

ENVIRONMENTAL ASSESSMENT REPORT 1-77

Strandings of Shortfin Squid, Illex illecebrosus, in Cape Cod Bay
in Fall 1976

by

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During the fall of 1976 massive strandings of shortfin squid, Illex illecebrosus, occurred in Cape Cod Bay. Local residents informed us that the strandings began about mid-October, were heavy through much of November, and tapered off in early December. The stranding squid swam directly to the shore and beached themselves or were stranded by the ebbing tide. When tossed back into the water they swam back to the beach. The great majority of strandings occurred along the eastern and southeastern shores of Cape Cod Bay, from Provincetown to Dennis (Figure 1). This is a shallow part of the Bay. Within this area, the heaviest strandings were found on beaches in Eastham and Wellfleet.

On November 16, 1976, in response to a number of inquiries about causes of the strandings, J. R. Uzmann and A. Tibbetts of the Northeast Fisheries Center, National Marine Fisheries Service (NMFS), Woods Hole, went to Eastham to investigate, in the company of H. F. Lind (Eastham Natural Resources Officer) and David Coates, (Cape Cod National Seashore in Eastham). They took samples of squid and verified that many were stranding and that great quantities had accumulated on the beaches. Large numbers of gulls were feeding on them. Live squid that were returned to the water restranded.

At a meeting at Northeast Fisheries Center on November 17, 1976 we planned an aerial photo reconnaissance of the eastern and southern shores of Cape Cod Bay in an effort to better define areas of strandings and to try to get some estimate of squid mortality. We also decided to further investigate the causes for stranding, including examination of the squid for pathogens and contaminants. What follows is a report of findings, along with notes on behavior of this squid. All references to squid, unless otherwise noted, refer to Illex illecebrosus, the only species known to have stranded in the 1976 strandings.

This squid is found from about Cape Hatteras to Labrador, in offshore waters. In the northern part of its range, Cape Cod to Newfoundland, it is found in some numbers closer inshore in summer to fall and is subjected to a fishery, such as in coves around Newfoundland. In recent years it generally has not been found in large numbers inshore in New England, although there is an offshore fishery by foreign vessels from fall to early spring. The offshore catch by the foreign fleet in 1974 was about 15,000 metric tons, according to International Commission for Northwest Atlantic Fisheries statistics. NMFS R/V ALBATROSS IV surveys take small catches in Massachusetts Bay in the fall and somewhat smaller catches, about 5 or 6 Illex per tow, in Cape Cod Bay then.

In 1976 Illex were exceptionally abundant inshore from Maine to Cape Cod, summer to fall. Fishermen frequently commented they had never seen so many. A modest fishery developed for it and some quantities were landed at various ports, including Gloucester and Provincetown (Prybot, 1977). Arv Poshkus, NMFS, Provincetown, said fishermen reported that this squid showed up in Cape Cod Bay about late July. It later became abundant enough so that several thousand pounds sometimes were obtained in a single otter trawl tow. Commercial catches in Cape Cod Bay declined greatly by late November. ALBATROSS IV catches during November 1976 also were much higher than usual, especially in Cape Cod Bay where survey hauls caught up to 96 individuals per tow (Figure 1).

Illex also were much more abundant than in many years along the Canadian coast, Nova Scotia to Newfoundland, in 1976; however, there were no known large strandings there this past year^{1/}.

The temperature preference of Illex while near the surface inshore around Newfoundland is about 7^o to 15^oC, although they are trawled offshore at the bottom there at colder temperatures of about 1^o to 9^oC (Squires, 1957). The bottom temperature at the Cape Cod Bay ALBATROSS IV stations November 21-22, 1976 was about 8^o-9^oC and therefore within their normal range. Coastal temperatures in eastern Cape Cod Bay, where most squid were stranding, were a good bit colder because of more rapid chilling in the shallows there. For example, on November 23 at the shore edge in Eastham it was 2.5^o-3.0^oC.

The stranding of Illex is not uncommon and has been reported repeatedly in the past, although reasons for stranding are obscure. Bigelow (1926) reported seeing stranded squid "in windrows on the flats in August and September," on islands at the mouth of the Bay of Fundy. He stated that, "for some inscrutable reason the squid, once aground, seems forced by instinct to drive farther and farther ashore -- throw it out ever so often into deeper water, and it shoots, arrowlike, back on the beach, to perish there as the tide ebbs." Verrill (1882) reported that Illex "often get aground on the sand-flats at Provincetown, Mass., in the night..." possibly when in pursuit of prey fish. He suggested that small mackerel sometimes hug the shore to escape squid and that this might sometimes bring the squid into shoals where they strand. The above described stranding behavior is similar to that observed in Cape Cod Bay this past fall.

Other strandings have been observed in the Bay through the years. None, so far as is known, was at all comparable in magnitude with the 1976 strandings, and in some cases probably involved only a few hundred or less squid. Strandings in the Brewster area were observed by local residents in the fall of 1959 and continued into February 1960, according to R. L. Prescott of the Cape Cod Museum of Natural History in Brewster. Philip Schwind of Eastham, who operated a charter fishing boat in Cape Cod Bay for many years, said that he had seen stranding squid in small numbers from time to time. He thought that in some cases they had been driven ashore by striped bass or other fish.

The strandings in 1976 took place primarily along the eastern and south-eastern shores of Cape Cod Bay, regions of shallow water and wide tide flats. The squid first appeared about mid-October. Peak strandings occurred from about late October to late November. From all accounts, the strandings came in waves, with many thousands or hundreds of thousands of squid stranding on one day and perhaps rather few on the next. Beachings tapered off near the end of November and early December, although some were still being reported as late as the second week in December. It is possible that a few strandings took place later, but large amounts of ice along the shore in the eastern part of the Bay made observations difficult. As mentioned earlier, commercial catches were down by late November, and so the number of squid in the Bay probably had been greatly reduced -- through strandings, fishing mortality, and migration to offshore grounds.

^{1/} Telephone communication with A. C. Kohler, Fisheries Research Board of Canada, St. Andrews, New Brunswick.

On November 18, the authors flew over the shore area, Barnstable to Provincetown, aboard a chartered plane, made a photo record of squid distribution, on beaches and at shore edges, and made relative abundance notes on charts of the area. On November 19, Uzmann and Lux, repeated about the same flight as above aboard a U.S. Coast Guard helicopter, including a touch-down to measure a patch of stranded squid in Eastham. The flights were followed with a number of trips to stranding areas by automobile.

In the course of the flights stranded squid were seen on the Bay side from Brewster to Provincetown; greatest concentrations were in the Eastham-Wellfleet area. In most cases only the mantles remained, the heads, tentacles, and internal parts having been eaten by herring gulls and blackback gulls which were present in flocks of thousands. It is likely that a great many of the mantles were consumed as well, since the gulls ate these also when freshly beached squid were in short supply. In view of the reported wave-like nature of the strandings, it seems unlikely that mantles remained on the beach more than a few days. Our on-the-ground observations on squid decay and bird habits support this view.

Aerial observations showed that dead squid on the beach and in the surf at the beach edge had a patchy distribution. It appeared that they were concentrated by wind and tides in certain areas, such as along the sides of groins, along jetties at harbor entrances, in some parts of salt marshes caught up in marsh grass, and on certain beaches (Figure 2). Patches in some cases had very heavy concentrations, and the squid frequently were lying two or three deep in the thickest part. One patch measured contained an estimated 50 to 75 thousand squid (mostly mantles). Along many beaches, however, there was only a thin line of scattered squid at the high tide mark.

It is difficult to make an estimate of the total mortality of squid over the period of strandings because of limited observations, loss to gulls as well as other animals, and the other problems involved. However, an estimate of 1.25 million dead squid present on beaches and in surf on November 18 was made from flight notes, photographs, and patch measurements. Considering that heavy strandings occurred over a period of a month, then, it seems likely that a total of at least 10 million squid stranded.

The size range of beached *Illex* was about 20-29 cm, mantle length, similar to the November catches aboard ALBATROSS IV in Cape Cod Bay. Mean size was about 25 cm, and mean weight for this length, about 340 g. Ten million of the squid would therefore weigh about 3,400 metric tons.

During the flight of November 18 we checked a stretch of beach on the seaward side of the Cape (Truro to Provincetown) and saw no squid. R. L. Prescott later told us that he had seen a few beached squid on the ocean side in Orleans on one field trip there. From all reports, however, the large strandings were only in Cape Cod Bay.

Fred Kern, NMFS, Oxford, Maryland, accompanied us on a trip to Eastham in November and he collected live and fresh dead stranded squid for pathology studies. He found no evidence of pathogens. Richard Greig, NMFS, Milford, Connecticut, ran mercury and other heavy metals analyses on samples of the squid. With the exception of cadmium and copper, the results were similar to those of an earlier study made on squid caught offshore. The amounts of cadmium and copper were somewhat higher in the stranded squid, but it is not presently known if any significance can be attached to this. We examined 13 of the stranded squid for internal parasites and found small infestations of cestode (tapeworm) larvae in the stomachs of 12 of these. This is not unusual. No other parasites were found.

R. E. Bowman, NMFS, Woods Hole, examined stomach contents of 19 of the beached squid. Some of these had full stomachs, and, in general, stomach fullness was about the same as Illex from ALBATROSS IV collections so it presumably was about normal for this species. Fish remains was the principal food in the stranded squid, about 95% by volume, with sand lance making up most of this portion. Other fish present in stomachs may have been cunners and butterfish, but this is tentative. Fish identification was based on scales in stomachs, since the food is finely chopped. Squid parts were found in a few of the stomachs, which is not unusual since squid are cannibalistic.

George King of Sea Land Aquarium in Brewster told us that he put some live, beached squid into his aquarium tanks (water temperature about 3°C) and that some lived for up to two weeks. He did not see them feed, although he put food (live mummichogs) in the tank. Charles Wheeler, NMFS Aquarium, Woods Hole, said that two weeks is about as long as he has been able to keep Loligo (longfin squid) alive in tanks if they do not feed. He has had no experience with Illex.

Water temperature records for the Cape Cod Bay end of the Cape Cod Canal, obtained from Charles Muirhead of NOAA, showed that late fall 1976 temperatures were colder than normal there, but not extremely so. As mentioned, however, strandings began about mid-October, when temperatures still were mild. It may be that later in the season, when coastal waters dropped to near the freezing point, some of the squid suffered temperature shock when approaching the colder water near shore. On December 4 when we were at a Dennis beach a few squid were stranding. The water temperature there was -1.4°C. Some of the squid were swimming ashore, up near the surface, and appeared to be in good condition, although slow moving because of the cold. Other squid coming ashore were rolling in along the bottom with the waves and quite clearly were near death.

Reasons for the strandings remain unknown. In view of what is reported above, however, concerning the stranding habits of this squid, their high level of abundance in 1976, the lack of pathological findings, that stranded squid were kept alive in tanks for some period, and that the stranding squid were feeding, it appears that the strandings occurred in a natural environmental setting rather than in an environment stressed by man's impact. The principal impacts in Cape Cod Bay, a relatively unstressed area, are waste heat from a power plant in the Cape Cod Canal and one near Plymouth, and entrainment of marine animals (largely plankton) in water used for cooling at these plants. These plants are not considered a significant factor in the temperature regime in Cape Cod Bay as a whole.

Regarding natural conditions that might have caused the strandings, one can do little more than speculate at this point. Some of our speculations follow.

We had earlier considered the possibility that the unusually rapid drop in fall temperatures played a direct role in stranding by inducing some kind of temperature shock. As noted earlier here, however, strandings already were occurring in mid-October when water temperatures still were mild. It therefore does not appear that temperature was the direct cause of strandings, although we do not think one can completely rule it out as a factor.

Another possible cause might relate to fall entrapment within Cape Cod Bay. There were exceptionally large numbers of Illex in 1976 and they still were abundant in Cape Cod Bay in late November, a time when this species generally is moving offshore for the winter. (Figure 1 shows abundance to have been a good deal higher in Cape Cod Bay than in Massachusetts Bay then.). The geography of Cape Cod Bay is such that it can serve as a trap to many warmer water fish and animals which might move into it in the summer. Some of these apparently fail to exit at autumnal cooling. Some animals may become disoriented or helpless when sufficiently chilled and strand. This apparently is the case with ocean sunfish and a few kinds of sea turtles which commonly strand there in the fall. In the case of squid, disorientation through failure to find exit from the Bay possibly influenced stranding.

As noted, this squid normally moves offshore in the fall and spends the winter in deeper, and warmer, waters of the outer shelf edge and possibly beyond. It begins to arrive on offshore grounds in some numbers in October. This fall migration leads the squid to move in easterly and southerly directions, with movement probably being triggered by declining water temperatures and perhaps other factors. The stranding squid were moving in these directions. Possibly they were attempting to migrate to offshore areas and were stopped by the barrier formed by outer Cape Cod.

The squid apparently were feeding not long before stranding, for many of their stomachs were full of freshly ingested food which consisted largely of sand lance. It appears possible that the squid might have been pursuing these small fish, a common species of sandy bottoms, became disoriented in the shallow water, and stranded. The feeding on sand lance may have increased in the fall, when some of the other prey species, such as mackerel, had left the Bay.

It should be mentioned, too, that the prevailing winds of the region are westerlies (southwest, west, and northwest) in the fall and winter. The winds, therefore, were blowing against the shores where the strandings occurred. The fall of 1976 was a particularly windy one, with frequent cold and strong northwest winds. These winds may have been a factor in the strandings, especially after the squid got into shallow water.

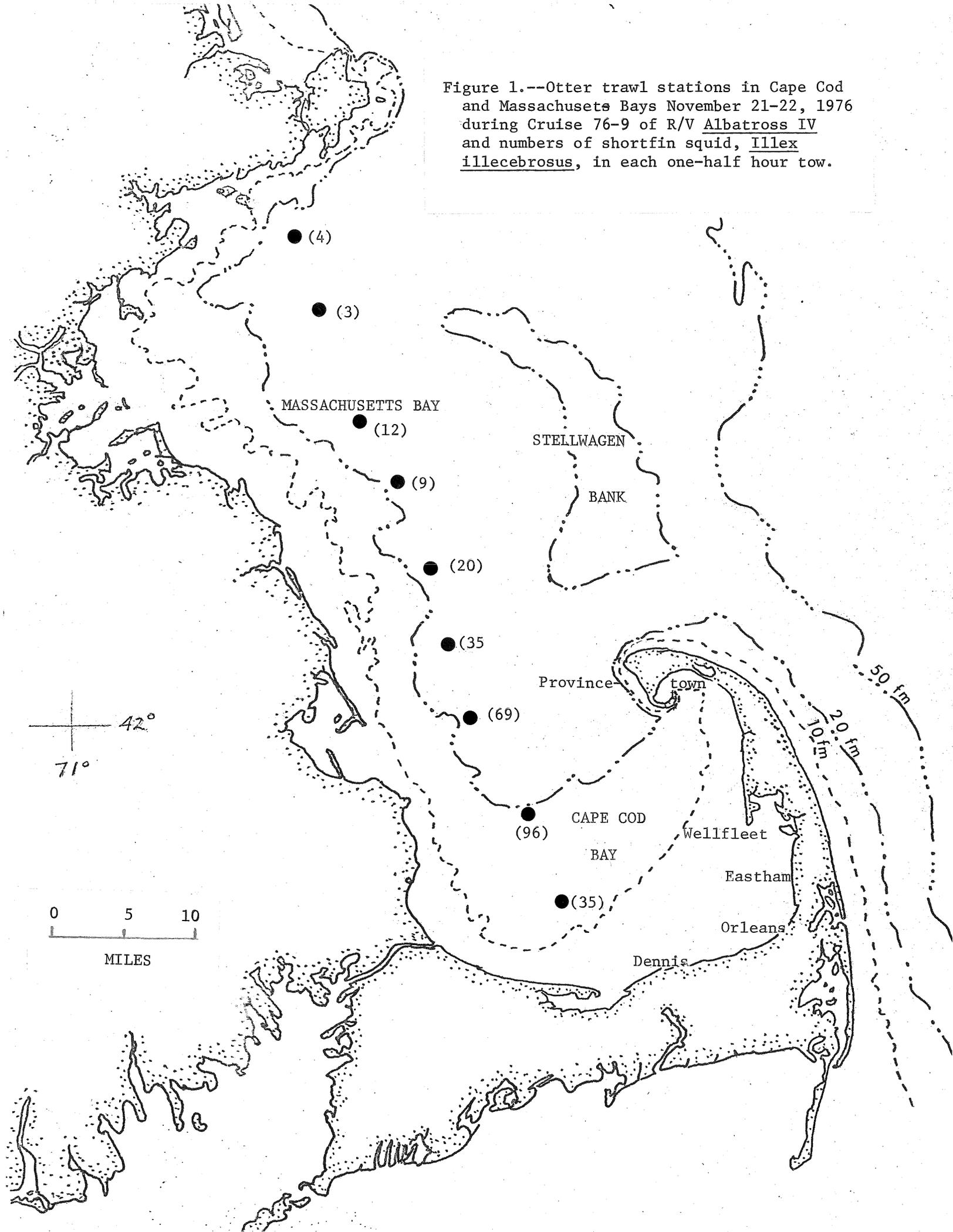
It was reported that bluefish, pilot whales, and some larger whales had been seen in Cape Cod Bay during part of the strandings. Some residents of the Bay area thought that the squid might have been driven ashore by these. Bluefish and pilot whales, and also striped bass, prey extensively on squid, and small groups of squid may have been driven ashore by them. It seems unlikely, however, that the massive strandings observed could have resulted from this. Also, it seems that strandings would have occurred in other areas than the one side of the Bay if the squid were driven ashore. In addition, it is unlikely that any large numbers of bluefish or striped bass remained in the Bay after about mid-November, since they move south with declining fall temperatures. The marine mammal report of ALBATROSS IV November 21-22, 1976 gave no whale sightings in Cape Cod Bay then, although some were seen outside of the Bay around Stellwagen Bank.

There may be other theories that will evolve from these studies. In the course of looking into the strandings we have established quite a few contacts in the Cape Cod Bay area who will alert us to further squid strandings. The Cape Cod National Seashore personnel, through regular patrols and from information sent in by local residents, maintain good records of strandings. We hope to gather more information on squid behavior and strandings in the future. Perhaps we can then more clearly define the causes of strandings.

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Figure 1.--Otter trawl stations in Cape Cod and Massachusetts Bays November 21-22, 1976 during Cruise 76-9 of R/V Albatross IV and numbers of shortfin squid, Illex illecebrosus, in each one-half hour tow.



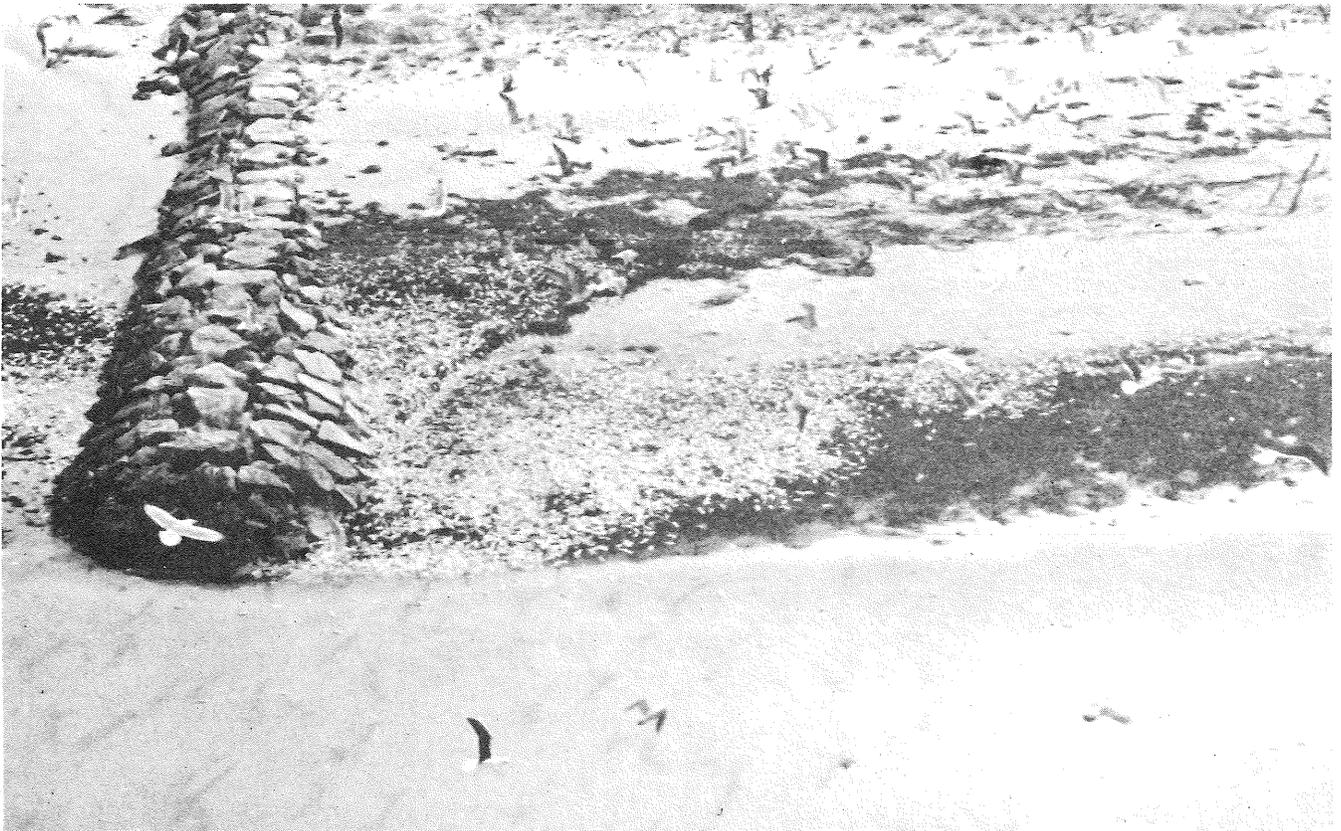


Figure 2.--Stranded shortfin squid on Eastham, Massachusetts beaches,
November 17, 1976.