STANDARDIZED CATCH RATES OF SILK SNAPPER, *LUTJANUS VIVANUS*, FROM THE ST. CROIX U.S. VIRGIN ISLANDS HANDLINE FISHERY DURING 1984-1997

by

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ABSTRACT

NOAA Fisheries Trip Interview Program (TIP) data were used to construct standardized indices of abundance for silk snapper, *Lutjanus vivanus*. The indices were constructed using a delta-lognormal approach which combines two general linear models, a binomial model fit to the proportion of positive trips, and a lognormal model fit to catch rates on positive trips. No obvious and consistent trends in abundance are noted.

INTRODUCTION

Silk snapper are distributed throughout the tropical western Atlantic Ocean as far north as Bermuda and North Carolina, and south to central Brazil. They are most abundant off the islands of the Bahamas and the Antilles, including the U.S. Virgin Islands. Silk snapper are a member of the deep-water snapper/grouper complex, and are most commonly distributed deeper than 50 meters. The known biological information pertaining to silk snapper is summarized by Cummings (2003:SEDAR4-DW-07).

Silk snapper are an important component of the Caribbean commercial fisheries. They are generally landed using various hook and line gears as well as fish traps. Detailed landings information is summarized by Valle (2003: SEDAR4-DW-08) and Cummings and Matos-Caraballo (2003: SEDAR4-DW-05 and SEDAR4-DW-06).

Catch per unit effort (CPUE) data were obtained from the NOAA Fisheries Trip Interview Program. The data were collected by port samplers during dockside interviews of commercial fishers, and include observations from the U.S. Virgin Islands for the years 1983-2003. Data routinely recorded includes date of fishing, area fished, location (island) landed, gear fished and total weight landed by species. Other data 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 portion of the interviewed trips.

MATERIAL AND METHODS

During the construction of the delta-lognormal indices, only trips that used hook and line gear and landed the catch at St. Croix were considered (205 of 303 trips).

Identifying Trips that Targeted Silk Snapper

Due to variations in fishing location, depth of fishing and gear choice, we believe that many fishing trips had an intrinsically low probability of landing silk snapper. As no data regarding targeting were available, we used two methods to attempt to identify trips with a higher than average probability of catching silk snapper. The first method (***Species Assemblage***) excluded trips if they did not catch at least one member of the Caribbean deep-water snapper/grouper assemblage as defined by Zweifel and Cummings[1] (Table 1). The second method (***Deep Trips***) excluded trips if (START DEPTH + END DEPTH)/2 was less than 50 meters.

Index Development

In order to develop a well balanced sample design, it was necessary to construct several categorical variables. The factor YEAR_CLASS was constructed to allow sufficient observations in each time period. When using the ***Species Assemblage*** approach, 9 time periods were considered: 1984-1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992-1994, 1995-1997. During the ***Deep Trips*** approach, only eight time period were possible (1984-1985, 1986-1987, 1988, 1989, 1990, 1991, 1992-1994, 1995-1997) since some trips did not report depth of fishing. No hook and line trips were interviewed in St. Croix after 1997.

The factor SEASON was constructed from MONTH to create four levels generally reflective of water temperatures and fishing conditions observed in the U.S. Virgin Islands.

IF MONTH in (Dec, Jan, Feb) then SEASON = 'WIN'
IF MONTH in (Mar, Apr, May) then SEASON = 'SPR'
IF MONTH in (Jun, Jul, Aug) then SEASON = 'SUM'
IF MONTH in (Sep, Oct, Nov) then SEASON = 'AUT'

The factor NUM_GEAR refers to the number of lines fished during a trip. Two levels were considered.

"1-2" = The number of lines fished was 1 or 2.
"ge 3" = The number of lines fished was greater than or equal to 3..

The factor GEAR_TYPE was defined using the TIP GEAR1 code. GEAR1 codes are 610 = 'Lines hand, Others Still Fish Bottom', 611 = 'Rod and Reel', 613 = 'Electric or Hydraulic Reel' and 616 = 'Electric Rod and Reel, Hand'. Two levels were considered, power and manual. Only hook and line gears were considered during the construction of these indices.

[1] James E. Zweifel and Nancie Cummings. NOAA Fisheries SEFSC, Miami Laboratory. 75 Virginia Beach Dr. Miami FL, USA 33149.

IF GEAR1 in (**610**,**611**) then GEAR_TYPE = 'Manual';
IF GEAR1 in (**613**,**616**) then GEAR_TYPE = 'Power'

We used the delta lognormal model approach (Lo et al. 1992) to develop the standardized indices of abundance. This method combines separate generalized linear modeling (GLM) analyses of the proportion of successful trips (trips that landed silk snapper) and the positive 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).

Factors considered as possible influences on the proportion of successful trips included YEAR_CLASS, SEASON, GEAR_NUM and GEAR_TYPE. During this GLM procedure, we fit a type-3 model, assumed a binomial error distribution, and selected the logit link. The response variable was SUCCESS. We examined the same factors during the analysis of catch rates on positive trips. In this case, a type3 model assuming lognormal error distribution was employed. The linking function selected was “normal”, and the response variable was ln(CPUE). CPUE was defined as weight of silk snapper landed (kg) per trip.

For each GLM, we used a stepwise approach to quantify the relative importance of the factors. First the null model was run. These results reflect the distribution of the nominal data. Next we added each potential factor to the null model one at a time, and examined the resulting reduction in deviance per degree of freedom. 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 ≥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.

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (glmm800MaOB.sas: Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except interaction terms containing YEAR (e.g. YEAR*GEAR_TYPE). These 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.

RESULTS

The U.S. Virgin Islands TIP database contains 5,807 interviewed trips during the period 1983-2003. The exact location of fishing is not recorded, but generally occurs within the area depicted in Figure 1.The number of interviewed trips, by year and landing location, is summarized in Table 2. Note that the number of interviewed trips declined substantially after 1991. Of the 5,807 interviewed trips, 303 landed silk snapper. The number of interviewed trips by island, year and gear is summarized in Table 3.

Species Assemblage Method

The Caribbean deep-water snapper/grouper species assemblage was defined by Zweifel and Cummings (in prep), and is summarized in Table 1. For this analysis, trips were included if they used hook and line gear, landed the catch at St. Croix, and caught at least one member of the designated species assemblage. Finally, trips were excluded if they did not report date of fishing, gear, and number of lines fished. 321 trips met all criteria, and were included in the analysis, of these, 177 caught silk snapper.

The stepwise construction of the binomial model of the probability of success (catching silk snapper) is summarized in Table 4. The final model was ***SUCCESS = NUM_GEAR + YEAR_CLASS.*** Annual variations in the proportion of positive trips are shown in Figure 2. With the exception of a single low success year, 1987, the proportion of positive trips is rather constant at approximately 0.6. Diagnostic plots were examined to evaluate the fit of the binomial model. The distribution of the chi-square residuals (Fig. 3) indicates an acceptable fit; the residuals are generally distributed near zero, and are without annual trend. The frequency distribution of the proportion of positive trips, by Num_Gear and Year_Class was also acceptable (Fig. 4).

The stepwise construction of the lognormal model of catch rates on positive trips is summarized in Table 5. The final model was ***ln(CPUE) = YEAR_CLASS + GEAR_TYPE + NUM_GEAR.*** Annual values of nominal CPUE on positive trips are shown in Figure 5. CPUE fluctuates annually, without obvious trend. However, recently (1992-1997), low CPUEs are noted. Diagnostic plots created to assess the fit of the lognormal model were acceptable. The residuals were distributed evenly around zero, without annual trend (Fig. 6). Also as expected, the frequency distribution of ln(CPUE), by Year_Class, Gear_Type and Num_Gear, approximated a normal distribution (Fig. 7). In summary, all diagnostic plots met our expectations, and supported an acceptable fit to the selected models.

The delta-lognormal abundance index, with 95% confidence intervals, is shown in Figure 8. To allow quick visual comparison with the nominal values, both series were scaled to their respective means. The index statistics can be found in Table 6. The standardized abundance index is quite similar to the nominal CPUE series. The standardized index has no obvious and consistent trend, although in recent years (1992-1997) the index values are substantially lower than the series average.

Deep Trips Method

About 50% of the hook and line trips that landed catch at St. Croix fished at an average depth less than 50 m (Fig. 9). In contrast, ~80% of silk snapper were captured deeper than 50 meters (Fig. 10). It is reasonable to conclude that shallow trips are unlikely to capture silk snapper. Thus, we used depth of fishing in a second attempt to identify targeting of deep-water snappers.

For this analysis, trips were included if they used hook and line gear, landed the catch at St. Croix, and fished at an average depth greater than or equal to 50 meters. Trips were excluded if they did not report date of fishing, gear, number of lines fished and depth of fishing. 380 trips met all criteria, and were included in the analysis, of these, 145 caught silk snapper.

The stepwise construction of the binomial model of the probability of success (catching silk snapper) is summarized in Table 7. The final model was ***SUCCESS = YEAR_CLASS + NUM_GEAR.*** The proportion of positive trips appears to fluctuate annually without obvious trend (Fig. 11). Diagnostic plots were examined to evaluate the fit of the binomial model. Most were acceptable, and are not shown. The distribution of the chi-square residuals (Fig. 12) was of concern because the magnitude of the residuals increases toward the latter part of the time series. This is an indication that insufficient observations were available.

The stepwise construction of the lognormal model of catch rates on positive trips is summarized in Table 8. The final model was ***ln(CPUE) = YEAR_CLASS.*** Nominal CPUE fluctuates annually, but recent years (1992-1997) are the lowest on record (Fig. 13). Diagnostic plots (not shown) met our expectations, and supported an acceptable fit to the selected models.

The delta-lognormal abundance index, with 95% confidence intervals, and the relative nominal CPUE are shown in Figure 14. The index statistics are summarized in Table 9. The standardized abundance index is quite similar to the nominal CPUE series. The standardized index has no obvious and consistent trend, and unlike the results of the ***Species Assemblage Method***, the index values are not substantially lower than the series average during the period 1992-1997. Instead, they are near average.

DISCUSSION

Although the majority of the diagnostics suggested adequate fits to the GLM models, we are quite concerned about the low sample sizes. To properly address the variability in catch rates, >20 positive trips are desirable in each model stratum (e.g. year, gear, etc.). For the ***Species Assemblage*** method, most year classes contained 12-18 positive trips, and one year class contained only seven positive trips (Table 6). During the ***Deep Trips*** approach it was necessary to reduce the year classes to eight, and still most year classes contained <18 positive trips, and one contained only five (Table 9).

We advise readers to use caution when contemplating the utility of these indices. Variability in catch rates is quite high, and a small increase in the sample size, particularly in recent years, could greatly influence the results. In summary, we feel that the information presented in this paper is useful to summarize the available data, and to evaluate the adequacy of the data. However, it is evident that the U.S. Virgin Island TIP dataset contains very few observations of deep-water snappers. Thus, we advise against the use of these indices within formal, quantitative population modeling procedures.

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Table 1. Members of the Caribbean deep-water snapper/grouper complex, as defined by Zweifel and Cummings (in preparation).

NODC Species Code	Scientific Name	Common Name
8835360201	*Apsilus dentatus*	Snapper,black
8835360106	*Lutjanus buccanella*	Snapper,blackfin
8835360301	*Etelis oculatus*	Snapper,queen
8835360113	*Lutjanus vivanus*	Snapper,silk
8835360701	*Pristipomoides aquilon*	Snapper,wenchman
8835020502	*Mycteroperca bonaci*	Grouper,black
8835020440	*Epinephelus inermis*	Grouper,marbled
8835020409	*Epinephelus mystacinus*	Grouper,misty
8835020412	*Epinephelus striatus*	Grouper,nassau
8835020506	*Mycteroperca venenosa*	Grouper,yellowfin
8835020411	*Epinephelus niveatus*	Grouper,snowy
8835020411	*Epinephelus niveatus*	Grouper,snowy
8835020550	*Mycteroperca tiguiri*	Grouper,tiger
8835020509	*Mycteroperca tigris*	Grouper,tiger
8835020410	*Epinephelus nigritus*	Grouper,warsaw
8835020405	*Epinephelus flavolimbat*	Grouper,yellowedge
8835020504	*Mycteroperca interstita*	Grouper,yellowmouth

Table 2. Total interviewed trips by year, and interviewed trips by island and year for all trips contained in the U.S.Virgin Islands TIP database.

YEAR	ST. CROIX	ST. JOHN	ST. THOMAS	Other/Unknown	Grand Total
1983	229	0	0	0	**229**
1984	346	0	3	18	**367**
1985	512	8	267	40	**827**
1986	422	1	53	21	**497**
1987	425	0	35	20	**480**
1988	478	0	0	3	**481**
1989	424	0	0	0	**424**
1990	519	0	0	0	**519**
1991	887	0	0	0	**887**
1992	3	6	46	28	**83**
1993	99	25	56	0	**180**
1994	117	6	35	0	**158**
1995	99	3	17	2	**121**
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	58	0	7	34	**99**
2003	0	0	9	18	**27**
Grand Total	**5030**	**49**	**544**	**184**	**5807**

Table 3. A summary of the interviewed trips that landed silk snapper, by island, year and gear. The data were obtained from the U.S. Virgin Islands TIP. The delta-lognormal index was created using only hook and line trips interviewed in St. Croix (shaded).

		GEAR					
ISLAND	YEAR	Bouy/Vert. Longline	Hook and Line	Longline	Other	Pots and Traps	Grand Total
OTHER	1992	0	0	0	2	2	4
	2002	1	0	0	0	0	1
St. Croix	1983	0	0	0	2	5	7
	1984	0	3	0	1	12	16
	1985	0	17	0	4	0	21
	1986	0	15	0	1	4	20
	1987	0	18	0	0	1	19
	1988	0	53	0	0	2	55
	1989	0	30	0	0	2	32
	1990	0	24	0	0	1	25
	1991	0	24	0	3	0	27
	1992	1	1	0	0	0	2
	1993	4	4	0	0	0	8
	1994	5	3	1	0	5	14
	1995	0	5	2	0	0	7
	1996	1	6	0	0	0	7
	1997	0	2	0	0	1	3
	2001	3	0	0	0	0	3
	2002	1	0	0	0	0	1
St. Thomas	1985	0	0	4	0	14	18
	1986	0	0	0	0	5	5
	1987	0	0	0	0	1	1
	1993	0	1	0	0	3	4
	1995	0	0	0	1	0	1
	1996	0	0	0	1	0	1
	2002	0	0	0	0	1	1
Grand Total		16	206	7	15	59	303

Table 4. A summary of formulation of the binomial model (***Species Assemblage Method***). Factors were added to the model if PROBCHISQ < 0.05 and %REDUCTION in DEV/DF ≥ 1.0% (bold font). The final model was SUCCESS = NUM_GEAR + YEAR_CLASS.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	320	441.6	1.3800		-220.8		
GEAR_TYPE	319	441.5	1.3841	-0.30	-220.8	0.06	0.80305
SEASON	317	438.2	1.3823	-0.17	-219.1	3.40	0.33384
YEAR_CLASS	312	423.9	1.3586	1.55	-211.9	17.70	0.02357
NUM_GEAR	**319**	**427.2**	**1.3392**	**2.96**	**-213.6**	**14.39**	**0.00015**

The explanatory factors in the base model are: NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	319	427.2	1.3392		-213.6		
GEAR_TYPE	318	426.3	1.3407	-0.11	-213.2	0.87	0.35117
SEASON	316	422.0	1.3354	0.29	-211.0	5.23	0.15574
YEAR_cLASS	**311**	**409.9**	**1.3181**	**1.58**	**-205.0**	**17.29**	**0.02720**

The explanatory factors in the base model are: NUM_GEAR YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	311	409.9	1.3181		-205.0		
GEAR_TYPE	310	409.9	1.3221	-0.31	-204.9	0.06	0.80384
SEASON	308	403.3	1.3093	0.66	-201.6	6.64	0.08432

The explanatory factors in the base model are: NUM_GEAR YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	311	409.9	1.3181		-205.0		
YEAR_CLASS*NUM_GEAR	303	399.4	1.3182	-0.01	-199.7	10.52	0.23052

Table 5. A summary of formulation of the lognormal model (***Species Assemblage Method***). Factors were added to the model if PROBCHISQ < 0.05 and %REDUCTION in DEV/DF ≥ 1.0% (bold blue font). The final model was LN(CPUE) = YEAR_CLASS + GEAR_TYPE + NUM_GEAR.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	176	265.8	1.5101		-287.1		
SEASON	173	263.5	1.5229	-0.84	-286.4	1.56	0.66922
GEAR_TYPE	175	262.7	1.5012	0.59	-286.1	2.06	0.15152
NUM_GEAR	175	258.8	1.4790	2.06	-284.8	4.69	0.03028
YEAR_CLASS	**168**	**230.7**	**1.3729**	**9.08**	**-274.6**	**25.09**	**0.00150**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	168	230.7	1.3729		-274.6		
SEASON	165	228.2	1.3829	-0.72	-273.6	1.92	0.59004
NUM_GEAR	167	225.8	1.3519	1.53	-272.7	3.79	0.05146
GEAR_TYPE	**167**	**223.3**	**1.3372**	**2.61**	**-271.7**	**5.73**	**0.01668**

The explanatory factors in the base model are: YEAR_CLASS GEAR_TYPE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	167	223.3	1.3372		-271.7		
SEASON	164	220.9	1.3472	-0.75	-270.8	1.88	0.59778
NUM_GEAR	**166**	**216.5**	**1.3040**	**2.48**	**-269.0**	**5.51**	**0.01895**

The explanatory factors in the base model are: YEAR_CLASS GEAR_TYPE NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	166	216.5	1.3040		-269.0		
SEASON	163	215.7	1.3232	-1.47	-268.6	0.64	0.88703

The explanatory factors in the base model are: YEAR_CLASS GEAR_TYPE NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	166	216.5	1.3040		-269.0		
YEAR_CLASS*GEAR_TYPE	163	215.0	1.3192	-1.16	-268.4	1.19	0.75629
NUM_GEAR*GEAR_TYPE	165	216.2	1.3103	-0.48	-268.9	0.22	0.63669
YEAR_CLASS*NUM_GEAR	159	202.1	1.2708	2.55	-262.9	12.19	0.09436

Table 6 The nominal CPUE, relative nominal CPUE, proportion positive trips, relative abundance index, confidence intervals and coefficients of variance associated with the relative abundance index for silk snapper, 1984-1997. (***Species Assemblage Method***).

YEAR	Nominal CPUE	Rel Nominal CPUE	Prop. Pos Trips	Positive Trips	Relative Index	Lower 95% CI	Upper 95% CI	CV Index
1984-1985	18.04	1.41	0.67	18	1.93	1.04	3.57	0.32
1986	18.46	1.44	0.68	13	2.14	1.03	4.46	0.38
1987	7.71	0.60	0.31	17	0.39	0.20	0.78	0.36
1988	12.02	0.94	0.58	53	0.86	0.56	1.32	0.22
1989	7.17	0.56	0.53	29	0.41	0.23	0.72	0.29
1990	22.14	1.73	0.61	14	1.36	0.63	2.91	0.40
1991	13.96	1.09	0.61	14	0.97	0.46	2.06	0.39
1992-1994	8.62	0.67	0.70	7	0.39	0.15	1.00	0.50
1995-1997	7.13	0.56	0.63	12	0.55	0.26	1.17	0.40

Table 7. A summary of formulation of the binomial model (***Deep Trips Method***). Factors were added to the model if PROBCHISQ < 0.05 and %REDUCTION in DEV/DF ≥ 1.0% (bold font). The final model was SUCCESS = YEAR_CLASS + NUM_GEAR.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	379	505.3	1.3332		-252.6		
GEAR_TYPE	378	504.8	1.3355	-0.18	-252.4	0.44	0.50727
NUM_GEAR	378	503.1	1.3309	0.17	-251.5	2.21	0.13732
SEASON	376	500.1	1.3300	0.24	-250.0	5.20	0.15776
YEAR_CLASS	**372**	**484.6**	**1.3028**	**2.28**	**-242.3**	**20.63**	**0.00436**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	372	484.6	1.3028		-242.3		
SEASON	369	481.9	1.3061	-0.25	-241.0	2.70	0.44075
GEAR_TYPE	371	482.2	1.2997	0.24	-241.1	2.45	0.11785
NUM_GEAR	**371**	**478.5**	**1.2897**	**1.00**	**-239.2**	**6.15**	**0.01315**

The explanatory factors in the base model are: YEAR_CLASS NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	371	478.5	1.2897		-239.2		
SEASON	368	474.7	1.2898	-0.01	-237.3	3.83	0.27988
GEAR_TYPE	370	476.7	1.2884	0.11	-238.4	1.79	0.18074

The explanatory factors in the base model are: YEAR_CLASS NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	371	478.5	1.2897		-239.2		
YEAR_CLASS*NUM_GEAR	365	472.8	1.2953	-0.43	-236.4	5.70	0.45721

Table 8. A summary of formulation of the lognormal model (***Deep Trips Method***). Factors were added to the model if PROBCHISQ < 0.05 and %REDUCTION in DEV/DF ≥ 1.0% (bold font). The final model was LN(CPUE) = YEAR_CLASS.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	144	203.9	1.4160		-230.5		
GEAR_TYPE	143	203.2	1.4210	-0.35	-230.2	0.50	0.47830
SEASON	141	199.2	1.4125	0.25	-228.8	3.42	0.33140
NUM_GEAR	143	200.2	1.3999	1.14	-229.1	2.68	0.10186
YEAR_CLASS	**137**	**179.2**	**1.3078**	**7.64**	**-221.1**	**18.75**	**0.00900**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	137	179.2	1.3078		-221.1		
SEASON	134	176.8	1.3195	-0.89	-220.1	1.92	0.58820
NUM_GEAR	136	178.2	1.3106	-0.21	-220.7	0.76	0.38473
GEAR_TYPE	136	176.6	1.2983	0.72	-220.0	2.12	0.14570

Table 9 The nominal CPUE, relative nominal CPUE, proportion positive trips, relative abundance index, confidence intervals and coefficients of variance associated with the relative abundance index for silk snapper, 1984-1997 (***Deep Trips Method***).

YEAR	Nominal CPUE	Rel Nominal CPUE	Prop. Pos Trips	Positive Trips	Relative Index	Lower 95% CI	Upper 95% CI	CV Index
1984-1985	7.69	0.77	0.71	10	1.43	0.68	2.98	0.38
1986-1987	8.79	0.88	0.24	17	0.56	0.27	1.12	0.36
1988	11.65	1.17	0.37	51	1.03	0.66	1.61	0.22
1989	7.01	0.70	0.46	27	0.69	0.39	1.22	0.29
1990	22.13	2.22	0.43	12	1.97	0.88	4.40	0.42
1991	13.46	1.35	0.27	12	0.89	0.39	2.03	0.43
1992-1994	2.83	0.28	0.56	5	0.45	0.15	1.34	0.59
1995-1997	6.34	0.63	0.58	11	0.99	0.47	2.11	0.39

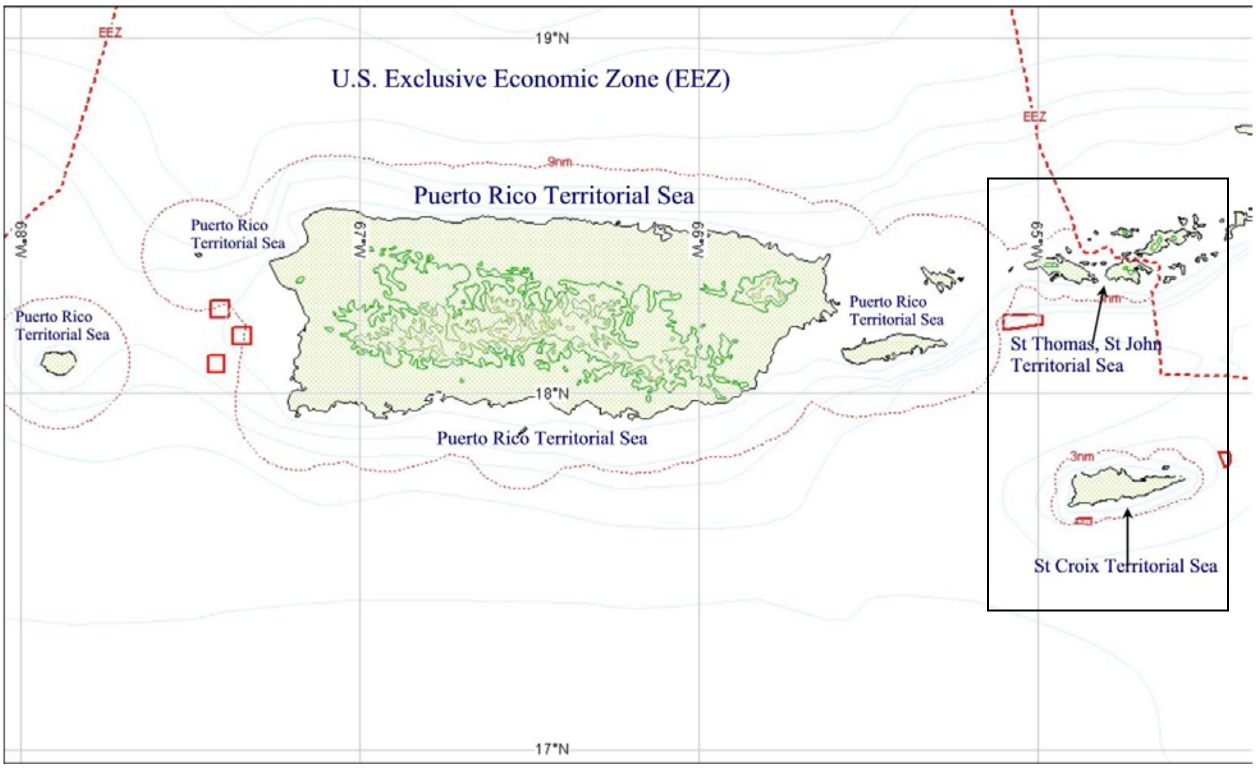

Figure 1. Trips interviewed by the U.S. Virgin Islands Trip Interview Programs, typically fish close to St. Croix, although small portion of trips occur off St. Thomas and St. John (inset box). Trips that fish near Puerto Rico are also interviewed, but these interviews are collected and maintained by a separate TIP program.

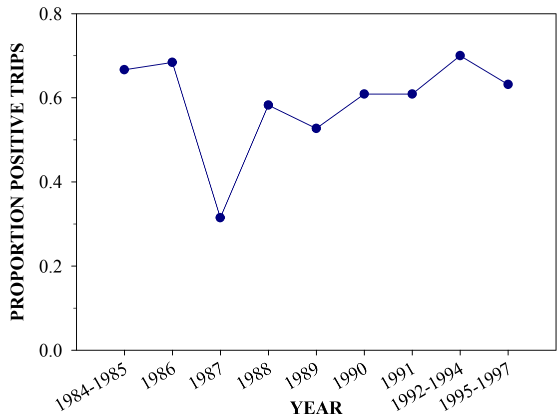

Figure 2. The proportion of positive trips (trips that kept or released a silk snapper), by year. ***Species Assemblage Method.***

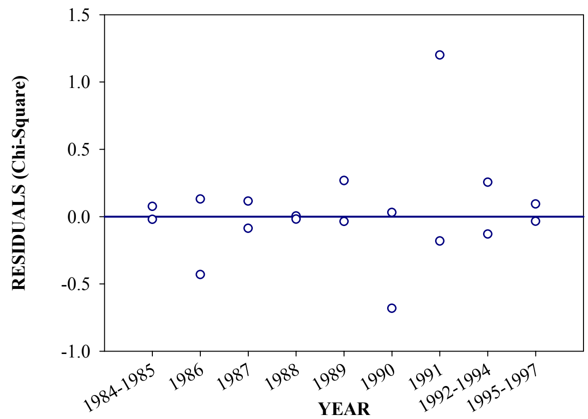

Figure 3. Chi-square residuals for binomial model on proportion positive trips. ***Species Assemblage Method***.

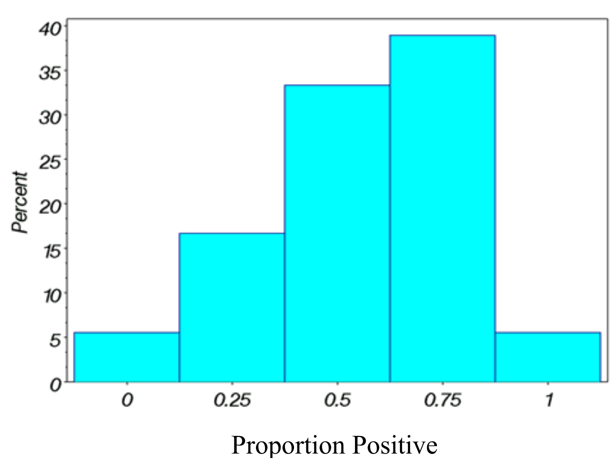

Figure 4. Frequency distribution of proportion positive trips by Num_Gear and Year_Class. ***Species Assemblage Method***.

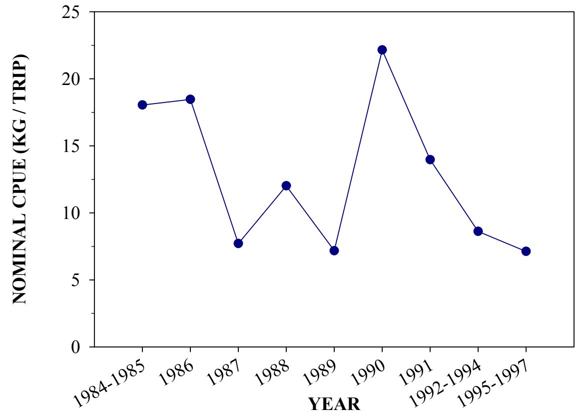

Figure 5. Annual variations in nominal CPUE on positive trips. ***Species Assemblage Method***.

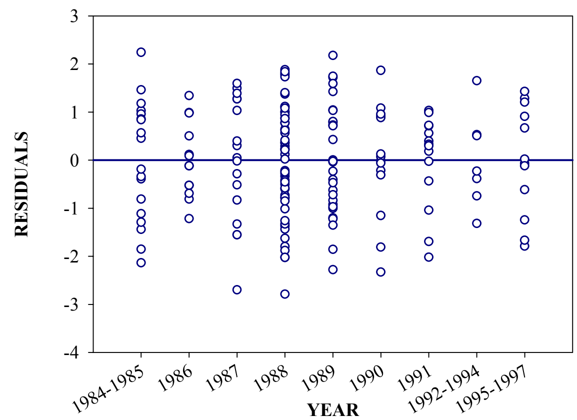

Figure 6. Residuals for the lognormal model on positive catch rates. ***Species Assemblage Method.***

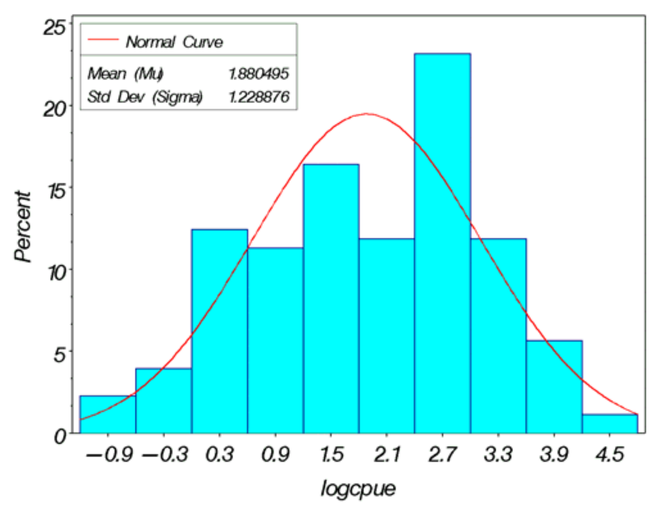

Figure 7. Frequency distribution of ln(CPUE) by Year_Class, Gear_Type and Num_Gear. The solid line is the expected normal distribution. ***Species Assemblage Method.***

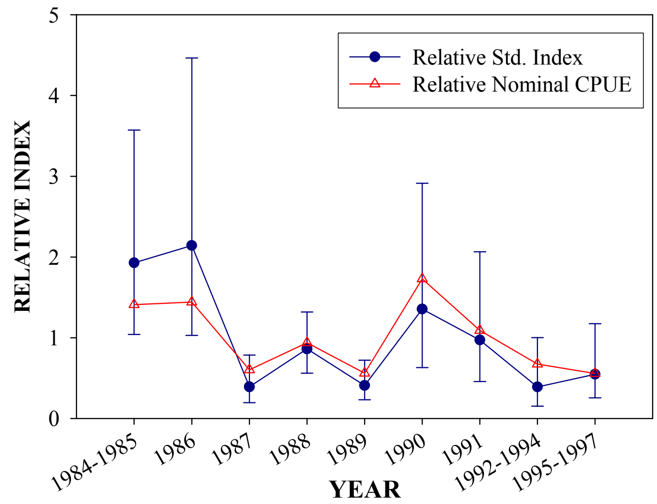

Figure 8. Relative Nominal CPUE (open red triangle), relative standardized CPUE index (solid blue circle) and upper and lower 95% confidence limits of the index. ***Species Assemblage Method.***

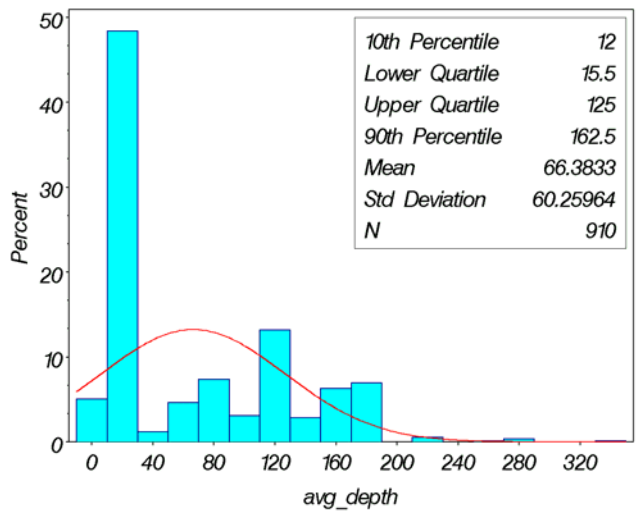

Figure 9. The average depth of fishing for all hook and line trips that landed catch in St. Croix.

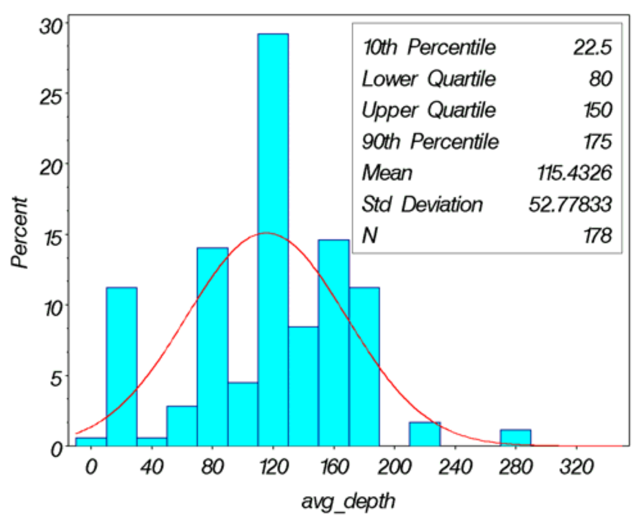

Figure 10. The average depth of fishing for all hook and line trips that landed ***silk snapper*** in St. Croix.

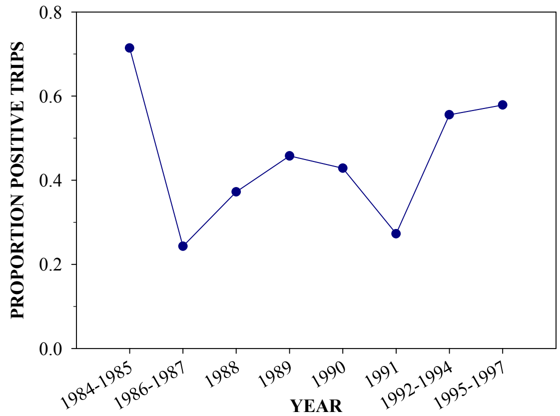

Figure 11. The proportion of positive trips (trips that kept or released a silk snapper), by year. ***Deep Trips Method.***

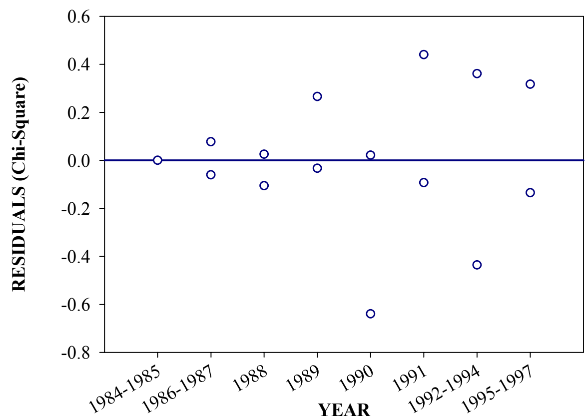

Figure 12. Chi-square residuals for binomial model on proportion positive trips. ***Deep Trips Method***.

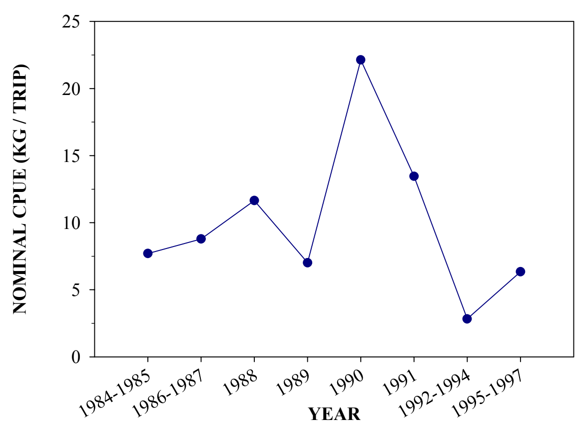

Figure 13 Annual variations in nominal CPUE on positive trips. ***Deep Trips Method***.

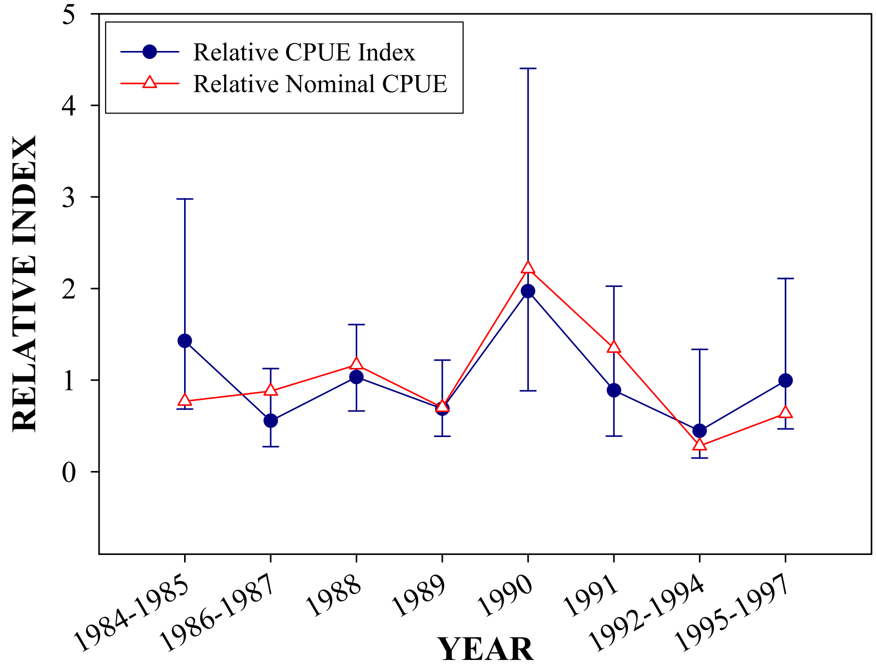

Figure 14. Relative Nominal CPUE (open red triangle), relative standardized CPUE index (solid blue circle) and upper and lower 95% confidence limits of the index. ***Deep Trips Method.***