INSTITUTE FOR FISHERIES RESEARCH
UNIVERSITY MUSEUMS
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THE PROBABLE CAUSES OF DEATH OF FISH FOUND DEAD IN NATURAL TROUT STREAMS (INCLUDING THOSE LODGED AGAINST THE HEAD SCREENS OF REARING STATIONS).

By J. Clark Salyer, of the Institute Staff

Shortly after the opening of the trout rearing stations in 1931, the Institute requested the caretakers at those places to save for examination, all fish carried down to their head screens from the stream above. These fish were desired for the predator and fish disease investigations carried on by the Institute. The results are so gratifyingly definite as to make it highly desirable that the practice be continued in the present season. Some dead trout specimens picked up on the various trout streams over the state by field investigators of the Institute, are included in the material herein reported upon.

Most of the fish received from the head screens of rearing stations were in a surprisingly good condition. The color of most was bright; the flesh was firm, and the peritoneum was normally pigmented. In the majority of cases the trout were fat and had full stomachs, showing that they died rather suddenly. The absence of crayfish marks on all but one or two specimens demonstrates the dispatch with which the fish were carried down to the head screens by the current. Crayfish marks are a sure sign of delay in the floating down of the fish to the head

~~head~~ screens. Crayfish remove from the stream in 24 hours most dead fish touching the bottom checked and lodged in backwaters, even trout up to 14" in length. These last facts were determined in the course of field work on fish predators last summer. The activity of crayfish in consuming dead trout limits to some degree the number of fish which will be carried down to the head screen. In spite of this fact, an adequate number of specimens for this preliminary study were secured from head screens.

The writer is convinced that the cause of death in the fish thus obtained is a valuable aid in estimating the relative severity of predator pressure on the trout streams in comparison with other forms of destruction. The careful recovery, preservation, and labelling of fish from screens will in the course of several seasons yield invaluable data as to the degree of predator activity on natural streams, information which stomach analysis will not always yield. The operator should carefully label each fish, noting the date, time of day it was found, and any unusual fact, as a run of hot weather. The need for this will be demonstrated later in this report. Suitable tags and preservative will be forwarded by the Institute to any of the hatcheries or other stations which do not have a sufficient supply already. The fish are to be preserved much as is the predator material.

SUMMARY TABLE OF PROBABLE CAUSES OF DEATH OF FISH IN MICHIGAN TROUT STREAMS

Based on dead fish caught on head screens of rearing stations and dead trout picked up in streams.

Not including several thousand small rainbow trout fingerlings found dead on the head screen of the Sturgeon River station in 1931, during a very hot period.

Predators	Fish killed	Brook trout	Brown trout	Rainbow trout	Perch	Ling	Common Sucker	Mud minnow	Long-nose dace	Short-nose dace	Muddler (*cognatus*)	Muddler (*bairdii*)	Silver Lamprey	Brook Lamprey	
Kingfisher		12	4	1			1	1						1	
Gt. Blue Heron		4	5	2							1	1			
Bittern		3		1			1								
Green Heron					1										
Mink		1													
Lamprey			1			2									
Disease		20							17	1					
(Sucker followed by fungus)		3									3	1			
Turtle		2				1							1		
Nutrition		2													
Hooking		19	1								1				
Dynamite		3	2												
Traumatic injuries		3													
Unknown (hot water in part)		30									1				
Totals	101	13	4	1	2	2	1	17	1	6	2	1	1		

Grand Total: 119 trout plus ~~34~~ 35 other fish equals 152 154

119
35
154
154

CAUSE OF TROUT DEATHS, EXPRESSED AS PERCENT OF SAMPLE KILLED BY EACH LETHAL AGENT.

Figures refer only to fish found dead in streams

All predators combined, ~~33~~ 32 %.

Bird predators, ~~27~~ 26 % (kingfisher, 14%; great blue heron, 9%; bittern, 3%).

Snake predators, ~~2~~ 2 % (water snake presumably; bites followed by fungus).

Turtle predators, 2% (snapping turtle in part at least).

Lamprey predators, 1% (silver lamprey only).

Mammal predators, 1% (mink).

Cause unknown (probably high temperatures in large part), 25%.--See also note in subtitle to preceding table.

Human agencies, 20% (hooking, ~~16~~ 17 %; dynamiting, 4%).--Note: dynamite proportion doubtless too high, owing to fact Conservation Officers sent in samples from streams where dynamiting was suspected.

Diseases, 17%. Including bacterial diseases (furunculosis, etc.), fungus diseases and parasite diseases (gill louse, etc.).

Malnutrition, 2% (due to disease?).

Traumatic injuries, 3% (head sheared off clean).

MEANS OF IDENTIFYING CAUSE OF DEATH

The predators leave a characteristic mark on the fish whereby they can be identified by the experienced worker. Snakes leave a series of punctures grouped in definite vertical lines at right angles to the long axis of the fish's body. These are made in manouvering the fish so as to swallow it head first. The point of seizure is generally apparent also, from rather deep creases and abrasions in that region. The vertical rows of punctures are overlain by a horizontal series of fine striae left by the teeth of the dentigerous bones when the swallowing process is actually initiated. It is apparent from some of the specimens that trout frequently escape the water snake in the early stages of the swallowing act, and are then subsequently overcome by the onset of fungus. I have not seen a case of recovery from snake wounds although this is rather frequent in injuries caused by birds and lampreys.

Turtles especially the larger ones, make large triangular gashes in the body of the fish. A turtle bite is generally fatal. Several small trout among the specimens reported on, evidently had their caudal fins amputated through these agents. This is also the case in a large lamprey (I. concolor) received from one station, which had the posterior half of its body severed by a clean-cut turtles bite.

Bird marks are the most characteristic of all. It is possible to identify the species of bird concerned. The Great Blue Heron can deliver a death-giving thrust with its pointed, closed bill; or slightly opening the bill, can pick up a fish as with a pair of forceps. The fact that the edges of the rami of the bill are serrated, makes the last-mentioned act more certain. It is untrue that herons always spear their fish. Most trout up to 7" in length in shallow water are taken by the forceps-like action of the bill, which with its halves somewhat opened is driven by the force of the blow well down into and over the sides of the fish. In deeper water, the fish if from 4"-8" in length is always speared. The Great Blue

always strikes at the point of the dorsal fin. Rarely in larger fish 17"-19", the thrust is given through the back of the head. If the blow is true, the back of the fish is broken. If not fully centered the result is equally fatal, the side of the fish being gouged out and often the viscera revealed. Those fish that escape the heron fall certain prey to fungus from their wounds. A heron rarely misses a medium or large-sized fish. It is the smaller fish which most often exhibit healed heron marks. The stroke of a heron's bill is delivered with such speed as to be fully comparable with the rapidity of the strike of a poisonous reptile or the tongue movements in certain amphibians. After striking the fish, the sharp edges of the bill leave a clean-cut pair of converging marks or lines on each side of the fish's body when it is picked up and further manipulated for swallowing. The size of these marks made them distinctive from the smaller ones left by a bittern or green heron.

The bittern, commonly called shikpoke or marsh-pump by hatchery men, more frequently spears its fish, often making several neat, rounded punctures deep into the body. The thrusts are made anywhere in the anterior dorsal region from the head to the dorsal fin. Characteristic beak marks are also made in handling fish preparatory to swallowing.

The kingfisher rarely, if ever, spears its fish. The prey is captured by a forceps-like action of the serrated bill, the force of the down-plunging bird wedging the fish securely in the slightly opened mandibles. The fish is almost invariabley seized in the nape region. Due to the kingfisher's habit of moving the fish backward or forward in the mandibles to balance it while flying or in its efforts to swallow a fish much larger than is possible, the region of the fish between the head and dorsal fin is severely champed and marked with an intricate pattern of fine lines left by the sharp edges of the mandibles. This pattern is a positive clue to the kingfisher when trout 6"-8" are picked up in the field thus marked. For the kingfisher frequently attempts to swallow larger fish than it is able. It is rare

for a kingfisher to swallow a fish longer than 4 inches, although some 5 inches long are managed. The larger fish, although frequently caught, are either dropped while flying or thru inability to swallow a fish of such size. It is not uncommon to see kingfishers fly about a stretch of stream for several minutes with a 5 to 8-inch fish, only to lose it finally. A kingfisher suddenly startled will usually drop a fish too large to be immediately swallowed. The same is true when the bird is fired on with a shot-gun, even if the bird is missed.

The peculiarities and marks of fish-eating birds described above have been adequately checked by field observations and the examinations of hundreds of fish from the stomachs of such birds in the course of the writer's study on fish predators.

Mink leave the mark of their characteristic dentition on the side of fish caught. This is a horseshoe shaped pattern of punctures.

Lamprey marks appear as round or oval spaces of bare skin on the trout which if examined closely show a slightly pitted surface. This applies to healed wounds. The raw or fresh lamprey mark is unmistakable. When healed it is interesting to note that the scar is devoid of scales and has lost its ability to secret the protective mucus. This last statement is true also of healed bird marks which appear as long sears or welts on the side of the fish's body. How much the loss of the secretory function of these areas is a factor in the ultimate survival of the fish is conjectural, although some mucous covers the demuded area from contiguous, healthy areas. It may be significant that many of the fungused trout in this material had bird and lamprey marks in various stages of recovery.

It will be seen that predators are responsible for a large proportion of the fish found dead in streams, after we exclude the heavy mortality due to streams drying up or becoming overly warm, in such years as 1930 and 1931. The number of fish definitely killed by fish-eating birds exceeds all other predator destruction and may be significant(see summary table).

It is regrettable that more cannot be learned of the part disease, aside from predators, plays in the death of head screen fish. In the case of a bacterial disease, the manner of preservation and the time which must elapse before the fish is obtained after it dies, militates against determining the specific organism at work. Still lesions and suppurating surfaces are apparent, as is fungus and ectoparasites, when examined with the aid of a microscope. On the evidence supplied by this report it will be seen that disease usually plays a minor part in causing the death of fishes.

Traumatic injuries are evident in a handful of specimens; at the manner of their happening we can only guess. An astonishing number of trout were badly hooked and seemingly died from their injuries. Despite previously described injuries many of the fish died from causes not detectable. They were in good color, fat, with full stomachs, and had no evident injuries.

A total of 135 fish was received by the Institute, of which 101 were trout and 34 were non-game fish.

Each specimen was measured, examined carefully inside and outside for injuries or disease, and examined with a microscope for ectoparasites. The causes of death in these fish are discussed under the following heads.

DEATHS DUE TO EACH AGENCY

1. Fish-eating birds.

This group of predators accounted for 32 trout ranging in size from 2 1/2" to 19". Six other fish were also killed by them. Listed as to species the kill is as follows:

Kingfisher – 17 trout, 1 brook lamprey, 1 common sucker, 1 mud minnow.

Gt. Blue Heron – 11 trout, 2 muddlers (Cottus cognatus, 1 Cottus bairdii).

Bittern – 4 trout, 1 common sucker.

Green Heron – no trout, 1 yellow perch.

All of these fish had bird wounds severe enough to have caused the death of each. A few bore bird marks from which they had recovered. Further, it should be remembered that all of these birds disdain dead fish. I have been unable to find the slightest trace of their utilization of fish offal in any instance.

2. Mink

One of the fish found dead had clearly been killed by a mink.

3. Lampreys

Lampreys were the initial cause of death in 8 trout and in 2 ling or burbots, the abrasions made by these parasites becoming secondarily fungused. A number of the fish concerned in this report show old lamprey scars from which the fish recovered only to subsequently fall a victim to another predator or disease. At the Sturgeon River station an eleven inch Rainbow caught by a fisherman in the main stream was turned over to the station man. This fish had had the whole top of the head eroded by lampreys but was healed at the time of capture, was fat and in perfect condition. There was no reason why it should not have been used for food. (It might be well for the Fish Division to issue a statement, to the fishing public in the news letter, or bulletin, to the effect that fishes bearing healed lamprey or bird scars are perfectly palatable if nothing else appears to be wrong with them).

4. Diseases.

The role played by disease in the death of these fish can best be understood by reading the cases of the individual fish listed at the listed at the end of this report. Twenty trout, 17 long-nose dace, and 1 black-nose dace belong in this group. Some 4 or 5 cases listed in this group doubtless originated from slight abrasions becoming subsequently heavily fungused which spread over the whole fish.

A heavy infestation of gill lice (Salmonicola edwardsii) was found in six instances ~~out~~ in the trout of this group. In four instances out of six, the hatchery attendant mentions a high water temperature for the day on which they were picked up. It is probable that numbers of gill lice interfere with the mechanics of respiration to such an

extent that on an abnormally hot day, the fish so infested succumb because of the added strain. At least we have here a good correlation between the two facts. The case of a 10" wild Brook Trout sent in from the Sturgeon River station is full of interest in this connection. This fish got into one of the rearing ponds where it lived for several days, finally dying on a day when the water temperature reached 81° F. There were 43 adult gill lice on the gills of this trout. Its nose was somewhat abraded and there was a recovery-mark of an old lamprey laceration on the caudal peduncle.

A number of the dead trout found in the streams had presumably been killed by the dread disease known as FARUNCULOSIS. This hatchery-spread disease is likely to become increasingly serious, in the opinion of the Institute.

The significant loss of trout in streams due to disease confirms the current policy of the Department in not dumping badly diseased trout into the stream, just to save them (or to save the hatchery's record). This loss due to disease also stresses the importance of further investigation of trout diseases, in hatcheries as well as in nature.

5. Snakes

Snake marks were definitely observable on 3 trout and on 4 muddlers (3 cognatus and 1 bairdii). The onset of fungus completed the job.

6. Turtles.

A turtle snapped the caudal fins off of 2 trout sent in, and may be responsible for the peculiar injuries listed under the heading of traumatic injuries. A large silver lamprey (I. concolor) sent in from the Bear Creek station had the posterior half of its body severed by a turtle bite. While examining the Pere Marquette River on July 14, 1931, Dr. Greeley of this Institute captured a 21 1/2 lb. snapping turtle which had just caught a 17" (estimated) brown trout. The trout was fresh and firm and the probability of its being caught by the turtle was verified by finding the bones and flesh of a 9" brown in this turtle's intestine when the stomach and intestines

were analyzed. Dr. Greeley states that the habit of the brown trout in taking refuge under stones ~~and~~in crevices when disturbed would make it a ~~ready~~ ready prey for the snapper which regularly investigates such places. Once seized by the snapper's powerful jaws, a trout has no chance to escape alive, even if it should struggle free from the grasp of the snapper.

7. Nutrition

Two of the trout were of the type known as "racers" by hatchery men. They were slender, had a compressed head large in proportion to body size, and had empty stomachs with no store of fat.

8. Hooked fish.

The 19 trout in this group had either the mouth parts or opercular apparatus badly torn, showing plainly the effects of having been hooked. No natural predator would leave similar lacerations. Many were hooked exterior to the mouth parts in the opercular region. One muddler (C. bairdii) had the lower part of mouth and jaw torn out, probably by a baited hook. It is significant that many of the hook-torn trout are just under legal size. From the mutilation of some, it is apparent that they were flipped off the hook by the lazy fisherman without resorting to the use of the hands, or that the hook was otherwise forcibly jerked out.

9. Dynamite

One trout was almost certainly and four were probably killed by dynamite (see Institute Reports 15 and 138).

10. Traumatic injuries.

This name is applied to one type of injury for want of a better term. The three trout included here had the snout portion of the head cut off smoothly and vertically as if it had been done with a knife. Turtles might be responsible but it is doubtful if they would have such a clean-cut wound.

11. Unknown causes

20 trout fall in this group. Examination failed to give any clue to their death. For the most part, they had good color, were unmarked and had food in their stomachs. The high water temperatures recorded at some of the stations may have been a causative factor.

It is well known that many thousands of trout were killed during the dry years of 1930 and 1931, especially in the Upper Peninsula. The thousands of small fingerling rainbow trout which were washed against the head screen of the Sturgeon River Rearing Station in Cheboygan Co. were presumably killed by high temperature.

No doubt many trout are killed in nature by unfavorable environmental conditions. Thus the death of trout and other fishes in the headwaters and the new Hardy Dam, on the Muskegon River in Mecosta County, was probably rightly attributed to the fouling of the water by decomposing vegetable matter. Probably some of the 20 trout of our sample which died of unknown cause, were killed by some bad chemical condition.

It must be emphasized that the figures just given, and summarized in the table (p. 3), do not represent the destruction ratios between the various agents which kill fish in our streams. They refer only to the cause of death of fishes found dead in streams. The actual ratio among predators can only be found by exhaustive stomach analyses. The material for such examinations should come from a wide range of stream localities over the state. This latter phase of predator investigation has been intensively followed by Institute workers in 1931-1932. The present report is merely a corrolary of the main line of research.

G. B. S.
4/9/35

I. CAUSE OF DEATH OF THE FISH FOUND DEAD ON HEAD SCREENS OF TROUT REARING STATIONS

All measurements are of total length

From White River Station

Brook trout

4" (Aug. 29, 1931): caudal peduncle severed by turtle. Color good. Wound fungused.

5 1/8" (Sept. 3, 1931): left side of head torn out by hook.

5 1/4" (Aug. 21, 1931): unmarked. Color good.

5 1/4" (Aug. 20, 1931): kingfisher lacerations.

5 1/2" (Aug. 20, 1931): hook torn mouth.

5 1/2" (June 29, 1931): kingfisher lacerations.

5 3/4" (June 24, 1931): kingfisher lacerations.

5 3/4" (Aug. 21, 1931): kingfisher lacerations.

5 3/4" (Aug. 21, 1931): maxillary torn out by hook.

6" (July 30, 1931): no marks. No parasites.

6" : cause undetermined. Color good.

6 1/4" (Aug. 21, 1931): badly hooked.

6 1/2" (Sept. 13, 1931): extremely thin and slender, of type called "racer". Color good. Stomach empty. No fat.

7 1/4" (July 8, 1931): no indications. Hot weather?

8" : cause undetermined. Color good.

From Pentwater Station

5 1/2" (Aug. 10, 1931): typical kingfisher marks.

6" (Aug. 2, 1931): kingfisher marks.

6" (Aug. 8, 1931): cause unknown, unmarked.

6 3/4" (July 30, 1931): hooked.

7" (July 29, 1931): cause unknown.

7" (Aug. 30, 1931): no marks. Condition good.

From Bear Creek Station

Brook trout

2 1/2" - bacterial rot on tail.

5 3/4" - kingfisher lacerations.

6 1/2" - kingfisher lacerations.

From Platte River Station

Brook trout

4" - side of head torn away by hook.

4 1/4" - unmarked.

4 1/2" - hook torn. Color good.

5 1/4" - kingfisher lacerations.

5 1/2" - hook torn. Color good.

5 1/2" - side and stomach torn out by Heron.

5 3/4" - unmarked.

5 3/4" - hook torn. Color good.

Sucker (presumably common sucker)

3" - kingfisher lacerations.

From Jordan River Station

Brook trout

5" - with preopercle torn out by hook. Shows characteristic opisthonic death spasm.

5 1/8" - blotches of fungus on sides. Gill lice present.

6" - severe infestation of gill lice. Water temperature of 79°F. Old bird mark behind dorsal fin healed.

7 1/2" - heavy infestation of gill lice. Station man makes notation of hot day.

From Oden Hatchery

Brook trout

3" (Oct. 6, 1931): kingfisher marked. (Guy Lincoln).

From Sturgeon River Station

Brook trout

5" (week of July 7, 1931): unmarked.

7" (Aug. 6, 1931): fat; stomach empty; peritoneum bloody; old lamprey mark back of dorsal (healed).

10" (week of July 7, 1931): wild trout got into pond and lived several days; died when temperature of water reached 81° F.; heavy infer-lation of gill lice, 43 adults; recovery mark of old lamprey lacera-tion on caudal peduncle.

Brown trout

8 7/8" (week of July 7, 1931): a fresh heron mark back of head. A previously healed one on right mid-dorsal region. Caudal peduncle slightly attached by crayfish.

9 3/4" (Aug. 3, 1931): right sub-orbital region and jaw torn out by large hook. Fungused.

14 1/4" (July 21, 1931): left side torn open by characteristic heron mark. Viscera exposed.

Common sucker

7 1/2" (week of July 7, 1931): with 2 bittern punctures.

Mud minnow

4" (week of July 7, 1931): with kingfisher lacerations.

Muddler (Cottus cognatus)

2 3/4" (week of July 7, 1932): with 2 bittern punctures.

2 3/4" (week of July 7, 1932): with 2 bittern punctures.

2 3/4" (week of July 7, 1932): with 2 bittern punctures.

3" (week of July 7, 1932): with heron mark.

3 3/4" (week of July 7, 1932): unmarked.

Muddler (Cottus bairdii)

4 1/4" (week of July 7, 1932): with heron mark in mid-body line.

From Hunt Creek Station

Brook Trout

4 1/8" - right subopercular region torn out by hook . A probable lamprey mark on left opercle.

4 1/2" - lower jaw torn out by hook. Throat eaten out by crayfish.

4 5/8" - champed by kingfisher.

4 7/8" - unmarked. Good condition; lower jaw displaced laterally from old hook wound.

5" - maxillary torn out by hook. Old injury healed on left posterior side of head.

5" - unmarked, color bright; fat; full stomach.

5 1/8 " - caudal peduncle amputated by turtle.

5 1/8" - snout sheared off vertically.

5 3/8" - bird mark (bittern) through isthmus up into posterior brain and gill cavity region. Probably speared as it was taking surface food.

5 3/8" - grayish lesions spotted over body.

5 1/2" - kingfisher marks, with stab through brain, probably inflicted by kingfisher after catching and taking to perch.

5 1/2" - marked by snake; fat, stomach full.

5 5/8" - hook torn.

5 7/8" - front of head sheared off vertically.

5 7/8" - right lower portion of opercle torn away and base of pectoral fin suppurating; old lamprey mark on left side behind pectoral.

5 7/8" - hooked and fungused.

5 7/8" - front of head sheared off vertically just before eyes.

6" - good condition; old and healed bird marks on left side.

6 1/4" - right side abraded and fungused.

6 1/2" - many tiny gill lice; somewhat bloated.

6 7/8" - lower jaw torn out by hook.

7 1/8" - unmarked, fat, stomach full.

8 1/2" - pierced through brain by heron.

Ling 7

7 7/8" - stomach full; a fresh lamprey mark on side; fungused; color bright.

11" - stomach full; 2 raw lamprey marks on head and a long scratch on each side; color bright.

Long-nose Dace

2" - 5" (17) - badly fungused.

Short-nose Dace

11" - stomach full; badly fungused.

From Silver Creek Station

Brook trout

1 3/4" - a "racer".

2" - unmarked. Color good.

2 1/2" - dorsal and tail fins rotted off.

2 3/4" - many minute gill lice.

2 3/4" - top of head abraded and fungused; color good.

3" - unmarked; color good; fat, stomach full.

3 1/8" - ulcer on nape (presumably farunculosis).

4" - color good; left gill region heavily fungused; right opercle very short, not covering gill at all. Fat, stomach full; recovered from kingfisher lacerations.

5 3/8" (Aug. 11, 1931): side ripped open by heron.

5 1/2" (July 6, 1931): parallel abrasions on sides of peduncle from water snake; fungused.

5 5/8" (Aug. 25, 1931): several crayfish marks; many abrasions on sides. Fungused. 7:00 A.M.

5 5/8" (July 31, 1931): color good; stomach full; no predator marks. 5:00 A.M.

From Eckerman Station

Brook trout

7 1/2" (Aug. 1931): hot weather; heavy infestation of large gill lice.

7 1/2" (Aug. 1931): hot weather; heavy infestation of large gill lice.

II. CAUSE OF DEATH OF FISH PICKED UP DEAD ON TROUT STREAMS OF STATE BY INSTITUTE WORKERS, SUMMER 1930, 1931 and 1932 (to JULY 1)

Little South Branch of Pere Marquette River, Newaygo County:

Rainbow trout, 6" (July 22, 1930): heron sear through right side (Greeley).

Pease Creek, Lake County;

Brown trout, 19" (Aug. 14, 1931): speared by Great Blue Heron through head and dorsal fin. Heron shot in act of retrieving trout from 2 ft. of water (Salyer).

Weldon Creek, Lake County;

Brown trout, 6" (July 12, 1931): kingfisher lacerations (Salyer).

Brown trout 10 1/2" (July 12, 1931): Killed by Heron (Salyer).

Big Sauble River, Lake County;

Brook trout, 6" (June 28, 1931): bittern puncture through dorsal fin (Salyer).

Yellow Perch, 3" (June 28, 1931): green heron stab on caudal peduncle (Salyer).

Little Manistee River near Peacock, Lake County;

Brown trout, 5 1/2"
Brown trout, 7"
Rainbow trout 6 1/2" } (June 22, 1931): these trout, freshly killed by kingfishers, were picked up along a one-mile stretch of river known to be the normal territory of a pair of breeding kingfishers and one intruding male kingfisher; the kingfisher marks on these fish are very typical, and are illustrative of the damage done to larger trout which could never be detected from analysis of stomach contents; such finds are frequent along the Little Manistee and other trout streams not too heavily inhabited by crayfish.

Brown trout, 6 1/2" (June 17, 1931): picked up below Nixars Bridge on L. Manistee River; shows characteristic heron puncture at base of dorsal fin; heron flushed downstream from point a few rods. (Salyer)

Bear Creek at Bear Creek Rearing Station, Manistee County:

Brook Lamprey, 7" (Aug. 7, 1931): Kingfisher lacerations (Salyer).

Pigeon River in State Forest, Otsego County:

Brook trout, 6" (July 1, 1932): chin torn open in hook removal (Hubbs).

Brook trout, 7" (June 7, 1932): large ulcer of furunculosis on side (Hubbs).

East Branch of Black River at Black River Ranch, Montmorency County:

Brook trout, 3 3/4" (July 3, 1931): Snake mark (Salyer).

Brook trout, 4 1/4" (July 2, 1931): unmarked, good condition (Salyer).

Brook trout, 6" (June 28, 1931): bittern puncture through dorsal fin (Salyer).

Brown trout, 6 3/4" (July 5, 1931): bird mark (Kingfisher) through brain and jaw torn by hook (Salyer).

Muddler (Cottus bairdii), 3" (July 5, 1931): snaked (Salyer).

Hunt Creek, Montmorency County:

Brook trout, 6" (June 25, 1931): mink tooth marks on side (Hubbs).

III. CAUSE OF DEATH OF TROUT FOUND IN STREAMS AND SUBMITTED BY CONSERVATION OFFICERS FOR REPORT (INVESTIGATIONS BY KRULL AND BY HUBBS).

Silver Cr., Allegan Co.; 3 brook trout and 1 brown trout; probably dynamiting, possibly lack of oxygen (see Institute Report 15).

Feeder to Muskegon River, Osceola Co.; 6 brook trout: cause unknown, but probably high temperature (see Institute Report 31).

West Branch of Tittabawasse R., Gladwin Co.; 2 brook trout: disease, probably furunculosis (see Institute Report 40).

Galien R.; Berrien Co., 1 brown trout: dynamite (see Institute Report 138).

Robinson Creek, Roscommon Co.: 1 brook trout: cause indeterminable (see letter of October 14, 1930, to Officer ~~Slutton~~ Dutton).

West Branch, Missaukee Co.: 3 brook trout: cause indeterminable (see letter of August 31, 1931, to Officer White).

INSTITUTE FOR FISHERIES RESEARCH

monthly meeting held in Lansing, December 11, 1931, voted to discontinue the issuance of special commissions.

If you have had such a commission in the past, we take this opportunity to thank you to the degree of your activities, for services rendered this department.

If this is your first request, kindly be advised that we have not been satisfied with results obtained by the majority of special officers in the past.

In either event, we desire to hold your friendly feeling, and I am positive any of our regular conservation officers will greatly appreciate your cooperation in the protection of the Wild Life in this State by giving, for investigation, any complaints you may offer.

Yours very truly,

H. R. Sayre
Chief, Field Administration

By.....
L. H. Rector

LHR:et

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UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

July 20, 1932

Mr. Fred A. Westerman
Fish Division
Department of Conservation
Lansing, Michigan

Dear Mr. Westerman:

We are chagrined at a number of mistakes in our Report 156, which was prepared in a rush while both Mr. Salyer and I were going into the field, and thus escaped being proof-read. Kindly make the following corrections in your copy.

Page 3 – Change "(Sucker followed by fungus)" to read Snake (followed by fungus).
Page 3 – Delete "1" opposite "Turtle" and below "Ling".
Page 3 – In "Grand Total" change "101" to to 102, and "152" to 153.
Page 4 – Under "Human agencies" change "20" to 21, and change "16" to 17.
Page 6, line 6 – Change "sizes" to sized.
Page 6, line 6 from bottom – Change "if" to it.
Page 8, line 5 – Change "is" to are.
Page 9, first line under Lampreys – Change 2 trout to 1 trout.
Page 21, second line – Change "Slutton" to Dutton.

The mimeographed sheets (pp. 2 and 3), with corrections checked, are enclosed. The first 3 corrections suggested for the second or percentage table are not needed, as the original figures are correct.

On the field trip from which I have just returned I obtained a considerable amount of additional data on this problem, but believe it best to hold the new data until a more complete report can be prepared. I mentioned to most of the hatchery and rearing station men the desirability of getting more fish which have died in the stream, but since you agree that more information needs to be gathered on this topic, it will be well to reinforce my statements with an official letter. I would suggest that the Overseers be requested to communicate with their rearing station attendants, since I found that this had not generally been done in regard saving predators.

I believe that all the hatcheries and state rearing stations in the Lower Peninsula now have a supply of jars, formalin and labels.

Carl L. Hubbs.
Carl L. Hubbs
Director.

SUMMARY TABLE OF PROBABLE CAUSES OF DEATH OF FISH IN MICHIGAN TROUT STREAMS

Based on dead fish caught on head screens of rearing stations and dead trout picked up in streams. Not including several thousand small rainbow trout fingerlings found dead on the head screen of the Sturgeon River station in 1931, during a very hot period.

Predators	Fish killed	Brook trout	Brown trout	Rainbow trout	Perch	Ling	Common sucker	Mud minnow	Long-nose dace	Short-nose dace	Muddler (cognatus)	Muddler (bairdii)	Silver Lamprey	Brook Lamprey
Kingfisher	12	4	1			1	1							1
Gt. Blue Heron	4	5	2								1	1		
Bittern	3		1			1								
Green Heron				1										
Mink	1													
Lamprey		1				2								
Disease	20								17	1				
Snake (~~Sucker~~ followed by fungus)	3										3	2		
Turtle	2					1							1	
Nutrition	2													
Hooking	19	1									1			
Dynamite	3	2												
Traumatic injuries	3													
Unknown (hot water in part)	30										1			
Totals	~~161~~	13	4	1	2	2	1	17	1	6	2	1	1	

Grand Total 119 trout plus ~~34~~ other fish equals ~~152~~.

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CAUSE OF TROUT DEATHS, EXPRESSED AS PERCENT OF SAMPLE KILLED BY EACH LETHAL AGENT.

Figures refer only to fish found dead in streams

All predators combined, 33%.

Bird predators, 27% (kingfisher, 14%; great blue heron, 9%; bittern, 3%).

Snake predators, 3% (water snake presumably; bites followed by fungus).

Turtle predators, 2% (snapping turtle in part at least).

Lamprey predators, 1% (silver lamprey only).

Mammal predators, 1% (mink).

Cause unknown (probably high temperatures in large part), 25% - See also note in subtitle to preceding table.

Human agencies, 20% (hooking, 16%; dynamiting, 4%) - Note: dynamite proportion doubtless too high, owing to fact Conservation Officers sent in samples from streams where dynamiting was suspected.

Diseases, 17%. Including bacterial diseases (furunculosis, etc.), fungus diseases and parasite diseases (gill louse, etc.).

Malnutrition, 2% (due to disease?).

Traumatic injuries, 3% (head sheared off clean).

July 18, 1932

Dr. Carl L. Hubbs, Director
Institute for Fisheries Research
University Museum
Ann Arbor, Michigan

Dear Dr. Hubbs:-

Acknowledging your letter of July 7th submitting Report No. 156 containing the reason for the probable causes of death of fish found dead in trout streams, we have arranged to have the report mimeographed as you suggested and will have the additional copies that you desire.

We note, however, what appear to be some discrepancies in the percentage table as indicated on the copy enclosed. However, we desire to have your approval of these corrections before making any changes in the table as submitted.

We are also arranging to have feeding station caretakers and hatchery overseers save additional material so that these studies can be continued. We shall send copies of report No. 156 to Ben East, Jack Van Coevering and Carl Saunders.

Very truly yours,

DEPARTMENT OF CONSERVATION

F. A. Westermann
FISH DIVISION

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INSTITUTE FOR FISHERIES RESEARCH
UNIVERSITY MUSEUMS
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

July 7, 1932

Mr. Fred A. Westerman
Fish Division
Department of Conservation
Lansing, Michigan

Dear Mr. Westerman:

Herewith we submit what we regard as a rather interesting report, treating the probable causes of death of fish found dead in trout streams. We draw from this at present no recommendations as to policy toward predators, etc., since the main mass of information on that point will come from the stomach analyses, and since the problems of hooking injury, disease in nature, etc., need further inquiry.

This report is a corkollary of the main line of work. It is issued now because this study has been completed; also in the hope of acquiring more data to lead toward a further and more complete report.

Since we need more material, and since the hatchery men cooperated finely in getting the material for this report, we would request that this report be mimeographed, so that each hatchery overseer could have a copy. At the Gaylord meeting the need of this material was emphasized, but a circular letter from the office would no doubt be helpful.

If the report is mimeographed, the Institute would appreciate having 15 or 20 extra copies.

I have no doubt that the outdoor editors would appreciate copies of this report. Probably Ben East or Jack Van Coevering at least would like to use more than the summary of this report which the News Bulletin might care to carry.

Sincerely yours,

INSTITUTE FOR FISHERIES RESEARCH

C. L. Hubbs

Carl L. Hubbs,
Director.
per sec'y