Erratum: line 22, column 2, page 21 should read "fourth" author, not "second" author. Joe Finnegan, Jr. owns and operates the Fu-Lin-Yu II.

Possible Temperature Effects on Charter Boat Catches of King Mackerel and Other Coastal Pelagic Species in Northwest Florida

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ABSTRACT—Dramatic changes occurred in the landings, species composition, and sizes of fishes caught in the charter boat fishery for pelagic fishes in northwest Florida in the summers of 1977 and 1978. These changes occurred after two of the coldest winters in 100 years. Catch per hour (CPH) of king mackerel, the target species, declined greatly, while CPH of Atlantic bonito and bluefish increased. Data indicated that warm winters resulted in high CPH, while cool winters resulted in low CPH. We concluded that catch rates of king mackerel were related to temperatures of the preceding winter.

Introduction

A large fleet of charter sportfishing boats and numerous private boats seek pelagic fishes during the warmer months in northwest Florida. Trolling techniques are usually employed and numerous pelagic species are caught: King mackerel, *Scomberomorus cavalla*; Spanish mackerel, *S. maculatus*; bluefish, *Pomatomus saltatrix*; blue runner, *Caranx crysos*; little tunny, *Euthynnus alletteratus*; Atlantic bonito, *Sarda sarda*; and dolphin, *Coryphaena hippurus*.

The areas of greatest trolling effort in northwest Florida are adjacent to Panama City (Bay County) and Destin (Okaloosa County). Historically, this fishery has been mostly dependent on catches of king mackerel (Irby, 1974; Brusher et al., 1978; Fisher, 1978). Sutherland and Fable (1980) have shown that these king mackerel winter off southeast Florida.

Studies by the National Marine Fisheries Service (NMFS) indicated that dramatic changes in the landings, species composition, and sizes of fishes have occurred during the summers of 1977 and 1978 in the charter boat pelagic fishery off Panama City. These changes occurred after equally dramatic changes in air temperatures during the preceding winters.

Our paper describes and discusses the changes in the northwest Florida charter boat pelagic fishery and discusses temperature as a possible cause for the observed changes.

Source and Treatment of Data

Catch records from the Panama City area were obtained from the logs or log summaries of the *Fu-Lin-Yu II*, a charter boat that fishes only by trolling and which is owned and operated by the second author. The available records consisted of total numbers of trolled hours and the numbers of fish of each species that were caught each month during 1970, 1973-76, and 1978-79 and each year for 1971 and 1977. No records were available for 1972. Eight charter boat captains that fish in the Panama City area were consulted to determine if these logs were representative. Each stated, based on memory, that the catch records were generally typical of charter boat catches in this area during the specified periods. All data were tabulated by year or month, and species composition and catch per unit effort were determined. Catch per unit effort for this report is defined as the catch per hour (CPH) for each species. Annual catch composition and CPH for each species that comprised over 3 percent of the catch for the entire 8 years were plotted.

We supplemented our catch information with data provided by J. A. Browder and C. J. Davis (NMFS and Gulf Fishery Management Council, November, 1979, pers. commun.) on charterboat catch rates of king mackerel from Destin, Fla., and Orange Beach Ala. Data from charter boat captain A. L. Hilpert in Destin were available from 1973 through 1977 and included catch-per-hour figures. Orange Beach landings by charter boat captain T. Clark included data from 1965 through 1977 and were in catch-per-day figures, which we converted to catch-per-hour by dividing by four (assuming an average of four hours of fishing each day).

Data for evaluating sizes of king mackerel and bluefish were obtained by the NMFS Panama City Laboratory in conjunction with life history studies. Data on bluefish from the Panama City area were acquired from gillnet catches in 1973 (Trent and Pristas, 1977) and gillnet, haul seine, and hook and line catches in 1977-78. King mackerel data were acquired from fish caught on hook and line off North Carolina, northwest Florida, and Texas in 1977 and 1978[1]. Fork length (FL), to the nearest millimeter was measured and grouped into 5.0 cm (king mackerel) or 2.5 cm (bluefish) intervals. Length data on king mackerel from Panama City in 1977 and 1978 were divided into small fish (<700 mm FL) and large fish (≥700 mm FL) and were plotted by month.

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[1]Trent, L., R. O. Williams, R. G. Taylor, C. H. Saloman, and C.S. Manooch III. In prep. Seasonal changes in the size and sex ratio of king mackerel *(Scomberomorus cavalla)* and comparisons among geographic locations in the southeastern United States.

Long-term water-temperature data were unavailable for the northeast Gulf of Mexico. Tolbert and Austin (1959) stated that water temperatures closely parallel air temperatures at Panama City. Pensacola, Fla., is approximately 100 miles west of Panama City and air temperatures are similar. We acquired the annual summary of local climatological data with comparative data for Pensacola from the Environmental Data and Information Service (EDIS, 1978). Data for January and February 1979 were taken from monthly climatological data pamphlets, also provided by EDIS. Average winter (December-February) air temperatures were computed and plotted.

Species Composition and CPH

Seven species composed 98.9 percent of the total of 22,349 fish caught by the *Fu-Lin-Yu II* during 1970-71 and 1973-79 (Table 1). King mackerel predominated and composed 60.8 percent of the total catch. Other species composing over 3 percent of the total catch were: Atlantic bonito (14.6), bluefish (5.4), blue runner (5.3), little tunny (5.3), Spanish mackerel (3.8), and dolphin (3.7).

The composition of the catch changed dramatically during the latter half of the 9-year (1970-79) period (Fig. 1) King mackerel composed over 80 percent of the total catch each year through 1975 and then declined as follows: 1976 (65.3

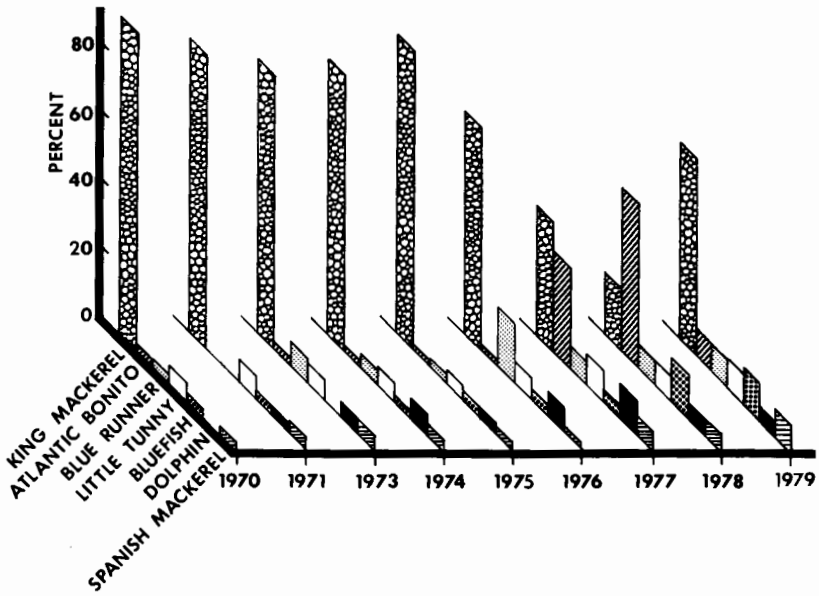

Figure 1.—Percent composition of the seven most abundant species caught during 1970-71 and 1973-79 in Panama City, Fla.

Table 1.—Catches of coastal pelagic fishes from the *Fu-Lin-Yu II* by trolling in the Panama City, Florida, area.

	Year (and hours fished)																		
	1970 (552)		1971 (550)		1973 (495)		1974 (329)		1975 (592)		1976 (589)		1977 (676)		1978 (706)		1979 (781)		
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
King mackerel *Scomberomorus cavalla*	2,263	92.9	1,963	86.9	1,400	81.5	850	81.5	2,270	88.4	1,426	65.3	976	38.7	909	18.9	1,742	57.2	13,599
Atlantic bonito *Sarda sarda*	18	0.7	0	0.0	1	0.1	2	0.3	8	0.3	9	0.4	742	29.5	2,266	47.0	216	7.1	3,262
Bluefish *Pomatomus saltatrix*	12	0.5	62	2.7	0	0.0	2	0.3	71	2.8	68	3.1	79	3.1	611	12.7	296	9.7	1,201
Blue runner *Caranx crysos*	15	0.6	0	0.0	109	6.3	27	3.4	11	0.4	381	17.5	150	5.9	290	6.0	205	6.7	1,188
Little tunny *Euthynnus alletteratus*	75	3.1	126	5.6	77	4.5	31	3.9	68	2.7	111	5.1	193	7.7	266	5.5	231	7.6	1,178
Spanish mackerel *Scomberomorus maculatus*	45	1.9	70	3.1	53	3.1	23	2.9	69	2.7	7	0.3	130	5.1	212	4.4	231	7.6	840
Dolphin *Coryphaena hippurus*	1	0.0	37	1.6	55	3.2	38	4.8	46	1.8	151	6.9	237	9.4	178	3.7	93	3.1	834
Ladyfish *Elops saurus*	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	0.9	0	0.0	79	1.6	8	0.3	106
Blackfin tuna *Thunnus atlanticus*	0	0.0	0	0.0	16	0.9	21	2.6	18	0.7	0	0.0	0	0.0	0	0.0	1	0.0	56
Crevalle jack *Caranx hippos*	5	0.2	0	0.0	7	0.4	1	0.1	6	0.2	3	0.1	3	0.1	6	0.1	20	0.7	51
Cobia *Rachycentron canadum*	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	0.2	6	0.2	2	0.0	4	0.1	18
Greater amberjack *Seriola dumerili*	0	0.0	0	0.0	0	0.0	3	0.4	1	0.0	3	0.1	0	0.0	0	0.0	0	0.0	7
Wahoo *Acanthocybium solanderi*	2	0.1	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	2	0.1	1	0.0	0	0.0	6
Great barracuda *Sphyraena barracuda*	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	1	0.0	1	0.0	3
Total	2,437		2,258		1,718		798		2,569		2,183		2,519		4,819		3,048		22,349

percent), 1977 (38.7 percent), and 1978 (18.0 percent). In 1979, they made up 57.2 percent of the catch. Atlantic bonito were rare in the catches until 1977 during which they composed 29.5 percent of the catch. In 1978 they comprised 47.0 percent of the catch, but in 1979 they dropped to only 7.1 percent of the catch. This species was unreported from the northern Gulf until 1966 when Boschung (1966) documented its occurrences east of the Mississippi Delta.

The CPH data reflect two periods of declining abundance of king mackerel in the Panama City area: Mean CPH delined from 4.1 in 1970 to 2.0 in 1974 and from 3.8 in 1975 to 1.3 in 1978 (Fig. 2). The CPH of king mackerel from Panama City, Destin, and Orange Beach is shown in Table 2 and plotted in Figure 3. From 1973 through 1977 the CPH values from all areas show the same trends. They decrease from 1973 to 1974, increase in 1975, then decrease in 1976 and again in 1977.

The assumption that these CPH data reflect abundance, or catchability, of king mackerel in the area seems valid. King mackerel is the target species for the local charter boat fleet and when they are available the captains fish for them almost exclusively. The CPH by the *Fu-Lin-Yu II* of 3.8 king mackerel in 1975 agrees closely with the average of 3.9 for the entire Panama City charter boat fleet in 1975 (Brusher et al., 1978).

During 1975-78, the CPH of Atlantic bonito and bluefish notably increased as the CPH of king mackerel declined (Fig. 2). For the 9 years of record, the CPH of Atlantic bonito increased dramatically in 1977-78; the CPH of blue runner was especially high in 1976; the CPH of dolphin was highest in 1977; the CPH of little tunny and bluefish were highest in 1978, and the CPH of Spanish mackerel was highest in 1979. During 1970-74, the CPH of other species did not increase as the CPH of king mackerel declined.

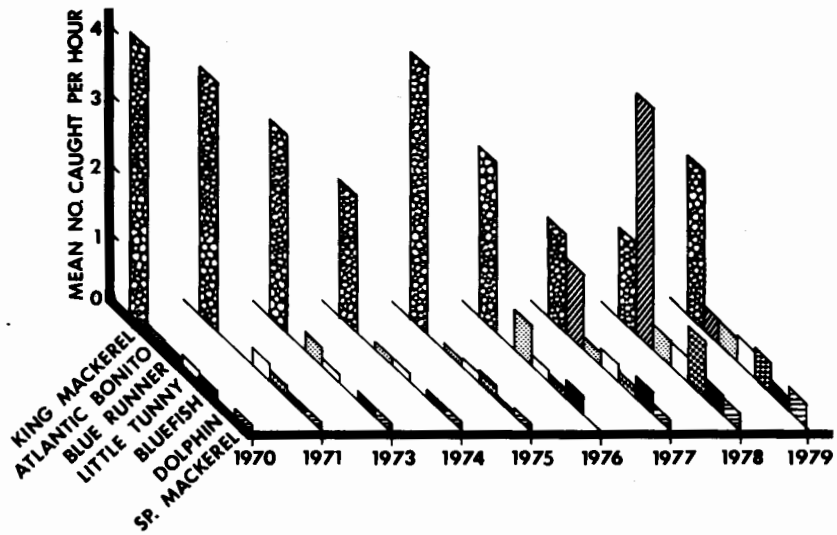

Figure 2.—Mean catch per hour of the seven most abundant species caught during 1970-71 and 1973-79 in Panama City, Fla.

Table 2.—Catch per hour of king mackerel from three areas.

Year	Panama City	Destin	Orange Beach	$\bar{X}$
1965	—	—	0.6	—
1966	—	—	1.9	—
1967	—	—	1.5	—
1968	—	—	1.6	—
1969	—	—	1.6	—
1970	4.1	—	1.1	2.6
1971	3.6	—	0.8	2.2
1972	—	—	1.1	—
1973	2.8	2.5	2.8	2.7
1974	2.0	1.4	2.0	1.8
1975	3.8	3.1	3.5	3.5
1976	2.4	1.7	0.7	1.6
1977	1.4	0.7	0.2	0.8
1978	1.3	—	—	—
1979	2.2	—	—	—

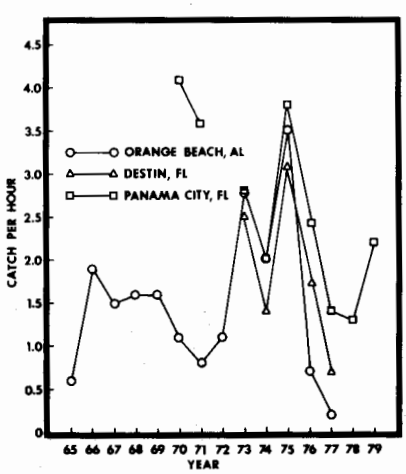

Figure 3.—King mackerel catch per hour from three areas of the northeastern Gulf of Mexico.

Seasonality of the Catch

In general, king mackerel are available to the fishery in the Panama City area in April, are abundant during June to November, and are most abundant, or catchable, in September (Fig. 4). Deviations from this general sequence occurred, however, during the 7 years on record (Fig. 5). During 1970, 1973, and 1974 the pattern of the CPH was bimodal, with relatively high CPH occurring in May or June and again in September or November. Although the CPH by the *Fu-Lin-Yu II* did not indicate a bimodal pattern in 1975, data from the charter boat fleet had peaks of CPH in June and September (Brusher et al., 1978). In 1976, the CPH was extremely low until June and in 1978 until July. Again, bimodal distributions of the CPH were indicated in 1976, 1978, and 1979. Catch rates were good in May of 1979 and very high in August. Highest CPH occurred in August or September in all years except 1974.

The CPH of the remaining six species (Fig. 4) indicated that Atlantic bonito, blue runner, little tunny, and dolphin were most abundant in the catches during June or July, while bluefish were most abundant in May and November and Spanish mackerel in March.

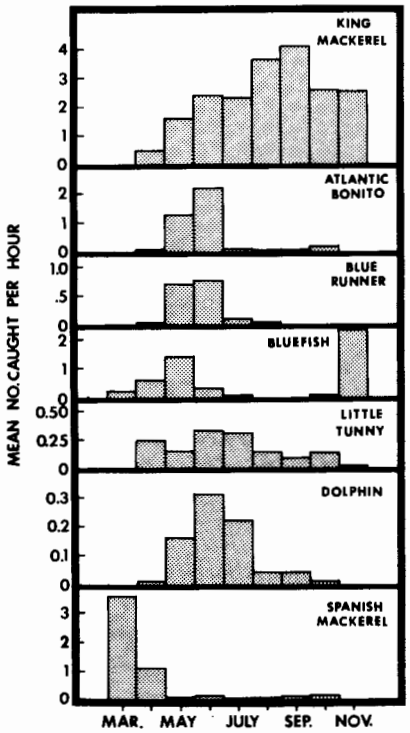

Figure 4.—Average monthly catch per hour of the seven most abundant species caught in Panama City, Fla.

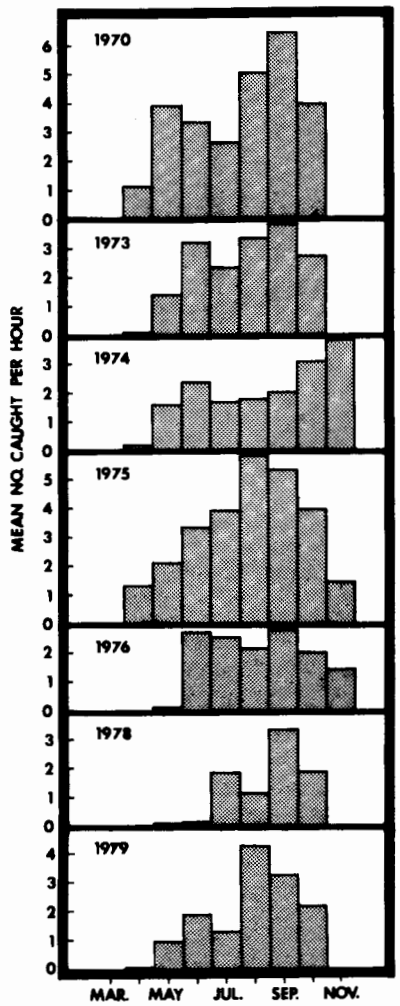

Figure 5.—Average monthly catch per hour of king mackerel by year in Panama City, Fla.

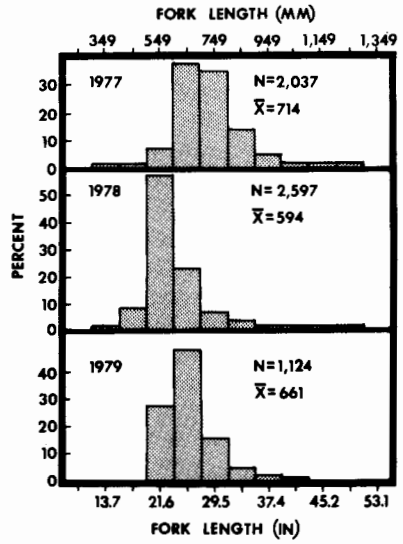

Figure 6.—Length-frequency distributions of king mackerel in Panama City Fla., during 1977-79.

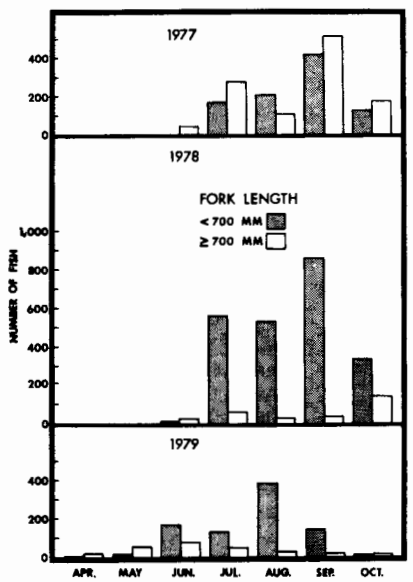

Figure 7.—Monthly distribution of small (<700 mm FL) and large (≥700 mm FL) king mackerel sampled during 1977-79 in Panama City, Fla.

Sizes of Fish

Discussions with charter boat captains indicated that the average size of king mackerel caught in the Panama City area during 1978 was the smallest they could remember. A size comparison (footnote 1) indicated that catches of king mackerel in the Panama City area were composed of many more small fish during 1978 than during 1977 or 1979 (Fig. 6). When fish sizes from other areas were compared, lengths of king mackerel from Panama City averaged about the same as those from North Carolina and Texas in 1977, whereas those from Panama City averaged much smaller in 1978. Mean fork lengths by area and year were: Panama City—714 mm (1977), 594 mm (1978), 661 mm (1979); North Carolina—713 mm (1977), 847 mm (1978); Texas—785 mm (1977), 872 mm (1978). No data from areas other than Panama City were available for 1979.

Sizes of king mackerel caught in the Panama City area varied seasonally (footnote 1). During each year, mean lengths were greatest at the beginning of the fishing season, declined to a seasonal low in August, and then increased in September or October. The data, grouped into small (<700 mm FL) and large fish (≥700 mm FL), indicated that during 1977 large fish were more abundant than small fish during June, July, September, and October, whereas in 1978, small fish predominated in every month except June (Fig. 7). In 1979, large fish were more abundant in April, May, and October.

Large bluefish (along with the usual

Table 3.—Average winter (December-February) air temperatures for Pensacola, Fla. 1964-79.

Winter	Avg. Temp. °F	Avg. Temp. °C	Winter	Avg. Temp. °F	Avg. Temp. °C
1963-64	47.6	8.6	1971-72	58.9	14.9
1964-65	53.7	12.0	1972-73	53.7	12.0
1965-66	51.0	10.5	1973-74	58.5	14.7
1966-67	51.9	11.0	1974-75	58.2	14.5
1967-68	51.2	10.6	1975-76	54.5	12.5
1968-69	51.3	10.7	1976-77	47.5	8.6
1969-70	50.4	10.2	1977-78	48.0	8.9
1970-71	54.6	12.5	1978-79	50.7	10.4

small bluefish) occurred in the Panama City area in the spring of 1978 for the first time that local fishermen could remember. These large fish averaged 758 mm FL (about 12 pounds or 5.5 kg), decidedly larger than we had observed in 1973 and 1977 (Fig. 8). Large bluefish occur in March and April off southeast Florida (DeSylva, 1976) but are rarely taken in the Gulf of Mexico. Most of the large bluefish caught off southeast Florida during early spring range between 10 and 14 pounds (4.5 and 6.5 kg) (Dunaway, 1979).

Temperature

The average winter (December-February) air temperatures for Pensacola are shown in Table 3 and Figure 9. The average winter temperature for an 84-year period (1879-1963) was 54.3°F (12.4°C) (EDIS, 1978). For this same period, the coldest winter on record (1957-58) averaged 48.7°F (9.3°C). The table and figure show that the winters of 1963-64, 1976-77, and 1977-78 all averaged lower than this previous record. It was very unusual that two of these low temperature winters occurred consecutively (1976-77 and 1977-78).

Discussion

The fishing seasons of 1977 and 1978 showed not only changes in the arrival time and size and abundance of king mackerel, but also differences in abundance of Atlantic bonito and size composition of the bluefish catch. This led us to believe that some environmental influence was primarily responsible for the changes in the charter boat catches, since several species showed changes in landings.

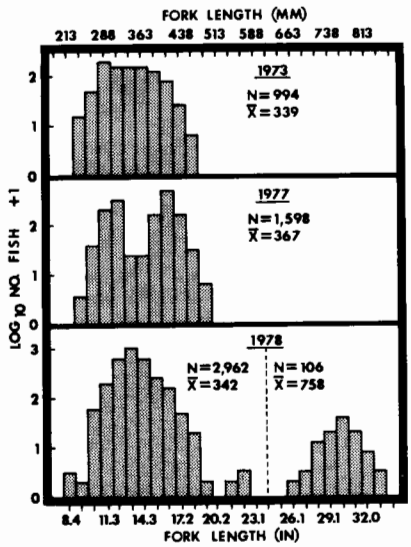

Figure 8.—Length-frequency distributions of bluefish in Panama City, Fla.

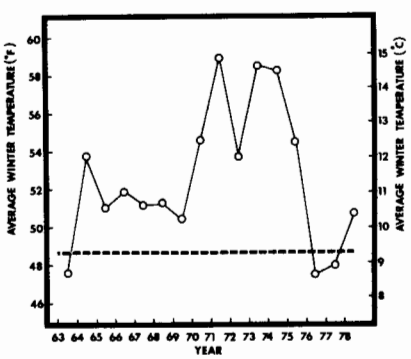

Figure 9.—Average winter air temperatures for Pensacola, Fla. Dashed line indicates coldest winter (1957-58) during the period 1879-1963.

To relate the CPH to winter temperature, we developed a scatter diagram of the CPH from Table 2 and the average preceding winter air temperatures from Table 3 (Fig. 10). The diagram revealed a relationship between winter air temperature and the CPH of the following fishing season. Generally, warm winters resulted in high CPH, while cool winters resulted in low CPH. Although outlying

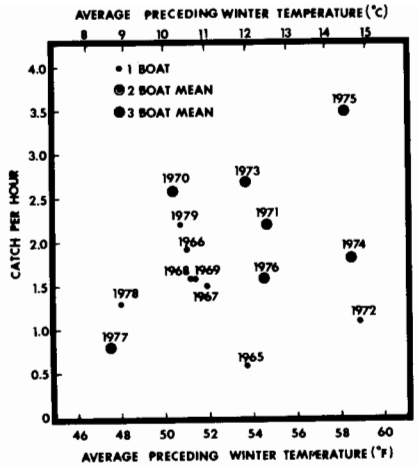

Figure 10.—King mackerel catch per hour plotted against preceding winter average air temperature.

points (1965, 1972) did not agree with this tendency, these points were based on the CPH values from one boat, whereas the points based on the CPH values from three boats (1973-77) did support this relationship. Although too few data were available to be conclusive, the highest CPH (1975) occurred after one of the warmest winters, and two of the lowest CPH's (1977 and 1978) occurred after the two coldest winters.

Williams and Taylor (1980) have stated that the first appearance of king mackerel off west central Florida is directly dependent on offshore water temperature and indirectly on air temperatures of the preceding winter. Our data suggest that catch rates in northwest Florida are also related to temperatures. We will continue to monitor the catch records of charter boats in the future to determine more definitely their relationship to environmental factors.

Acknowledgments

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Browder, Edward Houde, Frank Williams, and Roy Williams. Also, the charter boat captains of Panama City have provided countless suggestions and hypotheses which helped in the development of this manuscript.

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