STANDARDIZED CATCH RATES OF QUEEN SNAPPER, *ETELIS OCULATUS*, 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 queen snapper, *Etelis oculatus*. 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. There is some indication that queen snapper populations are lower in recent years, although this result is based on very small, and likely inadequate sample sizes.

INTRODUCTION

Queen 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. Queen 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 queen snapper is summarized by Cummings (2003:SEDAR4-DW-07).

Like silk snapper, queen 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-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 (234 of 318 trips). All methods were identical to those described in Cass-Calay and Valle-Esquivel 2003 (SEDAR4-DW-10).

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 1. Note that the number of interviewed trips declined substantially after 1991. Of the 5,807 interviewed trips, 318 landed queen snapper. The number of interviewed trips that captured queen snapper by island, year and gear is summarized in Table 2.

Species Assemblage Method

The Caribbean deep-water snapper/grouper species assemblage was defined by Zweifel and Cummings (in prep), and is summarized in Table 3. 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, 202 caught queen snapper.

The stepwise construction of the binomial model of the probability of success (catching queen snapper) is summarized in Table 4. The final model was ***SUCCESS = YEAR_CLASS + NUM_GEAR.*** Annual variations in the proportion of positive trips are shown in Figure 2. During 1984-86, the proportion positive was less than 0.4. Since that time, it has declined from a high of 0.8 in 1987 to ~0.6 in the most recent time period. 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 Year_Class and Num-Gear 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. 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, ~85% of queen snapper were captured deeper than 50 meters (Fig. 10). It is reasonable, therefore, to conclude that shallow trips are unlikely to capture queen 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, 180 caught queen snapper.

The stepwise construction of the binomial model of the probability of success (catching queen snapper) is summarized in Table 7. The final model was ***SUCCESS = YEAR_CLASS + NUM_GEAR + SEASON.*** Note that although the interaction term YEAR_CLASS * SEASON was significant, and reduced the deviance per degree of freedom by 6%, the model containing this interaction term did not converge. Therefore, the term was not included.

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) = NUM_GEAR + YEAR_CLASS GEAR_TYPE.*** It is important to note that the factor YEAR_CLASS did not meet the criteria for inclusion, but is necessary to create an annual CPUE series. Nominal CPUE fluctuates without annual trend (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 roughly similar to the nominal CPUE series, but the standardized index declines from a maximum value in 1986-87, to very low values in recent years.

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, many year classes contained <14 positive trips, and one year class contained only three 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 <13 positive trips, and one contained only two (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 change in the sample size, particularly in recent years, could greatly influence the results. In fact, we expect that this is the cause of the difference between the results of the ***Species Assemblage*** and ***Deep Trips*** methods. 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. 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 2. A summary of the interviewed trips that landed queen 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	2002	1	0	0	0	0	1
St. Croix	1983	0	2	0	5	11	18
	1984	0	1	0	0	11	12
	1985	0	10	0	6	2	18
	1986	0	4	0	0	1	5
	1987	0	46	0	1	0	47
	1988	0	68	0	0	0	68
	1989	0	40	0	0	3	43
	1990	0	25	0	1	0	26
	1991	1	20	0	0	0	21
	1992	1	1	0	0	0	2
	1993	8	5	0	1	0	14
	1994	7	0	4	0	2	13
	1995	0	7	2	0	0	9
	1996	1	3	0	0	0	4
	1997	0	2	0	0	0	2
	2001	0	0	0	1	0	1
	2002	0	0	0	0	1	1
St. Thomas	1985	0	0	11	2	0	13
Grand Total		**19**	**234**	**17**	**17**	**31**	**318**

Table 3. 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 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 = YEAR_CLASS + NUM_GEAR.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	320	423.3	1.3228		-211.6		
GEAR_TYPE	319	420.9	1.3194	0.26	-210.4	2.41	0.12072
SEASON	317	418.2	1.3192	0.27	-209.1	5.11	0.16365
NUM_GEAR	319	409.8	1.2846	2.89	-204.9	13.51	0.00024
YEAR_CLASS	**312**	**380.1**	**1.2181**	**7.91**	**-190.0**	**43.23**	**0.00000**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	312	380.1	1.2181		-190.0		
SEASON	309	375.6	1.2157	0.20	-187.8	4.42	0.21921
GEAR_TYPE	311	373.7	1.2016	1.36	-186.8	6.37	0.01160
NUM_GEAR	**311**	**354.1**	**1.1386**	**6.53**	**-177.1**	**25.95**	**0.00000**

The explanatory factors in the base model are: YEAR_CLASS NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	311	354.1	1.1386		-177.1		
GEAR_TYPE	310	350.7	1.1313	0.64	-175.4	3.41	0.06480
SEASON	308	347.8	1.1292	0.83	-173.9	6.31	0.09740

The explanatory factors in the base model are: YEAR_CLASS NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	311	354.1	1.1386		-177.1		
YEAR_CLASS*NUM_GEAR	303	346.4	1.1433	-0.41	-173.2	.	.

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	200	353.2	1.7658		-341.8		
SEASON	197	349.6	1.7748	-0.51	-340.8	2.01	0.56972
GEAR_TYPE	199	338.4	1.7007	3.69	-337.6	8.56	0.00344
NUM_GEAR	199	336.5	1.6911	4.23	-337.0	9.69	0.00185
YEAR_CLASS	**192**	**321.4**	**1.6739**	**5.20**	**-332.4**	**18.94**	**0.01518**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	192	321.4	1.6739		-332.4		
SEASON	189	314.8	1.6657	0.49	-330.3	4.16	0.24477
NUM_GEAR	191	308.1	1.6131	3.63	-328.1	8.49	0.00357
GEAR_TYPE	**191**	**307.5**	**1.6101**	**3.81**	**-327.9**	**8.86**	**0.00291**

The explanatory factors in the base model are: YEAR_CLASS GEAR_TYPE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	191	307.5	1.6101		-327.9		
SEASON	188	303.4	1.6136	-0.22	-326.6	2.75	0.43181
NUM_GEAR	**190**	**295.3**	**1.5544**	**3.46**	**-323.9**	**8.14**	**0.00434**

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	190	295.3	1.5544		-323.9		
SEASON	187	290.1	1.5516	0.18	-322.1	3.56	0.31305

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	190	295.3	1.5544		-323.9		
YEAR_CLASS*NUM_GEAR	183	288.6	1.5771	-1.46	-321.6	4.63	0.70469
NUM_GEAR*GEAR_TYPE	189	295.3	1.5626	-0.53	-323.9	0.00	0.99991
YEAR_CLASS*GEAR_TYPE	187	290.2	1.5521	0.15	-322.1	3.50	0.32128

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 queen 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
1984-85	6.37	0.52	0.33	9	0.17	0.06	0.50	0.57
1986	3.38	0.28	0.16	3	0.08	0.02	0.38	0.92
1987	19.08	1.56	0.80	43	1.95	1.25	3.04	0.22
1988	9.24	0.76	0.74	67	1.21	0.84	1.73	0.18
1989	9.71	0.79	0.69	38	1.44	0.92	2.25	0.23
1990	10.61	0.87	0.61	14	1.29	0.65	2.53	0.35
1991	27.16	2.22	0.48	11	2.15	0.99	4.67	0.40
1992-94	12.29	1.01	0.50	5	0.43	0.12	1.51	0.70
1995-97	12.12	0.99	0.63	12	0.28	0.10	0.79	0.55

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 + SEASON.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	379	525.7	1.3872		-262.9		
GEAR_TYPE	378	525.6	1.3905	-0.24	-262.8	0.12	0.72672
SEASON	376	515.1	1.3698	1.25	-257.5	10.68	0.01359
NUM_GEAR	378	508.3	1.3447	3.06	-254.1	17.45	0.00003
YEAR_CLASS	**372**	**491.8**	**1.3221**	**4.69**	**-245.9**	**33.93**	**0.00002**

The explanatory factors in the base model are: YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	372	491.8	1.3221		-245.9		
GEAR_TYPE	371	489.2	1.3187	0.25	-244.6	2.56	0.10929
SEASON	369	476.1	1.2902	2.41	-238.0	15.73	0.00129
NUM_GEAR	**371**	**477.3**	**1.2866**	**2.68**	**-238.7**	**14.47**	**0.00014**

The explanatory factors in the base model are: YEAR_CLASS NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	371	477.3	1.2866		-238.7		
GEAR_TYPE	370	475.8	1.2860	0.04	-237.9	1.50	0.22133
SEASON	**368**	**461.1**	**1.2529**	**2.62**	**-230.5**	**16.27**	**0.00100**

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	368	461.1	1.2529		-230.5		
GEAR_TYPE	367	459.4	1.2518	0.09	-229.7	1.65	0.19854

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	368	461.1	1.2529		-230.5		
SEASON*NUM_GEAR	365	459.6	1.2592	-0.50	-229.8	.	.
YEAR_CLASS*NUM_GEAR	362	452.1	1.2489	0.32	-226.0	8.97	0.17553
YEAR_CLASS*SEASON	**348**	**409.5**	**1.1769**	**6.07**	**-204.8**	**Did Not Converge**	

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) = NUM_GEAR + YEAR_CLASS + GEAR_TYPE.

There are no explanatory factors in the base model.

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	178	320.9	1.8031		-306.2		
SEASON	175	317.5	1.8141	-0.61	-305.3	1.95	0.58294
YEAR_CLASS	171	305.4	1.7860	0.94	-301.8	8.88	0.26132
GEAR_TYPE	177	312.0	1.7629	2.23	-303.7	5.04	0.02480
NUM_GEAR	**177**	**295.3**	**1.6684**	**7.47**	**-298.8**	**14.90**	**0.00011**

The explanatory factors in the base model are: NUM_GEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	177	295.3	1.6684		-298.8		
YEAR_CLASS	**170**	**287.5**	**1.6910**	**-1.35**	**-296.4**	**4.82**	**0.68241**
SEASON	174	290.1	1.6673	0.07	-297.2	3.18	0.36439
GEAR_TYPE	176	291.7	1.6574	0.66	-297.7	2.20	0.13810

The explanatory factors in the base model are: NUM_GEAR YEAR_CLASS

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	170	287.5	1.6910		-296.4		
SEASON	167	281.0	1.6824	0.51	-294.3	4.11	0.25033
GEAR_TYPE	**169**	**279.6**	**1.6545**	**2.16**	**-293.9**	**4.96**	**0.02591**

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	169	279.6	1.6545		-293.9		
SEASON	166	274.5	1.6539	0.04	-292.3	3.28	0.35062

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

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	169	279.6	1.6545		-293.9		
YEAR_CLASS*NUM_GEAR	164	277.8	1.6940	-2.39	-293.3	1.15	0.94922
YEAR_CLASS*GEAR_TYPE	168	279.6	1.6641	-0.58	-293.9	0.03	0.86040
NUM_GEAR*GEAR_TYPE	168	278.5	1.6578	-0.20	-293.6	0.71	0.40103

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 queen 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
1984-85	7.013875	0.636109	0.571429	8	0.597364	0.185064	1.928222	0.639987
1986-87	18.51167	1.678879	0.628571	44	2.292351	1.395829	3.764697	0.251909
1988	9.435769	0.855758	0.474453	65	1.242568	0.793739	1.945192	0.226933
1989	10.25484	0.930042	0.525424	31	1.678784	0.941439	2.993625	0.295362
1990	8.492308	0.770193	0.464286	13	1.449218	0.627665	3.346106	0.437381
1991	18.79484	1.704561	0.136364	6	0.303903	0.076397	1.208905	0.781428
1992-94	3.375	0.306089	0.222222	2	0.068674	0.006961	0.677553	1.645052
1995-97	12.33136	1.118369	0.578947	11	0.367138	0.107255	1.256724	0.678353

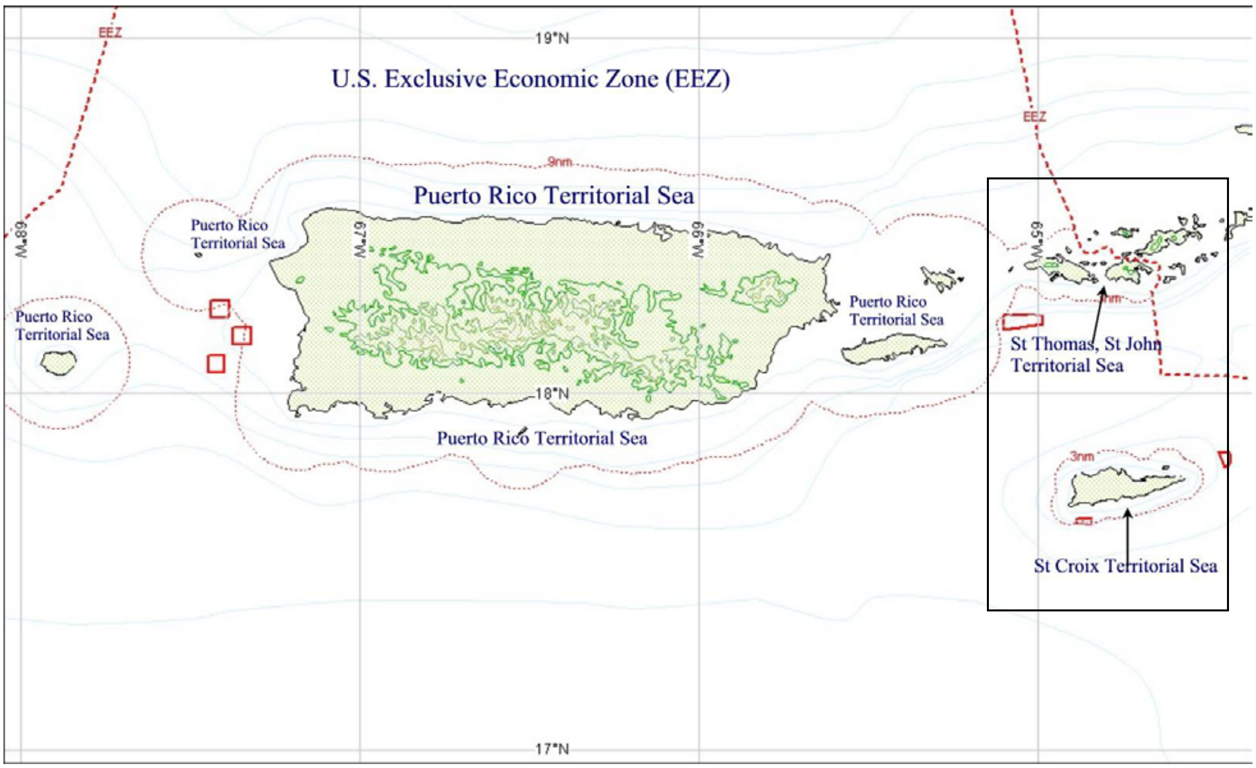

Figure 1. Trips interviewed by the U.S. Virgin Islands Trip Interview Programs, typically fish close to St. Croix, although small portion of trips occur off St. Thomas and St. John (inset box). Trips that fish near Puerto Rico are also interviewed, but these interviews are collected and maintained by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

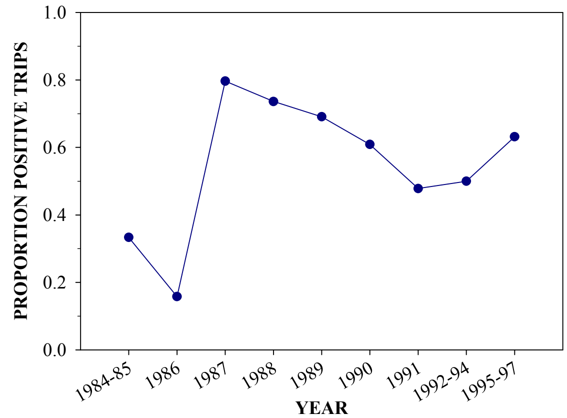

Figure 2. The proportion of positive trips (trips that kept or released a queen snapper), by year. ***Species Assemblage Method.***

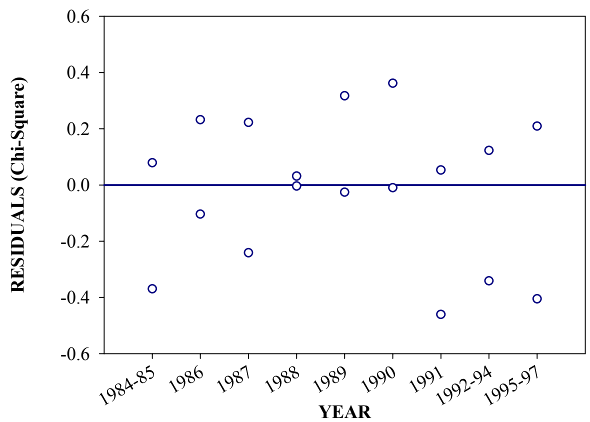

Figure 3. Chi-square residuals for binomial model on proportion positive trips. ***Species Assemblage Method***.

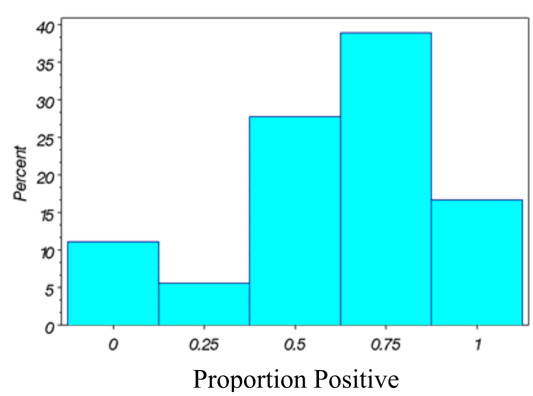

Figure 4. Frequency distribution of proportion positive trips by Year_Class and Num_Gear. ***Species Assemblage Method***.

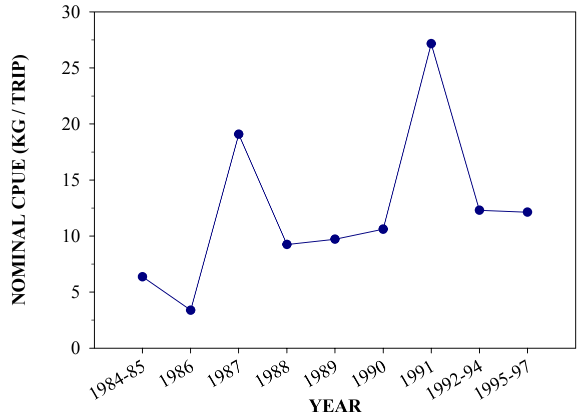

Figure 5. Annual variations in nominal CPUE on positive trips. ***Species Assemblage Method***.

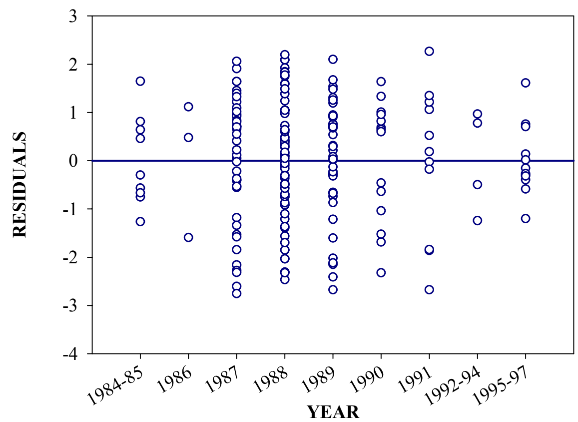

Figure 6. Residuals for the lognormal model on positive catch rates. ***Species Assemblage Method.***

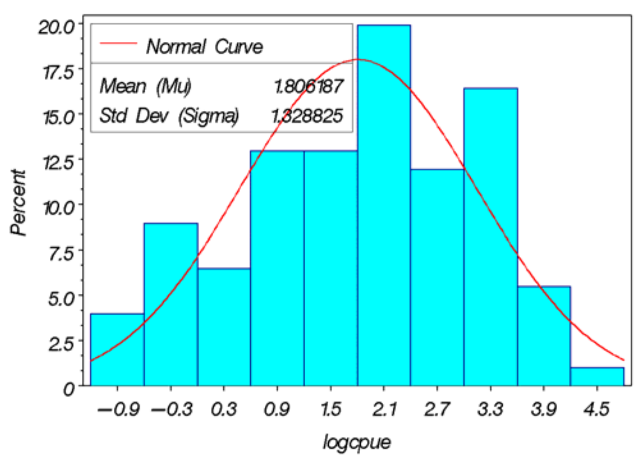

Figure 7. Frequency distribution of ln(CPUE) by Year_Class, Gear_Type and Num_Gear. The solid line is the expected normal distribution. ***Species Assemblage Method.***

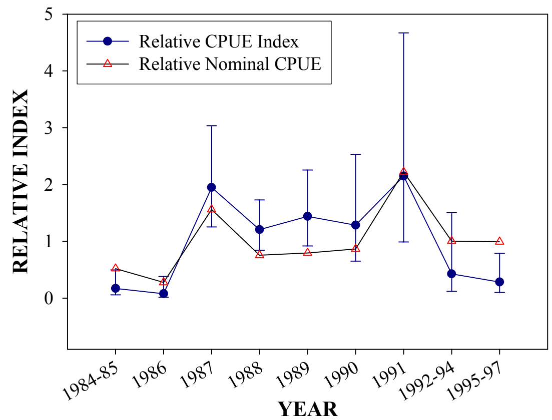

Figure 8. Relative nominal CPUE (open red triangle), relative standardized CPUE index (solid blue circle) and upper and lower 95% confidence limits of the index. ***Species Assemblage Method.***

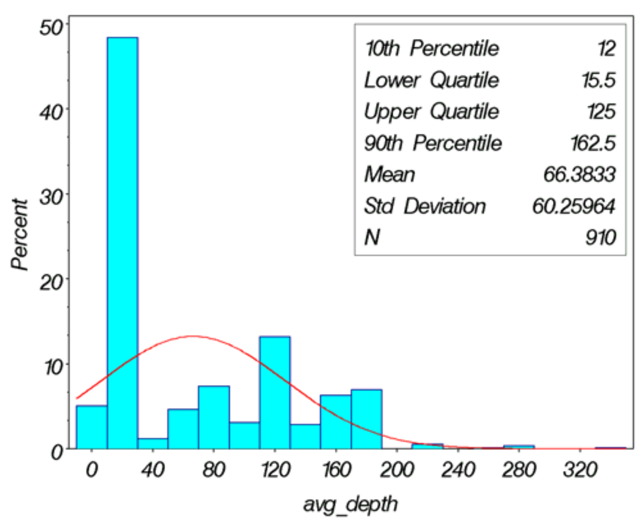

Figure 9. The average depth of fishing for all hook and line trips that landed catch in St. Croix.

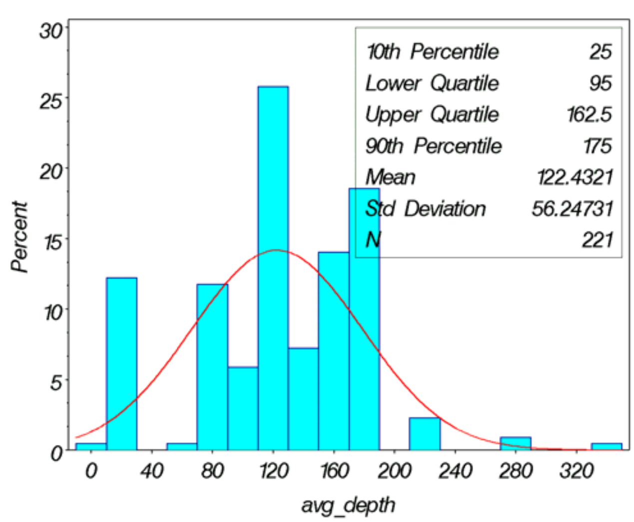

Figure 10. The average depth of fishing for all hook and line trips that landed ***queen snapper*** in St. Croix.

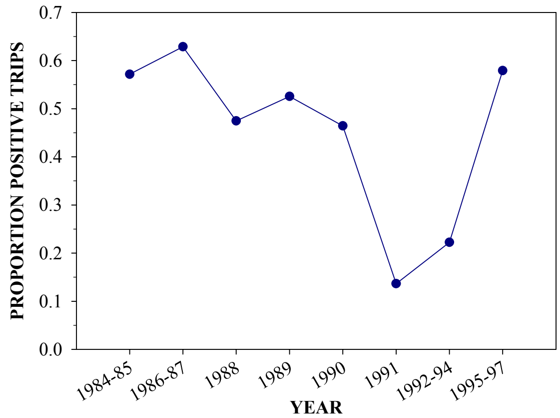

Figure 11. The proportion of positive trips (trips that kept or released a queen snapper), by year. ***Deep Trips Method.***

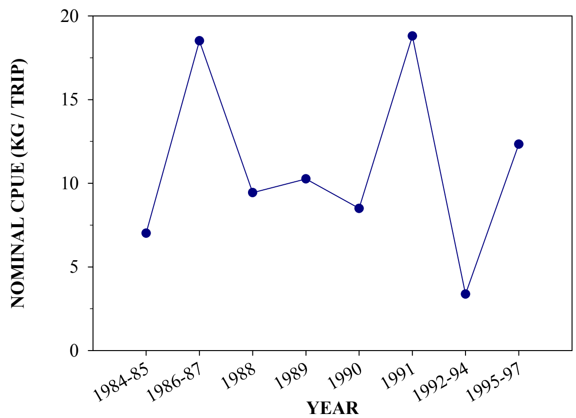

Figure 12. Chi-square residuals for binomial model on proportion positive trips. ***Deep Trips Method***.

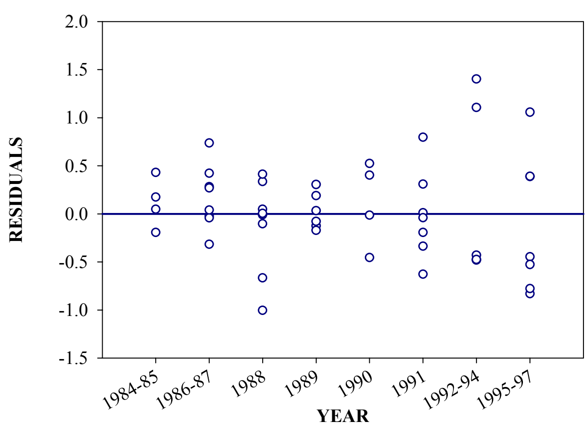

Figure 13 Annual variations in nominal CPUE on positive trips. ***Deep Trips Method***.

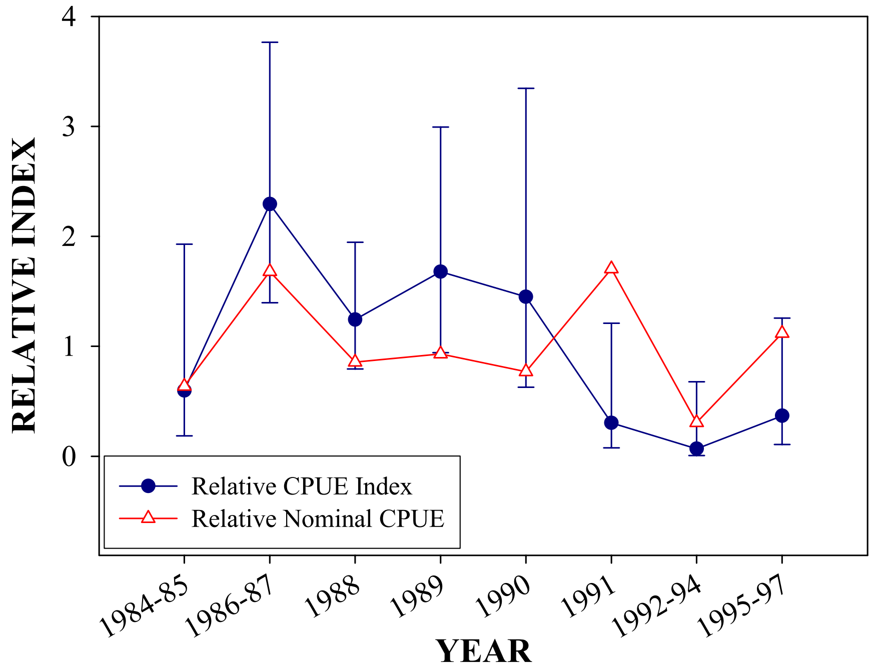

Figure 14. Relative Nominal CPUE (open red triangle), relative standardized CPUE index (solid blue circle) and upper and lower 95% confidence limits of the index. ***Deep Trips Method.***