Standardized catch rates of gulf of Mexico greater amberjack for the commercial longline and handline fisheries 1990-2004

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SUMMARY

Standardized indexes of abundance were estimated for Gulf of Mexico greater amberjack using data from the Reef Fish Logbook Program. Separate indexes were estimated for the longline, handline 1-9 hooks, and handline with more than 10 hooks fisheries. In general, handline indexes showed no trend and remained relatively stable during the period studied. In contrast, the longline index remained stable until year 2000 and showed a constant increase since then.

1. MATERIALS AND METHODS

Data for the present analysis was obtained from the Reef Fish logbook Program that collects catch and effort data on a per trip basis. Catch information is reported as total weight landed by species. Trips that reported using more than one gear or that fished in more of one area were not used in any of the analysis of catch rates because it is not possible to know what proportion of the catch was caught with each gear or in what area.

Only trips that fished within statistical grids 2-21 were retained for analysis. Area 1 was excluded because McClelland and Cummings (1997) concluded that fish from that area should be considered part of the Atlantic management unit.

Data previous to the establishment of the 36" minimum size (April 1990) and trips reported during the greater amberjack closed season established in 1998 (March-May) were not used in the analysis. For analysis purposes, four seasons were defined: Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec.

Relative indices of abundance were estimated by a GLM approach assuming a delta-lognormal model

distribution. The delta model fits separately the proportion of positive trips (proportion of trips that reported greater amberjack catches) assuming a binomial error distribution and the catch rate estimated only from positive trips assuming a lognormal error distribution. The standardized index is the product of these model-estimated components.

A step-wise procedure was used to determine the set of systematic factors and interactions that significantly explained the observed variability in the proportion of positive sets and the catch rates. Factors were included in the final models if: 1) their inclusion in the model reduced the model deviance by at least 1% and 2) the factor was significant ($Pr<0.05$). The factor *Year* was always included in the final models. Statistical analysis for the selection of significant factors were performed using SAS GENMOD Procedure (SAS Institute 1997)

The selection of trips for the analysis was performed with an objective approach recently developed by Stephens and McCall (2004) that subsets trip records by using the observed species composition of a fishing trip to infer if that trip's effort occurred in a habitat where the species of interest (greater amberjack) was likely to occur.

1.1 Longline fishery

Based on preliminary analysis of nominal catch rates (Turner 2000), the Gulf of Mexico was divided into 5 regions (Fig. 1). It was observed that, although fishers are required to report total number of fishing sets in the trip, many reports seemed to have number of sets per day. Thus, to assure that all records used in the analyses have reported effort for the entire trip, only records with at least ten reported sets or trips of one-day duration were selected. The assumption for this selection criteria was that 10 sets is the maximum number of sets that can be fished in a day, thus any record reporting 10 or more sets were assumed to correspond to total effort of the trip. The catch-per-unit-of-effort (CPUE) selected for the analysis was lbs/100 hooks.

1.2 Handline fishery

Handlines fishing with less than 10-15 hooks are generally targeting groupers and red snapper while lines with 20+ hooks might indicate targeting vermillion snapper (Turner, 2000). Separate catch rates analysis were performed on handlines fishing with (1) 1-9 hooks and (2) 10+ hooks. Within each group, a category 'hooks per line' was defined with two levels: 1-2 and 3-9 hooks per line for the 1-9 hooks data set and 10-20 and 21-40 hooks per line for the 10+ hooks data set . The selected unit of effort for the analysis of catch rates was the product of the number of hooks per line and the duration of the trip in days (Diaz, 2005). The same regions defined for the longline fishery were used in the analysis of handlines (Fig. 1).

The possibility that some trips/vessels using handlines with 1-9 hooks targeted greater amberjack was investigated to separate them from the analysis. To identify potential trips/vessels that specifically targeted greater amberjack, the frequency distribution of the proportion of greater amberjack to total landings by trips was plotted. Two different catch rate analysis were performed on handline trips using 1-9 hooks per line: one that included all trips and a second one on a reduced data set that did not include vessels that targeted greater amberjack. A third catch rate analysis was performed for trips that used handlines with 10+ hooks.

2. RESULTS

The list of species that were landed in at 5% of all trips and that were used for the species composition analysis is presented in Table 11 together with the estimated association coefficient with greater amberjack.

2.1. Longline fishery

The data set used in the analysis contained a total of 3,955 trip records. Table 1 shows the number of trips and total effort (in million hooks) by statistical grid all years combined from 1993 to 2004. Only data from this period is presented in Table 1 because prior to 1993 only 20% of all vessel registered in Florida were sampled. Effort was highest in SW and Central West (CW) Florida area (grids 2-6), other grids with relatively high effort were 8-9 and 14-17 and 20-21.

Table 2 shows the number of trips selected for the analysis by area and it indicates that 67% of all longline trips analyzed originated in the SW and CW FL area. The effect of partial reporting from FL vessels can be easily identified by the number of trips prior to 1993. To obtain a more balanced design, data previous to 1993 was not used in the catch rate analysis.

Results of the stepwise selection process of significant factors for the proportion of positive trips and catch rate models are presented in Table 3. For the analysis of the proportion of positive trips, the factor *Area* was the only one that reduced the model deviance by more than 1%. The inclusion of the factor *Year* into model only reduced de deviance by 0.95%. The factors selected for the analysis of positive trips were *Area* and *Year*. In the case of the analysis of positive catch rates, all main fixed factors (*Year, Area, Season*) were significant. The mixed effect interactions included in this model were *Year*Area* and *Year*Season*.

Gulf of Mexico greater amberjack standardized index of abundance for the longline fishery are presented in Table 4 and Figure 2. Coefficient of variation (CV) of the estimated standardized index ranges from approximately 24% to 31%. The standardized index showed a decrease from 1992 to 1994 when it reached the lowest value of the time series. From 1994 through 200 the index increased at a continuous but relatively low rate and at a higher rate from 2001 to 2004. The nominal index of abundance showed similar trends except for the period 2003-2004 when then nominal catch rate decreased.

2.2. Handline Fishery 10-40 hooks per line

The data set used in the analysis contained a total of 7,754 records (trips). Table 1 shows the number of trips and effort in each statistical grid area for the period 1993-2004. Table 5 shows the annual number of trips in each defined area. Effort was almost non existent in the SW and CW FL area (grids 2-5), so these areas were not included in the catch rate analysis. As it was done with the longline fishery analysis, data was restricted to the 1993-2004 period to obtained a more balanced design.

Results of the stepwise factor selection process are presented in Table 6. In the case of the proportion of positive trips analysis, the factors selected for the final model were *Area*, *Season*, and *Year*, and the only significant main effects interaction was *Area*Season*. For the catch rate model, all main

fixed effects (*Year, Area, Season, Hook-per-line*) were significant together with the interaction *Year*Season.*

Table 4 and Figure 3 shows the greater amberjack estimated nominal and standardized catch rates for the handline fishery using 10-40 hooks per line. The CV of the standardized index ranged from approximately 26% to 28%. The standardized index of abundance showed no discernable trend and remained stable during the period 1993-2001 and it slightly declined for the last 3 years of the series. Estimated indexes for year 2003 and 2004 were the lowest of the entire time series.

2.3. Handline Fishery 1-9 hooks per line

The number of trips and effort by statistical grid for the handline fishery with 1-9 hooks per line is presented in Table 1. The highest number of trips corresponded to grids 5-8. Table 7 shows the number of trips per defined area and year. The NW FL, AL area accounted for approximately 60% of all handline trips 1-9 hooks per line.

2.3.1 Analysis of all handline 1-9 hooks trips

The results of the stepwise selection process for the selection of significant factors are presented in Table 8. For the proportion of positive trips model, only the factor *Area* was significant and reduced the model deviance by 2.9%. The final factors included in this model were *Area* and *Year*. The factors that were significant for the catch rate model were *Area* (deviance reduction 3.7%) and *Hook-per-line* (deviance reduction 7%). Thus, the main effects selected for the final model were *Area, Hook-per-line,* and *Year* and the interaction *Area*Hook-per-line.*

Table 9 and Figure 4 show the estimated nominal and standardized indexes of abundance. The CV of the standardized index were lower than those estimated for the longline and handline 10+ hooks fisheries and ranged from approximately 11% to 15%. Although the indexes of abundance showed interannual variability, no discernable trend was observed and the index seemed to have remained relatively constant for the entire time series.

2.3.2 Analysis of handline 1-9 hooks trips that did not target greater amberjack

Figure 5 shows the frequency distribution of the proportion of greater amberjack in the landings of positive trips. The frequency declined as the proportion increased and stabilized at around 70%. At proportions higher than 80% the frequency increased. It was assumed that this increase in the proportion of trips with more than 80% greater amberjack in the landings was an indication of trips specifically targeting this species. If any of these vessels targeted greater amberjack three or more times in a year, all trips for that vessel for that particular year were not included in the analysis. These approach reduced the number of records (trips) from 10,054 to 8,199.

Table 10 shows the results of the main factors stepwise selection process. Similar to the analysis that included all trips, the significant factors included in the final model of the proportion of positive trips were *Area* (deviance reduction 3.1%) and *Year*. The factors included in the analysis of catch rates were *Hok-per-line, Area,* and *Year* and no interaction was significant.

For comparison purposes, a catch rates series was also estimated for the entire set of trips that did not target greater amberjack without using the species composition method for trip selection. Figure 7 shows both series.

DISCUSSION

The present document estimated four different standardized indexes of abundance for the commercial greater amberjack fishery in the Gulf of Mexico. One index was estimated for the longline fishery and three for the handline fishery depending of gear configuration and if specific trips were targeting or not greater amberjack. All three standardized indexes estimated for the handline fishery, although they showed some interannual variability, remained relatively stable for the period considered in this analysis. In contrast, the longline index, although it remained constant for the first part of the period, was the only that showed a continuous increase since 2000.

The highest percentage of greater amberjack landings corresponded to handline gear. The majority of handline greater amberjack landings are from vessels fishing with less than 10 hooks. Table 1 shows that the grids with the highest number of trips for this portion of the fishery are 5-8. In the case of the longline fishery, most of its effort is localized in grids 2-5. The different trends observed in the estimated indexes for these two fisheries could be the result of differences in greater amberjack abundance between the two areas where they operate. In addition, relative size frequency distribution of sampled landings from these fisheries showed that longline vessels tend to land larger greater amberjack than handline vessels. Thus, indicating that they might target different age classes.

The handline 10+ hooks fishery operates mostly in the northern and western Gulf of Mexico. Like the index from the 1-9 hooks fishery, the 10+ hooks index also remained relatively stable but with less interannual variability. But, the last two of the time series has the lowest values all the analyzed period.

REFERENCES

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Table 1: Number of longline, handline 1-9 hooks per line and handline 10-40 hooks per line trips and effort by statistical grid area for the period 1993-2004. Effort units in the table correspond to million hooksfor the longline fishery and hook-days for the handline fishery.

	Longline		Handline 1-9		Handline 10-40	
GRID	Trips	Effort	Trips	Effort	Trips	Effort
2	331	11.853	384	11,343	3	935
3	525	18.420	387	32,353	4	2,650
4	621	22.282	554	22,983	5	1,800
5	881	32.803	1322	56,847	15	5,535
6	264	9.589	1862	93,362	79	33,755
7	87	2.390	1466	39,829	122	39,537
8	169	4.304	1971	51,097	384	117,789
9	132	3.418	672	16,570	685	228,647
10	53	1.493	179	3,709	1,869	737,869
11	26	1.162	108	4,414	1,204	482,370
12	8	0.488	67	3,560	63	19,717
13	38	1.406	302	13,250	326	117,308
14	89	2.634	118	11,405	385	149,566
15	100	3.196	175	19,833	491	211,450
16	106	4.183	84	9,896	532	243,333
17	90	3.173	114	12,177	870	588,239
18	95	2.119	92	9,311	390	178,525
19	30	0.896	126	12,401	153	47,578
20	151	4.230	57	6,016	35	10,248
21	63	2.704	14	601	166	20,769

Table 2: Number of longline trips by area and year used in the catch rate analysis. Refer to Figure 1 for a map defining areas.

	AREA					
Year	W LA, TX (17-21)	LA (12-16)	NW FL, AL (6-11)	CW FL (4-5)	SW FL (2-3)	Total
1990	4	15	6	8	9	42
1991	7	21	7	28	16	79
1992	13	22	11	18	11	75
1993	29	32	27	81	52	221
1994	36	22	46	128	56	288
1995	37	44	49	104	52	286
1996	30	48	75	114	99	366
1997	25	25	79	158	122	409
1998	35	23	35	130	108	331
1999	65	18	38	114	86	321
2000	25	35	79	131	56	326
2001	24	20	73	142	61	320
2002	32	27	75	114	48	296
2003	58	23	108	163	47	399
2004	28	4	32	92	40	196
Total	448	379	740	1,525	863	3,955

Table 3: Results of the step-wise procedure to select significant factors, where d.f. indicates degrees of freedom, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of a factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		5207.9	1.386			
Area	4	5124.7	1.365	1.49	83.25	0.0000
Area Year	11	5060.9	1.352	0.95	63.80	0.0000
Area Year Season	3	5109.0	1.362	0.23	15.64	0.0013

B)

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		8588.7	4.709			
Area	4	8413.0	4.622	1.83	37.72	0.0000
Area Year	11	8176.3	4.520	2.22	52.08	0.0000
Area Year Season	3	7945.7	4.399	2.66	52.21	0.0000
Area Year Season Year*Area	44	7416.1	4.210	4.34	125.90	0.0000
Area Year Season Year*Season	12	7785.4	4.340	1.36	37.21	0.0002
Area Year Season Area*Season	33	7731.4	4.361	0.89	49.91	0.0298

Table 4: Nominal and standardized Gulf of Mexico greater amberjack catch rates (CPUE) in weight (lbs/100 hooks) and corresponding coefficient of variation (C.V.) of the standardized index.

	Longline			Handline 10-40		
Year	Nominal CPUE	Std. CPUE	C.V.	Nominal CPUE	Std. CPUE	C.V.
1993	0.674	0.275	30.8%	0.767	0.566	26.4%
1994	0.314	0.285	28.8%	0.689	0.479	26.7%
1995	0.506	0.309	29.1%	0.691	0.555	27.3%
1996	0.254	0.231	30.0%	0.503	0.474	27.4%
1997	0.295	0.296	28.3%	0.596	0.519	26.2%
1998	0.410	0.299	28.1%	0.478	0.460	27.9%
1999	0.382	0.273	29.1%	0.381	0.424	27.9%
2000	0.328	0.309	28.8%	0.587	0.477	28.1%
2001	0.346	0.353	27.7%	0.608	0.517	26.8%
2002	0.511	0.541	25.7%	0.524	0.462	26.5%
2003	0.797	0.638	23.9%	0.637	0.406	27.2%
2004	0.617	0.711	27.0%	0.402	0.363	28.7%

Table 5: Number of trips per area of the handline fishery fishing 10-40 hooks per line

Year	W LA, TX	LA	NW FL, AL	CW FL	SW FL	Total
1990						
1991	28	56	51	1		136
1992	40	84	47		1	171
1993	112	111	292	3	3	519
1994	143	180	351	3	2	680
1995	77	93	464			636
1996	143	112	567	1		823
1997	230	221	491	9		951
1998	141	96	284	1		522
1999	160	147	394	1		702
2000	106	104	246	1	1	458
2001	87	118	289			494
2002	113	182	358			653
2003	159	175	349			683
2004	75	118	160			353
Total	1,614	1,797	4,343	20	7	7,781

Table 6: Results of the step-wise procedure applied to the Handline 10-40 hooks-per-line data set to select significant factors, d.f. indicates degrees of freedom of the added model, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

FACTOR	d.f.	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		10110.9	1.3577			
Area	2	9854.8	1.3237	2.51	256.18	0.0000
Area Season	3	9697.7	1.3031	1.55	157.08	0.0000
Area Season Year	11	9620.8	1.2947	0.65	76.84	0.0000
Area Season Year Hook-per-line	1	1.3032	1.3032	-0.01	0.73	0.3944
Area Season Year Area* Season	6	1.2816	1.2816	1.01		

B)

FACTOR	d.f.	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		17934.1	4.1199			
Area	2	17169.2	3.9460	4.22	189.76	0.0000
Area Hook-per-line	3	16664.5	3.8309	2.92	129.92	0.0000
Area Hook-per-line Year	11	16422.8	3.7849	1.20	63.62	0.0000
Area Hook-per-line Year Season	3	16205.9	3.7849	1.25	57.89	0.0000
Area Hook-per-line Year Season Year*Season	33	15774.4	3.6659	1.92	117.49	0.0000
Area Hook-per-line Year Season Hook-per-line*Area	2	16123.6	3.7203	0.46	22.15	0.0002
Area Hook-per-line Year Season Year*Hook-per-line	11	16145.3	3.7330	0.12	16.29	0.13073
Area Hook-per-line Year Season Hook-per-line*Season	3	16178.8	3.7339	0.10	7.27	0.06380

Table 7: Total number of trips by area of the handline fishery 1-9 hooks per line.

	AREA					
Year	W LA, TX (17-21)	LA (12-16)	NW FL, AL (6-11)	CW FL (4-5)	SW FL (2-3)	Total
1991	40	13	128	21	25	227
1992	62	56	132	20	38	308
1993	159	47	457	70	29	762
1994	110	55	528	55	15	763
1995	108	78	640	72	23	921
1996	221	84	668	93	41	1,107
1997	193	62	668	74	43	1,040
1998	156	41	514	82	26	819
1999	129	47	474	42	63	755
2000	108	31	306	54	44	543
2001	175	38	466	71	23	773
2002	163	74	516	52	8	813
2003	153	84	419	28	10	694
2004	99	36	342	37	15	529
Total	1,876	746	6,258	771	403	10,054

Table 8: Results of the step-wise procedure applied to the Handline 1-9 hooks-per-line data set to select significant factors, d.f. indicates degrees of freedom of the added model, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

A)

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		12360.8	1.299			
Area	4	11998.4	1.261	2.89	362.40	0.0000
Area Year	11	11966.5	1.259	0.15	31.90	0.0008
Area Year hook-per-line	1	11976.9	1.259	0.17	21.53	0.0000
Area Year hook-per-line Season	3	11986.4	1.260	0.07	11.98	0.0074

b)

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		19461065				
Area	4	18716866	5793.7	3.71	131.0	0.0000
Area hook-per-line	1	17400058	5578.8	7.01	245.1	0.0000
Area hook-per-line Year	11	17181229	5187.8	0.93	42.5	0.0000
Area hook-per-line Year Season	3	17124270	5139.4	0.24	11.1	0.0109
Area hook-per-line Year Area*Hook-per-line	4	17147938	5127.0	0.07	6.52	0.1637

Table 9: Nominal and standardized Gulf of Mexico greater amberjack catch rates (CPUE) in weight (lbs/hooks-days) and corresponding coefficient of variation (C.V.) of the standardized index for the complete handline 1-9 hooks per line data set (all trips) and for trips that did not target greater amberjack.

	Handline all trips			Handline non- targeting trips		
Year	Nominal CPUE	Standardized CPUE	CV	Nominal CPUE	Standardized CPUE	CV
1993	13.32	12.09	12.0%	9.29	8.62	12.3%
1994	10.73	10.50	12.4%	8.39	7.36	12.3%
1995	12.83	15.05	10.7%	9.08	10.13	11.1%
1996	11.40	11.13	10.7%	6.14	6.64	11.7%
1997	11.61	10.84	10.9%	5.58	6.20	12.0%
1998	9.11	8.88	12.8%	5.60	5.39	13.9%
1999	10.23	11.77	12.3%	6.83	6.40	13.9%
2000	10.89	13.25	14.0%	8.66	9.44	14.9%
2001	8.69	8.62	13.3%	7.30	6.29	14.2%
2002	9.73	7.85	13.3%	7.01	5.48	14.5%
2003	11.44	14.25	12.5%	10.84	11.19	12.8%
2004	13.56	10.29	15.4%	8.37	7.05	16.4%

Table 10: Results of the step-wise procedure applied to the Handline 1-9 hooks-per-line data set to select significant factors, d.f. indicates degrees of freedom of the added model, Deviance/d.f. the model deviance per degrees of freedom, and % reduction is the reduction of the model deviance obtained by the inclusion of factor. Table A) shows the result of the binomial analysis (proportion of positive trips), and B) the results of the catch rate analysis on positive trips.

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		12220.9	1.265			
Area	4	11840.9	1.226	3.07	380.03	0.0000
Area Year	11	11794.3	1.223	0.26	46.58	0.0001
Area Year Season	3	11825.7	1.225	0.10	15.10	0.00173
Area Year Season Hook-per-line	1	11831.0	1.225	0.07	9.89	0.0016

FACTOR	d.f. added factor	Model deviance	Deviance/d.f.	% reduction	Chisq	Probability
Base		7275495.1	2657.23			
Hook-per-line	1	7026004.4	2567.05	3.39	95.57	0.0000
Hook-per-line Area	4	6706559.9	2453.92	4.41	127.45	0.0000
Hook-per-line Area Year	11	6655343.8	2445.02	0.36	21.00	0.0334
Hook-per-line Area Year Season	3	6601441.8	2427.89	0.70	22.27	0.0000
Hook-per-line Area Year Hook-per-line*Area	4	6649588.0	2446.50	-0.06	2.37	0.6681

Table 11: list of species landed in at least 5% of all trips and association factor with greater amberjack for the longline and handline 1-9 hooks and 10+ hooks fisheries.

Longline		Handline 1-9 hooks		Handline 10+ hooks	
Species	Factor	Species	Factor	Species	Factor
mutton snapper	1.098	scamp	1.370	vermilion snapper	1.025
yellowedge grouper	0.839	vermilion snapper	0.860	warsaw grouper	0.742
warsaw grouper	0.789	cobia	0.641	scamp	0.714
red porgy	0.652	black grouper	0.625	yellowedge grouper	0.623
tilefish	0.569	mutton snapper	0.545	gag	0.460
snowy grouper	0.528	king mackerel	0.388	cobia	0.426
silk snapper	0.526	black margate	0.350	atlantic hake	0.399
black grouper	0.458	gray triggerfish	0.292	whitebone porgy	0.390
scamp	0.415	gray snapper	0.151	king mackerel	0.299
cobia	0.357	yellowtail snapper	0.048	blueline tilefish	0.282
gag	0.352	red porgy	-0.199	black grouper	0.244
blueline tilefish	0.351	red grouper	-0.349	gray snapper	0.149
dolphin	0.289	red snapper	-0.453	red porgy	0.111
gray triggerfish	0.272	lane snapper	-0.549	gray triggerfish	0.093
red snapper	0.256	white grunt	-0.791	almaco jack	0.004
gray snapper	0.206	black sea bass	-0.905	snowy grouper	-0.070
unclasified shark	-0.145			lane snapper	-0.092
red grouper	-0.371			white seatrout	-0.279
sandbar shark	-.0389			lesser amberjack	-0.447
				red grouper	-0.677
				red snapper	-1.198

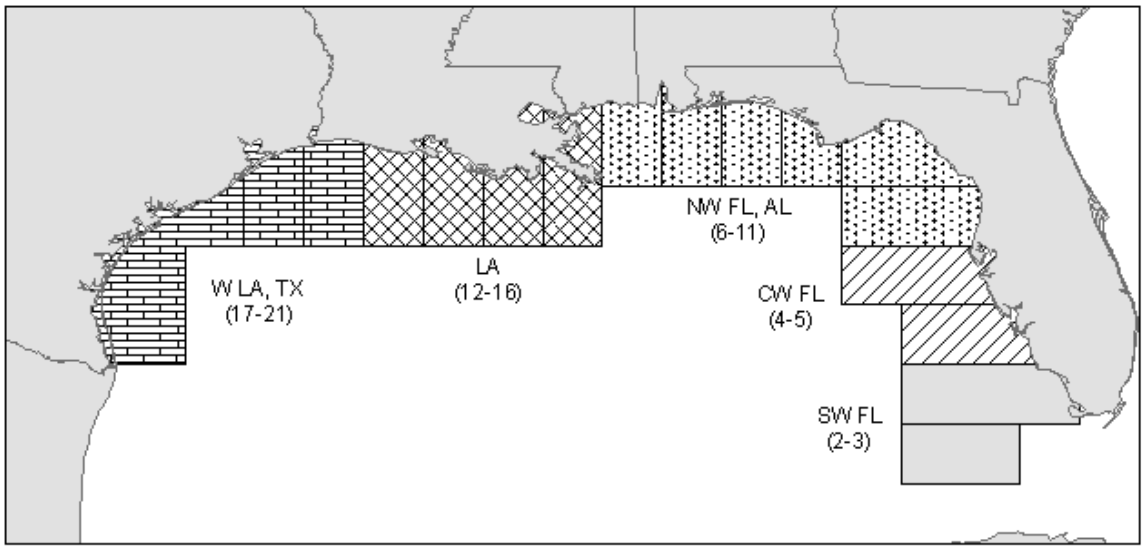

Figure 1: Areas used in the analysis of greater amberjack catch rates. Numbers in parenthesis correspond to the statistical grid cells in each area.

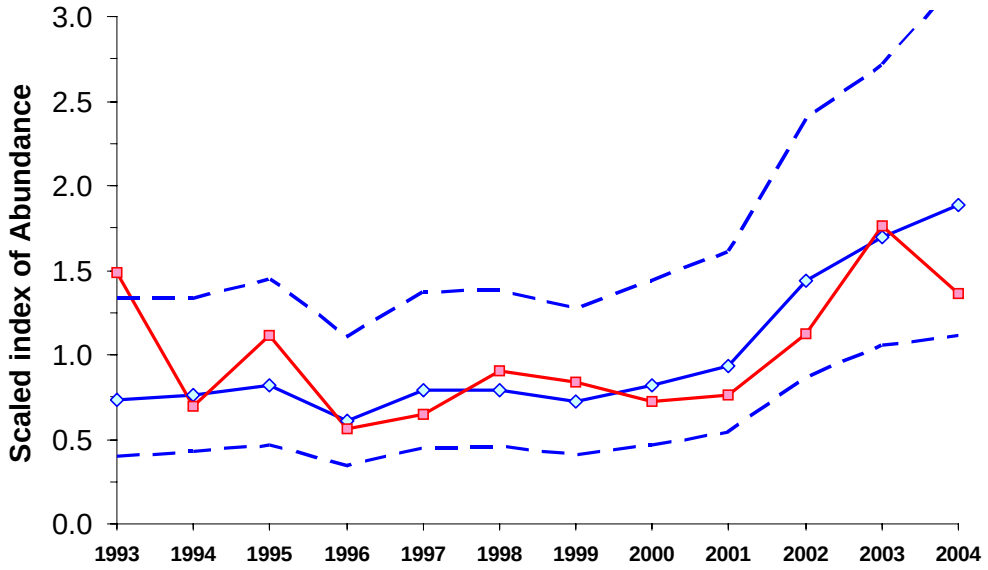

Figure 2: Greater amberjack nominal (red line) and standardized (blue line) indexes of abundance for the longline fishery. For comparison purposes both indexes were scaled to their means. Dashed blue line indicates 95% confidence interval of the standardized index.

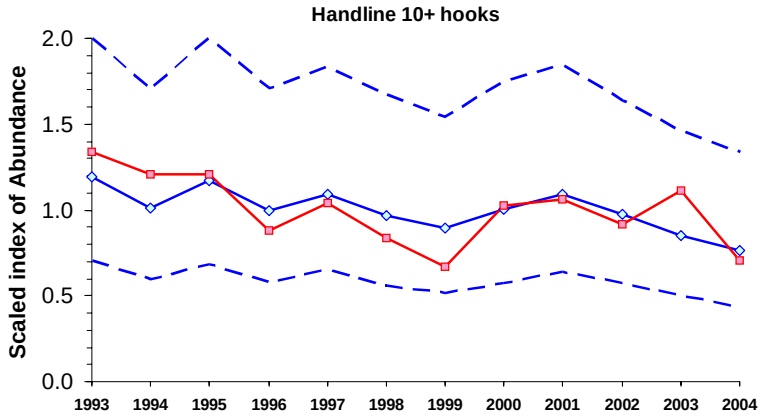

Figure 3: Greater amberjack nominal (red line) and standardized (blue line) indexes of abundance for the handline 10+ hooks fishery. For comparison purposes both indexes were scaled to their means. Dashed blue line indicates 95% confidence interval of the standardized index.

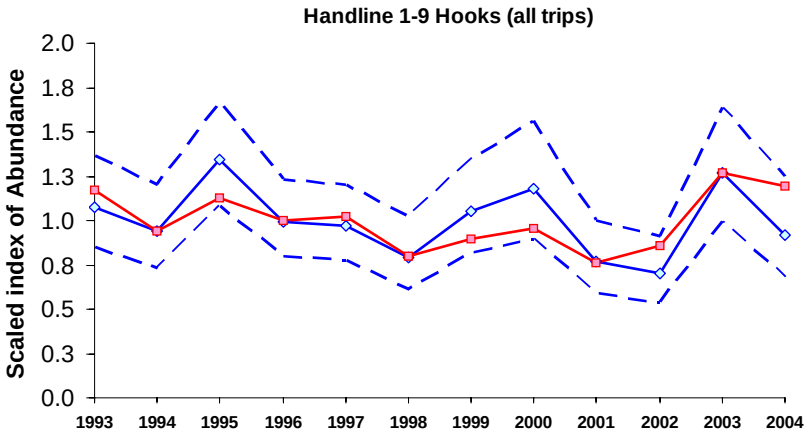

Figure 4: Greater amberjack nominal (red line) and standardized (blue line) indexes of abundance for the handline 1-9 hooks fishery all trips included. For comparison purposes both indexes were scaled to their means. Dashed blue line indicates 95% confidence interval of the standardized index.

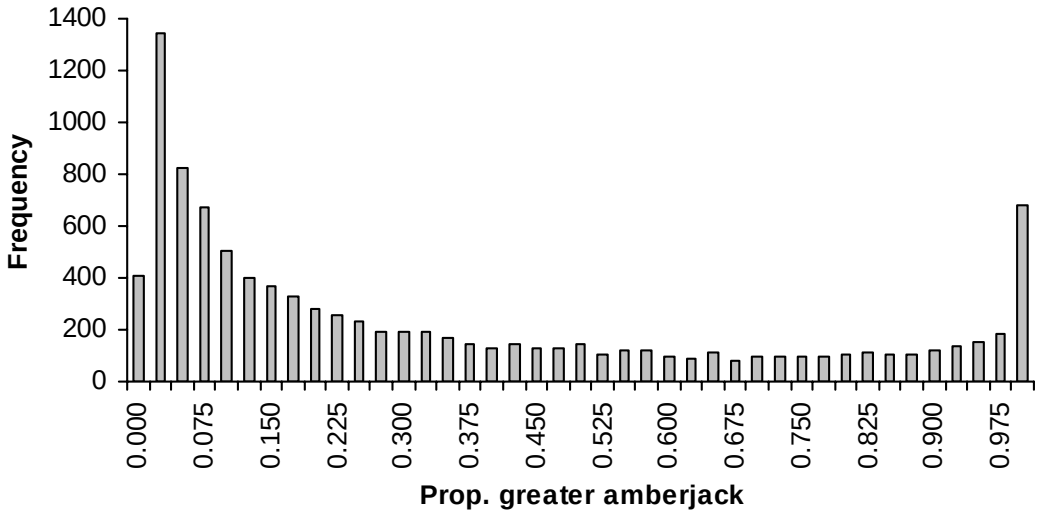

Figure 5: Frequency distribution of proportion of greater amberjack to the total landings by trip for the handline 1-9 hooks fishery.

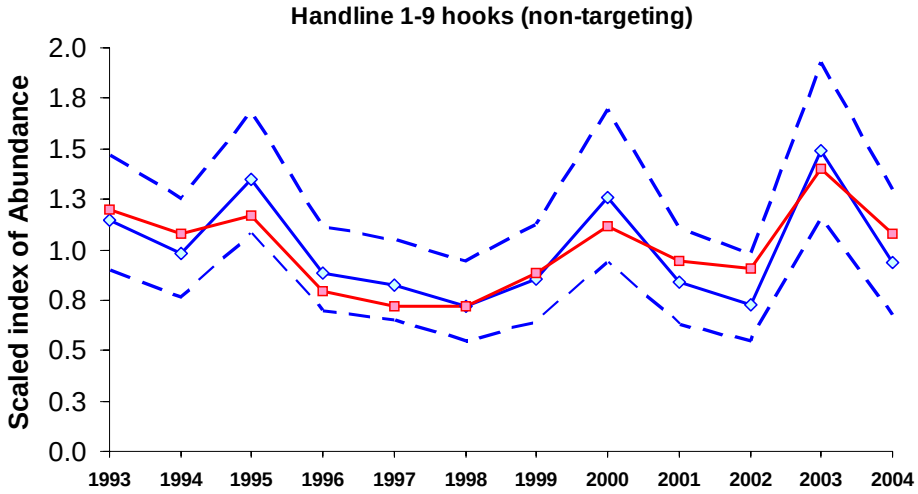

Figure 6: Greater amberjack nominal (red line) and standardized (blue line) indexes of abundance for the handline 1-9 hooks fishery not including vessels that targeted greater amberjack. For comparison purposes both indexes were scaled to their means. Dashed blue line indicates 95% confidence interval of the standardized index.

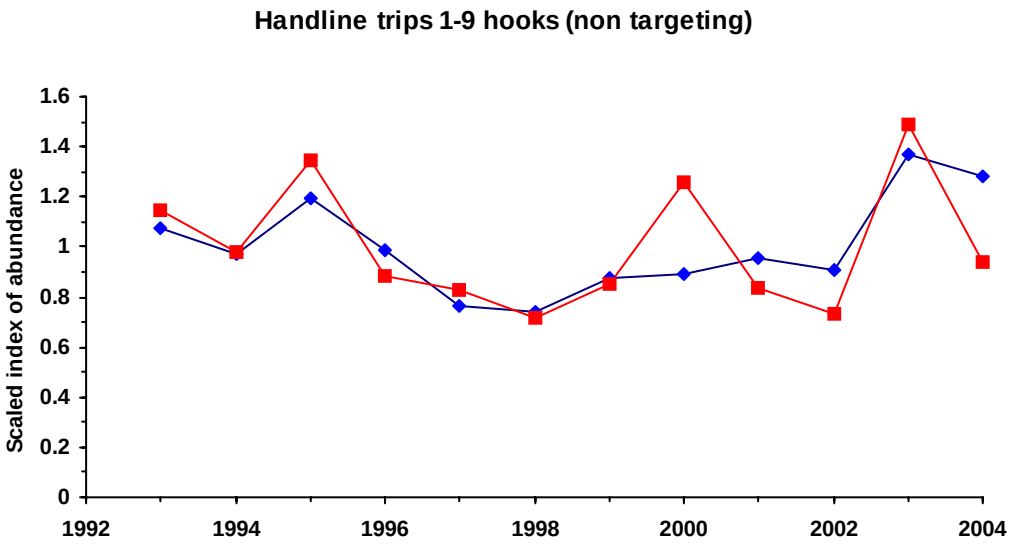

Figure 7: Estimated greater amberjack standardized indexes of abundance for handline 1-9 hooks trips (excluding trips targeting greater amberjack). The red line correspond to the index estimated from a set of trips selected using the species composition method. The blue line shows the index estimated using all available trips. For comparison purposes, the indexes were scaled to their mean value of the time series.

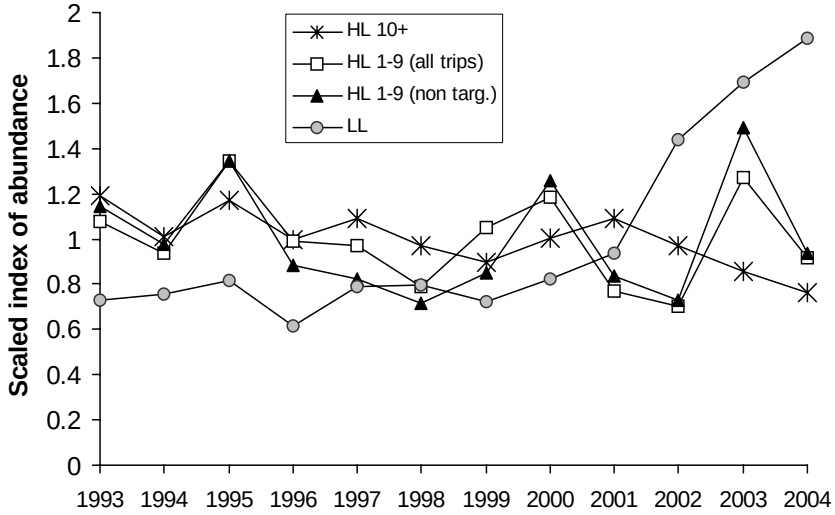

Figure 8: Estimated greater amberjack standardized indexes of abundance for the handline10+ hooks (HL 10+), handline 1-9 hooks (all trips included), handline 1-9 hooks excluding trips targeting greater amberjack (HL 1-9 non targ.) and longline fisheries. For comparison purposes, all indexes were scaled to their mean value of the time series.