

SEDAR8-AW-3**Standardized Catch Rates of Spiny Lobster (*Panulirus argus*) estimated from the U.S. Virgin Islands Commercial Landings (1974-2003)**

by

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March 2005

ABSTRACT

The commercial landing statistics from the United States Virgin Islands (1974-2003) were used to construct standardized indices of abundance for spiny lobster, *Panulirus argus*. A Generalized Linear Model Approach (GLM) was used to standardize the catch rates from the positive lobster trips. The three islands that comprise the U.S. Virgin Islands lay on different geological platforms and the lobster fisheries operate differently. Analyses were made for the entire fishery and by island complex for the two main gears used to harvest lobster: dive and fish traps. No obvious trends in relative abundance were identified for the trap fishery of St. Thomas/St. John during the first period, but a slight decline was observed toward the later years. The dive fishery of St. Croix showed a clear signal, suggesting that relative abundance has decreased over the period studied.

INTRODUCTION

The commercial landings information described in Valle and Diaz (2004) was used as a basis for estimation of lobster relative indices of abundance. The 3 master files described there (Old Format 1974-1986, Old Format 1986-1999 and New Format 1995-2003), with different formats, were combined into a single data base by separating lobster from rest of the catch. To the extent possible, lobster catch was also separated by gear. Two main gears to harvest lobster are present across the time series (1974-2003): DIVING (“Divelobster”, scuba, hand, free diving) and TRAPS (“Potlobster”, pots, lobster pots, traps). In some years the lobster landings are unclassified and no gear is reported, in the later years, a few lobster landings are reported with other gear (nets, lines, etc.).

The present analyses used the expanded landings reported in Valle and Diaz (2004). All estimates are preliminary and should be updated with better documented expansion factors (i.e., Holt and Uwate, 2004) and complete and re-edited landings, particularly for years 1986-87 to 1992-93. Lobster trips and landings were classified by district (i.e., island complex), gear, and ‘target’. Lobster was assumed to be the target species if it represented more than 50% of the total trip landings. A summary of the number of lobster records (trips) is presented in Tables 1-5 and Figures 1. Tables of preliminary expanded landings are given in Tables 7-10 and Figures 2-4. Note that lobster landings were filtered to upper 97.5% quantile (records with lobster catch > 250 lb/trip were removed).

These summaries indicate that both island platforms have an approximately equal contribution to the total lobster landings from the U.S. Virgin Islands (48% STT/STJ and 52% STX). However, the primary gear used to harvest lobster varies significantly among islands, with STT/STJ using mainly traps (80% of the trips) and STX mainly diving gear (80% of the trips).

METHODS

A Generalized Linear Model Approach (GLM) was used to estimate relative indices of abundance. This model uses only the positive CPUE observations of the target species to standardize the catch rates. The estimated CPUE is assumed to follow a lognormal error distribution of a linear function of fixed factors and fixed and random interactions.

A step-wise regression procedure was used to determine the set of factors and interactions that significantly explained the observed variability. Factors were added sequentially to the model based on the percentage reduction in deviance ($\geq 1.0\%$), using a χ^2 (Chi-square) statistic (McCullagh and Nelder, 1989). Deviance analysis tables for catch rates in pounds are presented only for the first index developed (entire U.S. Virgin Islands) to illustrate the process. Once a set of fixed factors was selected, possible interactions were evaluated, in particular interactions between the *year* effect and other factors. Selection of interactions followed the same criteria.

INDICES OF ABUNDANCE

Generalized linear models (GLM) Models were applied to estimate relative indices of abundance for spiny lobster from the commercial landings. Only positive trips were analyzed because the configuration of this database does not allow the estimation of effective effort from the identification of zero trips. Landings for other gear groups, species groups or species have been reported differently over the years, so no attempts were made to construct indices of species association or to otherwise select trips associated to lobster. Then, only trips that caught lobster in any amount were used for CPUE estimation. Years 1974, 1986-1992 and 2003 were excluded from analysis given that they are incomplete, missing, or currently undergoing review.

Based on the landings, trips and gear information presented above, on the fact that the data collection and reporting system has differed substantially between platforms, and

that there are marked differences in the fishing operations due to geomorphology, six relative indices of abundance were estimated:

- 1) U.S. Virgin Islands: all islands and gears (diving and traps) combined.
- 2) USVI- TRAPS, all islands.
- 3) St. Thomas/St. John, TRAPS
- 4) USVI- DIVE gear, all islands.
- 5) St. Croix- DIVE gear
- 6) St. Thomas/St. John- DIVE gear.

1) U.S. Virgin Islands – All Islands (DIVE+TRAP Index)

Examination of the entire U.S. Virgin Islands lobster landings showed the following trends(see diagnostic plots, Figure 5) :

- a) Lobster landings have showed a marked increase over time.
- b) There is no seasonality in the lobster fishery.
- c) Both island platforms contribute equally to the lobster landings.
- d) Approximately 60% of the positive lobster trips target this species (Target=lobster if more than 50% of the trip catch is lobster).
- e) Diving and Traps represent 53% and 47% of the lobster effort, respectively, when other (minor) gears are excluded from analysis.

The following restrictions were imposed on the data for CPUE analysis:

1. Years with incomplete or missing information were removed. The analysis was constrained to two periods, before 1987 (years 1976-1986) and after 1992(1993-2002).
2. Filtered lobster landings to >1 and < 250 lbs per trip.
3. Kept only TRAP and DIVE trips.
4. Explanatory variables considered for GLM model: year, season, district, gear, and target. The deviance analysis (stepwise selection of factors) is provided in Table 11. Interactions with year are considered random interactions.
5. The final model was:

$$\text{LNCPUE} = \text{YEAR} + \text{DISTRICT} + \text{TARGET} + \text{YEAR} * \text{DISTRICT} + \text{YEAR} * \text{TARGET}$$

The GLM model results are illustrated in Figures 6 and 7 and the standardized CPUE index is provided in Table 12.

2) U.S. Virgin Islands – All Islands (TRAP Index)

The same process applied above was used, except that in this case only the trips that harvested lobster with TRAPS were used for analysis. Although trap trips in STX only represented 7.5% of the (trap) trips, they were considered in the analysis; then the TRAP index was formulated for all islands combined.

The explanatory variables considered for the GLM model were: year, season, district, and target. A table with the selection of factors is not included, but the final model was:

$$\text{LNCPUE} = \text{YEAR} + \text{DISTRICT} + \text{TARGET} + \text{YEAR} * \text{DISTRICT} + \text{YEAR} * \text{TARGET}$$

USVI-Trap index estimates are provided in Table 13 and illustrated in Figure 8.

3) St. Thomas/St. John –TRAP Index

A similar index was calculated only for the STT/STJ trap fishery, given that in this district it represents an 80% of the lobster effort and that the data appear more consistent over the time series than the data from St. Croix ((see Figures 1, 3, and 4)).

The explanatory variables considered for the GLM model formulation were: year, season, and target. The final model was:

$$\text{LNCPUE} = \text{YEAR} + \text{TARGET} + \text{YEAR} * \text{TARGET}$$

GLM model estimates are provided in Table 14 and illustrated in Figure 9.

A comparison of the TRAP indices between the whole U.S.V.I. and STT/STJ (Figure 10) indicates that catch rates are greater when STT/STJ is isolated from STX. Apparently, the STX component depresses the index values and creates larger fluctuations over time. It is recommended to use the STT/STJ index, as it is more representative of the trap fishery.

4) U.S.Virgin Islands – DIVE Index

Only the trips that harvested lobster with DIVE gear were used for analysis. Although St. Croix represents an 85% of the DIVE fishery, this index was formulated for all the islands combined. Even when low, dive landings in STT/STJ have been fairly consistent over the time series, whereas the data for STX is mainly constrained to years 1992-2003 (see Figures 1, 3, and 4).

The explanatory variables considered for the GLM model were: year, season, district, and target. A table with the selection of factors is not included, but the final model was:

$$\text{LNCPUE} = \text{YEAR} + \text{TARGET} + \text{YEAR} * \text{TARGET}$$

Index statistics are given in Table 15 and illustrated in Figure 11.

5) St. Croix – DIVE Index

A relative index of abundance was estimated for the STX dive fishery, where this gear represents an 85% of the total DIVE fishery. The explanatory variables considered for the GLM model were: year, season, and target, but only the following were selected for the final model:

$$\text{LNCPUE} = \text{YEAR} + \text{TARGET} + \text{YEAR} * \text{TARGET}$$

Index estimates are provided in Table 16 and Figure 12.

6) St. Thomas/St. John – DIVE Index

A final index was estimated for the STT/STJ dive fishery, even when it only represents a 15% of this sector in the U.S.V.I. The same assumptions as above were considered, and the test for significant factors resulted in the same model. Estimates are given in Table 17 and Figure 13.

A comparison of the DIVE indices between districts (Figure 14) shows slightly larger values but a sharper decline for St. Croix during the first period (1976-1986). Differences are insignificant between 1993-2003. It is important to note that the STT/STJ fishery represents only a small proportion of the dive fishery (15%) but has been consistent over time, while in STX there was either underreporting during the first period or this sector developed rapidly after 1992 (see Figures 1, 3, and 4).

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Table 1. U.S. Virgin Islands. Number of lobster records (trips) by island complex (District) , years 1974-2003. Data for years 1974 includes only STT/STJ and only half of 2003 is represented.

DISTRICT	N	% of Total
STT/STJ	20851	49.2%
STX	21560	50.8%
Total	42411	

Table 2. U.S. Virgin Islands. Number of records (trips) by District and Gear (1974-2003).

DISTRICT			
STT/STJ	LOBGEAR	N	%
	DIVE	3662	17.0%
	OTHER	48	0.2%
	TRAPS	17141	79.5%
	ALL GEAR	20851	
STX			
	DIVE	17304	80.3%
	OTHER	1095	5.1%
	TRAPS	3161	14.7%
	ALL GEAR	21560	

Table 3. Target information for lobster landings by District. TARGET= Lobster if >50% of total trip catch is lobster. N= Number of records (trips).

District	Target	N	%
STT/STJ	0	12995	62.3%
	1	7856	37.7%
	Total STT/STJ	20851	
STX	0	11570	53.7%
	1	9990	46.3%
	Total STX	21560	

Table 4. Target information for lobster landings by District and Gear. TARGET= Lobster if >50% of total trip catch is lobster. N= Number of records (trips).

DISTRICT	LOBGEAR	N	Target=Spp		% Target by Gear
			N(0)	N(1)	
STT/STJ	DIVE	3662	1414	2248	61.4%
	OTHER	88	59	29	33.0%
	TRAPS	17101	11522	5579	32.6%
STX	DIVE	17304	8094	9210	53.2%
	OTHER	1113	1015	98	8.8%
	TRAPS	3143	2461	682	21.7%

Table 5. U.S. Virgin Islands. Number of lobster records (trips) by District, Gear, and Year (1974-2003). Note: Data for years 1974 includes only STT/STJ and only January-June of 2003 for both districts is represented.

DISTRICT= STT/STJ				DISTRICT= STX					
	DIVE	TRAPS	OTHER	ALL GEAR	YEAR	DIVE	TRAPS	OTHER	ALL GEAR
1974	20	65		85	1974				
1975	56	212		268	1975	4	147		150
1976	24	176		191	1976	8	142		148
1977	72	419		490	1977	60	92		152
1978	135	618		750	1978	108	49		157
1979	84	484		567	1979	16	71		87
1980	84	517		594	1980	35	30		65
1981	94	543		636	1981	49	42		91
1982	85	562		646	1982	48	77		125
1983	155	547		701	1983	41	204		245
1984	227	394		620	1984	198	147		345
1985	172	548		720	1985	133	61		193
1986	220	455		675	1986	43	22		65
1987	55	142		197	1987	37	15		50
1992	85	632		706	1992	235	110		345
1993	204	1025		1228	1993	793	356		1140
1994	182	891		1073	1994	707	176		882
1995	227	1183		1408	1995	743	195	1	938
1996	223	1423		1646	1996	886	153	63	1102
1997	195	1066	1	1261	1997	1032	183	142	1356
1998	107	907	11	1025	1998	1149	198	165	1512
1999	155	928	7	1090	1999	1307	239	74	1620
2000	179	868	7	1054	2000	2180	188	163	2531
2001	233	955	12	1200	2001	2938	108	162	3208
2002	295	1020	8	1323	2002	3092	112	224	3428
2003	134	561	2	697	2003	1480	44	101	1625

Table 6. U.S. Virgin Islands commercial landings. Spiny lobster trips and expanded landings (in pounds) by District, years 1974-2003. Note: Data is filtered to upper 97.5% quantile (records with lobster catch > 250 lb/trip were removed).

DISTRICT	N	% of Total
STT/STJ	20175	48.4%
STX	21507	51.6%
Total	41682	

Table 7. U.S. Virgin Islands. Spiny lobster trips and expanded landings (in pounds) by District and Gear, years 1974-2003. Note: data is filtered to upper 97.5% quantile (records with lobster catch > 250 lb/trip were removed).

DISTRICT				
STT/STJ	LOGGEAR	N Trips	LOB WT (lb)	% of Total
	DIVE	3643	173514	13.2%
	OTHER	71	2131	0.2%
	TRAPS	16461	1135864	86.6%
	ALL GEAR	20175	1311509	

STX				
	LOGGEAR	N Trips	LOB WT (lb)	% of Total
	DIVE	17289	609352	84.2%
	OTHER	1112	18498	2.6%
	TRAPS	3106	95715	13.2%
	ALL GEAR	21507	723565	

Table 8. Expanded Spiny lobster landings (LB) by year (1974-2003) for the whole U.S. Virgin Islands. NOTES: Data for year 1974 includes only STT/STJ and only January-June of 2003 for both districts. Lobster landings are filtered for outliers (to <250 lb/trip). Data from FY1986-87 to FY 1991-92 (highlighted) is incomplete, missing or contained only outliers and is currently under review.

Year	Lobster Trips	LOBSTER (LB)
1974	83	5,812
1975	408	23,123
1976	326	21,185
1977	604	46,582
1978	780	72,192
1979	615	49,734
1980	596	57,588
1981	645	59,555
1982	689	52,230
1983	863	49,147
1984	898	41,118
1985	871	46,963
1986	718	52,424
1987	231	17,446
1988		
1989		
1990		
1991		
1992	1051	48,060
1993	2353	124,283
1994	1950	97,489
1995	2346	116,986
1996	2725	145,008
1997	2617	118,576
1998	2537	101,868
1999	2710	105,332
2000	3585	136,473
2001	4408	169,799
2002	4751	184,640
2003	2322	91,462

Table 9. Expanded lobster landings (LB) by year (1974-2003) and gear for the whole U.S. Virgin Islands. NOTES: Data for year 1974 includes only STT/STJ and only January-June of 2003 for both districts. Lobster landings are filtered for outliers (to <250 lb/trip). Data from FY1986-87 to FY 1991-92 (highlighted) is incomplete, missing or contained only outliers and is currently under review.

YR	N Trips	DIVE	TRAPS	OTHER	TOTAL
1974	85	2724	3722		6531
1975	418	5233	27054		32704
1976	339	4145	23036		27520
1977	642	17672	54785		73099
1978	907	30293	123196		154396
1979	654	7824	62352		70830
1980	659	16211	81303		98173
1981	727	11575	79118		91420
1982	771	10802	76414		87987
1983	946	8104	74315		83365
1984	965	15987	53889		70841
1985	913	11981	53833		66727
1986	740	18919	42837		62496
1987	247	6193	18317		24757
1988					
1989					
1990					
1991					
1992	1051	9316	38744		49111
1993	2368	37294	91095		130757
1994	1955	29374	69411		100740
1995	2346	24072	92863	52	119280
1996	2748	30533	119744	702	153026
1997	2617	33651	83338	1588	119606
1998	2537	40196	59089	2584	101821
1999	2710	50724	53494	1114	106928
2000	3585	86407	47198	2867	137190
2001	4408	117959	48912	2928	171279
2002	4751	124221	56587	3832	185559
2003	2322	53820	35493	2150	91635

Table 10. U.S. Virgin Islands. Spiny lobster **expanded** landings (in pounds) by District, Gear, and Year (1974-2003). Notes: Data for years 1974 includes only STT/STJ and only January-June of 2003 for both districts is represented. Data is filtered to upper 97.5% quantile (records with lobster catch > 250 lb/trip were removed). Data from FY1986-87 to FY 1991-92 (highlighted) is incomplete, missing or contained only outliers, and is currently under review.

DISTRICT= STT/STJ					DISTRICT= STX						
	N Trips	DIVE	TRAPS	OTHER	ALL GEAR	YEAR	N Trips	DIVE	TRAPS	OTHER	ALL GEAR
1974	83	2442	3370		5812	1974					
1975	267	4434	11182		15617	1975	141	157	7349		7506
1976	186	1779	11890		13669	1976	140	753	6764		7517
1977	465	10493	25522		36015	1977	139	5847	4720		10567
1978	630	14850	45048		59898	1978	150	9768	2526		12294
1979	535	6716	38360		45076	1979	80	1107	3550		4658
1980	532	6256	47651		53907	1980	64	2404	1277		3681
1981	559	6719	47697		54416	1981	86	2828	2312		5140
1982	566	5681	38650		44331	1982	123	4223	3676		7899
1983	619	6060	36161		42221	1983	244	2043	4883		6926
1984	553	8251	23495		31746	1984	345	7395	1977		9372
1985	678	7266	34652		41918	1985	193	4166	879		5045
1986	653	16195	32659		48853	1986	65	2724	847		3571
1987	181	4075	10804		14879	1987	50	2118	449		2567
1988						1988					
1989						1989					
1990						1990					
1991						1991					
1992	706	1028	35667		36695	1992	345	8288	3076		11365
1993	1213	6720	76219		82939	1993	1140	30574	10770		41344
1994	1068	4837	61993		66830	1994	882	24536	6122		30658
1995	1408	7060	87678		94738	1995	938	17011	5185	52	22248
1996	1623	7650	110446		118096	1996	1102	22883	3327	702	26912
1997	1261	4607	79096	31	83734	1997	1356	29044	4242	1557	34842
1998	1025	3411	54911	166	58488	1998	1512	36785	4178	2418	43381
1999	1090	5512	47265	143	52921	1999	1620	45212	6229	970	52411
2000	1054	5964	43286	192	49442	2000	2531	80443	3912	2676	87031
2001	1200	8126	45866	142	54134	2001	3208	109833	3047	2786	115666
2002	1323	12734	52900	174	65809	2002	3428	111487	3686	3658	118831
2003	697	5372	33888	66	39327	2003	1625	48447	1605	2083	52136

Table 11. Deviance analysis of the GLM model for the U.S. Virgin Islands spiny lobster CPUE. Factors were added to the model if PROBCHISQ<0.05 and % REDUCTION in DEV/DF≥1.0%. The final model was LNCPUE= DISTRICT+ TARGET+ YEAR+ YEAR*DISTRICT+ YEAR*TARGET

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*****
There are no explanatory factors in the base model
FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
BASE     38736    27624    0.7131  -48416.8
SEASON   38733    27541.7  0.7111   0.29  -48358.9  115.67   0
LOBGEAR  38735    26616.8  0.6872   3.64  -47697.3  1438.85  0
YEAR     38715    25798.2  0.6664   6.56  -47092.3  2648.91  0
TARGET   38735    25726.4  0.6642   6.87  -47038.4  2756.81  0
DISTRICT 38735    25519.4  0.6588   7.62  -46881.9  3069.83  0
*****
Explanatory factors:  DISTRICT

FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
BASE     38735    25519.4  0.6588  -46881.9
LOBGEAR  38734    25518.4  0.6588   0  -46881.1   1.54  0.2149
SEASON   38732    25447.1  0.657   0.28  -46826.9  109.89   0
YEAR     38714    24458.8  0.6318   4.1  -46059.7  1644.28  0
TARGET   38734    23090.2  0.5961   9.52  -44944.4  3874.84  0
*****
Explanatory factors:  DISTRICT  TARGET

FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
BASE     38734    23090.2  0.5961  -44944.4

SEASON   38731    23034.9  0.5947   0.23  -44898   92.94   0
LOBGEAR  38733    22934.4  0.5921   0.67  -44813.3  262.35  0
YEAR     38713    21914    0.5661   5.04  -43931.7  2025.36  0
*****
Explanatory factors:  DISTRICT  TARGET YEAR

FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
BASE     38713    21914    0.5661  -43931.7

SEASON   38710    21864.3  0.5648   0.22  -43887.8  87.92   0
LOBGEAR  38712    21789.8  0.5629   0.56  -43821.7  220.13  0
*****
Test for Interactions:
Explanatory factors:  DISTRICT  TARGET YEAR
FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
-----  -----  -----  -----  -----  -----  -----  -----
BASE     38713    21914    0.5661  -43931.7

DISTRICT* 38712    21892    0.5655   0.1  -43912.4  38.77   0
SEASON   38710    21864.3  0.5648   0.22  -43887.8  87.92   0
LOBGEAR  38712    21789.8  0.5629   0.56  -43821.7  220.13  0
YEAR*TA  38692    21633.1  0.5591   1.23  -43681.9  499.78  0
YEAR*DIS 38692    21427.9  0.5538   2.16  -43497.3  868.88  0
*****
Explanatory factors:  DISTRICT  TARGET YEAR  YEAR*DISTRICT

FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
-----  -----  -----  -----  -----  -----  -----  -----
BASE     38692    21427.9  0.5538  -43497.3

DISTRICT* 38691    21410    0.5534   0.08  -43481.1  32.35   0
SEASON   38689    21379.6  0.5526   0.22  -43453.6  87.35   0
LOBGEAR  38691    21283.6  0.5501   0.67  -43366.4  261.76  0
YEAR*TA  38671    21140.5  0.5467   1.29  -43235.8  522.99  0
*****
Explanatory factors:  DISTRICT  TARGET YEAR  YEAR*DISTRICT  YEAR*TARGET

FACTOR  DEGF    DEVIANCE  DEV/DF  %REDUCTIO  LOGLIKE  CHISQ    PROBCHISQ
-----  -----  -----  -----  -----  -----  -----  -----
BASE     38671    21140.5  0.5467  -43235.8

DISTRICT* 38670    21109.2  0.5459   0.15  -43207.1  57.43   0
SEASON   38668    21095.4  0.5456   0.21  -43194.4  82.73   0
LOBGEAR  38670    21014.2  0.5434   0.6  -43119.7  232.27  0
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Table 12. U.S. Virgin Islands- DIVE and TRAPS combined. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for spiny lobster in the U.S. Virgin Islands, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	63.633	54.593	18.5%	0.659	0.707	1.020	0.489
1977	77.122	72.163	18.2%	0.798	0.934	1.339	0.651
1978	92.554	77.264	18.1%	0.958	1.000	1.432	0.698
1979	80.789	65.894	18.4%	0.836	0.853	1.227	0.592
1980	96.623	69.137	18.4%	1.000	0.894	1.289	0.620
1981	92.334	71.487	18.3%	0.956	0.925	1.330	0.643
1982	75.773	59.315	18.3%	0.784	0.768	1.103	0.535
1983	56.970	32.905	18.3%	0.590	0.427	0.613	0.297
1984	45.777	27.528	18.3%	0.474	0.357	0.514	0.248
1985	53.964	32.643	18.3%	0.559	0.423	0.609	0.294
1986	73.014	54.891	18.4%	0.756	0.710	1.024	0.493
1993	52.536	41.860	18.0%	0.544	0.543	0.776	0.379
1994	49.993	38.179	18.1%	0.517	0.495	0.709	0.346
1995	49.908	35.662	18.1%	0.517	0.462	0.662	0.323
1996	54.209	39.939	18.1%	0.561	0.518	0.741	0.362
1997	47.263	36.806	18.1%	0.489	0.477	0.683	0.333
1998	42.069	37.968	18.1%	0.435	0.492	0.705	0.344
1999	39.642	37.128	18.1%	0.410	0.481	0.689	0.336
2000	39.123	37.493	18.1%	0.405	0.486	0.696	0.340
2001	39.421	38.144	18.1%	0.408	0.495	0.708	0.346
2002	40.011	39.006	18.0%	0.414	0.506	0.724	0.354
2003	40.249	39.607	18.1%	0.417	0.513	0.735	0.359

Table 13. U.S. Virgin Islands- TRAPS. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the spiny lobster trap fishery, all islands included, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	60.942	68.838	25.6%	0.604	0.675	1.117	0.407
1977	63.534	75.724	25.5%	0.630	0.742	1.226	0.450
1978	85.719	88.210	25.6%	0.850	0.864	1.431	0.522
1979	81.356	87.302	25.5%	0.806	0.855	1.414	0.518
1980	100.882	82.687	25.9%	1.000	0.809	1.348	0.486
1981	98.441	102.145	25.7%	0.976	1.000	1.659	0.603
1982	75.665	64.777	25.6%	0.750	0.635	1.051	0.383
1983	61.502	47.711	25.4%	0.610	0.468	0.772	0.284
1984	53.672	36.175	25.6%	0.532	0.355	0.588	0.214
1985	62.542	37.219	25.8%	0.620	0.365	0.607	0.220
1986	73.638	63.892	26.3%	0.730	0.625	1.048	0.373
1993	63.664	53.470	25.2%	0.631	0.525	0.863	0.319
1994	64.169	49.854	25.3%	0.636	0.489	0.806	0.297
1995	67.526	49.758	25.3%	0.669	0.488	0.804	0.297
1996	73.260	48.033	25.4%	0.726	0.471	0.777	0.286
1997	66.760	47.394	25.3%	0.662	0.465	0.766	0.282
1998	53.522	46.877	25.4%	0.531	0.460	0.758	0.279
1999	45.839	48.955	25.3%	0.454	0.481	0.791	0.292
2000	44.695	41.373	25.5%	0.443	0.406	0.670	0.246
2001	46.013	49.818	25.5%	0.456	0.489	0.807	0.296
2002	49.988	51.680	25.5%	0.496	0.507	0.837	0.307
2003	58.666	55.782	25.8%	0.582	0.547	0.908	0.329

Table 14. St. Thomas/St. John- TRAPS. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the STT/STJ spiny lobster trap fishery, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	69.930	63.863	20.3%	0.668	0.629	0.940	0.421
1977	64.613	64.468	19.8%	0.617	0.636	0.941	0.429
1978	88.330	77.288	19.4%	0.843	0.762	1.120	0.519
1979	85.029	74.743	19.5%	0.812	0.737	1.084	0.501
1980	104.727	92.893	19.5%	1.000	0.916	1.348	0.622
1981	102.353	101.460	19.6%	0.977	1.000	1.474	0.678
1982	79.960	64.509	19.6%	0.764	0.636	0.939	0.431
1983	77.886	64.637	19.5%	0.744	0.638	0.939	0.433
1984	71.753	59.954	19.7%	0.685	0.591	0.874	0.400
1985	68.212	55.920	19.5%	0.651	0.552	0.812	0.375
1986	75.424	68.600	19.6%	0.720	0.677	0.997	0.459
1993	75.521	64.508	19.3%	0.721	0.637	0.933	0.434
1994	69.970	55.697	19.4%	0.668	0.550	0.807	0.375
1995	74.237	61.116	19.3%	0.709	0.603	0.884	0.412
1996	78.890	64.674	19.3%	0.753	0.638	0.935	0.436
1997	74.195	65.907	19.3%	0.708	0.650	0.953	0.444
1998	60.541	57.769	19.4%	0.578	0.570	0.837	0.388
1999	50.933	55.158	19.4%	0.486	0.544	0.800	0.371
2000	49.869	53.360	19.4%	0.476	0.527	0.774	0.358
2001	48.027	49.964	19.4%	0.459	0.493	0.725	0.336
2002	51.863	52.985	19.4%	0.495	0.523	0.769	0.356
2003	60.406	57.016	19.5%	0.577	0.563	0.828	0.382

Table 15. U.S. Virgin Islands- DIVE. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the spiny lobster dive fishery, all islands combined, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	103.993	86.762	24.3%	0.815	0.975	1.574	0.603
1977	127.653	88.344	21.1%	1.000	1.000	1.518	0.659
1978	109.412	84.361	20.8%	0.857	0.956	1.442	0.634
1979	77.840	50.122	21.5%	0.610	0.568	0.867	0.371
1980	78.014	62.201	21.1%	0.611	0.704	1.070	0.464
1981	69.687	54.390	21.1%	0.546	0.616	0.935	0.406
1982	76.242	52.301	21.1%	0.597	0.593	0.899	0.390
1983	41.467	15.498	21.9%	0.325	0.176	0.272	0.114
1984	36.930	19.840	21.2%	0.289	0.226	0.343	0.148
1985	37.831	23.583	21.2%	0.296	0.268	0.407	0.176
1986	71.935	54.635	20.8%	0.564	0.619	0.934	0.411
1993	37.249	33.212	20.7%	0.292	0.377	0.568	0.250
1994	33.057	28.744	20.8%	0.259	0.327	0.493	0.216
1995	24.856	23.522	20.9%	0.195	0.267	0.404	0.177
1996	27.532	27.388	20.8%	0.216	0.311	0.470	0.206
1997	27.416	24.191	20.9%	0.215	0.275	0.416	0.182
1998	32.003	28.378	20.8%	0.251	0.322	0.486	0.214
1999	34.695	31.229	20.7%	0.272	0.355	0.534	0.236
2000	36.629	32.609	20.6%	0.287	0.370	0.557	0.246
2001	37.211	34.561	20.6%	0.292	0.393	0.590	0.261
2002	36.676	35.151	20.6%	0.287	0.399	0.600	0.266
2003	33.345	31.714	20.7%	0.261	0.360	0.542	0.239

Table 16. St. Croix-DIVE. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the STX spiny lobster dive fishery, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	103.993	86.762	24.3%	0.815	0.975	1.574	0.603
1977	127.653	88.344	21.1%	1.000	1.000	1.518	0.659
1978	109.412	84.361	20.8%	0.857	0.956	1.442	0.634
1979	77.840	50.122	21.5%	0.610	0.568	0.867	0.371
1980	78.014	62.201	21.1%	0.611	0.704	1.070	0.464
1981	69.687	54.390	21.1%	0.546	0.616	0.935	0.406
1982	76.242	52.301	21.1%	0.597	0.593	0.899	0.390
1983	41.467	15.498	21.9%	0.325	0.176	0.272	0.114
1984	36.930	19.840	21.2%	0.289	0.226	0.343	0.148
1985	37.831	23.583	21.2%	0.296	0.268	0.407	0.176
1986	71.935	54.635	20.8%	0.564	0.619	0.934	0.411
1993	37.249	33.212	20.7%	0.292	0.377	0.568	0.250
1994	33.057	28.744	20.8%	0.259	0.327	0.493	0.216
1995	24.856	23.522	20.9%	0.195	0.267	0.404	0.177
1996	27.532	27.388	20.8%	0.216	0.311	0.470	0.206
1997	27.416	24.191	20.9%	0.215	0.275	0.416	0.182
1998	32.003	28.378	20.8%	0.251	0.322	0.486	0.214
1999	34.695	31.229	20.7%	0.272	0.355	0.534	0.236
2000	36.629	32.609	20.6%	0.287	0.370	0.557	0.246
2001	37.211	34.561	20.6%	0.292	0.393	0.590	0.261
2002	36.676	35.151	20.6%	0.287	0.399	0.600	0.266
2003	33.345	31.714	20.7%	0.261	0.360	0.542	0.239

Table 17. St. Thomas/St. John -DIVE. Nominal CPUE, estimated CPUE, coefficient of variation, and scaled relative abundance index for the STT/STJ spiny lobster dive fishery, years 1976-1986 and 1993-2003.

Year	Nominal	Estimated	CV Index	Scaled Index			
				Obscpue	StdIndex	Upper 95% CI	Lower 95% CI
1976	62.040	43.936	39.7%	0.811	0.553	1.189	0.257
1977	72.232	51.230	32.9%	0.944	0.663	1.258	0.349
1978	76.543	76.770	30.7%	1.000	1.000	1.822	0.549
1979	66.727	41.782	30.3%	0.872	0.546	0.988	0.302
1980	64.498	53.260	30.1%	0.843	0.696	1.253	0.386
1981	64.705	53.716	29.8%	0.845	0.702	1.260	0.392
1982	56.967	47.367	29.6%	0.744	0.620	1.107	0.347
1983	32.048	13.121	30.6%	0.419	0.173	0.314	0.095
1984	27.433	11.790	30.7%	0.358	0.155	0.283	0.085
1985	30.277	22.249	30.2%	0.396	0.292	0.527	0.162
1986	47.859	43.993	28.9%	0.625	0.577	1.018	0.327
1993	33.048	27.485	29.2%	0.432	0.361	0.640	0.204
1994	26.578	22.003	29.5%	0.347	0.289	0.515	0.162
1995	31.356	32.738	29.0%	0.410	0.430	0.759	0.244
1996	34.305	35.625	29.0%	0.448	0.468	0.826	0.265
1997	23.458	23.151	29.4%	0.306	0.304	0.541	0.171
1998	31.877	32.628	29.5%	0.416	0.428	0.762	0.240
1999	34.926	33.950	29.3%	0.456	0.445	0.790	0.251
2000	32.773	30.945	29.1%	0.428	0.406	0.719	0.230
2001	35.024	36.276	28.9%	0.458	0.476	0.839	0.271
2002	42.823	41.905	28.7%	0.559	0.550	0.966	0.313
2003	38.544	40.503	29.1%	0.504	0.531	0.939	0.301

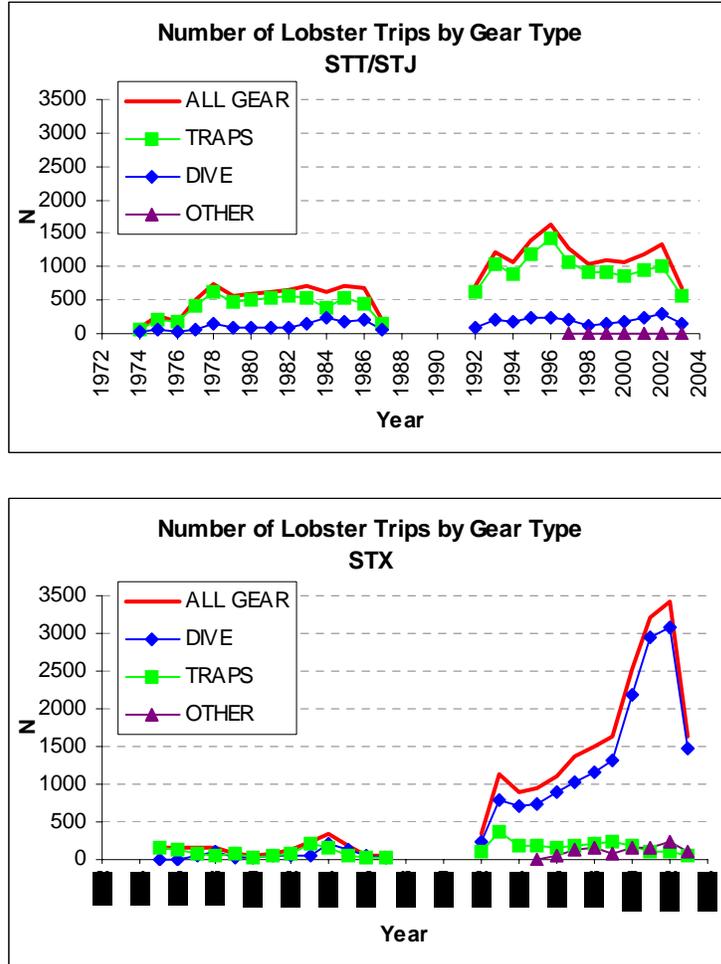


Figure 1. U.S. Virgin Islands. Number of records (trips) by District, Gear, and Year (1974-2003). Note: Data for years 1974 includes only STT/STJ and only January-June of 2003 for both districts is represented. Lobster landings are filtered for outliers (>250 lb/trip removed). Data from FY1986-87 to FY1991-92 (highlighted) is incomplete, missing or contained outliers and is currently under review.

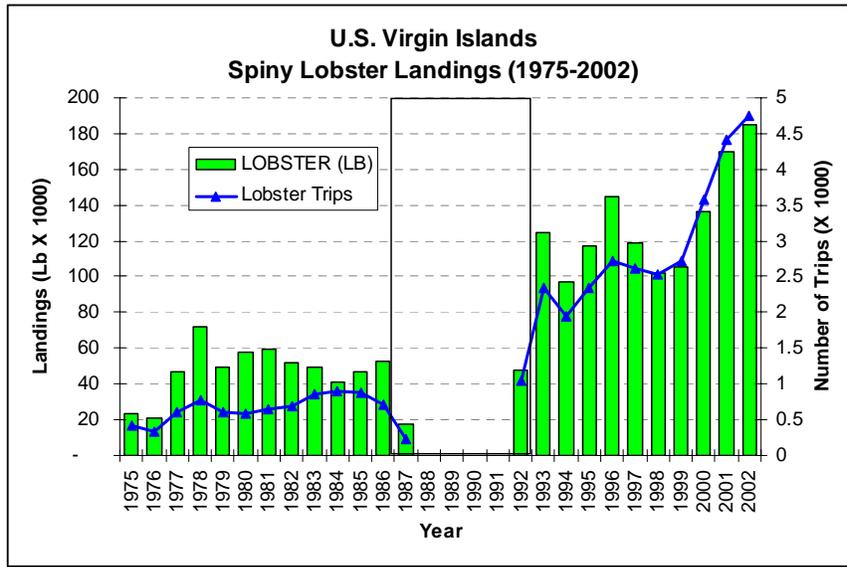


Figure 2. Spiny lobster landings (LB) by year (1974-2003) for the whole U.S. Virgin Islands. NOTES: Lobster landings are filtered for outliers (>250 lb/trip removed). Data from FY1986-87 to FY1991-92 (highlighted) is incomplete, missing or contained outliers and is currently under review.

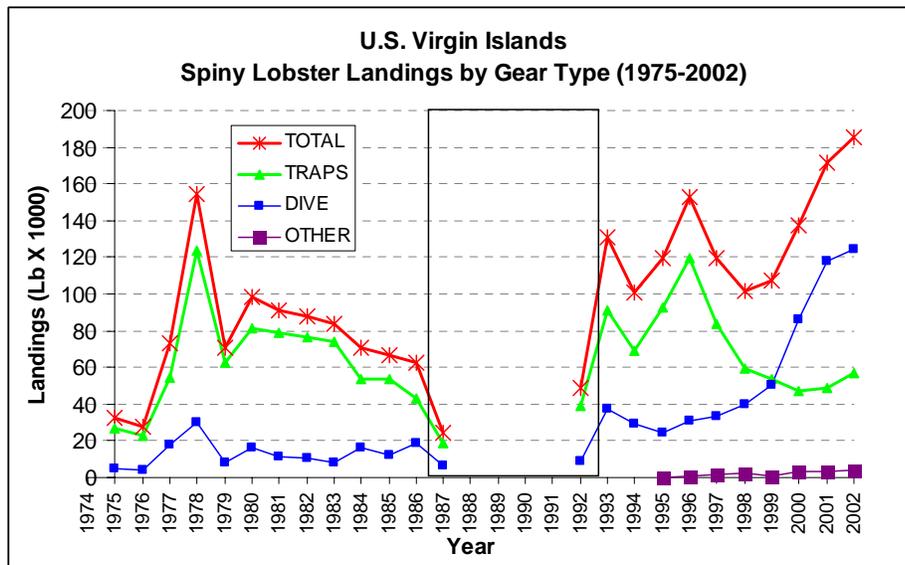


Figure 3. Spiny lobster landings (LB) by year (1974-2003) and gear for the whole U.S. Virgin Islands. NOTES: Lobster landings are filtered for outliers (>250 lb/trip removed). Data from FY1986-87 to FY1991-92 (highlighted) is incomplete, missing or contained outliers and is currently under review.

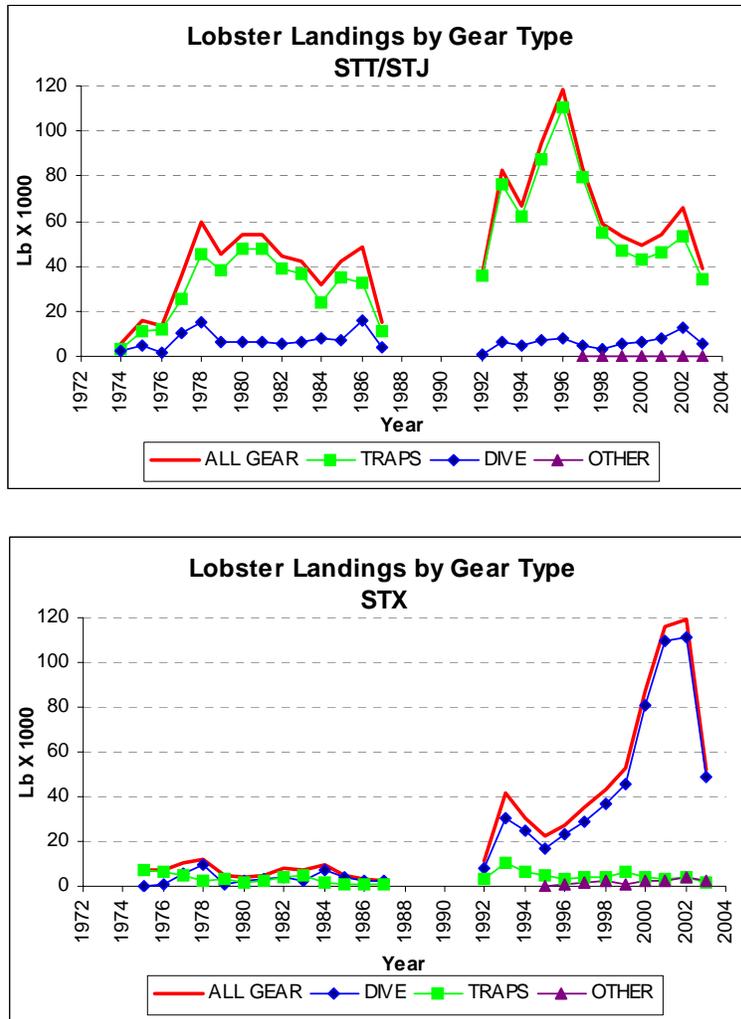
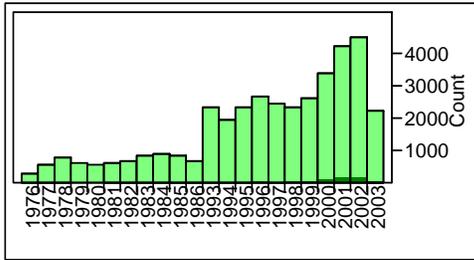


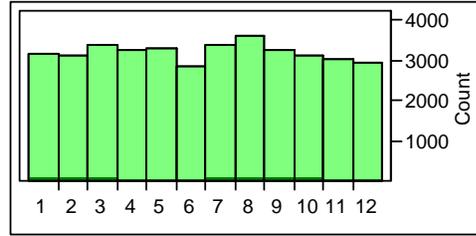
Figure 4. U.S. Virgin Islands. Spiny lobster **expanded** landings (in pounds) by District, Gear, and Year (1974-2003). Notes: Data for years 1974 includes only STT/STJ and only January-June of 2003 for both districts is represented. Lobster landings are filtered for outliers (>250 lb/trip removed). Data from FY1986-87 to FY1991-92 (highlighted) is incomplete, missing or contained outliers and is currently under review.

Figure 5. U.S.Virgin Islands- DIVE and TRAPS. Diagnostic plots for selection of explanatory variables for GLM model.

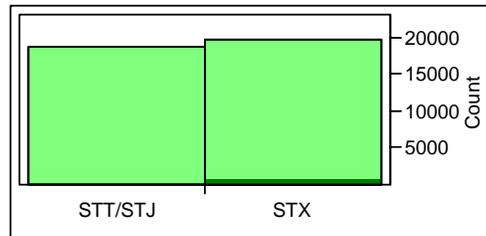
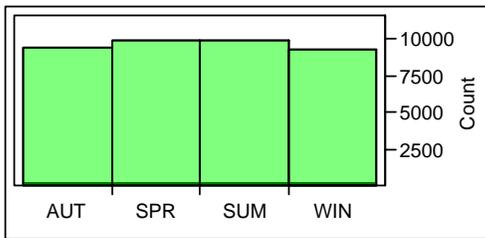
Distributions
YEAR



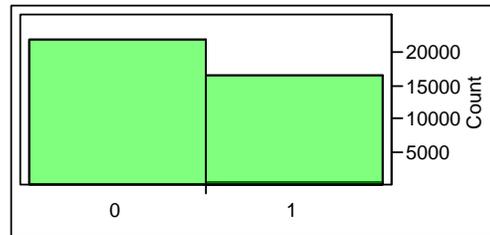
MONTH



SEASON DISTRICT



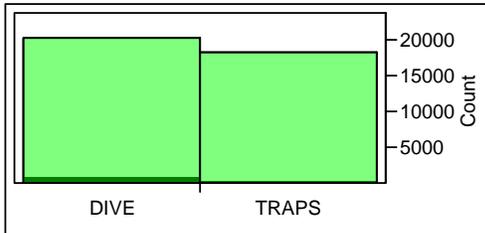
TARGET



Frequencies

Level	Count	Prob
0	22147	0.57173
1	16590	0.42827
Total	38737	1.00000

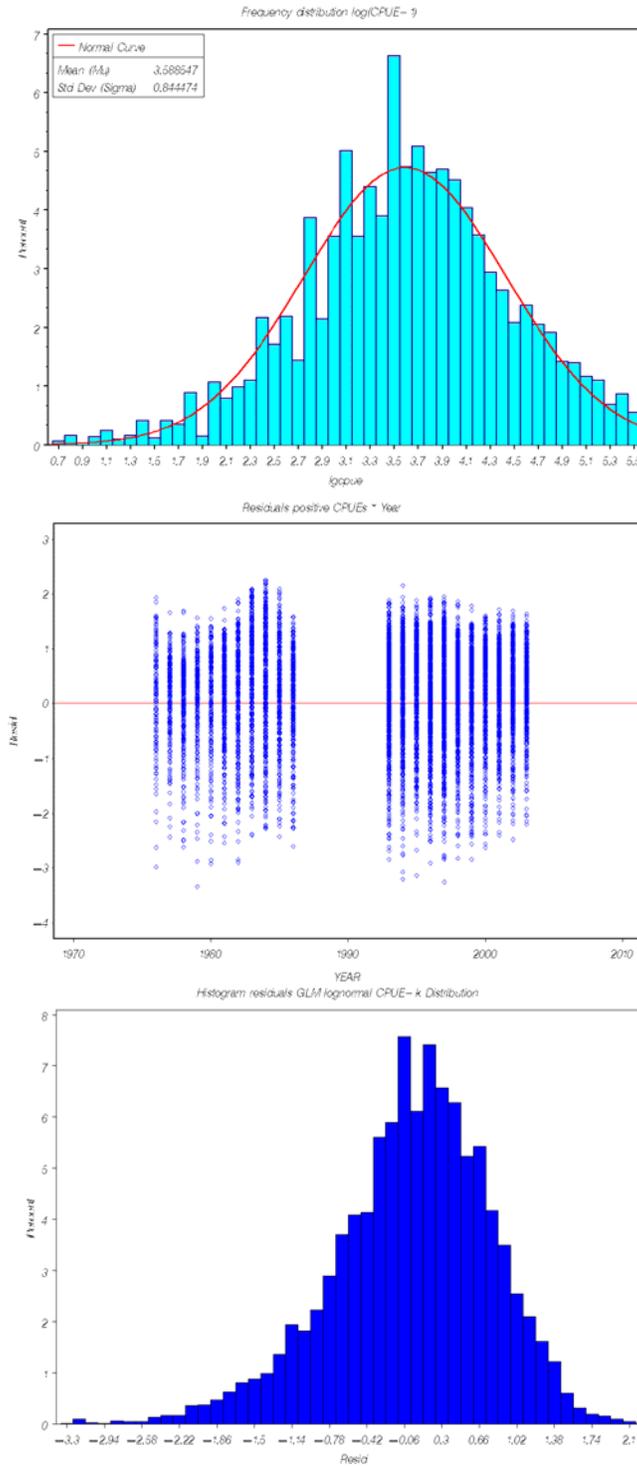
LOGGEAR



Frequencies

Level	Count	Prob
DIVE	20456	0.52807
TRAPS	18281	0.47193
Total	38737	1.00000

Figure 6. U.S. Virgin Islands- DIVE and TRAPS combined. Diagnostic plots from fitting a GLM lognormal model to U.S. Virgin Islands spiny lobster. The distribution of the $\log(\text{CPUE}+1)$ and the distribution of residuals for the model are shown. Note that years 1987-1992 are missing.



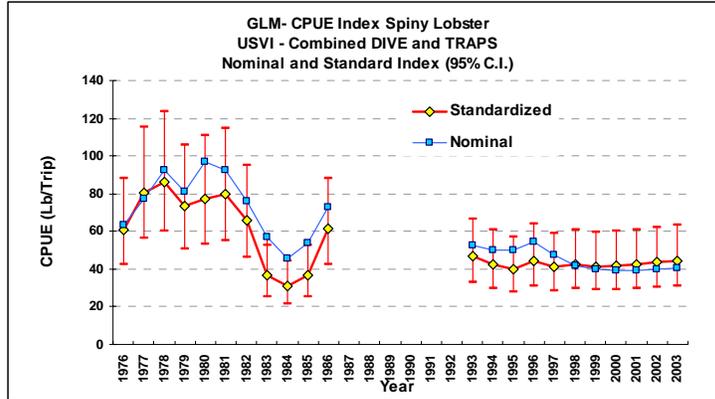


Figure 7. U.S.Virgin Islands- DIVE and TRAPS combined. Nominal CPUE, standardized index of abundance and 95% confidence limits for the U.S. Virgin Islands spiny lobster, all islands included, DIVE and TRAPS combined, years 1976-1986 and 1993-2003.

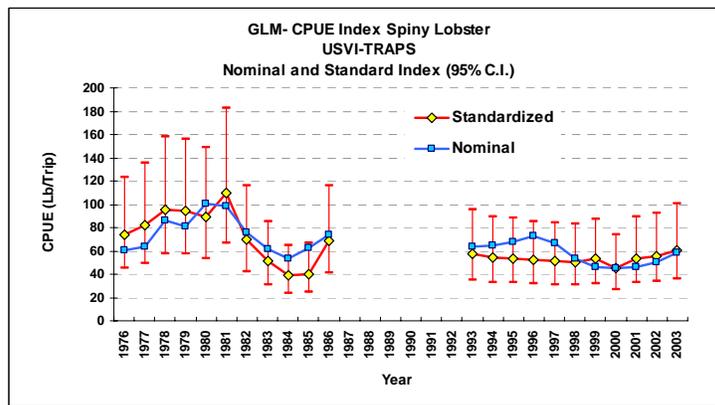


Figure 8. U.S.Virgin Islands- TRAPS. Nominal CPUE, standardized index of abundance and 95% confidence limits for the U.S. Virgin Islands spiny lobster trap fishery, all islands included, years 1976-1986 and 1993-2003.

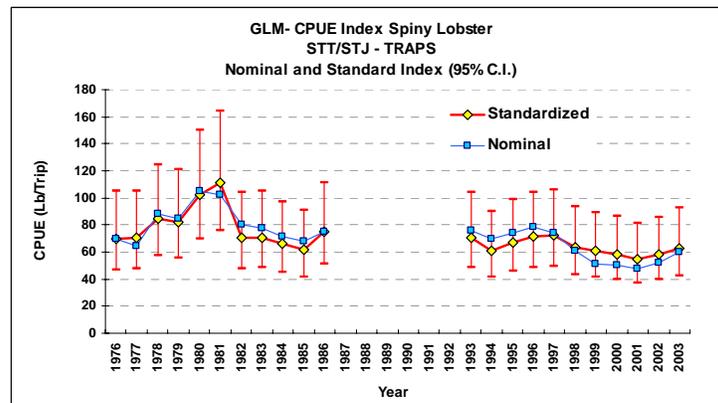


Figure 9. St. Thomas/St. John-TRAPS. Nominal CPUE, standardized index of abundance and 95% confidence limits for the STT/STJ spiny lobster trap fishery, years 1976-1986 and 1993-2003.

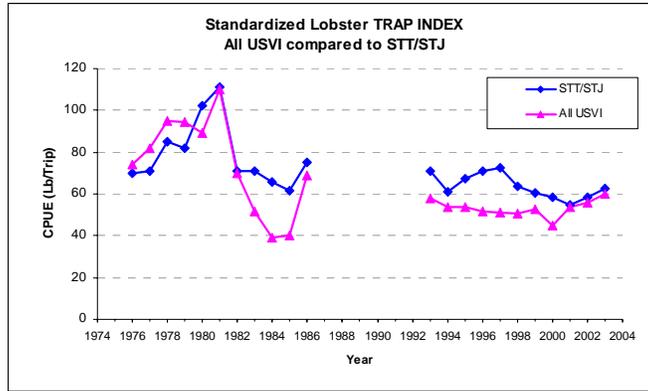


Figure 10. Comparison of standardized lobster TRAP indices for the whole USVI and only for St.Thomas/St. John, where this gear represents 80% of the lobster effort.

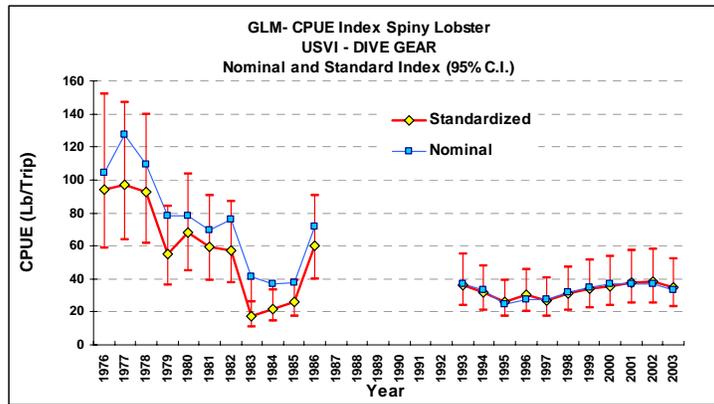


Figure 11. U.S.Virgin Islands- DIVE. Nominal CPUE, standardized index of abundance and 95% confidence limits for the U.S. Virgin Islands spiny lobster dive fishery, all islands included, years 1976-1986 and 1993-2003.

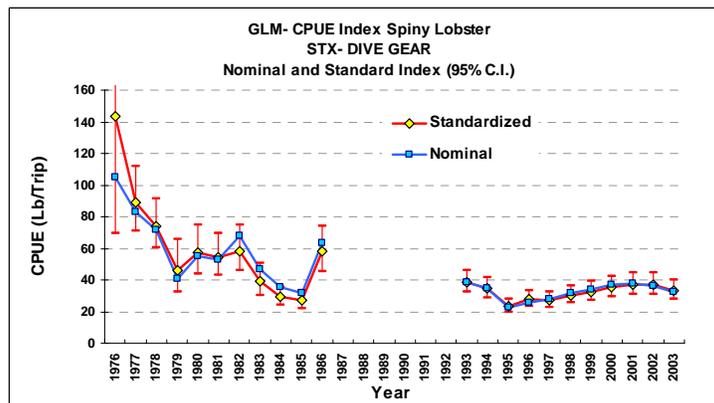


Figure 12. St. Croix- DIVE. Nominal CPUE, standardized index of abundance and 95% confidence limits for the STX spiny lobster dive fishery, years 1976-1986 and 1993-2003.

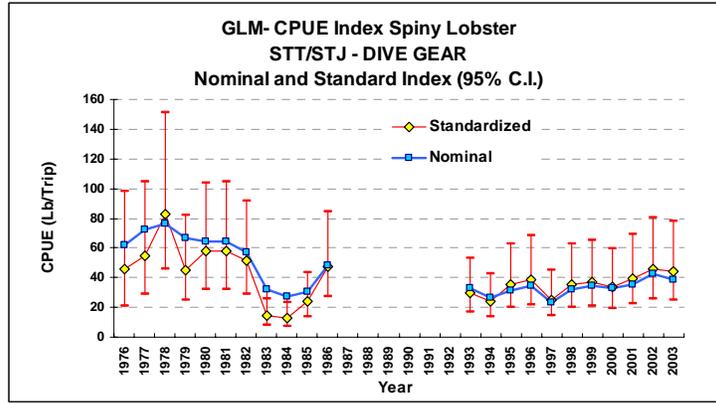


Figure 13. St. Thomas/St. John- DIVE. Nominal CPUE, standardized index of abundance and 95% confidence limits for the STT/STJ spiny lobster dive fishery, years 1976-1986 and 1993-2003.

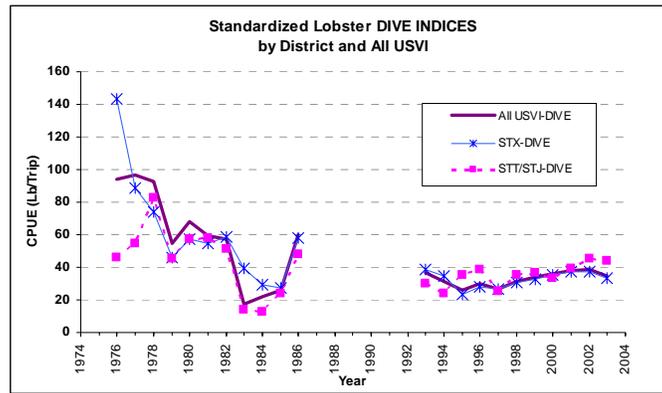


Figure 14. Comparison of standardized lobster DIVE indices among districts and the whole U.S.V.I.