Preliminary analysis of some deepwater species in the South Atlantic headboat survey data

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Headboat Survey Methods

For a complete description of the methods used in estimating catches and fishing effort of the Southeast United States headboat fleet see the draft report by Dixon and Huntsman, "Estimating Catches and Fishing Effort of the Southeast United States Headboat Fleet, 1972-1982", National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Beaufort Laboratory, Beaufort, North Carolina.

Deepwater Species

The species selected for this analysis include the following:

Table 1. Deepwater species selected for this analysis with their corresponding code used in the headboat survey database.

code	common name	scientific name
20	Speckled Hind	*Epinephelus drummondhayi*
21	Snowy Grouper	*Epinephelus niveatus*
23	Warsaw Grouper	*Epinephelus nigritus*
25	Yellowedge Grouper	*Epinephelus flavolimbatus*
40	Blueline Tilefish	*Caulolatilus microps*
43	Tilefish	*Lopholatilus chamaeleonticeps*
59	Misty Grouper	*Epinephelus mystacinus*
260	Queen Snapper	*Etelis oculatus*

Geographic Coverage

1972 - 1975 = Cape Hatteras, NC - Charleston, SC 1/
1976 - 1977 = Cape Hatteras, NC - Cape Canaveral, FL 2/
1978 - 2002 = Cape Hatteras, NC - Key West, FL (includes Dry Tortugas) 3/

1/ This period did not include vessels south of Charleston, SC, as did 1976 - 2002.
2/ The 1976 - 1977 definition of Area 8 was only as far south as Cape Canaveral, FL, while the 1978 - 2002 definition of Area 8 was from Daytona Beach, FL - Sebastian, FL.
3/ Coverage of South Florida and Florida Keys, by port agents, was very sparse and only part-time in the Florida Keys, 1978 - 1980, so landings and effort estimates were imprecise.

Landings Estimates

All estimates were calculated by hand prior to 1980. A computer was used in 1980 and 1981, to sum species by vessel/month and calculate mean weights of common species, but all expansions for missing trips and means weights of species with small sample size, were still calculated by hand. From 1981 - 2002, a computer program was used for all estimates except mean weights of rare species.

Landings data by species are not in computer files prior to 1981 and therefore, are unavailable for many species. Some previous reports included data by species, so landings data were available for snowy grouper, speckled hind, and blueline tilefish, 1973 - 1980.

For 1973 - 1980, landings data were unavailable for warsaw grouper and yellowedge grouper. The 1973 - 1980 estimates of grouper landings were grouped into *Mycteroperca* species and *Epinephelus* species. The following formula was used to estimate the 1973 - 1980 landings of these two species:

(Rep Wgr / Rep *E).* x (Est of *E.)* 1/
and
(Rep Yegr / Rep *E.)* x (Est of *E.)* 1/

1/ Rep Wgr = Number of warsaw grouper reported on trip reports
Rep *E.* = Number of *Epinephelus* groupers reported on trip reports
Est of *E.* = Number of *Epinephelus* groupers estimated (correcting for missing trips)
Rep Yegr = Number of yellowedge grouper reported on trip reports

For 1973 - 1975, the data were combined to produce one estimate of the North Carolina and South Carolina landings. For 1976 - 1980, the data were combined to produce an estimate of NC and SC landings, and a separate estimate of the Georgia and north Florida landings. No estimates were calculated for south Florida and the Florida Keys.

The calculated estimates, using the above equation, were somewhat imprecise. For three of the estimates, the estimated number landed were smaller (in parentheses) than the reported number landed. They were: (1) 1978 NC/SC Warsaw grouper (54) 58
(2) 1978 NC/SC Yellowedge grouper (322) 354
(3) 1979 NC/SC Warsaw grouper (83) 136

For these three estimates, the reported numbers were used in the data series.

To get an associated weight of landed fish for the Warsaw and yellowedge species before 1980 and 1981, respectively, the average weight of landed fish from 1980-1984 and 1981-1985 for Warsaw and yellowedge, respectively, were multiplied by the number estimated above. This extended the time series of landings back to 1972 and 1973 for Warsaw and yellowedge, respectively.

Note that reported landings before 1978 do not include all headboats which may have been in operation in the South Atlantic (see Geographic Coverage above). No correction factor has been determined at this time to account for any possible headboats operating in non-coverage areas from 1972-1977.

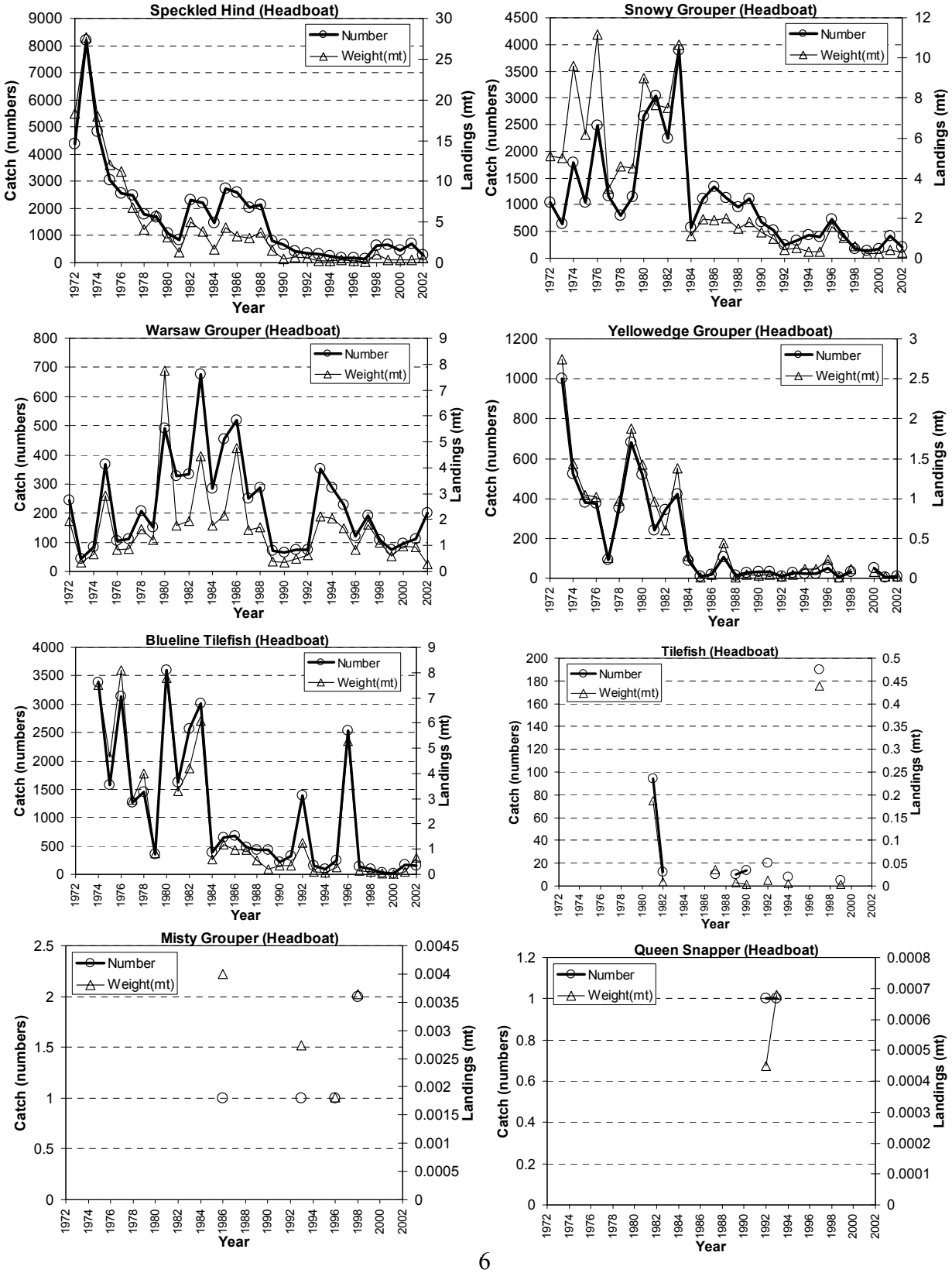
Table 2. Estimated total number of deepwater species landed from the South Atlantic headboat fishery.

Year	Speckled Hind	Snowy Grouper	Warsaw Grouper	Yellowedge Grouper	Blueline Tilefish	Tilefish	Misty Grouper	Queen Snapper
1972	4387	1035	243	-	-	-	-	-
1973	8189	636	44	1001	-	-	-	-
1974	4829	1793	84	522	3389	-	-	-
1975	3049	1039	368	380	1576	-	-	-
1976	2544	2486	104	373	3141	-	-	-
1977	2486	1157	110	92	1267	-	-	-
1978	1776	797	207	354	1450	-	-	-
1979	1691	1142	151	683	360	-	-	-
1980	1069	2664	491	520	3606	-	-	-
1981	844	3046	326	241	1621	94	-	-
1982	2319	2243	334	344	2566	12	-	-
1983	2189	3895	675	421	3015	-	-	-
1984	1476	570	283	87	389	-	-	-
1985	2735	1108	455	8	649	-	-	-
1986	2590	1338	519	17	679	-	1	-
1987	2022	1134	249	105	475	10	-	-
1988	2138	953	288	12	436	-	-	-
1989	793	1118	70	26	432	10	-	-
1990	649	677	66	32	209	14	-	-
1991	406	529	74	31	319	-	-	-
1992	349	238	74	8	1393	20	-	1
1993	314	325	353	27	151	-	1	1
1994	228	438	287	22	98	8	-	-
1995	175	395	229	22	254	-	-	-
1996	188	722	119	52	2534	-	1	-
1997	148	411	190	5	140	190	-	-
1998	613	172	109	34	94	-	2	-
1999	668	142	74	-	31	5	-	-
2000	455	178	95	49	23	-	-	-
2001	687	411	111	5	166	-	-	-
2002	268	200	200	7	157	-	-	-

Table 3. Estimated total weight (mt) of deepwater species landed from the South Atlantic headboat fishery.

Year	Speckled Hind	Snowy Grouper	Warsaw Grouper	Yellowedge Grouper	Blueline Tilefish	Tilefish	Misty Grouper	Queen Snapper
1972	18.33	5.12	1.94	-	-	-	-	-
1973	27.62	4.98	0.35	2.75	-	-	-	-
1974	17.98	9.58	0.67	1.43	7.52	-	-	-
1975	12.02	6.16	2.93	1.04	4.66	-	-	-
1976	11.20	11.16	0.83	1.02	8.11	-	-	-
1977	6.72	3.47	0.88	0.25	2.97	-	-	-
1978	4.10	4.58	1.65	0.97	3.98	-	-	-
1979	5.84	4.48	1.20	1.88	0.82	-	-	-
1980	3.10	9.00	7.73	1.43	7.77	-	-	-
1981	1.27	7.65	1.76	0.96	3.29	0.187	-	-
1982	4.96	7.52	1.94	0.60	4.21	0.008	-	-
1983	3.82	10.65	4.44	1.38	6.08	-	-	-
1984	1.66	1.10	1.79	0.28	0.59	-	-	-
1985	4.34	1.96	2.16	0.01	1.18	-	-	-
1986	3.31	1.92	4.77	0.04	0.99	-	0.004	-
1987	3.09	2.00	1.59	0.44	0.98	0.036	-	-
1988	3.76	1.49	1.69	0.02	0.54	-	-	-
1989	1.47	1.83	0.39	0.04	0.20	0.006	-	-
1990	0.52	1.29	0.34	0.04	0.34	0.003	-	-
1991	0.74	0.99	0.49	0.04	0.36	-	-	-
1992	0.57	0.40	0.62	0.02	1.26	0.012	-	0.0005
1993	0.25	0.49	2.12	0.05	0.11	-	0.003	0.0007
1994	0.23	0.33	2.05	0.12	0.07	0.005	-	-
1995	0.41	0.33	1.68	0.11	0.26	-	-	-
1996	0.18	1.55	0.82	0.23	5.30	-	0.002	-
1997	0.14	1.00	1.80	0.01	0.12	0.439	-	-
1998	1.02	0.59	1.12	0.12	0.12	-	0.004	-
1999	0.38	0.23	0.59	-	0.03	0.004	-	-
2000	0.37	0.23	0.97	0.08	0.01	-	-	-
2001	0.38	0.43	0.93	0.02	0.10	-	-	-
2002	0.58	0.26	0.26	0.02	0.65	-	-	-

Figure 1. Number and weight (mt) of landed deepwater species from the South Atlantic headboat fishery.



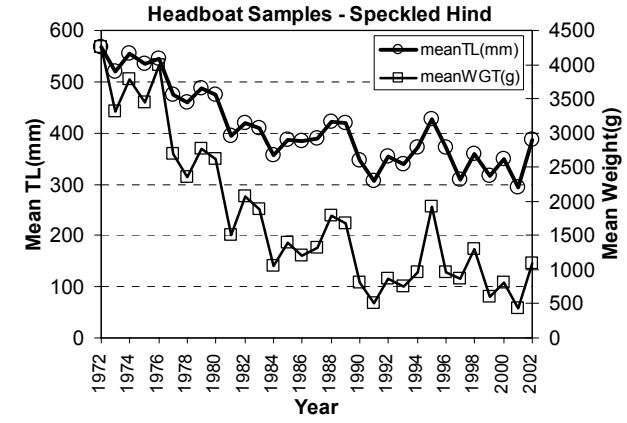
Length and Weight Measurements

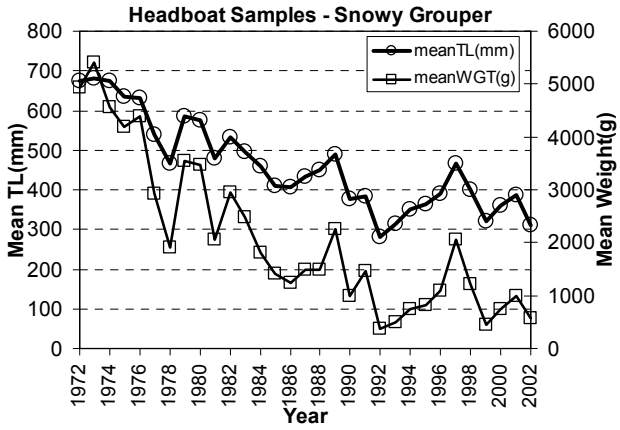
Measurements of length and weight are collected by port samplers either at the return of a headboat trip (i.e. dockside) or by riding on the headboat during a fishing trip. Fish are measured for total length (TL) to the nearest millimeter and for weight to the nearest gram. For some records there are fish weight measurements with no associated length. For those cases a length-weight relationship was fit and then used to predict the missing length. Some records have a length measurement with no associated weight measurement. In those cases the length measurement is likely a duplicate record for cases when additional otolith or gonad samples were collected. Therefore these data records were removed for later analyses.

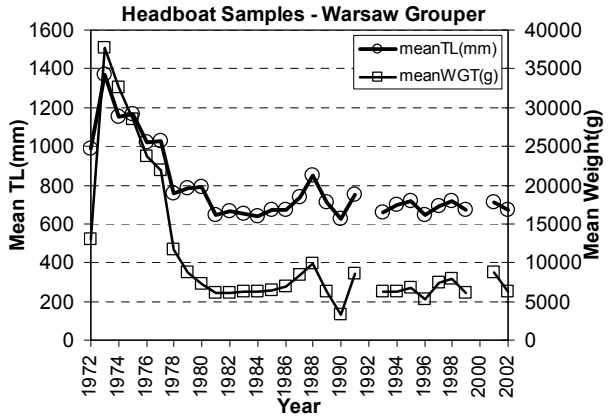
Table 4. Sample sizes of length and weight measurements sampled deepwater species from the South Atlantic headboat fishery.

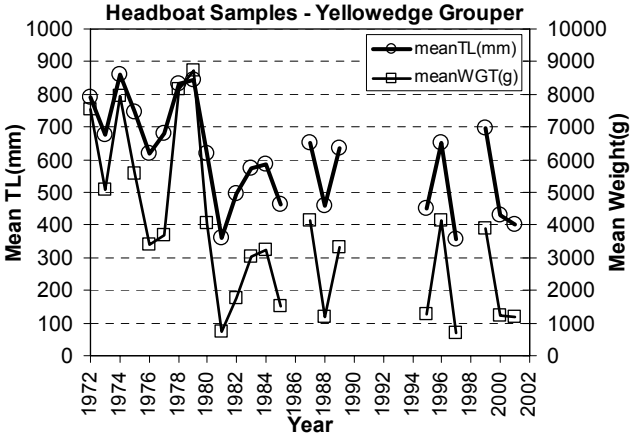
Year	Speckled Hind	Snowy Grouper	Warsaw Grouper	Yellowedge Grouper	Blueline Tilefish	Tilefish	Misty Grouper	Queen Snapper
1972	140	67	10	14	125			
1973	241	23	1	4	80			
1974	175	180	13	14	76			
1975	177	145	8	31	38			
1976	101	104	18	15	62			
1977	149	39	5	3	40		1	
1978	124	29	17	4	29			
1979	28	32	4	11	59			
1980	30	51	14	4	45			
1981	14	52	22	3	36	1		
1982	41	24	20	1	18			
1983	84	67	17	11	43			
1984	108	42	43	3	29			
1985	82	68	12	1	20			
1986	75	77	19		30			
1987	48	35	9	2	9			
1988	48	45	1	1	8			
1989	30	50	15	2	10	17		
1990	12	6	3		6	13		
1991	7	3	1		2			
1992	7	1				1		
1993	11	7	6					
1994	12	15	7					
1995	14	11	10	1				
1996	12	18	2	4	2			
1997	21	33	9	1	32		5	2
1998	22	10	8		6			
1999	15	1	4	1		2		
2000	10	4		7	36			
2001	4	12	2	3	15	2	1	
2002	7	5	5					

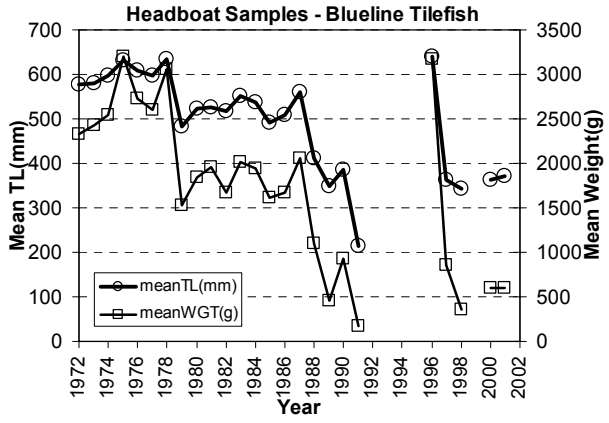
Figure 2. Average length (mm) and weight (kg) of sampled deepwater species from the South Atlantic headboat fishery.











Catch and Effort

Recorded catch records from the headboat survey include trip specific information including the date, trip duration, number of anglers, number of fish by species, and location. Table 5 indicates the total number of trips recorded for 1972-2002 from the South Atlantic headboat fishery. It is clear that the percentage of trips catching deepwater species declined rapidly in the 1970's and has remained fairly low, with a long term average of approximately 5%.

Table 5. Recorded trips in the South Atlantic headboat survey. Species trips include trips which reported catching at least one member of the deepwater complex listed in Table 1. Location trips include trips with a valid location record.

				Percent of Total Trips	
Year	Total Trips	Location Trips	Species Trips	Location Trips	Species Trips
1973	725	8	431	1.1%	59.4%
1974	1236	522	528	42.2%	42.7%
1975	1913	1207	442	63.1%	23.1%
1976	3010	2619	474	87.0%	15.7%
1977	3563	3051	396	85.6%	11.1%
1978	4903	4180	480	85.3%	9.8%
1979	8033	6293	479	78.3%	6.0%
1980	11182	10611	532	94.9%	4.8%
1981	11129	10943	543	98.3%	4.9%
1982	12097	11831	691	97.8%	5.7%
1983	11935	11855	712	99.3%	6.0%
1984	11039	10789	544	97.7%	4.9%
1985	11678	10645	1058	91.2%	9.1%
1986	13609	13340	660	98.0%	4.8%
1987	13824	13534	594	97.9%	4.3%
1988	11753	11326	524	96.4%	4.5%
1989	10596	10212	344	96.4%	3.2%
1990	11046	10938	232	99.0%	2.1%
1991	10480	10243	231	97.7%	2.2%
1992	14782	13556	266	91.7%	1.8%
1993	13709	12136	254	88.5%	1.9%
1994	12441	10841	429	87.1%	3.4%
1995	12168	10500	419	86.3%	3.4%
1996	9084	6343	364	69.8%	4.0%
1997	6359	3408	184	53.6%	2.9%
1998	9260	4429	325	47.8%	3.5%
1999	7676	3783	253	49.3%	3.3%
2000	7766	3893	184	50.1%	2.4%
2001	6950	3345	266	48.1%	3.8%
2002	5733	2851	213	49.7%	3.7%

The location information from the catch records of the headboat survey is reported by the captain of the headboat as a 10' x 10' grid location (Fig. 3). From Table 5 it can be seen that the percentage of trips which have "valid" location information was initially low (1973-1975), then remained above 80% through 1995, then dropped to around 50% until the present. The term "valid" is used rather loosely here. The location was converted to a latitude and longitude position representing the center of the 10' x 10' grid reported. Obvious records in the Arctic circle and near the equator were removed, more precisely latitudes were restricted to latitudes between 20 and 40 degrees N and longitudes between -85 and -73 degrees W. A plot of the remaining "valid" locations with a superimposed coastline clearly indicates that there remains some errant location records (Fig. 4).

Figure 3. Example of 10' x 10' latitude and longitude grid system used for reporting headboat fishing locations.

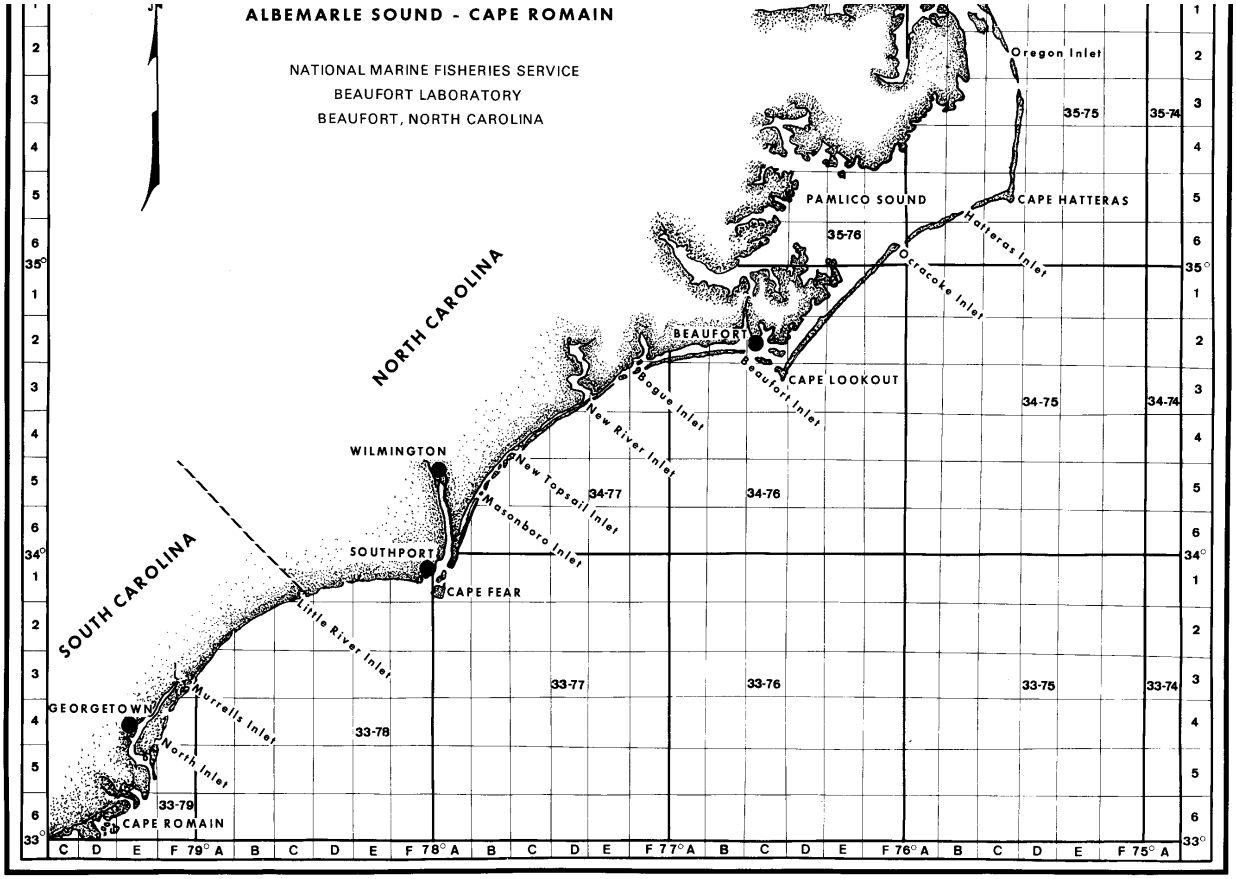
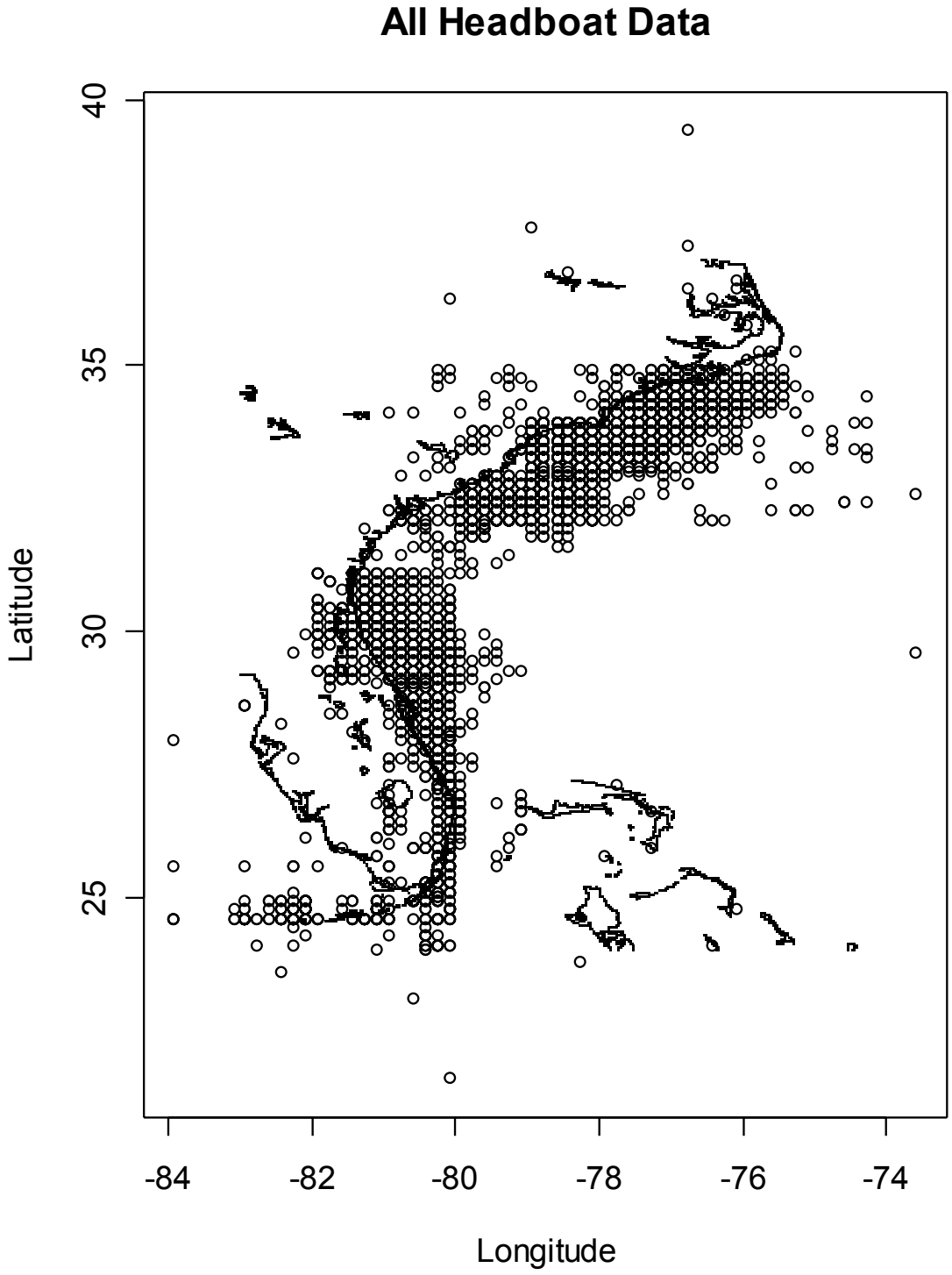


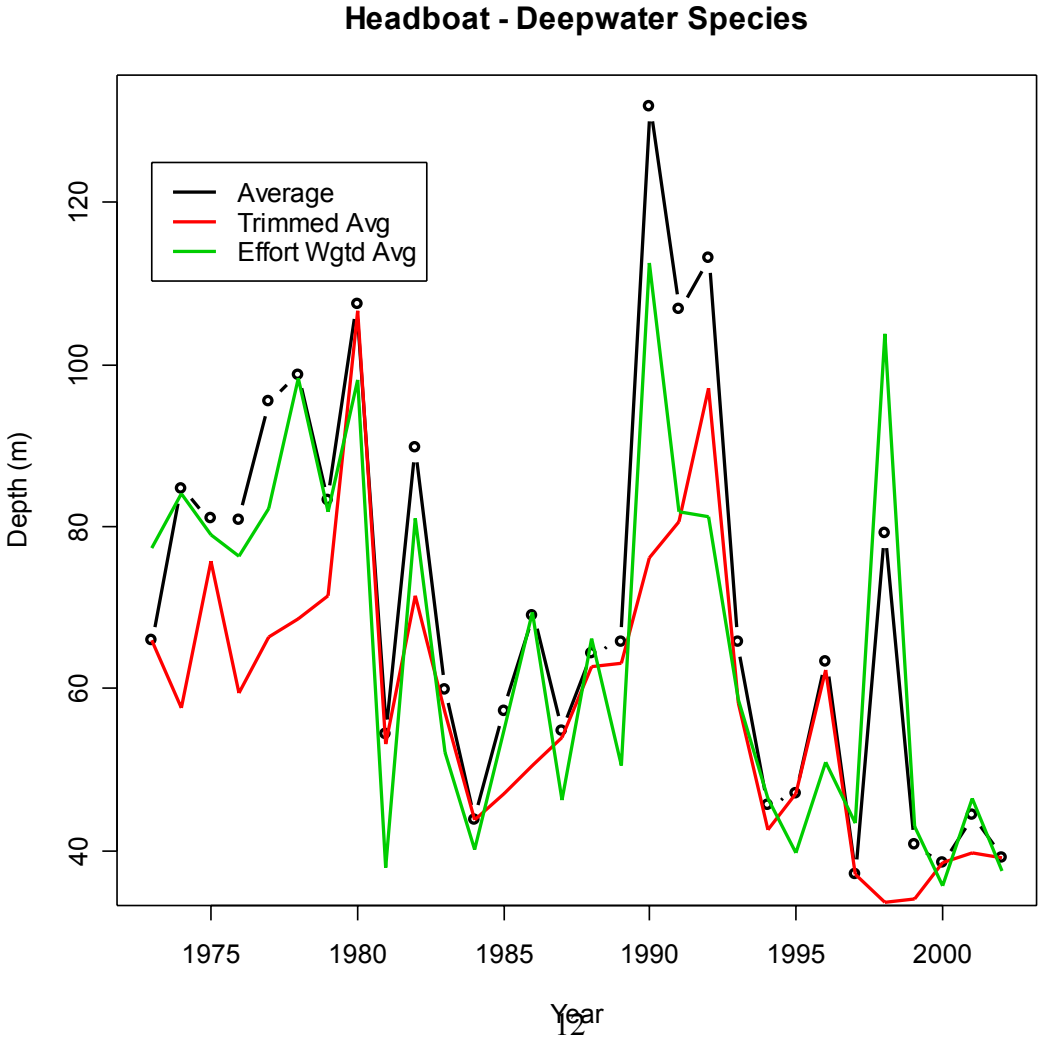
Figure 4. South Atlantic coastline showing set of unique location records from the South Atlantic headboat survey catch records.



The converted latitude and longitude grid centers were then used to get an associated depth measurement. A dataset of 10' x 10' grid depth measurements for the South Atlantic was provided by Jon Hare, National Ocean Service, Beaufort Laboratory, Beaufort, North Carolina. The depth measurements corresponded to the corners of the grids shown in Figure 3. The depth associated with the grid center was computed by trimming the minimum and maximum values and then taking the average of the remaining two measurements.

The catch record data was first subset into the trips in which at least one member of the deepwater complex was caught (Table 1 and 5). The depth information was then used to analyze further potential subsets of this data and any trends in the fishery with respect to depth. A first cut analysis of the depth information associated with just deepwater species trips indicated some depth measurements greater than 400 meters, unlikely depths for headboat fishing. These extreme depth measurements were either trimmed or set to the maximum depth in further analyses. An analysis of the average depth over time for deepwater species trips is shown in Figure 5.

Figure 5. Average depth of trips by year with location records which caught at least one member of the deepwater complex defined in Table 1.



It appears from Figure 5 that there has been some change in the depth of fishing over time, most notably in the most recent years. Further analyses examine the relationship of effort, computed as the product of anglers and trip duration, with depth and time (Figures 6-10).

Figure 6. Relationship of headboat fishing effort with trimmed depth (<400m) records for trips which caught at least one member of the deepwater complex as defined in Table 1.

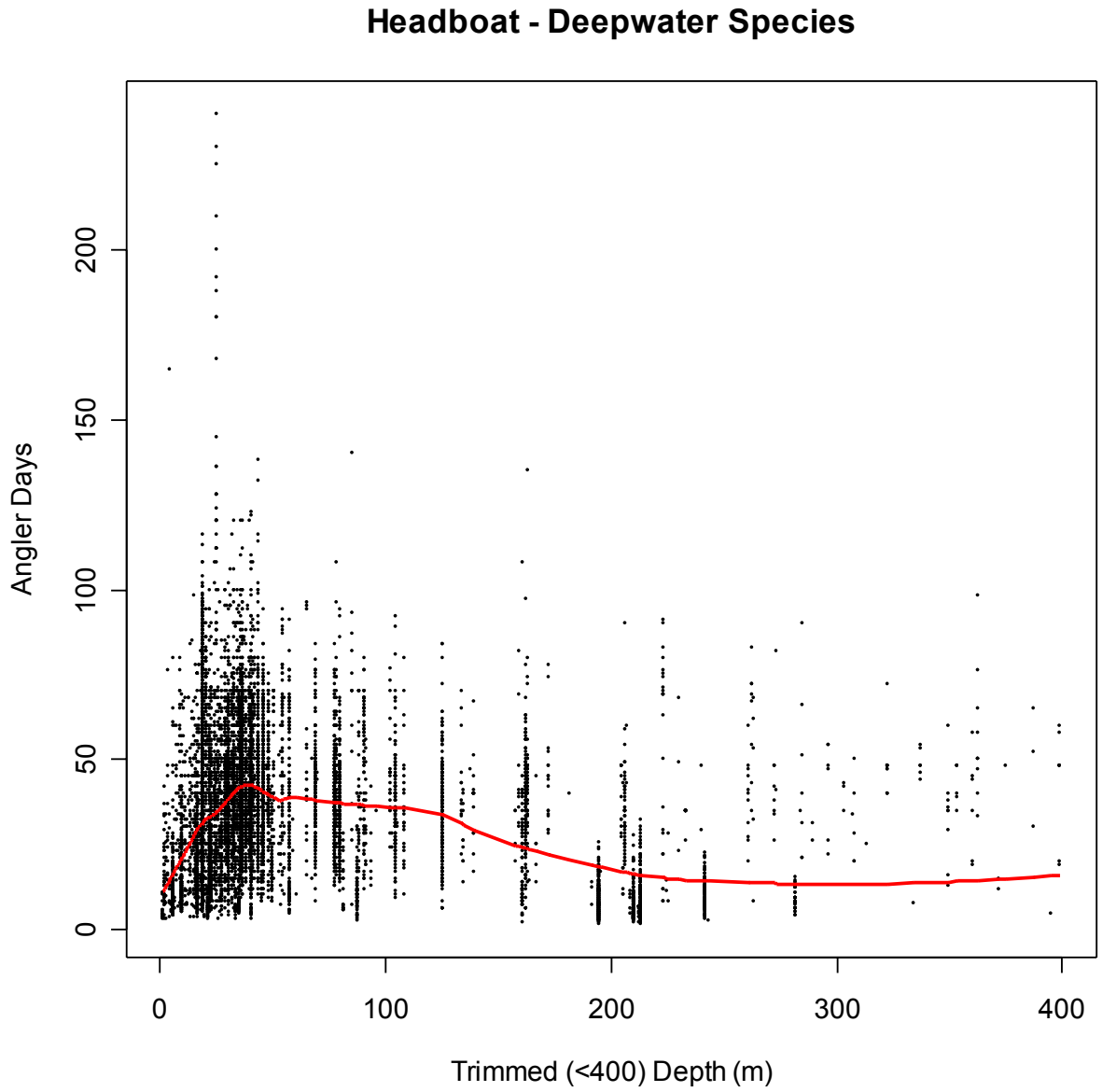


Figure 7. Total headboat fishing effort for trips which caught at least one member of the deepwater complex as defined in Table 1.

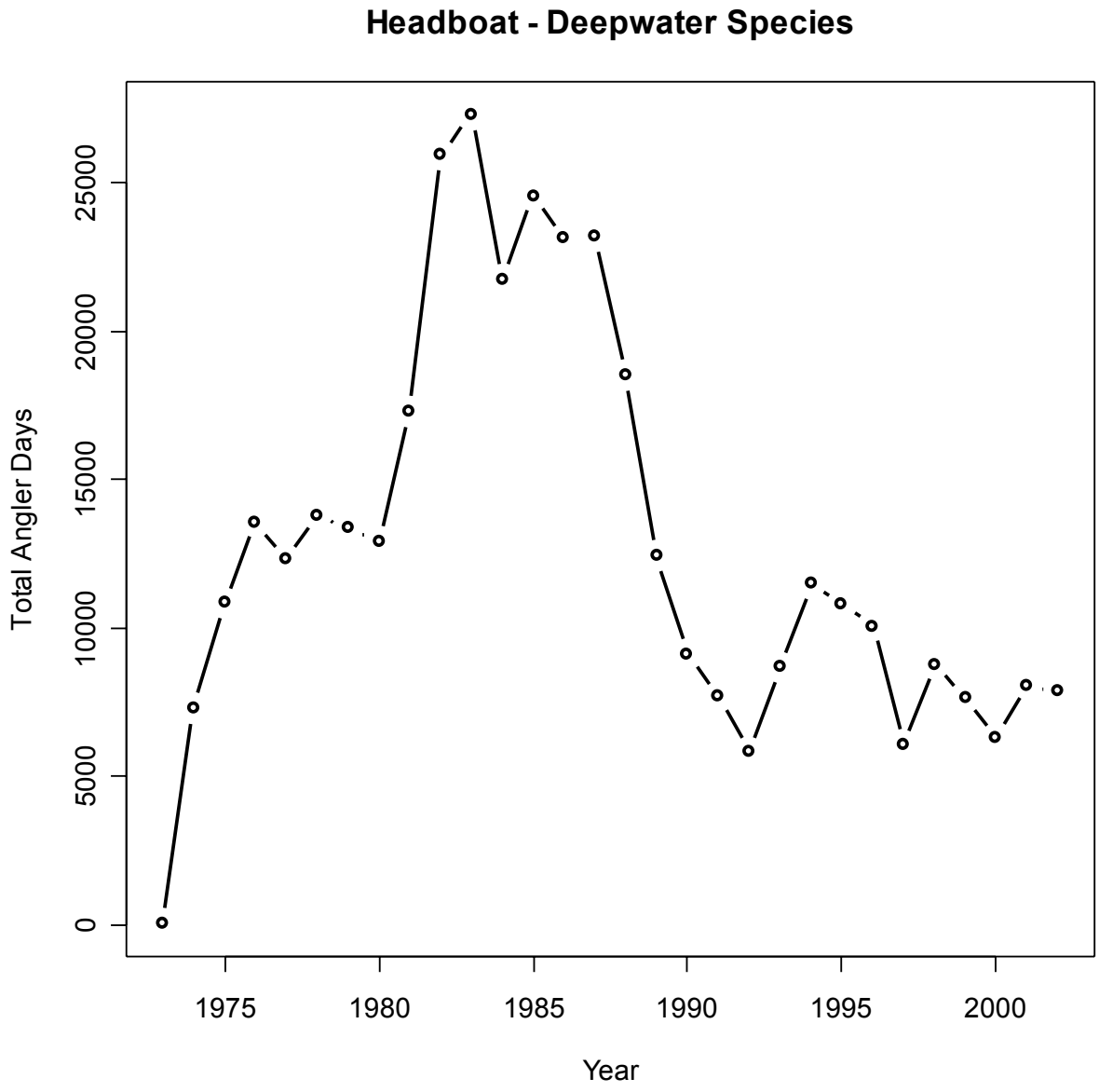


Figure 8. Distribution of fishing depths for trips which caught at least one member of the deepwater complex as defined in Table 1.

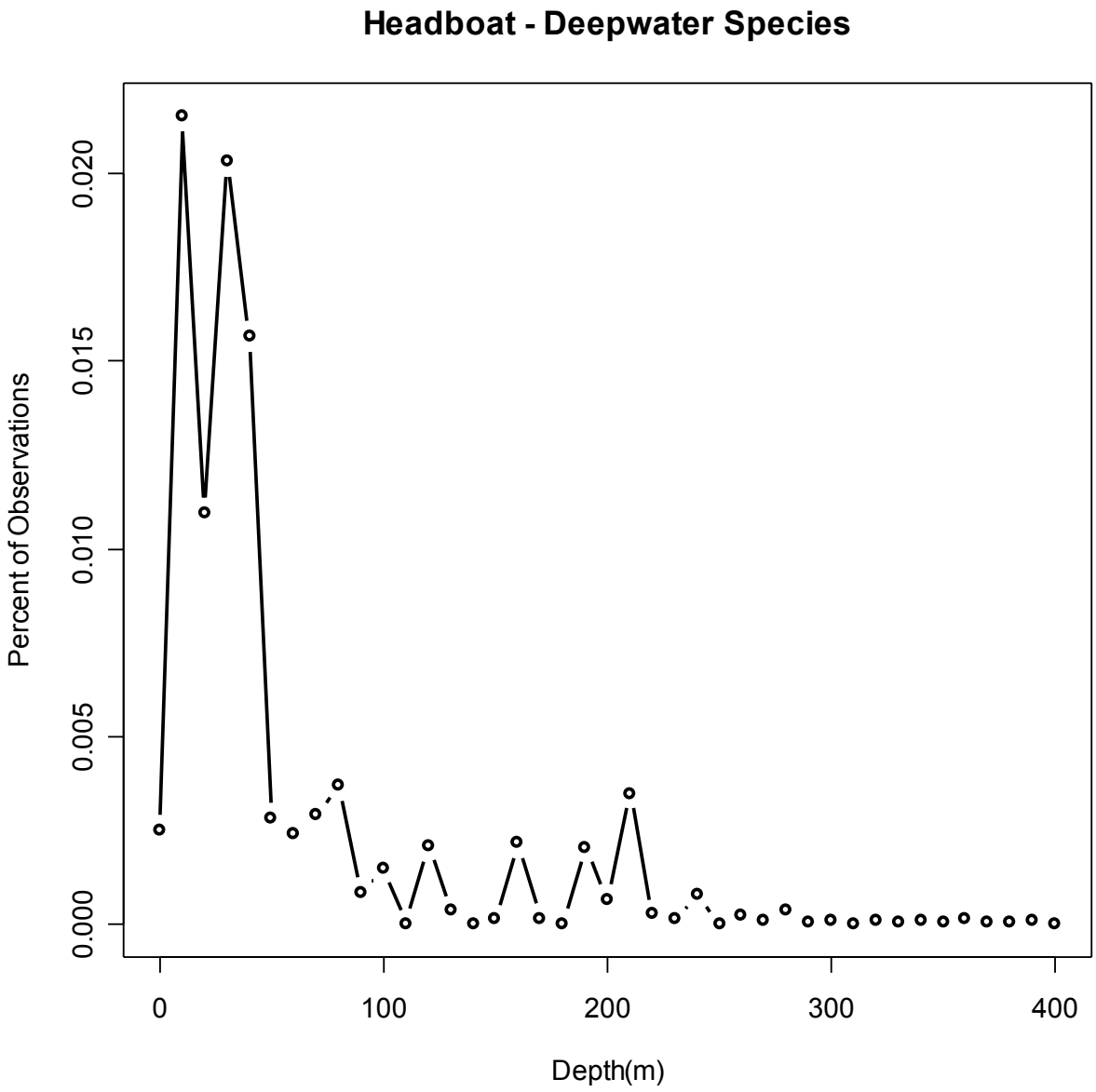


Figure 9. Headboat fishing effort by year for trips which caught at least one member of the deepwater complex as defined in Table 1 and for depths less than 80 meters.

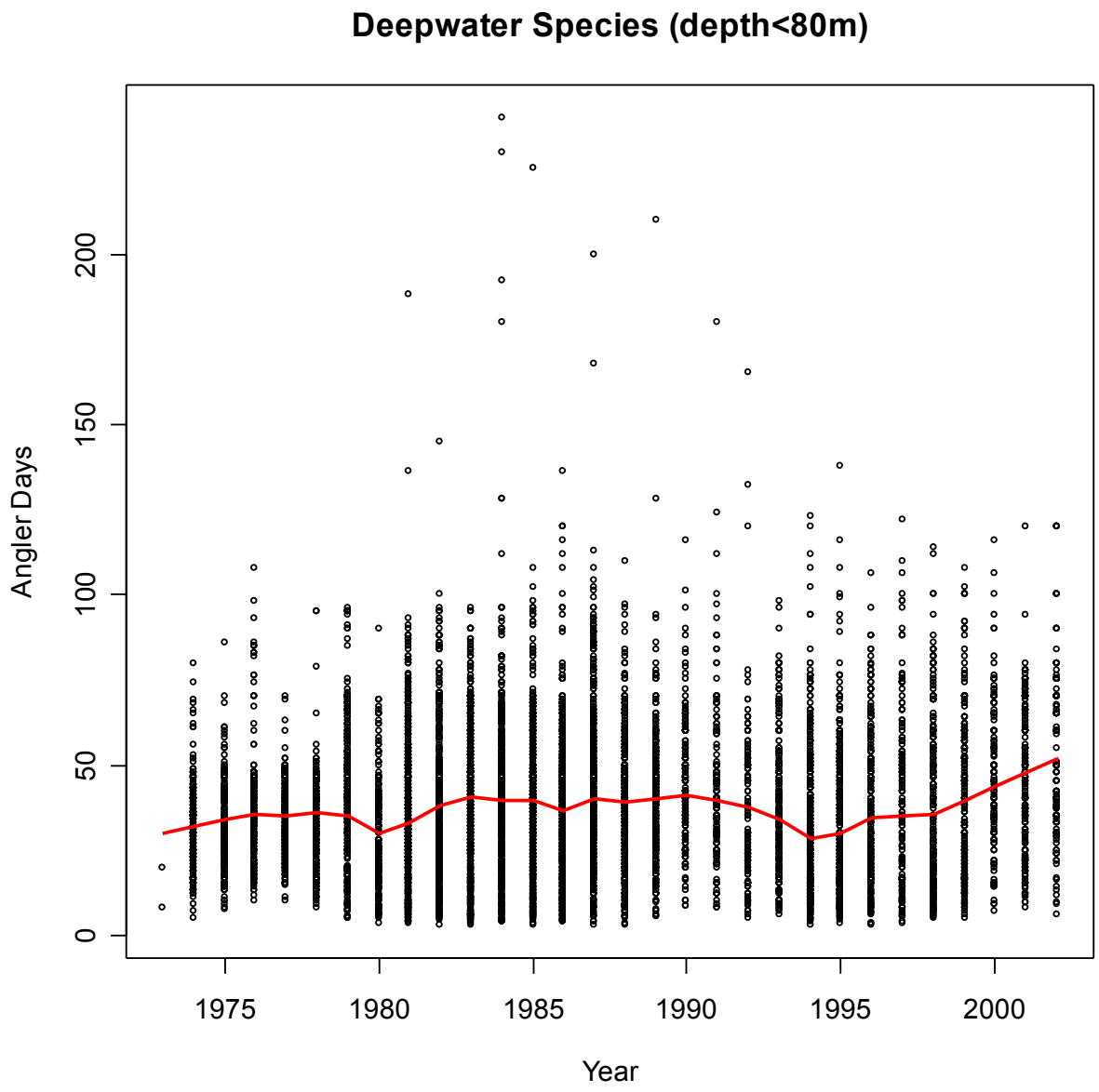
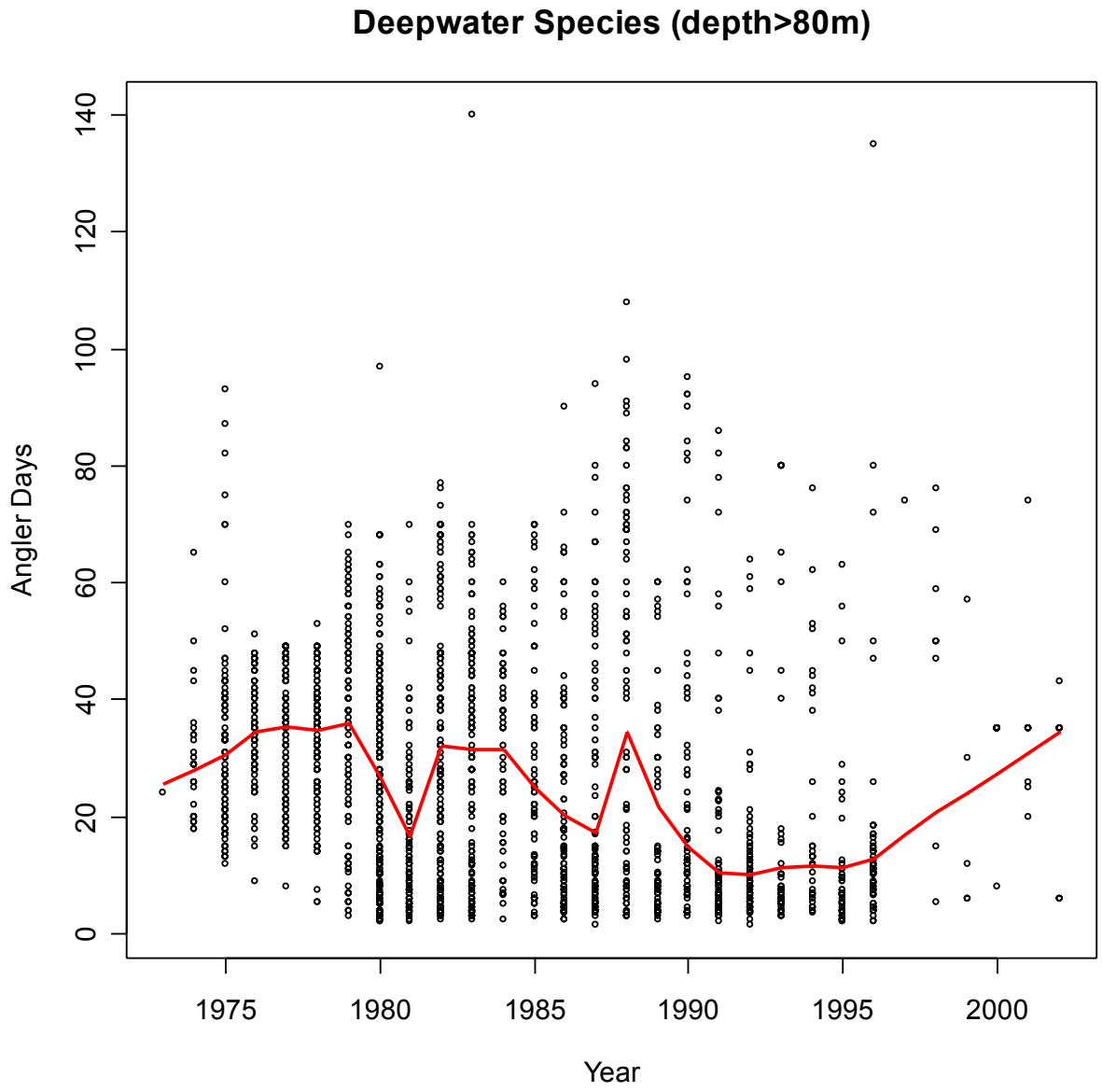


Figure 10. Headboat fishing effort by year for trips which caught at least one member of the deepwater complex as defined in Table 1 and for depths greater than 80 meters.



CPUE Indices

Catch per unit effort was computed as the number of fish caught divided by the product of anglers and trip duration. A delta-lognormal GLM procedure was used to obtain an annual index for use as an indicator of population abundance. Factors used in the GLM analysis included month and depth factor. Depth factor consisted of taking the depth measurements and classifying them into one of 3 categories: unknown, less than 80 meters, and greater than 80 meters. Given the amount of data available, indices could only be computed for 5 of the 8 species. An overall index was also computed for all species of the deepwater complex. The resulting indices are shown in Figures 11-16.

Figure 11. Catch per unit effort by year for speckled hind using trips which caught at least one member of the deepwater complex as defined in Table 1.

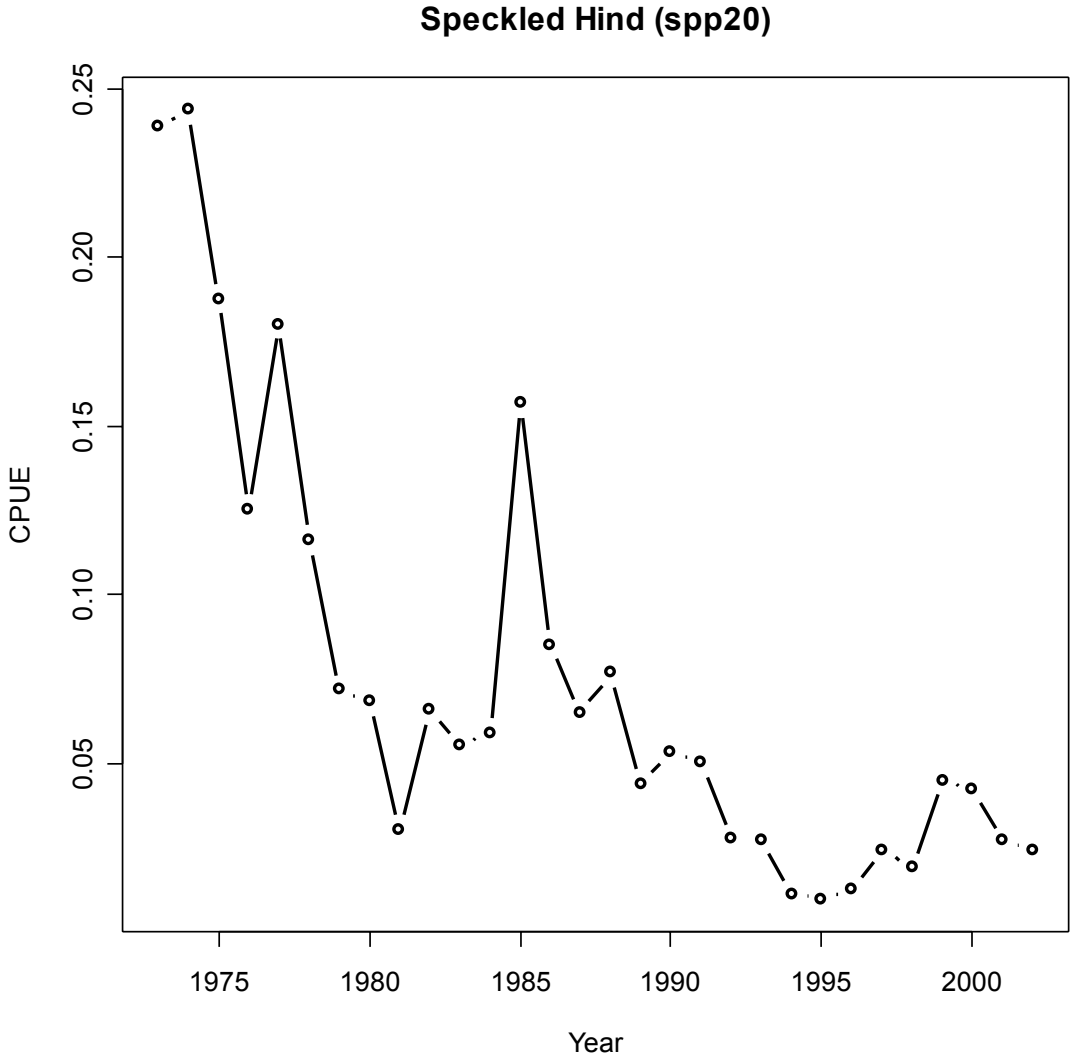


Figure 12. Catch per unit effort by year for snowy grouper using trips which caught at least one member of the deepwater complex as defined in Table 1.

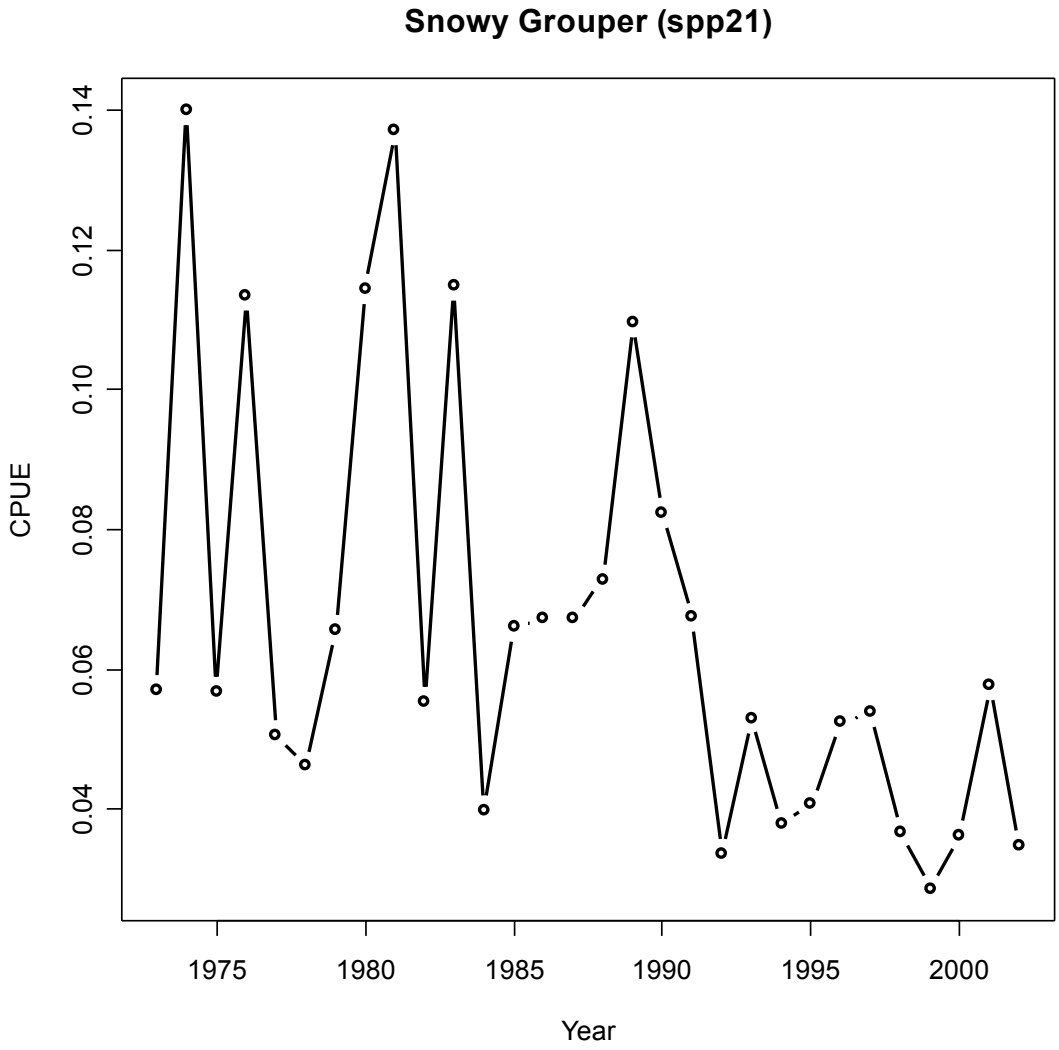


Figure 13. Catch per unit effort by year for warsaw grouper using trips which caught at least one member of the deepwater complex as defined in Table 1.

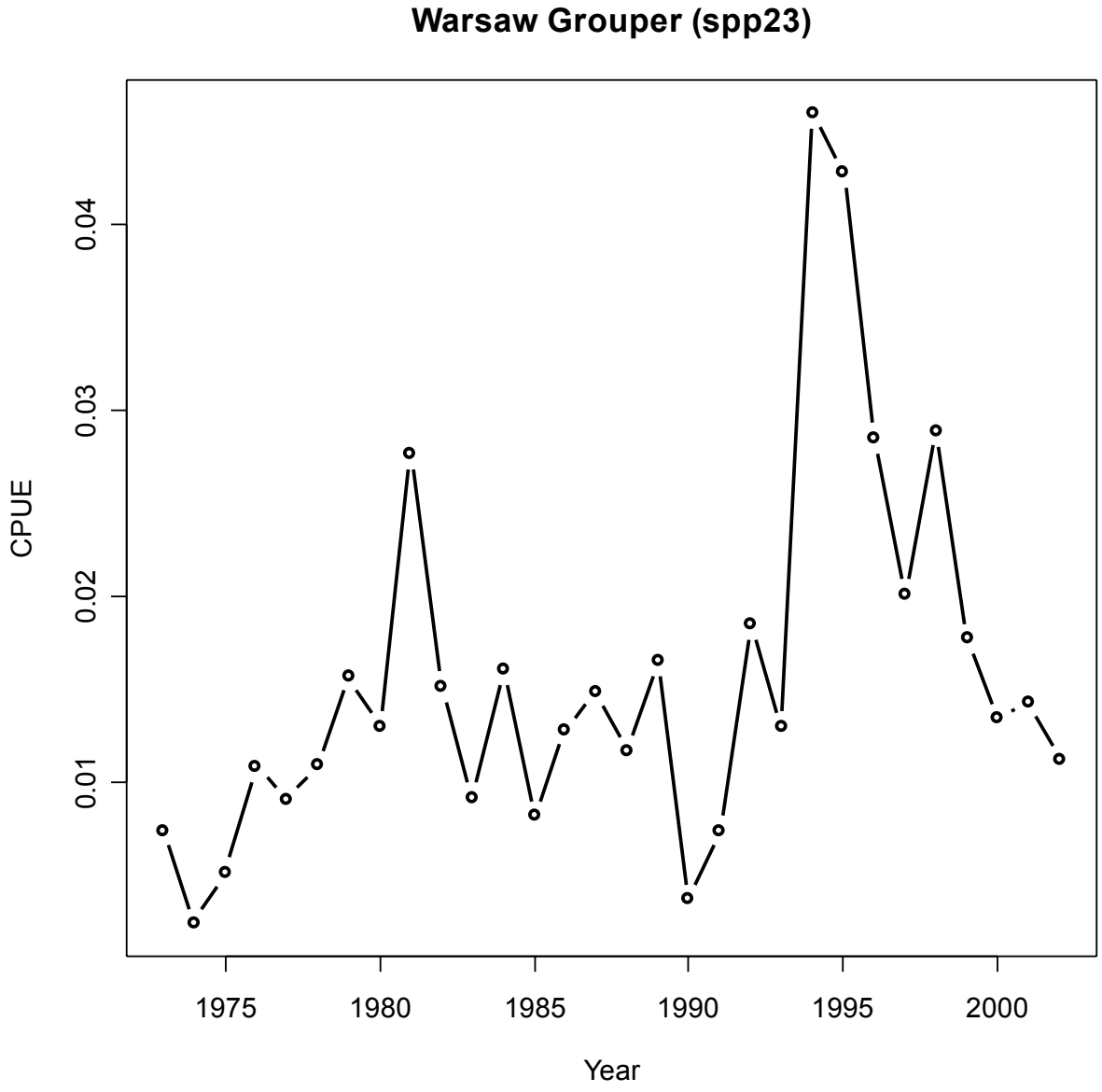


Figure 14. Catch per unit effort by year for yellowedge grouper using trips which caught at least one member of the deepwater complex as defined in Table 1.

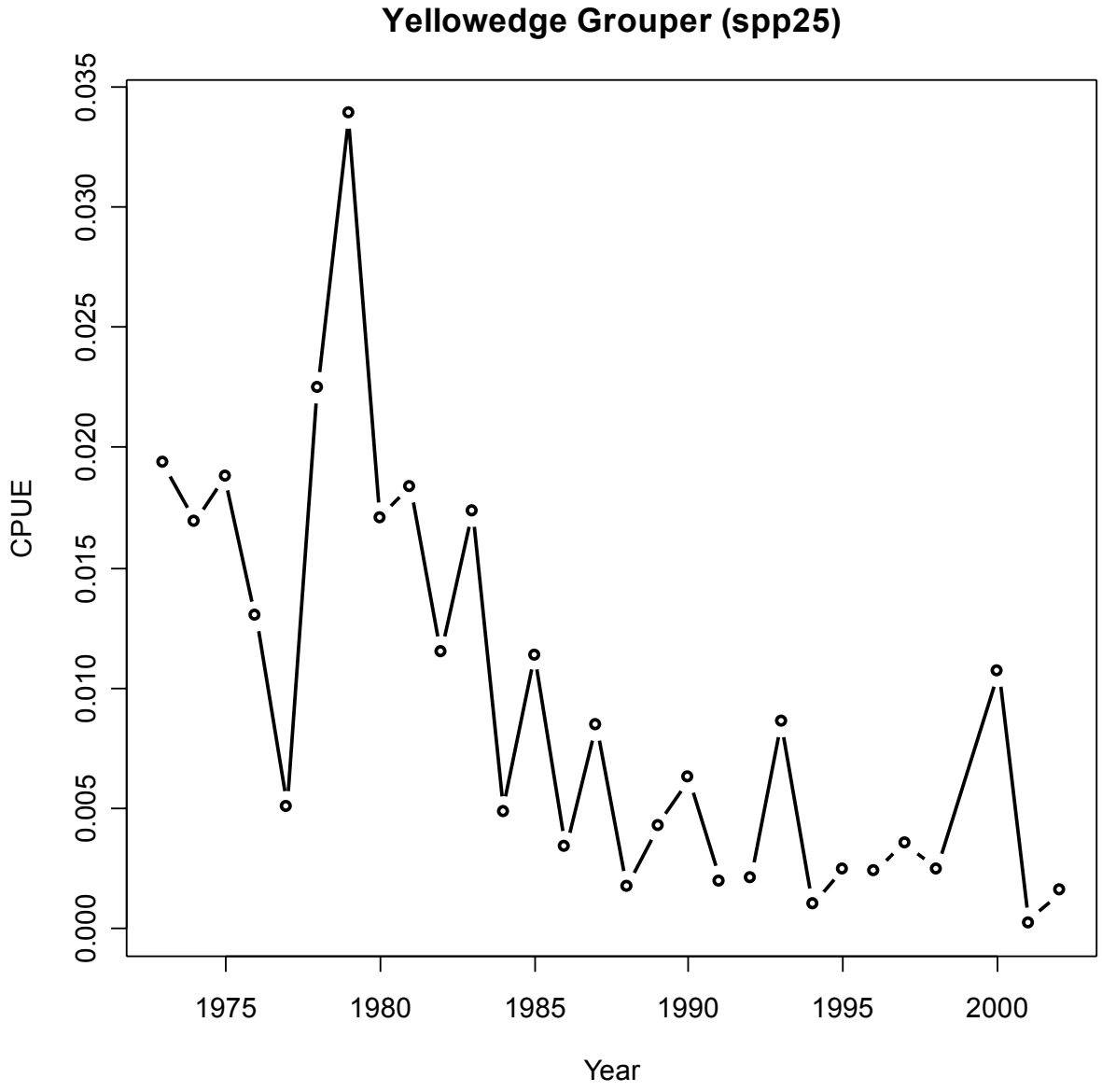


Figure 15. Catch per unit effort by year for blueline tilefish using trips which caught at least one member of the deepwater complex as defined in Table 1.

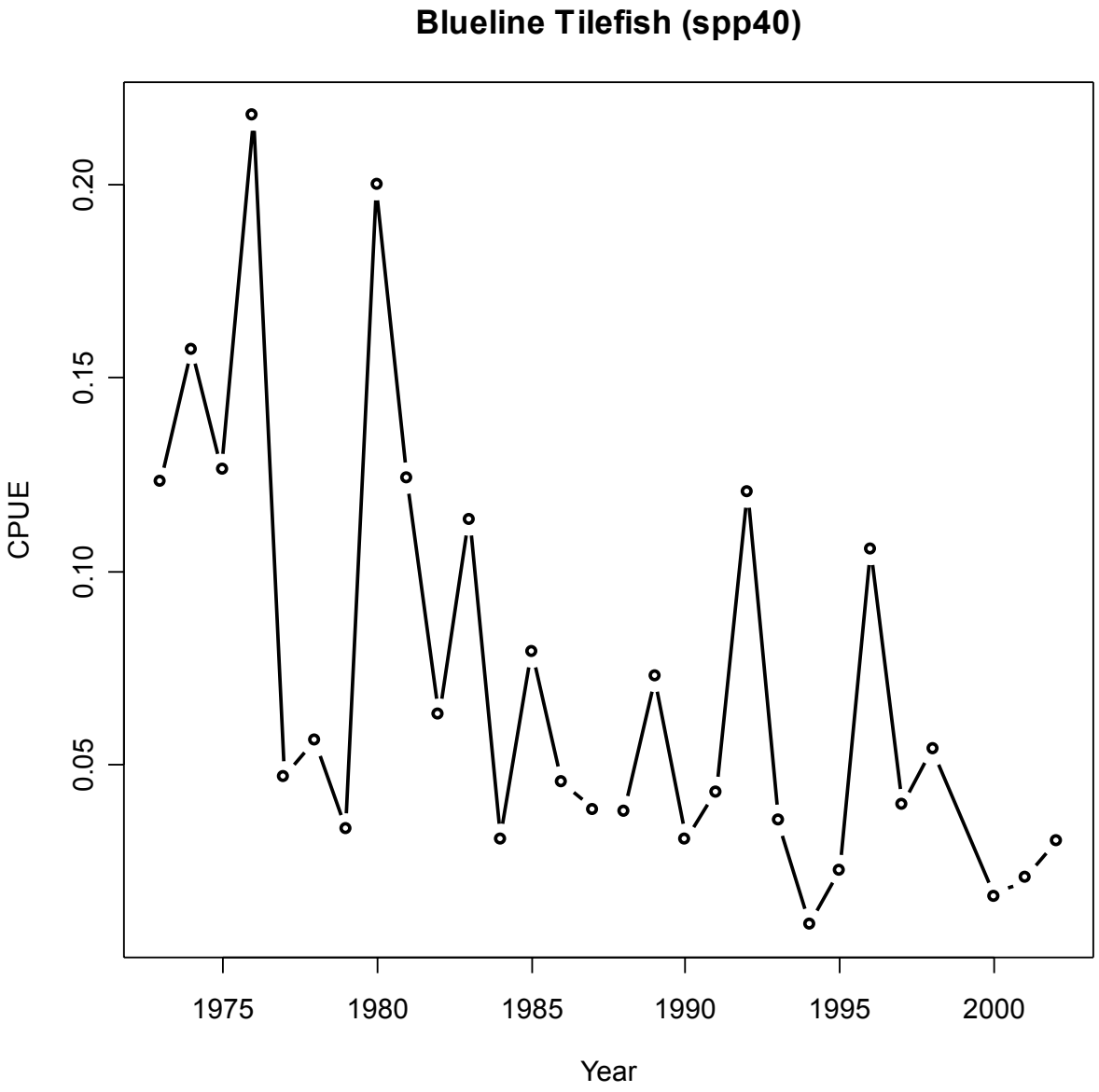


Figure 16. Catch per unit effort by year for all deepwater species using trips which caught at least one member of the deepwater complex as defined in Table 1.