Abundance of King Mackerel, *Scomberomorus cavalla*, in the Southeastern United States Based on CPUE Data From Charterboats, 1982-85

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ABSTRACT—In 1982, a survey was initiated to obtain daily catch and effort data on fishes commonly caught by charterboats in the southeastern United States. Boat effort and king mackerel, Scomberomorus cavalla, *CPUE data obtained from 1982 through 1985 were analyzed. The offshore fishing zone (>10 fathoms) received the highest amount of trolling and other fishing (nontrolling) efforts; the nearshore fishing zone (≤10 fathoms) received the second highest trolling effort and lowest other fishing effort; the estuarine fishing zone received the lowest trolling effort and the second lowest other fishing effort. Data to evaluate seasonal fluctuations in fishing effort were provided for 15 areas of the southeastern United States and for the U.S. Caribbean. Annual CPUE of king mackerel by other fishing was much lower than trolling for most areas and years. CPUE was higher in the nearshore or offshore zone than in the estuarine zone for all area-year combinations except North Carolina in 1983. CPUE values were highest in the nearshore zone about as often as in the offshore zone. Highest catch rates occurred in areas in both the U.S. south Atlantic and Gulf of Mexico when all years were evaluated; high catch rates occurred in North Carolina, Georgia, northwest Florida, Louisiana, and Texas. Seasonal patterns of CPUE along the U.S. south Atlantic coast varied among areas in such a way as to show that a temperature-dependent migration (north in the warm months and south in the cold months) was not indicated; king mackerel were high in abundance off North Carolina and the southern areas of Florida in late fall and early winter. In the Gulf of Mexico, it appeared that in the spring and early summer some groups of king mackerel simultaneously migrated northward along the east and west Gulf of Mexico coasts. Highest CPUE for king mackerel occurred in 1983 or 1985 when all areas were considered. Evaluation of the historical data bases in northwest Florida indicated cyclical patterns of abundance over a 20-year period.*

Introduction

The king mackerel fisheries of the southeastern United States are presently being regulated under a Fishery Management Plan (FMP) of the Gulf of Mexico and South Atlantic Fishery Management Councils (1983, 1985). Basic to the formulation and use of the mackerel FMP are various commercial and recreational fisheries statistics that include estimates of total effort, total catch, and catch per unit of effort (CPUE). Historical data on total catch in the commercial fisheries, and on total catch and effort in the recreational fisheries, were analyzed and presented for king mackerel by Eldridge (1985). Detailed CPUE data for king mackerel over broad geographic areas have become available only recently. In 1982, surveys were initiated to obtain daily catch and effort data on fishes commonly caught by charterboats in the southeastern United States (Brusher et al., 1984). These surveys generated valuable CPUE data on king mackerel from 1982 through 1985. This paper compares the data among fishing methods, fishing zones, areas, weeks, years, and also with historical data generated by other surveys.

Obtaining Data

Recreational fishing data were obtained through contract with charterboat captains (Brusher et al., 1984). Data were obtained from from 9 charterboats in 5 areas in 1982 (Williams, Brusher, and Trent, 1984; Brusher et al., 1984), from 100 boats in 16 areas in 1983 (Williams, Brusher, Palko, and Trent, 1984; Brusher and Palko, 1985), from 31 boats in 9 areas in 1984 (Williams et al., 1985), and from 43 boats in 16 areas in 1985 (Brusher and Palko, 1986). In 1983, the year of highest coverage, the number of selected captains per area represented about 10 percent of the total number of charterboats fishing in 16 areas (Fig. 1).

Logbooks containing weekly log forms were provided to the captains who completed the forms using the following definitions.

1) Fishing zone: Three fishing zones, estuarine, nearshore, and offshore, were identified as defined in Table 1. These and combinations of these zones resulted in 7 categories for analysis.

2) Fishing method: "Trolling" was defined as fishing with hooks and line at any depth while the boat was moving under its own power. "Other fishing" included all other fishing methods, such as bottom fishing, drift fishing, and flylining.

3) Hours actually fished: This was the total number of hours fished by a single boat on all of its trips for one day using a particular method. Only actual fishing times, rounded to the nearest half-hour, were reported. Running times when hooks were not in the water were specifically excluded.

4) Number caught: The number of each species caught (including releases) was recorded.

Data Analysis Methods

Effort was reported in two units, a boat-fishing-day and a boat-fishing-hour. A boat-fishing-day was defined as all fishing that occurred (trolling, other fishing, or both) from a single boat in a single day. Trips were combined if more than one trip occurred in a single day. A boat-fishing-day was recorded for each method of fishing on days that both types of fishing occurred. A boat-fishing-hour was defined as the fishing that occurred

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Table 1.—Fishing zones (1, 2, and 3) and combinations of fishing zones used to record and analyze catch and effort data.

Code	Zone(s)	Definition
1	Estuarine	Bays and sounds
2	Nearshore	0-10 fathoms in ocean or Gulf
3	Offshore	Beyond 10 fathoms in ocean or Gulf
4	Estuarine & nearshore	Combination of 1 & 2
5	Estuarine & offshore	Combination of 1 & 3
6	Nearshore & offshore	Combination of 2 & 3
7	Estuarine, nearshore, & offshore	Combination of 1, 2, & 3

on one boat in a single hour by a single method of fishing.

Our CPUE estimator was defined as "the number of king mackerel caught per boat-fishing-hour (CPUE)" and was computed for each boat-fishing-day for each method of fishing. The following notations were used in the computations:

$$CPUE = X_i = \frac{No.\ of\ mackerel\ caught}{Hours\ of\ fishing}$$

$$\bar{X} = Mean\ CPUE = \frac{\sum_i X_i}{n_i}$$

$$s^2 = \frac{\sum_i X^2{}_i - \left(\sum_i X_i\right)^2 \Big/ n}{n-1}$$

n = Number of boat fishing days

$s_{\bar{X}}$ = Standard error of the mean

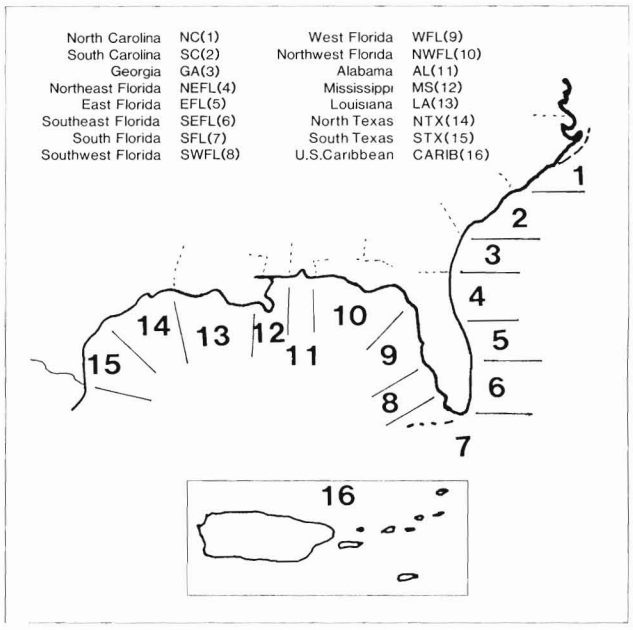

Figure 1.—Geographic areas of the charterboat survey.

$$= \sqrt{\frac{s^2}{n}} = \frac{s}{\sqrt{n}}$$

$$CI_{(95\%)} = 95\%\ \text{confidence interval}$$

$$= \bar{X} \pm t_{.05}\, s_{\bar{X}}$$

$$\text{Log CPUE} = \text{Log}_{10}\,(X_i + 1)$$

CPUE and Log CPUE were analyzed graphically (means, ranges, and standard deviations) and Log CPUE was compared among zones, areas, and years using a one-way analysis of variance with unequal replication and Duncan's multiple range test (Steel and Torrie, 1960).

CPUE data were compared among years for those areas and zones (1, 2, 3, and 1-7) where sufficient data were available. Sufficient is defined as: 1) having at

Table 2.—Sources of recreational CPUE data for king mackerel caught in southeastern U.S. waters 1965-85.

Area	Data source number	Boat type	Number months of year	Year(s) reported	Literature source	Reported unit of effort	Method of conversion to catch/boat hour	Notes
N.C.	1	Charter	8	1977	Manooch and Laws, 1979	Number of king mackerel caught per boat trip	Per trip data converted to per hour using 5.82 as divisor	Conversion factor from Table 3 (N.C. sum trolling hours/sum days)
	2	Charter	8	1978	Manooch et al., 1981	"	"	"
Dade County, Fla.	3	Charter	12	1976-77	Gentle, 1977	Number caught per boat hour, using most successful method	None	Estimates biased upward compared to estimates of this study
Panama City, Fla.	4	Charter	8	1970-71 & 73-85	Fable et al., 1981	Number of king mackerel caught per boat hour	None	Data from Capt. J. Finnegan, Jr
	5	Charter	8	1973	Sutherland, 1977	"	None	None
	6	Charter	8	1975	Brusher et al., 1978	"	None	None
Destin, Fla.	7	Charter	8	1973-77	Fable et al., 1981	"	None	Data from Capt. A. Hilpert
Orange Beach, Ala.	8	Charter	8	1965-77	Fable et al., 1981	"	None	Data from Capt. T. Clark
Grand Isle, La.	9	Charter	12	1977-78	Fischer, 1980	Number of king mackerel caught/fisherman hour	Per fisherman data converted to per boat hour by multiplying by 5.6	None
Texas	10	Charter	12	1978-79	McEachron and Matlock, 1983	Number of king mackerel retrieved per man per trip hour	Per fisherman data converted to per boat hour by multiplying by 3.9	None
Upper Padre, Tex.	11	Inboard[1]	6	1975	Trent, 1976	Number of king mackerel caught/fisherman hour	"	None
Lower Padre, Tex.	12	Inboard	6	1975	Trent, 1976	"	"	None
Galveston, Tex.	13	Inboard	8	1976	Trent et al., 1977	"	"	None

[1]Includes charterboats and private inboard boats.

Table 3.—Numbers of hours and days spent fishing by charterboats by month, area, type of fishing, and year (H=hours and D=days).

Area and type of fishing	Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Total	
		H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D	H	D
NC	1982							112.0	22	261.0	40	314.0	43	358.5	51	120.0	20	120.0	20	82.5	13					1368.0	209
Troll	1983							98.0	25	508.5	89	732.0	124	782.0	134	923.0	151	689.0	114	647.0	108	111.0	20	8.0	2	4498.5	767
	1984							53.0	13	158.5	30	287.5	56	309.5	52	327.0	58	214.0	37	289.5	51	138.5	28	0.0	0	1777.5	325
	1985							33.5	7	225.0	42	257.0	46	359.5	60	305.0	49	237.0	40	131.5	29	84.0	18	5.0	2	1637.5	293
Other	1982							0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0					0.0	0
	1983							53.0	10	50.0	10	60.0	12	70.0	15	62.0	14	49.0	10	6.0	2	25.0	4	0.0	0	375.0	77
	1984							6.0	2	5.0	1	21.5	4	24.0	5	20.0	4	8.0	3	6.0	1	0.0	0	6.0	1	96.5	21
	1985							0.0	0	0.0	0	24.5	9	27.5	10	10.5	3	13.0	3	0.0	0	8.0	4	1.0	1	84.5	30
SC	1982																										
Troll	1983							18.5	4	115.5	23	119.0	23	138.5	25	194.0	30	104.0	18	96.0	17	46.0	8			831.5	148
	1984																										
	1985							16.0	3	32.0	5	92.0	20	126.0	29	132.0	24	65.0	14	64.5	19	30.0	8			557.5	122
Other	1982																										
	1983							67.0	8	64.0	14	48.0	12	43.0	9	78.0	16	120.0	13	0.0	0	0.0	0			420.0	72
	1984																										
	1985							0.0	0	0.0	0	18.0	6	7.0	3	3.0	1	6.0	2	6.0	3	0.0	0			40.0	15
GA	1982																										
Troll	1983							0.0	0	25.0	6	36.5	9	37.5	8	74.0	14	7.5	2	0.0	0	0.0	0			180.5	39
	1984																										
	1985					0.0	0	11.5	5	28.0	10	59.0	14	70.0	15	20.0	5	0.0	0	0.0	0	0.0	0			188.5	49
Other	1982																										
	1983							30.0	3	39.0	8	22.5	7	21.0	5	3.0	1	1.5	1	0.0	0	0.0	0			117.0	25
	1984																										
	1985					17.5	4	35.5	7	91.5	20	75.0	20	69.0	16	22.0	5	0.0	0	0.0	0	0.0	0			310.5	72
NEF	1982																										
Troll	1983							43.5	11	112.5	21	87.5	16	76.0	14	103.5	18	32.0	6	57.0	14	21.0	6	7.0	1	540.0	107
	1984																										
	1985					0.0	0	53.0	11	146.0	29	109.5	20	87.5	18	75.5	19	27.0	7	25.5	10	9.0	3	3.0	1	536.0	118
Other	1982																										
	1983						82.0	14	15.5	5	53.0	10	16.0	5	29.0	6	13.5	3	21.5	5	72.0	17	0 0	0		302.5	65
	1984																										
	1985					4.0	1	57.0	14	12.5	3	50.5	12	36.0	10	33.5	10	25.5	8	30.0	9	42.0	12	43.0	12	334.0	91
EF	1982																										
Troll	1983					106.5	21	323.5	86	348.0	89	369.0	97	459.0	116	494.0	120	300.0	73	226.5	63	244.0	63	202.5	43	3073.0	771
	1984	263.5	46	250.0	44	243.0	41	330.5	71	169.5	49	180.0	50	194.0	47	221.0	49	95.0	24	96.5	30	95.5	26	129.5	26	2268.0	503
	1985	183.0	30	203.0	39	273.0	49	124.0	33	159.0	44	148.5	43	172.0	54	130.0	33	56.0	15	71.5	22	80.5	25	30.0	11	1630.5	398
Other	1982																										
	1983					8.0	2	85.5	36	65.5	34	85.5	40	76.5	30	50.0	23	55.5	15	27.5	11	14.5	11	3.0	4	471.5	206
	1984	1.5	3	24.5	12	28.5	15	47.0	26	56.0	20	49.0	19	30.0	14	27.5	18	22.5	12	36.5	11	26.0	10	27.0	8	376.0	168
	1985	18.0	6	36.0	12	65.5	16	18.5	11	51.0	26	45.5	25	85.0	35	27.0	12	36.5	10	69.0	17	50.0	13	13.0	4	515.0	187
SEF	1982																										
Troll	1983					16.0	3	620.0	146	539.0	128	435.0	93	347.0	74	379.5	101	358.5	77	406.0	97	377.5	94	270.5	64	3749.0	877
	1984	212.0	48	171.0	46	201.0	48																	162.5	40	746.5	182
	1985	152.5	35	123.0	29	199.5	51	140.0	41	132.0	37	125.5	34	106.0	23	53.0	13	62.5	15	61.0	16	90.0	24	99.0	26	1344.0	344
Other	1982																										
	1983					0.0	0	109.0	38	91.5	30	19.5	12	48.5	22	34.5	22	11.5	7	29.5	11	28.0	15	16.5	10	388.5	167
	1984	25.5	16	62.0	20	55.0	19																	34.5	11	177.0	66
	1985	146.5	36	169.5	32	122.0	32	6.5	6	27.0	19	6.0	5	7.0	2	0.0	0	6.5	4	0.0	0	3.0	3	22.0	12	516.0	151
SF	1982					21.5	5	184.0	37	177.0	38	128.5	23	156.0	30	148.0	30	86.5	17	189.5	34	148.0	27	135.0	27	1374.0	268
Troll	1983	102.0	17	17.0	4	15.5	4	599.0	137	924.5	165	906.5	158	799.0	151	614.0	123	422.0	86	544.5	105	591.5	104	403.0	71	5938.5	1125
	1984	159.0	31	248.0	47	247.0	52	335.0	70	268.0	57	321.5	64	248.0	52	235.5	47	155.0	29	158.5	31	274.5	54	134.0	29	2784.0	563
	1985	213.5	42	281.5	55	247.5	52	215.0	46	340.0	60	205.0	35	204.5	38	189.0	34	64.5	12	117.5	20	79.0	15	0.0	0	2157.0	409
Other	1982					1.0	1	19.0	15	9.0	7	2.5	2	5.5	2	4.5	2	16.0	2	0.0	0	0.0	0	0.0	0	57.5	31
	1983	0.0	0	0.0	0	20.0	7	327.5	98	190.5	51	60.5	22	63.5	18	46.0	18	56.5	18	122.5	33	150.5	34	182.0	33	1219.5	332
	1984	80.5	17	48.0	20	75.5	31	28.5	16	34.0	13	0.0	0	12.0	4	0.0	0	7.5	2	0.0	0	22.5	10	1.5	1	310.0	114
	1985	0.0	0	23.0	6	44.5	20	130.5	30	89.0	23	58.0	12	43.0	11	65.5	13	88.5	17	20.5	4	101.0	17	0.0	0	663.5	153
SWF	1982																										
Troll	1983							16.0	3	0.0	0	0.0	0	0.0	0	1.5	2	4.0	1	60.5	16	4.0	1	0.0	0	86.0	23
	1984	0.0	0	0.0	0	0.0	0																	38.5	7	38.5	7
	1985	3.5	1	7.0	4	25.5	11	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0			36.0	16
Other	1982																										
	1983							449.0	90	643.0	126	566.5	107	468.5	100	403.5	97	356.5	82	319.5	74	376.0	84	277.0	62	3859.5	822
	1984	384.0	78	358.5	73	489.0	87																	164.0	37	1395.5	275
	1985	219.5	49	193.0	45	198.0	52	297.5	51	204.0	37	168.5	37	54.5	11	58.5	13	89.0	18	74.5	15	72.5	12			1629.5	340

Continued on next page.

least 4 monthly means within each year and at least 3 years of data for a particular area and zone, 2) having excluded months in which all values were zero, and 3) having at least one annual mean (arithmetic) greater than 0.1 within the set to be compared. The monthly mean of log (CPUE + 1) was used as the observation. Arithmetic means are reported even when the statistical comparisons were made on the log values.

CPUE estimates from some other surveys were reported in effort units other than number caught per boat-fishing-hour (Table 2). For these surveys, the data were transformed to our CPUE base before interpretation and comparison. In North Carolina, Manooch and Laws (1979) and Manooch et al. (1981) reported CPUE as the number of fish caught per trip. These data were converted to our CPUE base by dividing by 5.82, the average duration of the trolling time per trip in North Carolina as deter

Table 3.—Continued.

Area and type of fishing	Year	Jan. H	Jan. D	Feb. H	Feb. D	Mar. H	Mar. D	Apr. H	Apr. D	May H	May D	June H	June D	July H	July D	Aug. H	Aug. D	Sept. H	Sept. D	Oct. H	Oct. D	Nov. H	Nov. D	Dec. H	Dec. D	Total H	Total D
WF	1982																										
Troll	1983					0.0	0	173.5	47	164.5	47	134.5	32	190.0	36	99.5	22	112.0	29	106.5	25	77.0	21	38.0	13	1095.5	272
	1984	18.5	6	13.5	5	19.5	8	238.0	52	161.5	42	182.0	43	255.5	59	220.0	52	113.0	29	201.5	46	116.0	29	25.0	10	1564.0	381
	1985	4.0	1	2.5	1	124.0	29	174.0	47	133.0	35	172.5	38	140.5	31	106.0	23	57.5	12	87.5	23	55.0	15	16.0	5	1072.5	260
Other	1982																										
	1983					11.0	2	144.5	33	177.5	37	216.5	45	152.5	41	219.5	56	128.5	31	105.0	25	148.5	34	113.0	27	1416.5	331
	1984	146.5	33	223.5	49	278.5	60	38.0	7	37.0	9	43.5	11	32.0	7	65.5	11	18.0	4	14.0	4	45.0	10	146.0	33	1087.5	238
	1985	64.0	15	165.5	31	155.5	34	115.5	26	78.5	20	73.0	20	84.0	23	104.5	20	83.0	16	41.0	11	80.0	16	38.0	10	1082.5	242
NWF	1982							42.5	7	83.5	15	105.5	24	77.0	19	86.5	20	118.5	21	63.0	12					576.5	118
Troll	1983					2.5	1	269.5	71	388.0	101	558.5	150	719.5	178	773.0	151	562.0	106	296.0	67	34.0	10			3603.0	835
	1984							24.0	6	19.0	7	110.0	29	102.5	25	88.5	22	79.0	17	37.0	11	10.5	3			470.5	120
	1985					2.5	1	34.0	7	34.5	9	26.0	8	116.5	28	100.0	23	44.0	7	1.5	1	0.0	0			359.0	84
Other	1982							0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0					0.0	0
	1983					7.5	2	379.0	74	602.5	117	542.0	130	587.5	126	357.5	80	438.0	88	415.0	81	120.0	20			3449.0	718
	1984							102.0	20	181.5	36	193.5	49	100.5	24	128.5	27	178.5	38	159.5	35	10.0	1			1054.0	230
	1985					41.5	9	183.0	38	236.0	50	219.0	48	192.0	38	176.0	33	157.0	36	200.5	45	70.0	15			1475.0	312
AL	1982																										
Troll	1983							55.0	11	151.0	35	231.5	56	299.0	68	253.5	62	139.5	38	130.0	40	22.0	9			1281.5	319
	1984																										
	1985							22 0	8	47.5	18	122.0	33	136.5	35	121.5	28	48.0	13	61.5	23	23.0	13	2.0	1	584.0	172
Other	1982																										
	1983							83.0	13	100.0	27	119.0	35	119.0	36	138.0	41	92.5	25	108.5	28	40.0	9			800.0	214
	1984																										
	1985							52.0	13	68.0	20	66.5	22	73.0	24	49.5	19	40.5	14	62.5	20	40.5	15	4.0	1	456.5	148
MS	1982																										
Troll	1983							16.5	3	133.0	28	126.0	30	172.0	33	163.0	35	112.0	24	26.0	5					748.5	158
	1984																										
	1985							56.0	11	125.0	23	144.0	29	176.0	35	90.5	19	50.5	12	37.5	10	30.0	8			709.5	147
Other	1982																										
	1983							6.0	1	32.0	7	17.0	4	14.0	3	10.5	3	0.0	0	15.0	4					94.5	22
	1984																										
	1985							24.0	5	70.5	9	61.0	13	20.5	7	19.5	4	24.5	6	61.0	11	31.0	7			312.0	62
LA	1982							6.0	3	30.5	14	38.5	11	115.5	21	58.5	19	44.0	11	1.5	1	8.0	3	0.0	0	302.5	83
Troll	1983	36.0	8	47.0	9	0.0	0	0.0	0	16.0	3	78.0	12	139.5	21	122.0	21	104.5	15	76.0	14	31.0	4	0.0	0	650.0	107
	1984	5.0	1	0.0	0	0.0	0	0.0	0	20.0	3	27.0	7	18.5	3	87.5	14	42.0	8	48.0	9	0.0	0	22.5	4	270.5	49
	1985	31.0	6	0.0	0	0.0	0	13.0	2	43.5	7	136.5	22	146.5	20	53.0	9	32.0	6	12.0	2	0.0	0	0.0	0	467.5	74
Other	1982							49.5	11	105.0	25	132.0	30	77.0	18	143.5	32	59.5	14	110.5	22	103.5	21	5.0	1	785.0	174
	1983	21.0	6	31.0	6	55.0	10	21.5	4	104.5	21	303.5	67	337.5	75	306.5	69	152.0	33	277.5	56	215.5	45	97.0	20	1922.5	412
	1984	86.0	19	186.0	37	282.0	52	99.5	21	227.0	40	224.0	51	241.5	54	234.0	50	159.0	36	251.5	58	219.0	50	150.5	36	2360.0	504
	1985	96.0	21	90.0	21	115.0	26	67.0	15	20.5	5	93.5	21	51.0	11	62.5	14	58.5	14	56.0	13	70.5	16	46.5	11	827.0	188
NTX	1982																										
Troll	1983							2.0	1	31.5	8	145.5	28	106.5	27	146.0	26	55.0	14	14.0	7	2.0	1	0.0	0	502.5	112
	1984																										
	1985							24.0	4	72.5	13	153.5	26	302.5	51	208.5	38	21.5	8	0.0	0	0.0	0			782.5	140
Other	1982																										
	1983							39.0	8	62.5	14	91.5	25	167.5	35	52.5	14	86.5	18	63.0	15	37.0	8	13.0	3	612.5	140
	1984																										
	1985							4.0	1	67.0	11	0.0	0	55.0	10	90.0	22	49.5	11	24.0	4	16.5	3			306.0	62
STX	1982							6.0	1	40.5	7	149.5	28	301.0	49	239.0	39	35.0	8	0.0	0					771.0	132
Troll	1983							81.5	17	334.5	57	498.0	79	638.5	95	560.0	81	211.0	35	179.5	33	82.5	15	5.0	1	2590.5	413
	1984							40.5	8	119.0	23	184.0	28	249.5	40	197.0	35	52.0	8	16.0	4	0.0	0			858.0	146
	1985							17.5	4	144.0	29	237.5	49	508.5	102	454.0	92	37.5	9	0.0	0	0.0	0			1399.0	285
Other	1982							9.0	2	18.0	4	9.0	3	0.0	0	4.0	4	12.0	3	24.5	5					76.5	21
	1983							19.0	6	37.5	8	35.5	8	2.0	3	8.0	4	43.0	9	112.0	27	87.0	16	7.0	1	351.0	82
	1984							78.5	16	169.5	27	229.0	32	272.0	32	244.5	35	144.0	19	117.0	20	54.0	14			1308.5	195
	1985							37.5	7	74.0	17	66.0	17	43.5	19	40.0	18	22.0	6	3.5	1	0.0	0			286.5	85
US Carib.	1982																										
Troll	1983					56.0	10	168.5	30	105.0	19	195.5	37	318.0	51	341.5	51	154.5	28	166.0	32	178.5	32	70.0	13	1753.5	303
	1984	330.0	59	322.5	59	379.5	67	241.5	46	192.0	36	110.5	19	388.5	56	352.5	53	271.5	48	285.0	50	259.5	50	216.0	46	3349.0	589
	1985	429.5	78	366.5	63	414.0	71	273.0	51	294.5	54	288.0	50	225.5	35	375.0	59	215.0	40	330.0	60	300.5	56	205.0	38	3716.5	655

mined from 4 years of data (Table 3). Fischer (1980) reported CPUE on a catch-per-fisherman-hour basis for Louisiana as did McEachron and Matlock (1983), Trent (1976), and Trent et al. (1977) for Texas. These data were converted to our CPUE base by multiplying by 5.6 and 3.9, the average numbers of fishermen per boat in Louisiana and Texas, respectively.

Distribution of Fishing Effort Among Habitats and Months

Fishing effort among zones 1-3 (Table 1) was evaluated to determine where most of the charterboat fishing effort occurred by each method of fishing (Table 4). The offshore zone (zone 3) with water depths >10 fm received the highest amount of effort; each year over 48 percent of the trolling or other fishing effort (in addition to the contributions from zones 5, 6, and 7) occurred in this zone. The second most important zone in terms of trolling effort was the nearshore zone (zone 2); over 21 percent of the trolling effort each year (in addition to the contributions from zones 4, 6, and 7) occurred in this zone. The second most important zone for other fishing was in the estuarine

zone; percentages of effort expended (not including the contributions from zones 4, 5, and 7) in this zone were: 7.1 percent in 1982, 21.4 percent in 1983, 15.1 percent in 1984, and 15.2 percent in 1985.

Much more other-fishing effort occurred in the estuarine zone (17.9 percent) than did trolling effort (2.2 percent) based on data combined for all years (Table 4). Percentages of total effort were similar between methods for zones 2 and 3.

Fishing effort was not monitored throughout the year in most areas and years (Table 3). The months of January, February, and March were not surveyed for the most part north of the east and west Florida areas (Fig. 1) except in Louisiana.

The number of areas varied considerably among years (Table 3). Only in 1983 and 1985 were all 16 areas surveyed using the contractual procedures described by Brusher et al. (1984). Volunteered data were obtained, however, in 1984 from northeast Florida, Alabama, and Mississippi and were used to evaluate seasonal abundance of king mackerel in these areas.

Data in Table 3 are useful to evaluate the seasonality of fishing effort because the numbers of boats in the survey remained relatively constant within an area and year with one exception. In North Carolina in 1982, during the pilot survey, two boats reported from April through July and only one boat reported the remainder of the survey.

CPUE Comparisons

Between Fishing Methods

CPUE of king mackerel by other fishing was much lower than by trolling for most areas and years (Table 5). Area-year combinations where other-fishing CPUE was at least one-fourth of trolling CPUE were Georgia in 1983 and 1985; south Florida in 1983, 1984, and 1985; Louisiana in all 4 years; north Texas in 1985; and south Texas in 1984.

CPUE by other fishing was higher than trolling in some months for some areas and years (Table 6). Those areas and years were: Northwest Florida and Louisiana in 1982; Georgia, northeast, south, and southwest Florida, Mississippi, and north Texas in 1983; south Florida, Louisiana, and south Texas in 1984; and North Carolina, southeast, south, and northwest Florida, and Mississippi in 1985.

Among Fishing Zones

CPUE was higher in the nearshore or offshore zone than in the estuarine zone for all area-year combinations except North Carolina in 1983 (Table 7). Most of the fish reported from the estuarine zone in North Carolina in 1983 were actually caught in, and just inside, the tidal inlets of the outer banks.

CPUE values were highest in the nearshore zone about as often as in the offshore zone when all values were compared (Table 7). There was a distinct trend through the period 1982-85, however, for CPUE to become higher in the nearshore than in the offshore zone.

Table 4.—Number of boat fishing days expended by fishing zone, method of fishing, and year.

Year and method of fishing	Variable	Fishing zone 1	2	3	4	5	6	7	Total
1982 Trolling	No. of boat days	15	204	499	22		70		810
	Percent of total	1.8	25.2	61.6	2.7		8.6		
Other	No. of boat days	16	9	199			2		226
	Percent of total	7.1	4.0	88.1			0.9		
	Subtotal	31	213	698	22		72		1,036
	Percent	3.0	20.6	67.4	2.1		6.9		
1983 Trolling	No. of boat days	207	1,367	3,864	66	5	864	3	6,376
	Percent of total	3.2	21.4	60.6	1.0	0.0	13.6	0.0	
Other	No. of boat days	790	701	1,781	87	4	321	1	3,685
	Percent of total	21.4	19.0	48.3	2.4	0.1	8.7	0.0	
	Subtotal	997	2,068	5,645	153	9	1,185	4	10,061
	Percent	9.9	20.6	56.1	1.5	0.0	11.8	0.0	
1984 Trolling	No. of boat days	25	639	1,751	8	1	440	1	2,865
	Percent of total	0.9	22.3	61.1	0.3	0.0	15.4	0.0	
Other	No. of boat days	274	248	1,231	22	1	35		1,811
	Percent of total	15.1	13.7	68.0	1.2	0.1	1.9		
	Subtotal	299	887	2,982	30	2	475	1	4,676
	Percent	6.4	19.0	63.8	1.7	0.0	10.2	0.0	
1985 Trolling	No. of boat days	55	901	2,104	14	77	415		3,566
	Percent of total	1.5	25.3	59.0	0.4	2.2	11.6		
Other	No. of boat days	324	514	1,206	19	3	72		2,138
	Percent of total	15.2	24.0	56.4	0.9	0.1	3.4		
	Subtotal	379	1,415	3,310	33	80	487		5,704
	Percent	6.6	24.8	58.0	0.6	1.4	8.5		
1982-85 Trolling	No. of boat days	302	3,111	8,218	110	83	1,789	4	13,617
	Percent of total	2.2	22.8	60.4	0.8	0.6	13.1	0.0	
Other	No. of boat days	1,404	1,472	4,417	128	8	430	1	7,860
	Percent of total	17.9	18.7	56.2	1.6	0.1	5.5	0.0	
	Total	1,706	4,583	12,635	238	91	2,219	5	21,477
	Percent	7.9	21.3	58.8	1.1	0.4	10.3	0.0	

Table 5.—Yearly effort and CPUE by area and method of fishing for king mackerel.

	1982				1983				1984				1985			
	Other		Trolling		Other		Trolling		Other		Trolling		Other		Trolling	
Area	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE	Hours	CPUE
North Carolina	0.0		1368.0	0.40	375.0	0.04	4498.5	0.71	96.5	0.13	1777.5	1.16	84.5	0.05	1637.5	1.41
South Carolina					420.0	0.00	831.5	0.65					40.0	0.02	557.5	1.24
Georgia					117.0	0.47	180.5	0.58					310.5	0.29	188.5	1.03
NE Florida					302.5	0.05	540.0	0.38					334.0	0.04	536.0	0.51
E Florida					471.5	0.06	3073.0	1.48	376.0	0.01	2268.0	0.51	511.0	0.01	1627.5	0.64
SE Florida					388.5	0.03	3749.0	0.34	177.0	0.00	746.5	0.11	514.0	0.01	1320.0	0.19
S Florida	57.5	0.00	1374.0	0.11	1219.5	0.33	5938.5	0.10	310.0	1.42	2784.0	0.19	663.5	0.16	2157.0	0.33
SW Florida					3859.5	0.00	86.0	0.01	1395.5	0.00	38.5	0.00	1629.5	0.00	36.0	0.00
W Florida					1416.5	0.01	1095.5	0.40	1087.5	0.00	1564.0	0.36	1082.5	0.04	1072.5	0.39
NW Florida	0.0		576.5	0.72	3449.0	0.03	3603.0	1.22	1054.0	0.17	470.5	0.76	1475.0	0.09	359.0	0.56
Alabama					800.0	0.00	1281.5	0.47					456.5	0.01	584.0	0.50
Mississippi					94.5	0.05	748.5	0.15					312.0	0.03	709.5	0.36
Louisiana	785.5	0.52	302.5	0.13	1922.5	0.48	650.0	0.90	2360.0	0.45	270.5	0.90	822.5	0.30	467.5	0.90
N Texas					612.5	0.21	502.5	2.14					306.0	0.45	782.5	1.49
S Texas	76.5	0.00	771.0	1.30	351.0	0.02	2590.5	0.70	1308.5	1.05	858.0	0.26	286.5	0.19	1399.0	1.16
US Caribbean					0.0		1753.5	0.04	0.0		3349.0	0.11	0.0		3677.5	0.11

CPUE was higher in the nearshore than the offshore in 1 of 5 areas in 1982, 5 of 14 areas in 1983, 5 of 7 areas (1 tie) in 1984, and 10 of 14 areas in 1985.

Only eight of the 27 statistical comparisons of CPUE among the three zones were significant (Table 7). Mean values of zone CPUE significantly greater in zone 3 than in the other two zones were: 1982, northwest Florida; 1983, east and northwest Florida; 1984, northwest Florida; and 1985, northeast Florida. Significant differences among any set of means within area and year can be read from Table 7. For example, in Georgia in 1985 zone 3 was significantly greater than zone 1 but not zone 2.

Among Areas

High catch rates of king mackerel occurred in areas in both the Gulf of Mexico and south Atlantic each year except 1982 (Table 8). In 1982 CPUE from south Texas was significantly higher than CPUE in the other four areas. In 1983, CPUE was significantly higher in north Texas than in the other 15 areas and significantly higher in east Florida than in the remaining 14 areas. In 1984, CPUE's in Louisiana, northwest Florida, and North Carolina were significantly higher than in all other areas except east Florida. In 1985, CPUE's were significantly higher in north Texas, South Carolina, and south Texas than in all other areas except Georgia and Louisiana.

CPUE was also compared among areas within each zone (Table 9). Area mean values of CPUE determined significantly greater than all other area means within the zone and year were: Zone 1, North

Table 6.—Monthly mean CPUE by area, method, and year for king mackerel.

Year	Area and type of fishing	Monthly mean CPUE											
		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1982	North Carolina												
	Other fishing						0.00	0.00	0.00	0.50		0.00	0.00
	Trolling				0.03	0.41	0.07	0.02	0.02	0.04	4.67		
	S Florida												
	Other fishing			0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	Trolling			0.03	0.04	0.00	0.00	0.01	0.19	0.02	0.00	0.06	0.79
	NW Florida												
	Other fishing			0.01	0.00	0.09	0.01	0.06	0.04	0.04	0.29	0.38	
	Trolling			0.00	0.00	0.05	0.10	0.58	1.11	0.50	0.67		
	Louisiana												
	Other fishing				0.20	0.05	0.54	0.24	0.19	0.35	1.00	1.56	1.60
	Trolling				0.00	0.18	0.11	0.02	0.23	0.04	0.00	0.47	
	S Texas												
	Other fishing				0.00	0.00	0.03	0.36	0.49	0.00	0.00		
	Trolling				0.29	0.90	0.29	1.45	1.40	1.39			
1983	North Carolina												
	Other fishing				0.00	0.00	0.08	0.00	0.00	0.08	0.67	0.00	
	Trolling				0.03	1.08	0.34	0.14	0.09	0.34	2.59	2.65	1.17
	South Carolina												
	Other fishing				0.00	0.00	0.00	0.00	0.00	0.00			
	Trolling				0.82	0.90	0.29	0.19	0.31	1.04	1.50	0.85	
	Georgia												
	Other fishing				0.28	0.08	0.20	1.32	2.33	0.00			
	Trolling					0.45	0.55	0.88	0.47	0.60			
	NE Florida												
	Other fishing				0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	
	Trolling				0.09	0.59	0.62	0.42	0.28	0.18	0.19	0.00	2.14
	E Florida												
	Other fishing			0.00	0.07	0.06	0.00	0.09	0.01	0.20	0.11	0.00	0.00
	Trolling	0.07		0.36	1.25	1.19	1.27	0.96	2.12	1.52	1.19	3.06	1.14
	SE Florida												
	Other fishing				0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00
	Trolling			0.00	0.12	0.18	0.12	0.16	0.52	0.36	0.73	0.65	0.43
	S Florida												
	Other fishing			0.02	0.04	0.02	0.00	0.00	0.13	0.04	0.23	0.43	2.39
	Trolling	0.56	1.38	0.00	0.02	0.01	0.00	0.01	0.03	0.01	0.13	0.34	0.55
	SW Florida												
	Other fishing				0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01
	Trolling				0.00				0.00	0.00	0.02	0.00	
	W Florida												
	Other fishing			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.00
	Trolling				0.40	0.30	0.28	0.18	0.17	0.10	0.19	0.49	3.01
	NW Florida												
	Other fishing			0.00	0.00	0.00	0.00	0.04	0.06	0.08	0.01	0.01	
	Trolling			0.00	0.00	0.02	0.31	1.63	2.73	2.10	0.61	0.05	
	Alabama												
	Other fishing				0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	
	Trolling				0.00	0.07	0.13	0.82	0.79	0.74	0.17	0.00	
	Mississippi												
	Other fishing				0.00	0.05	0.00	0.00	0.27		0.00		
	Trolling				0.00	0.00	0.00	0.00	0.41	0.30	0.55		
	Louisiana												
	Other fishing	0.00	1.97	1.52	0.09	0.05	0.07	2.25	0.36	0.23	0.77	0.64	2.02
	Trolling	2.10	2.46			0.00	0.00	0.00	0.41	1.70	1.30	1.23	
	N Texas												
	Other fishing				0.00	0.09	0.74	0.16	0.13	0.15	0.00	0.02	0.00
	Trolling				0.50	0.87	2.45	3.01	2.67	0.84	0.14	0.00	

Continued on next page.

Table 6.—Continued.

Year	Area and type of fishing	Monthly mean CPUE											
		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1983	S Texas												
	Other fishing				0.00	0.11	0.03	0.00	0.00	0.00	0.03	0.00	0.00
	Trolling				0.16	0.23	0.59	0.84	1.10	1.07	0.51	0.21	0.20
	US Caribbean												
	Other fishing												
	Trolling			0.00	0.03	0.02	0.02	0.04	0.02	0.06	0.07	0.06	0.08
1984	North Carolina												
	Other fishing				0.00	0.00	0.08	0.00	0.00	0.00	0.33		2.00
	Trolling				10.59	1.98	0.58	0.08	0.29	0.37	1.48	1.31	
	E Florida												
	Other fishing	0.00	0.00	0.00	0.01	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00
	Trolling	0.87	0.49	0.08	0.25	0.54	0.72	0.77	0.69	0.57	0.27	0.50	0.24
	SE Florida												
	Other fishing	0.00	0.00	0.00									0.00
	Trolling	0.26	0.04	0.03									0.08
	S Florida												
	Other fishing	3.60	3.06	1.22	0.00	0.00		0.00		0.00		0.13	0.00
	Trolling	1.16	0.71	0.22	0.03	0.00	0.02	0.02	0.04	0.03	0.06	0.15	0.34
	SW Florida												
	Other fishing	0.00	0.00	0.00									0.00
	Trolling												0.00
	W Florida												
	Other fishing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Trolling	0.00	0.00	0.35	1.87	0.43	0.12	0.01	0.01	0.03	0.14	0.18	0.00
	NW Florida												
	Other fishing				0.00	0.00	0.01	0.06	0.03	0.50	0.48	1.40	
	Trolling				0.00	0.17	0.19	1.38	0.77	0.69	1.54	1.43	
	Louisiana												
	Other fishing	0.61	0.35	0.29	0.13	0.00	0.09	0.50	0.44	0.61	0.72	0.66	0.99
	Trolling	0.80				0.29	0.00	0.00	0.16	0.80	2.49		2.91
	S Texas												
	Other fishing				0.21	0.36	0.49	2.42	2.41	0.74	0.01	0.02	
	Trolling				0.03	0.13	0.22	0.22	0.53	0.20	0.00		
	US Caribbean												
	Other fishing												
	Trolling	0.20	0.18	0.09	0.07	0.05	0.11	0.11	0.07	0.13	0.06	0.10	0.11
1985	North Carolina												
	Other fishing						0.00	0.00	0.00	0.50		0.00	0.00
	Trolling				6.82	1.28	0.39	0.45	0.29	0.42	2.86	8.00	4.67
	South Carolina												
	Other fishing						0.00	0.11	0.00	0.00	0.00		
	Trolling				1.30	0.00	0.85	1.01	0.76	1.02	2.81	1.95	
	Georgia												
	Other fishing			0.00	0.29	0.47	0.36	0.15	0.07				
	Trolling				0.70	1.31	1.27	1.07	0.00				
	NE Florida												
	Other fishing			0.00	0.00	0.00	0.14	0.15	0.02	0.00	0.00	0.00	0.00
	Trolling				0.38	0.61	0.89	0.67	0.43	0.00	0.02	0.00	0.00
	E Florida												
	Other fishing	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.01	0.00	0.00	0.00	0.00
	Trolling	0.17	0.11	0.20	0.40	1.02	1.05	1.18	0.74	1.05	0.40	0.53	0.61
	SE Florida												
	Other fishing	0.01	0.01	0.02	0.00	0.01	0.00	0.00		0.00		0.00	0.00
	Trolling	0.01	0.02	0.00	0.12	0.41	0.43	0.27	0.15	0.33	0.46	0.15	0.20
	S Florida												
	Other fishing		0.00	0.01	0.05	0.02	0.06	0.09	0.44	0.26	0.04	0.62	
	Trolling	0.88	1.51	0.12	0.02	0.04	0.01	0.00	0.06	0 00	0.02	0.08	
	SW Florida												
	Other fishing	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	
	Trolling	0.00	0.00	0.00									
	W Florida												
	Other fishing	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Trolling	0.00	0.00	0.85	1.39	0.19	0.01	0.04	0.03	0.00	0.03	0.06	0.00
	NW Florida												
	Other fishing			0.01	0.00	0.09	0.01	0.06	0.04	0.04	0.29	0.38	
	Trolling			0.00	0.00	0.05	0.10	0.58	1.11	0.50	0.67		
	Alabama												
	Other fishing				0.00	0.04	0.01	0.00	0.04	0.00	0.00	0.00	0.00
	Trolling				0.00	0.04	0.75	0.51	1.21	0.26	0.23	0.00	0.00
	Mississippi												
	Other fishing				0.00	0.00	0.05	0.00	0.06	0 13	0.00	0.00	
	Trolling				0.00	0.21	0.45	0.62	0.50	0 00	0.17	0.27	
	Louisiana												
	Other fishing	0.32	0.00	0.01	0.00	0.00	0.09	0.64	0.32	0 28	0.65	1.39	0.16
	Trolling	2.24			0.00	0.25	0.42	0.79	1.45	1.66	1.75		
	N Texas												
	Other fishing				0.00	0.10		0.99	0.73	0.06	0.00	0.00	
	Trolling				0.03	0.15	1.04	2.49	1.33	0.28			
	S Texas												
	Other fishing				0.00	0.00	0.03	0.36	0.49	0.00	0.00		
	Trolling				0.29	0.90	0.29	1.45	1.40	1.39			
	US Caribbean												
	Other fishing												
	Trolling	0.11	0.09	0.15	0.16	0.14	0.05	0.13	0.06	0.02	0.07	0.11	0.20

Carolina in 1983; zone 2, south Texas in 1982; and zone 3, northwest Florida in 1984. Significant differences among any set of means within zone and year can be read from Table 9. For example, in zone 2 in 1983 northwest Florida, Louisiana, and north and south Texas had CPUE values significantly greater than all others except east Florida and Alabama.

Seasonality of CPUE

Patterns of CPUE among areas were evaluated separately for the south Atlantic and the Gulf coasts. Weekly estimates of trolling CPUE were plotted to analyze abundance of mackerel through time in relation to area. The data bases for other-fishing CPUE were too small and discontinuous to be of use in defining seasonal patterns except for Louisiana.

Seasonal patterns of CPUE along the south Atlantic coast were distinctly different among the areas compared. Along the North and South Carolina coasts, king mackerel were more abundant in the spring and fall than during the summer months (Fig. 2-5). In Georgia and northeast Florida, the fish were most abundant from May to September with one exception—in northeast Florida in 1983 a high CPUE value occurred in November (Fig. 3). Seasonal trends in CPUE in east and southeast Florida varied among years; in northeast Florida highest values occurred in May (1983), July (1984), and May (1985); in east Florida highest values occurred in November (1983), January (1984), and April (1985). In south Florida, the highest CPUE values occurred in the winter months.

A temperature-dependent migration pattern (north in the warm months and south in the cold months) was not indicated by the CPUE data. In the spring, king mackerel became abundant in the Carolinas at the same time, or earlier, than in Georgia and northeast Florida. The fish became abundant in the Carolinas in the fall after declines had occurred in Georgia and northeast Florida. Fish were also abundant in east, southeast, and south Florida during the late fall and winter.

In the Gulf of Mexico, it appeared that in the spring and early summer king mackerel simultaneously migrated northward along the east and west Gulf of Mexico coasts (Fig. 6-8). In 1983 through 1985, data were available from west and northwest Florida, Alabama,

Table 7.—Comparisons among fishing zones of yearly CPUE by area for king mackerel caught by trolling (CPUE values are arithmetic means).

	1982				1983				1984				1985			
	Zone				Zone				Zone				Zone			
Area	1	2	3	Range test[1]	1	2	3	Range test[1]	1	2	3	Range test[1]	1	2	3	Range test[1]
NC	0.00	0.00	0.44	1 2 3	1.74	0.34	0.64	2 3 1	0.00	0.97	1.25	1 3 2	0.00	2.24	1.26	1 3 2
SC						0.39	1.59						0.80	1.49	1.02	1 3 2
GA						0.28	1.06						0.00	1.01	1.43	1 2 3
NEFL					0.19	0.23	0.56	1 2 3					0.00	0.27	0.80	1 2 3
EFL					0.00	0.47	1.77	1 2 3	0.00	0.53	0.44	1 3 2		0.00	0.65	
SEFL					0.14	0.28	0.37	1 2 3		0.17	0.10			0.50	0.18	
SFL		0.32	0.09		0.03	0.20	0.08	1 3 2		0.17	0.17			0.38	0.31	
SWFL																
WFL					0.00	0.37	1.21	1 2 3	0.06	0.36	0.11	1 3 2		0.40	0.13	
NWFL	0.00	0.76	2.33	1 2 3	0.02	0.91	2.36	1 2 3	0.37	0.50	1.51	1 2 3	0.27	0.95	0.66	1 3 2
AL					0.00	0.52	0.10	1 3 2					0.00	0.85	0.00	1 3 2
MS						0.16	0.00						0.00	0.37	0.15	1 3 2
LA	0.00	0.00	0.13	1 2 3	0.00	1.46	0.68	1 3 2		1.51	0.67		0.00	0.79	0.75	3 2 1
NTX						1.19	2.49							1.43	1.84	
STX	0.00	1.15	1.70	1 2 3	0.00	0.87	0.57	1 3 2		0.65	0.21		0.31	1.43	1.01	1 3 2

[1]Any two zones not underscored by the same line have significantly different means.

Table 8.—Statistical comparisons among areas of Log (CPUE + 1) of king mackerel (analysis of variance and multiple range test). Any two logarithmic means not underscored by the same line are significantly different.

1982	SFL	LA	NC	NWFL	STX
Log (CPUE + 1)	0.03	0.04	0.05	0.14	0.31
CPUE	0.11	0.13	0.40	0.72	1.30

1983	SWFL	CARIB	SFL	MS	SEFL	WFL	NEFL	AL	NC	SC	GA	STX	LA	NWFL	EFL	NTX
Log (CPUE + 1)	0.00	0.01	0.03	0.04	0.10	0.10	0.12	0.13	0.13	0.13	0.17	0.18	0.19	0.23	0.31	0.37
CPUE	0.01	0.04	0.10	0.15	0.34	0.40	0.38	0.48	0.71	0.65	0.58	0.70	0.90	1.22	1.48	2.14

1984	SWFL	SEFL	CARIB	SFL	STX	WFL	EFL	NC	NWFL	LA
Log (CPUE + 1)	0.00	0.03	0.04	0.05	0.07	0.08	0.14	0.16	0.16	0.21
CPUE	0.00	0.11	0.11	0.19	0.26	0.36	0.51	1.16	0.76	0.90

1985	SWFL	CARIB	SEFL	SFL	WFL	MS	AL	NWFL	NEFL	EFL	NC	LA	GA	STX	SC	NTX
Log (CPUE + 1)	0.00	0.04	0.06	0.07	0.09	0.10	0.12	0.14	0.14	0.17	0.19	0.23	0.24	0.26	0.28	0.30
CPUE	0.00	0.11	0.19	0.33	0.39	0.36	0.50	0.56	0.51	0.64	1.41	0.90	1.03	1.16	1.24	1.49

Mississippi, Louisiana, and north and south Texas to evaluate migratory trends. With one exception, the fish were first abundant in March-April in west Florida, in May or June in north and south Texas, in May, June, or July in northwest Florida, Alabama, and Mississippi, and in September in Louisiana. The exception was that in west Florida the fish were never abundant in the spring of 1983. CPUE data obtained by trolling in Louisiana support the idea that fish migrate up both sides of the Gulf of Mexico (Fig. 6-8), but those large fish caught by using live bait drifted near oil rigs ("other fishing") support the idea that part of the population of large fish remains in the area year-round and that the abundance of these fish is greatest during colder months (Fig. 9). King mackerel became abundant in south Texas earlier than in north Texas in the two years that comparative data were available (Fig. 6, 8).

Among Years

Highest CPUE for king mackerel occurred in 1983 or 1985 when all areas were considered. The mean CPUE data and results of the statistical comparisons among years are given in Table 10. Of the areas having significant among-year differences, CPUE was highest in 1985 in North Carolina, Louisiana, and the U.S. Caribbean, and in 1983 in east Florida. Further, for those areas having sufficient data for comparison but which did not show significant differences, log (CPUE + 1) was always highest in 1983 or 1985.

Table 9.—Comparison among areas of CPUE by year and zone for king mackerel caught while trolling.

Year	Zone	Mean CPUE by area 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Area in order of increasing CPUE and results of range test[1]
1982																		
	2	0.00						0.32			0.76			0.00		1.15		1 13 7 10 15
	3	0.44						0.09			2.33			0 13		1.70		7 13 1 15 10
1983																		
	1	1.74			0.19	0.00	0.14	0.03	0.00	0.00	0.02	0.00		0.00		0.00		5 8 9 11 13 15 10 7 6 4 1
	2	0.34	0.39	0.28	0.23	0.47	0.28	0.20	0.03	0.37	0.91	0.52	0.16	1.46	1.19	0.87		8 12 7 4 6 2 9 3 1 5 11 10 15 14 13
	3	0.64	1.59	1.06	0.56	1.77	0.37	0.08		1.21	2.36	0.10	0.00	0.68	2.49	0.57	0.04	12 16 7 11 6 1 15 13 9 4 3 2 5 10 14
1984																		
	1	0.00				0.00				0.06	0.37						0.00	1 5 16 9 10
	2	0.97				0.53	0.17	0.17	0.00	0.36	0.50			1.51		0.65		8 7 6 9 10 5 1 15 13
	3	1.25				0.44	0.10	0.17		0.11	1.51			0.67		0.21	0.11	6 9 16 7 15 5 1 13 10
1985																		
	1	0.00	0.80	0.00	0.00						0.27	0.00	0.00	0.00		0.31		1 3 4 11 12 13 10 15 2
	2	2.24	1.49	1.01	0.27	0.00	0.50	0.38	0.00	0.40	0.95	0.85	0.37	0.84	1 43	1.43	0.27	5 8 4 7 9 16 12 6 11 13 3 10 15 2 14 1
	3	1.26	1.02	1.43	0.80	0.65	0.18	0.31		0.13	0.66	0.00	0.15	0.76	1.84	1.01	0.11	11 9 16 12 6 7 1 10 5 13 4 15 2 14 3

[1]Any two areas not underscored by the same line have significantly different means.

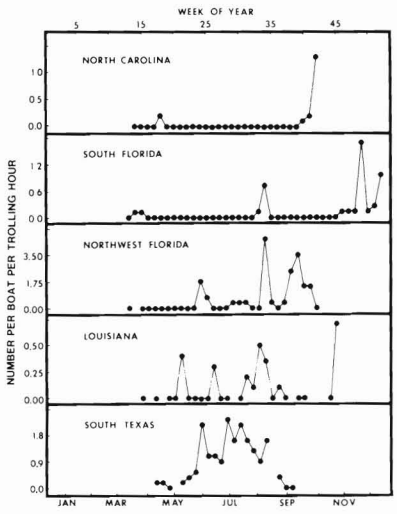

Figure 2.—CPUE by area for king mackerel caught by trolling on Atlantic and Gulf of Mexico coasts in 1982.

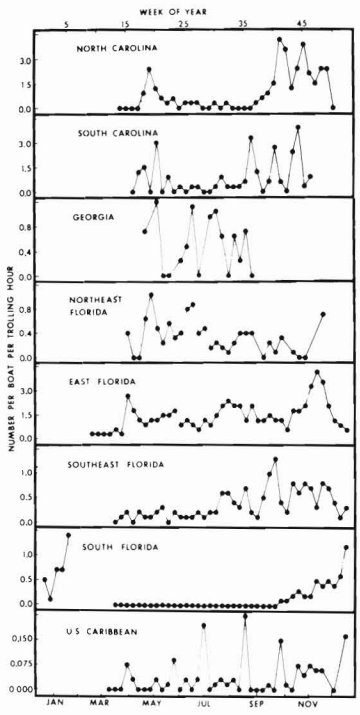

Figure 3.—CPUE by area for king mackerel caught by trolling on Atlantic and U.S. Caribbean coasts in 1983.

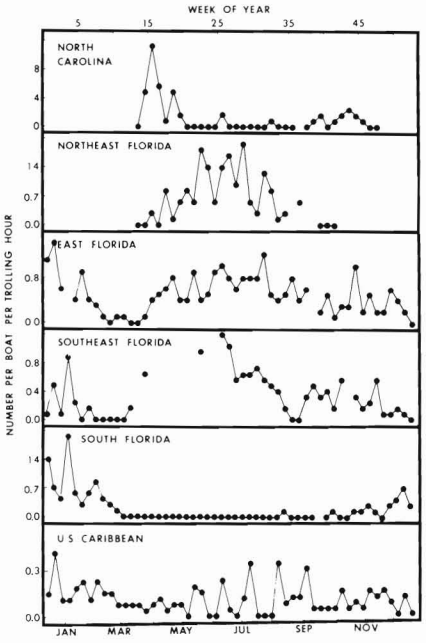

Figure 4.—CPUE by area for king mackerel caught by trolling on Atlantic and U.S. Caribbean coasts in 1984.

CPUE Data From Other Surveys

Sources of CPUE data for king mackerel from charter or private inboard recreational boats in the southeastern United States are provided in Table 2. The most extensive data bases are those provided by individual charterboat captains from Panama City and Destin, Fla., and from Orange Beach, Ala. All three of these captains fished for king mackerel as their target species. The remainder of the data bases defined in Table 2 cover areas no

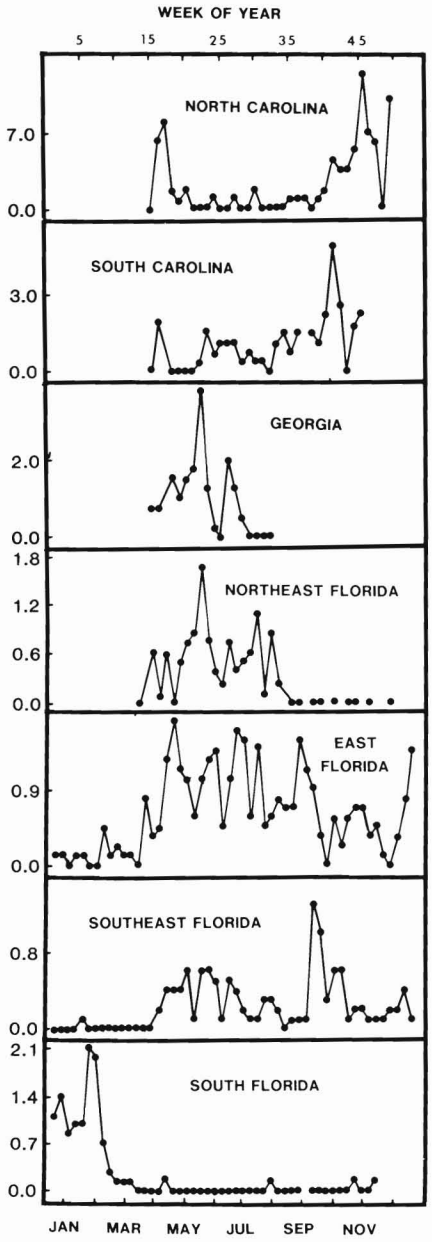

Figure 5.—CPUE by area for king mackerel caught by trolling on Atlanic coast in 1985.

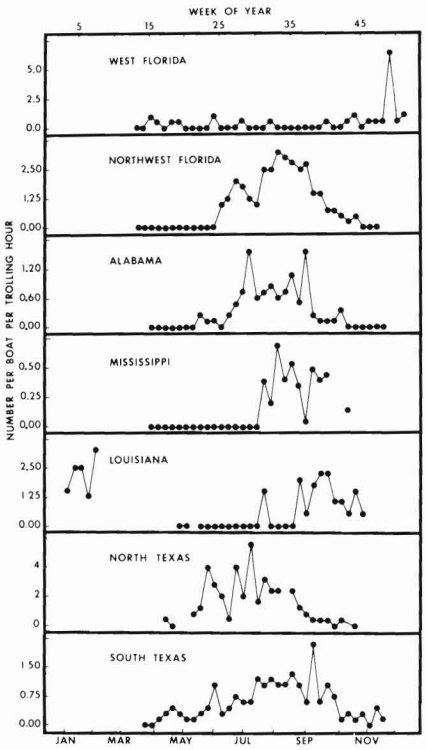

Figure 6.—CPUE by area for king mackerel caught by trolling on the U.S. Gulf coast in 1983.

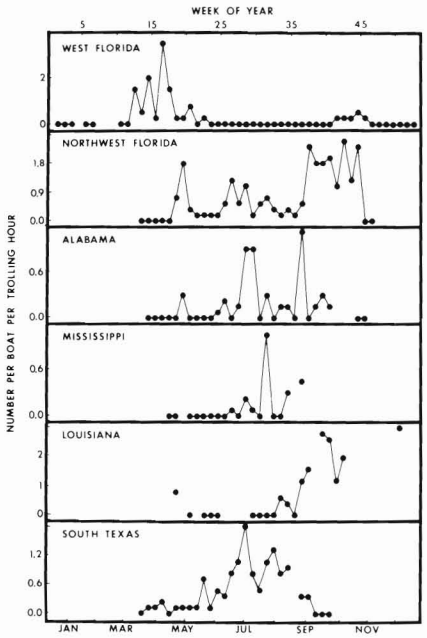

Figure 7.—CPUE by area for king mackerel caught by trolling on Gulf of Mexico coast in 1984.

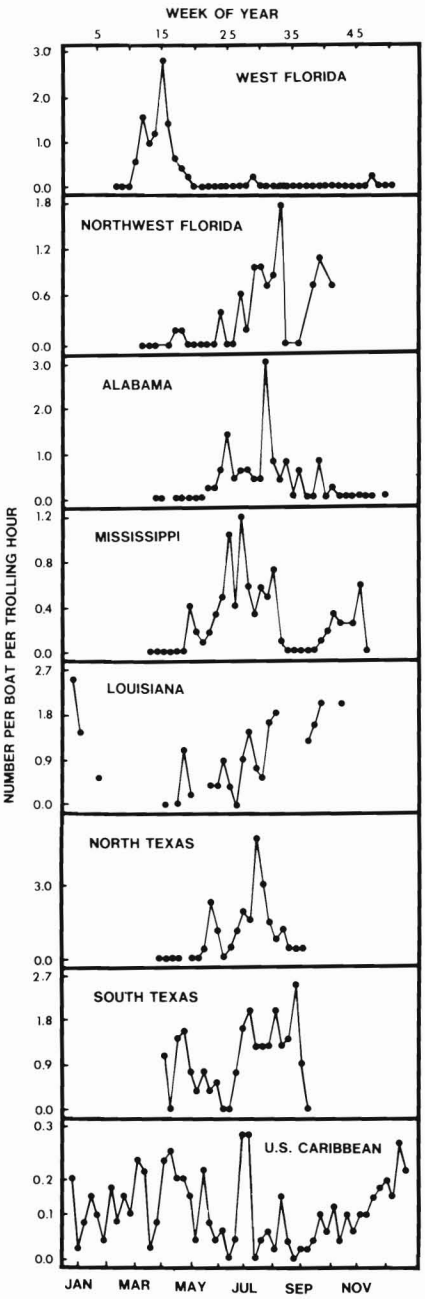

Figure 8.—CPUE by area for king mackerel caught by trolling on Gulf of Mexico and U.S. Caribbean coasts in 1985.

larger than a single state and time periods no longer than 2 years. Data from the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS) were not used because this survey did not, and was not designed to produce ample data for small geographic areas. Variability associated with these data is discussed by Nichols[1], who found the data too variable to pro-

[1]Nichols, S. 1985. A long-term catch per effort index for king mackerel. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., SEFC FAD Rep. ML1-85-18, 7 p.

Table 10.—Comparison for king mackerel of log (CPUE+1) among years for those areas, zones, and years with sufficient data.

Area	Zone	Year	Mean Arith-metic	Mean Log (CPUE+1)	F	d.f.	$F_{.10}$	Area	Zone	Year	Mean Arith-metic	Mean Log (CPUE+1)	F	d.f.	$F_{.10}$	Area	Zone	Year	Mean Arith-metic	Mean Log (CPUE+1)	F	d.f.	$F_{.10}$
NC	2	1983	0.41	0.14	6.84*	2,16	2.67	SF	1-7	1982	0.11	0.04	0.31	3,41	2.23	LA	3	1982	0.11	0.04	1.03	3,21	2.36
		1984	1.08	0.28						1983	0.25	0.08						1983	0.38	0.17			
		1985	2.33	0.50						1984	0.23	0.08						1984	0.42	0.13			
	3	1982	0.77	0.16	0.76	3,27	2.30			1985	0.25	0.07						1985	0.48	0.22			
		1983	0.99	0.22													1-7	1982	0.10	0.04	3.01*	3,23	2.34
		1984	2.79	0.35				WF	2	1983	0.51	0.15	1.06	2,24	2.54			1983	0.57	0.20			
		1985	2.74	0.41						1984	0.31	0.09						1984	0.62	0.18			
	1-7	1982	0.75	0.14	1.30	3,27	2.30			1985	0.20	0.06						1985	1.05	0.32			
		1983	0.91	0.23					1-7	1983	0.57	0.16	0.99	2,24	2.54								
		1984	2.09	0.35						1984	0.31	0.09				STX	2	1982	0.85	0.29	0.48	3,11	2.66
		1985	2.57	0.42						1985	0.19	0.06						1983	0.86	0.23			
																		1984	0.88	0.27			
EF	3	1983	1.78	0.42	12.62*	2,24	2.54	NWF	2	1982	0.50	0.15	0.98	3,20	2.38			1985	1.23	0.33			
		1984	0.41	0.16						1983	1.11	0.29					3	1982	1.01	0.25	2.08	3,18	2.42
		1985	0.73	0.23						1984	0.53	0.16						1983	0.58	0.19			
	1-7	1983	1.41	0.36	10.75*	2,27	2.51			1985	0.84	0.24						1984	0.19	0.07			
		1984	0.46	0.16					3	1982	2.10	0.45	2.29	3,11	2.66			1985	0.83	0.25			
		1985	0.72	0.23						1983	2.17	0.48					1-7	1982	0.78	0.22	2.24	3,20	2.38
										1984	1.53	0.40						1983	0.67	0.23			
SF	2	1982	0.24	0.07	0.23	3,36	2.25			1985	0.37	0.16						1984	0.22	0.08			
		1983	0.31	0.09					1-7	1982	0.76	0.22	0.75	3,20	2.38			1985	0.95	0.28			
		1984	0.22	0.07						1983	1.23	0.30											
		1985	0.17	0.05						1984	0.79	0.24				US	3	1983	0.04	0.02	8.43*	2,27	2.51
	3	1982	0.10	0.04	0.70	3,40	2.23			1985	0.50	0.16				CARIB		1984	0.09	0.04			
		1983	0.12	0.04														1985	0.11	0.05			
		1984	0.24	0.08																			
		1985	0.38	0.10																			

*Significant at the $F_{.10}$ level.

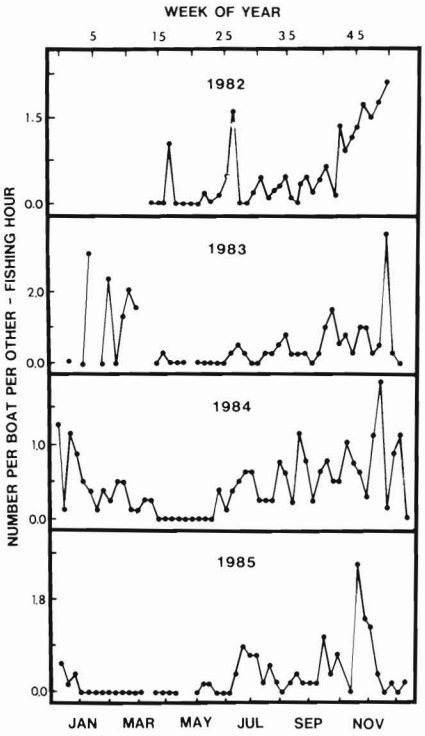

Figure 9.—CPUE for king mackerel caught by other fishing in Louisiana in 1982-85.

vide precise estimates for indices of abundance.

Annual estimates of CPUE for king mackerel within the southeastern United States varied greatly among areas in some years (Table 11). In northwest Florida and Alabama in 1973 and 1975, the three estimates generated by individual captains were close to those generated by a 1973 survey by Sutherland (1977) and a 1975 survey by Brusher et al. (1978), respectively. All CPUE estimates, ranging from 3.1 to 3.9, from the northwest Florida and Alabama areas in 1975 were, however, much higher than the two estimates (0.5 to 1.5) from Texas. In 1976, CPUE in Galveston (2.1) was within the range of values (0.7-2.4) generated by the three boats in northwest Florida and Alabama. In 1977, estimated annual CPUE (2.0) from North Carolina was higher than from the estimate in southeast Florida (0.6) and from the three individual boats in northwest Florida and Alabama (CPUE of 0.2-1.4). In 1978, estimates of CPUE in regard to area were: North Carolina 1.9, northwest Florida 1.3, and Grand Isle 1.1. In 1979 estimated annual CPUE for northwest Florida was 2.2 and for Texas was 0.6.

CPUE data for king mackerel from the northwest Florida and Alabama areas over a 20-year span reflect periods of increasing and decreasing abundance, but the patterns cannot be easily generalized (Fig. 10). In terms of sequential decline, CPUE dropped 2 years in a row from 1969 to 1971, from 1975 to 1977, and from 1980 to 1982. In terms of periods of increase and decline, three or four periods were apparent: These were 1965-71, 1971-78, and 1978-84 or 1978-82, and 1982-84.

The assumptions that CPUE data reflect abundance, or catchability, of king mackerel in northwest Florida seem valid. Although estimated annual mean CPUE by each of the three charterboats in northwest Florida and Alabama varied considerably, the directions of change from year to year were always the same (Fig. 10). Also the estimates by the surveys of Sutherland (1977) and Brusher et al. (1978) were in close agreement with those of the 3 boats in 1973 and 1975. Further, the estimates of CPUE from Captain Finnegan in 1983 and 1984 showed similar trends to those estimated from 15 boats in 1983 and 10 boats in 1984. However, the range of the esti-

Table 11.—Annual estimates of CPUE of king mackerel caught in the southeastern United States, 1965-85 from literature sources in Table 2.

Area	Literature source or boat captain	Mean number fish caught per boat fishing hour by year																		
		65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
N. Carolina	Manooch and Laws, 1979													2.0							
N. Carolina	Manooch et al., 1981														1.9						
Dade County, Fla.	Gentle, 1977													0.6							
Panama City, Fla.	Capt. J. Finnegan, Jr.						4.1	3.6		2.8	2.0	3.8	2.4	1.4	1.3	2.2	4.9	1.0	0.7	2.1	0.7
Panama City, Fla.	Sutherland, 1977									3.0											
Panama City, Fla.	Brusher et al., 1978											3.9									
Destin, Fla.	Capt. A. Hilpert									2.5	1.4	3.1	1.7	0.7							
Orange Beach, Ala.	Capt. T. Clark	0.6	1.9	1.5	1.6	1.6	1.1	0.8	1.1	2.8	2.0	3.5	0.7	0.2							
Grand Isle, La.	Fischer, 1980														1.1						
Texas	McEachron and Matlock, 1983															0.6					
Upper Padre, Tex.	Trent, 1976											1.5									
Lower Padre, Tex.	Trent, 1976											0.5									
Galveston, Tex.	Trent et al., 1977												2.1								

mates of CPUE among the boats that we surveyed from northwest Florida during 1983 through 1985 was great (Table 12). We suspect that much of the variation among boats is dependent upon the species of fish that is targeted. For example, trolling for marlin or sailfish usually produces a zero CPUE for king mackerel. It should be noted that the boats in our survey were not selected based on the species that the captains targeted.

CPUE as an Index to Abundance

Nichols[1] used the data from the three charterboat captains identified in Table 2, the data from this study for the years 1983-84, and the data from the MRFSS for northwest Florida, to evaluate their utility for a CPUE index for king mackerel. In evaluating the index, he pointed out reasons why these data sets may not be a good index of recruitment abundance in the Gulf of Mexico. One of the foremost reasons was that the data are obtained from only a small part of the range of the stock.

Data were made available in this study to look at the relations between CPUE in northwest Florida and in other areas of the southeastern United States for a 4-year period. These data coupled with analyses of length and age composition data can be used to evaluate the utility of predicting age-class strength. These analyses are not, however, presently available.

Table 12.—Mean annual CPUE and hours trolled by charterboats in northwest Florida, 1982-85.

1982			1983			1984			1985		
Hours	CPUE	S.D.	Hours	CPUE	S.D.	Hours	CPUE	S.D.	Hours	CPUE	S.D.
576.5	0.72	1.70[1]	518.0	2.09	3.34[1]	208.0	0.74	1.62[1]	128.0	0.21	0.35
			205.5	3.22	4.29	36.0	0.29	0.71	55.5	1.53	1.33
			113.0	0.73	1.45	118.0	0.61	1.18	175.5	0.39	0.71
			76.0	0.32	1.10	8.0	0.00	0.00	118.0	0.56	0.75
			423.0	1.43	1.87	172.5	1.30	1.72	115.0	0.55	1.20
			315.0	0.99	1.18	80.0	0.09	0.24	259.0	0.13	0.28
			315.0	1.11	1.13	56.0	0.43	1.10	42.5	2.46	2.99
			255.0	1.20	1.78	60.5	0.44	0.86	52.5	0.27	0.89
			354.5	0.92	1.63	260.5	0.76	1.22			
			14.0	2.29	3.23	269.5	1.02	1.80			
			160.0	1.01	1.01	12.0	0.00	0.00			
			19.0	0.00	0.00	144.0	0.17	0.34			
			150.0	1.00	1.72						
			129.0	0.03	0.09						
			65.5	1.11	2.19						
576.5[2]	0.72[3]	1.70[4]	3,112.5	1.34	2.16	1,425.0	0.71	1.40	946	0.49	1.11

[1]Data from Capt. Joe Finnegan, Jr.
[2]Total.
[3]Weighted mean.
[4]Annual S.D.

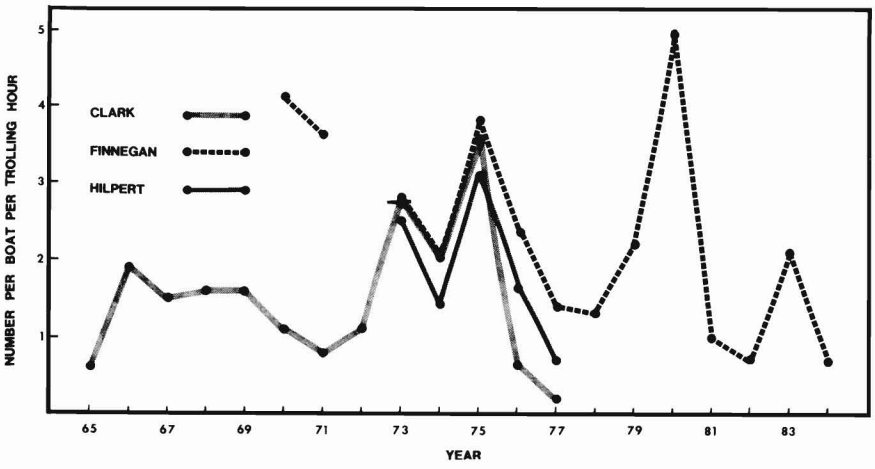

Figure 10.—CPUE by individual charterboat captain in northwest Florida and Alabama, 1965-84.

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