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EXPLORATORY FISHING IN LAKE ERIE, SEPTEMBER 1958-NOVEMBER 1959

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SUMMARY

Exploratory fishing to determine the commercial availability of smelt (Osmerus mordax) in the United States waters of Lake Erie, was conducted by the U. S. Bureau of Commercial Fisheries during the fall months of 1958 and from April to November 1959. In the 1958 investigation, lampara-seine operations were carried out from small Lake Erie trap net-type vessels. The 1959 investigation was expanded to include the systematic trawl coverage of Lake Erie, and the M/V Active, a large trap net-type vessel was chartered and successfully converted for the trawling work. Excellent catches of smelt were made with standard 50-foot cotton two-seam balloon trawls. Experimental efforts with a midwater trawl were not productive.

Fig. 1 - Canadian pound-net vessel. The crew is preparing to lift the smelt net.

Smelt was the most abundant species taken during the exploratory operations, and this species comprised more than 97 percent of the total catches recorded. Many

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trawl drags in the summer and early fall of 1959 resulted in catches of more than 500 pounds per half-hour drag. The best trawl drag produced a catch of 5,000 pounds of smelt in one hour. Large and medium size smelt (10 to 20 per pound) dominated most trawl catches and comprised over 80 percent (by weight) of all catches made by the Active.

Localities where otter-trawl drags yielded promising smelt catches included the west-central portion of Lake Erie in the late spring and early summer, the central portion in mid-summer, and the east-central portion of the lake in late summer and early fall.

Little fishing time was lost during spring and summer explorations. The late fall work, however, was hampered by strong winds, heavy seas, and hazardous vessel ice formations which prevented complete coverage of seasonal smelt distribution in 1959.

BACKGROUND

The American smelt (Osmerus mordax) was first successfully planted in the upper Great Lakes in about 1912 (Van Oosten 1936). It was not until the early 1940's, however, that any commercial abundance was noted in Lake Erie. About 1941 the Canadian fishing industry recognized the commercial possibilities of the resource and commenced production during the spring spawning run. Pound nets were used at first and later trap nets (fig. 1). By 1957, studies made by the U. S. Bureau of Commercial Fisheries, using the Bureau-owned vessels Cisco and Musky, showed that smelt had become one of the most abundant species in Lake Erie.

The decline in abundance of more valuable commercial species forced a general interest in smelt and other nonutilized species; but lack of fishing, except in restricted areas, left broad gaps in the knowledge of seasonal distribution. This interest in smelt, arising from the economic distress on the part of the industry, prompted the Ohio Commercial Fishermen's Association and the State of Ohio to request the assistance of the Bureau in developing efficient methods of exploitation of the smelt resource.

OPERATIONAL PROGRAM AND CRUISE ITINERARY

A search of the available literature failed to show any published information on the seasonal distribution of smelt in Lake Erie other than observations made on spawning concentrations in Canadian waters of Lake Ontario. With the exception of limited trawling work, confined to biological sampling, in the Central and Eastern Basins of Lake Erie by the Bureau vessel Cisco in 1957 and 1958, and by U. S. state and Canadian provincial agencies, no inventory work had been carried out.

Because of the lack of information on the distribution of smelt or other fish stocks in those areas, a program was planned to give primary emphasis to the systematic exploratory coverage of United States waters of the lake on a seasonal basis and to determining the commercial availability of smelt to both seines and standard-type otter trawls. Provisions were made in scheduled cruises for demonstrations of seine and trawling gear to commercial fishermen, research personnel from state agencies, and representatives from conservation groups.

In September 1958, preliminary explorations got under way from Vermilion, Ohio, with the trap-net vessel Pat. A lampara seine was used during the surface-scouting and echo-sounding operations which continued through November. From April through November of 1959, the surface-scouting and echo-sounding operations were continued and the operational program was expanded to include systematic trawl coverage of Lake Erie between Monroe, Mich., and Buffalo, N. Y. (table 1).

Table 1 - Cruises Completed During Bureau of Commercial Fisheries 1958-59 Lake Erie Fisheries Exploration

Cruise No.	Vessel	Dates	Area of Coverage	Depth Range (Fathoms)
1	Pat	10/2-10/14/58	Huron to Lorain, Ohio	2-12
2	Thelma	10/18-11/28/58	Vermilion, Ohio, to Erie, Pa.	2-13
1	Active	4/21-5/12/59	Monroe, Mich., to Sandusky, Ohio	2-6
2	Active	6/2-6/24/59	Sandusky to Cleveland, Ohio	2-13
3	Active	7/6-7/23/59	Cleveland to Conneaut, Ohio	2-13
4	Active	8/3-8/17/59	Conneaut, Ohio, to Buffalo, N. Y.	5-25
5	Active	8/27-9/6/59	Conneaut, Ohio, to Dunkirk, N. Y.	5-25
6	Active	9/22-10/8/59	Fairport, Ohio, to Erie, Pa.	5-13
7	Active	10/20-10/27/59	Fairport to Vermilion, Ohio	2-13
8	Active	11/9-11/23/59	Vermilion to Port Clinton, Ohio	2-12

VESSELS USED

Three vessels were used in portions of the 1958-59 lampara-seine and trawl operations: Pat; Thelma H.; and Active. All three vessels were actively engaged in the commercial trap-net fishery when obtained.

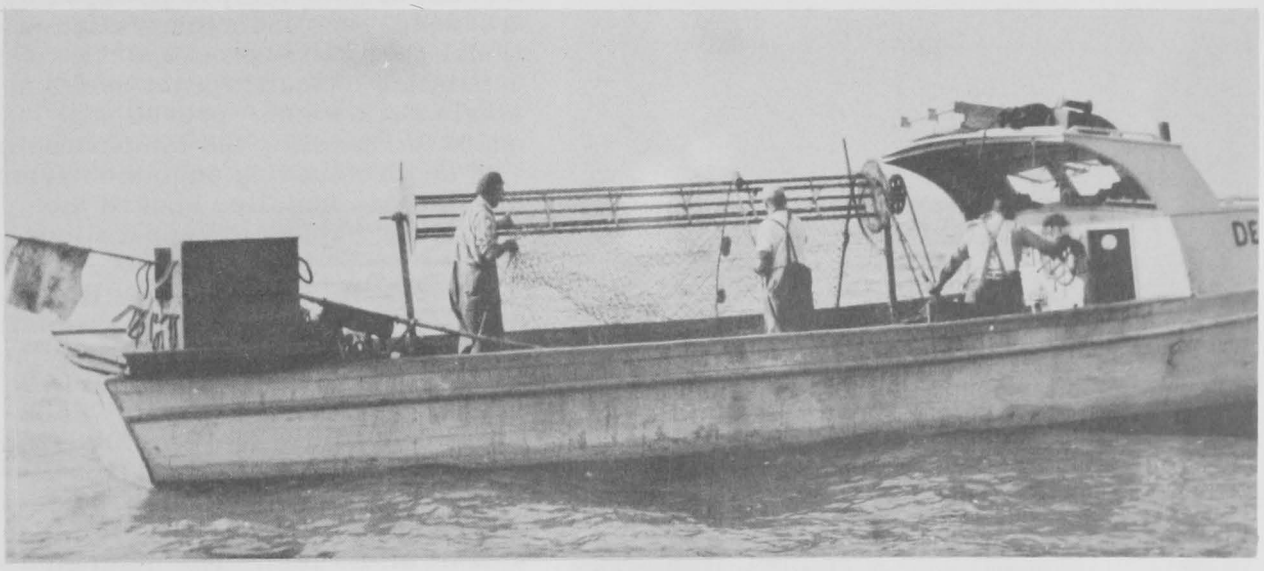

Fig. 2 - A typical Great Lakes trap-net vessel similar to the vessels Pat and Thelma H. used in lampara-seine exploratory operations.

M/V "PAT": The Pat was obtained by cooperative agreement with the owner and used in the first phases of lampara-seine work (September-mid-October 1958). This vessel, a conventional trap-net boat of steel construction, is 36 feet in length with an 11-foot beam (fig. 2). It is powered by a 90-hp. gasoline engine and was originally equipped with a standard net reel and single winch for use in the trap-net fishery. Few changes were required for the seine operations. The existing trap-net reel was used for hauling both seine wings simultaneously, but it proved to be too high for easy handling of the lampara and was modified by construction of shorter stanchions. In addition, a recording depth-sounder with a depth range of 150 feet was installed.

M/V "THELMA H.": The Thelma H., also of typical trap-net design, was chartered to continue operations through November 1958. The vessel, 38-feet long with

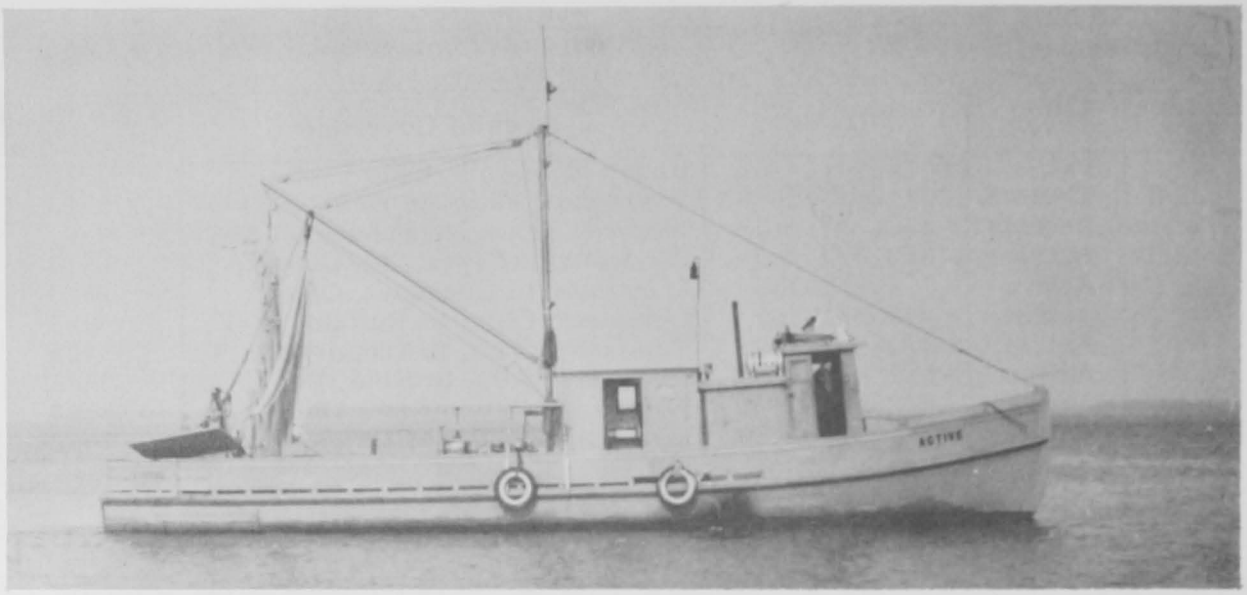

Fig. 3 - M/V Active, chartered 50-foot trap-net vessel converted for exploratory fishing in 1959.

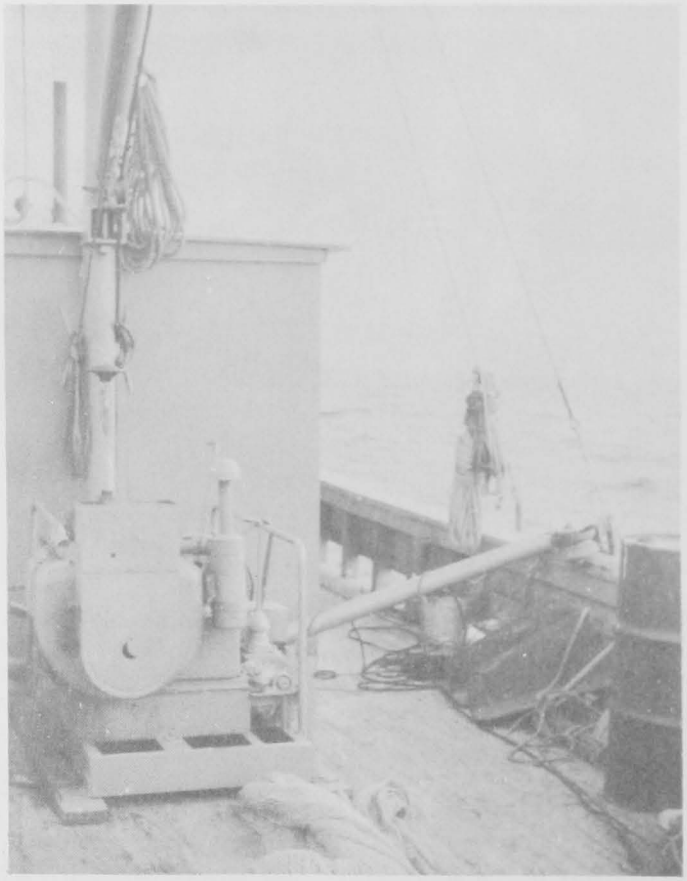

Fig. 4 - Winch engine and deck-gear arrangement aboard the M/V Active.

a beam of 13.5 feet, is powered by a 225-hp. gasoline engine. Conventional gear for trap-net operations--consisting of the trap-net reel and single deck winch--proved adequate for handling the lampara seine. The depth-sounding equipment from the Pat was installed aboard the vessel for exploratory operations.

M/V "ACTIVE": Since the smaller trap-net vessels were not ideally suited to the exploratory operations, a larger vessel, the Diesel-powered Active (fig. 3) was obtained by charter and operated from April to November 1959. This vessel is of wood construction, 50-feet in length with a 14.5-foot beam and a draft of 4.5 feet. The main engine is rated at 95 hp. (continuous duty).

The vessel underwent considerable modification for use in seining and trawling. Limited accommodations were added for three men aft of the existing pilothouse. A two-drum trawl winch, which held 80 fathoms of 3/8-inch cable on each drum, was mounted aft of the quarters (fig. 4). A modified net reel was mounted amidships on the starboard rail for hauling the lampara seine. Power for both winch and reel was supplied by a separate 20-hp. air-cooled engine. Pipe stern davits and outriggers from winch to bulwark were added and were equipped with 9- by 4-inch standard

towing blocks (fig. 5). A steel mast and boom and all conventional deck gear and rigging necessary for the fishing operations were installed. The Active was also equipped with radiotelephone, a shallow-water depth-recorder, and a second recorder with a range sufficient to permit sounding the deeper waters of Lake Erie (210 feet). A 2-kw., 115 volt, a. c. generator was also installed.

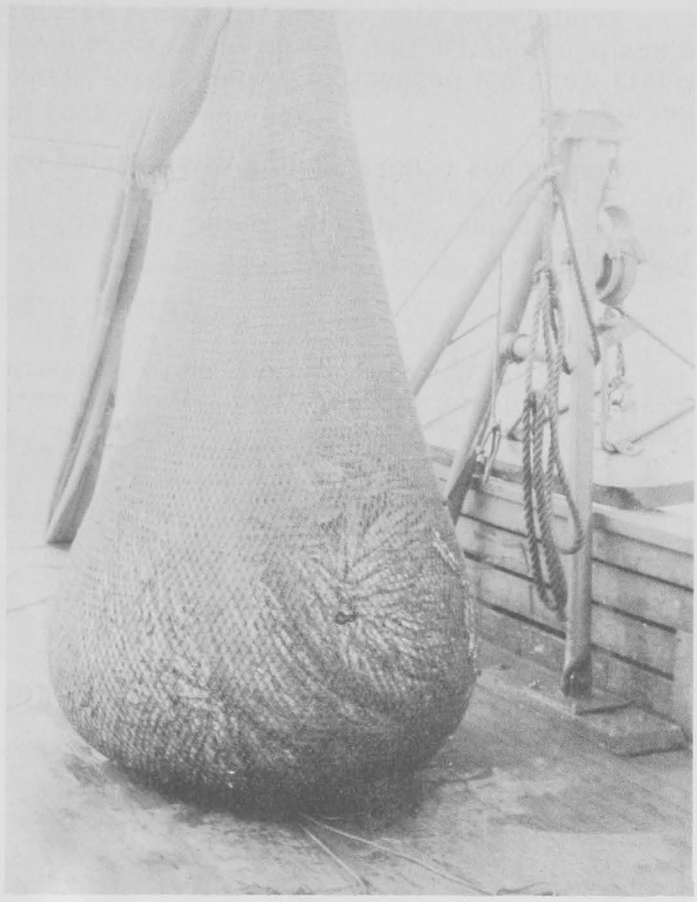

Fig. 5 - On the right, stern davit and towing block used aboard the M/V Active.

GEAR AND METHODS

LAMPARA SEINING: The lampara seine used during the 1958 operations was a Pacific coast-type bait seine, 60 fathoms long by 7 fathoms deep. The wings were constructed of 9-thread, 4-inch-mesh cotton twine and were 200 meshes deep. The bunt was made of 12-thread, $1\frac{1}{2}$-inch mesh cotton attached to a $\frac{1}{2}$-inch mesh woven nylon bag. The seine was modified, during the 1959 investigation, by the addition of 40 fathoms of twine to each wing and removal of 50 meshes in depth to permit use in shallower waters.

A standard steel trap-net reel, about 12 feet long, was used aboard the smaller trap-net vessels. For use aboard the Active, the reel length was shortened to 8 feet. The lampara was set over the stern with a skiff or drag-and-buoy attached to one wing, in the usual circular setting pattern, and closed with the vessel downwind. With the trap-net reel described, it was possible to "dry-up" the lampara in 12 to 15 minutes. Both wings were hauled simultaneously and stacked on deck. Using this method, it was possible to set the lampara again without restacking one wing.

TRAWLING: Gulf of Mexico-type two-seam balloon trawls, 50-feet along the headrope and of $2\frac{1}{2}$-inch, 18-thread cotton mesh in wings and body, constituted the principal trawl gear used during the 1959 operations. Cod end mesh sizes varied from 1 to $2\frac{1}{2}$ inches. Some trawls were modified by the addition of a 1-inch mesh second intermediate. Bracket doors used with the nets measured $2\frac{1}{2}$ by 6 feet and weighed about 180 pounds each. Dandyline gear (similar to that used in Pacific Coast otter trawling), with 60-foot cable extensions from doors to the trawl, was used on all exploratory drags. Only minor variations were made to permit fishing for smelt with the trawl running slightly above the bottom. The gear was set and hauled directly over the stern of the vessel. The cod end was hauled to the stern with a lazyline as the net was retrieved, and the catch was hoisted aboard.

With the exception of its action on certain soft-bottom areas, this gear performed well in Lake Erie at depths from 2 to 25 fathoms. The ratio of towing warp to depth (scope) varied from 5:1 in shallow water to 3:1 in deep water. Dragging speeds averaged approximately 2.5 miles an hour, and drags were normally either 30 minutes or 1 hour long. Most trawl drags were made downwind or with the sea, owing to a lack of reserve horsepower on the Active.

Trials were also conducted with a 40-foot-square nylon midwater trawl. Mesh sizes and construction of this trawl were discussed previously (Sand 1959). The trials were not productive owing to scattering of fish at midwater levels during the period.

Continuous echo-sounding was carried on during cruising and fishing operations for fish finding and locating bottom obstacles. Observations were recorded on weather and sea conditions, water temperatures, and bottom conditions at all fishing stations.

AREA COVERED

A total of 86 trawl stations and 9 lampara stations were established during the 1958-59 exploratory operations. Over three-fourths of these stations were east of Sandusky, Ohio (fig. 6).

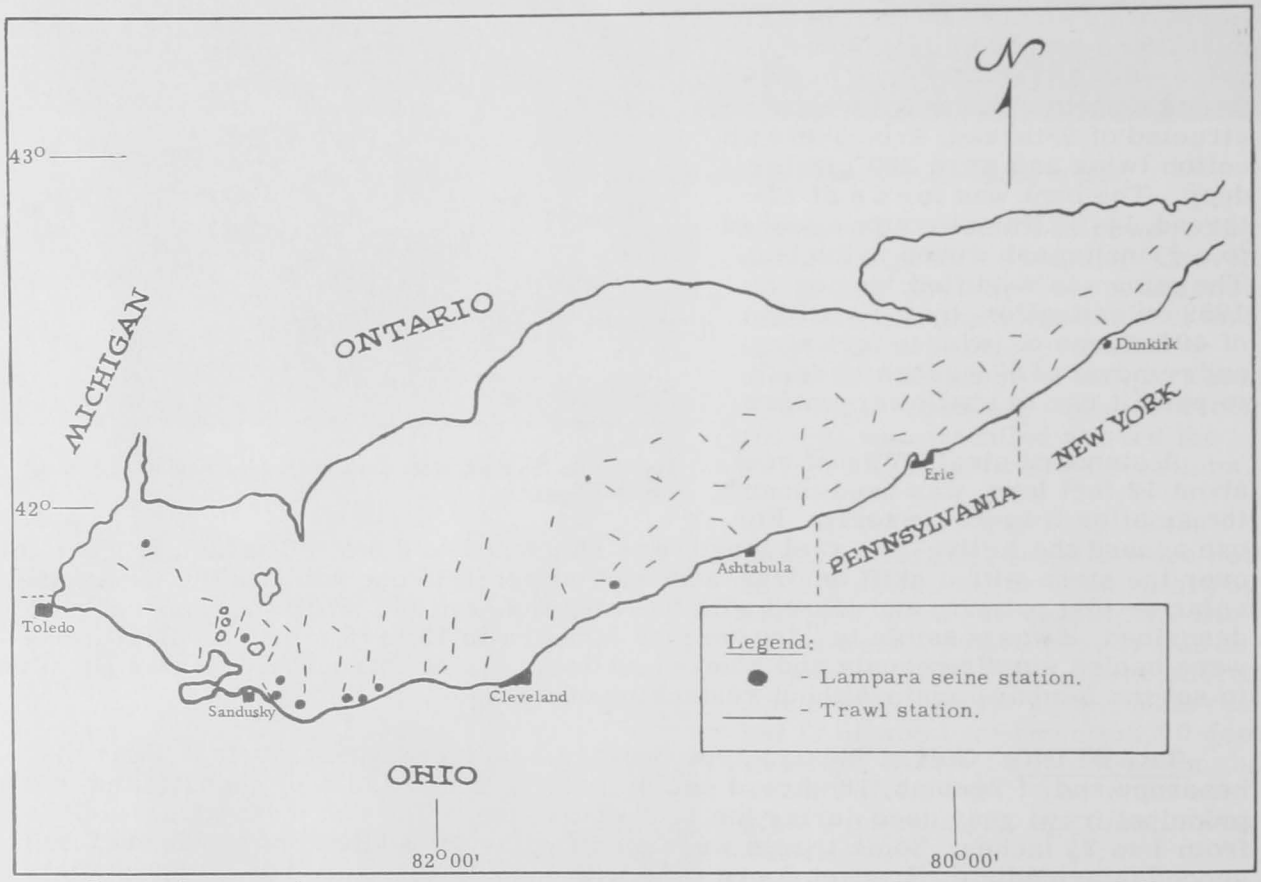

Fig. 6 - Locations of trawl and seine stations made by the vessels Pat, Thelma H., and Active--1958-59.

The southwest-northeast axis of the lake amplifies the effects of strong winds in these directions. During the spring and fall seasons, winds of moderate-to-fresh velocities frequently cause dangerous seas in short periods of time. Good harbors, however, are usually within easy distance of fishing vessels working Lake Erie. Seiches (oscillations of water level of lake or landlocked sea) often produce currents in excess of 2 miles an hour at both the eastern and western ends of the lake. Neither these nor the observed variations in force and direction of winds, which caused surface currents for short periods, seriously hampered fishing operations.

The bottom configuration of Lake Erie between Monroe, Mich., and Buffalo, N. Y., shows great variation in form and composition. In Ohio waters, studies by

soil-erosion engineers have shown that over two-thirds of the bottom surface is mud. Hard clay, sand, mixtures of sand and mud, and outcroppings of rock make up the remainder. The bottom materials of the Pennsylvania and New York waters of the lake are also clay, sand, or mud and rock outcroppings.

For study, the United States waters of Lake Erie were subdivided into three zones on the basis of differences in depth and bottom configuration. These three zones are: The West Basin from Toledo to Sandusky, Ohio; the Central Basin from Sandusky, Ohio, eastward to Erie, Pa., and the East Basin from Erie, Pa., to Buffalo, N. Y.

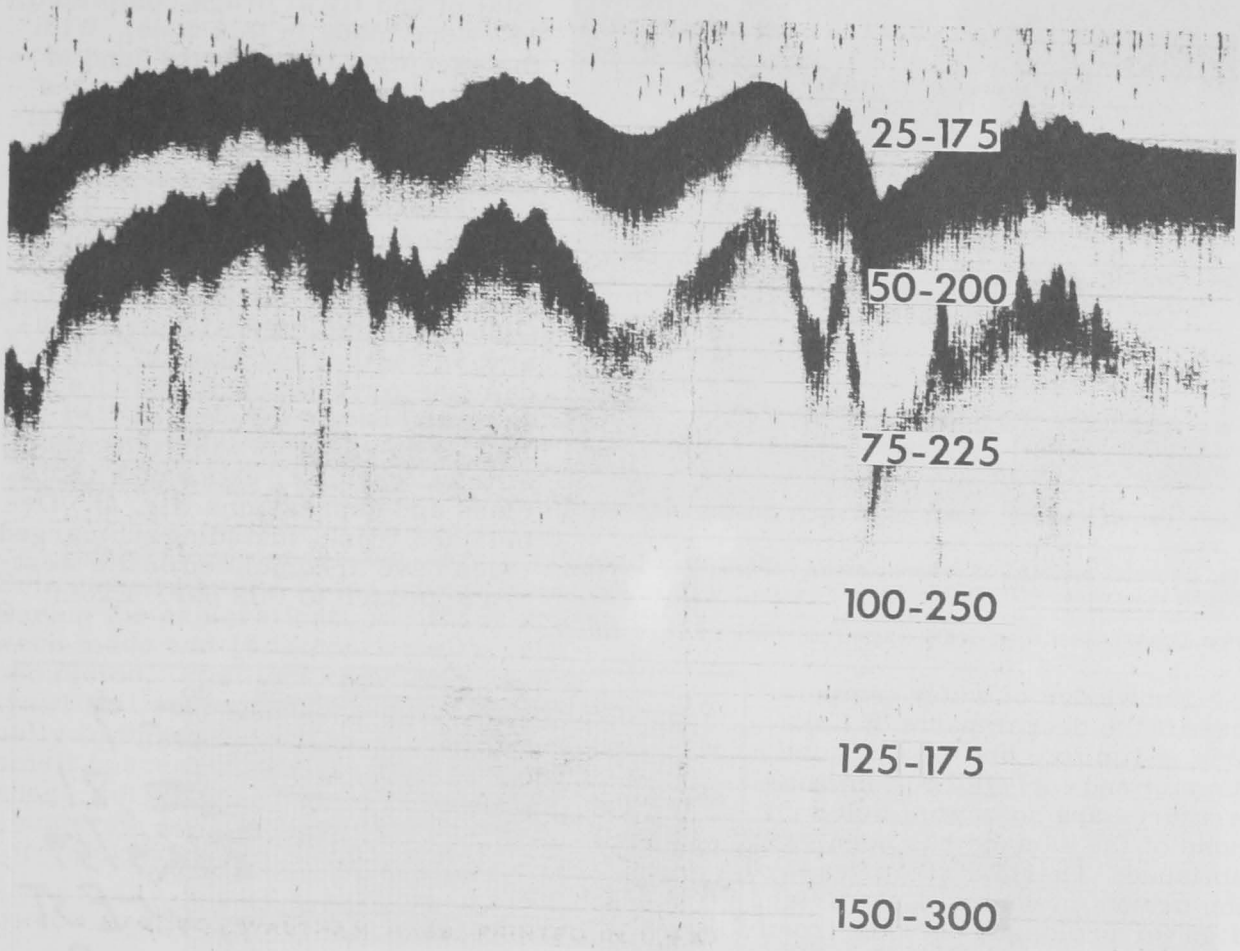

Fig. 7 - Depth recording made aboard the M/V Active in the vicinity of Port Clinton, Ohio. The typical irregular bottom of much of the inshore area of western Lake Erie is clearly shown.

WEST BASIN: This zone contains the island area extending westward from Sandusky to Toledo, Ohio. With a few exceptions, this zone is not well-suited to commercial-scale otter trawling. Limestone and dolomite bedrock crop out on the lake bottom in several areas. The largest areas of exposed rock occur near Marblehead, Ohio, and in all the interisland passages. Reefs composed of boulders and gravel are found off Locust Point and toward Port Clinton, Ohio (fig. 7). In addition to the generally poor trawling grounds there, the former pound-net fishery has left the bottom in some areas widely strewn with submerged net stakes. The intensive commercial trap-net fishery in this zone during the spring and fall seasons also further hinders trawling efforts. All drags in this zone, therefore, were of short duration. Western Lake Erie is also characterized by the almost total absence of thermal stratification. Normally, water temperatures in this zone are uniform over large

areas. Studies by Wright (1955) and work carried out by the Bureau's biological research vessel Cisco indicate that thermal stratification may be regarded as a minor factor in the aquatic environment of the West Basin.

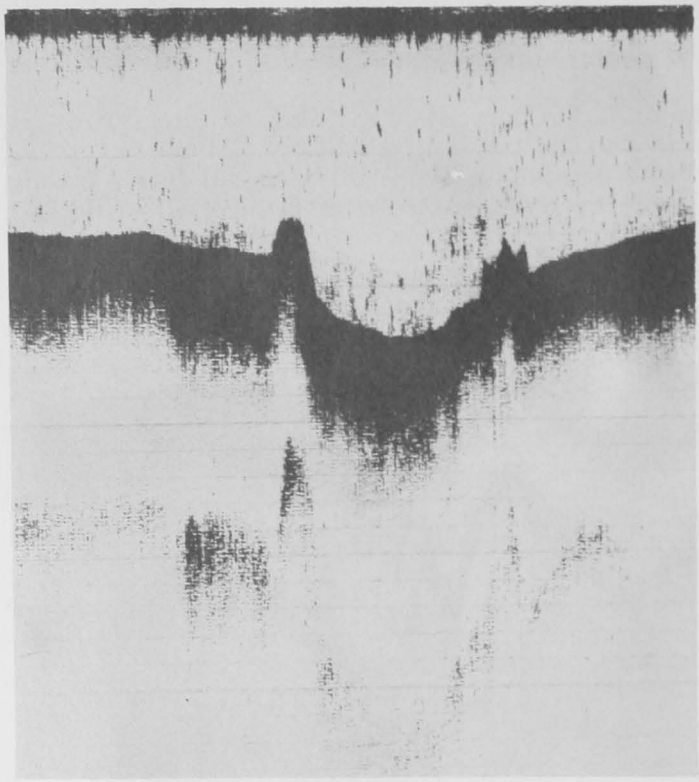

Fig. 8 - Depth recording of bottom northwest of Erie, Pa. Depth in 5-foot increments.

CENTRAL BASIN: The Central Basin received the greatest amount of trawl coverage. Of the total of 253 trawl drags completed, 187 were made in this zone. With the exception of a narrow band of rock and shale deposit along the shoreline from Huron, Ohio, to Walnut Creek, Pa., the bottom is composed of mud, sand, and clay and is free from trawling hazards. Two obstacles to trawling were found in the deeper waters of the Central Basin. One bar, north of Vermilion, Ohio, near the international boundary, is partly rock strewn. Minor damage to trawls occurred there. A second bar, northwest of Erie, Pa., is untrawlable with conventional trawl gear because of sharp rises and depressions (fig. 8). Debris and trash, including submerged trees have accumulated on the western approach to this bar. Extensive trawl damage was experienced in this area.

Knowledge of water temperatures in the deeper parts of Lake Erie is limited, but the fact that summer and early fall bottom temperatures are somewhat below those of the surface has been established. Thermal stratification occurs in central Lake Erie, often for prolonged periods, from late spring to early fall (fig. 9). Studies by the Bureau, the Ohio Division of Wildlife, and the Ontario Department of Lands and Forest indicate that oxygen depletions in the bottom waters occur prior to the close of thermal stratification. These oxygen depletions are attributed to natural causes and usually develop after prolonged periods of calm warm weather. The apparent effect on fish abundance and distribution is marked. Most trawl drags in the area during the period of oxygen depletion were water hauls.

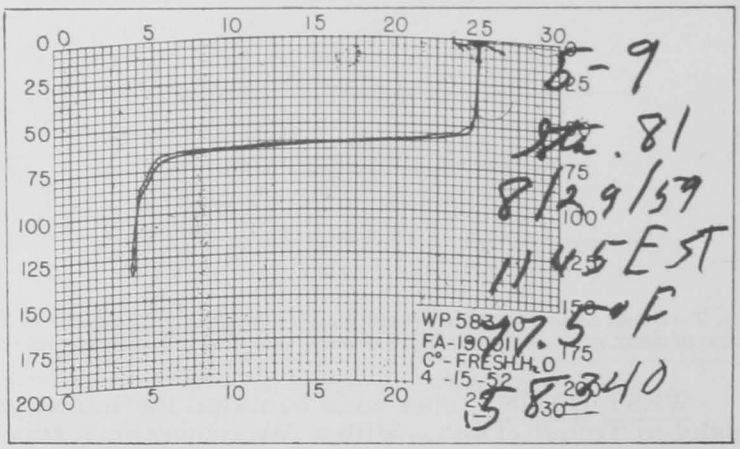

Fig. 9 - Bathythermograph tracing recorded in the East Basin of Lake Erie. Depth recorded in feet, temperature in degrees Centrigrade.

EAST BASIN: The East Basin includes the deepest waters of the lake. The inshore waters, less than 8 fathoms in depth, are strewn with shale rock known locally as "shelf or slab rock." The width of this outcropping varies from a few hundred feet to several miles. The slopes are generally steep and these prevented

normal trawling operations. Beyond 8 fathoms, the slope becomes more gradual, and the bottom is composed of sand, clay, and mud providing good trawling grounds.

A well-defined thermal stratification (fig. 9) existed over much of the East Basin during cruises 4 through 6 of the Active (August 3-October 8, 1959). Vertical temperature differences, between surface and bottom, of 37° F. (40.0-77.0° F.) were recorded during cruises. Data collected by Parmenter (1929) and more recently by the M/V Cisco in this basin, indicate that wide temperature differences between surface and bottom water may occur annually.

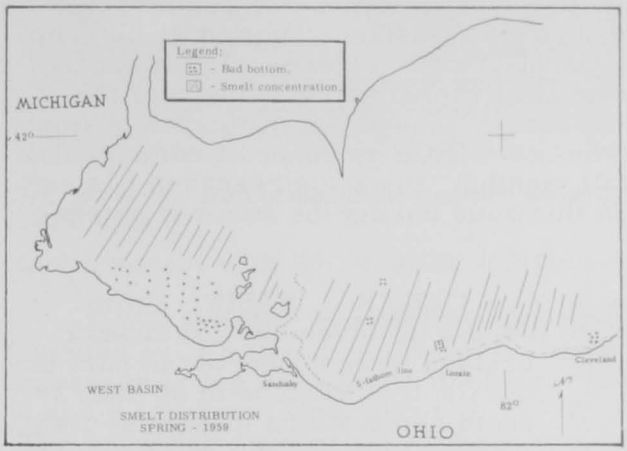

Fig. 10 - Chart of western Lake Erie depicting areas unsuitable for trawling and the spring distribution of smelt. Length of oblique lines is correlated with the area over which smelt were taken or observed.

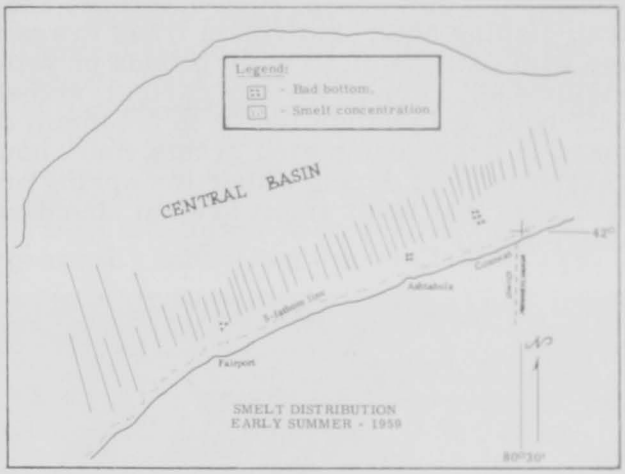

Fig. 11 - Chart of the fishing area showing early summer smelt distribution. Oblique lines designate areas where smelt were caught.

Exploratory operations were conducted along the entire south shore of Lake Erie and northward to the international boundary at depths greater than two fathoms. During the explorations, 253 trawl drags were made and 14 lampara-seine sets completed. Positions of seine sets and trawl stations are shown diagrammatically in figure 6. Areas of seasonal smelt concentration, and locations where snags, torn gear, or bad bottom were encountered, have been plotted on charts for reference (figs. 10, 11, and 12).

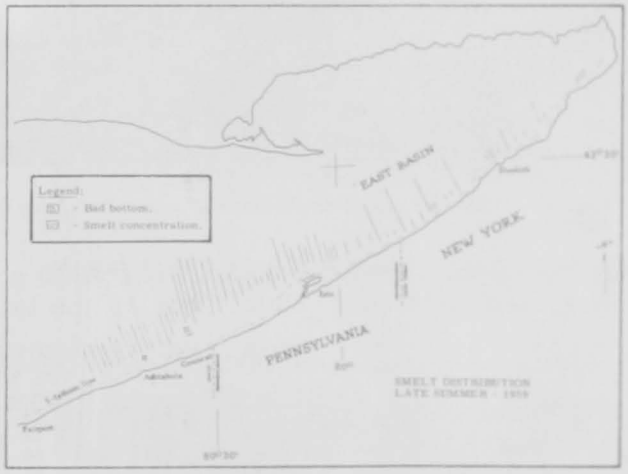

Fig. 12 - Chart of the eastern half of Lake Erie showing areas where snags or bad bottom were encountered and areas where smelt concentrations were observed.

FISHING RESULTS

LAMPARA-SEINE FISHING: The exploratory operations by the vessels Pat, Thelma H., and Active were not successful in producing commercial quantities of smelt with the lampara seine. Surface scouting, aerial surveys with light planes, and echo-sounding operations failed to reveal any large concentrations of smelt in surface waters.

During the periods October 15-November 24, 1958, and April 21-November 23, 1959, a total of 14 seine sets produced only trace amounts of smelt, white bass (Lepibema chrysops), gizzard shad (Dorosoma cepedianum), alewife (Pomolobus pseudo-harengus), and emerald shiners a subspecies of Notropis atherinoides. As shown in figure 6, most of the seine trials were conducted west of Cleveland, Ohio, and close to shore. Prior to the start of exploratory work in 1958, observations by commercial fishermen and others indicated the possibility that smelt appear in

surface schools in inshore waters and near the Lake Erie islands. Hundreds of surface schools of fish were sighted during the 1958-59 work. Samples from some of these were identified as emerald shiners. A total of three lampara-seine sets made in 1959 on other schools resulted in small catches of white bass and minnows. To date, smelt have not been found to be available to capture in surface-seine operations in Lake Erie.

OTTER-TRAWL FISHING, WEST BASIN: Exploratory trawling operations in the shallow West Basin between Toledo and Sandusky, Ohio, were handicapped by boulder-strewn areas, rock outcrops, and the presence of numerous commercial trap-fishing nets. Individual trawl drags made near the islands showed some promise with catches of 10 to 50 pounds of yellow perch (Perca flavescens), catfish (Ameiuridae), carp (Cyprinus carpio), and sheepshead (Aplodinotus grunniens) per half-hour drag within the 4- to 5-fathom depth range. The small quantities of smelt taken in drags completed in this zone, however, gave little evidence of commercial concentrations during either the spring or fall months. Previous research has established that adult smelt are not abundant in this zone during the summer warm-water period.

Fig. 13 - 5,000 pounds of smelt taken in a one-hour drag by the M/V Active.

CENTRAL BASIN: From June 2 to November 23, 1959, 7 cruises were conducted in part in the Central Basin with 50-foot 2-seam semiballoon industrial-fish trawls at depths of 5 to 13 fathoms. With few exceptions, drags completed in summer months resulted in from 80 to 5,000 pounds of commercially-salable smelt per hour (fig. 13). Trawl catches in this zone during the fall months were lighter and failed to produce evidence of large smelt concentrations (table 2).

A summary of the trawling operations in the Central Basin shows a seasonal shifting of smelt concentrations and considerable variation in availability. In late spring and early summer, catches of 20 to 600 pounds per hour were made between Sandusky and Ashtabula, Ohio. During the late summer, however, catches averaging over 1,000 pounds per hour were made over much of the area extending from Ashtabula eastward to Erie, Pa., at depths of 10 to 13 fathoms.

Table 2 - Fishing Log of M/V Active Otter Trawl Tows, 1959

Cruise No.	Dates	Geographic Area	Gear 1/	No. of Tows	Time Towed (Avg.)	Fishing Depth (Range in Fathoms)	Smelt Catch (Lbs.)	Other Fish Catch (Lbs.)
1	4/21-5/13	West Basin	50' Trawl	14	00.25	2-6	85	369
2	6/2 -6/24	Central Basin	50' Trawl	45	00.30	2-13	4,372	372
3	7/6 -7/23	Central Basin	50' Trawl	66	00.45	6-13	5,279	224
4	8/3 -8/17	Central & East Basin	50' Trawl	31	00.34	5-25	2,082	170
5	8/27-9/6	Central & East Basin	50' Trawl	29	00.34	5-25	4,325	89
6	9/22-10/8	Central Basin	50' Trawl	39	01.00	9-13	50,572	401
7	10/20-10/27	Central Basin	50' Trawl	14	00.29	5-13	95	94
8	11/9 -11/23	Central & West Basin	50' Trawl	16	00.33	2-12	53	195

1/ Standard 50-foot two-seam Gulf of Mexico trash fish trawl.

Based on these successful fishing efforts, commercial-scale production trials were made on two occasions. In July, 7 days of fishing produced a total of 3,340 pounds of smelt (12 to 18 count). The second attempt, in late September, resulted in the capture of over 40,000 pounds of smelt (10 to 20 count) in 6 days of trawling (fig. 14). No severe gear damage occurred during either of the commercial scale demonstrations.

Fig. 14 - A good catch of marketable-size smelt aboard the M/V Active.

At the start of each cruise, systematic echo-sounding transects were made to locate the best fishing areas and depths. Results indicated an intermittent distribution of smelt in the zone. Daily fluctuations in the catch rate were not fully understood, but diurnal vertical movement was determined to be one contributing factor (fig. 15).

Sample counts of smelt from the Central Basin ranged from 8 to 40 per pound. Data collected on the size distribution show that over 80 percent of the catches consisted of 10- to 20-count smelt. The difference in sizes was more marked, however, in the shallower depth range (shallower than 5-6 fathoms) in warm water, with the smaller individuals generally inhabiting the shallow waters.

EAST BASIN: The M/V Active also carried out limited exploratory trawling coverage of the East Basin during cruises 4 and 5 (August 3-September 6, 1959). The coverage accomplished, however, is not representative of the seasonal distribution of smelt or other fish stocks in this portion of the Lake.

Smelt catches here were light during the period August 5 to 11, 1959. Of the 14 trawl drags completed, 2 were water hauls; the remainder produced only 125 pounds of small smelt (20 to 40 count). Catch rates varied from 2 to 50 pounds per half-hour drag. On one occasion, the net and doors bogged down in the extremely soft bottom and only a portion of the catch was retrieved.

Commercially-salable smelt were taken in 12 drags in the East Basin in amounts of 20 to 500 pounds per half-hour drag August 28 to September 3. The best catch results were made on the slopes outside Dunkirk, N. Y., at depths of 10 to 12 fathoms, and off the Pennsylvania-New York border at depths of 15 fathoms. Catches up to 150 pounds per half hour were made along the 10-fathom contour. Deeper water catches were much lighter.

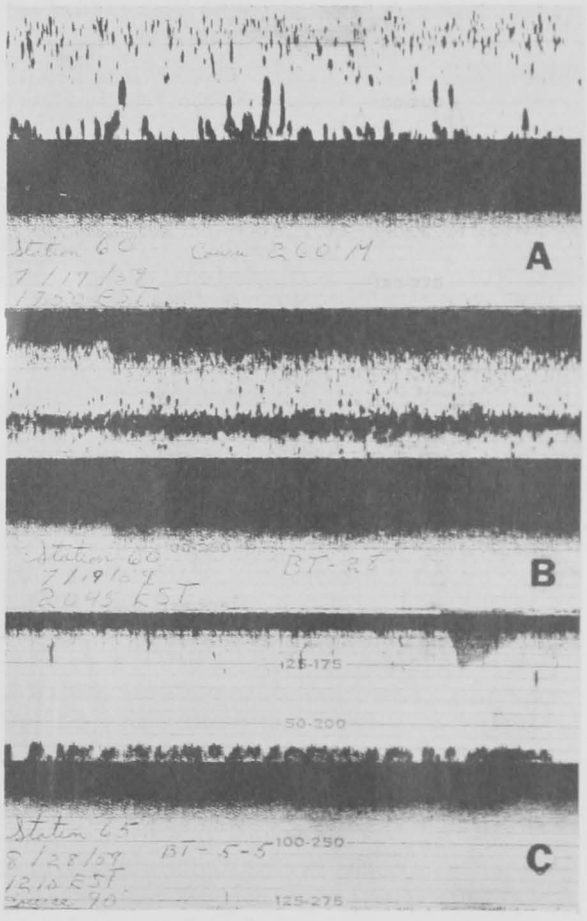

Fig. 15 - Depth recording made aboard the M/V Active off northeastern Ohio: (A) Typical tracings of fish concentrations made during daylight hours. (B) Tracings made during evening operations. (C) Tracings made 40 days later in same general area as A and B.

Several aspects of the smelt distribution pattern in the East Basin were notable. During the first cruise in this zone, few large smelt were taken, and the catch rate fluctuated widely with little regard to a particular depth range. Catches made during the second trip were more uniform, favored the larger individuals, and

the smelt appeared concentrated within a narrower depth range. These differences may be attributed to a possible recruitment of smelt from the central basin following the reported oxygen depletion which existed there during late summer.

CONCLUSION

Results of the explorations from the 1958-59 work in Lake Erie indicate that the abundant smelt can be taken profitably on a commercial scale with trawling gear. There is evidence that the seasonal availability and distribution is closely related to lake water temperatures within a range of 41° F. to 68° F., and with the colder mid-50-degree range of temperatures preferred. The thermal stratification of water and vertical migration of the smelt will affect the availability to the fishing fleet. Daylight trawling for smelt appears much more promising than night fishing. Evidence to date suggests that when commercial-scale concentrations of smelt are found, they tend to be uniform in composition with few other species present.

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CHINOOK SALMON PREFER PLUNGING FLOW

The passage of individual chinook salmon was studied by the U. S. Bureau of Commercial Fisheries in a non-orifice pool-type "endless" fishway with a slope of 1:16 whereby fish were subjected to plunging and streaming flows on alternate circuits of the 16-pool unit. The effects of the two flows on rate of ascent were determined by comparing time required for each circuit of the fishway. Also on each circuit, individuals were observed as they passed through a specially constructed viewing pool.

Based on these data, a plunging flow appears to be the desired condition for all fish even though the majority performed equally well in either plunging or streaming flows.

During the tests, a series of view-pool observations plotted the movements of individual fish in terms of the time spent in each of four quadrants of the pool. When flows were plunging, the lower downstream quadrant was the dominant area utilized, while in streaming flows, the lower upstream quadrant was the favored area. During rest periods fish always aligned themselves to head into the current.