

Distribution and Apparent Abundance of the Basking Shark, *Cetorhinus maximus*, off the Central and Southern California Coast, 1962-85

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Background

Basking sharks, *Cetorhinus maximus*, are frequently observed along the central and northwestern southern California coast during the winter and spring months. These large plankton feeding elasmobranchs, second in size only to the whale shark, *Rhineodon typus*, had been the subject of a small commercial fishery off California in the late 1940's and early 1950's for their liver oil, rich in vitamin A, and in later years for reduction into fish meal and oil (Roedel and Ripley, 1950). These fisheries were sporadic and did not take basking sharks in large numbers.

Along the west coast of North America, the other substantial amount of "fishing" occurred in the 1950's when an eradication program was conducted in British Columbia waters by the Canadian Fisheries Department. Basking sharks were damaging Pacific salmon, *Oncorhynchus* spp., gill nets and a boat equipped with a sharp plow-like device was used to ram and kill basking sharks. About 50 sharks were reported killed during the first month of operation (Anonymous, 1956).

Basking sharks are fished by harpoon in many areas of the world (Norway, Ireland, Scotland, Iceland, China, Japan, Peru and Ecuador). These fisheries are reported to be sporadic due to periodic depletion of basking shark stocks (Compagno, 1984). Basking shark meat is used for human consumption, fresh or dried salted. The fins are used for shark-fin

soup, the liver for squalene, the hide for leather, and the carcasses for fish meal (Compagno, 1984).

Observations on the occurrence of these sharks off central California, based on records of Edward Durden, an aerial fish spotter who worked with the basking shark fishery during the 1948-1950 period, were published by Squire (1967). These records indicate that basking sharks are commonly observed during October to May, with commercial concentrations noted off Pismo Beach and in Monterey Bay. This occurrence differs from that reported in north European waters where basking sharks are commonly observed during the summer.

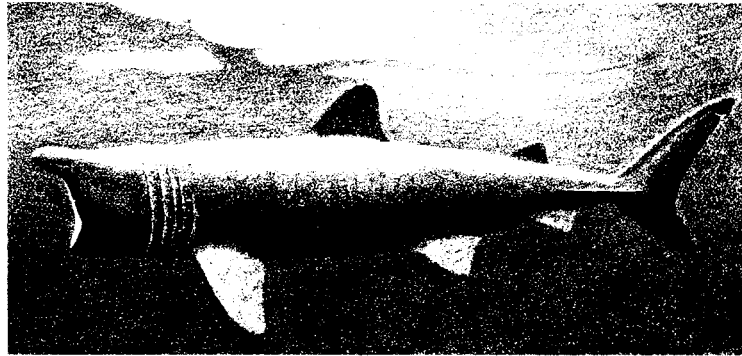
In European waters it is proposed that they may shed their gill rakers in early winter, and hibernate near the bottom during the winter and spring months (Matthews, 1962). Along the California coast, they are frequently observed in areas of high phytoplankton abundance.

In February 1955, the author recorded their occurrence in Monterey Bay during an aerial survey for pelagic fish (Anonymous, 1955). Seventy-four basking sharks were counted in the northeast portion of Monterey Bay, within 1.5 miles of shore. They appeared to be feeding in an area of patchy plankton.

This paper describes the distribution and abundance of basking sharks along the central and southern California coast (1962-85) as recorded by aerial fish spotters participating in the NMFS aerial monitoring program for coastal pelagic resources. Comparison is made of the seasonal occurrence of phytoplankton off the central California coast and the abundance of basking sharks.

Methods

In 1962, the National Marine Fisheries Service Southwest Fisheries Center (SWFC) started an aerial monitoring program for pelagic fish resources using the



The basking shark, *Cetorhinus maximus*.

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services of aerial fish spotter pilots that work with the California commercial purse seine fleet. The spotter pilots search the offshore areas from off Baja California, Mexico, to the Monterey Bay area for concentrations of such target species as the northern anchovy, *Engraulis mordax*; Pacific or chub mackerel, *Scomber japonicus*; jack mackerel, *Trachurus symmetricus*; Pacific bonito, *Sarda chilensis*; Pacific sardine, *Sardinops sagax*; and bluefin tuna, *Thunnus thynnus*. For the resource monitoring program the spotter pilots maintain a flight log indicating areas searched, species observed, and amount of fish observed (estimated in short tons) for the area, or numbers of schools and size (tonnage) of the schools. Aerial spotters under contract were also asked to make note of any basking sharks observed.

Aerial fish spotting records (1962-85) in the SWFC data base were searched for basking shark sightings. Data on numbers sighted are recorded by "block area," a 10' longitude by 10' latitude area (about 8 x 10 n. mi. at the latitude of California). This "block area" coding system is the same as that used by the California Department of Fish and Game for recording data from the marine waters off California. When a pilot enters a block area it is recorded as a block area flight (BAF). During 1962-85, aerial spotters recorded a total of 6,695 BAF's for the area north of Point Conception (Zones A and B) and 74,142 BAF's for the area south of Point Conception (Zones C and D). During 1962-85, 8,713 basking shark sightings were recorded, distributed along the coast from immediately south of Santa Cruz, California to off Port Hueneme, California, and along the Santa Barbara Channel Islands. Four basking sharks were recorded off northwest Baja California, Mexico.

Results

Figure 1 presents the geographical distribution of sightings, the total number of basking sharks sighted and average number sighted per sighting by block area during 1962-85. The area north of Point Conception, Monterey Bay (block areas 508, 516, 517) and the area off Point Buchon and Morro Bay (block areas 607,

615) had the greatest number of basking shark sightings. Block area 607 had the largest sighting record, 6,389 basking sharks, with an average of 96.8 sharks per sighting. South of Point Conception the greatest number sighted in any block area was the area southwest of Ventura (block 665) with an average of 6.7 individuals per sighting. In this area, block areas 664 and 683 had higher sighting rates, but few sightings (two for block 664 and one for block 683).

The monthly distribution of basking shark sightings for the coastal area from the Santa Barbara Channel to Monterey Bay as developed by the aerial monitoring program (1962-85) is compared with the monthly sightings in the Monterey Bay area as recorded by Edward Durden (Squire, 1967) in 1948-50 (Fig. 2). Both sets of observation data show the peak apparent abundance to be October with a lesser occurrence in February or March.

The Monterey Bay and central California coast is a major upwelling area and the highest phytoplankton concentrations are noted during the summer months. Figure 2 also shows the monthly distribution of phytoplankton volumes in the Monterey Bay area as recorded by Bolin and Abbott (1963). Zooplankton organisms, being grazers on phytoplankton, tend to coexist with phytoplankton, and the months of high phytoplankton should result in higher levels of zooplankton, the major food source for filter-feeding basking sharks. During the months of high phytoplankton volumes the occurrence of basking sharks is low. This may indicate that the basking sharks observed in greater numbers during the fall and winter are not necessarily in the coastal areas for feeding, but these concentrations in the inshore area could be related to mating as described by Compagno (1984) for the European population.

Abundance Trends

Greater abundance levels were observed prior to 1970. This is reflected in the number of basking sharks sighted per block area (for block areas having sightings) as shown in Figure 3. The distribution of sighting effort (number of BAF's) conducted north and south of

Point Conception by year, is also given in Figure 3. The number of flights conducted north of Point Conception in the areas of higher basking shark abundance was much greater before 1970 than after. Aerial fish spotters were actively searching for Pacific (chub) and jack mackerel and Pacific sardine north of Point Conception in the 1960's, but after the decline of both the mackerel and sardine resources to very low levels, little aerial spotting effort was conducted north of Point Conception. Edward Durden (personal commun.) reported that from his experience it appeared that the abundance of basking sharks was much reduced in all areas in the 1970's.

A total of 399 sightings totaling 8,709 basking sharks were recorded for the coastal area from Port Hueneme to Santa Cruz, Calif. This was an average of 21.8 basking sharks per sighting. The average number was 51.9 basking sharks per sighting for the area north of Point Conception; for south of Point Conception the average number of basking sharks per sighting was 2.9. South of Point Conception the sighting level was 0.009 basking sharks per BAF (74,143 BAF). North of Point Conception the sighting level was 1.19 basking sharks per BAF (6,695 BAF).

It would appear that some increase in population levels of basking sharks south of Point Conception may have occurred since 1975 with a peak in 1981 (Fig. 3). Severe El Niño perturbations occurred in 1982 and 1983 (Quinn et al., 1987). These abnormally warm years, including 1984 which was warmer off southern California than during the El Niño period, may have reduced again the availability of basking sharks south of Point Conception.

Historical experience in other areas of the world indicates that basking sharks cannot sustain a prolonged intensive fishery (FAO, 1984). Basking sharks, like many other elasmobranchs, have a slow growth rate and low fecundity (Holden, 1973). Fisheries in other parts of the world tend to sporadically fish the elasmobranch resource, as their abundance evidently declines rapidly during fishing (Compagno, 1984). Abundance surveys of the California basking shark resource

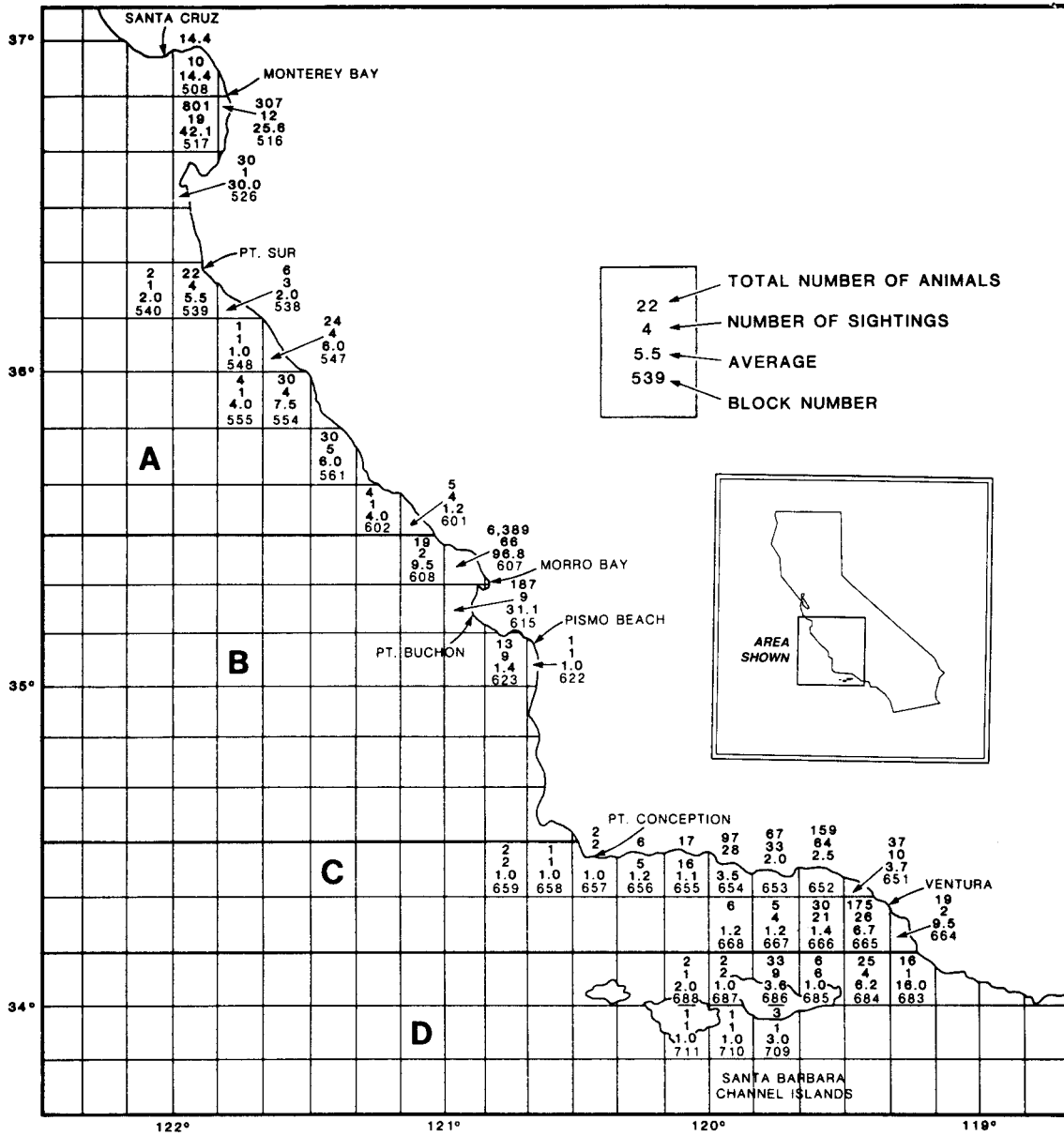


Figure 1.—Distribution of sightings, total number of basking sharks sighted, and average number sighted per sighting by block area (1962-85).

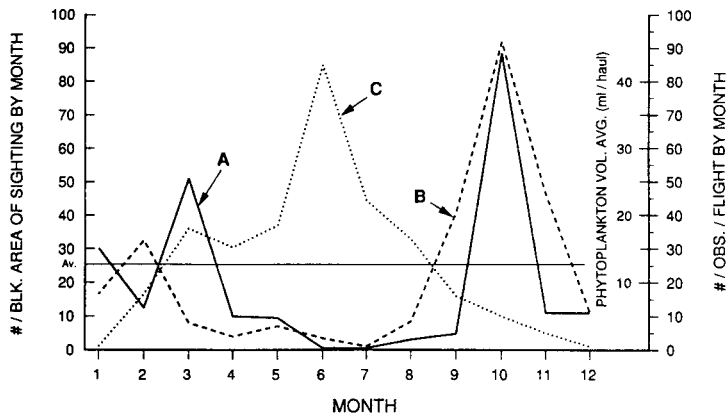


Figure 2.—A = average number of basking sharks sighted per block area, by month, by the aerial monitoring program (1961-85), B = number of basking sharks observed per flight in the Monterey Bay area, by month (1948-50), and C = average phytoplankton volumes recorded for Monterey Bay, by month (1954-60).

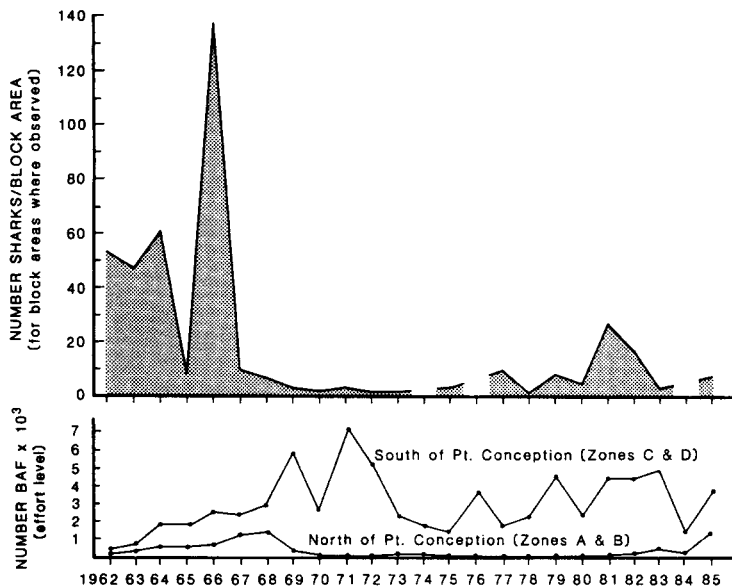


Figure 3.—Number of sharks per block area, for block areas where observed, and number of block area flights (BAF's) north and south of Point Conception, Calif.

should be conducted to establish a "base level" of apparent abundance prior to any commercial fishing, and compared with the historical abundance levels presented here. Continuing the survey program to monitor changes in apparent abundance from fishing would then provide necessary information for resource management.

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