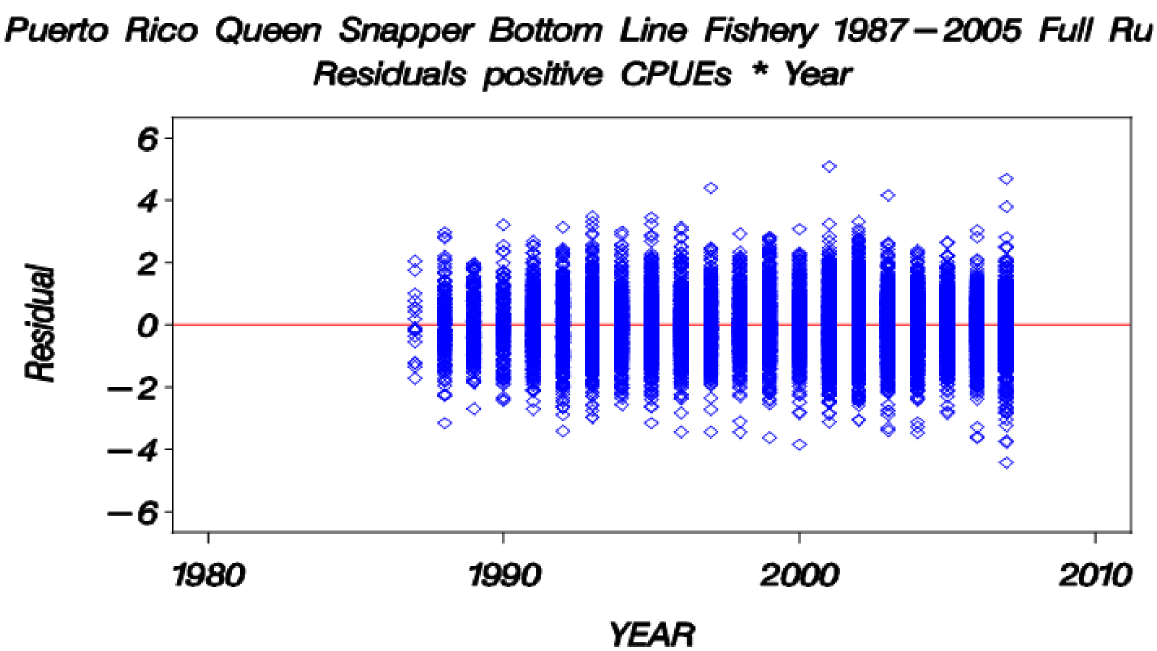


Figure 19: Residual distribution for the fitted logged CPUE observations for the Queen Snapper Bottom line fishery in Puerto Rico 1983-2007.

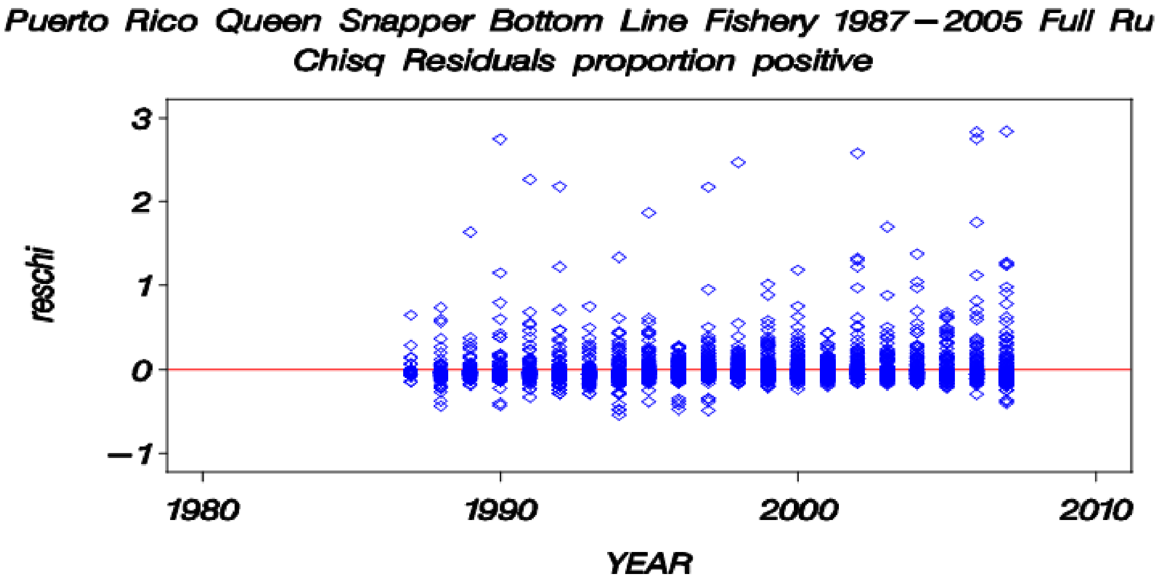


Figure 20: Residual chi-square distribution for the fitted proportion of positives success observations for the Queen Snapper Bottom line fishery in Puerto Rico by year.

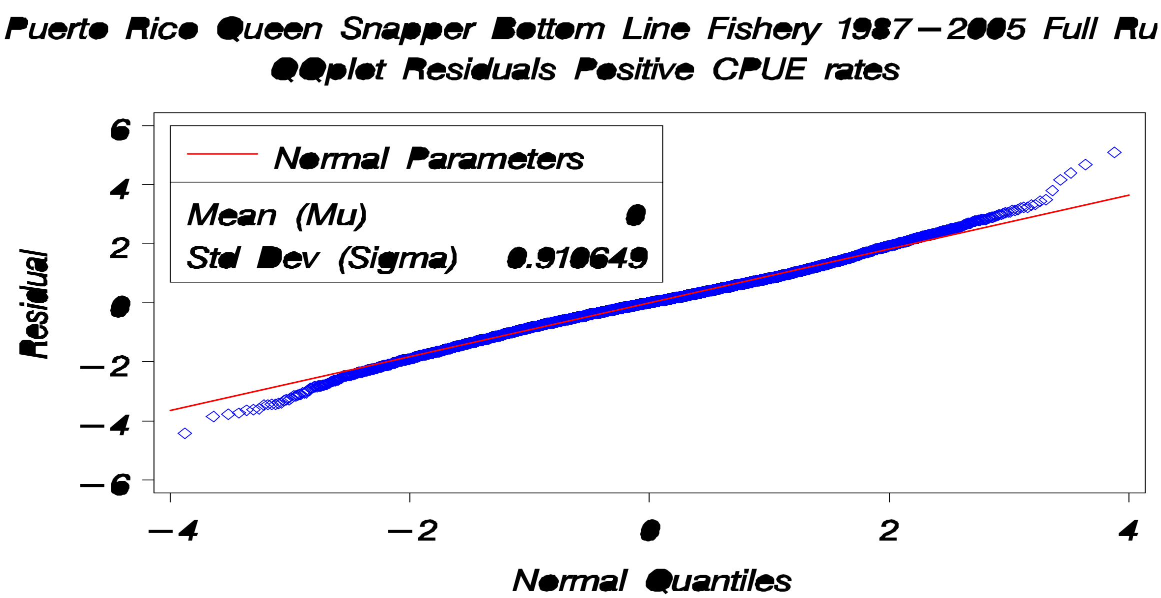


Figure 21: Q-Q Quantile plot of the residuals for the positive CPUE observations for the Queen Snapper Bottom line fishery in Puerto Rico 1983-2007.

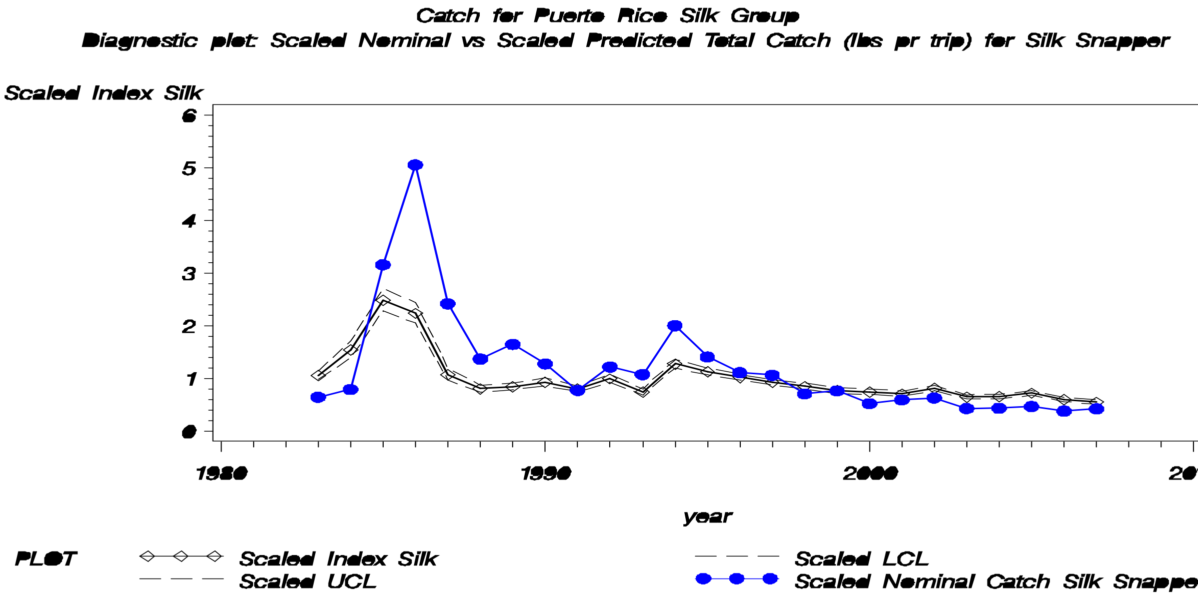


Figure 22: Standardized CPUE trend, observed, and 0.95 Confidence Interval for silk Snapper from the multinomial method.

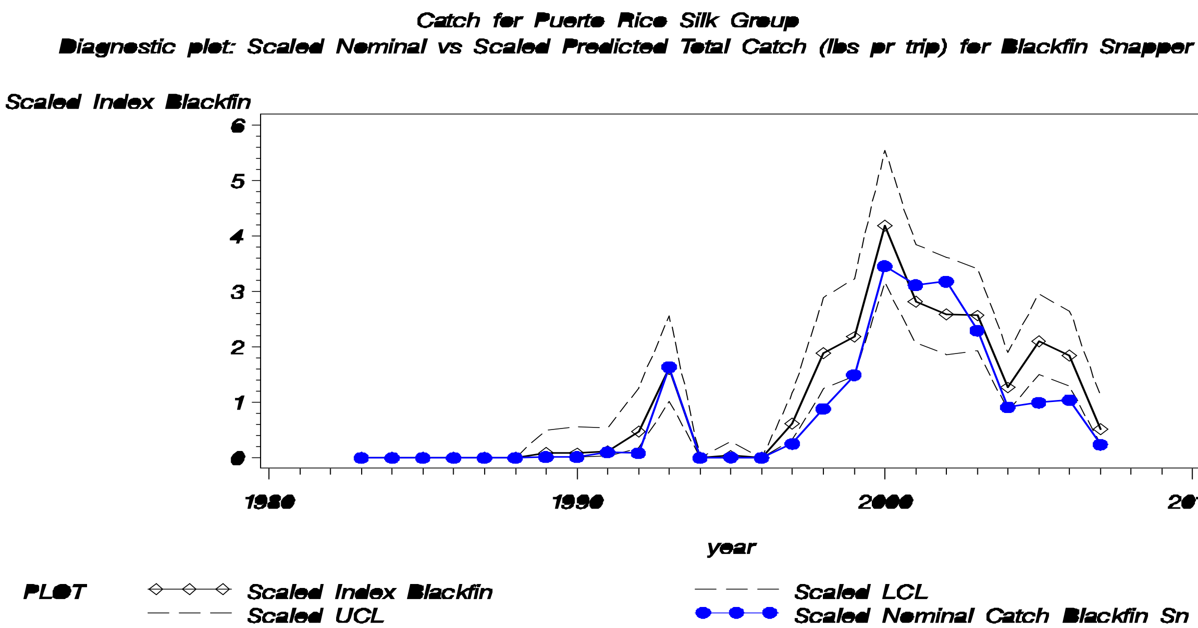


Figure 23: Standardized CPUE trend, observed, and 0.95 Confidence Interval for Blackfin Snapper from the multinomial method.

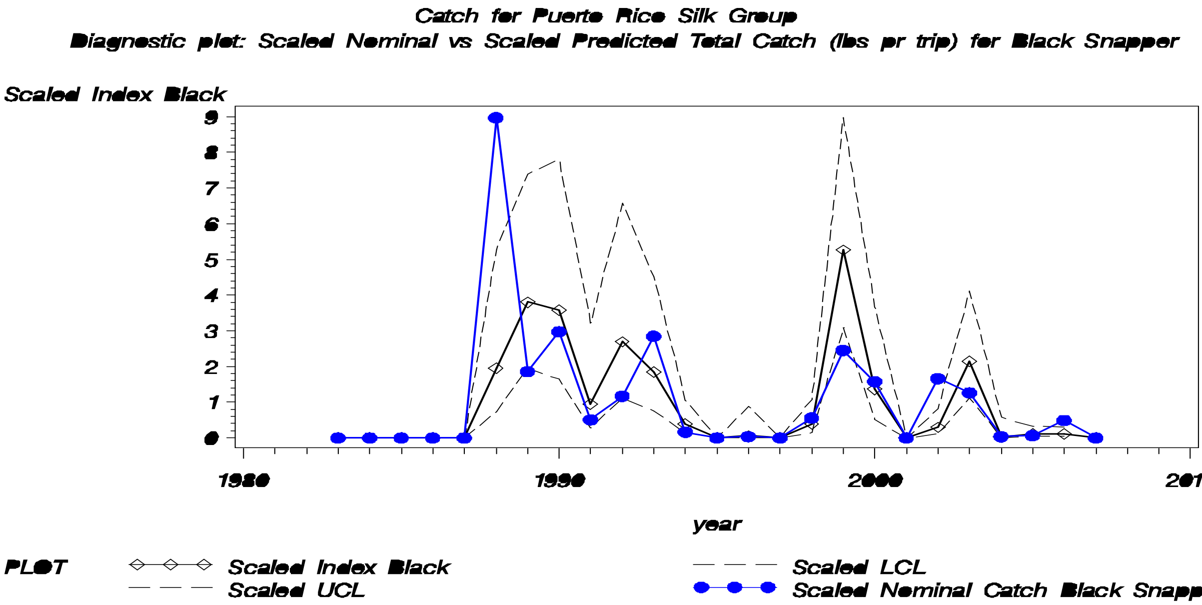


Figure 24: Standardized CPUE trend, observed, and 0.95 Confidence Interval for Black Snapper from the multinomial method.

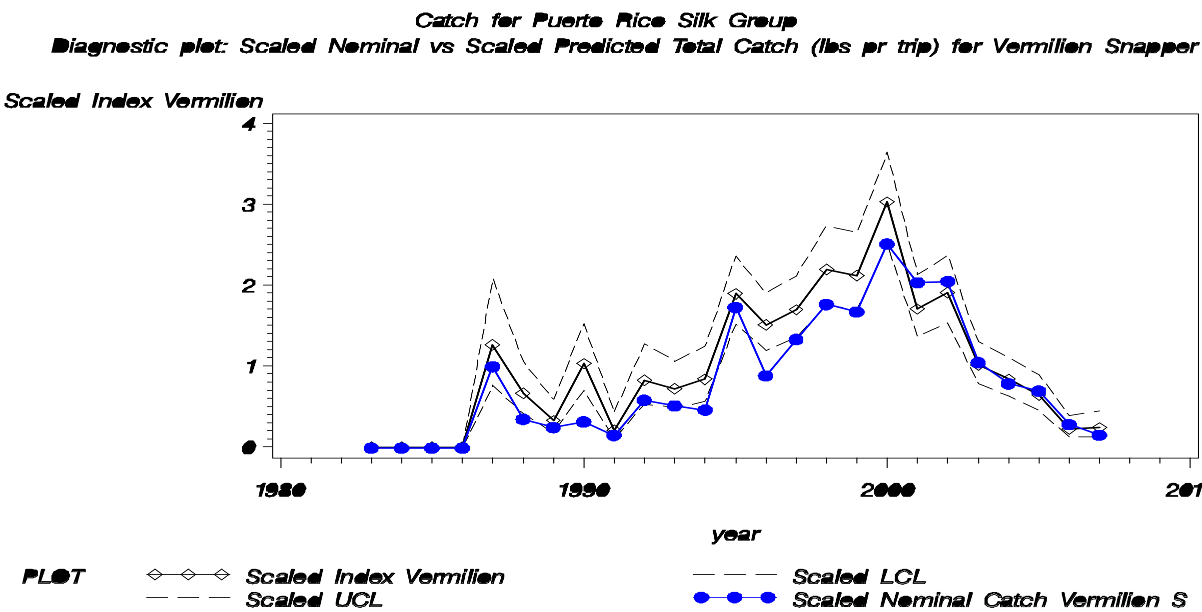


Figure 25: Standardized CPUE trend, observed, and 0.95 Confidence Interval for Vermillion Snapper from the multinomial method.

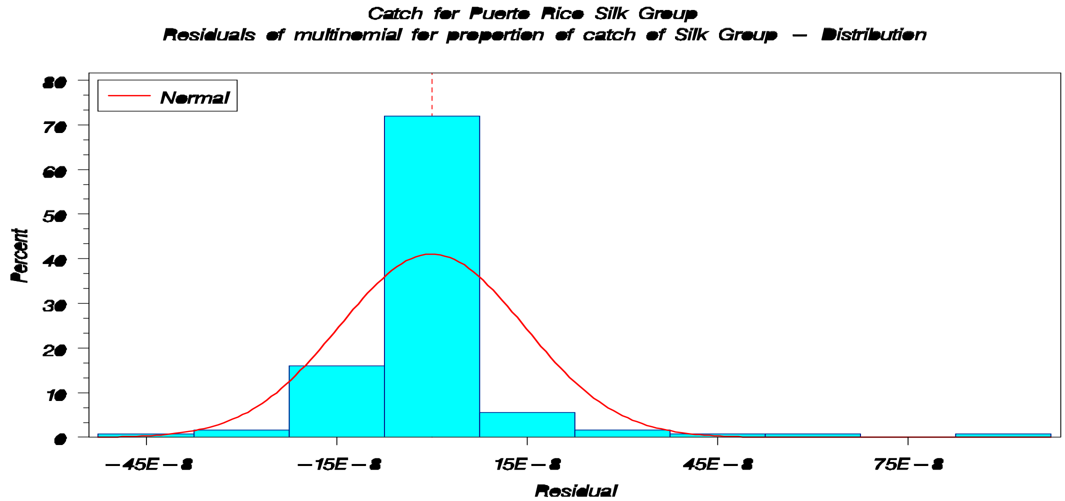


Figure 26: Residual distribution for multinomial fit to proportion of positives for Silk group.

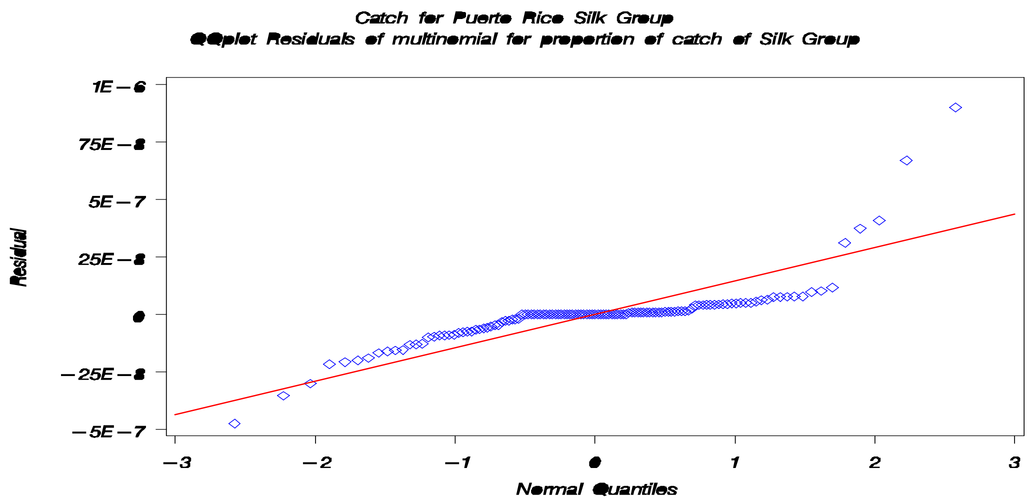


Figure 27: Q-Q plot of residuals for multinomial fit to proportion of positives for Silk Snapper Group.

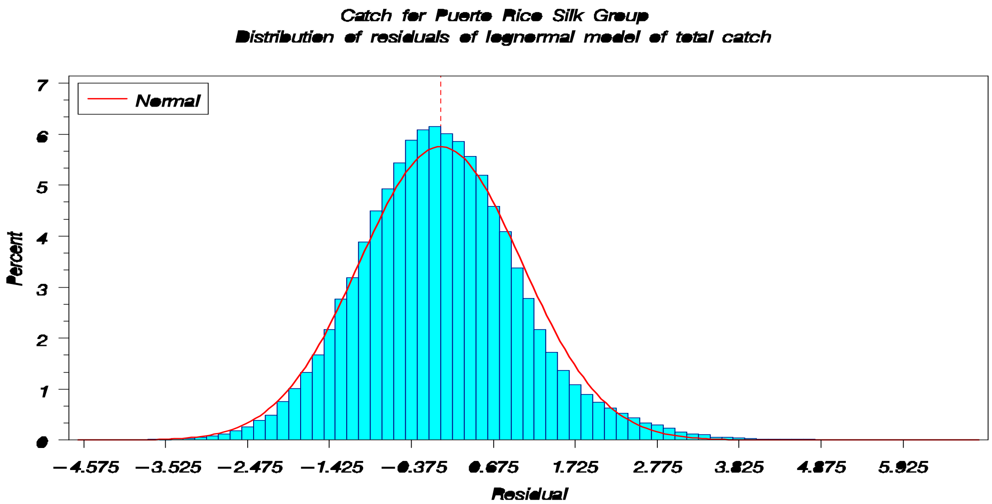


Figure 28: Residual distribution of multinomial fit to the log CPUE data.

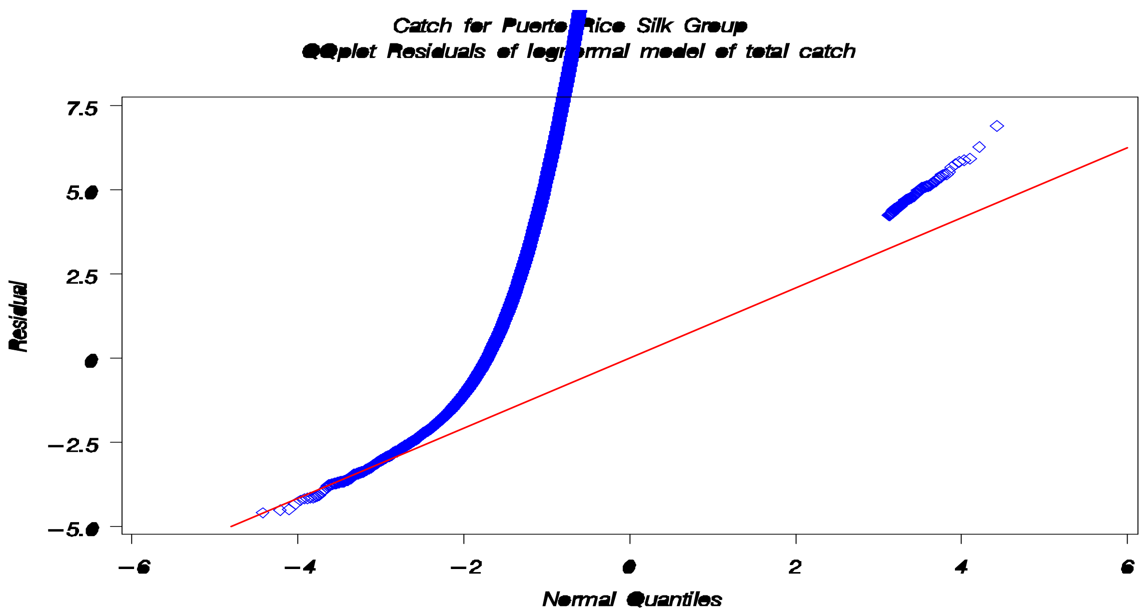


Figure 29: Residual distribution of multinomial fit to the log CPUE data.

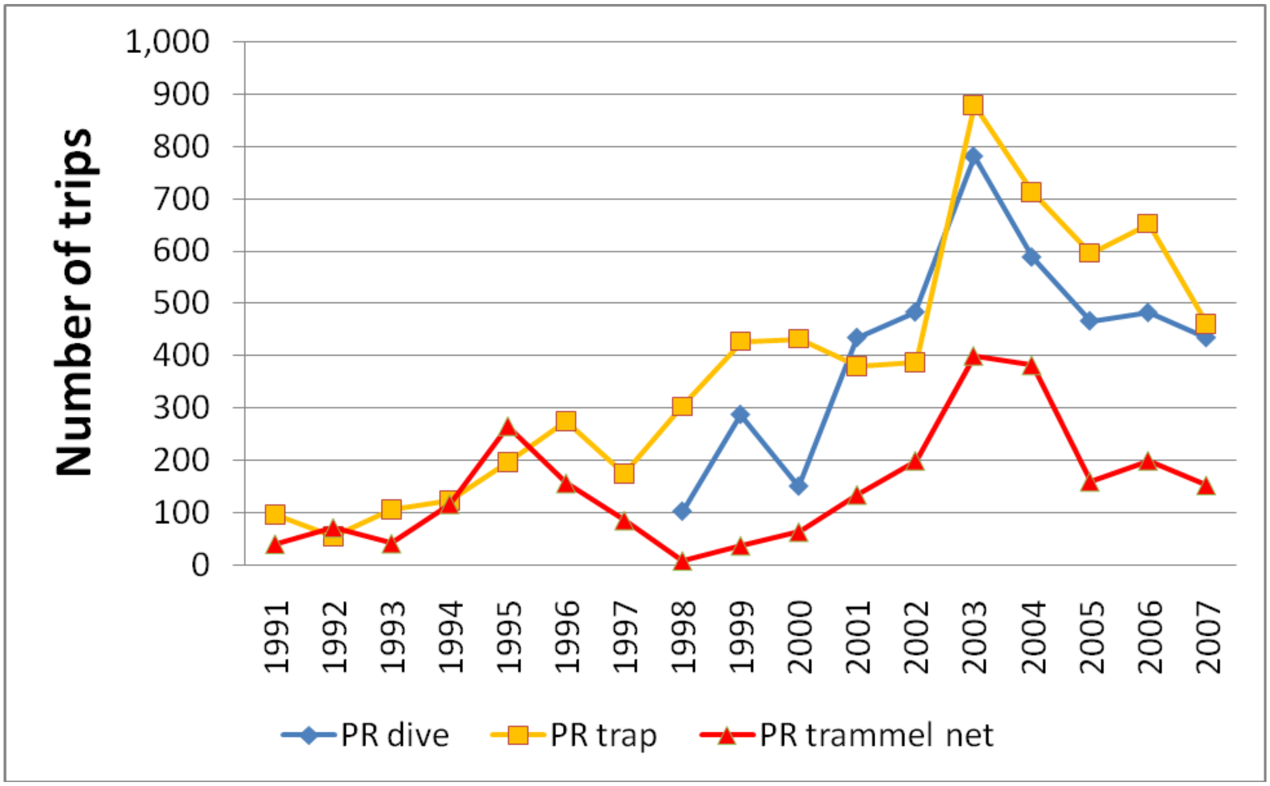


Figure 30: Yearly number of parrotfish trips by gear type in Puerto Rico as selected using the Stephens and MacCall (2004) method.

Figure 31: "Coast" factor defined for Puerto Rico.

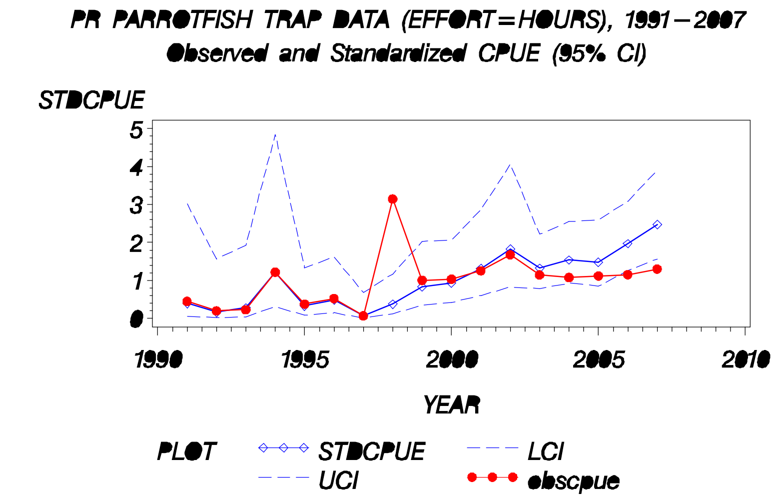


Figure 32: Puerto Rico parrotfish standardized index of abundance constructed from commercial trap landings data.

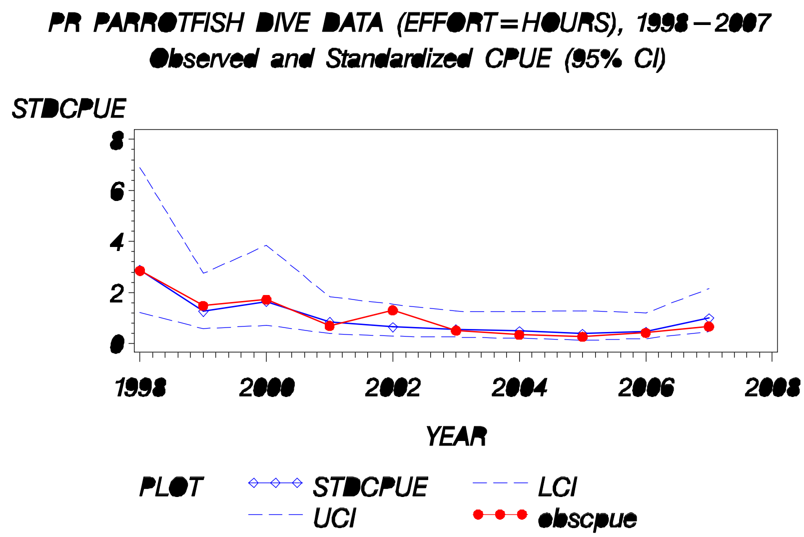


Figure 33: Puerto Rico parrotfish standardized index of abundance constructed from commercial dive landings data.

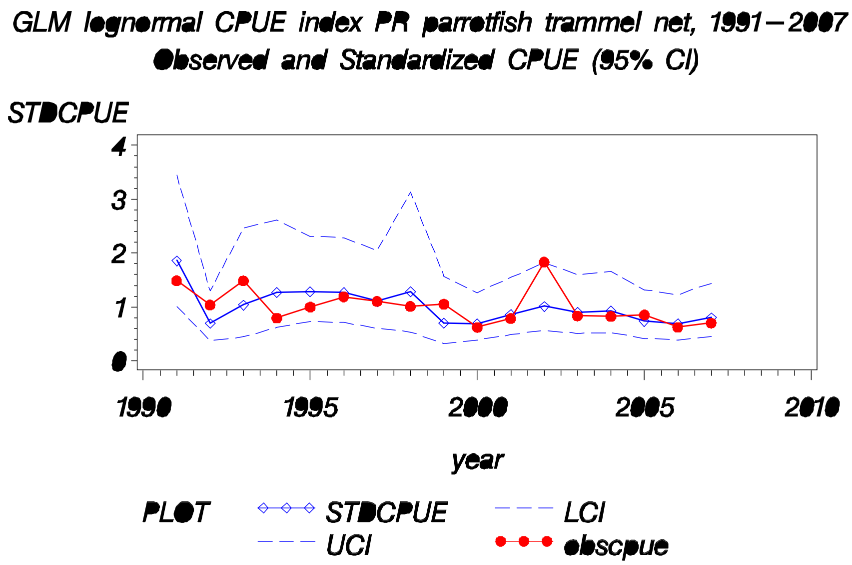


Figure 34: Puerto Rico parrotfish standardized index of abundance constructed from commercial trammel net landings data.

A. **B.**

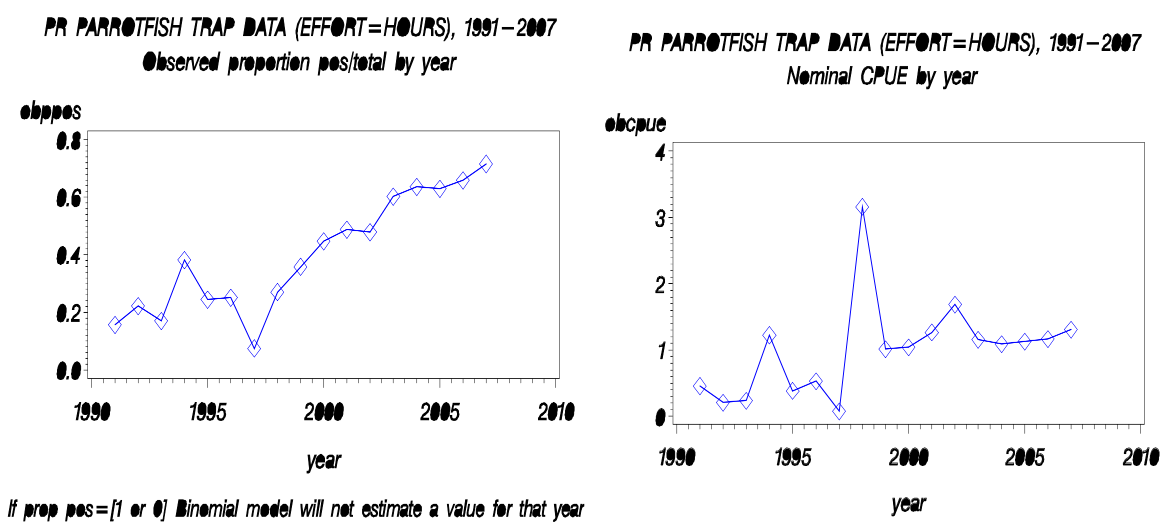


Figure 35: Annual trend in the proportion of positive trips (**A)** and nominal CPUE (**B)** for the Puerto Rico trap data model.

A. **B.**

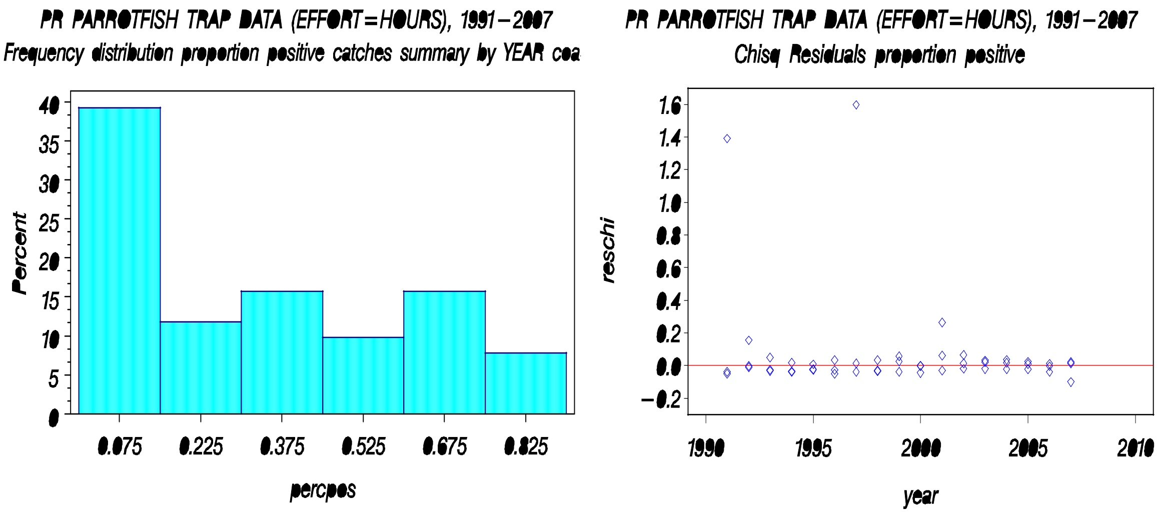


Figure 36: Diagnostic plots for the binomial component of the Puerto Rico commercial trap data model: **A**. the frequency distribution of the proportion positive trips; **B**. the Chi-Square residuals by year.

A. **B.**

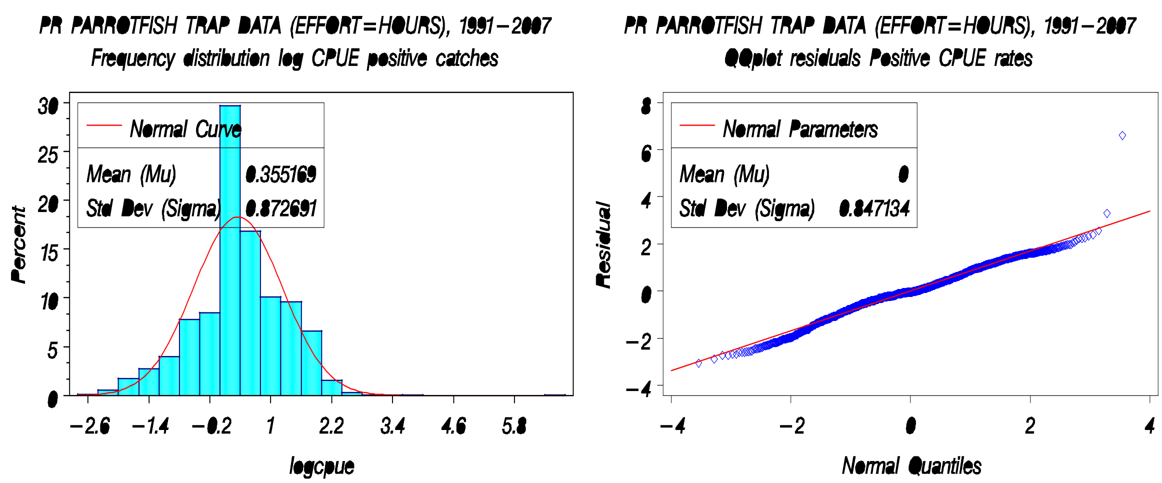


Figure 37: Diagnostic plots for the lognormal component of the Puerto Rico commercial trap data model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

A. **B.**

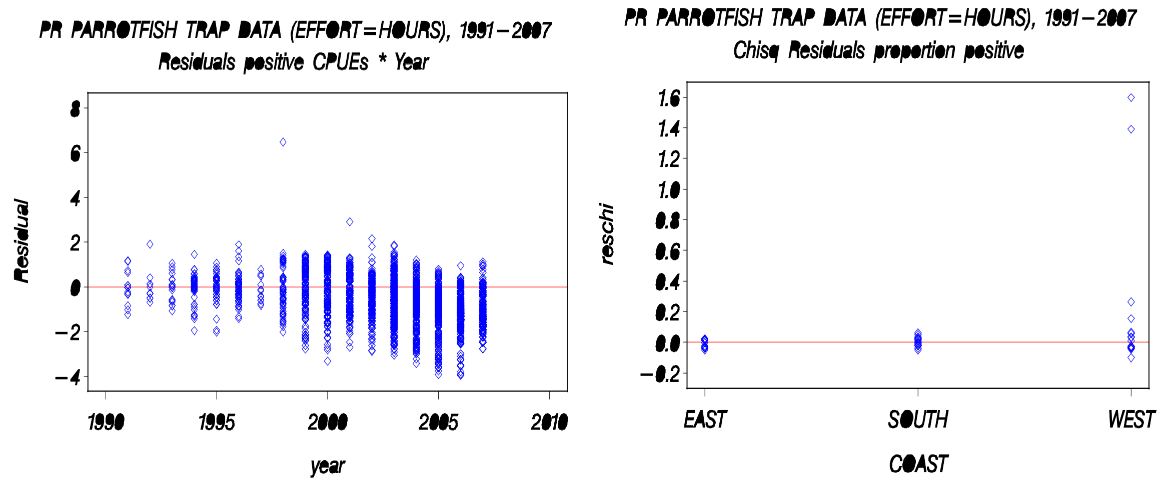


Figure 38: Diagnostic plots for the lognormal component of the Puerto Rico commercial trap data model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by coast.

A. **B.**

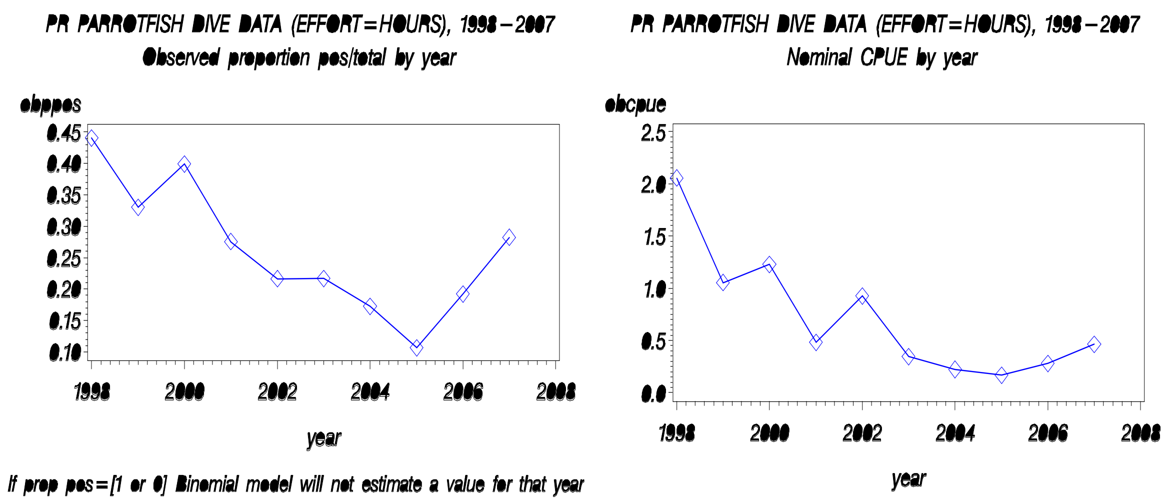
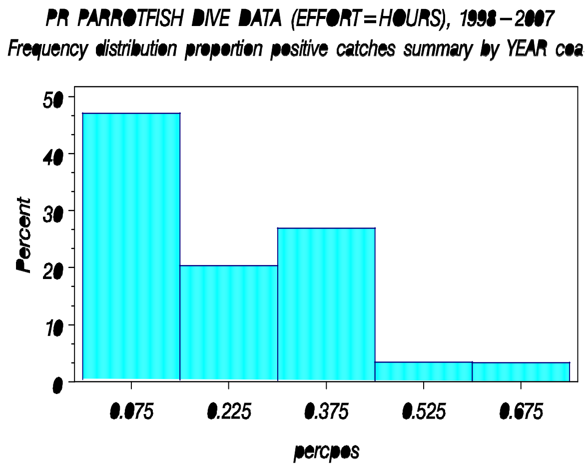
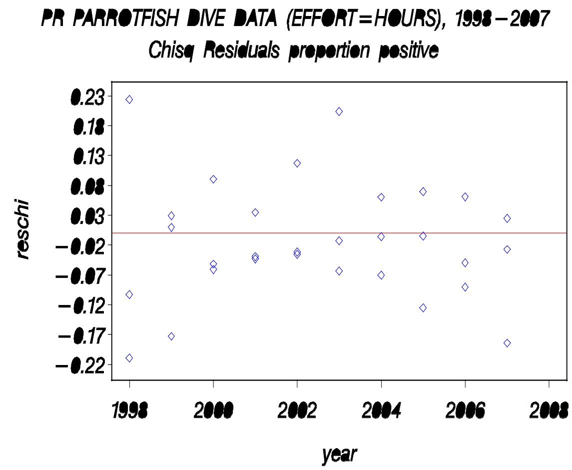


Figure 39: Annual trend in the proportion of positive trips **(A)** and nominal CPUE **(B)** for the Puerto Rico dive data model.

A.



B.



C.

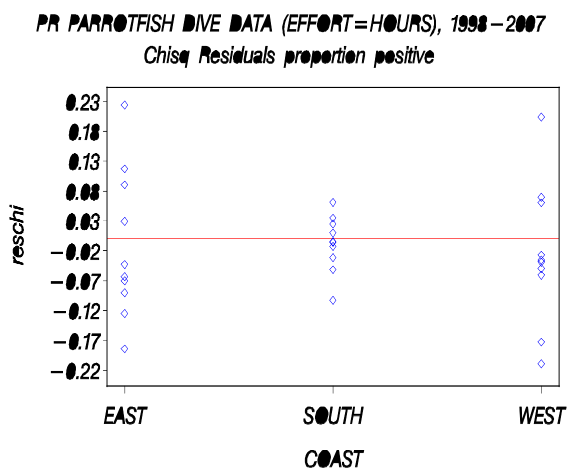


Figure 40: Diagnostic plots for the binomial component of the Puerto Rico commercial dive data model: **A**. the frequency distribution of the proportion positive trips; **B**. the Chi-Square residuals by year; C. the Chi-Square residuals by coast.

A. B.

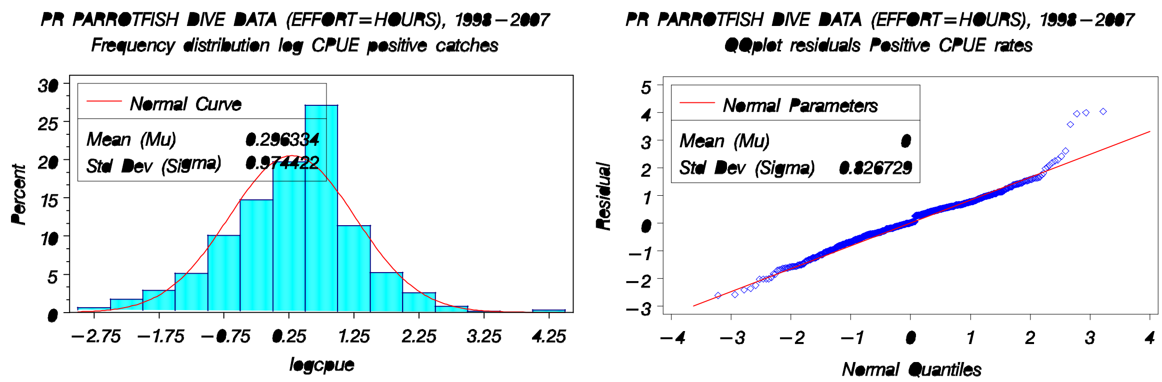
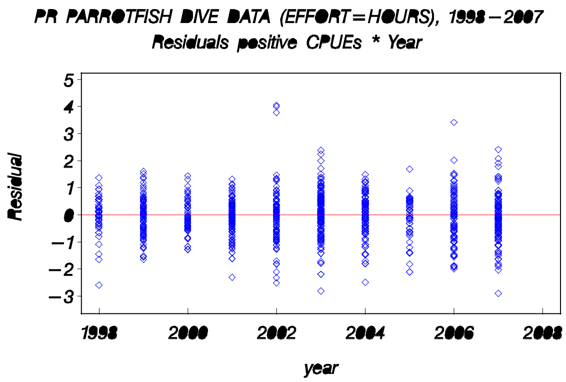
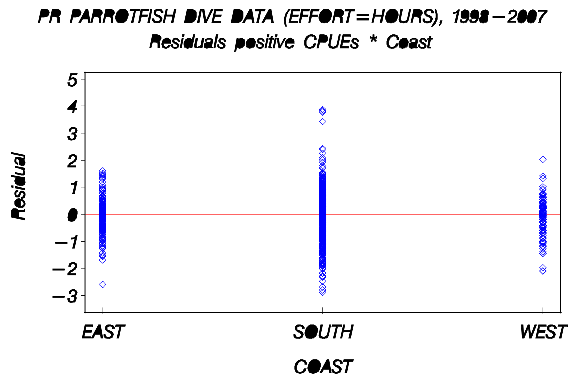


Figure 41: Diagnostic plots for the lognormal component of the Puerto Rico commercial dive data model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

A.



B.



C.

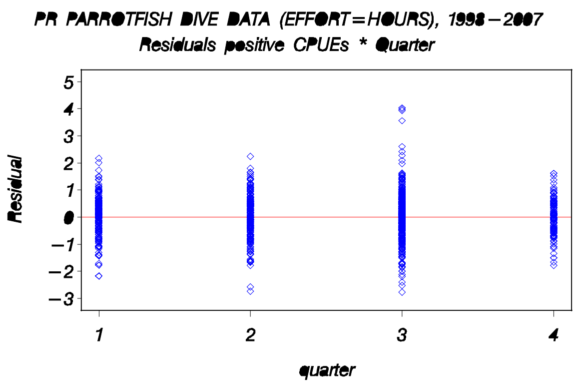


Figure 42: Diagnostic plots for the lognormal component of the Puerto Rico commercial dive data model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by coast; **C**. the Chi-Square residuals by quarter.

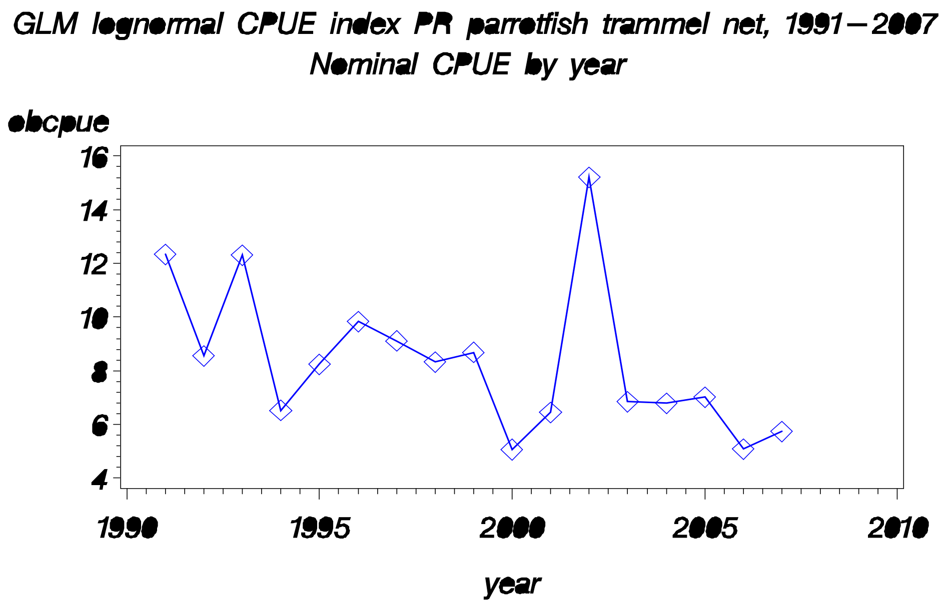


Figure 43: Annual trend in the nominal CPUE for the Puerto Rico trammel net data model.

A. **B.**

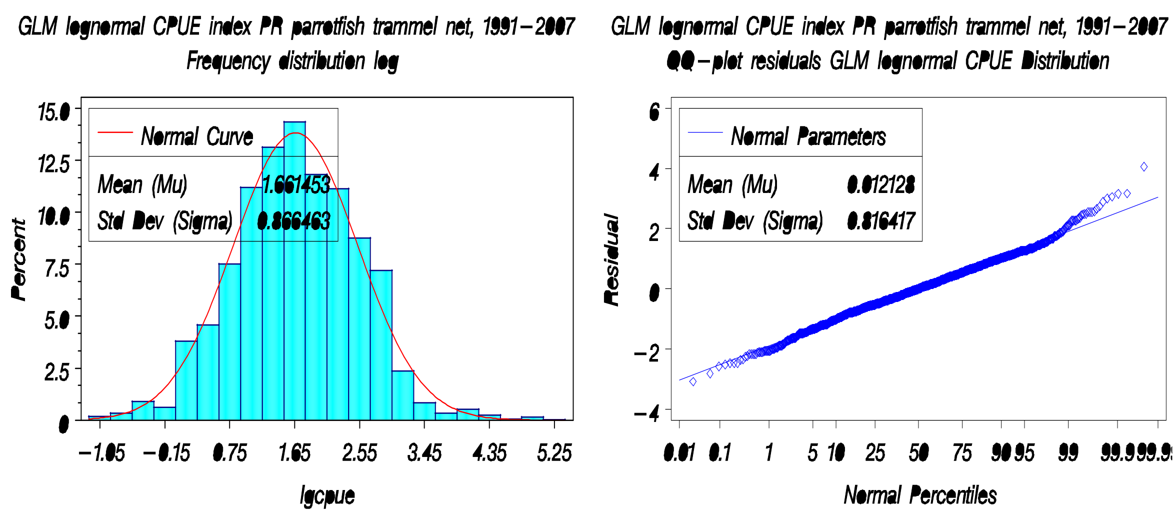


Figure 44: Diagnostic plots for the Puerto Rico commercial trammel net data lognormal model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

A. B.

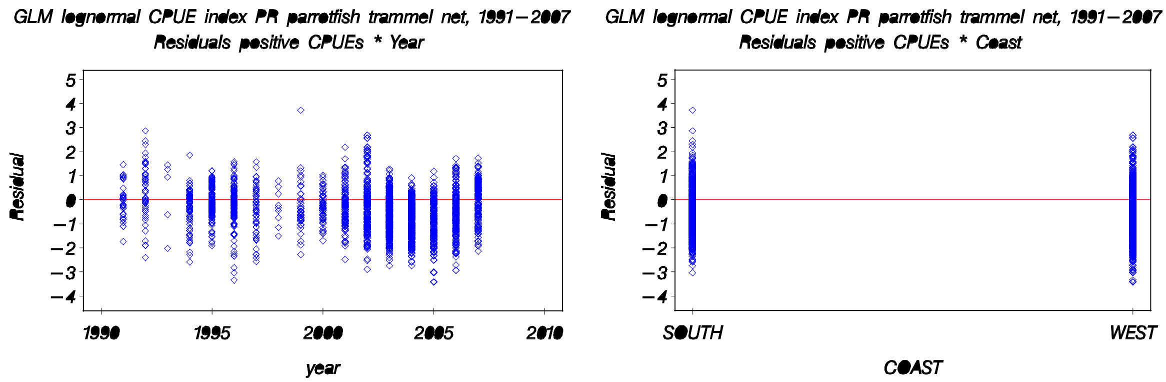


Figure 45: Diagnostic plots for the Puerto Rico commercial trammel net data lognormal model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by coast.

2.1.4. United States Virgin Islands Parrotfish Indices

US Virgin Islands self reported commercial landings data were used to construct parrotfish indices of abundance as examples of possible analyses that may be conducted using those data. Indices were developed for St. Thomas/St. John and for St. Croix.

Analytical approach

Indices were constructed following the methods described in section 2.1.4.3.

Available data

US Virgin Islands commercial landings data were the only data available for use in constructing indices of abundance. Landings were reported by species group, limiting the usefulness of the data. In most cases, management units do not correspond to the species groups that were reported in the Virgin Islands. Parrotfish were chosen for index construction because the management unit and species group reported in the landings data correspond. The landings data required extensive filtering before any analysis. That process included: removing trips reporting multiple areas or multiple gears fished and those with missing effort (hours fished or trap soak time) or missing amount of gear fished. In addition, data reported prior to 1995 (St. Croix) or 1997 (St. Thomas/St. John) were excluded because species group and effort data were not reported prior to those years.

Once filtered, sufficient data appeared available to explore the construction of a single index of abundance from St. Thomas/St. John trap data and three indices of abundance from St. Croix trap, SCUBA, and gillnet landings data. For the trap data, total soak time was calculated as the reported trap soak time*the number of traps fished. Often trap soak time was not reported and hours fished was then used to calculate total soak time. The number of traps/pots was reported in both the amount of gear fished and the number of pots data variables. The reported amount of gear fished was assumed to be the actual number of traps fished on a trip. “Number of fish pots” reported was assumed to be the number of traps owned, but not necessarily fished. Trap CPUE was calculated as pounds of parrotfish/total soak time. SCUBA and gillnet CPUE was calculated as pounds of parrotfish/hours fished. Amount of gear used was found to be inconsistently reported in the SCUBA (may have been number of divers, may have been number of tanks used) and gillnet (may have been number of nets fished, may have been number of divers or tanks used) data and those data were not used in the calculation of CPUE.

One method common in St. Croix for catching parrotfish has been deploying gillnets while diving. Many of those trips were reported as SCUBA trips. “True” SCUBA trips that landed parrotfish were those that used spear guns and the gillnet/SCUBA trips were separated from the SCUBA/spear gun trips. Following the recommendation of Toller (2007) those trips reported as SCUBA with >162.5 pounds of parrotfish landed were reclassified as gillnet trips.

All other gears were assumed to be correct as reported. The yearly number of trips (following selection using the Stephens and MacCall 2004 method) for each gear is provided in Figures 46 (St. Thomas/St. John) and 47 (St. Croix).

In constructing indices for each of the appropriate island/gear combinations, seven factors were considered for their possible affect on CPUE. Those factors were: year, area fished (Figure 48), quarter (January-March=1, April-June=2, etc.), distance from shore, number of helpers, and number of nets fished (gillnet) or number of tanks (SCUBA).

Results

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips were:

St. Thomas/St. John Traps (the binomial portion of the delta lognormal model failed to converge, therefore a lognormal model was used to construct this index):

LOG(CPUE) = Year + Distance from Shore + Number of Helpers + Quarter + Area Fished + Year*Quarter + Distance*Area + Year*Distance + Year*Helpers

St. Criox Traps (the model would not converge with any interaction terms included in the binomial (PPT) portion or with additional interaction terms included in the lognormal portion of the model):

PPT = Distance from Shore + Year + Area Fished

LOG(CPUE) = Year + Distance from Shore + Area Fished + Quarter + Year*Quarter

St. Criox Gillnets (greater than 90% proportion positive trips violate assumptions of the delta lognormal model, therefore a lognormal model was used to construct this index):

LOG(CPUE) = Year + Number of Nets Fished + Distance from Shore + Area Fished +Year*Nets + Distance*Area + Nets*Distance + Year*Area + Year*Distance + Nets*Area

St. Criox SCUBA (the model would not converge with any additional terms included in the binomial (PPT) portion):

PPT = Number of Helpers + Number of Tanks + Year

LOG(CPUE) = Number of Tanks + Number of Helpers + Year + Area Fished + Tanks*Year + Helpers*Year + Tanks*Area + Year*Area + Tanks*Helpers

The number of trips and standardized abundance index are provided in 1.5.4 Table 1 for St. Thomas/St. John trap data. Examination of diagnostic plots produced during index construction indicated a bimodal, rather than the expected normal, distribution of the frequency of the log of CPUEs (Figure 54). Further examination found that the distribution of the log of CPUEs for trips reporting hours fished differed from the log CPUE distribution of trips reporting trap soak time (Figure 56). A second index was constructed using St. Thomas/St. John trap data limited to only those trips reporting trap soak time. The number of trips per year for the second St. Thomas/St. John trap index (trap soak time reported) is provided in Figure 46. The revised St. Thomas/St. John standardized index is provided in Table 28. The standardized indices constructed from St. Thomas/St. John trap data are shown in Figures 49.

The number of trips, proportion positive trips (for delta lognormal models only), and standardized abundance indices are provided in Table 29 (St. Croix trap data), Table 30 (St. Croix gillnet data), and Table 31 (St. Croix SCUBA) for US Virgin Islands parrotfish. The standardized abundance indices developed for each gear, with 95% confidence intervals, are shown in Figures 50 to 52.

Plots of the nominal CPUE, frequency distributions of log(CPUE) for positive catch, cumulative normalized residuals, and plots of chi-square residuals by each main effect for the St. Thomas/St. John trap lognormal model are shown in Figures 53 to 55 (including trips with hours fished or trap soak time reported; diagnostic plots not shown for the trap soak time only index). Diagnostic plots for the constructed St. Croix indices are provided in Figures 57 to 60 (trap), Figures 61 to 63 (gillnet), and Figures 64 to 67 (SCUBA). With the exception of the St. Thomas/St. John trap data discussed above, those diagnostic plots indicate that the fit of the data to the lognormal and binomial models was acceptable. There were some outliers among these data, however, and the frequency distribution of log(CPUE) varied somewhat from the expected normal distribution. Those variations from the expected fit of the data were likely not sufficient to violate assumptions of the analyses, however.

Accuracy/reliability of data

In the parrotfish example described here, the St. Thomas/St. John trap data (initial index including both trips reporting hours fished and trips reporting trap soak time) do not appear to meet the assumptions of the analyses conducted. Analysis should be limited to those trips that reported trap soak time, as was done in constructing the second St. Thomas/St. John trap index. Such a limitation results in a very short time series (2003 to present) and an index of abundance constructed from those data may include too few years to be useful. Continued data collection will likely allow for useful indices to be constructed from the St. Thomas/St. John trap data in the future. Further investigation of the St. Croix data should be conducted to determine if a similar data reporting issue has occurred in the landings from that island. Initial examination of the St. Croix trap index diagnostic plots do not indicate the same bimodal distribution of log CPUE as was found with the St. Thomas/St. John trap data. Additional examination of all the indices constructed should be carried out before using those results in any stock assessment. The index constructed from the St. Croix data certainly needs further scrutiny, given the conflicting trends in the trap index compared to the SCUBA and gillnet indices. The sudden, drastic decrease in then St. Croix trap index warrants investigation. No clear explanation was provided at the SEDAR workshop.

Lengths of the time series were limited by lack of species group identification and effort data prior to 1995 (St. Croix) or 1997 (St. Thomas/St. John). In the parrotfish examples provided, the time series was further limited due to incomplete or limited reporting for the first few years the species group and effort data were collected. The longest CPUE time series began in 1997 in St. Croix. Trap effort data from St. Thomas/St. John are unreliable prior to 2003, as discussed above. It is unclear how hours fished relates to actual fishing effort for those trap data. When both trap soak time and hours fished were reported for a trap trip, those values were sometimes equal, but differed greatly in other trip reports.

At present, only the commercial landings data is useful for constructing indices of abundance of Virgin Islands fisheries. Several characteristics of those data complicate data analyses. Lack of species specific information significantly limits the usefulness of the US Virgin Islands data. As stated above, reported species groups rarely correspond to management units. During the analyses presented here data were also often limited by incomplete reporting or misreporting. The numbers of reported trips for each island, fishing gear, and year are provided in Table 32. Island and gear combinations with very few landings reports for gear were not included. Species groups with very few reported trips (e.g. redman and flatfish were only reported in two years) were also excluded. The category "other species" is uninformative and was not included. The number of parrotfish trips in Table 32 do not match the number of trips reported in the parrotfish indices tables and figures due to the Stephens and MacCall data selection process or other data filtering, e.g. including only trips with trap soak time in the data analysis. Apparent from this table is that in some cases separate indices may be constructed using data reported from vessels fishing different gears. Data from vessels reporting multiple gears fished on a single trip should be excluded from those analyses because landings cannot be unambiguously assigned to a gear in those cases. In addition, the data must be carefully screened to eliminate those records missing gear information and records missing effort information. Incompletely reported trips resulted in the exclusion of many records. Those trips with no report of hours fished or trap soak time (the effort measure) were also excluded in the parrotfish example described here, but might be included in an analysis if "trip" were used as the measure of effort. Using trip as the effort measure, however, is not recommended because it represents only a gross measure of effort.

The "gear amount" information could not be used with any confidence in calculating CPUE. Those data would have been extremely useful for defining effort, however, there appears to have been no consistent reporting of those data over time. The data were often missing or there was uncertainty in how to interpret the values reported; e.g. for SCUBA, was gear amount the number of divers or the number of tanks. More detailed gear information, such as the number of lines fished and the number of hooks per line, would allow for better measures of effort. As an initial effort to determine if those gear amount data were at all informative regarding differences in CPUE among trips, they were included in the GLM analyses. The amount of gear was found to affect CPUE in both the St. Croix gillnet (ostensibly number of nets fished) and SCUBA (number of divers) analyses. Further examination of those data to determine what has been reported should be done before any future analysis to be used in an assessment, however. Additional outreach work with fishers should also be done to ensure that the proper information is reported for the amount of gear fished.

Proper identification of gillnet trips reported as SCUBA trips followed the recommendation of Toller (2007). No objection to this approach was presented at the SEDAR workshop. Neither was an alternative approach offered. Identifying gillnet trips reported as SCUBA trips following Toller's recommendation is suggested for future analyses.

Analyses of US Virgin Island data are limited by the lack of depth data in the commercial landings reports. Reporting minimum and maximum depth fished would allow for more detailed analyses in the future. More detailed spatial information in general would be extremely useful. The distance from shore data appears to be frequently misreported and requires additional work both for full understanding what has been reported and for obtaining the required information in the future.

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Table 27: Number of trips and standardized abundance index for parrotfish. Index constructed using St. Thomas/St. John trap landings data.

YEAR	Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
2000	1,627	1.81131	0.856315	3.831354	0.388116
2001	1,730	2.209205	1.045161	4.6697	0.387724
2002	1,557	2.135331	1.009111	4.518468	0.388329
2003	1,509	0.569128	0.268971	1.204243	0.388302
2004	1,454	0.118967	0.056215	0.251768	0.388392
2005	1,154	0.084933	0.040105	0.179868	0.388776
2006	897	0.071126	0.033406	0.151438	0.39176

Table 28: Number of trips and standardized abundance index for parrotfish. Index constructed using St. Thomas/St. John trap landings data. Data limited to only those trips with trap soak time reported.

YEAR	Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
2003	590	1.865721	0.796411	4.370752	0.44567
2004	1,302	0.995205	0.447626	2.212638	0.415978
2005	1,153	0.657106	0.295717	1.46014	0.415669
2006	895	0.481968	0.215917	1.075844	0.418227

Table 29: Number of trips, proportion positive trips, and standardized abundance index for parrotfish. Index constructed using St. Croix trap landings data.

YEAR	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1997	1,735	0.854755	1.33107	0.715968	2.47462	0.317655
1998	1,470	0.908163	1.374651	0.748216	2.525562	0.311302
1999	1,228	0.937296	1.521611	0.837241	2.765394	0.305495
2000	1,599	0.884303	1.435851	0.771387	2.672675	0.318309
2001	1,698	0.846879	1.402982	0.745457	2.640472	0.324248
2002	1,746	0.865979	1.296983	0.691616	2.432223	0.322313
2003	1,424	0.86236	1.199641	0.629445	2.286358	0.331037
2004	1,384	0.783237	0.254129	0.101266	0.637741	0.485496
2005	1,257	0.859984	0.108901	0.038971	0.304314	0.549664
2006	1,043	0.820709	0.074181	0.021106	0.260722	0.695952

Table 30: Number of trips and standardized abundance index for parrotfish. Index constructed using St. Croix gillnet landings data.

YEAR	Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1997	479	0.506867	0.358113	0.717411	0.175019
1998	379	0.538195	0.376853	0.768612	0.179606
1999	508	0.947284	0.667143	1.345061	0.176653
2000	493	0.864913	0.613717	1.218926	0.172818
2001	484	0.995072	0.712377	1.38995	0.168277
2002	575	1.063153	0.760506	1.486238	0.168687
2003	584	0.986291	0.705005	1.379806	0.169063
2004	666	1.190258	0.852336	1.662154	0.168143
2005	669	1.447448	1.0351	2.024063	0.168837
2006	685	1.460519	1.042581	2.045995	0.16975

Table 31: Number of trips, proportion positive trips, and standardized abundance index for parrotfish. Index constructed using St. Croix SCUBA landings data.

YEAR	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1997	256	0.675781	0.687666	0.396051	1.193998	0.281213
1998	380	0.718421	0.798701	0.489406	1.303465	0.248615
1999	373	0.699732	0.742783	0.45151	1.221959	0.252808
2000	828	0.646135	0.871928	0.541654	1.403585	0.241451
2001	912	0.64364	0.926182	0.581872	1.47423	0.235584
2002	1,029	0.737609	1.093033	0.696668	1.714908	0.228087
2003	1,338	0.765321	1.14267	0.732948	1.781431	0.224789
2004	1,411	0.805103	1.12232	0.714798	1.76218	0.228477
2005	1,329	0.790068	1.147782	0.73282	1.797718	0.227196
2006	1,264	0.829114	1.466935	0.936489	2.297834	0.227251

Table 32: US Virgin Islands commercial landings reported trips - after removing trips reporting multiple gears or areas fished and those with missing effort (hours fished or trap soak time) or missing amount of gear fished.

ISLAND	gear	years	total trips	grouper	snapper	grunt	jack	surgeonfish	parrotfish
ST. CROIX	Free Diving	1997	154	34	53	54	6	42	99
		1998	199	49	57	50	1	39	82
		1999	275	27	55	33	1	23	106
		2000	367	8	44	26	0	15	83
		2001	407	101	124	46	3	31	88
		2002	615	202	221	91	18	78	283
		2003	455	59	126	26	5	9	109
		2004	370	27	126	2	0	3	102
		2005	223	9	7	45	4	6	66
		2006	425	6	10	22	0	11	135
Total			3,490	522	823	395	38	257	1,153
ST. CROIX	Gillnet	1996	194	6	61	101	88	94	175
		1997	545	49	158	257	131	228	480
		1998	487	25	128	186	150	194	380
		1999	586	31	107	111	92	151	510
		2000	532	68	158	184	109	231	494
		2001	505	76	166	254	121	302	486
		2002	619	84	269	350	146	425	578
		2003	649	135	244	314	90	323	585
		2004	696	153	227	346	129	360	666
		2005	703	91	280	412	131	390	672
		2006	704	66	191	400	153	454	685
Total			6,220	784	1,989	2,915	1,340	3,152	5,711
ST. CROIX	Line Fishing	1996	966	122	361	131	96	24	77
		1997	2,889	320	1,193	182	183	24	96
		1998	2,839	378	1,370	289	186	80	161
		1999	3,396	482	1,550	294	218	79	194
		2000	3,860	512	1,661	257	185	128	156
		2001	4,865	703	2,471	400	190	70	147
		2002	5,779	846	3,413	332	257	46	42
		2003	4,798	849	2,604	382	213	13	52
		2004	3,996	858	2,390	508	245	93	104
		2005	3,959	424	2,483	324	138	74	96
		2006	4,025	612	2,569	412	180	43	112
Total			41,372	6,106	22,065	3,511	2,091	674	1,237
ST. CROIX	SCUBA	1996	420	122	112	63	9	17	205
		1997	1,129	104	145	78	9	43	354
		1998	1,769	108	224	98	10	59	545
		1999	2,076	146	210	99	10	47	629
		2000	3,055	279	412	319	10	133	1,117
		2001	4,058	457	600	395	35	182	1,287
		2002	3,862	602	789	447	18	347	1,559
		2003	4,077	825	988	734	28	585	1,601
		2004	4,240	989	1,120	701	38	495	1,698
		2005	4,451	958	1,016	704	21	564	1,794
		2006	4,688	821	976	695	39	519	2,030
Total			33,825	5,411	6,592	4,333	227	2,991	12,819
ST. CROIX	Traps	2004	887	230	548	766	68	717	655
		2005	1,340	418	829	1,064	85	1,050	1,089

		2006	1,110	265	635	805	35	836	857
Total			3,337	913	2,012	2,635	188	2,603	2,601

Table 32: (continued).

ISLAND	gear	years	shellfish	triggerfish	angelfish	barracuda	goatfish	mackerel	porgy
ST. CROIX	Free Diving	1997	7	29	33	7	3	10	0
		1998	8	49	30	12	3	0	0
		1999	10	32	17	24	1	5	11
		2000	5	18	0	10	1	4	0
		2001	9	37	0	41	1	2	7
		2002	50	70	0	77	5	5	14
		2003	28	4	0	13	1	1	0
		2004	5	20	0	23	0	4	0
		2005	18	8	0	10	5	1	2
		2006	11	8	0	9	3	1	0
Total			151	275	80	226	23	33	34
ST. CROIX	Gillnet	1996	53	76	29	21	8	8	0
		1997	98	130	46	43	6	20	0
		1998	68	107	25	59	6	5	0
		1999	58	111	30	52	16	0	32
		2000	98	128	0	87	22	1	49
		2001	83	189	0	74	1	2	58
		2002	154	257	0	126	24	2	116
		2003	137	154	0	79	19	3	71
		2004	135	184	0	94	48	1	116
		2005	120	283	0	34	123	0	74
		2006	110	286	0	50	83	3	94
Total			1,114	1,905	130	719	356	45	610
ST. CROIX	Line Fishing	1996	0	46	17	132	15	41	0
		1997	21	115	14	285	38	145	0
		1998	47	184	76	280	49	173	0
		1999	26	185	48	322	23	194	3
		2000	15	193	0	499	7	414	3
		2001	69	313	0	573	39	373	28
		2002	37	401	0	950	107	672	20
		2003	15	368	0	792	27	496	24
		2004	10	383	0	513	24	482	11
		2005	5	262	0	429	6	489	11
		2006	12	306	0	484	6	588	20
Total			257	2,756	155	5,259	341	4,067	120
ST. CROIX	SCUBA	1996	4	82	78	21	13	3	0
		1997	15	112	115	21	5	7	0
		1998	15	204	141	38	11	2	0
		1999	3	163	33	123	4	17	13
		2000	29	406	0	210	20	25	12
		2001	71	502	0	140	6	6	127
		2002	85	549	0	164	62	11	259
		2003	359	732	0	111	149	28	220
		2004	306	691	0	118	152	15	189
		2005	151	702	0	81	84	13	297
		2006	175	653	0	128	75	19	389
Total			1,213	4,796	367	1,155	581	146	1,506
ST. CROIX	Traps	2004	276	422	0	23	119	5	57
		2005	580	658	10	44	130	10	56
		2006	506	588	2	55	105	19	28

Total			1,362	1,668	12	122	354	34	141

Table 32: (continued).

ISLAND	gear	years	squirrelfish	dolphin	tuna	wahoo	baitfish	lobster	conch
ST. CROIX	Free Diving	1997	0	2	0	0	3	40	41
		1998	0	1	0	0	1	24	109
		1999	0	3	0	0	0	55	128
		2000	0	0	0	0	0	49	263
		2001	0	0	2	0	3	218	270
		2002	0	0	1	0	0	319	354
		2003	0	0	0	0	0	133	312
		2004	0	0	0	0	0	117	239
		2005	0	0	0	0	2	57	124
		2006	0	0	0	0	3	102	250
Total			0	6	3	0	12	1,114	2,090
ST. CROIX	Gillnet	1996	0	0	0	0	5	26	8
		1997	0	0	0	0	31	69	13
		1998	0	0	0	0	22	71	19
		1999	0	0	0	1	9	64	19
		2000	0	0	0	0	3	140	27
		2001	0	0	0	0	0	111	16
		2002	0	0	0	0	2	139	26
		2003	0	0	0	0	2	185	41
		2004	0	0	0	0	0	249	27
		2005	0	0	0	0	0	264	105
		2006	0	0	0	0	12	305	103
Total			0	0	0	1	86	1,623	404
ST. CROIX	Line Fishing	1996	0	59	93	49	95	5	0
		1997	2	429	416	141	540	3	6
		1998	2	465	310	116	458	6	14
		1999	0	359	453	245	370	10	16
		2000	0	650	511	184	882	4	1
		2001	0	802	587	334	663	22	25
		2002	8	944	408	266	751	36	12
		2003	9	855	448	318	859	17	16
		2004	10	620	319	297	591	3	0
		2005	2	479	447	367	489	5	9
		2006	12	613	216	210	672	11	102
Total			45	6,275	4,208	2,527	6,370	122	201
ST. CROIX	SCUBA	1996	0	0	0	0	0	267	130
		1997	0	0	2	0	3	682	443
		1998	0	0	0	0	15	1,055	781
		1999	0	0	1	1	0	1,239	827
		2000	0	0	0	0	11	2,056	1,101
		2001	0	1	0	0	6	2,624	1,481
		2002	0	7	0	0	28	2,641	1,549
		2003	2	0	0	1	3	2,818	1,473
		2004	0	0	0	0	0	2,878	1,746
		2005	0	1	0	0	12	2,829	2,090
		2006	0	6	0	0	34	2,954	2,386
Total			2	15	3	2	112	22,043	14,007
ST. CROIX	Traps	2004	0	0	0	0	45	49	1
		2005	0	0	0	0	81	99	18

		2006	24	0	1	1	29	92	47
Total			24	0	1	1	155	240	66

Table 32: (continued).

ISLAND	gear	years	total trips	grouper	snapper	grunt	jack	surgeonfish	parrotfish
STT/STJ	Line	1997	225	13	140	14	52	0	2
	Fishing	1998	645	62	376	29	68	7	22
		1999	1,278	115	790	78	198	7	53
		2000	1,785	135	1,154	114	314	7	63
		2001	2,273	170	1,362	111	543	12	94
		2002	2,237	174	1,369	112	538	17	72
		2003	1,841	204	1,186	109	445	13	119
		2004	1,504	282	915	73	307	6	51
		2005	1,448	185	881	76	246	11	51
		2006	1,710	243	1,112	57	367	13	45
Total			14,946	1,583	9,285	773	3,078	93	572
STT/STJ	SCUBA	1997	17	9	1	14	0	0	11
		1998	44	31	24	6	0	5	24
		1999	131	91	101	5	0	10	106
		2000	101	18	39	0	4	0	38
		2001	201	44	80	10	3	7	73
		2002	312	29	131	1	2	5	108
		2003	253	66	144	0	2	0	154
		2004	84	13	25	0	0	0	27
		2005	83	3	6	0	2	0	14
		2006	142	1	7	1	2	0	11
Total			1,368	305	558	37	15	27	566
STT/STJ	Seine Net	1996	0	59	93	49	95	5	0
		1997	14	0	4	0	4	0	0
		1998	120	0	19	0	46	2	4
		1999	311	2	66	2	117	0	3
		2000	358	1	124	1	184	2	3
		2001	360	5	154	1	204	0	0
		2002	425	1	166	14	228	0	0
		2003	374	7	147	20	205	0	0
		2004	405	16	158	2	210	3	3
		2005	408	20	153	11	163	0	8
		2006	492	43	275	21	274	5	5
Total			3,267	95	1,266	72	1,635	12	26
STT/STJ	Traps	2003	938	502	682	635	9	714	685
		2004	2,127	1,254	1,514	1,538	95	1,613	1,510
		2005	2,275	1,355	1,649	1,705	102	1,728	1,624
		2006	2,244	1,085	1,676	1,578	65	1,662	1,491
Total			7,584	4,196	5,521	5,456	271	5,717	5,310

Table 32: (continued).

ISLAND	gear	years	shellfish	triggerfish	angelfish	barracuda	goatfish	mackerel	porgy
STT/STJ	Line Fishing	1997	0	17	0	1	0	29	3
		1998	2	54	4	49	6	76	2
		1999	9	108	2	92	21	187	38
		2000	1	145	0	90	19	184	106
		2001	4	150	1	154	22	273	92
		2002	10	148	0	232	31	308	100
		2003	4	143	0	99	14	229	101
		2004	2	111	0	89	7	119	75
		2005	5	88	1	128	15	107	109
		2006	6	88	1	143	15	214	84
Total			43	1,052	9	1,077	150	1,726	710
STT/STJ	SCUBA	1997	4	13	11	0	1	1	0
		1998	0	15	22	0	0	1	0
		1999	1	18	59	0	0	2	1
		2000	0	14	0	0	0	0	0
		2001	0	14	8	2	2	0	3
		2002	10	34	5	2	0	0	1
		2003	2	21	8	1	0	0	0
		2004	0	2	2	0	0	0	0
		2005	0	6	0	0	0	0	0
		2006	0	25	0	1	0	48	0
Total			17	162	115	6	3	52	5
STT/STJ	Seine Net	1997	0	0	0	0	0	0	0
		1998	0	0	0	0	1	11	0
		1999	0	0	0	0	0	14	0
		2000	0	0	0	0	1	22	0
		2001	2	0	0	0	0	11	0
		2002	0	0	0	1	0	26	0
		2003	0	0	0	1	0	29	3
		2004	0	5	1	5	1	17	12
		2005	1	7	0	8	0	56	11
		2006	1	13	3	10	0	72	27
Total			4	25	4	25	3	258	53
STT/STJ	Traps	2003	648	687	145	1	9	0	633
		2004	1,435	1,628	397	5	31	1	1,404
		2005	1,507	1,688	405	10	21	1	1,553
		2006	1,532	1,612	470	5	38	3	1,494
Total			5,122	5,615	1,417	21	99	5	5,084

Table 32: (continued).

ISLAND	gear	years	squirrelfish	dolphin	tuna	wahoo	baitfish	lobster	conch
STT/STJ	Line Fishing	1997	0	7	29	11	71	0	0
		1998	0	23	40	27	197	7	0
		1999	4	31	130	38	425	5	0
		2000	15	68	191	57	521	4	0
		2001	8	174	338	101	896	1	0
		2002	8	197	397	91	853	3	1
		2003	11	104	157	55	672	2	0
		2004	6	88	237	69	576	5	7
		2005	0	47	160	38	461	81	0
		2006	3	94	204	63	694	70	0
Total			55	833	1,883	550	5,366	178	8
STT/STJ	SCUBA	1997	0	0	0	0	0	12	2
		1998	0	0	0	0	0	39	6
		1999	0	0	1	0	4	125	63
		2000	0	0	0	0	0	73	23
		2001	9	0	0	0	1	156	42
		2002	2	0	0	0	8	257	78
		2003	0	0	0	0	0	227	82
		2004	0	0	0	0	1	74	20
		2005	0	0	0	0	0	59	14
		2006	0	1	4	0	0	77	17
Total			11	1	5	0	14	1,099	347
STT/STJ	Seine Net	1997	0	0	1	0	3	0	0
		1998	0	0	1	0	35	0	0
		1999	0	0	29	0	69	2	1
		2000	0	1	38	0	55	0	0
		2001	0	1	8	0	42	1	0
		2002	0	0	25	0	24	2	0
		2003	0	0	24	0	21	0	0
		2004	1	0	44	0	22	0	0
		2005	0	0	6	0	28	0	0
		2006	2	2	14	0	37	1	2
Total			3	4	190	0	336	6	3
STT/STJ	Traps	2003	97	0	0	0	9	477	0
		2004	210	4	0	0	25	1,175	0
		2005	163	2	0	0	24	1,225	1
		2006	66	4	1	0	42	1,078	26
Total			536	10	1	0	100	3,955	27

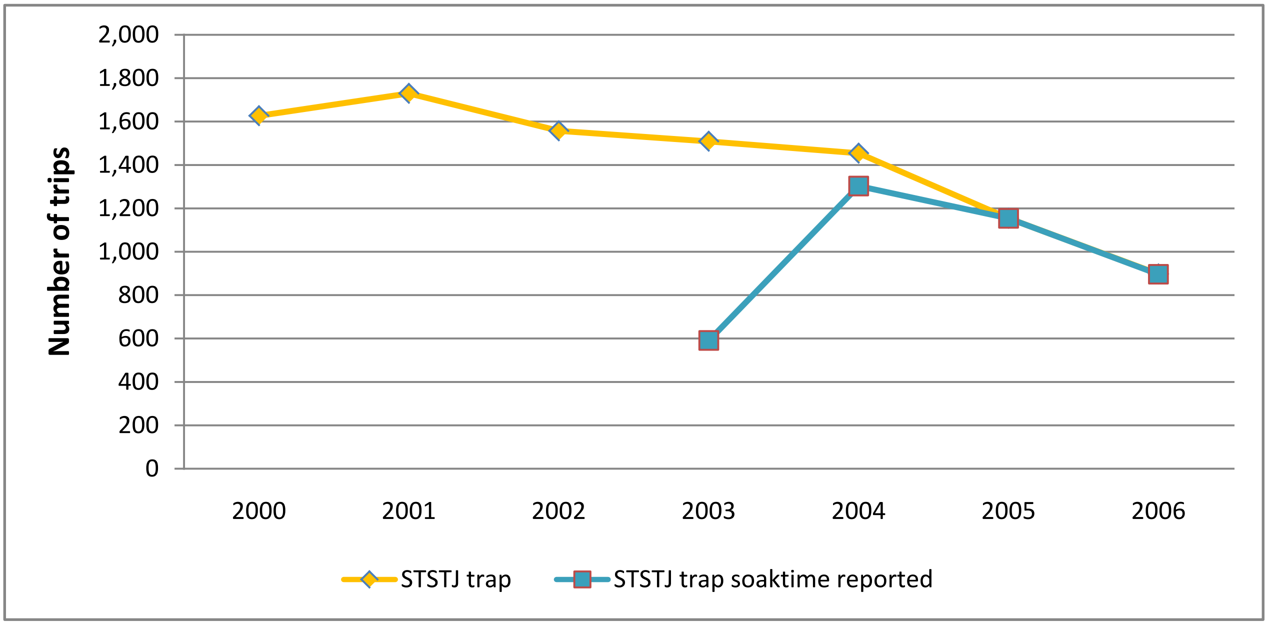


Figure 46: Yearly number of parrotfish trips by gear type in St. Thomas/St. John as selected using the Stephens and MacCall (2004) method.

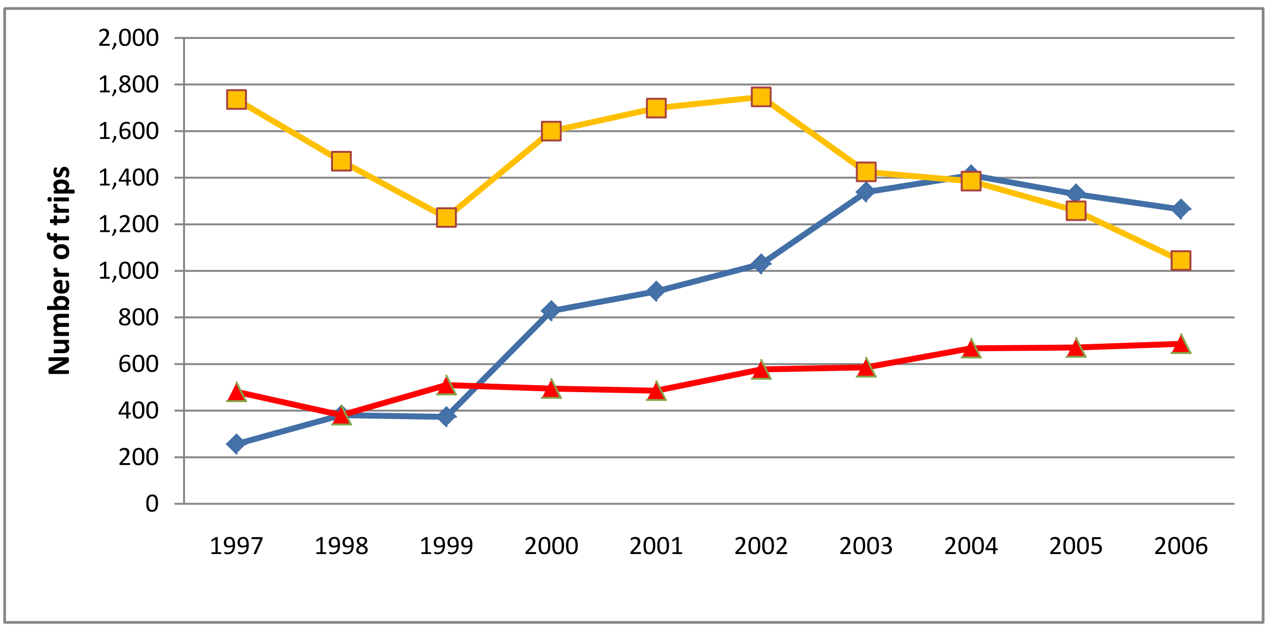


Figure 47: Yearly number of parrotfish trips by gear type in St. Croix as selected using the Stephens and MacCall (2004) method.

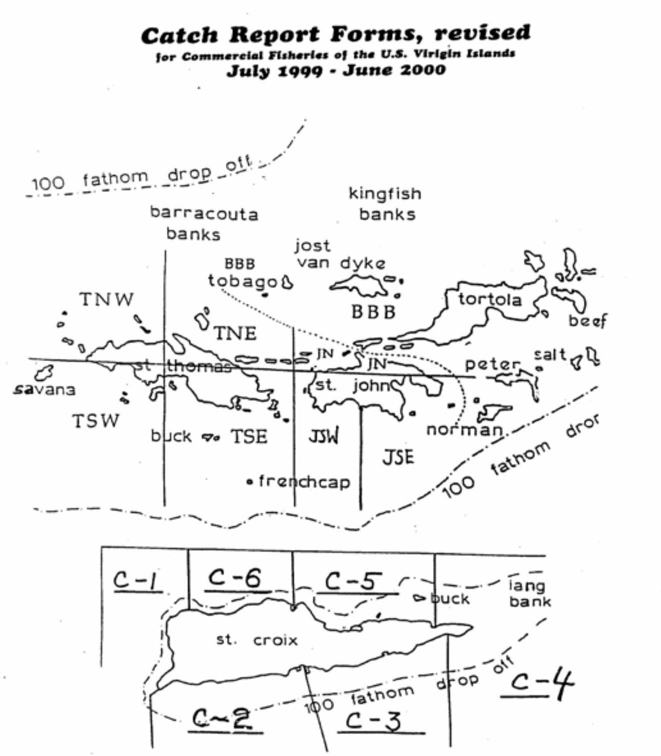


Figure 48: "Area" factor defined for the Virgin Islands.

A. **B.**

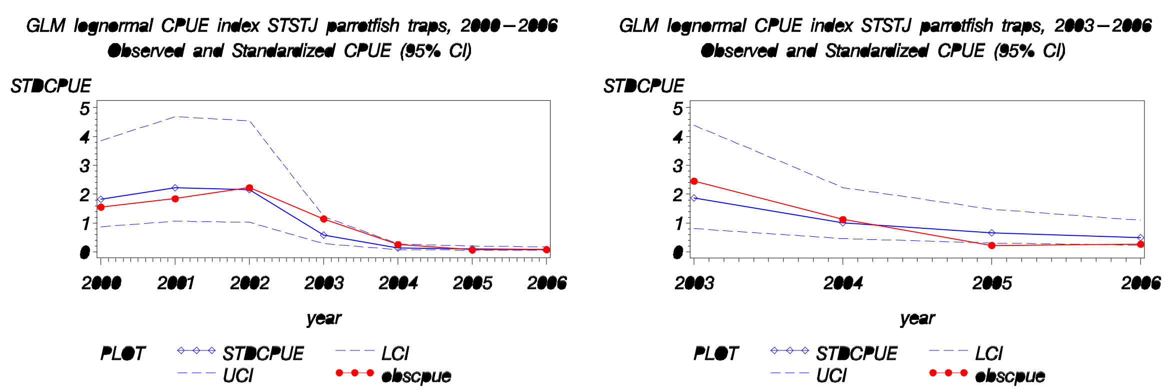


Figure 49: St. Thomas/St. John parrotfish standardized index of abundance constructed from commercial trap landings data. **A.** Trips reporting either hours fished or trap soak time; **B.** Only trips reporting trap soak time.

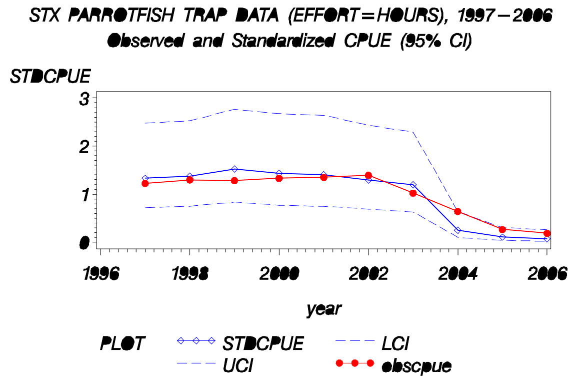


Figure 50: St. Croix parrotfish standardized index of abundance constructed from commercial trap landings data.

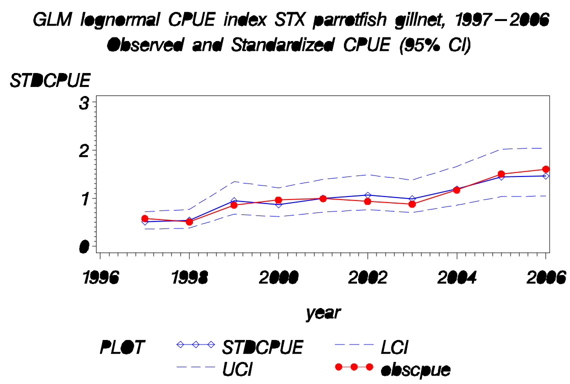


Figure 51: St. Croix parrotfish standardized index of abundance constructed from commercial gillnet landings data.

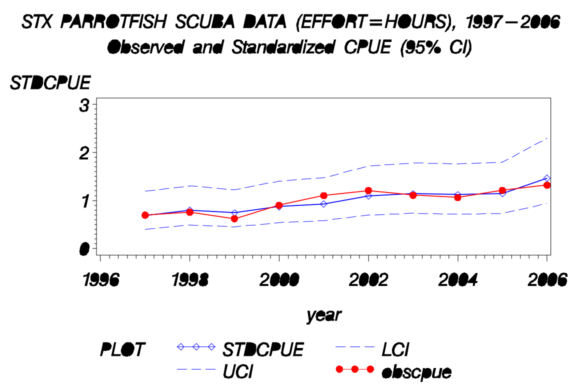


Figure 52: St. Croix parrotfish standardized index of abundance constructed from commercial SCUBA landings data.

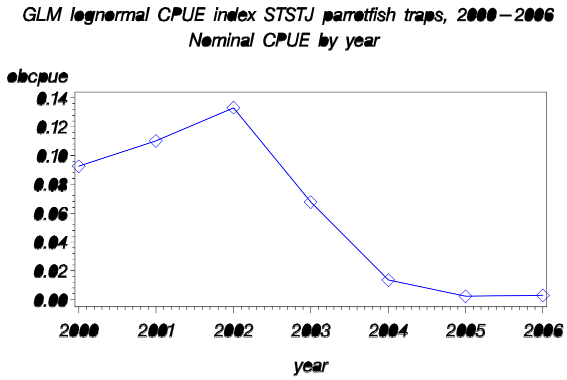


Figure 53: Annual trend in the nominal CPUE for the St. Thomas/St. John trap lognormal model.

A. **B.**

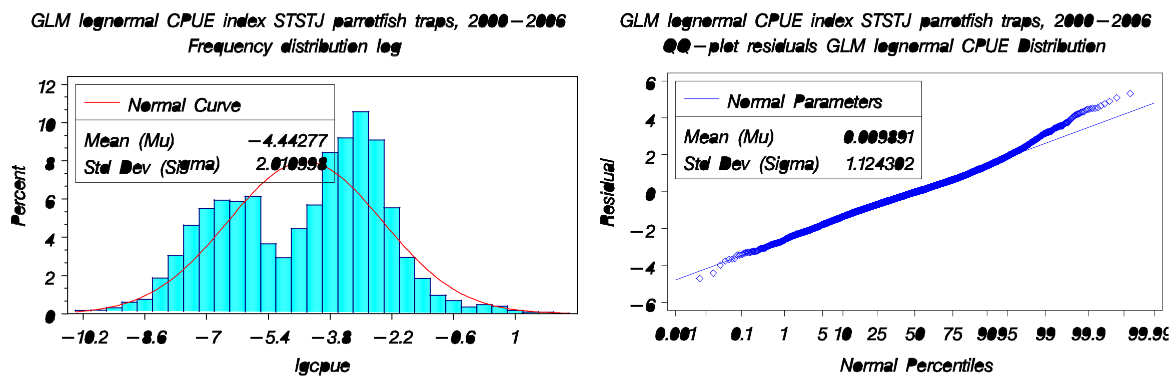


Figure 54: Diagnostic plots for the St. Thomas/St. John commercial trap lognormal model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model.

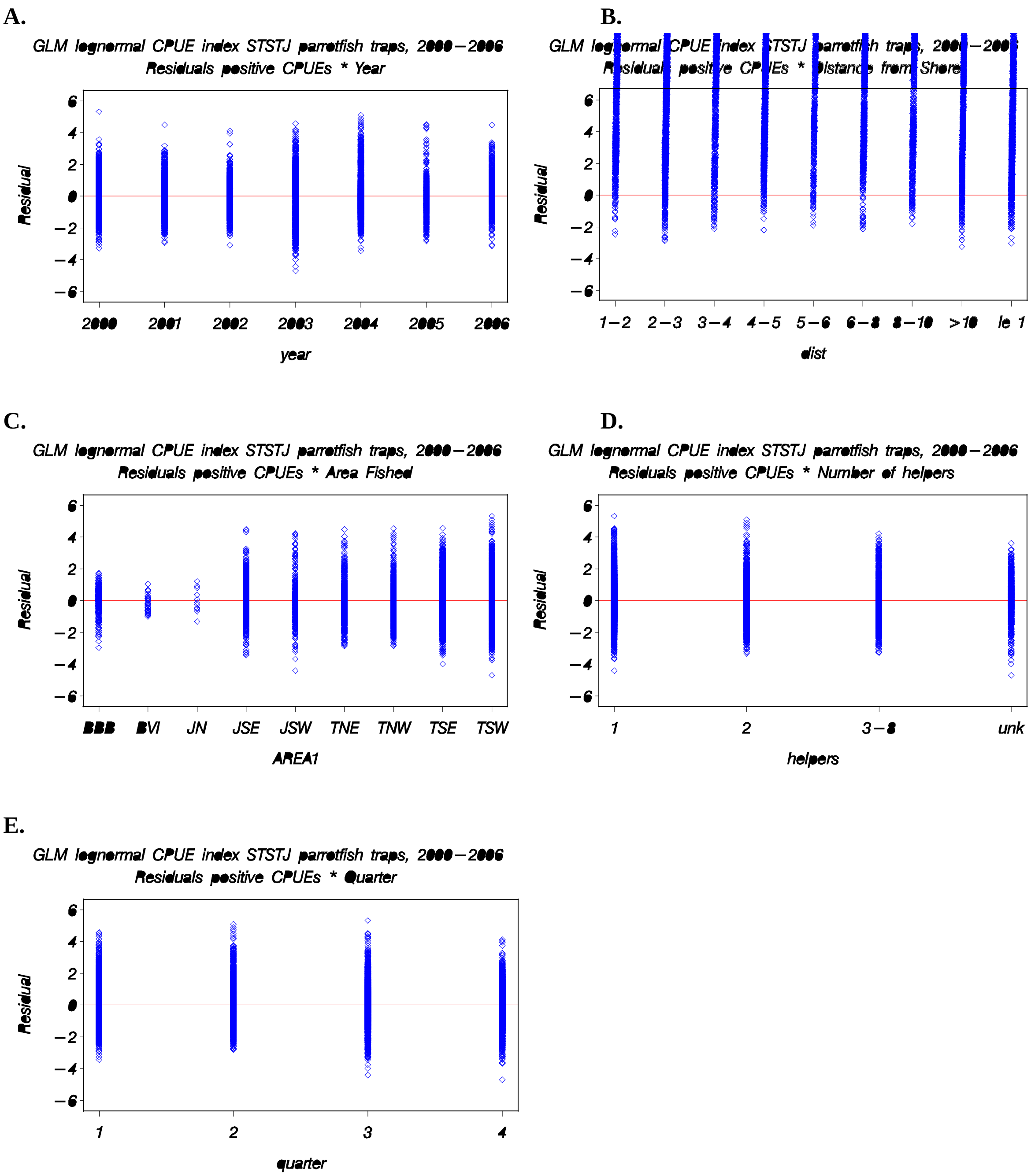
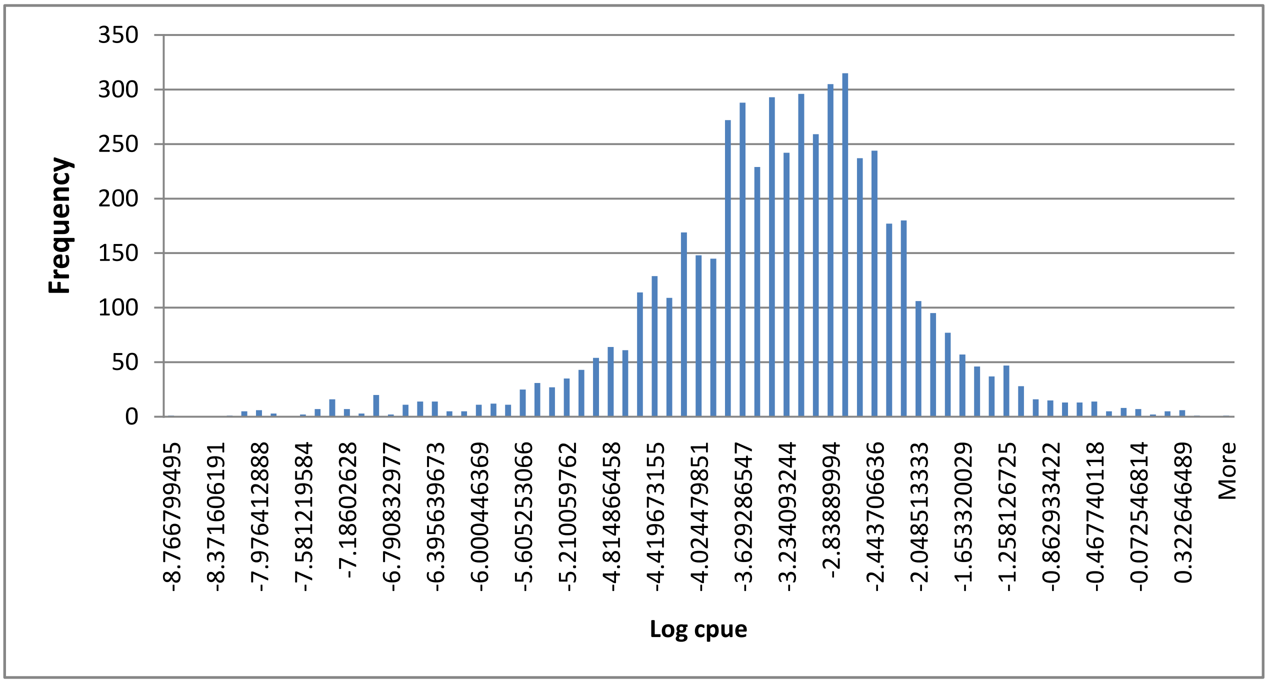


Figure 55: Diagnostic plots for the St. Thomas/St. John commercial trap lognormal model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by distance from shore (dist). **C**. the Chi-Square residuals by area fished (area1); **D**. the Chi-Square residuals by number of helpers; **E.** the Chi-Square residuals by quarter.

A.



B.

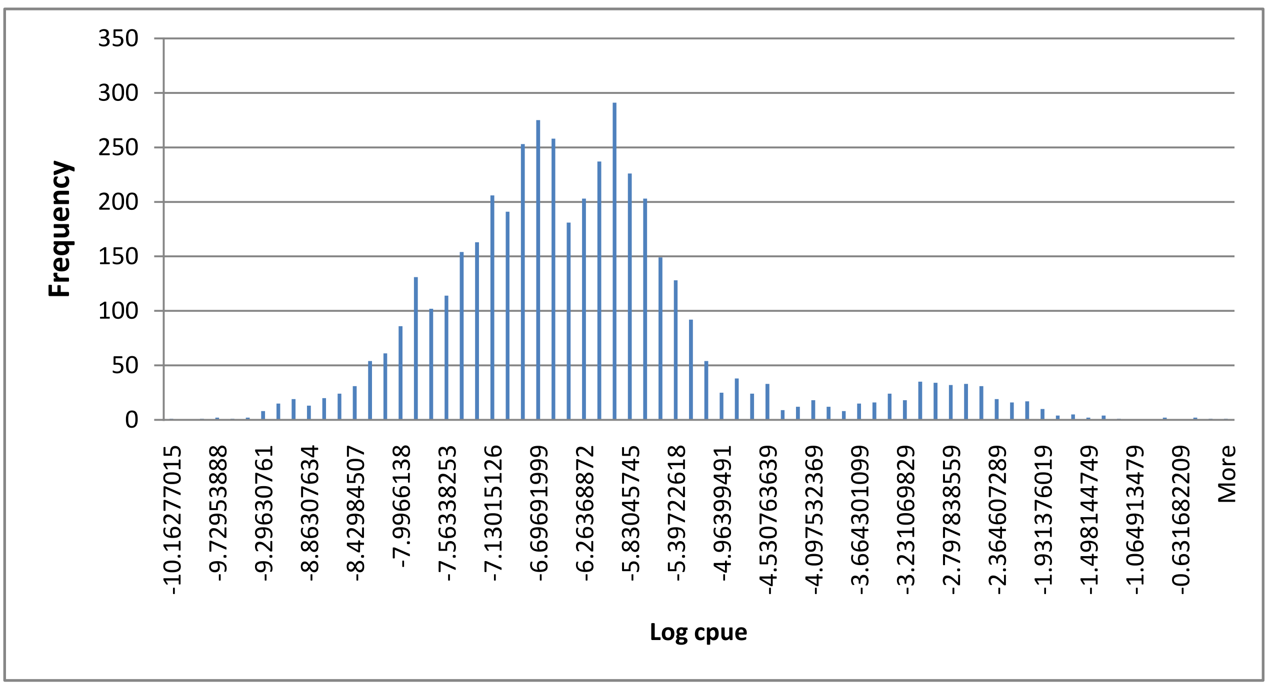


Figure 56: Frequency distribution of log CPUE of St. Thomas/St. John trap data. **A.** Data from trips reporting either hours fished or trap soak time; **B.** Data only trips reporting trap soak time.

A. B.

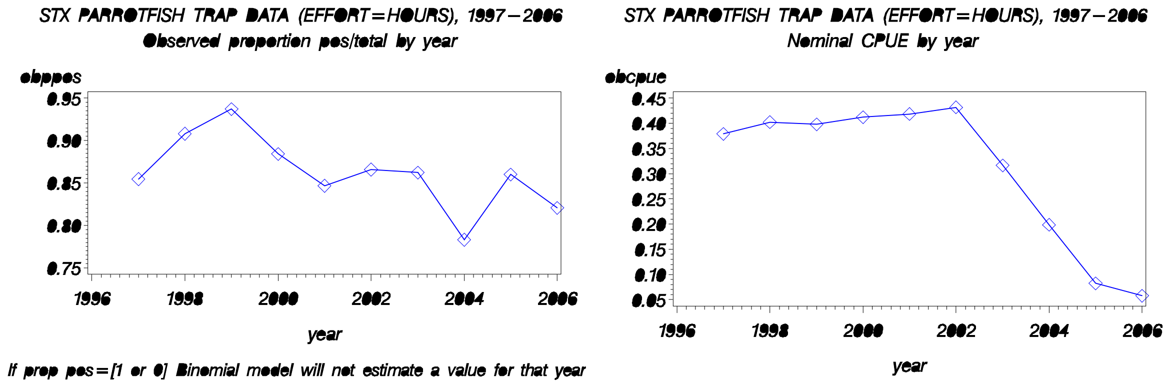


Figure 57: Annual trend in the proportion of positive trips (**A)** and nominal CPUE (**B)** for the St. Croix trap model.

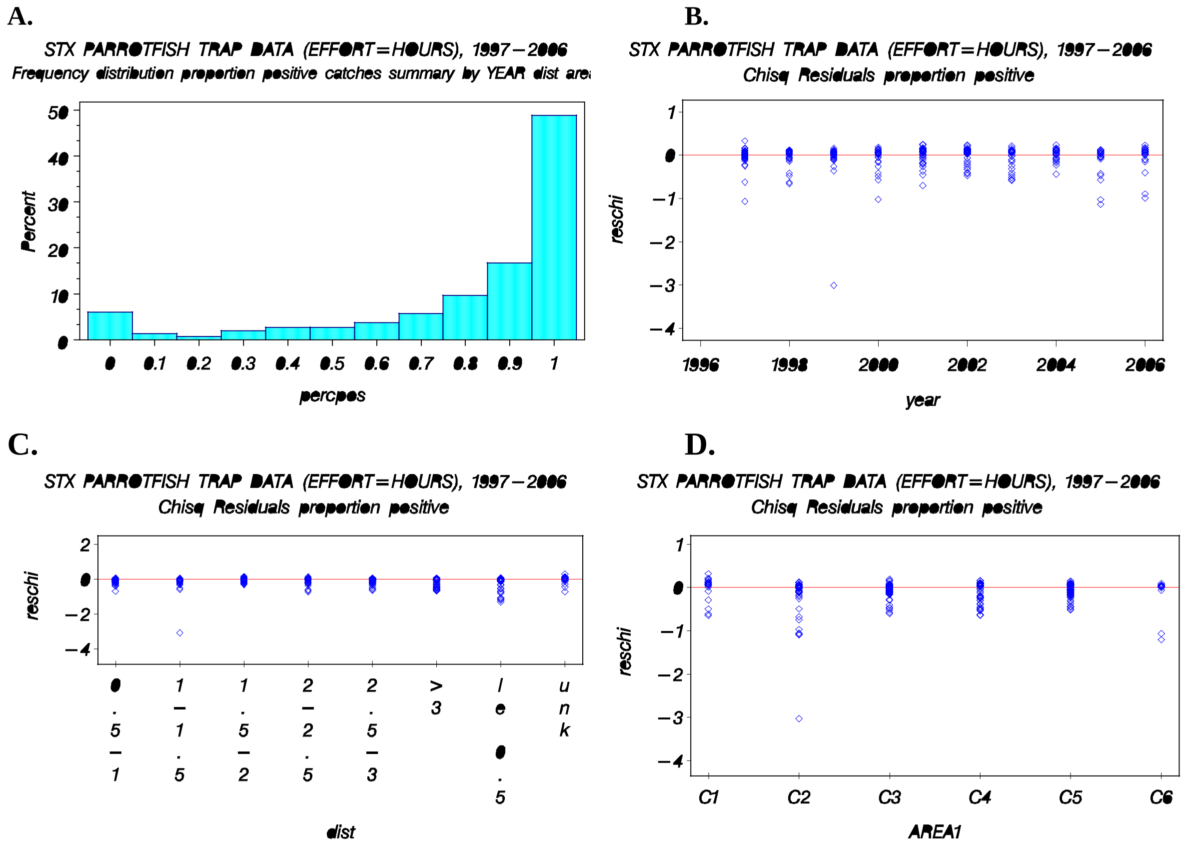


Figure 58: Diagnostic plots for the binomial component of the St. Croix commercial trap model: **A**. the frequency distribution of the proportion positive trips; **B**. the Chi-Square residuals by year; **C.** the Chi-Square residuals by distance from shore (dist); **D.** the Chi-Square residuals by area fished (area1).

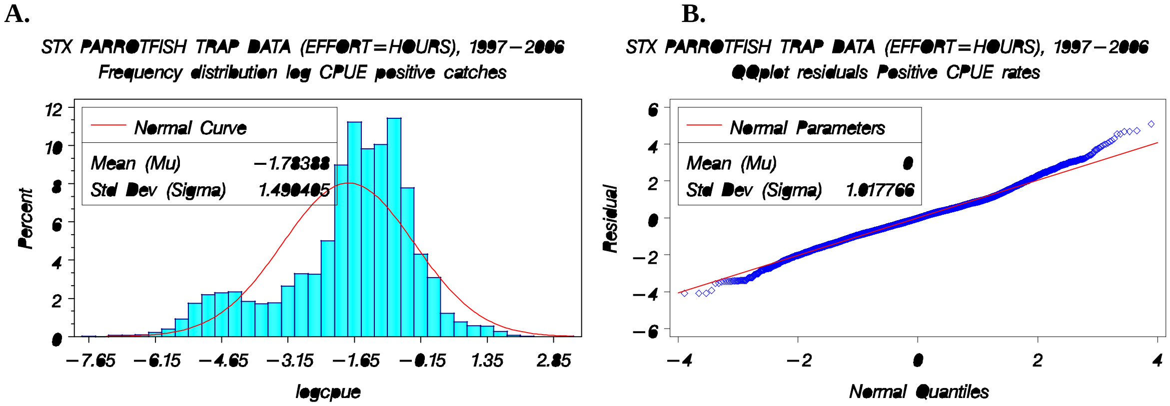


Figure 59: Diagnostic plots for the lognormal component of the St. Croix commercial trap model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

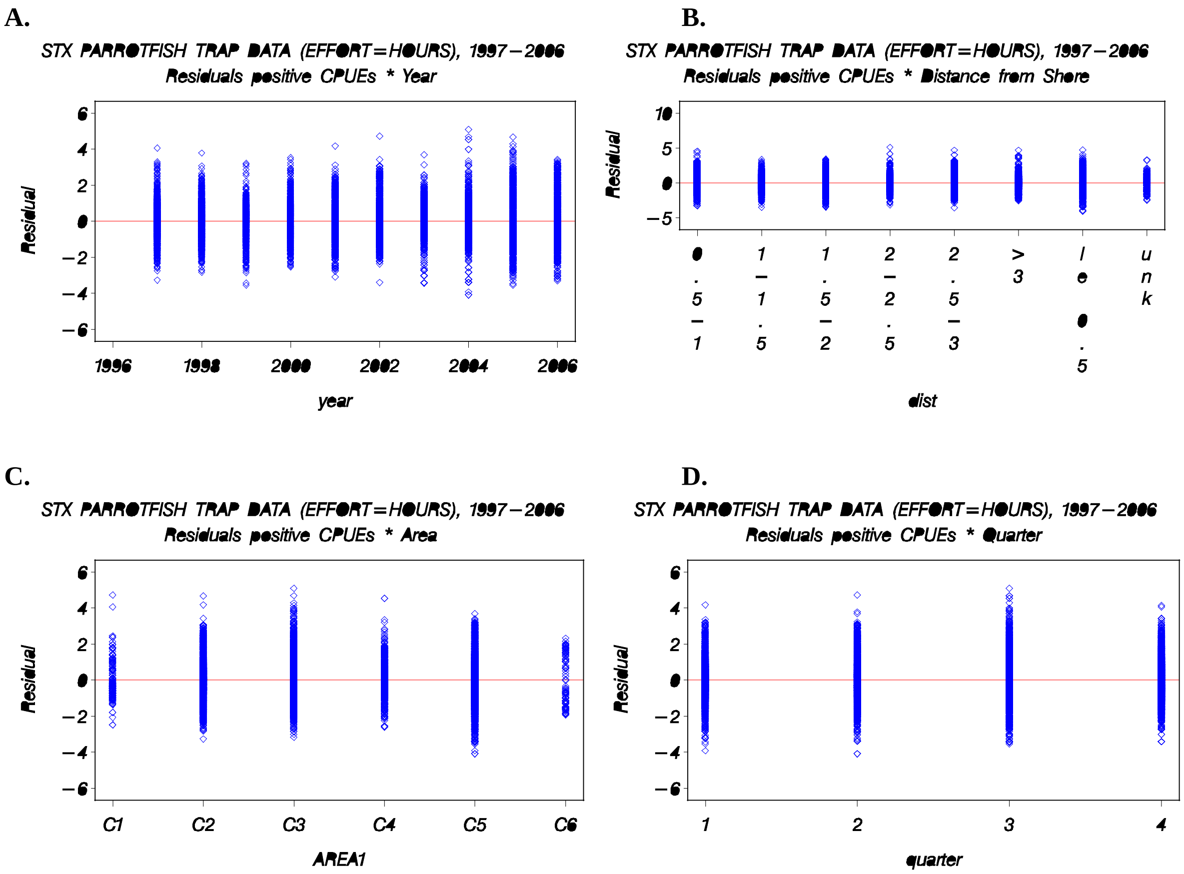


Figure 60: Diagnostic plots for the lognormal component of the St. Croix commercial trap model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by distance from shore (dist); **C**. the Chi-Square residuals by area fished (area1); **D.** the Chi-Square residuals by quarter.

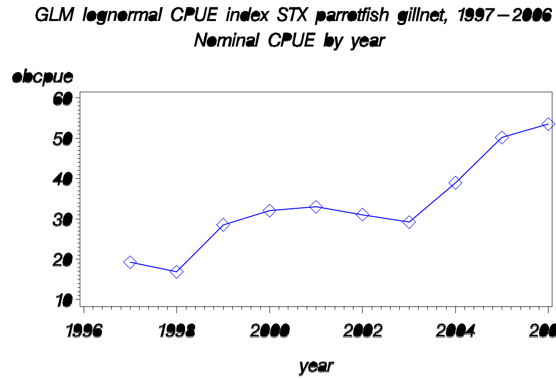


Figure 61: Annual trend in the nominal CPUE for the St. Croix gillnet lognormal model.

A. **B.**

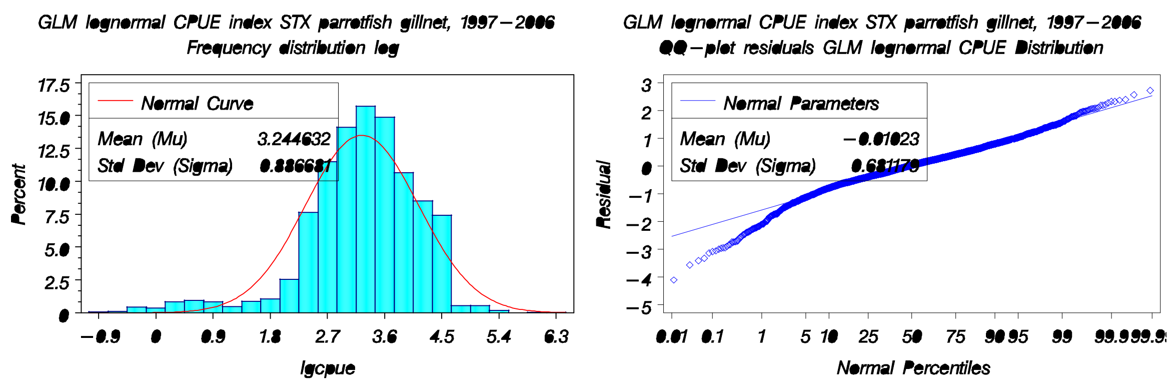


Figure 62: Diagnostic plots for the Croix commercial gillnet lognormal model: **A**) the frequency distribution of log(CPUE); **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

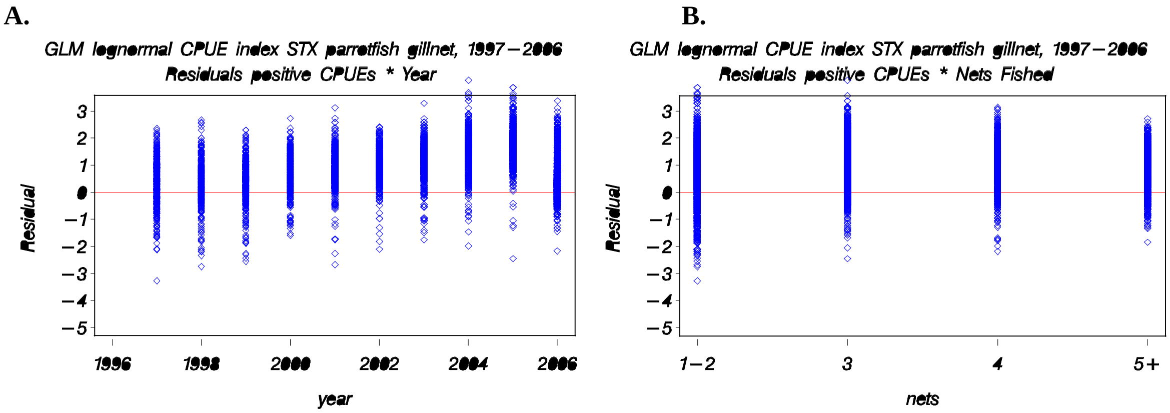


Figure 63: Diagnostic plots for the St. Croix commercial gillnet lognormal model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by number of nets fished (nets).

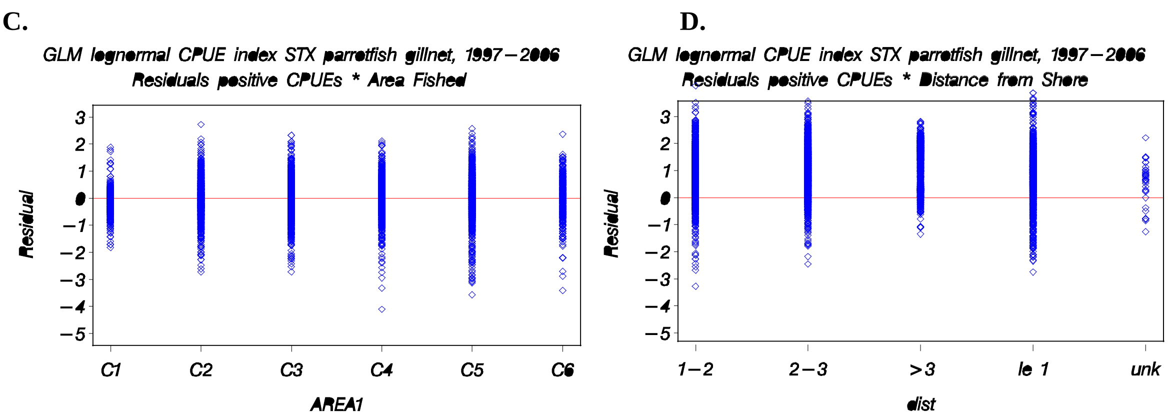


Figure 63 (continued): Diagnostic plots for the St. Croix commercial gillnet lognormal model: **C**. the Chi-Square residuals by area fished (area1); **D**. the Chi-Square residuals by distance from shore (dist).

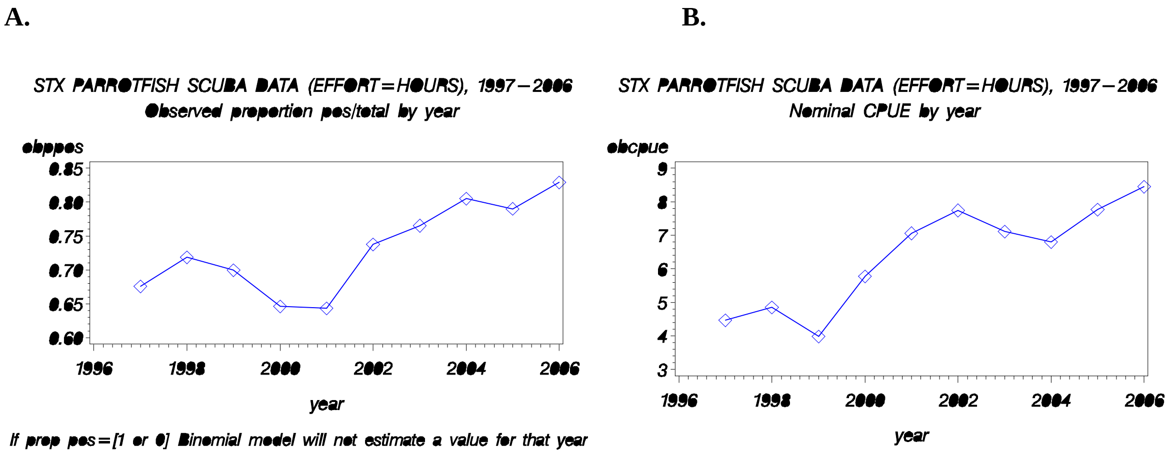


Figure 64: Annual trend in the proportion of positive trips (**A)** and nominal CPUE (**B)** for the St. Croix SCUBA model.

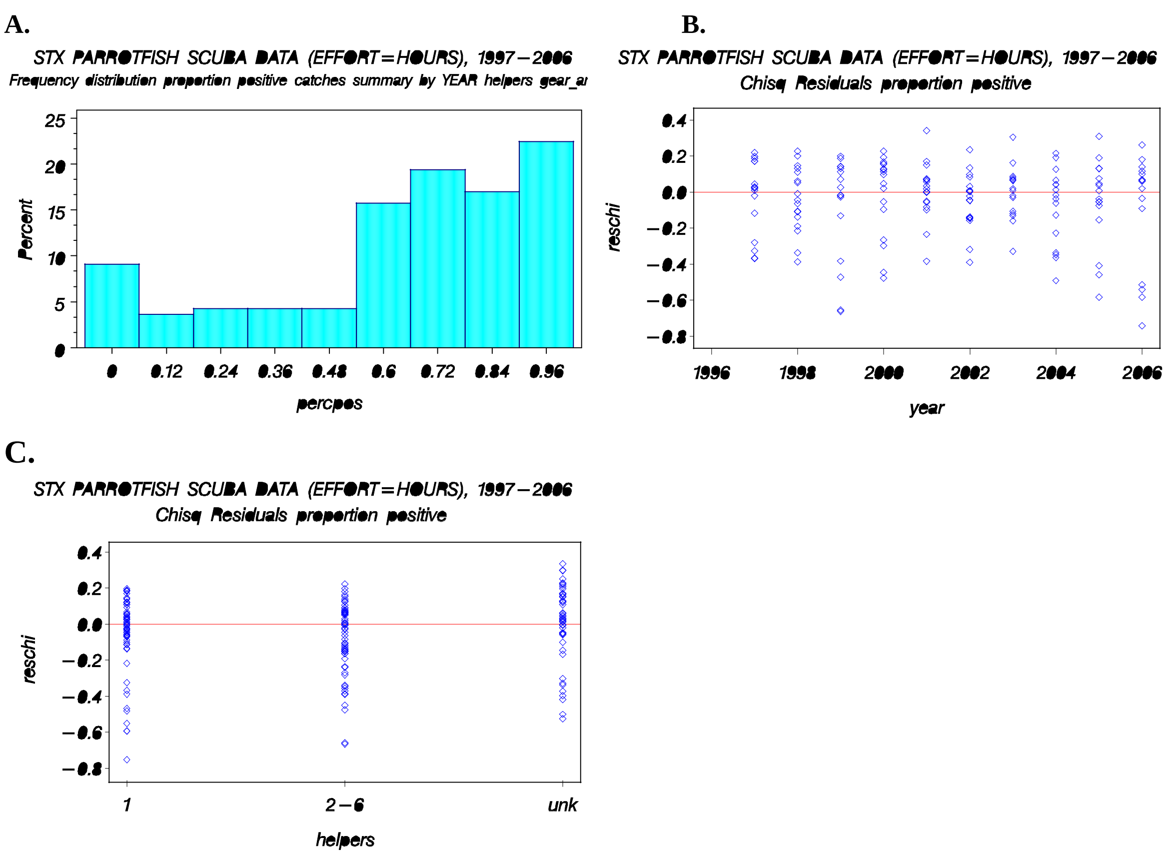


Figure 65: Diagnostic plots for the binomial component of the St. Croix commercial SCUBA model: **A**. the frequency distribution of the proportion positive trips; **B**. the Chi-Square residuals by year; **C.** the Chi-Square residuals by number of helpers (helpers).

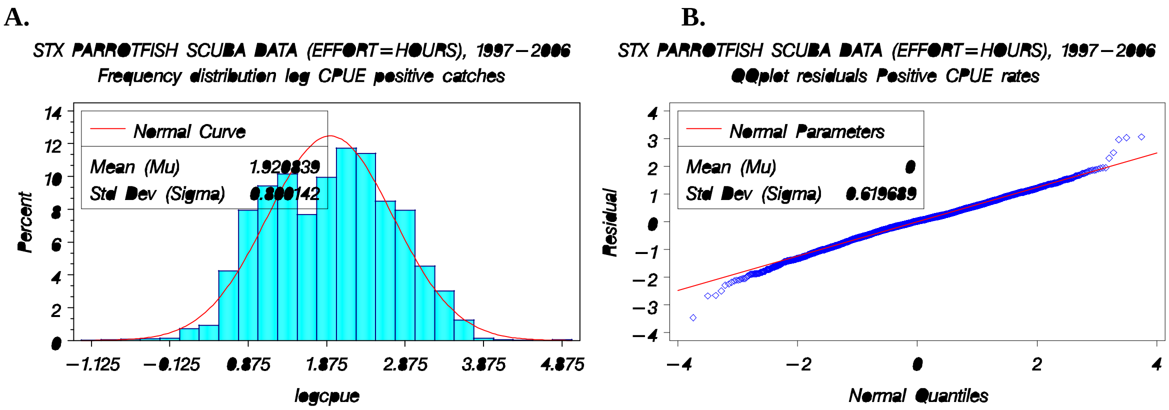


Figure 66: Diagnostic plots for the lognormal component of the St. Croix commercial SCUBA model: **A**) the frequency distribution of log(CPUE) on positive trips, **B**) the cumulative normalized residuals (QQ-Plot) from the lognormal model. The red line is the expected normal distribution.

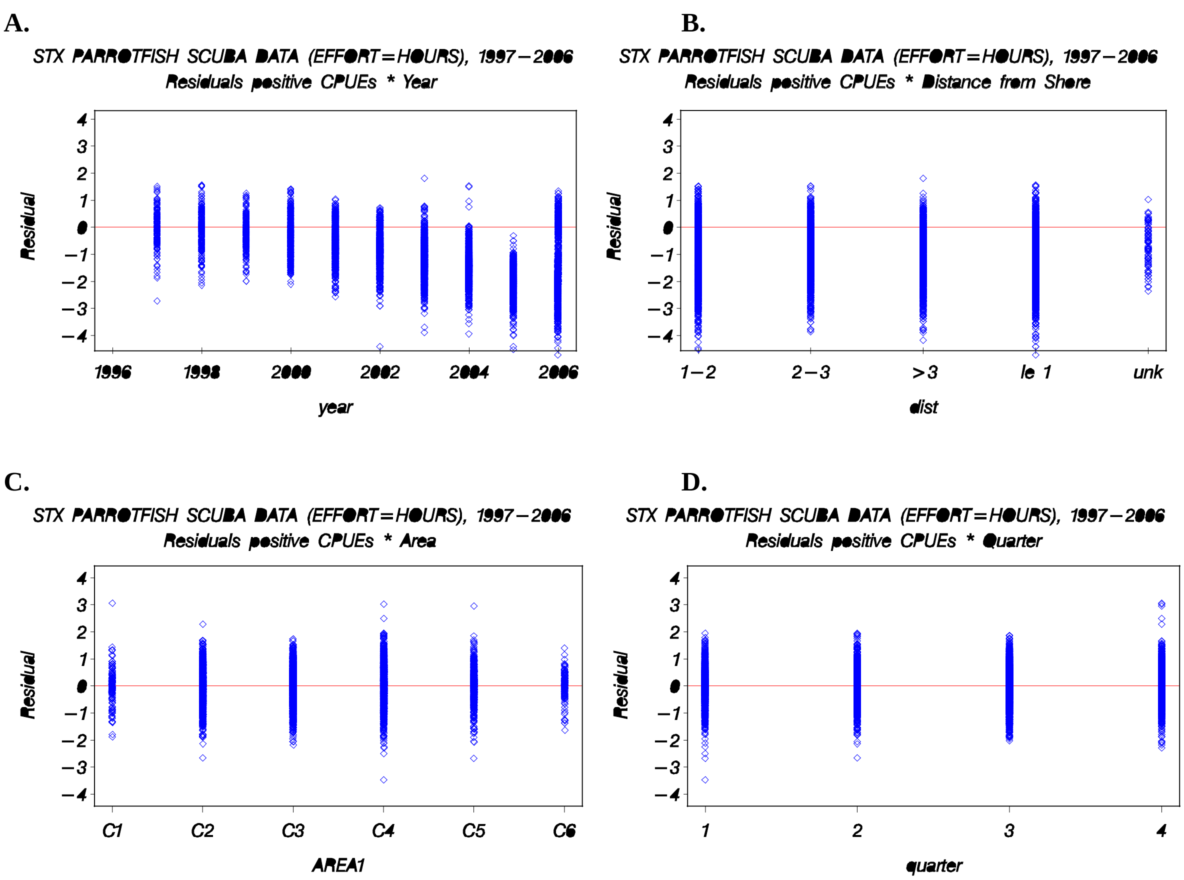


Figure 67: Diagnostic plots for the lognormal component of the St. Croix commercial SCUBA model: **A**. the Chi-Square residuals by year; **B**. the Chi-Square residuals by distance from shore (dist); **C**. the Chi-Square residuals by area fished (area1); **D.** the Chi-Square residuals by quarter.

2.2. TOR 2. Stock Complexes

Review the basis for existing stock complexes and evaluate whether adjustments to these complexes are suggested based on available data.

The basis for existing stock complexes was reviewed during the workshop. Following the presentation and initial discussion, a subgroup of participants convened and developed the following recommended complexes.

Table 33: Recommended Caribbean Fisheries Management stock complexes.

Complex	**Current (SFA)**	**Proposed (ACL)**
Snapper Unit 1	Silk Black Blackfin Vermilion	Silk Black Blackfin Vermilion Queen Wenchman (*Pristopomoides aquilonaris*)
Snapper Unit 2	Queen Wenchman (*Pristopomoides aquilonaris*)	Queen Cardinal (*Pristopomoides macrophthalmus*)
Snapper Unit 3	Gray Lane Mutton Dog Schoolmaster Mahogany	Gray Lane Mutton Dog Schoolmaster Mahogany
Snapper Unit 4	Yellowtail Snapper	Yellowtail Snapper
Grouper Unit 3	Red hind Coney Rock hind Graysby Creole-fish (*Paranthias furcifer*)	Red hind Coney Rock hind Graysby
Grouper Unit 4	Yellowfin Red Tiger Yellowedge Misty	Yellowfin Red Tiger Black (*Mycteroperca bonaci*)
Grouper Unit 5		Yellowedge Misty

2.2.1. ST. Thomas Stock Complexes

The St. Thomas stock complexes are based on 4 different fishery/gear methods (Fig. 68). The conch fishery is currently underutilized with potential for growth in the future and is rarely prosecuted. The yellowtail snapper and blue runner/bar jack fisheries are predominantly a hook-and-line fishery, although blue runner is also fished by net and is prosecuted somewhat independent of other fisheries, except for a small amount of yellowtail snapper captured in the trap fishery. The lobster fishery is targeted by a trap fishery and a SCUBA fishery. Additionally, there is a large incidental lobster trap fishery, whose main target is finfish species. The finfish species are primarily targeted with traps with a smaller percentage targeted by hand lines (17%) and nets (14%). Therefore, these additional finfish species are identified as the "Trap Complex" even though they are captured by other gears. The reconfigured Snapper Unit 1 and new Grouper Unit 5 (see Table 33) are treated as independent units, but for the purposes of computing an ACL, the recommendation is to combine Snapper Unit 3, Grouper Unit 3, and Grouper Unit 4 into the "Trap Complex."

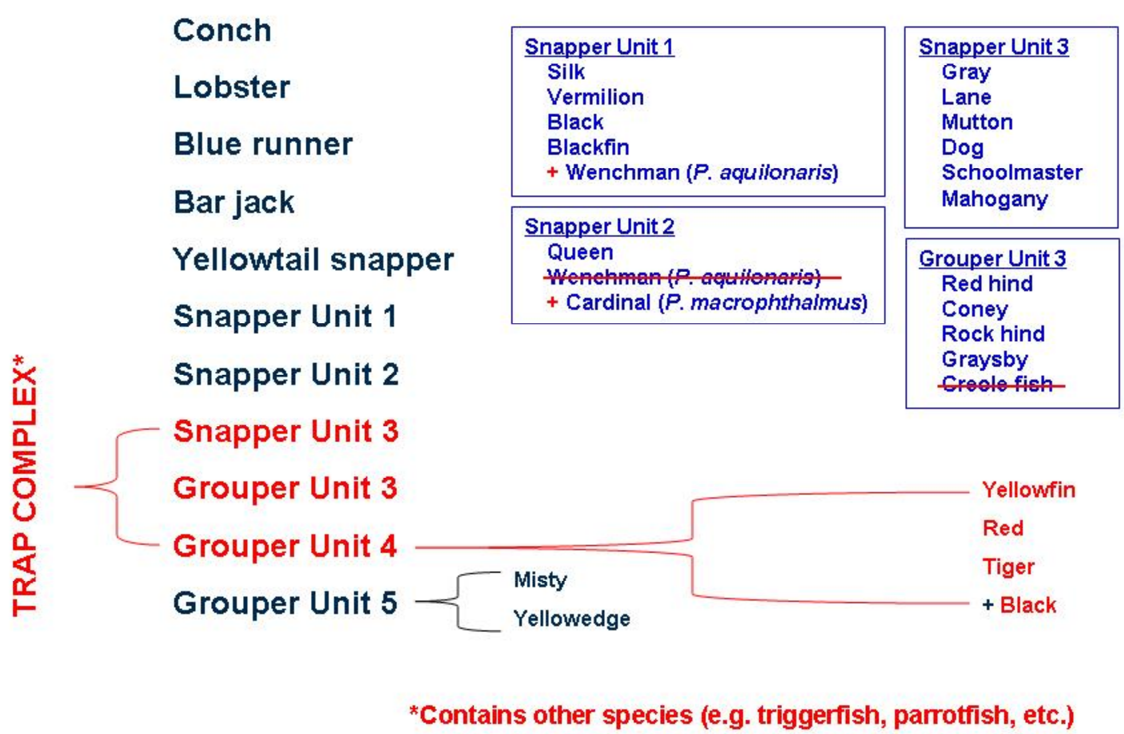


Figure 68: Recommended stock complexes for St. Thomas, with '+' denoting a suggested addition, and strikethrough denoting a suggested deletion.

2.2.2. St. Croix Stock Complexes

Species complexes in St. Croix are determined by depth, gear, and method of capture (Fig. 69). Misty and yellowedge grouper are found at depths much greater than are other species in the Grouper Unit 4 complex; therefore, it is recommended to create a new Grouper Unit 5 for these two species. For the purposes of setting an ACL, it is recommended to combine yellowtail snapper, proposed Snapper Unit 1 (Table 33), and Snapper Unit 3 into a "Snapper Complex." Similarly, Grouper Unit 3, Grouper Unit 4, and Grouper Unit 5 should be combined into a "Grouper Complex." Other finfish species will remain categorized as in the SFA (CFMC 2005).

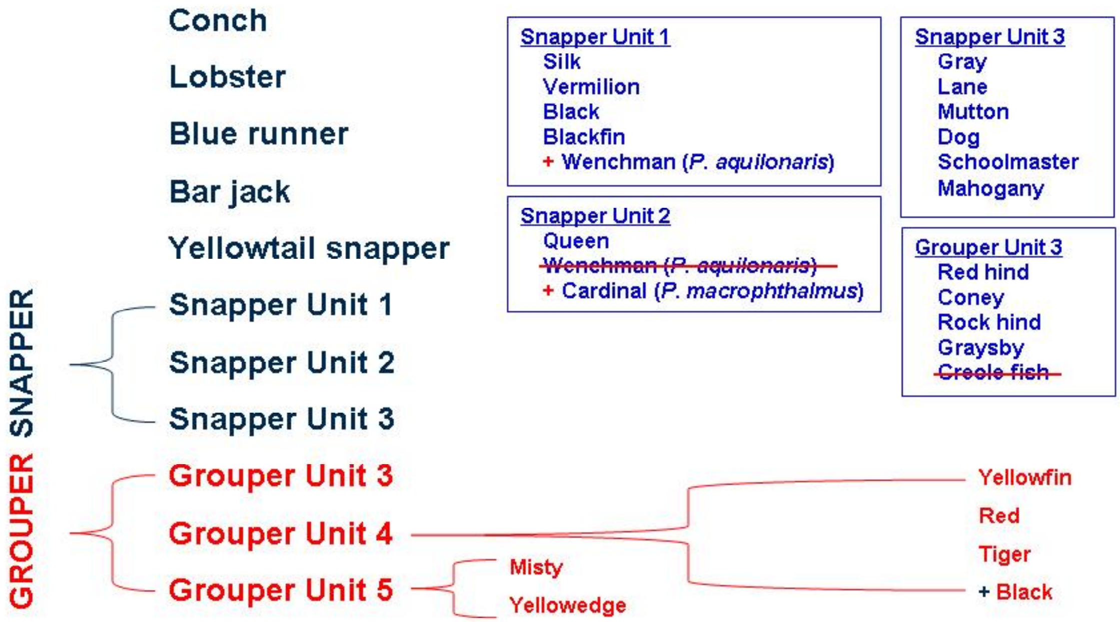


Figure 69: Recommended stock complexes for St. Croix, with '+' denoting a suggested addition, and strikethrough denoting a suggested deletion.

2.2.3. Puerto Rico Stock Complexes

Species complexes in Puerto Rico are determined by depth at capture and gear/methods used for capture (Fig. 70). Misty and yellowedge grouper are found at depths much greater than are other species in the Grouper Unit 4 complex; therefore, it is recommended to create a new Grouper Unit 5 for these two species. The species of wenchman currently listed in the Caribbean management plan is *Pristipomoides aquilonaris*; whereas the species commonly captured and known locally as 'wenchman' (also known as cardinal snapper) is *Pristipomoides macrophthalmus*. It is recommended *P. macrophthalamus* be added to Snapper Unit 2 based upon strong clustering with Queen snapper in analyses of landings records and similar habitats by depth (Table 34). It is recommended that *P. aquilonaris* be added to Snapper Unit 1 based upon similar habitats by depth (Table 34). It is recommended that Snapper Units 1 and 2 remain separated due to differences in landings patterns from cluster analysis, hook sizes used, distance from shore and depth of fishing effort, and biological habitats. However, we note that Snapper Units 1 and 2 are occasionally vulnerable to the same fishing effort due to the steepness of the shelf and tendency of gear to drift after setting, and these two units also share a similar reproductive cycle (Table 35). As such, the closed season (October 1 – December 31) for Snapper Unit 1 might also benefit Snapper Unit 2. It is recommended that black grouper (*Mycteroperca bonaci*) be added to Grouper Unit 4 based upon similar habitats by depth. Finally, it is recommended that creolefish (*Paranthias furcifer*), with less than 12 lbs average reported annual landings from 1983 – 2007, be removed from the management unit.

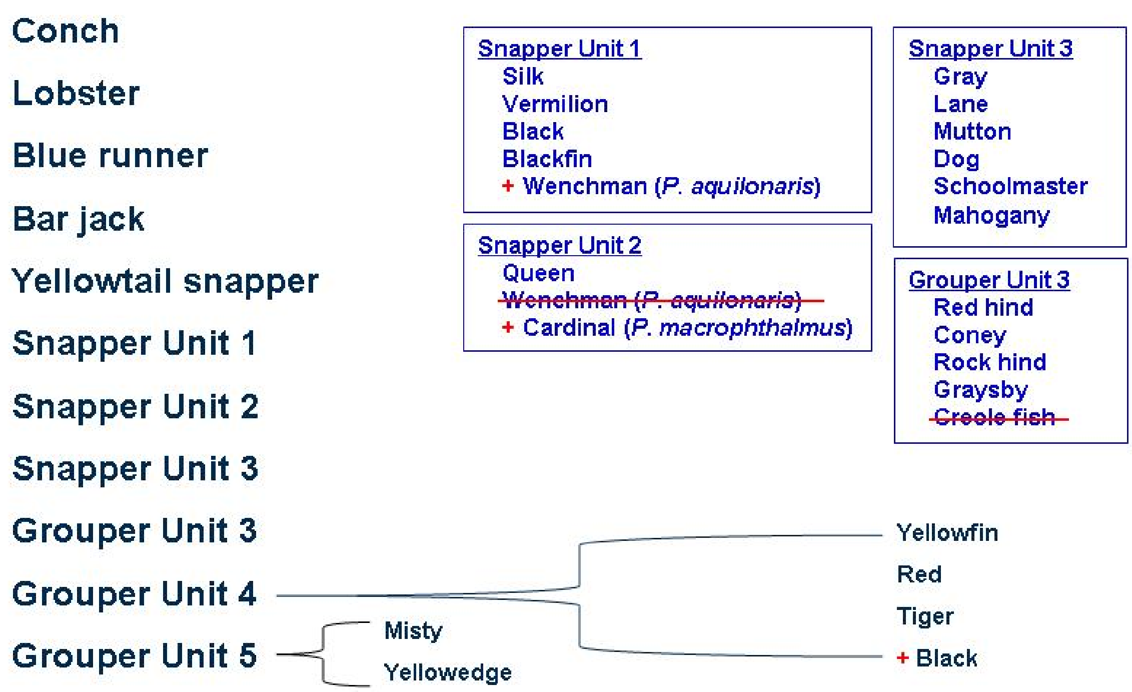
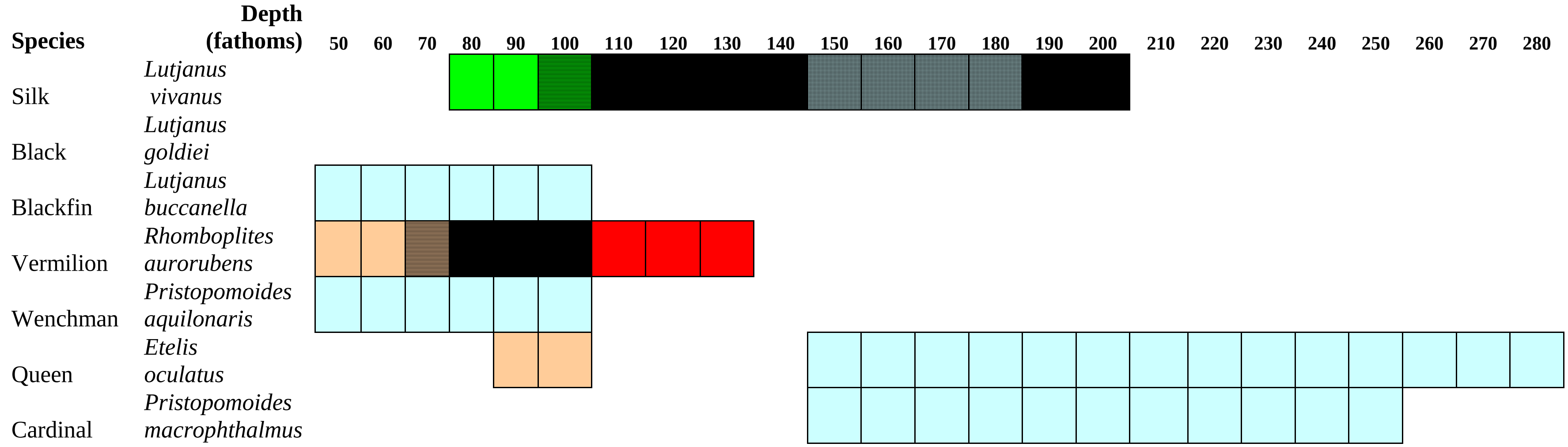


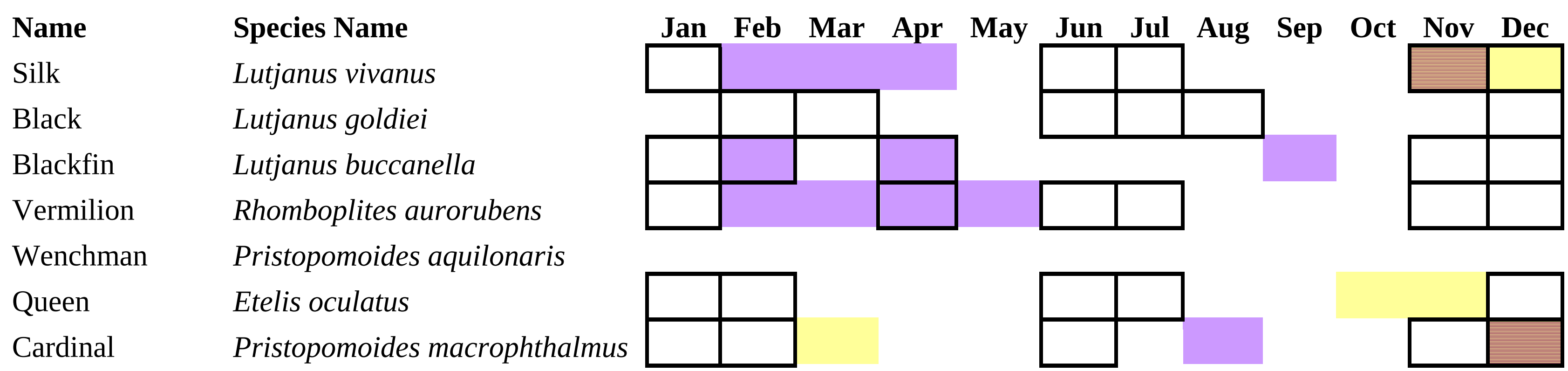
Figure 70: Recommended stock complexes for Puerto Rico, with '+' denoting a suggested addition, and strikethrough denoting a suggested deletion.

Table 34: Association of snapper species by depth, where turquoise denotes all life stages, light green denotes 1 lb 'marketable' fish, tan denotes juveniles, black denotes adults, and red denotes 'unmarketable' sizes.



Source: This table was developed with the help of Miguel Angel 'Guelo' Vargas, Nelson Crespo, Eugenio 'Geño' Piñeiro, Edwin Font 'Pauco' and fishers from the Villa Pesquera Geño in Rincón, Puerto Rico.

Table 35: Association of snapper species by reproductive cycle, where purple denotes observations of 'ripe' individuals (Erdman 1976), yellow denotes peaks in GSI (Rosario et al. 2006a, b), and dark borders denote above-average landings (1983 – 2007).



2.2.4 References

Erdman, D.S. 1976. Spawning patterns of fishes from the northeastern Caribbean. Agric. Fish. Contrib. Dep. Agric. (Puerto Rico), 8(2): 1-36.

CFMC. 2005. Amendment to the Fishery Management Plans of the U.S. Caribbean to Address Required Provisions of the Magnuson-Stevens Fishery Conservation and Management Act. Caribbean Fishery Management Council, San Juan, PR. 533 pp.

Rosario, A., Rojas., J., Piñeiro, E., Figuerola, M., Peña, N., and Torres, W. 2006a. Reproductive cycle and maturation size of silk snapper (*Lutjanus vivanus*). Final Report to CFMC. 20 pp.

Rosario, A., Rojas., J., Piñeiro, E., Figuerola, M., Peña, N., and Torres, W. 2006b. Reproductive cycle of queen snapper (*Etelis oculatus*) and the wenchman (*Pristipomoides macrophthalmus*). Completion Report to NMFS. 31 pp.

2.3. TOR 3. Recommended Stocks to Assess

Recommend species or stock complexes for which informative SEDAR benchmark assessments may be feasible.

The group developed a quality rating system of commercial, recreational and fishery independent data available for species listed in the Caribbean Fishery Management Council's fishery management plans. The numerical rating scale used was: (5) reliable data for more than 10 years; (4) reliable data for recent years; (3) data for more than 10 years, but reliability, comprehensiveness or coverage is questionable; (2) data for recent years, but reliability, comprehensiveness or coverage is questionable; (1) scattered or occasional observations, reliability questioned; (0) data unavailable or unreliable. Using this system to provide objective guidance as to which species may warrant a full SEDAR benchmark assessment, the group recommended the following species:

Puerto Rico:

Silk snapper	Parrotfish
Queen snapper	Grunts (6 spp)

St. Thomas/St. John

Parrotfish
Triggerfish and filefish (6 spp)

St. Croix

Parrotfish	Surgeonfish (3 spp)
Grunts (6 spp)	Triggerfish and Filefish (6 spp)

It should be noted that these recommendations are based on the ranking system developed during the workshop based on data availability. They do not take into account that past independent

SEDAR Review Panels have had issues with conducting age-structured models on species complexes. Finally, additional Puerto Rico species (lane snapper, for example) may have sufficient data to conduct a benchmark assessment if the Council is willing to restrict the geographic coverage of the assessment to the Puerto Rico platform.

2.4. TOR 4. Alternative Assessment Methods

Review alternative methods for estimating mortality rates and abundance trends that might be useful for those species or stock complexes for which data are deemed sufficient.

2.4.1. Catch Per Unit of Effort Abundance Trends

Puerto Rico and US Virgin Islands Fishery Dependent Data

Development of standardized CPUE abundance trends using the Puerto Rico and US Virgin Islands commercial sales records and fisher logbook data employed classical statistical modeling in index development. Index development focused on use of the fishery dependent data in both single species (i.e., Puerto Rico Silk and Queen snapper), species groups analyses (Parrotfish) as well as initial exploration of the data for multispecies CPUE development (i.e., Puerto Rico Multinomial CPUE analysis method applied to the Silk Snapper group). The Puerto Rico Snapper unit 1 (Silk, Black, Blackfin, and Vermillion) and Queen Snapper analyses focused on commercial fishing trips from the bottom line fishery. This sector was selected as the focus group since harvest of Silk and Queen Snapper groups by this sector dominated the 25 year study period, 1983-2007.

During the CPUE presentations, the investigators noted several concerns and difficulties associated with the analyses similar to previous SEDAR evaluations. These concerns included data quality issues, technical issues related to models used, as well as problems and concerns associated with result interpretations. These included the following issues and relate to both single species, grouped species (such as for Parrottfishes), and multispecies models:

1) Difficulties associated with selection of trips that could have caught the species of interest, but did not (i.e., zero catch trips) for inclusion in analyses.   Although rigorous statistical analyses such as the Stephens and MacCall data reduction approach was utilized to aid in zero catches selection some concern remained. In particular, with both the Silk and Queen Snapper bottom line data sets, the proportion of positives was low for both species in nearly all years.

2) Uneven proportion of positives across the study time period. This was the case for the two snapper groups evaluated, silk and queen. In the case of the Silk group, the proportion of positives declined over time suggesting perhaps that fishers included in the analysis may have switched targeting over time. In the case of the queen group, the proportion of positives increased over time, nearly doubling. This observation

may suggest that some bottom line trips included from the early years may have been actually been targeting other species or groups.

3) There was much discussion related to the zero trip selection and some commercial fishers present at the workshop confirmed that some trips do take place on which both of the deep water complexes are targeted. It was conveyed to the workshop participants that sometimes early in the day, fishers would stop in shore and fish the Silk Snapper group before heading out to deeper waters to target the Queen Snapper group. In addition, the Puerto Rico DWSN fishers also confirmed that routinely if fishing events were unsuccessful when out targeting for Queen group or if weather became a problem, that they would move inshore and fish the Silk group before returning to dock. Presently, the fisher sales ticket does not allow for separation of multi species targeting events making it most difficult to separate or apportion the separate fishing events and thus to identify Silk Snapper group fishing events from Queen snapper fishing events.

4) It was noted that further exploration of CPUE trends using data from sales/trip records on which hours fished should be explored as time allows.

5) During the discussions it was also noted that additional attempts to isolate trips specific to unique species or species groups should consider depth information as recorded on the sales records. It was noted as with hours fished effort data and exclusion of trips which represented multi trip records (i.e., NTrips variable > 1) that this would greatly reduce the number of trip records due to a) lack of depth information recorded or b) inability to determine correct units of depth variable (i.e., feet, fathoms, meters).

Discussion relating to the Multinomial CPUE Approach occurred. Simple multinomial proportions were modeled with only year. These could be expanded to include more variables for more standardization if managers or analysts want to explore the method for other species groups where the composition (number of species) is expected to be greater. An example might be for inshore reeffish effort (notably, fish pots and hook and line type gear). It was noted though that the coding of the model is not trivial and would require a significant amount of time. The multinomial model as applied here for the silk Snapper group (5 proportions) produced very similar trends in estimated CPUE for the Silk component as indicated from the single species model.

Additional work needs to be done to determine what benefits, if any, are gained in using the multinomial model particularly in the US Caribbean. Some information improvements might result for the less frequently occurring species of the group under consideration, such as Vermillion, black, and blackfin in the group as applied here. Previous SEDAR's for which single species CPUE models were used for species which occurred infrequently in the catch (e.g., yellowfin grouper) resulted often in the standardization models not converging. Resulting indices from the multinomial model for these more rare or infrequently occurring species however were variable and the CV's large suggesting the need for a great deal of caution when trying to make definitive statements as to changes in abundance over time. It was also noted confounding of black and blackfin catches might be present in the Puerto Rico data thus contributing additional variability to the Black and Blackfin CPUE trends form the multinomial method. Clearly additional examinations using the multinomial approach are needed

2.4.2. Evaluation of Length Data

The overall logic behind the analysis of length data was to use a time series of calculated mean lengths to determine total mortality rates and evaluate if changes in mortality could be detected. The focus was on the priority FMP units (Grouper unit 4, Snapper unit 1, and Parrotfish), however, summary tables of available data for all species in the TIP data base are also included for reference (Tables 36 through 38).

2.4.2.1. Base Model

The base model used in this analysis was derived by Gedamke and Hoenig (2006) and consists of a transitional form of a mean length mortality estimator for application in non equilibrium conditions. This extension of the Beverton and Holt mortality estimator (1956, 1957) has the same limited data requirements as in the previous formulation and, as such, has the potential for widespread use. The only required information is the von Bertalanffy growth parameters K and L_∞, the so-called length of first capture (smallest size at which animals are fully vulnerable to the fishery and to the sampling gear), L_c, and the mean length of the animals above the length L_c. Unlike the Beverton and Holt mortality estimator (1956, 1957) and the Ault et al. (2008) approach, however, the assumption of equilibrium conditions is not a requirement of the Gedamke and Hoenig (2006) approach. The new transitional form of the model allows mortality estimates to be made within a few years of a change rather than having to wait for the mean lengths to stabilize at their new equilibrium level. In other words, as soon as a decline in mean lengths is detected, this model can be applied and the trajectory of decline can be used to estimate the new total mortality rate (Z) and how mean lengths will change over time.

The methodology and an application to goosefish are described in detail in Gedamke and Hoenig (2006) and a summary of the approach and an application to mutton snapper is described in SEDAR14-AW-05. The method will only be described briefly here. Like the Beverton and Holt estimator this extension requires only a series of mean length above a user defined minimum size and the von Bertalanffy growth parameters, so it can be applied in many data poor situations. Gedamke and Hoenig (2006) demonstrated the utility of this approach using both simulated data and an application to data for goosefish caught in the NEFSC fall groundfish survey.

The mean length in a population can be calculated *d* years after a single permanent change in total mortality from Z_1 to Z_2 yr^{-1} by the following equation:

$$\bar{L} = L_\infty - \frac{Z_1 Z_2 (L_\infty - L_c)\{Z_1 + K + (Z_2 - Z_1)\exp(-(Z_2 + K)d)\}}{(Z_1 + K)(Z_2 + K)(Z_1 + (Z_2 - Z_1)\exp(-Z_2 d))}.$$

This equation can also be generalized to allow for multiple changes in mortality rate over time. A maximum likelihood framework is then used to estimate Z_1, Z_2, and the year of change (alternatively d) from the observed mean lengths.

2.4.2.2. Spatial Analysis

Based on concerns from previous evaluations of the TIP data set, an exploratory spatial analysis was conducted to determine if spatial changes have occurred in the fishery which would confound a length frequency analysis. Three specific questions were addressed:

- Has the spatial distribution of the fishery changed over time?
- Has the depth distribution of the fishery changed over time?
- Is there enough information to answer either of these questions?

Details of the analysis are presented in SEDAR SP3-01 and the primary focus, at this point, was the priority FMP units (Grouper unit 4, Snapper unit 1, and Parrotfish). Overall, low sample sizes and a lack of detailed spatial resolution hampered the ability to detect changes in the fishery. However, changes in both depth and spatial distribution of samples appear to have occurred in the snapper unit 1 fishery (gear codes 610 and 345) in Puerto Rico. In the hand line (610) fishery, samples prior to ~1998 were collected primarily in the Eastern part of the island and in shallower water as compared to the second half of the time series where mean depth has been increasing over time and samples were primarily collected from the WNW part of the island. All other combinations showed no clear trends. For the USVI, sample sizes in recent years have been very low and determining changes which have occurred since the larger sample sizes from the 1980’s and early 1990’s may not be possible.

2.4.2.3. Development of Multi-species model and Preliminary Results

A multi-species version of the Gedamke and Hoenig (2006) approach was developed in an attempt to maximize the amount of information available to determine changes in fishing pressure. The primary assumption behind the development of these models is that species within each FMP group, and used in each analysis, have been subject to similar patterns of exploitation.

The base model was re-paramaterized in two ways. The first assumed that all species were subject to a change in mortality that occurred at the same time. In this version of the model a common ‘year of mortality change’ was estimated in addition to species-specific total mortality rates. The second form of the multi-species model also assumed a common ‘year of mortality change’ but also assumed that the change in fishing mortality rate (F) would be proportional for all species so that a common ‘proportional change in F’ was estimated instead of species-specific mortality rates. The benefit of these approaches is a reduction in the number of parameters that need to be estimated. For example, if the model assumed three changes in mortality and included four species, the number of parameters to be estimated would be: 32 using the original Gedamke and Hoenig (2006) single species model, 23 using the multi-species model which only assumes a common ‘year of mortality change’, and 14 using the multi-species model which also assumes a common ‘proportional change in F’.

As a case study and test of these new models, the methodology was applied to the Snapper Unit 1 fishery in Puerto Rico using measurements from both the hook and line (code 610) and the trap (code 345) gears (black snapper was not included due to low sample sizes). The von Bertalanffy parameters from the Ault et al. (2008) study were used for comparative purposes. The models were applied to data from each gear individually, data from the gears combined, and then for each case from records which indicated a maximum depth of 80 fathoms (this was done in an attempt to remove the potential affect of the fishery moving into deeper water). All of the models indicated that total mortality rates were reduced during the time series with most indicating the reduction occurred between 1998 and 2002 and with an overall reduction of between 30 to 70%. The multi-species models performed well and the model which assumed a common “year of mortality change” was most strongly supported with the lowest AIC values.

2.4.2.4. Summary of Discussion and Recommendations

The group agreed that the methodology presented was promising and could provide guidance for the setting of ACL’s and, in limited cases for contributing to benchmark assessments. While all agreed that the absolute values of total mortality should be used with caution due to a variety of factors (e.g. uncertainty surrounding von Bertalanffy and natural mortality parameters), the trends or directionality in mean length alone could provide valuable insights to stock status (e.g. rapidly declining mean lengths may indicate that overfishing is occurring). The group thought that evaluating the mean length of stocks annually may be a simple way to monitor changes in stock status or changes in the fishery. The only significant concern that was raised was the inability to fully address the question of spatial changes in the fisheries and how this might affect results. The CIE reviewer recommended that the data be explored for a depth-selectivity relationship and others in the group thought that conducting regionally-specific analyses might address the problem. As was alluded to in the spatial analysis section, low sample sizes hamper the ability to conclusively evaluate and adequately correct for this potential problem. These concerns will be carefully considered and included as a critical component of the interpretation of any subsequent results.

The group compared the results of the new study, which employs the dynamic method of Gedamke and Hoenig (2006) with those of the recently published study by Ault et al. (2008), which employs the equilibrium-based method of Ehrhardt and Ault (1992). While the overall logic behind the use of mean lengths to estimate mortality is similar, the group agreed that the analyses presented during the meeting included a more thorough review of the data and that the Gedamke and Hoenig (2006) approach (including the new multi-species/multi-gear extensions) represented a significant advance in methodology. Specifically, the group identified the following points:

- the new study included a comprehensive evaluation of the entire TIP database, resulting in significantly larger sample sizes and better representation of the mean lengths and corresponding total mortality rates
- the assumption of ‘equilibrium conditions’ required by the method of Ault et al. (2008) was clearly violated in the examples examined. With increasing mean lengths, as has been observed in a number of stocks, this assumption violation will result in an overestimate of total mortality. The Gedamke and Hoenig (2006) method and newly derived multispecies approaches allow time-series of mean lengths to be evaluated which provides greater insights into temporal trends in mortality and an increased ability to interpret results
- the new study estimated the length at full vulnerability (L_c) based on these larger sample sizes and from length data for each gear, rather than from basic statistics on all gears combined. All mean-length mortality estimators are particularly sensitive to this parameter and the new multi-species/multi-gear approaches allow the selectivity of each gear to be explicitly incorporated into the selection of an appropriate L_c
- the Ault et al. (2008) approach provides point estimates of total mortality rates and the uncertainty in von Bertalanffy growth parameters, L_c, and mean lengths is not adequately described or reflected in the final point estimates.

Ault et al. (2008) also proposed proxies for biomass-based status determination criteria (SDC) that could, in principle, be used to define the minimum stock size threshold (MSST) described by the guidelines for implementing National Standard 1. While estimates for biomass-based SDCs would clearly be beneficial to the process, the group agreed that the candidates discussed by Ault et al. (2008) should be viewed with caution given that they are equilibrium-based and assume, among other things, that the number of spawners has no effect on subsequent recruitment. The group did agree, however, that Ault et al.'s use of the natural mortality rate M as proxy for F_{MSY} was reasonable, given the lack of alternatives (see section 2.6).

2.4.2.5. References

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Ehrhardt, N.M., and Ault, J.S. 1992. Analysis of two length-based mortality models applied to bounded catch length frequencies. Transactions of the American Fisheries Society. 121: 115-122.

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Table 36: Summary of available TIP length frequency data for Puerto Rico. All records in the TIP database have been included in this summary. Records attributed to multiple gears, for example will have to be evaluated on a species by species basis.

SPECIES_NAME	Total Number Measured	# of Years with Measured Fish	# of Years with 50+ Measured	First Year 50+ fish measured	Last Year 50+ fish measured	# Measured since 2002
AFRICAN POMPANO (THREADFIN)	40	11				5
ALMACO JACK	276	10	1	1993	1993	6
AMERICAN EEL	6	1				
ATLANTIC BUMPER	157	7	2	1986	1992	12
ATLANTIC CUTLASSFISH	152	9				107
ATLANTIC FLYINGFISH,CYPSELUR.M	12	1				
ATLANTIC MOONFISH	450	17	3	1989	2006	218
ATLANTIC SPADEFISH	8	4				
ATLANTIC THREAD HERRING	727	9	5	1989	2005	143
BALLOONFISH	1	1				1
BALLYHOO	858	11	5	1997	2007	640
BANDED BUTTERFLYFISH	4	1				4
BANDTAIL PUFFER	4	2				
BAR JACK	7020	25	22	1984	2008	2425
BARBU	87	7	1	2000	2000	
BARRACUDAS, SPHYRAENIDAE	63	13				19
BARRED GRUNT,CONODON NOBILIS	327	8	2	1989	1990	30
BEARDED BROTULA,BROTULA BARBAT	1	1				
BEARDFISH	3	2				
BERMUDA CHUB	30	5				13
BIGEYE SCAD	1076	15	7	1998	2007	359
BIGEYE,PRIACANTHUS ARENATUS	151	13	1	1992	1992	15
BIGEYED SEVENGILL SHARK	7	2				6
BIGEYED SIXGILL SHARK	5	3				3
BIGEYES, PRIACANTHIDAE	6	3				3
BLACK DURGON	73	11				18
BLACK GROUPER	214	18				14
BLACK GRUNT	21	7				
BLACK JACK	79	9				
BLACK MARGATE	210	21				20
BLACK SNAPPER	80	12				2
BLACKBAR SOLDIERFISH	72	8				1
BLACKCHEEK TONGUEFISH	1	1				
BLACKFIN SNAPPER	2895	25	18	1985	2007	963
BLACKFIN TUNA	2041	24	13	1988	2007	1144
BLACKLINE TILEFISH	31	7				1
BLACKTIP SHARK	2	1				
BLUE ANGELFISH	2	2				
BLUE LAND CRAB	64	2	1	1997	1997	
BLUE MARLIN,MAKAIRA NIGRICANS	4	4				1
BLUE PARROTFISH	64	11				2
BLUE RUNNER,CARANX CRYSOS	1466	23	10	1986	2006	618
BLUE SHARK	6	3				
BLUE TANG	115	8	1	2006	2006	91
BLUE TILAPIA	1	1				
BLUEGILL	45	3				
BLUESTRIPED GRUNT	7849	25	22	1985	2007	2018
BOBO JOTUR	3	1				
BOCON	18	1				
BONEFISH	25	6				

BONEFISHES, ALBULIDAE	3	2				
BROWN BULLHEAD	4	1				4
BROWN CHROMIS,CHROMIS MULTILIN	5	3				
BULLET MACKEREL	7	3				
BURRO GRUNT	25	6				
BUTTERFISH (TRIACANTHUS)	682	16	2	1991	1992	17
BUTTERFISH AND HARVESTFISH	7	1				
BUTTERFLYFISHES, CHAETODONTIDA	20	5				14
CAESAR GRUNT	558	16	3	1986	1993	70
CARDINAL SNAPPER	321	10	3	1987	1989	
CARDINALFISHES, APOGONIDAE	1	1				
CARIBBEAN RED SNAPPER	4	3				
CARIBBEAN SPINY LOBSTER	27693	25	25	1984	2008	10410
CERO MACKEREL	4778	26	20	1986	2007	1390
CHALK BASS	3	1				
CHANNEL CLINGING CRAB	5	3				5
CLOWN WRASSE	1	1				1
COBIA	5	3				
COBIAS, RACHYCENTRIDAE	1	1				
CONEY	17689	26	24	1983	2006	1194
COTTONMOUTH JACK	14	2				
COTTONWICK	31	3				
CREOLE-FISH	27	8				
CREVALLE JACK	216	15	1	1989	1989	26
CRUSTACEA	5	2				4
CRUSTACEANS,DECAPODA	68	4				65
CUBERA SNAPPER	397	21	3	1991	1993	31
DAMSELFISHES, POMACENTRIDAE	12	1				
DOCTORFISH,ACANTHURUS CHIRURGU	120	5				69
DOG SNAPPER,LUTJANUS JOCU	1429	26	14	1985	2007	451
DOLPHIN	2621	23	12	1990	2008	1652
DOLPHINS, CORYPHAENIDAE	205	13				36
DRUMS, SCIAENIDAE	198	7	1	1988	1988	
DUSKY SHARK	11	3				
FALSE PILCHARD	36	1				
FAT SLEEPER	2	1				
FAT SNOOK	269	5	3	1989	2006	106
FINFISH, UNCLASSIFIED	392	20	2	1989	1990	77
FLAMEFISH	1	1				
FLORIDA SMOOTHHOUND	8	2				8
FOUREYE BUTTERFLYFISH	8	4				
FRENCH ANGELFISH	60	14				16
FRENCH GRUNT	2956	25	13	1983	2003	222
GLASSEYE SNAPPER	2	1				
GOAT FISHES, MULLIDAE	20	5				16
GOLDFACE TILEFISH	2	1				
GOLDFISH	1	1				
GOLIATH GROUPER, E. ITAJARA	78	17				5
GRACEFUL CATFISH	8	1				
GRAY ANGELFISH	98	15				7
GRAY SNAPPER	535	23	2	1988	2007	125
GRAY TRIGGERFISH	121	5	1	2001	2001	20
GRAYSBY	1822	25	10	1986	2001	124
GREAT BARRACUDA	40	11				7
GREAT HAMMERHEAD	12	4				
GREATER AMBERJACK	98	21				17
GREATER SOAPFISH	3	3				
GREEN SWORDTAIL	5	1				

GROUPERS AND SEA BASSES, SERRA	42	8				13
GROUPERS, EPINEPHELUS	1	1				
GRUNTS, HAEMULIDAE	302	7	2	1988	1991	
GUAGUANCHE	132	9	1	1992	1992	24
HAMMERHEAD SHARKS, SPHYRNIDAE	2	2				
HARDHEAD SILVERSIDE	1	1				
HARVESTFISH,PEPRILUS ALEPIDOTU	36	6				5
HERRINGS, CLUPEIDAE	244	7	1	2001	2001	101
HOGFISH	4273	26	24	1983	2007	981
HONEYCOMB COWFISH	2549	20	14	1983	2003	115
HONEYCOMB COWFISH, ACANTHOSTRA	322	5	3	2004	2006	310
HORSE-EYE JACK	1509	24	14	1988	2005	367
HOUNDFISH	53	8				31
JACKKNIFE-FISH	1	1				
JACKS, CARANGIDAE	245	12	2	1984	1989	1
JOLTHEAD PORGY	4244	24	21	1984	2007	636
KING MACKEREL	8126	25	23	1984	2008	3413
LADYFISH	116	9				1
LANE SNAPPER	32351	26	26	1983	2008	7300
LARGEMOUTH BASS	1	1				
LEATHERJACKET,OLIGOPLITES SAUR	11	3				
LEMON SHARK	65	9				
LITTLE TUNNY	2279	21	9	1988	2004	870
LITTLEHEAD PORGY	33	1				
LIZA,MUGIL LIZA	97	5	1	1999	1999	1
LIZARDFISHES, SYNODONTIDAE	4	3				
LONGFINNED ALBACORE	134	7	1	1999	1999	27
LONGSPINE SQUIRRELFISH,HOLOCEN	164	10	1	1992	1992	15
LOOKDOWN	6	2				
MACKEREL SCAD	92	3	1	2000	2000	1
MACKEREL SHARKS, LAMNIDAE	2	2				
MACKERELS AND TUNAS, SCOMBRIDA	51	14				11
MAHOGANY SNAPPER	1416	26	9	1985	2001	217
MANGROVE OYSTER	3	2				
MAN-OF-WAR FISH	50	1	1	2001	2001	
MANTA RAY	10	2				9
MARBLED GROUPER	4	3				1
MARGATE	383	24				87
MARLIN,SAILFISH,SPEARFISH - IS	1	1				1
MIDNIGHT PARROTFISH	15	8				1
MISTY GROUPER	98	18				46
MOJARRA, DIAPTERUS RHOMBEUS	89	10				18
MOJARRAS, GERREIDAE	1101	19	6	1988	2006	214
MOLLUSKS, TWO SHELL,BIVALVIA	3	2				
MONGOLAR DRUMMER	32	3				
MORAYS, MURAENIDAE	2	1				
MOUNTAIN MULLET	12	2				
MULLET, MUGIL DUSSUMIERI	5	1				
MULLETS, MUGILIDAE	55	3				
MUTTON HAMLET	291	16	2	1986	1987	7
MUTTON SNAPPER	6567	26	23	1983	2007	2721
NASSAU GROUPER	1106	23	8	1983	1992	24
NURSE SHARK	7	4				
OCEAN SURGEON	181	18				37
OCEAN TRIGGERFISH	35	14				14
OCTOPUSES,OCTOPUS	6	1				6
OILFISH	3	1				
ORANGE FILEFISH	5	2				

ORANGESPOTTED FILEFISH	11	3				7
ORTHOPRISTIS RUBER	4	1				4
PALOMETA,TRACHINOTUS GOODEI	139	11	1	1992	1992	36
PARROTFISHES, SCARIDAE	1001	19	8	1992	2003	217
PEACOCK CICHLID	2	2				1
PEACOCK FLOUNDER	2	2				
PEARLY RAZORFISH	4	1				
PERMIT	180	20				91
PINK OR QUEEN CONCH	326	9	1	2005	2005	252
POMPANO DOLPHIN	13	2				
PORCUPINEFISH,DIODON HYSTRIX	3	2				
PORCUPINEFISHES, DIODONTIDAE	2	2				1
PORGIES, CALAMUS	988	5	2	1983	1984	
PORGY, CALAMUS PENNATULA	9291	25	22	1984	2007	1998
PORKFISH	1532	23	12	1986	2005	366
PRINCESS PARROTFISH	1341	21	12	1987	2006	343
PUDDINGWIFE	102	16				5
PURPLE SNAKE MACKEREL	1	1				
PYGMY FILEFISH	8	2				
QUEEN ANGELFISH	151	12				71
QUEEN PARROTFISH	1120	20	10	1990	2006	419
QUEEN SNAPPER,ETELIS OCULATUS	5006	25	20	1986	2008	2517
QUEEN TRIGGERFISH	7346	26	25	1983	2007	1534
RAINBOW PARROTFISH	73	16				12
RAINBOW RUNNER	141	16	1	2002	2002	110
RAINBOWFISH,POECILIA RETICULAT	2	2				2
RED GOATFISH,MULLUS AURATUS	23	1				
RED GROUPER	51	17				8
RED HIND	22512	26	26	1983	2008	5327
REDBAND PARROTFISH	869	19	4	1986	1990	37
REDEAR SARDINE	46	2				17
REDEAR SUNFISH	2	1				
REDFIN PARROTFISH	176	11				96
REDTAIL PARROTFISH	12854	23	22	1986	2007	3571
REEF CROAKER	758	19	4	1983	2003	196
REEF SHARK	27	6				3
REQUIEM SHARKS, CARCHARHINIDAE	38	12				22
RHINCODONTIDAE	3	3				
RIBBONFISHES, TRICHIURIDAE	12	1				
ROCK BEAUTY	5	1				
ROCK HIND	472	23	3	1988	1991	40
RONCO	53	1	1	1989	1989	
ROUND SCAD	1	1				
SAILFISH	2	2				
SAILORS CHOICE	611	19	4	1988	2002	113
SAND DIVER,SYNODUS INTERMEDIUS	11	4				
SAND DRUM	87	3	1	1989	1989	
SAND PERCH	27	2				
SAND TILEFISH	57	11				35
SAPPHIRE EEL	37	1				37
SARGASSUM TRIGGERFISH	1	1				
SARGASSUMFISH	1	1				
SAUCEREYE PORGY	1364	6	2	1986	1987	
SCALED SARDINE,HARENGULA JAGUA	60	3				58
SCALLOPED HAMMERHEAD	2	2				1
SCHOOLMASTER	4116	25	22	1984	2007	779
SCRAWLED COWFISH, ACANTHOSTRAC	381	4	3	2004	2006	381
SCRAWLED COWFISH, LACTOPHRYS Q	3925	21	14	1983	2002	102

SCRAWLED FILEFISH	13	5				2
SCUPS OR PORGIES, SPARIDAE	3830	20	17	1983	2006	374
SEA BREAM	204	15				92
SEA CHUBS, KYPHOSIDAE	18	3				13
SEAHORSES, SYNGNATHIDAE	20	7				6
SERGEANT MAJOR	8	3				
SEVENGILL SHARK	1	1				
SHARKSUCKER	12	3				1
SHEEPSHEAD PORGY	123	9	1	1988	1988	
SHORTFIN MAKO	30	6				
SHORTNOSE BATFISH	3	2				
SHRIMPS,PENAEIDEA	5	1				5
SILK SNAPPER	23073	26	26	1983	2008	9722
SILVER JENNY	6	3				1
SILVERSTRIPE HALFBEAK	4	1				
SIRAJO	11	1				
SIXGILL SHARKS, HEXANCHIDAE	13	8				1
SKATES AND RAYS,RAJIFORMES	1	1				
SKIPJACK TUNA	1172	21	11	1988	2007	363
SLOUGH ANCHOVY	7	1				
SMALLMOUTH GRUNT	37	11				8
SMOOTH DOGFISH	1	1				
SMOOTH PUFFER	4	4				1
SMOOTH TRUNKFISH	1313	25	9	1984	2006	123
SNAPPERS	1	1				
SNAPPERS, LUTJANIDAE	269	14	2	1983	1984	39
SNOOK	818	23	7	1988	2007	346
SNOOKS, CENTROPOMIDAE	325	15	1	1988	1988	9
SOUTHERN SENNET	469	19	4	1992	2006	238
SOUTHERN STINGRAY	3	3				
SPADEFISHES, EPHIPPIDIDAE	68	11				36
SPANISH FLAG	1	1				
SPANISH GRUNT	93	6				
SPANISH HOGFISH	178	21				24
SPANISH MACKEREL,SCOMBEROMOR.M	3	1				
SPANISH SLIPPER LOBSTER	394	9	3	2005	2007	365
SPECKLED SWIMMING CRAB	37	1				
SPINY LOBSTERS, PALINURIDAE	3316	6	6	1980	1987	
SPOTFIN BUTTERFLYFISH	1	1				1
SPOTTED DRUM	7	4				1
SPOTTED EAGLE RAY,AETOBATUS NA	3	2				
SPOTTED GOATFISH	13579	26	23	1983	2007	955
SPOTTED MORAY,GYMNOTHORAX MORI	3	1				
SPOTTED SCORPIONFISH	6	2				4
SPOTTED SPINY LOBSTER	14	6				1
SPOTTED TRUNKFISH	1472	25	11	1984	2006	198
SQUIRRELFISH	1964	21	11	1986	2006	180
SQUIRRELFISHES, HOLOCENTRIDAE	466	16	3	1992	2003	175
STOPLIGHT PARROTFISH	15383	23	22	1986	2007	4309
STRIPED ANCHOVY	8	1				
STRIPED MOJARRA	487	11	2	1989	1990	70
SWORDFISH	28	1				
SWORDSPINE SNOOK	55	5				9
TANGS, ACANTHURIDAE	63	7				2
TARPON	112	11				24
TARPON SNOOK	1	1				
TATTLER	8	2				
TIGER GROUPER	3309	20	9	1991	2004	212

TIGER SHARK	3	2				1
TOBACCO TRUMPETFISH	14	3				10
TOBACCOFISH	28	5				
TOMTATE,HAEMULON AUROLINEATU	457	16	5	1988	1993	18
TRIGGERFISHES	1	1				
TRIGGERFISHES AND FILEFISHES,B	55	9				3
TRIPLETAIL	217	10	1	2002	2002	177
TRUNKFISH	1505	23	8	1983	2006	731
TRUNKFISHES, OSTRACIIDAE	1078	13	2	1984	2007	124
UNICORN FILEFISH	1	1				1
VERMILION SNAPPER	12987	26	23	1984	2007	1071
VIOLET GOBY	1	1				
VIPER MORAY	3	2				
WAHOO	583	18	4	1999	2006	343
WARMOUTH	4	2				1
WENCHMAN	456	12	4	1990	2007	219
WEST INDIAN FIGHTING CONCH	3	2				
WHITE CATFISH	5	2				
WHITE GRUNT	50150	26	25	1983	2007	6329
WHITE MARLIN	19	1				
WHITE MULLET	1203	18	6	1988	2006	285
WHITEMOUTH DRUMMER	165	12				98
WHITESPOTTED FILEFISH,CANTHE.M	25	8				12
WOBBEGONGS, ORECTOLOBIDAE	1	1				
WRASSES, LABRIDAE	25	6				12
YELLOW CHUB	24	5				
YELLOW GOATFISH	3325	25	12	1983	2001	139
YELLOW JACK,CARANX BARTHOLOMAE	776	22	3	1990	2004	240
YELLOWEDGE GROUPER	2	1				
YELLOWFIN GROUPER	322	24				14
YELLOWFIN MOJARRA	532	19	2	1988	2006	149
YELLOWFIN TUNA	858	22	7	1998	2006	304
YELLOWHEAD WRASSE	1	1				
YELLOWMOUTH GROUPER	16	11				4
YELLOWTAIL SNAPPER,OCYURUS CHR	86203	26	26	1983	2008	22895

Table 37: Summary of available TIP length frequency data for St. Croix. All records in the TIP database have been included in this summary. Records attributed to multiple gears, for example will have to be evaluated on a species by species basis.

SPECIES_NAME	Total Number Measured	# of Years with Measured Fish	# of Years with 50+ Measured	First Year 50+ fish measured	Last Year 50+ fish measured	# Measured since 2002
AFRICAN POMPANO	8	3				
ALMACO JACK	29	3				
AMBERJACKS	1	1				
ATLANTIC BONITO	7	3				
ATLANTIC SPADEFISH	53	9				19
BALAO	20	1				20
BALLYHOO	787	1	1	2005	2005	787
BANDED BUTTERFLYFISH	75	6	1	2005	2005	73
BAR JACK	1376	26	6	1984	2005	272
BARRACUDAS, SPHYRAENIDAE	68	7				
BARRED GRUNT,CONODON NOBILIS	37	1				
BATWING CORAL CRAB	11	3				11
BEARDFISH	40	4				19
BEARDFISHES	4	1				
BERMUDA CHUB	28	7				18
BIGEYE SCAD	1584	3	1	1986	1986	14
BIGEYE,PRIACANTHUS ARENATUS	8	2				2
BIGEYED SIXGILL SHARK	12	1				12
BIGEYES, PRIACANTHIDAE	1	1				1
BIGSCALE POMFRET,TARACTICHTHYS	2	1				
BLACK DURGON	141	10	1	2004	2004	86
BLACK GROUPER	2	2				
BLACK GRUNT	2	2				2
BLACK JACK	60	14				2
BLACK MARGATE	30	9				24
BLACK SNAPPER	356	12	3	1990	1992	6
BLACKBAR SOLDIERFISH	186	12	2	1988	1989	10
BLACKFIN SNAPPER	3926	21	14	1984	2005	212
BLACKFIN TUNA	597	12	4	1984	1990	6
BLUE MARLIN,MAKAIRA NIGRICANS	13	3				
BLUE RUNNER,CARANX CRYSOS	180	10	1	1989	1989	14
BLUE TANG	32832	26	25	1983	2008	2524
BLUEFIN TUNA	5	1				
BLUEFISH,POMATOMUS SALTATRIX	25	1				
BLUESTRIPED GRUNT	1047	22	12	1984	2008	295
BONEFISH	17	1				17

BURRO GRUNT	939	9	6	1984	1989	
BUTTERFISH (TRIACANTHUS)	210	2	1	1983	1983	
BUTTERFLYFISHES, CHAETODONTIDA	1	1				
CAESAR GRUNT	1985	24	10	1984	2007	160
CARDINAL SNAPPER	2818	12	9	1988	2006	239
CARIBBEAN REEF OCTOPUS	1	1				1
CARIBBEAN SPINY LOBSTER	17237	28	28	1981	2008	3502
CERO MACKEREL	44	11				7
CHANNEL CLINGING CRAB	12	3				12
CHUBS, COREGONUS	4	1				
CONEY	11537	26	19	1983	2008	786
CORNETFISHES	2	1				
COTTONWICK	184	11	1	1987	1987	22
CREOLE-FISH	3	2				2
CREVALLE JACK	2	2				1
CRUSTACEANS,DECAPODA	7	2				1
CUBERA SNAPPER	7	4				
DOCTORFISH,ACANTHURUS CHIRURGU	10999	26	24	1983	2008	1157
DOG SNAPPER,LUTJANUS JOCU	131	16				17
DOLPHIN	807	13	6	1984	1992	
DOLPHINS, CORYPHAENIDAE	7	1				
DOLPHINS,CORYPHAENA	2	1				
Eumegistus	1	1				1
FINFISH, UNCLASSIFIED	85	5	1	1992	1992	2
FLATFISHES,PLEURONECTOIDEI	1	1				
FLYING GURNARD,DACTYLOPTERUS V	4	1				4
FLYINGFISHES AND HALFBEAKS, EX	49	2				
FOUREYE BUTTERFLYFISH	2	1				
FRENCH ANGELFISH	314	24				68
FRENCH GRUNT	5350	26	10	1983	2002	336
GAG	4	1				
GLASSEYE SNAPPER	9	5				3
GOAT FISHES, MULLIDAE	1592	8	5	1983	1987	
GOLDFACE TILEFISH	1	1				
GRAY ANGELFISH	278	23				28
GRAY SNAPPER	42	8				39
GRAYSBY	115	18				49
GREAT BARRACUDA	497	19	2	1987	1988	14
GREATER AMBERJACK	4	2				3
GROUPERS AND SEA BASSES, SERRA	15	2				
GROUPERS, EPINEPHELUS	1	1				
GRUNTS, HAEMULIDAE	720	6	1	1983	1983	1
HOGFISH	61	9				1
HONEYCOMB COWFISH	8400	26	18	1984	2005	585
HORSE-EYE JACK	93	10				28
HOUNDFISH	112	7				28

HYPOPLECTRUS PUELLA	1	1				
JACKS, CARANGIDAE	2	1				
JOLTHEAD PORGY	98	14				31
KEELTAIL NEEDLEFISH	14	2				
KING MACKEREL	84	11				1
LADYFISH	1	1				1
LANE SNAPPER	265	23				35
LEFTEYED FLOUNDERS, BOTHIDAE	3	1				
LITTLE TUNNY	160	12				23
LIZARDFISHES, SYNODONTIDAE	2	2				1
LONGFIN BULLEYE	1	1				1
LONGSPINE SQUIRRELFISH,HOLOCEN	3741	26	20	1983	2008	662
MACKEREL SCAD	158	1	1	2005	2005	158
MACKERELS AND TUNAS, SCOMBRIDA	7	3				
MAHOGANY SNAPPER	552	25	2	1984	1987	100
MARGATE	57	14				25
MIDNIGHT PARROTFISH	1	1				
MISTY GROUPER	93	14				2
MOJARRA, DIAPTERUS RHOMBEUS	1	1				
MOJARRAS, GERREIDAE	5	2				1
MOLLUSKS, TWO SHELL,BIVALVIA	1	1				
MORAYS, MURAENIDAE	1	1				1
MULLETS, MUGILIDAE	52	1	1	1992	1992	
MUTTON HAMLET	1	1				1
MUTTON SNAPPER	744	24	4	1984	2008	121
NASSAU GROUPER	185	10				1
NEEDLEFISHES, BELONIDAE	40	4				6
Neoscombrops	1	1				1
NEOSCOMBROPS ATLANTICUS	6	1				6
NURSE SHARK	100	9				9
OCEAN SURGEON	4810	25	18	1983	2007	616
OCEAN TRIGGERFISH	169	12	1	1987	1987	6
OILFISH	3	1				3
ORANGE FILEFISH	78	6				58
ORANGESPOTTED FILEFISH	1769	21	13	1987	1999	33
PARROTFISHES, SCARIDAE	1981	2	2	1983	1984	
PEACOCK FLOUNDER	18	4				12
PERMIT	11	6				3
PIGFISH	4	2				
PINK OR QUEEN CONCH	8	4				4
POMFRETS, BRAMIDAE	1	1				1
POMPANO DOLPHIN	12	1				
PORCUPINEFISH,DIODON HYSTRIX	15	2				15
PORGIES, CALAMUS	26	8				3
PORGY, CALAMUS PENNATULA	28	1				

PORKFISH	97	18				23
PRINCESS PARROTFISH	3584	26	10	1984	2002	168
PUDDINGWIFE	116	15				65
PURPLE SNAKE MACKEREL	4	1				4
PYGMY FILEFISH	1	1				1
QUEEN ANGELFISH	406	23	3	1988	1992	43
QUEEN PARROTFISH	868	23	6	1987	2004	163
QUEEN SNAPPER,ETELIS OCULATUS	4185	22	15	1983	2005	433
QUEEN TRIGGERFISH	8442	26	21	1983	2008	592
RAINBOW PARROTFISH	1	1				1
RAINBOW RUNNER	64	12				1
RAINBOWFISH,POECILIA RETICULAT	28	1				
RED GOATFISH,MULLUS AURATUS	19	2				
RED GROUPER	1	1				
RED HIND	7331	26	21	1983	2008	693
RED PORGIES,PAGRUS	33	3				
RED SNAPPER,LUTJANUS CAMPECHAN	2	1				
REDBAND PARROTFISH	8115	24	14	1983	2008	1038
REDEAR SARDINE	1	1				
REDFIN PARROTFISH	2558	21	9	1995	2008	1478
REDTAIL PARROTFISH	37480	25	25	1983	2008	4734
REEF SCORPIONFISH	15	2				15
REEF SHARK	13	4				2
REQUIEM SHARKS, CARCHARHINIDAE	1	1				
ROCK BEAUTY	628	23	6	1983	1992	30
ROCK HIND	127	10				8
SAILFISH	1	1				1
SAILORS CHOICE	8	5				2
SAND DIVER,SYNODUS INTERMEDIUS	1	1				1
SAND TILEFISH	20	6				17
SAUCEREYE PORGY	3	2				3
SCHOOLMASTER	2083	26	13	1983	2008	295
SCOMBROPS	2	1				2
SCORPIONFISHES, SCORPAENIDAE	1	1				1
SCRAWLED COWFISH, ACANTHOSTRAC	17	4				2
SCRAWLED COWFISH, LACTOPHRYS Q	470	16	3	1988	1997	
SCRAWLED FILEFISH	54	12				12
SEA BREAM	1	1				
SERGEANT MAJOR	1	1				1
SHARKSUCKER	1	1				
SHEEPSHEAD PORGY	3	1				
SILK SNAPPER	3054	22	14	1983	2004	162
SIXGILL SHARKS, HEXANCHIDAE	4	1				
SKIPJACK TUNA	138	11				
SLIPPERY DICK	1	1				

SMALLMOUTH GRUNT	2	2				
SMOOTH DOGFISH	1	1				1
SMOOTH TRUNKFISH	1137	22	11	1984	2005	181
SMOOTHTAIL SPINY LOBSTER	1	1				1
SNAPPERS, LUTJANIDAE	64	6				
SNOOKS, CENTROPOMIDAE	1	1				
SOUTHERN SENNET	4	1				4
SOUTHERN STINGRAY	7	2				7
SPADEFISHES, EPHIPPIDIDAE	3	1				3
SPANISH GRUNT	4	3				1
SPANISH HOGFISH	304	21	1	2002	2002	123
SPANISH SLIPPER LOBSTER	10	3				10
SPIDER CRABS, MAJIDAE	2	2				2
SPINY LOBSTERS, PALINURIDAE	1700	4	4	1983	1986	
SPOTFIN BUTTERFLYFISH	1	1				
SPOTTED DRUM	1	1				
SPOTTED GOATFISH	467	18	2	1984	1994	67
SPOTTED SCORPIONFISH	1	1				1
SPOTTED SPINY LOBSTER	8	3				2
SPOTTED TRUNKFISH	473	22	3	1984	2005	151
SQUIRRELFISH	346	3	2	1984	1987	
SQUIRRELFISHES, HOLOCENTRIDAE	69	5				
STINGRAYS, DASYATIDAE	4	1				
STOPLIGHT PARROTFISH	26586	25	24	1983	2008	2335
STOUT BEARDFISH	1	1				1
STRIPED GRUNT	185	7	1	1995	1995	3
STRIPED PARROTFISH	19	1				
SWORDFISH	2	1				
TANGS, ACANTHURIDAE	440	4	1	1984	1984	
TIGER GROUPER	31	8				2
TIGER SHARK	1	1				
TILEFISH	2	2				
TILEFISHES, MALACANTHIDAE	36	5				1
TOMTATE,HAEMULON AUROLINEATU	157	14				67
TRIGGERFISHES AND FILEFISHES,B	595	15	5	1992	1996	5
TRUNKFISH	109	16				20
TRUNKFISHES, OSTRACIIDAE	73	1	1	1984	1984	
VERMILION SNAPPER	437	17	3	1990	2008	99
WAHOO	485	13	4	1984	1988	1
WENCHMAN	1586	13	7	1983	2005	139
WHITE GRUNT	21703	26	24	1983	2008	1571
WHITE MARLIN	3	1				
WHITEMOUTH DRUMMER	1	1				1
WHITESPOTTED FILEFISH,CANTHE.M	655	11	3	1988	1991	14
WRASSES, LABRIDAE	60	8				14
WRECKFISH	8	1				
YELLOW GOATFISH	4261	21	7	1984	2008	141

YELLOW JACK,CARANX BARTHOLOMAE	79	15				13
YELLOWFIN GROUPER	295	15				5
YELLOWFIN MOJARRA	25	5				22
YELLOWFIN TUNA	139	12				
YELLOWMOUTH GROUPER	30	5				
YELLOWTAIL SNAPPER,OCYURUS CHR	6457	26	17	1983	2008	942

Table 38: Summary of available TIP length frequency data for St. Thomas/St. John. All records in the TIP database have been included in this summary. Records attributed to multiple gears, for example will have to be evaluated on a species by species basis.

SPECIES_NAME	Total Number Measured	# of Years with Measured Fish	# of Years with 50+ Measured	First Year 50+ fish measured	Last Year 50+ fish measured	# Measured since 2002
AFRICAN LOBSTER	1	1				1
AFRICAN POMPANO (THREADFIN)	7	3				
ALMACO JACK	341	9	2	1992	1993	1
AMBERJACKS	2	2				
ATLANTIC BONITO	5	2				
ATLANTIC SPADEFISH	3	3				1
BALLOONFISH	73	2				73
BANDED BUTTERFLYFISH	30	4				14
BAR JACK	943	12	5	1985	2006	174
BARRACUDAS, SPHYRAENIDAE	2	1				
BATWING CORAL CRAB	2	1				2
BERMUDA CHUB	18	7				7
BIGEYE SCAD	48	4				36
BIGEYE,PRIACANTHUS ARENATUS	34	5				22
BIGEYES, PRIACANTHIDAE	1	1				
BLACK DURGON	2	2				
BLACK GROUPER	1	1				
BLACK GRUNT	1	1				1
BLACK JACK	40	8				2
BLACK MARGATE	11	4				5
BLACK SNAPPER	2	1				
BLACKBAR SOLDIERFISH	1	1				
BLACKFIN SNAPPER	1024	15	4	1984	2002	158
BLACKFIN TUNA	1	1				1
BLACKTIP SHARK	3	2				2
BLUE PARROTFISH	19	4				5
BLUE RUNNER,CARANX CRYSOS	1134	12	5	1993	2006	509
BLUE TANG	2218	17	13	1984	2006	566
BLUESTRIPED GRUNT	698	17	7	1985	2006	229
BONEFISH	2	1				
BONEFISHES, ALBULIDAE	2	1				
BULL SHARK	1	1				1
BURRO GRUNT	6	1				
BUTTERFLYFISHES, CHAETODONTIDA	3	2				
CAESAR GRUNT	10	4				9
CARDINAL SNAPPER	41	3				
CARDINALFISHES, APOGONIDAE	10	1				
CARIBBEAN RED SNAPPER	3	1				
CARIBBEAN SHARPNOSE SHARK	1	1				1

CARIBBEAN SPINY LOBSTER	7693	18	17	1980	2006	2405
CERO MACKEREL	44	5				16
CONEY	1360	16	8	1983	2006	170
COTTONWICK	276	10	2	1985	2005	132
CREOLE-FISH	3	1				
CREVALLE JACK	13	4				1
CRUSTACEA	1	1				
CRUSTACEANS,DECAPODA	1	1				1
CUBERA SNAPPER	4	2				
DAMSELFISHES, POMACENTRIDAE	5	2				1
DOCTORFISH,ACANTHURUS CHIRURGU	1053	15	8	1984	2006	419
DOG SNAPPER,LUTJANUS JOCU	103	10				11
DOLPHIN	7	2				
DUSKY DAMSELFISH	1	1				1
FINFISH, UNCLASSIFIED	85	4	1	1988	1988	
FLAT NEEDLEFISH	17	2				17
FLORIDA STONE CRAB	1	1				1
FOUREYE BUTTERFLYFISH	2	2				1
FRENCH ANGELFISH	336	15	2	1995	2002	85
FRENCH GRUNT	287	13	1	1984	1984	8
GLASSEYE SNAPPER	11	5				
GOAT FISHES, MULLIDAE	9	3				
GRAY ANGELFISH	1026	17	7	1984	2006	280
GRAY SNAPPER	33	5				26
GRAY TRIGGERFISH	13	2				
GRAYSBY	54	5				45
GREAT BARRACUDA	18	4				16
GREATER AMBERJACK	5	1				
GROUPERS AND SEA BASSES, SERRA	24	2				
GROUPERS, MYCTEROPERCA	1	1				
GRUNTS, HAEMULIDAE	27	4				
GRUNTS,HAEMULON	2	1				2
HERRINGS, CLUPEIDAE	10	1				
HOGFISH	242	16	1	1985	1985	55
HONEYCOMB COWFISH	314	10	2	1992	1993	93
HONEYCOMB COWFISH, ACANTHOSTRA	511	2	2	2005	2006	511
HORSE-EYE JACK	33	7				10
HOUNDFISH	211	5	1	2006	2006	170
JACKKNIFE-FISH	1	1				1
JACKS, CARANGIDAE	1	1				
JOLTHEAD PORGY	123	8				32
KING MACKEREL	39	7				10
LADYFISH	1	1				
LANE SNAPPER	925	16	5	1984	2006	138
LEMON SHARK	5	2				3
LITTLE TUNNY	307	9	2	1993	2006	65
LIZARDFISHES, SYNODONTIDAE	2	1				

LONGJAW SQUIRRELFISH	23	2				3
LONGSPINE SQUIRRELFISH,HOLOCEN	314	5	2	2005	2006	302
MACKERELS AND TUNAS, SCOMBRIDA	15	2				4
MAHOGANY SNAPPER	92	12				10
MARGATE	81	16				17
MIDNIGHT PARROTFISH	7	1				
MISTY GROUPER	88	5	1	1984	1984	2
MUTTON HAMLET	6	2				1
MUTTON SNAPPER	318	16	1	1985	1985	93
NASSAU GROUPER	269	9	2	1984	1985	
NEEDLEFISHES, BELONIDAE	61	3	1	1993	1993	
NURSE SHARK	1	1				
OCEAN SURGEON	575	15	6	1984	2002	207
OCEAN TRIGGERFISH	23	5				1
ORANGE FILEFISH	61	6				60
ORANGESPOTTED FILEFISH	78	9				18
PALOMETA,TRACHINOTUS GOODEI	9	3				2
PARROTFISHES, SCARIDAE	124	8	1	1983	1983	1
PEACOCK FLOUNDER	4	3				1
PERMIT	4	3				1
PINK OR QUEEN CONCH	5	1				5
PORGIES, CALAMUS	1020	13	5	1985	2002	137
PORGY, CALAMUS PENNATULA	319	7	2	2005	2006	271
PORKFISH	41	9				7
PRINCESS PARROTFISH	107	9				2
PUDDINGWIFE	18	4				
QUEEN ANGELFISH	288	16	1	1993	1993	88
QUEEN PARROTFISH	12	5				4
QUEEN SNAPPER,ETELIS OCULATUS	188	4	2	1984	1985	25
QUEEN TRIGGERFISH	4585	17	14	1984	2006	950
RAINBOW PARROTFISH	14	4				5
RAINBOW RUNNER	50	10				7
RED GROUPER	115	7	1	1985	1985	11
RED HIND	3597	17	15	1983	2006	635
RED SNAPPER,LUTJANUS CAMPECHAN	2	2				1
REDBAND PARROTFISH	267	14	2	1985	1992	9
REDEAR SARDINE	52	1	1	1993	1993	
REDEYE BASS	4	1				4
REDFIN PARROTFISH	87	3	1	2006	2006	83
REDTAIL PARROTFISH	1290	17	9	1984	2002	220
REEF SHARK	10	3				1
REMORA	2	1				2
ROCK BEAUTY	118	9				6
ROCK HIND	24	7				3
SAILORS CHOICE	16	7				10
SAND TILEFISH	1	1				
SAUCEREYE PORGY	157	6	1	1994	1994	12

SCHOOLMASTER	261	11	2	1985	2005	125
SCORPIONFISHES, SCORPAENIDAE	12	2				12
SCRAWLED COWFISH, ACANTHOSTRAC	290	4	2	2005	2006	255
SCRAWLED COWFISH, LACTOPHRYS Q	189	12	1	1996	1996	16
SCRAWLED FILEFISH	17	5				11
SCUPS OR PORGIES, SPARIDAE	326	9	3	1984	1988	3
SEA BREAM	7	1				
SERGEANT MAJOR	2	1				2
SHARKS AND RAYS, CHONDRICHTHYE	1	1				
SHARKSUCKER	2	1				2
SHARKSUCKERS, ECHENEIDIDAE	1	1				
SHEEPSHEAD PORGY	10	3				
SILK SNAPPER	355	9	3	1984	1996	39
SLIPPERY DICK	1	1				
SMALLMOUTH GRUNT	2	2				1
SMOOTH TRUNKFISH	44	7				1
SNAPPERS, LUTJANIDAE	24	4				
SOUTHERN STINGRAY	1	1				
SPADEFISHES, EPHIPPIDIDAE	4	3				
SPANISH GRUNT	10	3				2
SPANISH HOGFISH	47	7				2
SPANISH SLIPPER LOBSTER	4	2				4
SPINY LOBSTERS, PALINURIDAE	374	2	1	1985	1985	
SPINYCHEEK SLEEPER	5	1				
SPOTFIN BUTTERFLYFISH	2	1				
SPOTTED GOATFISH	60	9				2
SPOTTED MORAY,GYMNOTHORAX MORI	1	1				1
SPOTTED TRUNKFISH	228	12	2	2005	2006	164
SQUIRRELFISH	516	12	6	1985	1996	9
SQUIRRELFISHES, HOLOCENTRIDAE	697	12	3	1984	1988	51
STOPLIGHT PARROTFISH	949	16	8	1984	2002	199
STRIPED GRUNT	8	2				8
STRIPED PARROTFISH	5	2				
SWORDFISH	2	1				
TANGS, ACANTHURIDAE	372	5	2	1984	1985	
TIGER GROUPER	63	5				
TIGER SHARK	1	1				1
TOBACCOFISH	1	1				1
TOMTATE,HAEMULON AUROLINEATU	87	9				7
TRIGGERFISHES AND FILEFISHES,B	15	3				
TRUNKFISH	148	10	1	2005	2005	109
TRUNKFISHES, OSTRACIIDAE	42	4				34
UNICORN FILEFISH	2	1				2

VERMILION SNAPPER	330	7	2	1985	1987	25
VIPER MORAY	8	1				
WEB BURRFISH	2	1				2
WENCHMAN	24	3				1
WHITE GRUNT	1761	16	13	1984	2006	514
WHITEMOUTH DRUMMER	5	1				
WHITESPOTTED FILEFISH,CANTHE.M	56	8				11
YELLOW CHUB	1	1				1
YELLOW GOATFISH	251	14	1	1985	1985	12
YELLOW JACK,CARANX BARTHOLOMAE	7	2				
YELLOWEDGE GROUPER	3	2				
YELLOWFIN GROUPER	493	12	2	1984	1985	43
YELLOWFIN MOJARRA	19	2				1
YELLOWHEAD WRASSE	1	1				
YELLOWMOUTH GROUPER	43	6				10
YELLOWTAIL SNAPPER,OCYURUS CHR	4854	17	13	1983	2006	1604
	723	12	4			1

2.4.3. Approaches discussed at the National SSC Workshop

On November 12th -14th, 2008, the Regional Fishery Management Councils held their first-ever meeting of their Scientific and Statistical Committees. The meeting was held in Honolulu. Each Council selected three SSC members plus one staff member to attend. The Caribbean Fishery Management Council (CFMC) selected Barbara Kojis, Jim Berkson, Rich Appeldoorn, and Miguel Rolón to attend. Rich Appeldoorn had to cancel at the last minute due to an injury.

The meeting had two purposes: (1) to receive presentations and reports from each SSC on operating procedures, analytical document review and recommendations, and developing research priorities, and (2) to receive presentations and reports from each SSC on setting catch limits including assessment, peer review process, and determination of OFLs/ACLs. The full report of the meeting is available online at: http://www.fakr.noaa.gov/npfmc/misc_pub/SSCWorkshop08.pdf

Regarding OFL/ACL, three Council's SSCs presented material relevant to the CFMC. The Western Pacific Fishery Management Council's (WPFMC) SSC, representing Hawaii, Guam, and other Pacific Islands, have fisheries and data most similar to the CFMC. Their SSC reported that most fisheries have not been managed by quotas or TACs. Data availability is better than that available in the U.S. Caribbean, however. The process for establishing OFLs and ABCs for the WPFMC had not been established by the time of the meeting.

The North Pacific Fishery Management Council (NPFMC) has a long history of setting catch limits and working with highly variable data sets. The NPFMC SSC has established a tier system, whereby data availability determines the methods of establishing reference points and control rules. Tier 6, the worst case scenario for the NPFMC, was established for stocks that only have a *reliable* catch history from 1978-1995. In these cases the OFL is set to the average catch from 1978-1995 and the ABC is less than or equal to 0.75 multiplied by the OFL. A value less than 1.0 is used to incorporate uncertainty into the calculation of the ABC and to be precautionary. They reported that the NPFMC had a long-standing practice of adopting all of their SSC's OFL and ABC recommendations.

The Pacific Fishery Management Council (PFMC) SSC reported that their history was similar to the NPFMC's. They reported that if *reliable* catch is all that is available, then OFL is set to the average catch over a specified time period. The ABC is then set less than or equal to 0.50 multiplied by the OFL. The PFMC SSC set their scalar equal to 0.50 independently of the NPFMC SSC's value of 0.75. They mentioned that they felt it was important to be especially precautionary in the case of these stocks, where little is known. The NPFMC and PFMC provide strong precedents of how to develop OFLs when only reliable catch estimates are available.

Next, the question came up as to what to do when reliable catch data are not available. There was general sentiment that in the absence of reliable catch data, an SSC cannot set an ABC in the manner applied by the NPFMC or the PFMC and that increased emphasis should instead be placed on collecting reliable catch data. Rick Methot, from NMFS, stressed that this situation does not allow for the absence of management until reliable data are collected. The revised National Standard One (NS1) guidelines, which have come out since the National SSC meeting, state, "There are limited circumstances that may not fit the standard approaches to specification of reference points and management measures set forth in these guidelines. … In these circumstances, Councils may propose alternative approaches for satisfying the NS1 requirements of the Magnuson-Stevens Act than those set forth in these guidelines." This suggests that management alternatives to ACLs may be allowed in limited circumstances, but that sufficient justification must be provided as to the need for and effectiveness of the alternatives.

2.5. TOR 5. Research and Monitoring Review

Review the research and monitoring recommendations from the previous assessments in the U.S. Caribbean. Note any which have been completed, make any necessary additions or clarifications, and prioritize data and research needed to successfully complete benchmark stock assessments.

Research and monitoring recommendations provided by SEDAR 4, 8, and 14 were documented in a working paper for review during the workshop (SP3-07). Many of these data needs identified during these assessments are common to all of the species considered, and can be summarized into categories of catch statistics, biological information, and surveys. All areas of the Caribbean will benefit from improved catch statistics; with the USVI in particular suffering from the lack of reporting by species. Recreational landings information is also lacking, although recent MRFSS coverage in Puerto Rico provides some insight into the magnitude of recreational activities. Increased biological sampling and life history research is needed in all areas. Comprehensive fishery-dependent monitoring is critical to improving future assessments. Some key quotes provided in previous SEDAR reports provide insight into the types of information needed:

> *It is important to determine the feasibility of expansion factors to estimate total catch. The information used to calculate expansion factors by year needs to be verified. Reporting of single trips, rather than multiple-trips per record in the catch report forms should be encouraged. This would greatly facilitate the estimation of effort and CPUE.*
>
> *The collection of landings statistics in the U.S.V.I. should also aim at breaking down the reported catch into species, since analysis of the current species-groupings is not straightforward without additional information on species composition from TIP or alternative sampling programs.*
>
> *It would be important to encourage fishermen to submit all the monthly catch reports, to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.*
>
> *Well-designed, systematic research programs are essential to providing the data necessary for effective management. Much of the research reviewed lacked the necessary sample sizes and regular (ongoing) data collection needed to construct an adequate time-series of catch and abundance indices*
>
> *A commitment to long-term research and data collection is essential for effective management. Short-term research and data collection are not the solution to the data problems identified in this assessment. Long-term research and monitoring are necessary in the Caribbean, as in any other managed fishery*
>
> *Need to develop partnerships with local fishermen to conduct research and to collect needed data. Partnerships with the fishing community and other stakeholders are a cost-effective way to collect components of the data necessary for the assessment process*

Emphasis should be placed on the improvement of the TIP sampling program, as catch rate standardization, catch composition and size-frequency analyses will continue to rely upon this information. However, fishery-independent surveys and the collection of other biological data are extremely important to develop alternative indices of abundance.

It is recommended that early biological or biostatistical sample data for the U.S. V.I., from the early to mid 1970's be computerized and made available for future data workshops. It is strongly recommended that formal discussions between NMFS, SEFSC TIP program coordinator and the USVI DFW are held to ascertain what steps/procedures, etc. are needed to improve sampling in the U.S.V.I. fisheries. Similarly, discussions should be initiated between Puerto Rican biologists and NMFS assessment staff to identify any remaining historical data sets not yet available. It is noted that an effort to computerize Puerto Rico biostatistical samples from the mid 1980's is ongoing.

Avoid repetitive analyses on incomplete information. Use only complete data sets in stock assessment analysis. A solid foundation will then be established for the analysis of other species to be included in future assessments.

Despite the many data shortcomings, progress has been made in recent years in a number of areas identified in prior SEDAR assessments. The following list summarizes progress noted during this workshop.

<u>USVI Sampling</u>

- Completion of electronic databases: recovery and entry of USVI trip reports is completed, and current records are entered as received.
- Encourage fishermen to submit monthly catch reports: The USVI DNR now requires monthly reporting and is making steady improvements in compliance and quality assurance.
- Determine expansion factors for estimating total catch: As noted above, considerable progress was made toward developing acceptable expansion factors through this workshop.
- Collect complete recreational catch statistics: The MRIP program is expected to improve recreational catch statistics in the US Caribbean
- Collection of information on discards: A recent study through MRAG provides the first information on discards in the USVI.
- Improved biological monitoring: Recent MARFIN projects are providing increased biological sampling in the USVI

<u>Puerto Rico Sampling</u>

- Improving Puerto Rico commercial statistics and linking landings and biological records: PR DNR now assigns fishermen IDs to trip records and has conducted surveys to allow comparing reported and observed landings
- Determine expansion factors for estimating total catch: As noted above, considerable progress was made toward developing acceptable expansion factors through this workshop.
- Collect complete recreational catch statistics: The MRIP program is expected to improve recreational catch statistics in the US Caribbean

- Collect information on discards: PR DNR conducted a survey of discards in 2005
- Collection of biological statistics: PR DNR has conducted several studies in recent years

Developing partnerships with fishermen

- SEFSC is working with fishermen to evaluate the ParFish assessment approach
- SERO's CRP program has funded numerous projects in the Caribbean over the last several years

Improving Fishery-Independent Monitoring

- NMFS is conducting a sampling cruise in the Caribbean in 2009
- PR DNR and USVI DFW have expanded and redesigned the SEAMAP-C survey
- PR DNR and USVI DFW will assess spawning aggregate sites over the next 3 years (2009-2012)
- NOAA/NOS REEF surveys began in 2001

2.6. TOR 6. Developing ACLs

Provide guidance on developing ACLs given data accuracy and reliability recommendations and comment on issues that should be considered by the Council and its committee's when making ACL determinations.

The National Standard 1 (NS1) guidelines define the annual catch limit (ACL) as the "level of annual catch of a stock or stock complex that serves as the basis for invoking AMs [accountability measures]." They stipulate that Councils must set the ACL at a level that avoids overfishing using an approach that accounts for uncertainties in both the scientific information and management control of the fishery. To this end, the NS1 guidelines introduce a framework that incorporates three additional catch levels: OFL, ABC and ACT. The OFL (overfishing limit) is defined as the level of catch that corresponds to the best estimate of the maximum fishing mortality threshold (MFMT) applied to a stock's abundance. The long-term average of such catches should be the maximum sustainable yield (or optimum yield as applicable). The ABC (allowable biological catch) is defined as the level of annual catch that accounts for the uncertainty in the estimate of OFL. The ABC is expected to be set by the Council's SSC at a level that is below the estimate of OFL to account for uncertainty in the scientific advice and other relevant factors such as the length of time between assessments. The system of ACLs and AMs designed by the Council are required to ensure that the ABC is not exceeded, taking into particular account the degree of management uncertainty. The ACT (annual catch target) is an optional management tool recommended by the NS1 guidelines as part of the system of accountability measures designed to avoid exceeding the ACL.

Term of reference 6 requests guidance on developing ACLs based on the types and quality of data available for the U.S. Caribbean management area. As indicated above, ACLs are

Term of reference 6 requests guidance on developing ACLs based on the types and quality of data available for the U.S. Caribbean management area. As indicated above, ACLs are intended to address both uncertainties in the data (science) and uncertainties in management. Given the overall context of the workshop, data evaluation, the group interpreted the charge given in TOR 6 as pertaining to the specification of OFL and ABC.

2.6.1. Data and methods for estimating OFL

In an ideal situation the OFL, ABC and associated status determination criteria (e.g., MSY, MFMT, MSST) would be estimated through a full 'benchmark' stock assessment. Such an assessment typically requires reliable time series of catches and relative abundance, preferably extending back to a point when the impact of fishing was negligible. It is usually also important to incorporate data on the size or age-structure of the stock. As discussed under TOR 3, the group identified only a handful of stocks where the data might be sufficient to merit consideration for a benchmark assessment; for most stocks the time series of catch and/or abundance were too short or uncertain. In that light, the group discussed methods for estimating OFL and ABC from the types of data reviewed during the workshop and then identified stocks where the quality of the data might be sufficient for the task.

2.6.1.1. Catch data

Information on the total amount of catch (landed and discarded dead) is obviously critical to a management scheme that attempts to employ ACLs. Rough estimates of OFL could in principle be derived solely from a time series of catches provided the time series extends back to a time when fishing was relatively light and includes a period of higher effort when catches appeared to stabilize. In that case one could use catch levels during the stable period as a proxy for MSY. If recent catches remained at or above the MSY proxy and effort is believed to have remained constant or decreased, one could simply set OFL equal to the MSY proxy. If, on the other hand catches have decreased with constant or increasing effort, then it is reasonable to assume overfishing is occurring and OFL should be set lower than recent catches (see Figure 71). The ABC should be set lower than the estimate of OFL to a degree commensurate with the degree of uncertainty in the catch.

The group found that commercial catch estimates were available for most of the stocks (or FMP units) for more than a decade, with the exception of the snapper/grouper complex which has not generally been distinguished by species (see section 2.1.2.2). Recreational catch statistics, however, have only been available for finfish in Puerto Rico since 2000 and are spotty for the U.S. Virgin Islands. In some cases, such as spiny lobster, the recreational catches are believed to be comparable to the commercial catch and therefore constitute a considerable source of uncertainty. With these limitations in mind, the group found no examples where the catch history was sufficient to attempt an approach similar to that described in the preceding paragraph. The group agreed, however, that the recent catch data could still be used in tandem with length or abundance data to estimate OFL for some species (see below)..

2.6.1.2. Abundance indices

Data from abundance indices have been used to derive proxies for the biomass at MSY (B_{MSY}) and associated minimum stock size threshold and could, in principle, be used to derive an estimate of OFL. For example, if an index of relative abundance were available that extended back to a period when fishing was negligible, a proxy for the biomass at B_{MSY} might be half of the values observed at the beginning of the time series (i.e., $0.5B_0$, see Figure 72). A proxy for MSY could then be the average catches during the time when the biomass index was at B_{MSY} (particularly if the catches show some sign of stability). If the biomass in recent years was a fraction p of B_0, then an estimate of OFL would be obtained by from the ratio of the two catch equations $MSY = F_{MSY}\,0.5B_0$
and $OFL = F_{MSY}\,pB_0$, resulting in the estimator

(1) $OFL=2p\text{MSY}$

Note that the fishing mortality at MSY cancels out of the equation and all that is needed to estimate OFL is the proxy for MSY and current abundance relative to the unfished level. Similar estimators for OFL can be derived to make more efficient use of the time series or accommodate different assumptions about the level of B_{MSY} relative to B_0, but the bottom line is that the time series of abundance must be long enough to include a time when the abundance of the stock was at or near the MSY level.

The group reviewed both fishery independent and fishery dependent (catch per unit effort) indices of abundance. Although a number of indices were available that extended more than a decade back in time, it was not clear that they included a period that could fairly be taken as a proxy for MSY (the deepwater snapper fishery in Puerto Rico may be an exception as it is a relatively new fishery). Moreover, there were a number of issues relating to insufficient sampling and coverage that appeared to compromise their use as indicators for the entire stock (see sections 2.1.3 and 2.1.4). During the meeting the group was informed of the existence of a survey conducted by the National Park Service off the island of St. Johns that extends back to the 1980s (longer than any other time series), but the data were not available for examination during the meeting.

2.6.1.3. Stage (length) composition data

Length-based estimates of mortality were discussed at length during the meeting (Section 2.4.2). In principle, these provide estimates of total mortality (Z), but estimates of current fishing mortality F may be obtained by subtracting an estimate of the natural mortality rate (F=Z-M). If the recent catches are known, and one is willing to adopt a proxy for MFMT (i.e., F_{MSY}), then an estimate of OFL may be obtained from the ratio of the two catch equations C = FB and OFL = F_{MSY} B, resulting in

(2) $OFL = C\ F_{MSY} / F$

Note that the current biomass (or abundance) *B* cancels out of the equation and all that is needed to estimate OFL is the proxy for F_{MSY} and an estimate for current catch *C*. One possible proxy for F_{MSY} is the natural mortality rate M (reference), another is the fishing mortality rate associated with a particular spawning potential ratio.

The group felt that the length-based analyses, couple with estimates of recent catch were the most promising alternative to ‘informed judgment’ (described below) for setting OFLs, subject to the caveats discussed in section 2.4.

2.6.1.4. Informed judgment

Presentations were made on several ways OFL could be specified as a scalar multiple of current catches. For example, the Pacific Fishery Management Council and North Pacific Fishery Management council have both adopted a decision rule where, if the only reliable data are recent catches, the OFL would be set to the average catch. The obvious problem with this approach is that it may be uncertain if the observed catches are a result of overfishing. The Pacific Council handles this uncertainty by setting the ABC equal to half the OFL, whereas the North Pacific Council sets the ABS equal to 0.75 OFL. Both multipliers are, of course, somewhat arbitrary.

The Caribbean Fishery Management Council’s SSC has suggested similar formulation in an attempt to characterize the acceptable level of risk:

(3) OFL = status scalar * average catch * vulnerability

where the status scalars are {At risk < 1, Undetermined = 1.0, Not at risk > 1} and the vulnerability scalar incorporates susceptibility and productivity factors. Determining specific values for these scalars is not trivial and it may be appropriate instead to employ a single scalar based the results of productivity/susceptibility (PSA) analyses (as described in Rosenberg et al. 2007, Milton 2001, Stobutzki et al. 2001).

Another method that was presented was the so-called Depletion Corrected Average Catch approach (DCAC, reference). The method assumes that the biomass at MSY is about 40% of the unfished level and that a reasonable guess may be obtained for (1) a proxy to FMSY (MFMT) and (2) the degree of depletion *d* the stock experienced during the period when catch data are available. If the total catch is known for *n* number of years, then a possible estimate for OFL is

(4) $OFL = \Sigma C/(n + d/(0.4*F_{MSY}))$

Note that the quantity *d* is a measure of the amount of decline in abundance that occurred between the first and last year of the catch series, expressed as a fraction of unfished biomass, i.e., $(B_{last}-B_{first})/B_0$. In the special case where $d = 0$, then equation (4) essentially reduces to equation (3).

2.6.2. Summary conclusions

The "informed judgment" approaches mentioned above require parameters to be supplied based on expert opinion. The choice between the approaches would depend on the types of quantities the decision-making body (e.g., an SSC) feels most competent to supply. For example, the SSC may prefer to adopt the DCAC approach if they can agree on a proxy for F_{MSY} (say $F_{MSY} = M$) and are willing to guess how much the given stock was depleted (relative to the unfished level) over the time period with reliable catch data (*d*). On the other hand, if the SSC felt that there was insufficient information on the fishery to hazard a guess for *d* and F_{MSY}, but felt that the life history traits of the stock were reasonably well known, then a PSA approach might be more appropriate. In the absence of expert knowledge about either the fishery or the life history characteristics of a stock, then it may be appropriate to follow precedents established by other organizations such as the Pacific Fishery Management Council. However, it was noted that, at this stage, no Bayesian approaches were proposed.

The clear advantage of the methods based on various types of data (summarized in section 2.6.1) is that they provide an objective way of scaling the OFL to observed catches. For example, the depletion parameters *p* or *d* might be deduced from an index of abundance and substituted into either equation (1) or equation (4), depending upon whether one was more comfortable with estimating a proxy for MSY or F_{MSY}.

The Caribbean Data Evaluation workshop participants reviewed the data available for all species the Caribbean Fishery Management Council's FMPs. The group agreed that the catch and index data, by themselves, were probably insufficient to apply an approach such as illustrated by equation (1) to any of these species. It is likely that additional information would be required to complete a stock assessment, and therefore improvements in catch and index data and analysis should be accompanied by development of other information sources.

The evidence suggested that the length data could be used to estimate the total mortality rate for some of the species in the Caribbean FMP. It was noted that in some cases the available indices of abundance, while insufficient in themselves for generating OFL advice, may be helpful in refining the mortality estimates as described for mutton snapper in SEDAR14.

Based on the analyses described in section 2.4 the group agreed that potentially useful OFL advice may be obtained for species that have reasonably reliable data for recent catches and length data (e.g. at least 10 years of relatively large sample sizes). The species that met these criteria are identified in Table 39[1]. Note that the level of recreational catch is poorly known in the Virgin Islands, however for stocks where local experts were confident that recreational catches were negligible the above criteria were considered met.

The group agreed that further investigation of these species is warranted and suggested that equation 2 be applied to a proxy for F_{MSY}, such as M, to derive an estimate of OFL. For species where the data are not deemed sufficient to apply the mean-length estimator, but reasonably reliable estimates exist for recent catches, the group recommended trying alternative "informed judgment" approaches (such as the DCAC or PSA presented), depending on the expertise of the SSC. The group did not offer specific advice on setting the ABC, other than it should be set lower than the estimate of OFL to a degree commensurate with the degree of uncertainty in the catches. Methods for dealing with risk could be further explored.

In summary, the group suggests that, in the absence of adequate index data, the following is tried:

1) If stock has adequate length and catch data (listed as 'OFL' in Table 39)
   - Estimate total mortality (*Z*) using the methods outlined in section 2.4.2.
   - Compute recent fishing mortality rate by subtracting out an assumed natural mortality rate ($F = Z – M$).
   - Select a proxy for F_{MSY} such as the natural mortality rate or the fishing mortality rate associated with a given spawning potential ratio
   - Set OFL = F_{MSY}*(recent average catch)/F

2) Otherwise, if stock has adequate catch data, then use informed judgment
   a) if consensus can be reached on a proxy for F_{MSY} and the level of depletion relative to unfished levels, $d = (B_{first} – B_{last})/B_0$, then set OFL = (average catch)/($n + d/(0.4*F_{MSY})$)
   b) if consensus can be reached on a vulnerability scalar from a PSA analysis, then set OFL = (average catch) * vulnerability scalar

[1] Note that the mean-length method also requires reliable estimates of the von Bertalanffy growth parameters and species-specific availability, which was not thoroughly evaluated at this meeting.

c) if no consensus can be reached, adopt protocol of PFMC, i.e., OFL = average catch and ABC = 0.5*(average catch).

3) Otherwise, if no reliable catch data exist, develop rationale for alternative management measures that do not conform to the framework established in the NS1 guidelines.

2.6.3. References

Rosenberg, A, D. Agnew, E. Babcock, A. Cooper, C. Mogensen, R. O'Boyle, J. Powers, G. Stefansson, and J. Swasey. 2007. Setting annual catch limits for U.S. fisheries: An expert working group report. MRAG Americas, Washington, D.C. 36 pp.

Stobutzki, I., M. Miller, and D. Brewer. 2001. Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. Environmental Conservation 28: 167-181.

Milton, D. A. 2001. Assessing the susceptibility to fishing of populations of rare trawl bycatch: sea snakes caught by Australia's Northern Prawn Fishery. Biological Conservation 101: 281-290.

Table 39: Summary rating of the quality of commercial, recreational and fishery independent data available for species listed in the Caribbean Fishery Management Council's fishery management plans. The labels 'BENCH' or 'OFL' indicate the data may be sufficient to warrant either a full SEDAR benchmark assessment or OFL advice, respectively (it is assumed a benchmark assessment would also render OFL advice). The numerical rating scale is: (5) reliable data for more than 10 years; (4) reliable data for recent years; (3) data for more than 10 years, but reliability, comprehensiveness or coverage is questionable; (2) data for recent years, but reliability, comprehensiveness or coverage is questionable; (1) scattered or occasional observations, reliability questioned; (0) data unavailable or unreliable.

Saint Croix

FMP unit (species)	Commercial			Recrea-ional	Fishery independent		Advice potential
	Catch	Length	CPUE	length	index	length	
Snapper Unit 1							
Black snapper	0	1	0	1?	0	0	
Blackfin snapper	0	3	0	1?	1	1	
Silk snapper	0	3	0	1?	0	0	
Vermillion snapper	0	2	0	1?	0	0	
Grouper Unit 4							
Tiger grouper	0	1	0	0	1	1	
Yellowfin grouper	0	1	0	0	2	2	
Yellowedge grouper	0	0	0	0	0	0	
Misty grouper	0	1	0	0	0	0	
Red grouper	0	0	0	0	0	0	
ParrotFish	3	3	3	1?	3	3	BENCH
Queen Conch	3	0	0	1?	3	3	
Nassau grouper	0	1	0	0	3	1	
Goliath grouper	0	0	0	0	0	0	
Spiny lobster	3	3	3	1?	1	1	OFL
Snapper Unit 2							
Queen snapper	0	3	0	1?	1	1	
Wenchman snapper	0	2	0	1?	0	0	
Snapper Unit 3				1?			
Gray snapper	0	2	0	1?	3	1	
Lane snapper	0	1	0	1?	3	1	
Mutton snapper	0	2	0	1?	2	1	
Dog snapper	0	1	0	1?	3	1	
Schoolmaster snapper	0	3	0	1?	3	3	
Mahogany snapper	0	2	0	1?	3	2	
Snapper Unit 4							
Yellowtail snapper	0	3	0	1?	3	3	
Grouper Unit 3							
Red hind	0	3	0	1?	3	3	
Coney	0	3	0	1?	3	3	
Rock hind	0	1	0	1?	3	1	

Graysby	0	1	0	1?	3	1	
Creole fish	0	0	0	1?	3	1	
Grunts (6 spp.)	3	3	3	1?	3	1	BENCH
Goatfish (2 spp.)	3	3	2	1?	3	1	OFL
Porgies (4spp)	3	1	2	1?	3	1	OFL
Squirrelfish (4 spp)	3	3	1	1?	3	1	OFL
Tilefish (2 spp)	0	0	0	1?	3	3	
Jacks (7 spp)	3	3	3	1?	3	1	OFL
Surgeonfish (3 spp)	3	3	3	1?	3	3	BENCH
Triggerfish & filefish (6 spp.)	3	3	3	1?	3	1	BENCH
Boxfish (5 spp.)	3	3	0	1?	3	1	OFL
Wrasse (3 spp.)	0	0	0	1?	3	1	
Angelfish (3 spp.)	3	2	1	1?	3	1	OFL

Saint Thomas and Saint Johns

FMP unit (species)	Commercial			Recrea-tional.	Fishery-independent		Advice potential
	Catch	length	CPUE	length	index	length	
Snapper Unit 1							
Black snapper	0	0	0	1?	0	0	
Blackfin snapper	0	2	0	1?	0	0	
Silk snapper	0	2	0	1?	0	0	
Vermillion snapper	0	2	0	1?	0	0	
Grouper Unit 4							
Tiger grouper	0	1	0	1?	1	1	
Yellowfin grouper	0	2	0	1?	2	2	
Yellowedge grouper	0	0	0	1?	0	0	
Misty grouper	0	1	0	1?	0	0	
Red grouper	0	1	0	1?	0	0	
ParrotFish	3	2	2	1?	3	3	BENCH
Queen Conch	3	0	0	1?	3	3	
Nassau grouper	0	1	0	1?	3	3	
Goliath grouper	0	0	0	1?	0	0	
Spiny lobster	3	3	3	1?	1	1	OFL
Snapper Unit 2							
Queen snapper	0	2	0	1?	1	1	
Wenchman snapper	0	1	0	1?	1	1	
Snapper Unit 3			0	1?			
Gray snapper	0	1	0	1?	3	3	
Lane snapper	0	2	0	1?	3	3	
Mutton snapper	0	2	0	1?	1	1	
Dog snapper	0	1	0	1?	1	1	
Schoolmaster snapper	0	2	0	1?	3	3	
Mahogany snapper	0	1	0	1?	3	3	
Snapper Unit 4							
Yellowtail snapper	0	3	0	1?	3	3	
Grouper Unit 3							
Red hind	0	3	0	1?	3	3	
Coney	0	3	0	1?	3	3	

Rock hind	0	1	0	1?	3	3	
Graysby	0	1	0	1?	3	3	
Creole fish	0	0	0	1?	3	3	
Grunts (6 spp.)	3	3	2	1?	3	3	OFL
Goatfish (2 spp.)	1	1	1	1?	3	3	
Porgies (4spp)	3	1	2	1?	3	3	OFL
Squirrelfish (4 spp)	3	2	2	1?	3	3	OFL
Tilefish (2 spp)	0	0	0	1?	2	2	
Jacks (7 spp)	3	3	3	1?	3	3	OFL
Surgeonfish (3 spp)	3	3	2	1?	3	3	OFL
Triggerfish & filefish (6 spp.)	3	3	3	1?	3	3	BENCH
Boxfish (5 spp.)	3	2	0	1?	3	3	OFL
Wrasse (3 spp.)	3	0	0	1?	3	3	OFL

Puerto Rico

FMP unit (species)	Commercial			Recrea-tional	Fishery-independent		Advice potential
	Catch	length	CPUE	length	index	length	
Snapper Unit 1							
Black snapper	3	1	0	2	0	0	
Blackfin snapper	3	2	1	2	1	1	
Silk snapper	3	3	3	2	0	3	BENCH
Vermillion snapper	3	3	1	2	1	1	OFL
Grouper Unit 4							
Tiger grouper	1	2	0	2	1	1	
Yellowfin grouper	3	1	1	2	2	2	
Yellowedge grouper	0	0	0	2	0	0	
Misty grouper	3	2	1	2	0	0	
Red grouper	0	1	0	2	0	0	
ParrotFish	3	3	3	2	3	3	BENCH
Queen Conch	3	0	0	2	3	3	OFL
Nassau grouper	3	2	1	2	1	1	
Goliath grouper	0	1	0	2	0	0	
Spiny lobster	3	3	3	2	1	1	OFL
Snapper Unit 2							
Queen snapper	3	3	3	2	0	0	BENCH
Wenchman snapper	1	2	1	2	0	0	
Snapper Unit 3							
Gray snapper	1	3	0	2	3	3	
Lane snapper	3	3	3	2	3	3	OFL
Mutton snapper	3	3	3	2	1	1	OFL
Dog snapper	1	3	0	2	3	3	
Schoolmaster snapper	0	3	0	2	3	3	
Mahogany snapper	1	3	0	2	3	3	
Snapper Unit 4							
Yellowtail snapper	3	3	3	2	3	3	OFL
Grouper Unit 3							
Red hind	3	3	3	2	3	3	OFL
Coney	3	3	1	2	3	3	OFL

Rock hind	0	1	0	2	3	3	
Graysby	0	3	0	2	3	3	
Creole fish	0	0	0	2	3	3	
Grunts (6 spp.)	3	3	3	2	3	3	BENCH
Goatfish (2 spp.)	3	3	1	2	3	3	OFL
Porgies (4spp)	3	3	1	2	3	3	OFL
Squirrelfish (4 spp)	3	1	1	2	3	3	OFL
Tilefish (2 spp)	1	1	0	2	3	3	
Jacks (7 spp)	3	3	1	2	3	3	OFL
Surgeonfish (3 spp)	0	1	0	2	3	3	
Boxfish (5 spp.)	3	2	3	2	3	3	OFL
Wrasse (3 spp.)	3	0	0	2	3	3	OFL
Angelfish (3 spp.)	0	1	0	2	3	3	

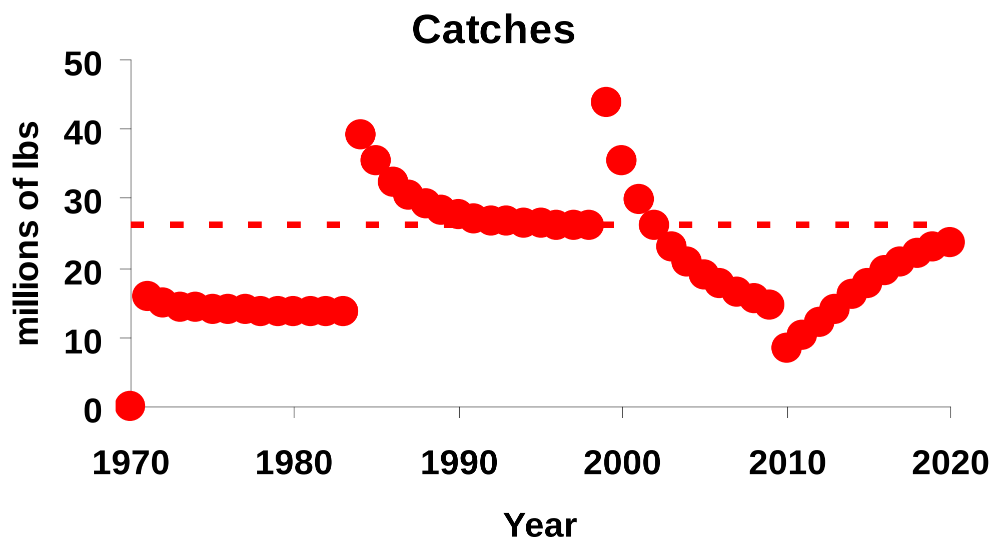

Figure 71: Hypothetical example of the complete catch history of a stock where it is possible to discern a proxy for MSY based simply on an inspection of the time series. The pattern shown reflects a period of relatively low fishing pressure (1970s to early 1980s), stable fishing at the optimal F_{MSY} level (late 1980s and 1990s), overfishing at twice the MSY level between 2000 and 2008, and projected reduction to F_{MSY} in 2010. The dashed line represents the proxy for MSY.

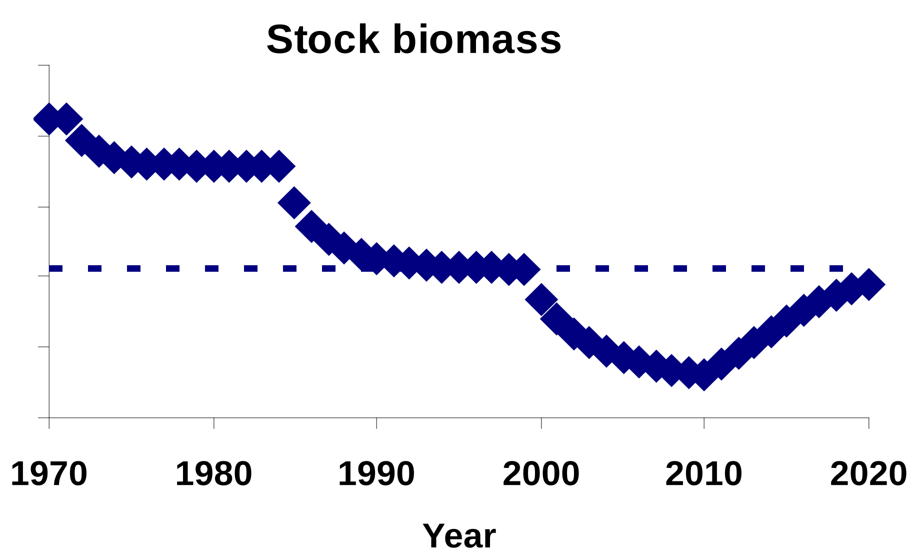

Figure 72: Hypothetical example of an index of abundance that covers the exploited history of a stock, from which it is possible to discern a proxy for the biomass at MSY. The pattern shown reflects the exploitation history described in Figure 71. The dashed line represents the proxy for BMSY.

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