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THE DEVELOPMENT OF SMELT RUNS IN LAKE CHARLEVOIX WITH A SUMMARY OF THE
SMELT SITUATION IN MICHIGAN

CONTENTS

	Page
I Introduction.....	1
II Lake Charlevoix as a Habitat for smelt.....	2
III The Spawning Run in Lake Charlevoix	8
IV The Source of the Smelt in Lake Charlevoix.....	13
V The Spawning Habits of the Smelt	14
VI The Age and Growth of the Smelt in Lake Charlevoix.....	17
VII Effect of Smelt Dipping on other Fishes.....	20
VIII The Establishment and Possible Control of the Smelt.....	20
IX Status of the Smelt and its Relation to other Fishes and to Fishing ..	21

I. INTRODUCTION

It is now well known that the smelt (Osmerus mordax) is securely established in several sections of the Lake Michigan drainage in addition to Crystal Lake. Specimens have been taken in Lake Michigan near Frankfort and Charlevoix, and from Green Bay and Lake Charlevoix. It is reliably reported from Grand Traverse Bay and elsewhere in the northeastern part of Lake Michigan. Repeated reports of a trustworthy character indicate its occurrence about Cheboygan, St Mary's River, Rogers City, Rockport and Alpena. Very recently a specimen has been captured in Saginaw Bay off Sebawaing, proving the spread of the species southward in Lake Huron. A specimen from Manitowoc, Wisconsin, indicates a similar spread in Lake Michigan.

It is evident from these records that runs may be expected in the near future in any favorable shoreward stream in the northern half of the Lower Peninsula. The main body of the present report covers the development of such runs in the tributaries of Lake Charlevoix (Charlevoix County). Since this lake is unlike Crystal Lake (Benzie County) in several important respects, the establishment of the smelt there is of special interest in indicating what may be expected of the smelt in other parts of the state. Observation based on the several runs of this lake should furnish more information upon the spawning habits of the smelt and its interrelation with other fishes. Such information will enable us to render a more intelligent opinion upon the many-sided problem of the future of the smelt in Michigan.

The investigations recounted in this report were made by Prof. C. W. Creaser of the College of the City of Detroit, who has taken the leading part in the study of the establishment of the smelt in Michigan. The report while essentially his, has the approval of the Institute for Fisheries Research, for which the investigations were

made. In a few points we are not in complete agreement as indicated in the text.

Two trips were made by Dr. Creaser this spring to the Lake Charlevoix region to study the smelt. The findings of the first trip, undertaken before the run started, were submitted as Report No. 4 of the Institute.

II. LAKE CHARLEVOIX AS A HABITAT FOR SMELT

Lake Charlevoix has an extensive area, and much deep water which is closely connected with Lake Michigan. It is about thirteen miles long and about three miles wide at the maximum, and is divided into two parts. The main portion extends from the deep though narrow outlet at the city of Charlevoix to Boyne City in a general southeasterly direction. From a point about one-third the distance along the south shore, a long arm extends for nine miles almost straight south to the city of East Jordan.

This lake differs physiographically from Crystal Lake in several important respects. It has a rather deep and short outlet, which is unobstructed. This makes possible the invasion of any Great Lakes fish adapted to its waters. It is probably this fact which accounts for its quick acquisition of a large smelt population. Furthermore, this lake is in the drainage path of a large area of land between Little Traverse Bay and the east portion of Grand Traverse Bay. Numerous small streams and two important rivers flow into it, all available for spawning runs of the smelt, as contrasted with the one small tributary and several inflowing trickles of Crystal Lake, which furnish extremely ~~very~~ limited spawning areas of that lake.

The streams tributary to Lake Charlevoix and their relation to the smelt may be considered separately. These streams are indicated on the map accompanying this report. ~~1. Stover Creek~~

1. Stover Creek —

Sec. 35, T. 34 N., R. 8 W.

This stream flows through the southern outskirts of the city of Charlevoix and enters the lake at the point designated above. Its lower reaches, comprising a distance of some 450 feet, is at present all that is available for a smelt run. The stream is narrow, scarcely ten feet wide as it enters the lake. It has been much modified for use in connection with an abandoned sugar factory, the decadent dam of which is the obstruction to the smelt run. It has a gravel bottom and the water is shallow. It has been equipped for smelt fishing with electric lights, etc.

The stream is a trout stream, but has been kept closed.

Its headwaters are to the south of the city of Charlevoix and it runs through the property of the Belvedere Golf Club and a public cemetery before it crosses the main road leading around the lake which is just above the dam.

Considerable more area for a spawning run could be made by the removal of the obstruction. If this is done it might be advisable to place a screen at the east end of the cemetery and hold the smelt at this point, since the fishing would probably be more satisfactorily controlled if the fish were prevented from running into the cemetery and the golf course. Of course no occasion for these changes will exist if the smelt fail to develop a run in this stream.

Stover Creek may be characterized as an excellent stream for smelt dipping, since it is rather shallow, has a firm bottom, and would be easy to regulate and administer. ~~2. Barker Creek~~

2. Barker Creek — Sec. 2, T. 33 N., R. 8 W.

A rather small stream (10-12 ft. wide), a very short distance south of Stover Creek. It is rather shallow and is unobstructed to the road around the lake. Smelt may use this stream in spawning runs and if the Department decides to protect and increase the spawning of the smelt, it might be simpler to close this stream for undisturbed spawning, rather than to devise complicated rules for their partial pro-

tection on Stover Creek. ~~3. Loeb Creek~~

3. Loeb Creek. — Sec. 1, T. 33 N., R. 8 W.

The head of this stream is in Adams Lake, reputed to be a good bass lake. The extremely swift waters of this stream, near the road around the lake, would possibly form an effective barrier to the invasion of this lake by the smelt. However, this can not be stated with assurance until observations are made. If the smelt does reach this lake, its subsequent history there would be extremely interesting, since the smelt has not been found in Michigan in this type of lake, which would give it an entirely different faunal relationship.

Most of the property traversed by this stream is within the boundaries of the Loeb Farm, which is not open to the public. This fact suggests that Loeb Creek might also be held closed to smelt dipping. Any spawning run of smelt would thus be protected, if such a policy were determined upon as desirable by the Department.

This stream is about 10 to 12 feet wide and has a moderate current to the bridge, at the road around the lake, for a distance of upwards of a mile by water course. This fine lower part of Loeb Creek furnishes potential spawning grounds for the smelt. ~~4. Miller Creek~~

4. Miller Creek — Sec. 26, T. 33 N., R. 7 W. (location as furnished by Prof. Creaser).

This stream is available to the spawning smelt only to the gravel road which runs around the lake. Below this road its current slows down and it winds towards the lake. At the outlet the current is extremely sluggish and flows through the summer garden now developed as a rustic retreat at a private resort. The available area for smelt is certainly less than 1/8 mile. The mouth is 25-30 ft. wide, often frozen back for some distance during the cold weather of the smelt run.

Except Jordan River, this is one of the two streams of any size flowing into the south Arm. 5. ~~Monroe Creek~~

5. Monroe Creek — Sec. 9, T. 32 N., R. 7 W.

This stream is unobstructed for several miles of its length, but only the lower portion would be of importance for smelt runs. Below the road leading around the lake it has fine prospects for the development of a spawning run. At the mouth it is about 15 ft. wide and has a rather slow current. Due to the condition of the current and its location on the south west shore of the lake it was frozen over for a short distance on the very cold night of the 14th of March. The south bank of this stream is occupied by the developed estate of a local lumberman, which fact would make it difficult to dip from this side without serious damage to the property.

The upper reaches, above the road, are cold, swift trout waters, ~~6. Tourist~~

6. Tourist Park Creek -

Sec. 22, T. 32 N., R. 7 W.

A very small trickle flowing into the South Arm of Lake Charlevoix at the Tourist Park of East Jordan. This stream is too small to be of much importance in its present state but enough water is present to allow its development into a deeper and wider ditch, which might be of importance in smelt fishing, due to the very favorable location of this stream mouth on public land. ~~7. Jordan River~~

7. Jordan River - At the city of East Jordan.

This stream is the main tributary to the South Arm of Lake Charlevoix and is unobstructed throughout its 15 miles of swift running trout waters. It has several tributaries, one or two of which are suitable for smelt. The mouth below the bridge at East Jordan is broad and remains open throughout the winter up to and often out into the lake. At this mouth and for some distance above the bridge, the stream is not available for smelt dipping because of the deep water and swampy nature of the shore. The Jordan River should develop into a fine spawning stream. Much of the spawning area is naturally protected from dipping.

Not far from the mouth there are two tributaries which are of importance in a consideration of the spawning run.

One and one half miles south of the East Jordan Bridge the Jordan River is crossed by another bridge. Here it is a fine, rapid, open stream well adapted for smelt, 30 to 40 feet in width and with a gravel bed. ~~8. Brown Creek~~

8. Brown Creek - Sec. 26, T. 32 N., R. 7 W.

This small creek flows through the city of East Jordan and joins the Jordan River near its mouth. It is unobstructed almost to the pavement (M 66), to the east of which there is an impassable dam. ~~Deer Creek~~

9. Deer Creek - Sec. 25, T. 32 N., R. 7 W.

This stream is about one half mile south of East Jordan, and is tributary to the Jordan River. It is open to the power dam which is one-half mile from its outlet into the Jordan River. It is almost twenty feet wide at the bridge, and the water is two feet and more in depth. It has firm banks and gravel bottom, giving it an excellent character for smelt dipping. ~~Porter Creek~~

10. Porter Creek - Sec. 29, T. 33 N., R. 6 W.

This stream is the only tributary of any importance on the south shore of Charlevoix Lake lying to the east of the entrance of the South Arm. Numerous trickles and small spring fed openings are available for very small runs.

Porter Creek is unobstructed to the mill dam at the road, a distance of 750 feet. If protection is deemed desirable, this stream might be closed as the Boyne River is near enough so as not to work any hardship on local fishermen. ~~11. Boyne~~

11. Boyne River

This stream is by far the very best of the smelt spawning streams of Lake Charlevoix. It has a wide expansive mouth which is open throughout the winter. At the mouth it is 45 to 50 feet wide and very deep, making only bank dipping possible

up to the Front Street Bridge. Above this and to the Park Street bridge, it is about 40 feet wide and rather shallow (the water varies in depth, as the dam is controlled). This portion of the stream is private property and backs against the stores of the city. From the Park Street Bridge to Pearl Street Bridge the river is canaled with stone and its west bank is a Public Park. The water is about two feet to two and one-half feet deep with the ordinary run from the dam, but may be lowered by the control at the dam. The situation here is ideal for dipping and will supposedly become the center of the smelt fishing. Above the Pearl Street Bridge, the Boyne River is a fine swift gravel-floored stream available for smelt run up to the dam, some three miles distant. ~~Horton Creek~~

12. Horton Creek - Sec. 6, T. 33 N., R. 6 W.

This is the only stream on the north shore of Lake Charlevoix of any size, having a mouth at present open for a smelt run. It is unobstructed to a rustic dam about one-fourth mile from the mouth. This dam is of no commercial importance and creates no lake or pond. Its removal or reconstruction to permit its opening during the smelt run, would much increase the value of the stream for smelt. There is a large marsh at the mouth which will interfere with smelt dipping and leaves a naturally protected spawning area.

Several other streams enter the lake along the north shore, but all have mouths that would preclude the development of any very large runs, unless they could be artificially opened up.

The Lake Charlevoix tributaries now known to have developed spawning runs are as follows:

Boyne River (to the dam, about three miles).

Porter Creek (to the dam, about 750 feet).

Jordan River (to the junction with Deer Creek).

Deer Creek (to the dam, one half mile from the junction).

Brown Creek.

Horton Creek (to the rustic dam, one fourth mile).

Stover Creek ? (no run during the open season of 1930).

As is indicated by this discussion, Charlevoix forms an almost ideal situation for the smelt, and could be improved by opening the streams further. In Lake Charlevoix we have a combination of circumstances which favor them at every turn. Of the many spawning tributaries, several are of such a nature as to afford natural protection to the spawning smelt and the developing eggs. Two of the streams are of ample size, and thus able to accomodate immense numbers of smelt. They are open at their mouths all winter, or at least so early in the year that the smelt can start their spawning run as soon as they mature. It is likely that food and enemies will be the chief factors limiting their numbers here. Undoubtedly many will escape into Lake Michigan, especially at the time of the spawning run. It is to be expected that if the smelt is not now thoroughly established in northwestern Lake Michigan, it is but a matter of time until the Charlevoix development will accomplish this. The Charlevoix runs will certainly hasten the spread of the smelt through the northern part of Lake Michigan.

III THE SPAWNING RUN FROM LAKE CHARLEVOIX

Smelt were first discovered on spawning runs in Stover Creek in 1929, on March 27-28. A heavy snowstorm came during the next few days and nothing more was seen of them. On March 28, 1929, an investigation by local conservation officers showed a few in Porter Creek. From all evidence this was no doubt the end of the spawning run of 1929, and little idea can be gained as to the extent of that run, beyond the fact that it occurred.

In 1930, close inspection of all the streams near Boyne City, East Jordan and Charlevoix was made by the local officers. The first run was noted in the Boyne River on March 17, and the heaviest run developed at once, on March 18. This information was furnished by Mr. Lewis McIntire of Boyne City.

Observations were started the evening of March 20 by Professor Creaser. A fine run was discovered at Horton Creek at 8 P. M. on March 20. A large pool below the rustic dam was filled with smelt, and two large pails were filled by the officers. The stream was opened for smelt dipping at once. On Friday March 21, runs were discovered on the Jordan River at East Jordan and its two tributaries, Brown and Deer Creeks. The Jordan River and the Deer Creek were then opened for smelt fishing.

No other runs were discovered during the next few days. Repeated inspection of Stover Creek and Monroe Creek, the two most promising streams of the southwest shore failed to reveal any smelt. It is probable that these streams did not develop runs, because of the sudden drop in temperature during the run, which caused their mouths and streams for some distance from the lake to freeze over.

An inspection of all the streams of Little Traverse Bay from Five Mile Creek north-west of Harbor Springs to the Bear River at Petosky was made on Friday evening. All were found with their mouths free of ice and with conditions identical with those of streams in which the smelt were running at Lake Charlevoix. No smelt runs, however, were discovered. A constant watch throughout most of the run was kept on the mouth of Bear River at Petosky, by the watchman at the power dam, but no smelt appeared.

The Boyne River Spawning Run

The run up Boyne River was found by conservation officers to have started March 17, 1930. A count of several hundred was reported to show 98% males, of a small

size. On March 18, the weather was cold and cloudy, with many small squalls at night. The best run then developed. It was estimated by the officers in charge that 2000 pounds were taken from the stream and many more escaped, by going up the river beyond the open fishing ground before the dipping started at 10:00 P. M., and later in the evening when dipping was prohibited. An investigation was made at a point about two miles from the mouth, on Saturday, March 22, of the smelt which were found up the stream at various places. About 98% were found to be males, (about 300 counted), indicating that the fish then in stream belonged to the first run.

On March 18 a count of the sexes near the mouth of the stream was reported to show about 90% males, while on March 19 the proportions were about equal, indicating a normal development of the run. The temperature of the river was then about 37°F.

Thursday, March 20, the river was 35°F., and a fair run developed as far as the Pearl Street Bridge. The weather turned sharply cold. Ice was forming in the river at 10 P. M., with a temperature reading of 32.5°F. Friday at 9:30 A. M. a maximum-minimum thermometer was placed in the river at the Front Street Bridge. During the day (Friday, March 21) the stream rose in temperature until at 3 P. M., it was 35.6°F. at the Park. A few smelt stayed under the Park Street Bridge all day.

Friday at 10:30 P. M. the maximum-minimum thermometer read 31° to 36°, as compared with 31° to 32°, as it was set. This indicates that the stream was warmed up about 4 degrees during the day. The run of smelt was not great but the stream contained some fish from the lake to Pearl Street.

The temperatures of the air continued to lower and by Saturday morning about 1/6 of the former open water at the mouth of the Boyne River was all that remained. Much ice was formed in the river and smelt nets and fishing clothes were frozen the instant they came in contact with the air. During the day (Saturday, March 22) the

river warmed up and the reading of the maximum-minimum thermometer showed 31° to 38° as compared to 31° to 32°, at which it was set, — a rise of 6 degrees. At 8 P. M. the river was at 37.5°. As the run was starting, the lake was at a temperature slightly above freezing. A fair run of smelt developed up to the screens placed above the Pearl Street screen. A row boat placed just below the screenⁿ was filled with smelt by the wardens keeping the screen and river clear for six feet below the screen. Many smelt returned from up river and in the early morning the fish were to be found on both sides of the screen.

Saturday the river was inspected at an accessible point some two miles above the mouth, where numerous smelt were to be found under all projecting rocks, logs or sand obstructions. About 300 were dipped and only three females were among those captured.

"On the morning of the 24th a large quantity of fish from up stream were forced against the wire which caused the water to rise and pass over the top of the screen and during the excitement the wire was torn apart leaving a hole about 10 feet long by 1 ft. wide at the bottom in the center of the stream, which was not discovered until the work of removing the screen," according to the conservation officer. Fishing on the Boyne River was closed March 30, as the run seemed to be over. However, Mr. McIntire observed smelt still coming up from the lake and were above the first bridge as late as April 6 th. Smelt continued to come into the Boyne River as late as April 27, 1930, according to reliable observers.

The Porter Creek Run

The run at Porter Creek started on March 18, a day later than the start at Boyne River, and the same date as one of the best runs at Boyne River. On March 18, a day later than the start at Boyne River, and the same date as one of the best

runs at Boyne River. On March 19 more smelt appeared in Porter Creek, the temperature of which at 6 P. M. was 33°. March 20 a real run developed. As at the Boyne River the first run was mostly of small males, but by the 20th the females were much in abundance. At 10:30 P. M. the temperature was only slightly above freezing, with ice forming in the water as the fishermen hunted for the smelt. The temperature of the stream had been 33 degrees F. late in the afternoon.

Friday night the run was fair at Porter Creek, and Saturday night at 9:30 the stream was 33.8°, while the lake was 32.9°C., and a few smelt were making their way toward the dam.

Extent of the Lake Charlevoix Run of 1930

The officers in charge of ^{Porter Creek} ~~this stream~~ kept a rather close estimate of the catch and reported 6000 pounds caught. The officers in charge of the Boyne River run estimated the catch in that river as 50,000 pounds. Certainly only a small portion of the fish which entered the streams were captured. This computation may be compared with the 48,000 pounds taken in 1928 from Cold Creek at Beulah, when all that entered the stream were caught and recorded.

Other Runs

An inspection of the mouth of the Jordan River Saturday at 10:00 P. M. showed a few smelt, and the temperature of the water at 35°F. At the bridge one and one-half miles south, at 10:10 no smelt were observed. The temperature was 35.6°. At Deer Creek at the bridge below the dam, the water was at 35.6°, and there were a few smelt here at 10:15 P. M.

Stover Creek at 11:15 P. M. was at 32°, and the mouth, scarcely free of ice, was also at the freezing point. There were no smelt here. Monroe Creek was frozen for several yards up the stream and no smelt were observed through the ice.

IV THE SOURCE OF THE SMELT IN LAKE CHARLEVOIX

It is now well known that developing smelt eggs were repeatedly planted in various Great Lakes waters. Some of the detailed records of point of planting, if they exist, have not been discovered, and it is therefore difficult to reach final conclusions as to the source of the smelt of new runs. It is known that egg plantings were made in Lake Michigan in 1921. It is also known that smelt were escaping from Crystal Lake into Lake Michigan as early as 1923, and probably earlier.

The oldest specimens of the smelt from Charlevoix are four years old. This would suggest entrance into the lake several years ago. It is extremely probable that the large runs of this spring at Boyne City were the result of previous spawning in the lake tributaries. They were for the most part two and three year old fish. It would seem that the smelt records go back at least to 1927, for during the winter of 1927-1928 a very few were taken through the ice of the lake. In the spring of 1929, there was a small run, and in the spring of 1930 the well developed one here recounted. Since the smelt spawn at night, it is quite easy for a run to be overlooked. The run at Stover Creek in 1929 was discovered by young boys who caught a few in a deep pool during the last days of the run, and gave them to an informed fisherman.

It seems doubtful if the smelt were in Lake Charlevoix in any numbers before 1928, because the numerous ice fishermen would certainly have noted their presence, since ice fishing in Lake Charlevoix is by no means uncommon, nor confined to a single species of fish. At most there might have been a small run in the early years. In this connection we should recall the history of the smelt in Crystal Lake, where the results of the planting made in 1912 were first discovered in 1922, just ten years later. If this time relation held and if by any chance smelt egg plantings were made in the lake, 1921 would be suggested as a possible date of planting. In that

year the Bureau of Fisheries shipped smelt eggs to Michigan, the disposition of which has not been learned. But it appears most probable to us that the Lake Charlevoix smelt have originated from the Crystal Lake escapement. Another possibility exists, that adult smelt or even eggs were carried into Lake Charlevoix from Crystal Lake within the last few years, but the local Conservation officers do not think this likely.

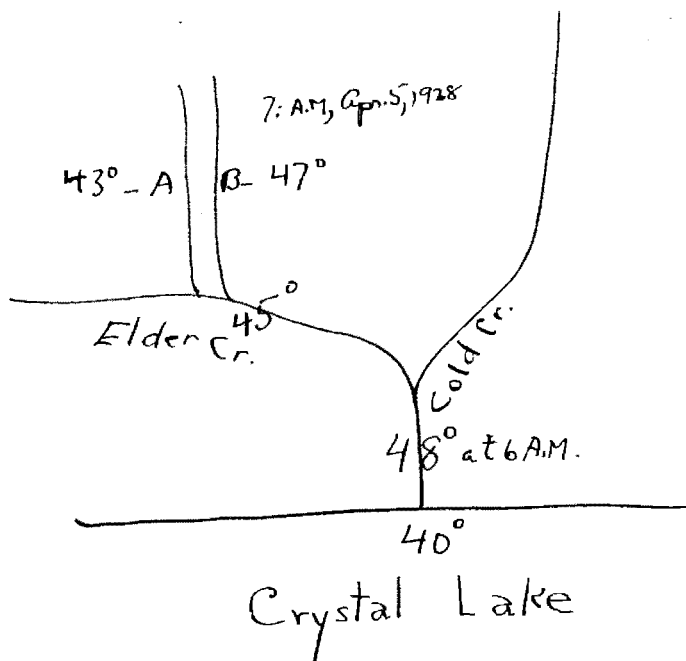
V. SPAWNING HABITS OF THE SMELT

Two environmental factors have been thought to control the spawning run of the smelt. The first deals with the current and the second with the temperature of the water. According to the current theory, which is held to by Prof. Greaser, when the smelt become mature and ripe a reaction is developed causing them to orient themselves against a current, and this movement brings the fish together at the inlet or outlet of the lake. Aversion to the light keeps them from moving up the stream during the daylight, and causes them to drop back to the lake in the morning or to seek shelter under banks, bridges, logs and deep dark pools during the day. Much information in support of this explanation was obtained during the Boyne City run. Since several of the streams of this lake have open mouths throughout most of the year, a run is to be expected as soon as the fishes mature. This year no smelt were to be found on March 14 to 15, although the rivers were open and some rather warm weather had proceeded the inspection; at least colder weather existed during the run. On the evening of the 17th the smelt were discovered in the Boyne River and the run continued uninterruptedly until April 6.

The theory involving the temperature of the water, explains the run on the basis of the difference in the temperature usually found between the water of the stream running into the lake and the lake water itself. The lake being filled with ice is usually at about the freezing point, while the streams are a bit warmer.

This difference usually exists, although it may be very slight, and at least in the case of Lake Charlevoix streams may exist throughout the spring.

Several observations are difficult to explain on the basis of this temperature interpretation. Granting that the mouths of the streams are slightly warmer than the lake, the usual temperature gradient in a stream is toward colder water at its source. This is true in Cold Creek at Beulah and a study of data collected there in 1928 indicates, according to Prof. Greaser, that a temperature explanation is untenable even for the two branches of Elder Creek, cited by Mr. Langlois. The following diagram, with the temperature of Cold Creek at its mouth and at the lake, added to the data given by Langlois, shows that the smelt run from the lake to the east branch of Elder Creek passed from colder to warmer water (40° to 48°), then from warmer to colder (48° to 45°), and finally from colder to warmer again (45° to 47°).



It is to be remembered also that the gradient of temperature in most streams in this region during this time of snow and ice is usually from cold lake to warmer creek mouth, warmer creek mouth to colder source. It is difficult, therefore, to see how the theory that smelt migrate from cold to warm water without reference to current, can be maintained as an explanation of the spawning run.

Furthermore at the outlet of Crystal Lake the smelt are all found working against the current in an effort to regain the lake water, while if responding to temperature alone their reaction should be to swim down stream in the direction of the presumptive thermal gradient, toward the warmer waters of the lower part of the stream. Prof. Creaser believes that other objections could be urged against the temperature-control theory, but that these alone seem to be sufficient to discredit it. The current theory Prof. Creaser holds to be apparently adequate to account for most of the observations, and not to conflict with our observation to date.

It is the opinion of the Institute that neither temperature nor current differences alone are sufficient to explain ~~alone~~ the spawning movements of the smelt. Much depends on the condition of the mouth of the stream.

The smelt become mature about the middle of March (March 17, 1930) in Lake Charlevoix (possibly at about the same time in Crystal Lake), and the runs start at once on such streams as the Boyne River, Porter Creek, Horton Creek, and Jordan River, probably because the mouths of these streams are exposed to the sun and are open and free of ice, throughout the late winter. The streams of the southwest shore bearing cold water from the north slopes and with shaded mouths remained closed in 1930 throughout the period of the early run (March 17 to 22), and no run developed in them. These streams are Monroe, Miller, Barker, and Stover. Observations continued by the Conservation officers up to April 6 showed that no runs developed on these streams of the south west shore. When changed weather

warmed up the streams and opened the mouths, a very few smelt are said to have strayed into them.

It is interesting to note in connection with the Crystal Lake condition, that the two streams available for smelt runs there are on the south and west sides of the lake, which tends to hold up spawning until about the first of April, which is about the time Stover Creek became free of ice.

The run may be expected at Boyne City as soon as the fish ripen, about March 15, and the run will usually continue through the first week of April. The heaviest run will likely occur the first week. Open season for smelt in Lake Charlevoix should be at least from the middle of March to the middle of April, if designed to cover the run.

The streams on the southwest side of Lake Charlevoix are often closed at the mouth, and no run may be expected to occur in them until an ice free pool is developed at the lake. If the streams are closed by ice throughout the big Boyne River run, it is likely that very small runs or none at all will develop in these streams, because the fish will have already spawned in the streams which open early. Runs on such creeks as Stover, at Charlevoix, are very likely to be much later than those at the north, east, and southeast shore of both the main lake and the southern arm, or the other streams such as Porter Creek with very swift current which retards freezing.

VI THE AGE AND GROWTH OF THE SMELT OF LAKE CHARLEVOIX

A preliminary examination of the age and growth of the smelt of Lake Charlevoix has been made. Ten specimens from Boyne River run selected for their large size, were aged by the scale method, which is surely reliable for the smelt. Seven of these were two years old, ranging from 172 mm. standard length (7 6/8 inches over all) to 188 mm. (8 1/2 inches total length). Two were three years old, 184 mm.

(8 3/4 inches) and 190 (8 3/4 inches) in length. One, ~~was~~ ^{was} four years old, 10 3/4 inches in total length or 228 mm. standard length.

A random sample of the Jordan River run made by the district conservation officers containing 13 specimens, was found to contain 11 two years old and two three year old smelt. Three others, two years old, were examined from Deer Creek. The data are given in the accompanying table.

TABLE SHOWING SOME AGE DETERMINATIONS OF LAKE CHARLEVOIX
SMELT FOR 1930 RUN

Boyne City sample, selected for large size, early in run				Jordan River sample selected at random by conservation officer				Deer Creek Sample			
Age	Sex	Standard length, mm.	Total length, inches	Age	Sex	Standard length, mm.	Total length, inches	Age	Sex	Standard length, mm.	Total length, inches
II	M	176	7 3/4	II	M	135	6 1/4	II	M	146	6 3/4
II	M	188	8 1/2	II	M	143	6 3/4	II	M	150	6 7/8
II	F	163	7 1/2	II	M	145	6 3/4	II	M	165	7 5/8
II	F	172	7 7/8	II	M	145	6 5/8				
II	F	182	8 1/4	II	M	148	6 3/4				
II	F	197	8 7/8	II	M	148	6 7/8				
II	F	200	9	II	M	148	6 7/8				
III	M	184	8 3/8	II	M	150	6 7/8				
III	F	190	8 3/4	II	M	152	7				
IV	F	228	10 3/4	II	M	156	6 7/8				
				II	M	164	7 3/8				
				III	M	184	8 3/8				
				III	M	205	9 1/4				

These two year old fish are as large or larger than those of the same age in Crystal Lake, and the same is true of those three years old. Whether they would average longer is undertain, because the numbers examined are small.

Undoubtedly two as well as three year old smelt entered heavily into the portion spawning run of Lake Charlevoix. One fourth of a breeding run studied by Dr. Creaser

at Beulah was composed of two-year old fish, and the sample was taken after the first days of the run, when the two year old fish are commonest. These findings rather poorly agree with Dr. Metzelaar's idea that the three year class is the only breeding class of any consequence. His statement "We therefore feel safe to say that apart from a few male forerunners ("grilse"), the Crystal Lake smelt do not spawn before they are three years old" certainly is far from the truth for the 1930 Lake Charlevoix run and also extremely questionable for Crystal Lake. Large numbers of the two year old fish, especially males, do spawn. The explanation of Metzelaar's finding at least in part may be the fact that his sample did not include the first part of the run (March 30-April 2) which involves so many two year old males. Furthermore, his study covered but one run, in which a single dominant year class may have existed. Conclusions as to ratio of classes based on the very selective gill net catches are also subject to considerable question. Especially is this true of a fish with the shape of smelt.

The frequency of spawning of two year old smelt is also attested by the fact that an apparent spawning mark very often accompanies and intensifies the second winter mark on the scales.

This evidence as to age at maturity in the smelt is taken by Dr. Creaser to weaken those interpretations and recommendations of Dr. Metzelaar which were based on the assumption that one year class makes up practically all of the breeding stock. Those conclusions of Dr. Metzelaar will be validated, however, in proportion to the degree that the three year old fish do predominate in the breeding run. This ratio of the year classes has not been accurately determined, because samples for aging have not been available from all stages of the run.

The opinion of Metzelaar that the taking of the spent fish does not harm the fishery, because most of them spawn but one fails to meet the approval of Dr. Creaser. The Institute, however, is inclined to the belief that the conclusion of

Metzelaar is essentially sound. During the latter part of the run, the three year old fish certainly appear to predominate greatly, and relatively few of these return to spawn a year later. Therefore the spent fish may be taken with relative immunity to the species. During the first part of the run there are many two year old fish, but the evidence indicates that these are mostly males, and we have no reason to think that a considerable reduction in males would greatly lessen the natural production. The fishing out of the two year males during the first few days of the run we would expect not to harm the species to any great degree.

VII. EFFECT OF SMELT DIPPING ON OTHER FISHES

Some fear has been expressed by the conservation officers that fishes other than smelt, particularly brook-trout, might be taken in the dipping for smelt. At Boyne City, so far as could be determined, only one single fish was so captured, a small grass pike, dipped near the mouth of the river. No brook trout have been observed in the stream where dipping takes place, and conditions are such that it is probable that no fish of any value will be taken in this manner, certainly never in any numbers.

No other species is known to spawn on the smelt spawning grounds, before or during the smelt run. Therefore we have no evidence that the smelt dipping destroys the spawn of other species.

VIII. THE ESTABLISHMENT AND POSSIBLE CONTROL OF THE SMELT

The smelt is now fully established in Lake Charlevoix, and it would be almost impossible to remove it. Experience at Crystal Lake seems to indicate, after the eight years of heavy destruction, that the matter of removal or even of the sharp reduction in numbers would be a matter of considerable difficulty. The

difficulty of removing the smelt from Lake Charlevoix appears many times greater, perhaps quite impractical, because of the more numerous and larger streams, in part with marshy mouths difficult to close. This is also true for Lake Michigan as a whole and for Green Bay. The smelt is firmly entrenched, and therefore any consideration of its extermination is futile. The possibility of controlling the numbers remains, although it is not certain that an effective control would be possible, if desirable.

Some reduction in numbers of smelt could doubtless be effected by the more complete removal of the spawning fish and the destruction of the spawn in all streams developing a spawning run. It is more than possible, however, that such means would not be highly effective, and it is virtually certain that large numbers of eggs are laid in the lake and in inaccessible stream mouths.

Whether control or encouragement of the smelt is the proper policy, from the biological point of view, we are not yet in a position to say. From the standpoint of inland fishing, we are strongly of the opinion that the smelt has increased the fish supply and fishing resources. From the standpoint of the commercial fisheries, no evidence of a conclusive nature is available.

IX STATUS OF THE SMELT AND ITS RELATION TO OTHER FISHES AND FISHING

In our large inland lakes, which are very deep and closely associated with the Great Lakes, the smelt has proved itself capable of thriving. In several respects, it is an asset to such lakes. First, it provides an early spring incentive for the fishermen to open the recreation season in the north regions of the state. The extension of the season of this lucrative business is of great importance to the natives of this region. Second, in some of these lakes it will we believe serve as a fine food for lake trout, which furnish excellent sport in summer, in the form of

deep trawling. Ice fishermen on Lake Charlevoix last winter reported taking smelt frequently in lake trout stomachs. The perch and lake herring of these lakes may suffer to some degree from the presence of the smelt, but not to a degree ^{sufficient} relative to offset the increase in the smelt. Third, the smelt furnishes much winter sport (ice fishing). This likewise aids in the extension of the recreation season into a period having little other attractions in outdoor sports. This ice fishing could be encouraged and advertised, to advantage and without objection, since it does not conflict with the ideas either of those who would conserve the smelt or of those who would destroy it. Furthermore, it may be possible to create a business of catching smelt through the ice and marketing them in Detroit, Chicago and elsewhere, where they are already an established market fish. It is possible that a full development of the potential value of the smelt of these inland lakes might serve to compensate for any damage it may do to the Great Lakes fisheries.

It is this ignorance of the effect of the smelt on the commercial species of the Great Lakes that still makes it impossible for us to present a definite opinion on whether the encouragement and spread of the smelt would have beneficial or harmful results. We think the advantages of the presence of the smelt are strongly indicated by the evidence to date. Nevertheless we still hold, as we have ^{held} from the beginning of the smelt investigations, that the species may become an obnoxious predator on the most valuable commercial species of the Great Lakes. That is still, however, a fear largely unfounded in concrete fact.

It seems to us imperative that a fuller investigation ^{should} be made of the status of the smelt in the Great Lakes. Until this is done, it is ~~improbable~~ that any sound opinion on the effects of the smelt establishment can be given. We urge, and urge vigorously, that every effort be made to determine how extensively the smelt is established in the open Great Lakes; to what degree the range of the species is being extended, and above all, what the smelt feeds on in the Great Lakes, and what

feeds on the smelt. It is quite possible that the lake trout will benefit by feeding on the smelt. The smelt may (or may not) aid this fishery and simultaneously damage others to a greater or less degree. What the smelt is doing and will do in the Great Lakes we shall never know until we find out. There is surely enough of a smelt population in the Great Lakes now to yield us a great deal of information if the problem is studied.

The Bureau of Fisheries is of course interested in the status of the smelt in the Great Lakes, and Dr. Van Oosten assures us that a special effort will be made in Lake Michigan to obtain information. Efforts by both the Bureau and the Institute will be made to interest commercial fishermen in the problem, so that they will assist in furnishing information and specimens.

We suggest that the Department of Conservation could directly assist in this project in one or all of the following ways:

1. Giving general publicity to the need of information concerning the effect of the smelt on the Great Lakes fisheries.
2. Sending with licenses and other communications to commercial fishermen the request for a report on the occurrence of smelt, and for specimens preserved in formalin, one part to ten of water, with a slit into the belly.
3. Requesting such information and specimens from all conservation officers who are concerned with commercial fisheries.
4. Instructing all patrol boat commanders to carry jars and formalin for preserving any smelt obtainable; to collect information from fishermen; to leave a jar with preservative in the hands of fishermen who are taking smelt occasionally.

Whether the Bureau^{of} Fisheries or the Institute for Fisheries Research carries on the investigation of material obtained, or whether both units do part of the work, is a matter of secondary importance which could be decided upon in Ann Arbor.

Again we emphasize, that the main call in the smelt investigations now is the

determination of the effect of the smelt in the Great Lakes on the commercial fishes and fisheries.

Carl L. Hubbs.
Carl L. Hubbs
Director

MAP of SMELT WATERS
about LAKE CHARLEVOIX

To accompany Report No. 11

INSTITUTE FOR FISHERIES RESEARCH

Known smelt waters indicated in RED

Location of barriers indicated.

