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APPARENT FEEDING BY THE FIN WHALE, *BALAENOPTERA PHYSALUS*, AND HUMPBACK WHALE, *MEGAPTERA NOVAENGLIAE*, ON THE AMERICAN SAND LANCE, *AMMODYTES AMERICANUS*, IN THE NORTHWEST ATLANTIC

On 18 May 1977 a large group of fin, *Balaenoptera physalus*, and humpback, *Megaptera novaengliae*, whales was observed on Stellwagen Bank north of Cape Cod (lat. 42°26'N, long. 70°26'W) by Northeast Fisheries Center (NEFC) personnel conducting an annual spring bottom-trawl survey aboard the National Oceanic and Atmospheric Administration RV *Albatross IV*. Nine fin and 14 humpback whales were identified and observed near the vessel. More whales were sighted in the vicinity, but were too far away to identify positively or to observe conveniently. Many great black-back, *Larus marinus*, and herring, *Larus argentatus*, gulls were seen feeding at the surface and circling around the whales. The whales displayed a characteristic feeding behavior described by Gunther (1949) and mentioned in Katona et al. (1975). The animals we observed were circling, spouting often, making short shallow dives, and not moving in any set direction. They behaved in a leisurely manner and were seemingly undisturbed by our presence as noted by Gunther (1949). Echo sounding traces indicated a depth of 40 m in this area and large patches of densely concentrated small fishes throughout the water column, but particularly near the surface. During several 30-min bottom-trawl tows in the area, up to 400 kg of adult American sand lance, *Ammo-*

dytes americanus, were netted per tow (Northeast Fisheries Center[1]) with Atlantic cod, *Gadus morhua*, and spiny dogfish, *Squalus acanthias*, the only other abundant fish species. An examination of several cod stomachs showed them to be packed with sand lance while a similar inspection of sand lance showed them to be feeding on copepods. It is our contention that the abundance and behavior of whales in this area indicates that they were feeding on a concentration of American sand lance.

Similar whale feeding behavior had been previously observed on 18 June 1976 with a humpback whale located at lat. 42°09'N, long. 70°10'W, and with a fin whale located at lat. 42°04'N, long. 70°20'W, and on 20 June 1976 with a humpback whale located in the same general area (Northeast Fisheries Center[2]). During these three observations many herring gulls were again seen feeding at the surface and circling around the whales. Large numbers of American sand lance were also visually observed at the surface by NEFC personnel aboard the Alpine Geophysics RV *Atlantic Twin* and in the water column again by NEFC personnel aboard the General Oceanics research submersible *Nekton Gamma*. These latter two vessels were involved in testing the feasibility of using a research submersible to survey marine organisms (Northeast Fisheries Center[3]).

Bigelow and Schroeder (1953) reported that fin whales were observed feeding on American sand lance that were abundant in Cape Cod Bay in 1880. Nemoto (1959) listed American sand lance as one of the food items of baleen whales of the North Pacific, along with a variety of other fishes and euphausids. Fin and humpback whales are reported to feed on capelin, *Mallotus villosus*, a fish similar to the American sand lance in size, summer habitat, and schooling behavior in the continental shelf waters off Nova Scotia and Newfoundland (Mitchell 1974a). Fin whales landed at Blandford, Nova Scotia, from 1967 to 1972 contained sand lance (May-August), and stomachs from Newfoundland fin whales had >1% sand lance (June-July) in 1970-1972 (Mitchell 1974b). There is little stomach analysis data, though, from baleen whales captured in New England waters in the late 1880's when whaling was popular (True 1904), and no such data since the early 1900's when, for all practical purposes, whaling had ceased. Thus, it is difficult to confirm exactly what fin and humpback whales in the Cape Cod region eat.

The feeding observations which we made imply that the rorqual whales off New England, particularly fin and humpback whales, may be utilizing the high standing stock of American sand lance that is currently available (Northeast Fisheries Center[4]). Additionally noteworthy is that the Atlantic herring, *Clupea h. harengus*, a commonly mentioned rorqual whale food (Allen 1916; Ingebrigtsen 1929; Bigelow and Schroeder 1953; Nemoto 1959), is in low abundance at this time (International Commission for the Northwest Atlantic Fisheries 1976).

[1]Northeast Fisheries Center. 1977. Cruise Results, NOAA R/V ALBATROSS IV. Cruise No. 77-02, Spring Bottom Trawl Survey: Part III. Woods Hole, Mass., 6 p.

[2]Northeast Fisheries Center. Gulf of Maine whale sighting network reports. Groundfish Survey Unit. Data on file, Woods Hole, Mass.

[3]Northeast Fisheries Center. 1976. Cruise Results, R/V Atlantic Twin, Cruise 76-01. Woods Hole, Mass., 8 p.

[4]Northeast Fisheries Center. Spring groundfish survey research cruises 1967-1977. Groundfish Survey Unit. Data on file, Woods Hole, Mass.

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ESTIMATION OF INTERTIDAL HARVEST OF DUNGENESS CRAB, *CANCER MAGISTER*, ON PUGET SOUND, WASHINGTON, BEACHES[1]

There are two major methods employed in the sport fishery for the Dungeness crab, *Cancer magister*, in Puget Sound, Wash. The first is a passive method. A baited pot, trap, or ring net is placed on a subtidal substrate, left for a period of time, and retrieved. The second is an active method. During periods of low minus tides, sport crabbers seek crabs by sight. The crabbers usually wade out into water between knee and waist level, then walk parallel to the beach. A round metal loop, about 1 ft in diameter, covered with wire mesh and attached to a long handle, is generally used to capture crabs. Beginners often bring fish nets, but find it difficult to extricate the crabs caught in the net. When a crab is seen, the crabber maneuvers the hoop quickly under the crab. The crab's legs go through the mesh, making escape difficult, and the hoop is then pulled from the water. Only male crabs may be taken, and they must be a minimum of 152 mm (6 in) in width, as determined by a caliper measurement across the carapace, directly in front of the 10th anterolateral spines. The daily crab catch is limited to six per person.

Knowledge of the size and distribution of the intertidal sport fishery was limited until 1969, when the Washington Department of Fisheries began aerial surveys to estimate low tide usage of Puget Sound beaches for clam digging and crabbing. By summer 1973, enough data had been collected to show which beaches were being used for crabbing. However, the aerial surveys did not reflect the total use of beaches by crabbers over the entire low tide period, since only a single count was made sometime between 90 min before and 90 min after low tide.

This study was initiated in fall 1973 in an effort to determine the availability of crabs and the magnitude of intertidal harvest on one high-use Puget Sound beach. From data collected, an estimate was made of the total use of Puget Sound beaches by sport crabbers for daylight low tides in 1974.

Methods

From preliminary aerial survey data, Mission Beach, located 60 km north of Seattle and just beyond the Port of Everett, was selected as the study site (Figure 1). The beach is 3 km long, shallow, and sandy, with eelgrass beds below the mean lower low water (MLLW) level. This beach had only one public access, cut through a 15-m bluff. This location provided me with a good view of the entire area and made it possible to interview almost all crabbers using the beach.

From October 1973 to October 1974 there were 19 low tide series with tides lower than −0.30 m MLLW. These tidal series occurred in all months of the year except March and September. I visited Mission Beach during all tides lower than −0.30 m, except under adverse weather conditions in the winter months. I arrived 2.25 h before low water and walked to point 'a' (Figure 1), where I entered the water and moved toward the access at a depth of 0.15 to 0.85 m through the area most intensively utilized by the sport crabbers. For all crabs observed, I recorded the size to the nearest millimeter (taken in a horizontal measurement directly in front of the anterolateral spines on the carapace, by means of a caliper) and sex. Sampling was by the method used by most crabbers.

Beginning 2 h before low tide, I made half-hourly counts of the number of crabbers at the beach, but continued beach sampling of crabs until crabbers began to leave the beach, usually about 0.5 h before the low. At this time, I interviewed the crabbers about their success and time spent crabbing. About 90% of all crabbers using Mission Beach, on tides checked, were interviewed. During the interviews, I measured as many crabs as possible. From the interview data, I estimated the number of crabbers on the beach at any time during a period of 14 min before to 15 min after the half-hourly counts. The average time spent crabbing was slightly over 1.5 h; thus, if all crabbers

[1]Based on work submitted in partial fulfillment of the requirements for the degree of Master of Science.