

Experimental Fishing for Squid With Lights in Nantucket Sound

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Introduction

Harvesting squid by light attraction techniques has been practiced on the U.S. west coast since late in the 19th century. The first successful technique used torches, small skiffs, and purse seines in the waters off Monterey, Calif. By 1953, the fishery along southern California became dependent upon lamps, principally the incandescent type, combined with a power assisted brail or purse seine.

The successful use of lights in the west coast squid fishery relates to the unusual behavior of the target species, *Loligo opalescens*. This species, like *L. pealei* on the east coast, moves into the coastal waters to spawn. While in shoal waters, *L. opalescens* will often rise and "float" at the surface, although this behavior is neither consistent nor predictable. Artificial lights have provided a means to concentrate these squid near the surface frequently enough to allow for commercial exploitation.

The first documented attempt to use artificial lights to attract and "float" the longfin squid, *Loligo pealei*, was in 1974, when a contract to the University of Rhode Island (URI) was funded through the New England Fisheries Development Program. A series of trials in waters south of Rhode Island and Massachusetts demonstrated that squid could be attracted and concentrated under 1,000-watt incandescent lights¹. However, the squid never

floated quietly in a manner in which they could be brailed or pumped aboard. Recommendations from this effort resulted in a second series of trials in 1975 by URI wherein attempts to purse seine squid were not successful since no large concentrations were ever encountered².

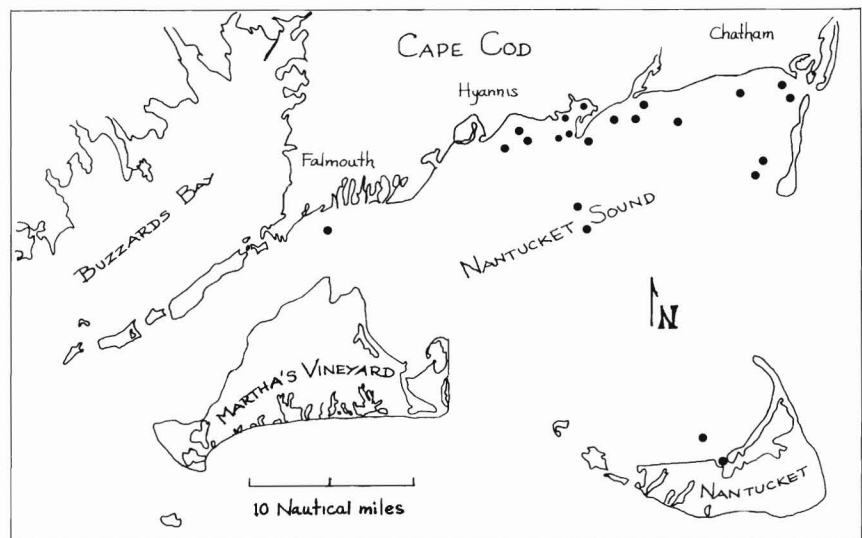
This project capitalized on the existing technology from Japan and the U.S. west coast and previous findings on the east coast by URI, and applied these methods to Nantucket Sound, an area where squid are known to be abundant in May and June.

²Taber, R. E. 1976. Purse seining for squid using light attraction methods at night. Univ. Rhode Isl. Mar. Advis. Serv., Narragansett. Unpubl. manuscr., 10 p.

The principal investigators for this project are Fred Powell and Mark Simonitsch, owners of a company that operates five fish weirs in Nantucket Sound. Captain Powell has set fish traps for 30 consecutive years and has caught squid in them each year. He first became interested in this type of project in 1973, when he made small scale experiments with lights on the fish traps with encouraging results. Further investigation led to the initiation of this project.

The five operational phases of the project are as follows: 1) A series of preliminary evaluations of gear performance using herring as a target species; 2) a secondary evaluation of gear by encountering the early arrival of squid at the western entrance to Nantucket Sound; 3) a concentrated effort to catch squid in the Sound using prior experience with weather and squid distribution to direct the vessel to various flats, holes, and shoals; 4) an evaluation of lights near and in the participants' traps; and 5) experiments with various lights and gear.

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Nantucket Sound squid survey areas.

¹Allen, R. B., and R. E. Taber. 1974. Light attraction for squid in New England waters. Univ. Rhode Isl., Dep. Fish. Mar. Technol., Narragansett. Unpubl. manuscr., 20 p.



The squid research vessel *Payday* (left), photographed by Paul Kemprecos. Below is a night view of the vessel's lights.

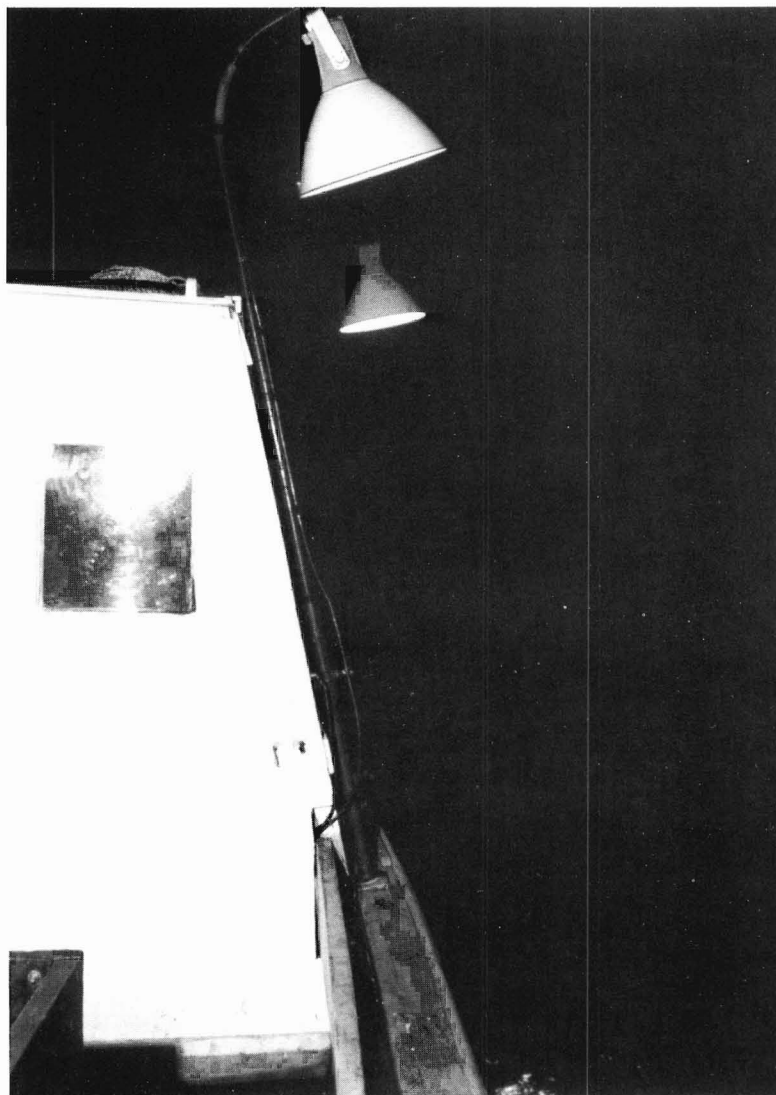
Vessel, Rigging, and Operation

The principal investigators used a $12.5 \times 3.4 \times 1.1$ m wooden vessel suitable to work in extreme shoal water. Modifications and rigging began in January 1979. A 6-kW electrical generator, powered by a natural gas engine, was installed astern to provide 110 volt A.C. power. Lights were installed forward, midships, and astern approximately 3 m above the water on both sides of the vessel *Payday*.

Initially, three 750-watt and three 1,500-watt incandescent lamps were mounted on the port and starboard sides, respectively. These lights illuminated the water surface out to 5-6 m abeam of the vessel. Two 175-watt mercury vapor lights later replaced two of the 1,500-watt incandescent bulbs. Also used were a 300-watt incandescent underwater light and a 1,000-watt quartz halogen lamp. The quartz halogen lamp was mounted on the gunwale.

A Raytheon Explorer III³ depth recorder was the principal instrument used to locate concentrations of squid. Suspect concentrations showing on the recorder were verified by hand lining with Japanese-type squid jigs. Three killdevils and a large checker located on the aft deck were constructed to brail and hold the catch.

The *Payday* departed port before dusk, allowing sufficient daytime to steam toward a predetermined location in Nantucket Sound. When the vessel arrived on station, the crew searched for suspected concentrations of squid with the depth sounder, prior to anchoring. After dusk, the lighting operation began and would continue, weather permitting, until dawn. If the weather became foul, but still workable, or if no concentrations of squid were seen on the depth sounder, the *Payday* moved



³Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

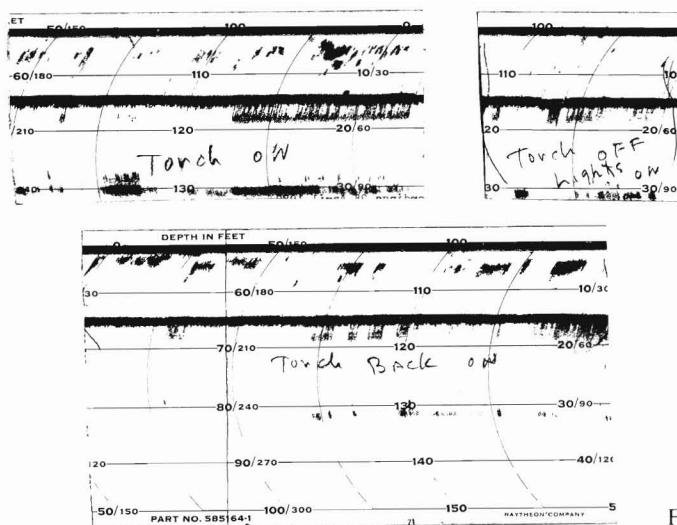


Figure 1.—Depth recordings 25 April 1979.

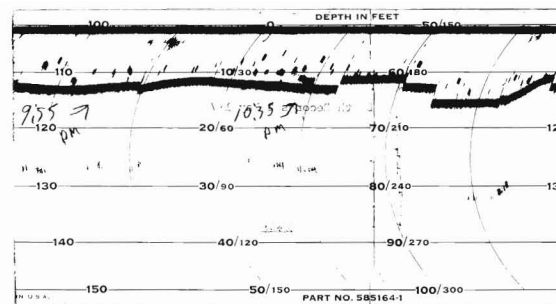


Figure 2.—Depth recordings 2 May 1979.

Table 1.—Squid lighting trips.

Date (1979)	Location ¹	Surface water temp. (°C)
4/16	Just outside Stage Harbor, Chatham	5.6
4/17	South of Falmouth Harbor	6.7
4/18	Off Bass River buoy	5.6
4/19	Off Hyannis Harbor breakwater	7.8
4/20	Centerville Harbor	8.9
4/23	Off Chatham (Middle Ground) and Harwich; Rodgers Shoal (at tip of Monomoy Island)	8.9
4/24	South of Bass River—trip terminated by foul weather	8.9
4/25	Hyannis Harbor and just outside	11.7
4/30	Bass River breakwater	12.2
5/ 2	Hyannis Harbor (outside harbor)	8.9
5/ 3	Hyannis Harbor	12.2
5/ 4	Hyannis Harbor	14.4
5/ 5	Centerville Harbor	14.4
5/ 6	Lewis Bay	14.4
5/ 7	Lewis Bay	15.0
5/ 8	Centerville Harbor; Collier and Gannet Ledges (south of the harbor)	15.0
5/11	Lewis Bay	17.2
5/12	Lewis Bay	17.2
5/14	Dogfish Bar (near fish trap) and off Point Gammon, Great Island	17.8
5/15	West of Point Gammon and into Lewis Bay	
5/16	Collier Ledge, Gannet Ledge to Hyannis Harbor	17.8
5/17	Lewis Bay—trip terminated because of foul weather	17.8
5/21	Bishop and Clerks; Hyannis Harbor	14.4
5/22	Southeast of Bass River breakwater (fish trap)	16.7
5/25	Lewis Bay; Hyannis Harbor	17.8
5/29	Lewis Bay breakwater; off Point Gammon	19.4
5/31	Bishop and Clerks; Point Gammon and Dogfish Bar (fish trap)	18.9
6/ 1	Bishop and Clerks to Broken Ground	16.7
6/ 2	WNW of Nantucket breakwater	17.8
6/ 3	North side, Nantucket Pier	16.7
6/ 5	Pleasant Bay, Chatham to Round Cove, Harwich	16.7
6/10	Chatham Harbor, Pleasant Bay	

¹Refer to chart 13237 Nantucket Sound and Approaches.

to another location. Details on the operation and weather for each trip were recorded on a logsheet.

Vessel Trials

The *Payday* made her initial light attraction trial in Nantucket Sound on 16 April. A total of 32 night trips were made between 16 April and 10 June (Table 1). Each trip consisted of anchoring at one station or more. Nineteen stations were inside bays and harbors bordering Nantucket Sound and 26 stations were in Nantucket Sound proper. Between 16 and 20 April, the vessel traversed the Sound from Stage Harbor, Chatham, to Nobska Point, Falmouth, primarily checking the lighting and secondarily looking for signs of squid. Both incandescent lights and a kerosene herring torch were used. On two evenings herring were attracted to the torch where they swam actively near the vessel, chasing bait, and marking well on the recorder. When the torch was extinguished and the incandescent lights turned on the herring disappeared, both visually and on the recorder. When the lights were turned in toward the centerline of the vessel, about 0.6 m (2 feet) from the gunwale, heavy clouds of fish were seen on the recorder. These were shortly verified visually as sea herring (Fig. 1).

The *Payday* crew first saw squid on 30 April, 0.8 km (0.5 mile) southwest of the Bass River breakwater. The water temperature was 12.2°C. As the vessel traversed the leader of a fish trap, six squid were seen at the water surface; however, jigging was not successful.

Between 2 and 8 May the *Payday* concentrated efforts in Hyannis Harbor, Lewis Bay, and Centerville Harbor. By this time, squid were prevalent inshore over most of the Sound and reported in the inner bays and harbors where people were successfully jigging them under dock lights. Three 1,500-watt incandescent lights were used almost exclusively; 750-watt bulbs were already found to be less effective in attracting squid.

On 2 May the recorder showed concentrations of squid on the bottom (Fig. 2). A total of 175 pounds (79.3 kg) were caught by jigging just off the bottom with two hand-held jigs. Squid were also observed actively chasing bait near the surface throughout the evening. On 4 May, 20 squid could be seen within 0.6-0.9 m (2-3 feet) of the surface for just a few moments before darting away. Jigging success was erratic; only 30 were jigged over a period of several hours. Division biologists examined several squid and found them ripe.

On 6 May the *Payday* worked Lewis Bay where the water temperature was 14.4 °C and the depth 2.4 m (7.9 feet). Large concentrations of squid could be seen 1.2 m (3.9 feet) below the surface. The depth recorder indicated something deeper, too (Fig. 3). When bow and stern lights (1,500-watt) were shut off, these squid seemed to "crowd" more. The captain described them as "more stationary and more bunched up" than previously observed. When bow and stern lights were lighted and turned in-board, the squid crowded closer to the boat. Jigging during this period seemed to scatter squid near the vessel. When the 750-watt bulbs were also lit and all lights were out over the side, squid circled the boat. They gathered back under the 1,500-watt lamps when the 750-watt bulbs were extinguished. During the nights of 7 and 8 May, the lack of squid activity, both visually and on the recorder, was attributed to a bright, nearly full moon. From 20 to 30 squid would appear below the surface and rapidly disappear. Squid were jigged infrequently.

After two nights off during the full moon, the crew continued 12 trips into Lewis Bay and just offshore, to Collier Ledge and Bishop and Clerks. The captain saw the greatest amounts of squid in Hyannis Harbor. The three 1,500-watt bulbs were mostly used with the additional two 750-watt bulbs used only occasionally. On 16 May small squid (15-20 cm or 5.9-7.9 inches) were sighted for the first time in schools numbering 50-60 in Hyannis Harbor.

On 21 May squid were jigged near the bottom but few were seen near the water surface. Seven squid were examined: Five ripe females had no sperm in the mantle and of two males, one was spent and one was ripe. A Rhode Island vessel utilizing mercury vapor lights and lift net set over the side anchored nearby. A brief discussion with the crew of this vessel revealed that they had successfully attracted and caught squid in previous years with mercury vapor lights.

On 22 May, two 175-watt mercury vapor lamps replaced the mid and aft 1,500-watt incandescent lights aboard the *Payday*. The initial trial with new

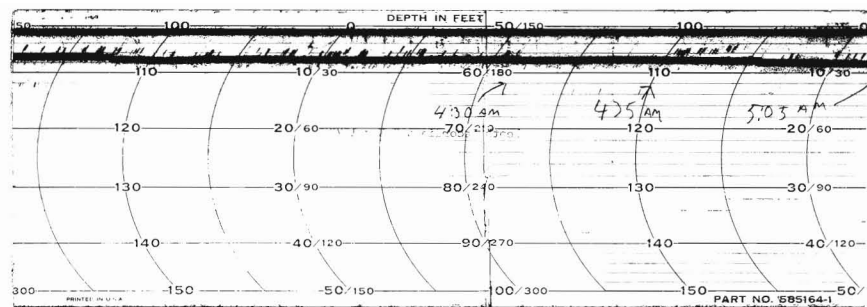


Figure 3.—Depth recordings 6 May 1979.

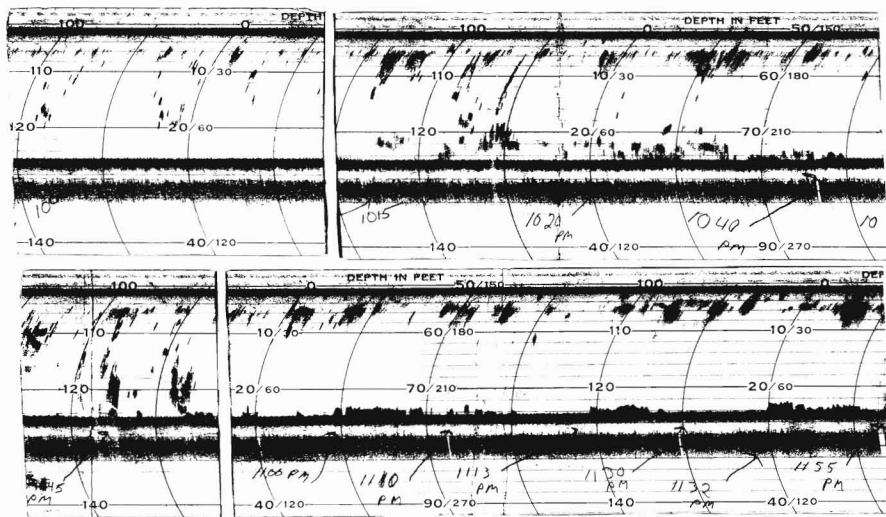


Figure 4.—Depth recordings 2 June 1979.

lights was directed near a fish weir off Bass River where heavy squid landings were reported. The two mercury vapor fixtures alone were lighted the entire night. Very few squid were observed throughout the night in contrast to recent evenings; however, they could be jigged at a constant rate of one every 3-5 minutes. A lift net, fashioned after that on the Rhode Island vessel, was rigged over the *Payday*'s starboard side on the night of 25 May. The net proved ineffective due to the short length of the boom and slow net retrieval speed. Squid activity, visually and on the recorder, was minimal during the evening; the net was thereafter abandoned.

At the end of May, as the squid dispersed from the inner bays bordering Nantucket Sound, the crew of the *Pay-*

day concentrated more on the shoal areas in the Sound. On 1 June, the vessel anchored off Bishop and Clerks (south-southeast of Hyannis Harbor). Little registered on the recorder and the crew jigged only a few squid.

On 2 June the *Payday* travelled to Nantucket. They fished west-northwest of the Nantucket breakwater in the vicinity of heavy squid dragging activity. Two mercury vapor lights and two 750-watt incandescent lights were turned on shortly after 2100 hours when the recorder indicated some small targets. At 2200 hours the marks became heavier, particularly between 1.2 and 6 m (3.9 and 19.7 feet), but also along the bottom (Fig. 4). Squid would appear occasionally chasing bait but were not easily jigged. Between 2240

and 0030 hours the recorder showed the heaviest targets to date; these were near the bottom. As bottom markings increased, those at the 3-m (9.8-foot) depth decreased or disappeared. Squid observed this night were all small (15-20 cm or 5.9-7.9 inches) and appeared more frequently under the incandescent than the mercury vapor lights, all positioned over the side. Squid movements were described as "spooky" as they would settle under the lights for several minutes, scatter, and then reappear once again. This activity continued all evening and may have been related to a bright moon and several dogfish, *Squalus* sp., circling the vessel. During the following night (3 June) inside Nantucket Harbor, no appreciable numbers of squid showed throughout the evening. The last trial was on 5 June in Pleasant Bay, Chatham. With the exception of one pulse of activity when 13 squid were jigged in 10 minutes, recorder marks were sparse and the night ended unproductively.

On several evenings two other light fixtures were rigged for experiment, a 300-watt underwater incandescent light and 1,000-watt quartz halogen lamp. The latter was placed just over the gunwale. The former was tried for usually 1 hour at a time per given night, attracting little or nothing other than two dogfish. The quartz halogen lamp never attracted squid but did attract large schools of unidentified small (2.5-10 cm or 1-3.9 inch) "bait fish." As long as the light was illuminated, these small schools, swimming against the current, would remain at the surface directly under the light. "Bait fish" were also seen gathering under the incandescent lights, but not under the mercury vapor lights.

Discussion

Although the *Payday* operated in areas of known squid concentrations, squid were not attracted in commercial quantities to the various lights used nor were squid observed to float quietly near the surface.

Squid were abundant in Nantucket Sound and its adjacent harbors during the period of this experiment. On

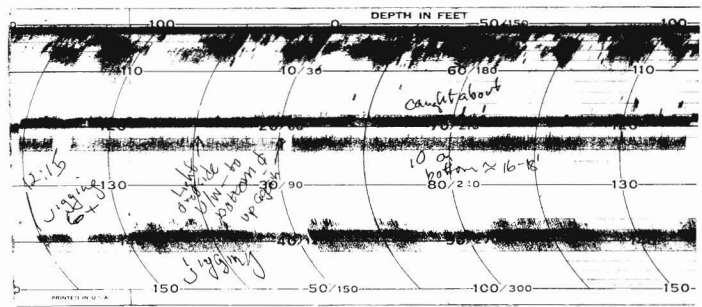


Figure 5.—Depth recordings 21 May 1979.

11 May, 10 days after the crew of the *Payday* sighted their first squid, the Massachusetts Division of Marine Fisheries spring resource assessment cruise found squid at six out of eight stations that were scattered throughout the Sound. Commercial draggers trawled successfully in permitted waters of the Sound, first off Falmouth and later off Nantucket catching approximately 680.4 t (1,500,000 pounds) of squid. The fish traps, located along the northeast shore of Nantucket Sound, reported landings of 394.5 t (870,000 pounds). When the contractors operated around their traps during the last three weeks of May, the catch from the traps was 134.6 t (297,000 pounds) 75 t (165,000 pounds); and 36.9 t (81,000 pounds) per week, respectively.

The crew of the *Payday* and Division biologists did question the reliability of the Raytheon Explorer III depth recorder in registering concentrations of squid. The high frequency of the recorder (200 KHz) had good range resolution in shallow depths (<50 m or <164 feet) (Forbes and Nakken, 1972). However, the recorder would frequently record "noise" or turbulence near the surface (Fig. 5). These markings were thought to be large schools of fish or squid but visual observation in clear water proved that no fish or squid were near the surface.

Incandescent lights were the primary type of light chosen for this experiment because, on the west coast, it is the only successfully used fixture. The captain of the Rhode Island fishing vessel *Summer Dawn*, encountered on 21 May, said that prior to this year,

mercury vapor lights were the most successful⁴. The use of mercury vapor lights on the *Payday* late in May proved ineffective. Squid were not as readily attracted to the mercury vapor lights as they were to the incandescent lights when both types were illuminated.

Positioning of lights on the vessel revealed some interesting patterns in *L. pealei* behavior. This behavior was not only observed during this experiment, but in the two previous URI trials. The first (1974) URI trial rigged four 1,500-watt lights directly out over the rail, two on each side of the vessel. The lights on the *Payday* were swung out over the rail, but at least 3 m (9.8 feet) from the water surface. Squid were often seen at the periphery of the brightly illuminated area, approximately a meter below the surface. When the lights were turned inboard the squid concentrated closer to the vessel. Preference of squid to the periphery of the illuminated water or to the shadow of the vessel when lights were turned inboard was reported previously (Ben-Yami, 1976).

Squid behavior inside the illuminated area during this experiment also paralleled that during the URI trials. Five or six squid followed a jig to the surface and then darted away. Squid remained with the vessel throughout the night (on the recorder) but were seen only sporadically. Small schools rose around the boat, lingered momentarily, then disappeared.

The experiment continued through

⁴C. Snow, FV *Summer Dawn*, Little Compton, R.I. Personal commun.

the spring spawning season for squid. Masses of eggs were first picked up on the nets in the fish weirs during mid-May. On the west coast, *L. opalescens* is expected to float sometime during the middle of spawning⁵. Floating then occurs approximately 50 percent of the nights fished. This behavior did not occur with *L. pealei*. Therefore, behavior of the two species appears radically different.

Experiments on the behavior of longfin squid to lights were recently undertaken at the Marine Biomedical Institute of Galveston, Tex. Trials of various types of lights and techniques resulted in the conclusion that *L. pealei* are not as phototactic as other species⁶. The effect of lighting operation around the fish traps was inconclusive. Both types of lights elicited no new behavior from the squid; however, squid were occasionally seen near the surface and were frequently jigged. The depth recorder indicated targets throughout the water column (Fig. 6). These targets were believed to be squid since squid was the predominant catch in the trips during this period.

The brail net and the lift net were not an effective means of harvesting during this operation since the squid never

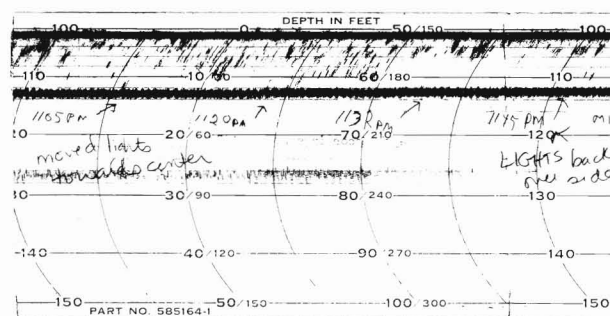


Figure 6.—Depth recordings 22 May 1979.

floated or appeared docile. Jigging resulted in a 79.5-kg (175-pound) catch on 2 May but thereafter jigging did not yield large quantities of squid.

The potential use of the jig as a means to commercially harvest *L. pealei* is questionable. It was considered of little commercial use in these waters during the squid spawning season by Arnold et al. (1974). The purse seine has been tried but never used effectively. Its use in the waters of Nantucket Sound and its embayments would be difficult due to swift currents, irregular bottom, and shoal areas.

Acknowledgments

To the crew of the *Payday*, Robert Nickerson, Captain, Russell Chase and Tom DeFriend, we extend sincere thanks for continual cooperation and enthusiasm through long "squid-less"

nights. Fred Powell and Mark Simonitsch provided guidance to all of us with their knowledge of Nantucket Sound and squid behavior in the Sound. We offer special thanks to Warren F. Rathjen, New England Fisheries Development Program, and Philip G. Coates, Director, Massachusetts Division of Marine Fisheries, for their support and input into this contract.

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⁵S. Kato, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Tiburon, Calif. Personal commun.

⁶R. Hixon, Marine Biomedical Institute, Galveston, Tex. Personal commun.