**SEDAR8-AW-4**

# Standardized Catch Rates of Spiny Lobster (*Panulirus argus*) Estimated from the United States Virgin Islands Commercial Trip Interview Program (Years 1983-2003)

by

Mónica Valle-Esquivel

University of Miami
Rosenstiel School of Marine and Atmospheric Science
Cooperative Institute for Marine and Atmospheric Studies (NOAA/UM)
4600 Rickenbacker Cswy., Miami, FL 33149
mvalle@rsmas.miami.edu

March 2005

## ABSTRACT

NOAA Fisheries Trip Interview Program (TIP) data from the United States Virgin Islands (1983-2003) were used to construct standardized indices of abundance for spiny lobster, *Panulirus argus*. Separate indices were estimated for each main gear type used to harvest this species: dive, fish traps, and lobster traps, using the Delta-Lognormal approach. This method combines two general linear models, a binomial model fit to the proportion of positive trips, and a lognormal fit to catch rates on positive trips. Effective effort was approximated by considering zero trips through the construction of species assemblages by gear. No clear trends in relative abundance were noted in any of the fisheries examined. It appears that abundance has been fairly stable over the period studied, although with some inter-annual fluctuation and a large variability within each year. Index values suggest that fish traps may be a more effective method to harvest spiny lobster than diving gear.

## INTRODUCTION

The Trip Interview Program (TIP) collects biostatistical data on spiny lobster via port sampling agents conducting personal interviews with commercial fishers at landing sites and sale locations. Data routinely recorded includes date of fishing, area fished, location (island) landed, gear fished and total weight landed by species. Other information such as days fished, hours fished, quantity of gear, and number of fish landed by species is less frequently recorded. TIP data also contains fish length and weight information for a proportion of the interviewed trips. All sampling is conducted by or through voluntary cooperation of the fishers.

TIP data from the U. S. Virgin Islands is available from years 1983 through 2003. It is important to note that this data base is currently under review, so the analyses presented here are preliminary, and based on incomplete data or data that needs validation.

## METHODS

### Data Description

TIP data were utilized to estimate CPUE as the mean weight (in pounds) of spiny lobster per fishing trip by gear type. Indices were estimated for the three main gear types used to harvest lobster: DIVE (Hand/Spear/Diving), FISH TRAPS (Fish Pots/Traps), and LOBSTER TRAPS, either for the whole U.S. Virgin Islands or per island complex (or District), depending on where each fishery occurs. Islands were grouped by geological platform: 1) St. Thomas and St. Croix (STT/STJ) and St. Croix (STX). Only those records with a single gear type recorded were used.

### Data Conversions

The TIP data for spiny lobster include a number of length and weight measurement types and units of measurement. All length data were converted to carapace length (CL) in millimeters, and individual weight was converted to grams. In cases where weight information was missing, a length-weight relationship from Florida (FAO, 2001) was used to perform the conversion:

$$W_T = 2.519\ L_C^{\ 2.71}$$

where $W_T$= Total weight and $L_C$= carapace length.

### Identifying Trips Associated with Spiny Lobster

For a studied species, defining effort from the TIP data set is not straightforward, given the multi-specific nature of the U.S. Virgin Islands fisheries. The data set contains information about species caught, but not regarding the species targeted. Effective fishing effort (i.e., including trips that landed lobster and trips that may have targeted this species but did not catch it, or zero trips) was estimated using the species assemblage method developed by D. Heinemann and described in Sass-Calay and Bahnick, (2002) and in the NOAA-Fisheries SEDAR4-DW report (2004).

An association statistic (DH) was computed to determine the species often landed in association with *Panulirus argus* and other (unidentified) members of the same family, Panuliridae:

$$DH = \frac{N(S,x)\ \ N(s)}{N(x)\ N}$$

where *N(s)* is the number of trips that caught the studied species; *N(x)* is the number of trips that caught species *x*; *N(s,x)* is the number of trips that caught the studied species and species *x; N* is the total number of trips. The statistic gives less weight to species that are more abundant but unreasonably high scores are given to species caught very infrequently, but alongside the studied species (i.e., small sample size). Species selection used a minimum co-occurrence sample size of (i.e., $N(s,x) \geq 20$ trips), and the association index values that scored the highest. Trips that landed the species from the assemblage were included for catch rate analysis.

**Definition of Fishing Effort**

In addition to 'trips', units of effort must also be defined. The following units available in TIP were considered: the number of traps, the number of gear (divers or dives per trip), and the hours fished or soak time. Unfortunately, none of this information was complete in the database across the whole time series or across platforms, so the best available unit was the number of trips. Each 'sequence number' was assumed to correspond to one fishing trip. Some of those effort units were however considered as categorical variables.

**Relative Abundance Indices**

A Generalized Linear Mixed Model Approach (GLMM) was used to estimate relative indices of abundance. Two different methods were used, depending on the characteristics of the data by gear and island: 1) a conventional GLM model to describe only the positive lobster CPUE observations, and 2) a Delta-Lognormal model that combines the proportion of positive trips (trips that landed spiny lobster over total trips) and positive catch rates on successful trips to construct a single index (Lo et al., 1992).

The influences of the following categorical variables on relative abundance were investigated: year, season (Winter, Spring, Summer, Fall), island (STT/STJ and STX), gear (dive, fish traps, lobster traps), number of gear (number of traps, number of dives), hours or days fished (soak time from trap set to haul, hours diving), and the average depth of fishing (for dive trips).

A step-wise regression procedure (GENMOD, SAS Institute Inc., 1999-2001) was used to determine the set of factors and interactions that significantly explained the observed variability in each model component. Factors were added sequentially to the model based on the percentage reduction in deviance per degree of freedom ( $\geq$1.0%)**,** using a $\chi^2$ (Chi-square) test ($p<0.05$). Fixed and random interactions between significant factors were evaluated under the same criteria. To illustrate this procedure, Deviance analysis tables for catch rates in pounds are presented for the first index developed (Table 7).

The final GLM or Delta-Lognormal model was fit to the data using algorithms developed by Ortiz et al. (2000, 2001) that incorporate the GLIMMIX and MIXED procedures from SAS® (SAS Institute Inc., 1999-2001). An examination of the data, the assumptions used for analysis and the relative indices of abundance developed are described below.

# RESULTS

## General Observations

The U.S. Virgin Islands TIP database contains 5,840 interviewed trips during the period 1983-2003. The exact location of fishing is not recorded, but the general area or island where the catch is landed is generally known. The total number of interviewed trips by year and island is summarized in Table 1. Note that the number of interviewed trips declined substantially after 1991. In addition, this database is currently under review, and incorrect or incomplete data for some years is being re-entered, particularly from that year onward (Uwate, pers. comm.). Of the total interviewed trips, 935 landed spiny lobster (Table 2), with 3 main gears: DIVING (spears, scuba, free diving, hand), FISH TRAPS (or 'pots') and LOBSTER TRAPS. Of the lobster trips, 61% of the dive trips catch lobster, while this species is observed in only 14% of the fish trap trips. The number of interviewed trips that landed lobster by island and gear and by island, gear, and year are provided in Table 3 and 4, which show that most of the interviews were conducted in St. Croix.

Based on the gear used to harvest spiny lobsters, the location fished, and the sample size by island, it was only possible to pursue CPUE analysis for St. Croix, for all gears combined (traps and dive), and separately for DIVING and TRAPS. A brief diagnostic of the data for the whole U.S. Virgin Islands and the assumptions used for each index developed are described in the sections that follow.

The proportion of spiny lobster trips by gear were Fish Traps (42.6%), Dive (29%), Lobster Traps (2.25%), Unknown Gear (26%) (Table 4 and Figure 1). Only 22 trips with Lobster Traps were identified so due to small sample size, a separate analysis was not performed for this gear. Lobster traps were grouped with Fish Traps for CPUE analysis.

The average depth in Dive trips that capture lobster is 11.6 Fathoms (1 Fathom=6 ft), and ranges between 9 and 13.5 Fathoms. Given this restricted and relatively uniform depth range, it was not worth to include this factor in the CPUE analyses. Average depth in other dive trips (that don't harvest lobster) is 7.5 Fathoms.

In the selection of explanatory variables, only interactions that contained significant fixed factors were included in the model. Inclusion of other significant interactions (fixed and random) did not improve model fit, and caused larger deviations from the observed CPUE values.

## Species Assemblages

Lists of species assemblages for lobster are presented for Dive gear and Fish Traps (Table 5 andTable 6). Although a variety of species are harvested with Dive gear in the U.S. Virgin Islands, none showed association with lobster. This may indicate that either associated species (such as queen conch) are not sampled in TIP or that simply dive trips target lobster exclusively, and all other catch is incidental. For Fish Traps, all the trips that harvested the species from this assemblage were considered in the CPUE index estimation.

**Relative Abundance Indices**

Diagnostics for the entire U.S. Virgin Islands TIP database indicated that a number of restrictions must be imposed on the data for further analysis:

1) Some years have very small sample sizes.
2) Outliers in positive catch are present, may use 95% Quantiles.
3) A 78% of the lobster trips occur in St. Croix, so St. Thomas/St. John (STT/STJ) will only be included in a general trap index for the U.S. Virgin Islands.
4) A 43% of the lobster trips use Traps; 29% use Diving gear. In St. Croix, the proportion is 48% Fish Traps and 35% Dive trips.
5) All Dive trips occur in STX, none in STT/STJ.
6) Very few lobster trap trips are observed (<1%), all in STT/STJ.
7) Of all **selected** lobster trips, 61% are positive (catch Lobster) and 39% are zero-trips.
8) The number of traps range from 0 to 130, with an average of 26 traps per trip. In St. Croix, 40% of the trips deploy more than 40 traps; in STT/STJ, 57% of the trips deply less than 20 traps.
9) The mean soak time for trap trips is 142 hr in STT/STJ and 93 hr in STX.
10) Lobster is harvested year-round, with fairly even catches among seasons, perhaps peaking in the Spring, with 32% of the total lobster landings.
11) Given these observations, the explanatory variables that can be considered for analysis are: year, season, island/district/area fished, number of gear, soak time, depth.

In order to develop a well balanced design, these variables were classified into the following categories:

YEAR= 1983-2003

SEASON = 1. Winter (Dec, Jan, Feb)
2. Spring (Mar, Apr, May)
3. Summer (Jun, Jul, Aug)
4. Autumn (Sep, Oct, Nov)

DISTRICT= 1. St. Thomas/St. John (STT/STJ)
2. St. Croix (STX)
3. Unknown

AREA FISHED (within STX)= 1. South-Southeast (XS_XSE).
2. Southwest (XSW)
2. Northeast (XNE)
3. Northwest (XNW)
4. Unknown (XXX)

NUMBER OF GEAR
Num. TRAPS= 1. 1-20 traps
2. 21-40 traps
3. More than 40 traps
4. Unknown

TIME FISHED

TRAPS=> Soak Days(time between trap set and haul):

1. 1-6 days
2. More than 7 days

DIVE=> Hours diving per trip:

1. 1-5 hr
2. More than 5 hr.
3. Unknown

AVERAGE DEPTH (Average of start and end depth):

1. < 10 Fathoms
2. 10-12 Fathoms
3. > 12 Fathoms

Three indices of relative abundance were developed:

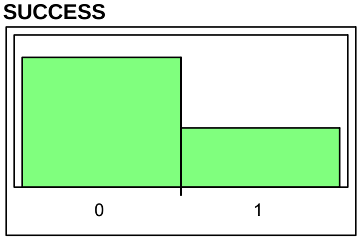
1. U.S.Virgin Islands Traps
2. St. Croix- Fish Traps
3. St. Croix- Dive.

## 1. U.S. VIRGIN ISLANDS- TRAPS

Observations and restrictions imposed on this subset of data:

1) Years 1986-2002.
2) Includes fish and lobster traps from both districts, STX and STT/STJ.
3) Used positive lobster trips and trips that harvested associated species.
4) Used the Delta-Lognormal approach.
5) The proportion of positive trips was 31% with the trips selected from the species assemblage method:

**SUCCESS**




**Frequencies**

| Level | Count | Prob |
|---|---|---|
| 0 | 913 | 0.68750 |
| 1 | 415 | 0.31250 |
| Total | 1328 | 1.00000 |

6) The final model selected was:

**LNCPUE= YEAR+ SEASON+ NUM_GEAR+ SOAK_DAYS+ YEAR*NUM_GEAR+ YEAR*SOAK_DAYS**

**SUCCESS=YEAR+NUM_GEAR+DISTRICT+SEASON+SOAK_DAYS**

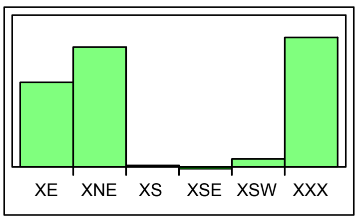
The Binomial model did not converge with any interactions, so only main factors were selected. To illustrate the stepwise procedure use for the selection of factors, Deviance analyses tables for this index are shown in Table 7.The observed, standardized, and scaled index is given in Table 8 and illustrated in Figure 2.

## 1. ST. CROIX- FISH TRAPS

Observations and restrictions imposed on the data:

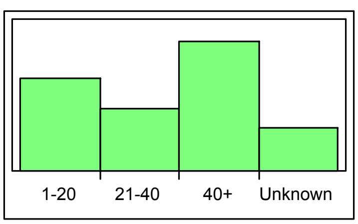
1) Only St.Croix Island.
2) Years 1986-2000, exclude 1993.
3) No lobster traps observed in STX.
4)Areas grouped into 3 regions: North East (XNE), East (XE), South (XS, XSE, XSW), and Unknown (XXX).

**Distributions STX**
**RZIP**




| Level | Count | Prob |
|---|---|---|
| XE | 168 | 0.24348 |
| XNE | 239 | 0.34638 |
| XS | 5 | 0.00725 |
| XSE | 3 | 0.00435 |
| XSW | 17 | 0.02464 |
| XXX | 258 | 0.37391 |
| Total | 690 | 1.00000 |

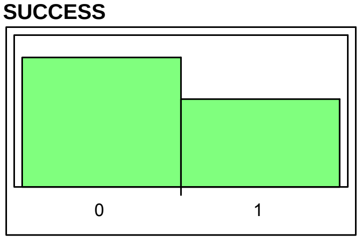
5) Removed outliers from positive catch (Lobster >130 lb and <1 lb;   95% Quantile).
6) Removed records with unknown island soak time.
7) Classified the number of gear (traps), "GEARNUM" into 4 levels:




| Level | Count | Prob |
|---|---|---|
| 1-20 | 265 | 0.28312 |
| 21-40 | 179 | 0.19124 |
| 40+ | 369 | 0.39423 |
| Unknown | 123 | 0.13141 |
| Total | 936 | 1.00000 |

8) Proportion of positive trips observed:

**SUCCESS**




| Level | Count | Prob |
|---|---|---|
| 0 | 559 | 0.59722 |
| 1 | 377 | 0.40278 |
| Total | 936 | 1.00000 |

9) Classified the time (hours) traps are deployed ("SOAK") into 3 categories (in days): unknown, 1-6 days, 7 days or more (60% of the distribution).

10) Explanatory variables considered:

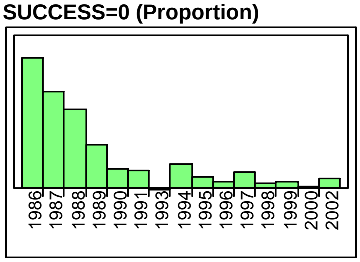
YEAR SEASON REGION NUM_GEAR SOAK_days

11) The final **Delta-Lognormal** model was:

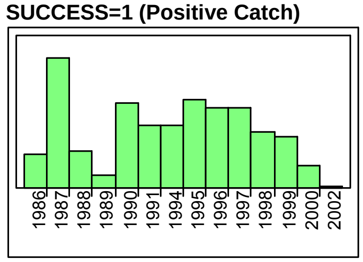
```
SUCCESS= YEAR+ NUM_GEAR+ SOAK_DAYS+ SEASON
LNCPUE= YEAR+ SOAK_days+ NUM_GEAR+ YEAR*NUM_GEAR+
          +YEAR*SOAK_DAYS
```

The Delta-Lognormal model did not provide a good fit to the data and standardized index values were therefore not estimated. The lack of fit was due to a highly unbalanced number of observations by year in the Success mode (see below)l, and to marked differences in the distribution of explanatory variables between the Binomial and the Lognormal models. In particular, the area fished (region) was distributed differently for positive and zero trips, and caused problems with convergence. This factor was removed from analysis. The positive observations have a more balanced design for all the factors considered (except Area), so A GLM model was used to estimate the relative index.

SUCCESS=0 (Proportion)




SUCCESS=1 (Positive Catch)




12) The final **GLM Model** for Positive trips was:

```
LNCPUE= YEAR+ SOAK_days+ NUM_GEAR+ YEAR*NUM_GEAR+
          YEAR*SOAK_DAYS
```

Deviance analysis tables are not provided for this index. The observed, standardized, and scaled index is given in Table 8 and illustrated in Figure 3

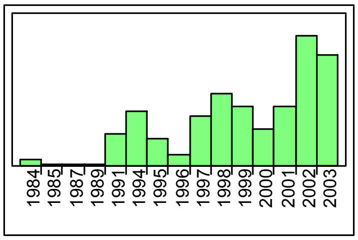
## 2. ST. CROIX- DIVE

A close examination of the DIVE trips for STX was conducted to select plausible explanatory variables for index estimation. These included the area fished (RZIP), the gear number (number of dives per trip), the dive time in hours (SOAK), the season of the year, and the average depth.

Even when a clear imbalance in the number of observations by year and by variable was observed, or that the range of observations was quite constrained, an attempt was made to test some variables as factors for the CPUE model. Variables Depth and Area fished were not tested, as a common classification into meaningful levels for both the positive and zero trips could not be made. As for the TRAP index, the Success model did not converge, so a GLM approach was used to explain trends in the positive trips.
The observations for the Positive trips can be summarized as follows:

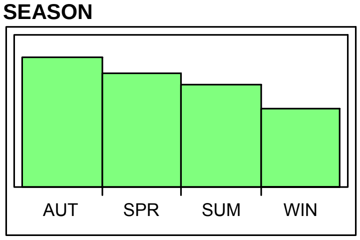
1) Before 1991, few dive trips occurred or were sampled.

**YEAR**




2) A 50% of the lobster trips land in the Northeast coast of STX; 28% in the South West, and the remaining proportion is distributed among the South, Southeast and South. Almost no trips occur in the Northwest coast.
3) The average number of dives per trip is 5.
4) The average time diving per trip is 5 hours.
5) There is no clear seasonality in the number of trips, but slightly more are observed in the Fall (30%), compared to Winter (18.5%). 25% of the trips occur in each of the other seasons (Spring and Summer).

**SEASON**




6) Median dive depth is 12.5 Fathoms, with a tight range between 8-14 Fathoms, so this factor was not examined.

The constraints imposed for the GLM model were:
1) Only St.Croix island.
2) Only DIVE gear.
3) Years 1991-2003
4) No lobster traps observed in STX, so only Fish Traps were considered.
5) Main areas grouped into regions: South-Southeast (XS-XSE), South West (XSW), North East (XNE), and East (XE). The Northwest (XNW) and unknown areas were removed due to small sample size.
6) The gear number (in num dives per trip) was classified into <5 and ≥ 5 dives.
7) The number of hours diving was classified into 2 categories: 1-5 hrs and > 5 hrs.
8) Final GLM Model was:

**LNCPUE=YEAR+ REGION +NUM_GEAR+ YEAR*REGION +YEAR*NUM_GEAR**

Deviance analysis tables are not provided for this index. The observed, standardized, and scaled index is given in Table 10 and illustrated in Figure 4.

For comparative purposes, all the standardized and scaled indices are shown in Table 11 and illustrated in Figure 4. Scaled values are relative to the average standard value.

**Conclusions**

No dramatic or consistent trends in relative abundance were noted in any of the fisheries examined. If any, the estimated indices suggest that abundance has remained relatively stable over the twenty-year period studied (1983-2003), with some inter-annual fluctuation. No seasonal clear seasonal trends were detected, the fishery appears to operate year-round, and relative abundance is fairly constant throughout the year.

A large variability was associated to all the indices, ranging from an average of 27% for the STX-DIVE index to approximately 45% for STX-TRAPS. The Delta – Lognormal index for the whole U.S. Virgin Islands TRAP fishery showed unreasonable amount of variance (average of 61% C.V.). Possible reasons may be an unbalanced design of model factors due to small sample sizes, a low proportion of positive trips, large differences in the way the the trap fishery operates when lobster is not the real target, and numerous data inconsistencies, coding errors and gaps of information. Finally the selection of trips with associated species may be rather arbitrary, and may not convey information on true targeting or effective fishing effort.

The Delta-Lognormal TRAP index values fluctuated around 14.6 lb/trip, while the GLM index for St. Croix averaged 30 lb/trip, but does not consider the zero-catch trips. The St. Croix DIVE index showed smaller values, averaging 21 lb per trip, suggesting that (fish) traps are a more effective method to catch spiny lobster. This observation is surprising, since DIVE trips target mostly this species or queen conch (*Strombus gigas*).

It is important to consider that these analyses are preliminary, as the TIP database needs to undergo an exhaustive revision. This problem is being addressed by the Deparment of Fish and Wildlife, Fisheries Research Laboratory in the U.S. Virgin Islands. In the meantime, the standardized catch rates developed here may serve as indicators of general trends in abundance.

**Acknowledgements**

I gratefully acknowledge Shannon Cass-Calay, who provided the SAS code to estimatethe species association index and guided me in the handling of the TIP database. Josh Bennett provided all the data and gave good information about the TIP program in the Caribbean.

**Literature Cited**

Bohnsack, J., S. Meyers, R. Appledoorn, J. Beets, D. Matos-Caraballo, and Y. Sadovy. 1991. Stock Assessment of Spiny Lobster, *Panulirus argus*, in the U.S. Caribbean. Miami Laboratory Contribution No. MIA-9C91-49, National Marine Fisheries Service - Southeast Fisheries Science Center.

Bolden, S. K. 2001. Status of the U.S. Caribbean spiny lobster fishery 1980-1999. Miami Laboratory Contribution No. PRD-99/00-17, National Marine Fisheries Service. Southeast Fisheries Science Center, Miami, Florida.

Cass-Calay, S. and M. Bahnick. 2002. Status of the Yellowedge Grouper Fishery in the Gulf of Mexico: Assessment 1.0. NMFS/SEFC SFD-02/03-172.

Cass-Calay, S. and M. Valle-Esquivel. Standardized Catch Rates of Queen Snapper, *Etelis oculatus*, from the St. Croix U.S. Virgin Islands Handline Fishery. NOAA/NMFS/SEDAR4-DW-11.

FAO, 2001. Western Central Atlantic Fishery Commission. Report on the FAO/ DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus*) Belize City, Belize, 21 April–2 May 1997; Merida, Mexico, 1–12 June 1998. FAO Fisheries Report No. 619 FIRM/R619. 381p.

FAO, 2001. Workshop on Management of the Caribbean Spiny Lobster (*Panulirusargus*) Fisheries in the Area of the Western Central Atlantic Fishery Commission. Mérida, Mexico, 4–8 September 2000. FAO Fisheries Report No. 643 FIPP/R643 (Bi). UN, Rome.

Lo, N. C., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. **49**:2515-2526.

McCullagh, P. and J.A. Nelder. 1989. Generalized Linear Models 2nd edition. Chapman and Hall.

Ortiz, M. a. G. P. S. 2001. Standardized Catch Rates for White Marlin (Tretapturus albidus) and Blue Marlin (Makaira nigricans) from the Pelagic Longline Fishery in the Northwest Atlantic and the Gulf of Mexico. Col. Vol. Sci. Pap. ICCAT **53**:231-248.

Ortiz M., Legault C., and G. Scott . 2000. Variance component estimation for standardized catch rates of king mackerel (*Scomberomorus cavalle*) from U.S. Gulf of Mexico recreational fisheries useful for inverse variance weighting techniques. NMFS/SEFSC Sustainable Fisheries Division Contribution SFD-99/00-86.

SEDAR 4 Data Workshop Report for the Caribbean-Atlantic Deepwater Snapper-Grouper Species. NOAA-Fisheries, November 3-7, 2003.

**Table 1.** Total interviewed trips by year and by island contained in the U.S. Virgin Islands TIP database.

| Year | ST. CROIX | ST. JOHN | ST.THOMAS | Other/Unknown | TOTAL |
|---|---|---|---|---|---|
| 1983 | 233 | 0 | 0 | 0 | **233** |
| 1984 | 379 | 0 | 3 | 18 | **382** |
| 1985 | 522 | 8 | 279 | 40 | **809** |
| 1986 | 425 | 1 | 53 | 21 | **479** |
| 1987 | 430 | 0 | 35 | 20 | **465** |
| 1988 | 478 | 0 | 0 | 3 | **478** |
| 1989 | 424 | 0 | 0 | 0 | **424** |
| 1990 | 523 | 0 | 0 | 0 | **523** |
| 1991 | 911 | 0 | 0 | 0 | **911** |
| 1992 | 3 | 6 | 46 | 29 | **55** |
| 1993 | 99 | 25 | 56 | 0 | **180** |
| 1994 | 118 | 6 | 35 | 0 | **159** |
| 1995 | 99 | 3 | 17 | 2 | **119** |
| 1996 | 75 | 0 | 16 | 0 | **91** |
| 1997 | 94 | 0 | 0 | 0 | **94** |
| 1998 | 85 | 0 | 0 | 0 | **85** |
| 1999 | 70 | 0 | 0 | 0 | **70** |
| 2000 | 41 | 0 | 0 | 0 | **41** |
| 2001 | 47 | 0 | 0 | 0 | **47** |
| 2002 | 92 | 0 | 31 | 0 | **123** |
| 2003 | 61 | 0 | 11 | 0 | **72** |
| **TOTAL** | **5209** | **49** | **582** | **133** | **5840** |

**Table 2.** Number of interviewed trips that landed lobster and other species (only) by gear from the U.S. Virgin Islands TIP database. The proportion of trips that lobster and those that landed only other species by gear are given. The gears that landed the largest proportion of lobster are highlighted.

| | | | | % Trips by Gear | |
|---|---|---|---|---|---|
| GEAR_CODE | Lobster Trips | Other Spp Trips | Total Trips | %SppTrips | % Lobster Trips |
| LOBTRAPS | 21 | 1 | 22 | 4.5% | 95.5% |
| DIVE | 271 | 172 | 443 | 38.8% | 61.2% |
| TRAPS | 397 | 2352 | 2749 | 85.6% | 14.4% |
| GILLNETS | 1 | 603 | 604 | 99.8% | 0.2% |
| HANDLINES | 0 | 1070 | 1070 | 100% | 0% |
| LONGLINES | 0 | 24 | 24 | 100% | 0% |
| SEINE | 0 | 1 | 1 | 100% | 0% |
| TROLL | 0 | 239 | 239 | 100% | 0% |
| OTHER | 245 | 390 | 635 | 61.4% | 38.6% |
| **Total** | **935** | **4852** | **5787** | | |

**Table 3.** Number of interviewed trips that landed lobster by island and gear from the U.S. Virgin Islands TIP database. The main gears that harvest lobster are highlighted and proportions by gear are given.

| ISLAND | LOBTRAPS | FISH TRAPS | DIVE | OTHER | GILLNETS | TOTAL |
|---|---|---|---|---|---|---|
| ST_CROIX | 0 | 370 | 272 | 132 | 1 | 775 |
| ST_JOHN | 1 | 5 | 0 | 1 | 0 | 7 |
| ST_THOMAS | 17 | 18 | 0 | 50 | 0 | 85 |
| OTHER | 3 | 4 | 0 | 62 | 0 | 69 |
| **TOTAL** | 21 | 397 | 272 | 245 | 1 | 936 |
| Percent by Gear | **2.2%** | **42.4%** | **29.1%** | **26.2%** | **0.1%** | |

**Table 4.** Number of interviewed trips that landed spiny lobster by island, year and gear from the U.S. Virgin Islands database. The relative indices of abundance were developed for the gears that landed the largest proportion of the total lobster landings (highlighted). The data were obtained from the U.S. Virgin Islands TIP.

| ISLAND | Year | DIVE | LOBTRAPS | TRAPS | OTHER | GILLNETS | TOTAL |
|---|---|---|---|---|---|---|---|
| **OTHER** | 1984 | 0 | 0 | 0 | 18 | 0 | **18** |
| | 1986 | 0 | 0 | 0 | 21 | 0 | **21** |
| | 1987 | 0 | 0 | 0 | 20 | 0 | **20** |
| | 1988 | 0 | 0 | 0 | 3 | 0 | **3** |
| | 1992 | 0 | 3 | 4 | 0 | 0 | **7** |
| **ST_CROIX** | 1983 | 0 | 0 | 1 | 0 | 0 | **1** |
| | 1984 | 2 | 0 | 2 | 0 | 0 | **4** |
| | 1985 | 1 | 0 | 0 | 73 | 0 | **74** |
| | 1986 | 0 | 0 | 11 | 58 | 0 | **69** |
| | 1987 | 1 | 0 | 59 | 0 | 0 | **60** |
| | 1988 | 0 | 0 | 20 | 0 | 0 | **20** |
| | 1989 | 1 | 0 | 6 | 0 | 0 | **7** |
| | 1990 | 0 | 0 | 42 | 1 | 0 | **43** |
| | 1991 | 13 | 0 | 31 | 0 | 0 | **44** |
| | 1994 | 21 | 0 | 28 | 0 | 0 | **49** |
| | 1995 | 11 | 0 | 39 | 0 | 0 | **50** |
| | 1996 | 5 | 0 | 36 | 0 | 1 | **42** |
| | 1997 | 21 | 0 | 36 | 0 | 0 | **57** |
| | 1998 | 30 | 0 | 25 | 0 | 0 | **55** |
| | 1999 | 24 | 0 | 23 | 0 | 0 | **47** |
| | 2000 | 15 | 0 | 10 | 0 | 0 | **25** |
| | 2001 | 30 | 0 | 0 | 0 | 0 | **30** |
| | 2002 | 52 | 0 | 1 | 0 | 0 | **53** |
| | 2003 | 45 | 0 | 0 | 0 | 0 | **45** |
| **ST_JOHN** | 1986 | 0 | 0 | 0 | 1 | 0 | **1** |
| | 1992 | 0 | 1 | 1 | 0 | 0 | **2** |
| | 1993 | 0 | 0 | 3 | 0 | 0 | **3** |
| | 1995 | 0 | 0 | 1 | 0 | 0 | **1** |
| **ST_THOMAS** | 1984 | 0 | 0 | 0 | 3 | 0 | **3** |
| | 1985 | 0 | 0 | 0 | 46 | 0 | **46** |
| | 1986 | 0 | 0 | 0 | 1 | 0 | **1** |
| | 1992 | 0 | 1 | 6 | 0 | 0 | **7** |
| | 1993 | 0 | 2 | 2 | 0 | 0 | **4** |
| | 1994 | 0 | 0 | 2 | 0 | 0 | **2** |
| | 1995 | 0 | 1 | 1 | 0 | 0 | **2** |
| | 1996 | 0 | 1 | 2 | 0 | 0 | **3** |
| | 2002 | 0 | 5 | 5 | 0 | 0 | **10** |
| | 2003 | 0 | 7 | 0 | 0 | 0 | **7** |
| **TOTAL** | | **272** | **21** | **397** | **245** | **1** | **936** |

**Table 5.** Species assemblage analysis for spiny lobster, DIVE GEAR from the U.S. Virgin Islands. No species were selected.

| NODC_CODE | SCI_NAME | COM_NAME | Lobstrips | Alltrips | Numerator | Denominator | DH |
|---|---|---|---|---|---|---|---|
| 6182010101 | PANULIRUS ARGUS | LOBSTER,SPINY | 276 | 276 | 1.00E+00 | 6.05E-01 | 1.652 |
| 5103580100 | STROMBUS | SNAILS(CONCHS) | 1 | 1 | 3.62E-03 | 2.19E-03 | 1.652 |
| 5500000000 | BIVALVIA | CLAM,UNC | 1 | 1 | 3.62E-03 | 2.19E-03 | 1.652 |
| 8835360104 | LUTJANUS APODUS | SNAPPER,SCHOOLMASTER | 1 | 4 | 3.62E-03 | 8.77E-03 | 0.413 |
| 5103580105 | STROMBUS PUGILIS | WEST INDIAN FIGHTING | 1 | 161 | 3.62E-03 | 3.53E-01 | 0.0103 |

**Table 6.** Species assemblage for spiny lobster and unidentified Panuliridae, Primary gear=FISH TRAPS from the U.S. Virgin Islands. Only species with co-occurrence>20 trips and largest DH values were selected (highlighted).

| NODC_CODE | SCI_NAME | COM_NAME | .obstrips | Alltrips | Numeratoı | Denominato | DH_Stat |
|---|---|---|---|---|---|---|---|
| 6182010101 | PANULIRUS ARGUS | LOBSTER,SPINY | 416 | 416 | 0.50 | 0.13 | 3.85 |
| 6182010000 | PALINURIDAE | SPINY LOBSTERS, PALIN | 68 | 68 | 0.08 | 0.02 | 3.85 |
| 8835430500 | CALAMUS SPP | PORGY,G:CALAMUS | 31 | 201 | 0.04 | 0.06 | 0.59 |
| 8835020412 | EPINEPHELUS STRIATUS | GROUPER,NASSAU | 24 | 174 | 0.03 | 0.05 | 0.53 |
| 8835360106 | LUTJANUS BUCCANELLA | SNAPPER,BLACKFIN | 21 | 161 | 0.03 | 0.05 | 0.50 |
| 8810080101 | HOLOCENTRUS ASCENSIONIS | SQUIRRELFISH | 24 | 215 | 0.03 | 0.07 | 0.43 |
| 8835020506 | MYCTEROPERCA VENENOSA | GROUPER,YELLOWFIN | 33 | 298 | 0.04 | 0.09 | 0.43 |
| 8860030101 | LACTOPHRYS TRIGONUS | TRUNKFISH | 22 | 231 | 0.03 | 0.07 | 0.37 |
| 8835550401 | POMACANTHUS ARCUATUS | ANGELFISH,GRAY | 35 | 392 | 0.04 | 0.12 | 0.34 |
| 8835020406 | EPINEPHELUS GUTTATUS | HIND,RED | 47 | 1072 | 0.06 | 0.33 | 0.17 |
| 8860020202 | BALISTES VETULA | TRIGGERFISH,QUEEN | 49 | 1315 | 0.06 | 0.41 | 0.14 |
| 8835020438 | EPINEPHELUS FULVUS | CONEY | 36 | 1117 | 0.04 | 0.35 | 0.12 |
| 8849010103 | ACANTHURUS COERULEUS | BLUE TANG | 42 | 1389 | 0.05 | 0.43 | 0.12 |
| 8835360401 | OCYURUS CHRYSURUS | SNAPPER,YELLOWTAIL | 26 | 913 | 0.03 | 0.28 | 0.11 |
| 8849010102 | ACANTHURUS CHIRURGUS | DOCTORFISH | 26 | 1091 | 0.03 | 0.34 | 0.09 |
| 8835400102 | HAEMULON PLUMIERI | GRUNT,WHITE | 25 | 1295 | 0.03 | 0.40 | 0.07 |
| 8839030403 | SPARISOMA CHRYSOPTERUM | PARROTFISH,REDTAIL | 24 | 1458 | 0.03 | 0.45 | 0.06 |

**Table 7.** Deviance analysis tables for the selection of explanatory variables in the Lognormal and Binomial Model components for the U.S. Virgin Island TRAP fishery. Factos were added to the model if PROBCHISQ<0.05 and % REDUCTION in DEV/DF≥1.0%. Only the first and last steps in the stepwise process are show, with the final models in bold font.

**Positive (Lognormal Model)**

****************************************************************************************************

The explanatory factors in the base model are: YEAR

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 402 | 285.1 | 0.7093 | | -516.1 | | |
| SEASON | 399 | 284.5 | 0.7130 | -0.52 | -515.6 | 0.99 | 0.80454 |
| DISTRICT | 401 | 282.0 | 0.7033 | 0.84 | -513.8 | 4.62 | 0.03167 |
| SOAK_DAYS | 400 | 278.6 | 0.6964 | 1.82 | -511.2 | . | . |
| NUM_GEAR | 398 | 274.7 | 0.6902 | 2.70 | -508.2 | 15.77 | 0.00335 |

****************************************************************************************************

The explanatory factors in the base model are: YEAR NUM_GEAR

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 398 | 274.7 | 0.6902 | | -508.2 | | |
| SEASON | 395 | 273.5 | 0.6923 | -0.31 | -507.2 | 1.89 | 0.59453 |
| DISTRICT | 397 | 273.1 | 0.6880 | 0.31 | -507.0 | 2.39 | 0.12196 |
| SOAK_DAYS | 396 | 264.4 | 0.6677 | 3.25 | -500.2 | . | . |

****************************************************************************************************

The explanatory factors in the base model are: YEAR NUM_GEAR SOAK_DAYS

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 396 | 264.4 | 0.6677 | | -500.2 | | |
| DISTRICT | 395 | 263.7 | 0.6675 | 0.04 | -499.6 | 1.23 | 0.26799 |
| SEASON | 393 | 262.4 | 0.6677 | 0.00 | -498.6 | 3.23 | 0.35817 |

****************************************************************************************************

The explanatory factors in the base model are: YEAR NUM_GEAR SOAK_DAYS

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 396 | 264.4 | 0.6677 | | -500.2 | | |
| SOAK_DAYS | 396 | 264.4 | 0.6677 | 0.00 | -500.2 | . | . |
| DISTRICT | 395 | 263.7 | 0.6675 | 0.04 | -499.6 | 1.23 | 0.26799 |
| SEASON | 393 | 262.4 | 0.6677 | 0.00 | -498.6 | 3.23 | 0.35817 |
| NUM_GEAR*SOAK_DAYS | 390 | 249.1 | 0.6388 | 4.34 | -487.6 | . | . |
| YEAR*SOAK_DAYS | 379 | 238.9 | 0.6304 | 5.60 | -478.7 | . | . |
| YEAR*NUM_GEAR | 367 | 206.3 | 0.5622 | 15.80 | -447.8 | 104.69 | 0.00000 |

The explanatory factors in the base model are: YEAR NUM_GEAR SOAK_DAYS YEAR*NUM_GEAR

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 367 | 206.3 | 0.5622 | | -447.8 | | |
| SOAK_DAYS | 367 | 206.3 | 0.5622 | 0.00 | -447.8 | . | . |
| DISTRICT | 366 | 206.0 | 0.5627 | -0.09 | -447.4 | 0.76 | 0.38431 |
| NUM_GEAR*SOAK_DAYS | 362 | 203.2 | 0.5613 | 0.16 | -444.6 | . | . |
| SEASON | 364 | 202.1 | 0.5553 | 1.23 | -443.5 | 8.68 | 0.03380 |
| YEAR*SOAK_DAYS | 352 | 187.4 | 0.5324 | 5.30 | -427.5 | . | . |

The explanatory factors in the base model are: **YEAR NUM_GEAR SOAK_DAYS YEAR*NUM_GEAR YEAR*SOAK_DAYS**

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 352 | 187.4 | 0.5324 | | -427.5 | | |
| SOAK_DAYS | 352 | 187.4 | 0.5324 | 0.00 | -427.5 | . | . |
| DISTRICT | 351 | 187.3 | 0.5337 | -0.23 | -427.4 | 0.22 | 0.63799 |
| NUM_GEAR*SOAK_DAYS | 349 | 185.8 | 0.5324 | 0.01 | -425.7 | . | . |
| SEASON | 349 | 181.3 | 0.5193 | 2.46 | -420.5 | 14.12 | 0.00275 |

## Proportion of Positive (Binomial Model)

There are no explanatory factors in the base model.

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1328 | 1661.2 | 1.2509 | | -830.6 | | |
| SEASON | 1325 | 1620.4 | 1.2229 | 2.24 | -810.2 | 40.85 | 0.00000 |
| SOAK_DAYS | 1326 | 1602.7 | 1.2086 | 3.38 | -801.3 | . | . |
| DISTRICT | 1327 | 1542.4 | 1.1623 | 7.08 | -771.2 | 118.81 | 0.00000 |
| NUM_GEAR | 1324 | 1462.8 | 1.1049 | 11.68 | -731.4 | 198.39 | 0.00000 |
| YEAR | 1309 | 1053.2 | 0.8046 | 35.68 | -526.6 | 608.08 | 0.00000 |

The explanatory factors in the base model are: YEAR

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1309 | 1053.2 | 0.8046 | | -526.6 | | |
| SEASON | 1306 | 1018.8 | 0.7801 | 3.04 | -509.4 | 34.40 | 0.00000 |
| SOAK_DAYS | 1307 | 1005.3 | 0.7692 | 4.39 | -502.7 | . | . |
| DISTRICT | 1308 | 999.1 | 0.7638 | 5.06 | -499.5 | 54.06 | 0.00000 |
| NUM_GEAR | 1305 | 981.0 | 0.7517 | 6.57 | -490.5 | 72.17 | 0.00000 |

***************************************************************************************************

The explanatory factors in the base model are:  YEAR NUM_GEAR

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1305 | 981.0 | 0.7517 | | -490.5 | | |
| SEASON | 1302 | 958.5 | 0.7361 | 2.07 | -479.2 | 22.52 | 0.00005 |
| SOAK_DAYS | 1303 | 949.9 | 0.7290 | 3.02 | -475.0 | . | . |
| DISTRICT | 1304 | 916.7 | 0.7030 | 6.49 | -458.3 | 64.33 | 0.00000 |

***************************************************************************************************

The explanatory factors in the base model are:  YEAR NUM_GEAR DISTRICT

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1304 | 916.7 | 0.7030 | | -458.3 | | |
| SOAK_DAYS | 1302 | 897.6 | 0.6894 | 1.93 | -448.8 | . | . |
| SEASON | 1301 | 892.0 | 0.6856 | 2.47 | -446.0 | 24.67 | 0.00002 |

***************************************************************************************************

The explanatory factors in the base model are:  YEAR NUM_GEAR DISTRICT SEASON

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1301 | 892.0 | 0.6856 | | -446.0 | | |
| SOAK_DAYS | 1299 | 877.6 | 0.6756 | 1.46 | -438.8 | . | . |

***************************************************************************************************

The explanatory factors in the base model are:  **YEAR NUM_GEAR DISTRICT SEASON SOAK_DAYS**

| FACTOR | DEGF | DEVIANCE | DEV/DF | %REDUCTION | LOGLIKE | CHISQ | PROBCHISQ |
|---|---|---|---|---|---|---|---|
| BASE | 1299 | 877.6 | 0.6756 | | -438.8 | | |

***************************************************************************************************

**Table 8, U.S.Virgin Islands- TRAPS- Delta-Lognormal Index.** Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the spiny lobster trap fishery, all islands included, years 1986-2002.

| | | | | | Scaled Index | | |
|---|---|---|---|---|---|---|---|
| Year | Nominal | Estimated | C.V. | Obscpue | StdIndex | U95% CI | L95% CI |
| 1986 | 4.544 | 0.583 | 87.5% | 0.280 | 0.040 | 0.009 | 0.180 |
| 1987 | 16.276 | 1.633 | 82.4% | 1.003 | 0.112 | 0.026 | 0.471 |
| 1988 | 12.725 | 5.472 | 62.2% | 0.784 | 0.374 | 0.119 | 1.175 |
| 1989 | 3.612 | 1.836 | 87.2% | 0.223 | 0.126 | 0.028 | 0.565 |
| 1990 | 25.413 | 29.818 | 45.9% | 1.566 | 2.039 | 0.851 | 4.887 |
| 1991 | 14.141 | 7.654 | 52.0% | 0.871 | 0.523 | 0.197 | 1.392 |
| 1992 | 12.338 | 13.355 | 60.6% | 0.760 | 0.913 | 0.299 | 2.793 |
| 1993 | 12.586 | 5.426 | 88.7% | 0.776 | 0.371 | 0.081 | 1.703 |
| 1994 | 14.322 | 11.965 | 48.2% | 0.883 | 0.818 | 0.328 | 2.040 |
| 1995 | 19.676 | 19.307 | 42.9% | 1.212 | 1.320 | 0.580 | 3.005 |
| 1996 | 20.514 | 26.257 | 45.2% | 1.264 | 1.795 | 0.759 | 4.249 |
| 1997 | 21.966 | 22.295 | 48.9% | 1.354 | 1.524 | 0.604 | 3.850 |
| 1998 | 19.839 | 16.616 | 52.6% | 1.223 | 1.136 | 0.423 | 3.053 |
| 1999 | 21.450 | 24.414 | 49.4% | 1.322 | 1.669 | 0.656 | 4.250 |
| 2000 | 20.553 | 22.825 | 64.4% | 1.267 | 1.561 | 0.481 | 5.065 |
| 2001 | | | | | | | |
| 2002 | 19.693 | 24.545 | 57.6% | 1.213 | 1.678 | 0.575 | 4.899 |

**Table 9. STX- TRAPS, GLM Index.** Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the spiny lobster Trap fishery of St. Croix, years 1986-2002.

| | | | | | Scaled Index | | |
|---|---|---|---|---|---|---|---|
| Year | Nominal | Estimated | C.V. | Obscpue | StdIndex | U95% CI | L95% CI |
| 1986 | 43.018 | 22.408 | 58.3% | 1.352 | 0.698 | 2.057 | 0.237 |
| 1987 | 42.159 | 19.166 | 82.8% | 1.325 | 0.481 | 2.041 | 0.114 |
| 1988 | 49.834 | 44.969 | 44.0% | 1.567 | 1.515 | 3.513 | 0.654 |
| 1989 | 21.671 | 20.534 | 52.3% | 0.681 | 0.665 | 1.778 | 0.249 |
| 1990 | 32.672 | 52.916 | 47.4% | 1.027 | 1.750 | 4.303 | 0.711 |
| 1991 | 18.982 | 16.345 | 41.8% | 0.597 | 0.561 | 1.252 | 0.252 |
| 1992 | 0.000 | 0.000 | 0.0% | 0.000 | 0.000 | 0.000 | 0.000 |
| 1993 | 0.000 | 0.000 | 0.0% | 0.000 | 0.000 | 0.000 | 0.000 |
| 1994 | 29.292 | 26.320 | 41.6% | 0.921 | 0.900 | 2.000 | 0.405 |
| 1995 | 25.905 | 23.900 | 40.9% | 0.814 | 0.821 | 1.802 | 0.374 |
| 1996 | 24.347 | 30.721 | 43.3% | 0.765 | 1.041 | 2.384 | 0.455 |
| 1997 | 28.677 | 30.772 | 42.4% | 0.902 | 1.047 | 2.362 | 0.464 |
| 1998 | 23.013 | 22.382 | 47.7% | 0.724 | 0.743 | 1.840 | 0.300 |
| 1999 | 26.113 | 30.715 | 42.5% | 0.821 | 1.045 | 2.360 | 0.463 |
| 2000 | 24.664 | 34.075 | 53.5% | 0.775 | 1.090 | 2.971 | 0.400 |
| 2001 | | | | | | | |
| 2002 | 54.956 | 66.487 | 81.3% | 1.728 | 1.642 | 6.822 | 0.395 |

**Table 10. STX- DIVE, GLM Index.** Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the spiny lobster Dive fishery of St. Croix, years 1991-2003.

| | | | | | Scaled Index | | |
|---|---|---|---|---|---|---|---|
| Year | Nominal | Estimated | Coeff Var | Obscpue | StdIndex | U95% CI | L95% CI |
| 1991 | 30.630 | 24.015 | 41.0% | 1.419 | 1.092 | 2.401 | 0.497 |
| 1992 | | | | | | | |
| 1993 | | | | | | | |
| 1994 | 30.033 | 32.530 | 24.4% | 1.392 | 1.565 | 2.534 | 0.967 |
| 1995 | 21.993 | 24.307 | 32.4% | 1.019 | 1.143 | 2.152 | 0.607 |
| 1996 | 11.087 | 13.192 | 37.1% | 0.514 | 0.613 | 1.257 | 0.299 |
| 1997 | 23.904 | 19.964 | 26.3% | 1.108 | 0.958 | 1.606 | 0.572 |
| 1998 | 18.394 | 16.253 | 26.3% | 0.852 | 0.781 | 1.310 | 0.466 |
| 1999 | 24.502 | 17.374 | 26.8% | 1.135 | 0.834 | 1.412 | 0.492 |
| 2000 | 31.226 | 29.436 | 27.1% | 1.447 | 1.407 | 2.394 | 0.826 |
| 2001 | 16.722 | 14.943 | 27.4% | 0.775 | 0.717 | 1.228 | 0.418 |
| 2002 | 23.278 | 17.947 | 22.7% | 1.079 | 0.870 | 1.362 | 0.556 |
| 2003 | 27.219 | 21.077 | 23.5% | 1.261 | 1.019 | 1.620 | 0.641 |

**Table 11.** A summary of the standardized CPUE indices estimated in this study. The standard and the scaled standard indices are shown for traps and dive gear, and the model used is specified. Scaled values are relative to the average standard value.

| | USVI-Delta-Traps | | STX-GLM-Traps | | STX-GLM-Dive | |
|---|---|---|---|---|---|---|
| Year | Estimated | Scaled | Estimated | Scaled | Estimated | Scaled |
| 1986 | 0.58 | 0.04 | 22.41 | 0.70 | | |
| 1987 | 1.63 | 0.11 | 19.17 | 0.48 | | |
| 1988 | 5.47 | 0.37 | 44.97 | 1.52 | | |
| 1989 | 1.84 | 0.13 | 20.53 | 0.67 | | |
| 1990 | 29.82 | 2.04 | 52.92 | 1.75 | | |
| 1991 | 7.65 | 0.52 | 16.34 | 0.56 | 24.01 | 1.09 |
| 1992 | 13.36 | 0.91 | | 0.00 | | |
| 1993 | 5.43 | 0.37 | | 0.00 | | |
| 1994 | 11.96 | 0.82 | 26.32 | 0.90 | 32.53 | 1.57 |
| 1995 | 19.31 | 1.32 | 23.90 | 0.82 | 24.31 | 1.14 |
| 1996 | 26.26 | 1.80 | 30.72 | 1.04 | 13.19 | 0.61 |
| 1997 | 22.29 | 1.52 | 30.77 | 1.05 | 19.96 | 0.96 |
| 1998 | 16.62 | 1.14 | 22.38 | 0.74 | 16.25 | 0.78 |
| 1999 | 24.41 | 1.67 | 30.72 | 1.05 | 17.37 | 0.83 |
| 2000 | 22.82 | 1.56 | 34.08 | 1.09 | 29.44 | 1.41 |
| 2001 | | | | | 14.94 | 0.72 |
| 2002 | 24.55 | 1.68 | 66.49 | 1.64 | 17.95 | 0.87 |
| 2003 | | | | | 21.08 | 1.02 |

**Figure 1.** Proportion of lobster trips by gear from the U.S. Virgin Islands TIP database.

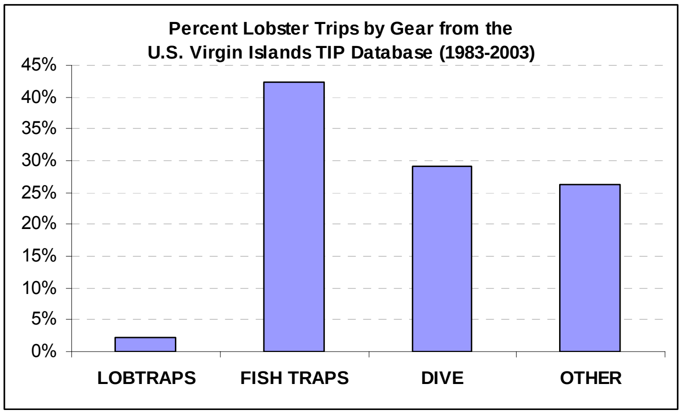



**Figure 2. U.S.Virgin Islands- DIVE and TRAPS combined- Delta-Lognormal Model** Nominal CPUE, standardized index of abundance and 95% confidence limits for the U.S. Virgin Islands spiny lobster, all islands included, DIVE and TRAPS combined, years 1986-2002.

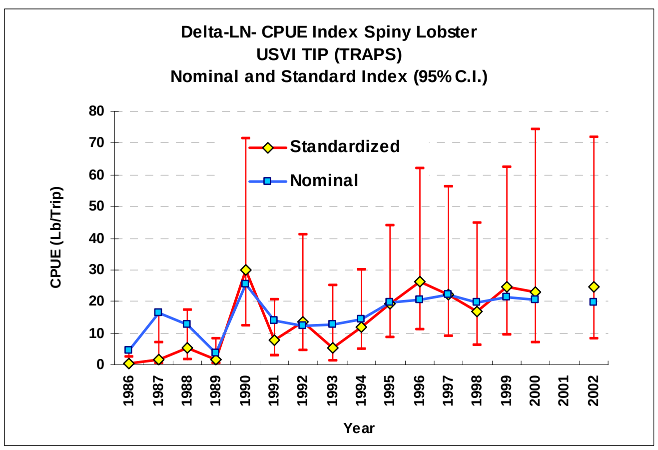



**Figure 3. STX- TRAPS- GLM Model.** Nominal CPUE, standardized index of abundance and 95% confidence limits for the St. Croix spiny lobster Trap fishery, years 1986-2002.

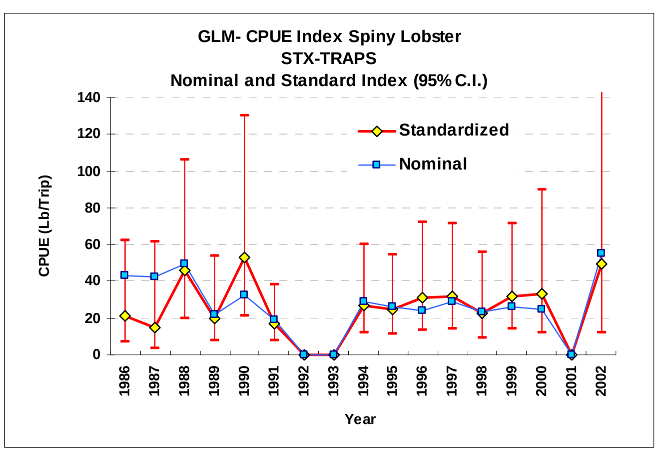


**Figure 4. STX- DIVE- GLM Model.** Nominal CPUE, standardized index of abundance and 95% confidence limits for the St. Croix spiny lobster Dive fishery, years 1991-2003.

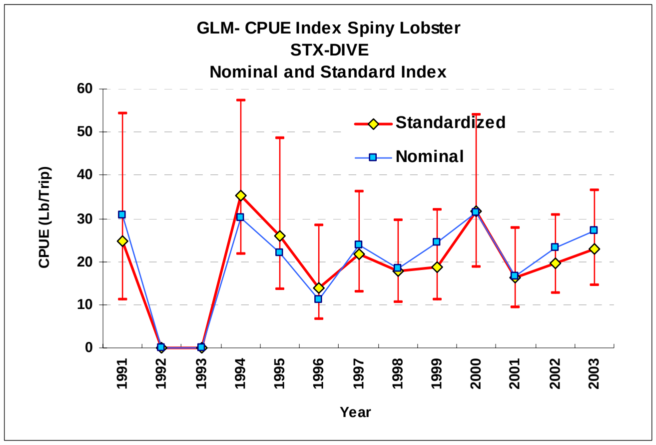



**Figure 5.** A summary of the standardized CPUE indices (in lb/trip) estimated in this study for lobster trap and dive fisheries; the model used is specified.

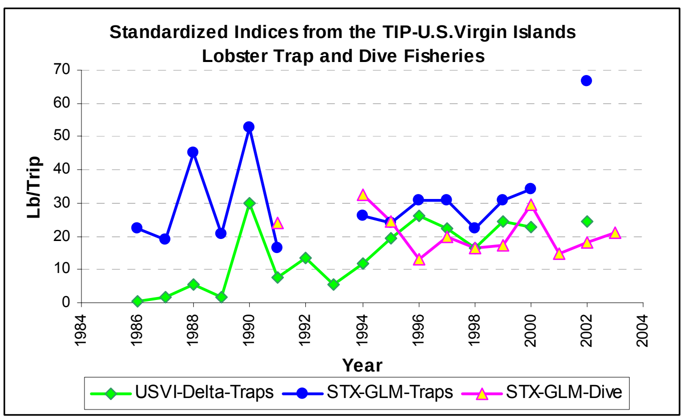



**Figure 6.** A summary of the standardized scaled CPUE indices estimated in this study for lobster trap and dive fisheries. Scaled values are relative to the average standard value.