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SEASONAL ABUNDANCE OF HAMMERHEAD SHARKS OFF CAPE CANAVERAL, FLORIDA.—Hammerhead sharks, *Sphyrna* spp., were observed during bimonthly aerial surveys in the Atlantic Ocean off Cape Canaveral, Brevard County, Florida from June 1980 to May 1981. Surveys were conducted in a 111 by 222-km study area situated between 27°35′N, 28°35′N, 80°20′W, and 78°04′W (Fig. 1). Four 111-km transects and two 222-km transects, each separated by 18.5 km, were flown three times during each survey month. Transects started or ended at 80°20′W, and most transected both boundaries of the Gulf Stream. The Gulf Stream was identified by changes in sea surface temperature, water color, water clarity, and often by sea state. Typically, one set of six transects was flown per day at speeds of about 222 km/h and at altitudes of 91 and 228 m with a twin-engine Beechcraft AT-11 airplane equipped with a plexiglass observation dome in the nose, a TDL-711 Loran C Navigation system, and a Barnes PRT-55 infrared radiometer for measuring sea surface temperatures.

Hammerhead sharks were sighted during each of the monthly surveys (Table 1). Sightings, as used herein, consisted of one or more sharks observed at the same time. Shark abundance across months was not uniform ($\chi^2 = 216.8$, df = 5, $P < 0.001$). Hammerhead sharks were seen within and outside the Gulf Stream during June, Aug. and Oct. but only outside the Gulf Stream during Dec., Feb. and April (Fig. 1). Of a total of 65 April sightings (from 31 March to 1 May) 64 were west of the Gulf Stream and one was east of the current. During this period most sharks were seen on 31 March (60 sharks, 39 sightings); 30 sightings occurred in the southeastern portion of the study area (about 1,370 km²) where the Gulf Stream is closest to the shore. On 1 April only 18 sharks (17 sightings) were seen and on 1 May only seven hammerhead sharks (seven sightings) were seen. Seasonal patterns of hammerhead shark abundance seen during this study are concordant with seasonal patterns based on data from longline catches (J. Hoey and J. Casey, pers. comm.).

Headings were recorded for 70 of 85 hammerhead sharks seen during the April survey period. Headings were categorized into four major directions: N (316 to 45°), E (46 to 135°), S (136 to 225°), and W (226 to 315°). Fifty-six sharks were oriented south, 5 north, 4 east and 5 west; the bias toward a southern direction was significant ($\chi^2 = 89.8$, df = 3, $P < 0.001$).

Most of the hammerhead sharks seen off Cape Canaveral were estimated to be 3.5 to 4.0 m long and could be assigned to any of three species of hammerheads known from the Atlantic Ocean off Florida, *Sphyrna mokarran, S. zygaena* and *S. lewini* (Gilbert, 1967). Distributional and seasonal patterns described by Springer (1938), Clark and von Schmidt (1965), Gilbert (1967) and Hoese and Moore (1977) did not help identify the sharks seen in the study area.

Hammerhead sharks were sighted in cooler,

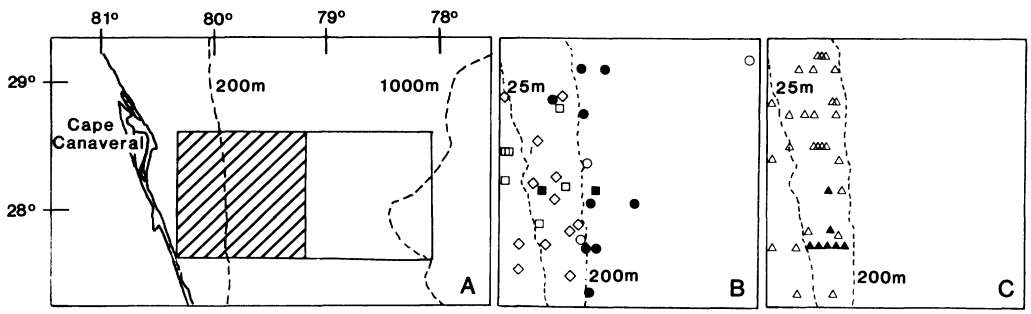

Fig. 1. Sighting locations for hammerhead sharks. The western Gulf Stream boundary varied seasonally but typically corresponded with the 200-m contour. A) Study area off Cape Canaveral. B) Sightings in inshore half (hatched) during June (○), Aug. (■), Oct. (●), Dec. (□) and Feb. (◇). C) April sightings (△ = single sighting; ▲ = five sightings).

TABLE 1. NUMBERS OF HAMMERHEAD SHARKS, SIGHTINGS AND SEA SURFACE TEMPERATURES (MEANS ± STANDARD DEVIATIONS, °C) OBSERVED IN DIFFERENT PARTS OF THE STUDY AREA OFF CAPE CANAVERAL, FLORIDA DURING BIMONTHLY AERIAL SURVEYS (1980–1981). The far right column shows monthly sea surface temperatures for the entire study area.

Month	Total number of sharks	Total number of sightings	Number of sightings (N) and sea surface temperatures ($\bar{x}$ ± SD)						Monthly range of sea surface temperatures in study area
			West of the Gulf Stream		Within the Gulf Stream		East of the Gulf Stream		
			N	$\bar{x}$ ± SD	N	$\bar{x}$ ± SD	N	$\bar{x}$ ± SD	
June	5	5	2	27.0	1	28.0	2	27.0	25–29
Aug.	6	3	2	26.5	1	27.0	—	—	25–28
Oct.	15	10	1	27.0	9	26.1 ± 0.3	—	—	25–28
Dec.	6	6	6	22.7 ± 0.5	—	—	—	—	22–26
Feb.	17	13	13	22.3 ± 0.9	—	—	—	—	19–26
April	85	65	64	21.5 ± 0.9	—	—	1	23.0	19–25
Total	134	102	87		11		3		

inshore waters during Dec., Feb. and April than in other survey periods, although warmer waters of the Gulf Stream were available (Table 1 and Fig. 1). Seasonal differences in hammerhead distribution in relation to the Gulf Stream and the sea surface temperatures where sightings occurred, could reflect the seasonal occurrence of different species in the study area. The sharks seen during Dec., Feb. and April when temperatures were lowest could have been *S. zygaena* or *S. lewini*, which are found in colder waters than *S. mokarran* (Gilbert, 1967). An alternative explanation is that seasonal shark distribution is affected by factors other than water temperature.

The reasons for the abundance of hammerhead sharks off Cape Canaveral on 31 March and 1 April are not known. Previous concentrations of sharks have been associated with migration, feeding, and reproduction (Gilbert, 1967; Springer, 1967; Parker and Bailey, 1979; Klimley and Nelson, 1981). Feeding schools have been described as denser aggregations (Parker and Bailey, 1979) than those seen off Florida during this study; furthermore, sharks seen during the April survey period were not actively feeding. Some sharks move inshore to mate or deposit their young (Springer, 1967), occasionally resulting in massive aggregations (Parker and Bailey, 1979). The sightings during the Feb. and April surveys were limited primarily to waters inshore from the Gulf Stream, but sightings were usually of single sharks and generally no interaction between sharks was observed.

Migration seems the most plausible explanation, because larger numbers were seen on 31 March and 1 April than on other dates or survey periods. However, neither *S. zygaena* nor *S. mokarran*, both of which are reported to be migratory (Gilbert, 1967), would be expected to be moving south during April. If *S. zygaena* were migrating in spring or early summer, it would be expected to be heading north to cooler waters. *S. mokarran* would be expected to be farther south during the winter and to move north into the warming waters off Florida during the late spring and early summer. *S. mokarran* is never believed to be common north of Cape Hatteras, North Carolina (J. Casey, pers. comm.). Seasonal movements of *S. lewini* are not as well understood. It is known to range off the coast of Florida north to Cape Cod, Massachusetts. During the summer *S. lewini* may range north to the Grand Banks along the edges of the Gulf Stream (J. Casey, pers. comm.).

Sharks may migrate in response to reproductive cycles (Springer, 1963). Hammerhead sharks seen on 31 March and 1 April during this study may represent sharks moving south and toward the Gulf of Mexico for reproduction, although there are few data to support this hypothesis. The sightings of 31 March and 1 April could also represent a more localized movement rather than a migration covering large latitudinal changes. The lower number of sharks seen on 1 April support this possibility. Further observations are needed to explain the phenomenon observed off Cape Canaveral.

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IDENTIFICATION OF THE PERCID, *IOA VIGIL* HAY.—In the recent note by Page (1983), *Ioa vigil*, Hay Holotype: US National Museum 32201 (23 mm SL), Pearl River at Jackson, Mississippi, July–Aug. 1881, was considered to be a junior synonym of *Hadropterus shumardi* Girard (=*Percina shumardi*). Page based his determination on its moderately blunt snout, 10 dark spots along the back (reported by Hay) and its extremely narrow interorbital width. His determination followed a restriction in its identification to one of three Pearl River-inhabiting species of *Percina* possessing the combination of a modified scale between the pelvic fins and no premaxillary frenum.

I disagree with Page in his identification of *Ioa vigil*. Collette and Knapp (1967) determined *Etheostoma ouachitae* Jordan and Gilbert to be = *Percina uranidea* and thought perhaps that *Ioa vigil* Hay also to be =*P. uranidea*. When I examined the holotype of *Ioa vigil* in the mid 1960's there was some pigmentation present, in particular the basi-caudal spot was jet-black and the body was entire but the dorsal, anal and caudal fin rays were partially broken off. The remaining body pigmentation was insufficient to corroborate Hay's (1883) description. My second examination of the holotype of *Ioa vigil* was in late 1977. Fin rays were broken off even closer to the body, the caudal fin was split down to the spot which had faded (or bleached) considerably. Moreover, there was a break in the body at the occiput and some bone was lost off the top of the head. Meaningful measurements of the head region were not possible, however some counts were made. I thank Ernest A. Lachner and Susan Jewett, US National Museum of Natural History for making available research equipment. Microscopic examination of *Ioa vigil* gave the following fin ray counts: Dorsal (XI, 13) and anal (II, 10). The latter count agrees with Hay (1883) but he gave X, 12 as the dorsal fin ray count. Susan Jewett made a series of radiographs of *Ioa vigil* and six views revealed that my counts with the microscope for the dorsal and anal fins were correct. If the last ray of the second dorsal fin is not considered to be separated into two ray elements, the count would be 12 as enumerated by Hay. The last anal fin ray seems to be typically separated into two elements.

Comparative counts for 100 *Percina ouachitae*, 100 *P. shumardi* and 154 *P. copelandi* from the Pearl River are presented in Table 1. An examination of the fin ray data in Table 1 shows great similarity between the counts for *P. ouachitae* and the counts for *Ioa vigil*. All 100 *P. shumardi* have a higher dorsal and anal soft-ray count than the type of *Ioa vigil*. Fifty-two of the 154 *P. copelandi* from the Pearl River have 13 dorsal soft-rays but only two of the 154 have the same anal soft-ray count (10) as *Ioa vigil*.

Page (1983) stated that "at 23 mm, *P. ouachitae* characteristically has four or five large blotches on the back, rather than about 10 square spots along the back as Hay described for *I. vigil*." Fifty small specimens (17.8–32.6 mm SL) of *P. ouachitae* from the Pearl River