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Title

The control of jackfish, Esox lucius, in Heming Lake, Manitoba, in relation to the parasitization of whitefish by the tapeworm Triaenophorus crassus

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INTRODUCTION

A fisheries problem of considerable economic importance in central Canada concerns the infestation of whitefish, Coregonus clupeaformis, by an intermediate stage of the tapeworm Triaenophorus crassus. On account of this parasite, a portion of the annual commercial production of about 12 million pounds of whitefish from the prairie provinces is refused entry into its principal market, the United States. The tapeworm will not live in the human body, but is aesthetically objectionable to a customer purchasing whitefish.

The life history of this tapeworm may be stated briefly. Adult worms live in the intestines of jackfish, Esox lucius, and in the spring they die after having produced eggs which hatch in the water into small ciliated coracidia; a young tapeworm may be swallowed by a water-flea, Cyclops bicuspidatus, and if the water-flea is eaten by a whitefish about 10 days later, the tapeworm penetrates the fish's stomach wall and lodges in the flesh of its back. Here it lies within a sac, and at this stage is of economic importance. If the whitefish is taken as food by a jackfish, the worm is released from its sac, attaches itself to the inside of the jackfish's upper intestine, and grows to maturity. The jackfish is the only known host of adult Triaenophorus crassus, but several coregonines and related fishes may

harbor the intermediate stage.

It maybe recognized from the foregoing account that destruction of any of the hosts of the various stages of the tapeworm would impede completion of the parasite's life cycle. This has been discussed by Miller[1]. In this report is given an account of the experimental reduction of a population of jackfish in a small lake: this control programme will be continued for several seasons, by which time its effect on the quality of whitefish in the lake should be evident.

HEMING LAKE

In searching for a suitable experimental lake, it was stipulated that (1) the lake should contain a population of whitefish which are heavily parasitized by cysts of Triaenophorus crassus, (2) the lake should be small enough to offer reasonable hopes of effecting a successful destruction of the greater part of the jackfish population, (3) the lake should be in the headwaters of a river's drainage basin, so that tributaries would be few and there would be little chance of additional jackfish or whitefish continually entering the lake, (4) the lake should be unexploited by other fishermen, so that the experimental operations would represent total fishing effort, (5) the lake should be of reasonably easy access by road or rail, and (6) there should be a limited number of marshy bays where jackfish might be expected to congregate.

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[1] Miller, R. B. 1944. Suggestions for experiments in the control of the pike-whitefish tapeworm, Triaenophorus crassus. Fisheries Branch, Dept. Lands and Mines, Provo of Alberta; pp. 1-15.

The desirability of using Heming Lake was suggested by field officers of the Game and Fisheries Branch of the Manitoba Department of Mines and Natural Resources. In order to check on the suitability of this lake for the control programme, it was visited by the author and Dr. W. M. Sprules during the period March 1 to 12, 1945. The Manitoba government provided considerable material assistance including men and a dog team. It was found that Heming Lake adequately satisfied the six requirements above, and in addition there was a log cabin made available to the survey party through the courtesy of the registered trapper.

Heming Lake is situated in the province of Manitoba, township 68, ranges 24 and 25 west of the principal meridian. This is approximately 54 degrees, 53 min. N. Lat., and 101 deg. 7 min. west long. The Sherridon-Flin Flon line of the Canadian National Railways passes along the west side of the southern part of the lake 18 miles south of Sherridon. Heming Lake is 3 miles in length from north to south, from $\frac{1}{4}$ to $\frac{1}{2}$ mile in width, and is 588 acres in area. It is in the headwaters of the Grass River which flows into the Nelson at Split Lake.

There are eight main bays with muskeg shores and muck bottom, depths of water up to about 6 feet, and having a fringe of emergent and considerable submerged vegetation. The remainder of the lake shore is rock and sand, and the lake bottom is mostly inorganic silt covered with decayed organic matter; there is very little aquatic vegetation. No depths over 16 feet were found in Heming Lake. The water is presumably acid, since the lake lies in the Precambrian Shield,

is brownish in colour, and the bottom is visible at depths up to 6 feet. The ice broke up on May 27, 1945, and the lake froze over again on October 31.

There are two main tributary streams. One, Heming Creek, flows into the south end of Heming Lake; it comes from a small lake about one mile to the south, and this lake is blocked at its outlet by a beaver dam. Heming Creek is used in the spring by spawning runs of jackfish, pickerel, suckers and trout perch which enter it from Heming Lake, but it is not believed that any additional fish find their way into Heming Lake via this creek. Heming Creek flows in a meandering course through muskeg, and is about 5 feet in width and 12 feet in depth where it nears Heming Lake. This lower portion, when it floods the muskeg, is used by spawning jackfish. The upper half mile of the creek flows rapidly over rocks and sand, is about 3 feet in width and 1 foot in depth, and is used by spawning pickerel.

The second tributary stream flows into the northwest corner of Heming Lake. It is only about $\frac{1}{4}$ mile in length, and drains a small shallow lake containing suckers and a very few jackfish. The outlet of this lake is also dammed by beavers, and their work offers a 5 foot barrier to upgoing fish and effectively filters out any downgoing fish trying to leave the small lake. Buckers, pickerel, and perhaps jackfish from Heming Lake spawn in this creek, but on the whole it is too rocky and rapid for jackfish.

There are a few other small creeks entering Heming Lake, but they either arise in muskeg, or are too small and

have too many obstructions for the passage of fish.

The outlet river at the northeast corner drains Heming Lake into Home Lake, about 2 miles distant, and is 35 feet in width where it leaves Heming Lake. There are 4 rapids between Heming Lake and Home Lake, with quieter, Wider, expanses of river between. During the spring it is quite possible for fish to come up this river to Heming Lake, and there is also a summer population of jackfish in the river. A screen barrier was erected at the outlet, to prevent entrance of fish into Heming Lake.

FIELD WORK

A summary of field work, showing dates, personnel, and the subjects of investigation, is given below. Approximately 11 weeks were spent at Heming Lake, in March, May - June, and August - September.

Summary of field work at Heming Lake, Manitoba during the experimental jackfish control operation, 1945

Date		
March 1-12	Dr. K. H. Doan	Gill netting;
March 1-12	Dr. W. M. Sprules	Testing whitefish infest-
March 1-12	C. Morrish	ation; whitefish stomachs;
March 6-10	D. Austin (Manitoba) Department)	growth; jackfish egg counts; map of lake.
May 17-June 27	Dr. K. H. Doan	Gill netting, hoop net-
May 17-June 11	Dr. W. M. Sprules	ting; whitefish, jack-
May 31-June 20	R. Jackson	fish, pickerel measure- ments, growth, food; jackfish spawning
Aug. 25-Sept. 17	Dr. K. H. Doan	Gill netting, hoop net-
Aug. 25-Sept. 7	Dr. W. M. Sprules	ting; testing whitefish
Aug. 25-Sept. 17	R. Jackson	infestation; whitefish,
Aug. 25-Sept. 17	J. Keleher	jackfish, stomachs;

WHITEFISH INFESTATION

A total of 178 whitefish was tested March 2-10, 1945. These fish were taken in gill nets of $4\frac{1}{2}$- and $5\frac{1}{2}$-inch stretched mesh set through the ice in 10 feet of water in the narrows one mile north of the south end of the lake. The whitefish were mostly from 13 to 17 inches in total length, and between 1.0

and 2.5 pounds in weight (see Tables 2 and 3.) Eighty-five per cent of the fish contained 1 or more cysts .each, and the greatest number in one individual was 40. The average infestation was 511.8'cysts per 100 fish or 291.1 cysts per 100 pounds of whitefish. The average number of cysts increased with the age of the fish from 4 to 6 years, and was maintained at a high level to age 10 (Table 6).

A total of 102 whitefish was tested September 6-10, 1945i these were also taken by gill nets and were of the same size range as the sample caught in March (Tables 4 and 5). There was an average infestation of 540.2 cysts per 100 fish, or 287.3 cysts per, 100 pounds of whitefish. Eighty-one per cent contained 1 or more cysts each, and 99 cysts was the greatest number found in an individual. The average number of cysts increased with the age of whitefish from 4 to 8 years (3 to 7 when compared to March) and then decreased. (Table 6).

FISH CAUGHT DURING 1945 OPERATIONS

Fishing operations at Heming Lake in 1945 took a total of 3051 fish. This catch was composed of 591 jackfish, 843 suckers, 774 whitefish, 808 pickerel, 13 burbot, 11 perch and 11 tullibee. All fish were killed except 176 whitefish and 334 pickerel which were returned to the water alive. The weight of the fish that were killed was approximately 5017 pounds, (Table 7). Nine-tenths of the jackfish were taken during the last week in May and the first 3 weeks in June. All fish were

caught in hoop nets and gill nets with the exception of 67 jackfish taken by angling. The total weight of jackfish destroyed was 1323.2 pounds. Most of the whitefish were taken in March and September.

RATE OF CATCH

Since the primary objective of the investigation was to effect a reduction in the population of jackfish, the availability of these fish to capture by gill nets and hoop nets was measured. Only 1.3 pounds of jackfis?'per gill net (standard 4¼-inch stretched mesh, 12 meshes deep, 70 yards length) per night was taken in March, but this rose to 13.7 during the last week in May, and dropped to 0.3 pounds per net per night later in June. August and September fishing yielded from 2.1 to 4.3 pounds per net per night (Table 8).

Hoop nets[2] at the mouth of Heming Creek, where a run of spawning jackfish occurred, caught 49.3 pounds per net per night at ihe end of the third week in June. Only a few fish (1.7 to 0.0 pounds per net per night) were available in this location in August and September.

Hoop nets elsewhere in Heming Lake, mostly at the heads of shallow bays, took 2.0, 6.2 and 5.4 pounds of jackfish per net per night during the first 3 weeks in June, respectively, and from 0.3 to 2.4 pounds in August and

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[2] Each net was provided with 4 oak hoops; the first two were 5 feet in diameter, and the last 2 were 4 feet. There were 2 tunnels and 2 20-foot wings seamed in 9 thread rope. Wings were of 4-inch mish of 9 to 12 thread seaming twine. The net was made of from 12 to 15 thread seaming twine, and around the hoops of about 36 thread twine. From the first hoop to the first tunnel it was 4-inch mesh, to the second tunnel it was 3¼-inch mesh, and the pot was between 2½- and 2½-inch mesh. The pot was closed with a draw-rope, but greater

convenience in emptying the pot was obtained by using a dip net through a laced slit in the side of the pot. Each hoop net was tarred.. No leads were used.

September. There is some correlation between high catches at the creek and low catches of jackfish elsewhere in the lake.

Angling for jackfish in the vicinity of the northwest inlet stream also showed a progressive decline through June, with catches of 3.8, 3.5 and 1.0 pounds per rod per hour on June 5, 8 and 21, respectively.

Fishing operations in 1945 yielded 8.53 pounds of fish per surface acre of Heming Lake. Of the total, 2.25 pounds were jackfish, and this, along with ihe rate of catch, will be compared with results obtained in 1946 so that some estimate of the effectiveness of the control programme will be obtained.

FECUNDITY OF JACKFISH

Dr. Sprules made some actual counts of eggs in the ovaries of 6 jackfish taken at Heming Lake in March and the egg production of females of various ages and weights may be given in round numbers as follows:

Number of annuli	Total length, inches	Weight, pounds	Number of eggs
3	16½	1.0	4,000
4	18¾	1.5	7,500
5	20½	2.0	15,000
6	23¼	3.0	23,500
7	27½	5.0	33,000.
8	32¼	9.0	42,500

It may be calculated from the given data that female jackfish produced from 4,000 to 7,800 eggs per pound weight of fish, and the greatest yields, on a basis of unity body weight, were from 5- and 6-year-old fish weighing 2 to 3 pounds.

DATE OF JACKFISH SPAWNING

According to the data (Table 9), spawning was well under way when the first jackfishwere taken during the last week in May. Although the lake was still ice-bound, the jackfish had entered Heming Creek at the south end of Heming Lake, and were spawning along the edges of grassy tussocks and muskeg through which the creek meandered. Ice had disappeared from the creek on May 19, and each day subsequently a greater area of open water formed in the lake off the mouth of the creek. After May 25 the number of spent female jackfish increased in proportion to those still unspawned, so that practically no ripe females were taken after June 1.

Male jackfish, on the other hand, were taken in almost equal proportions of ripe and spent fish until June 5, after which date no more ripe males were caught. Thus, male fish were ripe for nearly a week later than female jackfish.

LENGTHS AT MATURITY AND SEX RATIOS OF JACKFISH

Based on length measurements and observations of gonads of 318 jackfish taken at Heming Lake between May 23 and June 16, 1945 (Table 10), most male and female fish became mature and spawned for the first time at a total length of 14 inches. Only

a few immature fish were taken at lengths up to 16 inches. Females were from 14 to 33 inches in length, males from 14 to 32 inches, and both sexes were most numerous at lengths of 18 to 21 inches. There was 1.00 male to 1.81 female jackfish.

Between August 29 and September 13, 1.00 male was taken to 1.39 female jackfish (Table 11). Lengths of mature females were from 15 to 38 inches, and of male from 15 to 26 inches. It may be noted that a few large male jackfish were taken in the spring, but that all the large fish caught during autumn operations were females.

FOOD OF JACKFISH

Two of the 6 stomachs of jackfish examined between March 6 and 10 were empty; the remaining 4 contained trout perch, sucker, and burbot (Table 12).

One of the 65 stomachs of jackfish taken between May 23 and June 9 at the mouth of Heming Creek was empty; the other 64 stomachs showed a food intake of 99.4 per cent, by volume, of 6 species of fishes. Of this amount, 93.1 per cent was composed of trout perch (Table 13), Amphipods made up 0.5 per cent and debris 0.1 per cent of the remainder of the food.

The stomachs of 15 jackfish were examined at scattered localities elsewhere in Heming Lake, between May 23 and June 9. Two were empty. The 13 fish with stomach contents had eaten 91.7 per cent by vClume of fishes; these were mostly trout perch, burbot, sucker, and jackfish, with small amounts of spot-tail minnow, Johnny darter, perch, pickerel and sculpin

(Table 14). These jackfish had also consumed a toad 5.4 per cent, crayfish 1.9, mayfly nymphs and caddis larvae 0.4, leech 0.1, and debris 0.7 per cent. A much wider selection of food was made by jackfish from scattered areas over Heming Lake than by those jackfish feeding in the mouth of Heming Creek. The latter were apparently concentrating upon the spawning run of trout perch.

Fourteen out of 26 jackfish taken at scattered localities about Heming Lake between August 29 and September 13 contained food in their stomachs. Fishes composed 86.1 per cent of this food, and these were whitefish 53.4 per cent, sucker 25.6, spot-tail minnow 4.2, perch 0.2, brook stickleback 0.2, and unidentified fish remains 2.5 per cent. The remainder of the organisms eaten were crayfish 13.4 per cent, mayfly nymphs 0.3, and mollusca 0.2 per cent (Table 14). No trout perch were found in the stomachs at this time of year.

PICKEREL

Pickerel were the most abundant of the predatory fishes in Heming Lake, and 808 individuals were handled during operations designed to take jackfish or whitefish. On the whole, these pickerel were of small size, and none over 19 inches in length were caught (Table 15). Pickerel at the same lengths were, on the average, three and one-half ounces heavier in August-September than in May-June. In a total sample of 107 fish, there was 1.0 male to 2.6 females. As with jackfish, only a very few pickerel, 5 fish, were taken in March, and all were females. Nearly all pickerel examined

under 13 inches were immature, and no males over 16 inches in length were found.

Examination of the stomachs of 7 pickerel taken between May 28 and June 16 showed that the fish had eaten trout perch almost exclusively, with only minute amounts of mayfly nymphs and amphipods. Of 25 stomachs taken from fish caught between August 28 and September 10, 14 contained food; this was made up of tullibee 6.0 per cent, whitefish 31.9, perch 13.0, jackfish 31.7, nine spined stickleback 2.3, fish remains 11.6, frog 2.1, may fly nymphs 0.7, and dragon fly nymphs 0.6 per cent. by volume. Thus pickerel, like jackfish, ate mostly trout perch in the spring and a greater variety of other fishes in the autumn. They were not, however, quite as omnivorous as jackfish.

SUCKER

A total of 843 suckers were destroyed during the control operations. These fish weighed 1833 pounds, and were between 14 and 19 inches in length (Table 16). There was 1.0 male to 2.0 female suckers in a sample of 51 fish. Suckers were running on May 22, but were at the peak of their spawning activity on June 3, and the rocks of the outlet stream and the northwest inlet stream were covered with their eggs. Only a few pickerel remained in the spawning rapids at this date. Sucker fry were observed in dense schools in Heming Lake off the mouth of the northwest inlet stream on June 21, at which time no adult suckers remained in the stream.

SCREEN AT OUTLET OF HEMING LAKE

To preclude the possibility of the entry of additional fishes into Heming Lake, a screen barrier was erected a cross the outlet river in September. The river at this point has a width of about 25 feet, and flows over a bottom of granite rock and boulders. The water was about 2 feet in depth in the centre of the river, and a few inches towards the sides. The water level in September was approximately 1½ feet lower than during the spring runnoff in May.

The barrier was made 65 feet in length, extending up on land at each end to be sure that the river continued to be screened in the spring when higher water might cause flooding over the banks. Two jack-pine timbers were installed across the river, and were supported at the September water level by attaching them to a number of posts arranged as inverted V's. Another long timber crossed the apices of these triangles. Flooring was laid between the two stringers at each end and in the centre, and piled with rocks. The sloping upstream side of the framework was faced with 2 widths of 36-inch galvanized wire of I-inch mesh. The lower width of wire was laid on the bottom of the river so that it extended about I foot upstream, and rocks were laid to hold this wire flap snugly against the bottom. The two widths of wire were joined by stapling against the stringer. This screen extended a bout 1½ feet above me expected spring water level.

There was little indication of a possibility of clogging owing to flpating vegetation and debris, but the field party's

first duty in the spring would be to clear t he screen. The I-inch mesh should effectively block runs of adult fish seeking entry into Heming Lake, including jackfish and whitefish. The position of the screen, above the rapids atihe outlet, should also eliminate one of the spawning places for suckers from Heming Lake.

SUMMARY

The tapeworm Triaenophorus crassus passes an intermediate stage of its life cycle in coregonines and is of particular economic importance to Canada's trade in whitefish.

It was considered important to demonstrate that reduction in a population of jackfish, which harbour the adult Triaenophorus, would effect a diminution in the number of cysts in whitefish.

Heming Lake, 80 miles north of The Pas, Manitoba, was selected for the control operations. The whitefish in the lake contained over 500 cysts per 100 fish.

Fishing was done with gill nets and hoop nets, and 2541 fish were removed from the lake over 11 weeks; this catch was composed of 23.4 per cent jackfish, 33.3 suckers, 23.6 whitefish, 18.7 pickerel, 0.5 burbot, 0.4 perch and 0.4 per cent tullibee.

Fishing operations yielded 8.53 pounds of fish per surface acre of Heming Lake, of which 2.25 pounds were jackfish. Gill nets took jackfish most successfully during the last week in May, at an average rate of 13.7 pounds per70-yard net per night.

Hoop nets took up to 49.3 pounds of jackfish per. net per night during a spawning run at Heming Creek in May; the . catch declined through June, and these nets took but few jackfish in August - September.

Female jackfish produced from 4.000 to 7,8000 eggs per pound weight of fish.

Spawning of jackfish occurred in Heming Creek in May while there was still ice on the lake. Males were no longer ripe after June 5, which was about a week later than for females. Maturity was attained at a total length of 14 inches. There were about **1.7** mature females to each mature male.

During May and June the jackfish1s food was largely trout perch. Small jackfish up to 1 pound in weight fed mostly upon small fishes such as perch, trout perch and spot-tail minnow. Medium-sized jackfish ate trout perch, crayfish and some burbot, and larger jakcfish over 4 pounds were ahle to consume suckers, whitefish, and other jackfish.

Some data were gathered on the size distribution, sex ratio, and stomach contents of pickerel; also, on the size distribution and spawning of suckers.

A wire screen was erected at t he outlet of Heming Lake, primarily to prevent more jackfish from entering the lake during high water in the spring.

RECOMMENDATIONS

Because jackfish are more available during their spawning season than at other times in the year, it is recommended that in 1946 the field party be established at Heming Lake at

least two weeks previous to the expected break-up of the *ice* on the lake. *i.* e. by May **1.**

Hoop nets should be concentrated *in* Heming Creek, and *gill* nets *in* selected places about the shore of Heming Lake; both types of gear should be fished as early as *ice* conditions permit, with special effort devoted to hoop nets. There would seem to be little reason to continue intensive *fishing* after June 30.

During the spring of 1945 not enough jackfish had been removed from Heming Lake to materially affect the season's production of young tapeworms. This is reflected in an infestation of 511.8 *in* March and 540.2 cysts per 100 whitefish in September. The tapeworm encysts in whitefish during July, so that if a sample of fish were tested in May, 1946, they would be expected to show the same infestation as in September, 1945. Accordingly, to find out if the 1945 reduction in jackfish had any effect upon the infestation *in* whitefish, it is recommended that a test on 100 whitefish be made in September, 1946. This could be done in a few days.

No more whitefish should be killed than absolutely necessary. A reduction in the whitefish population would be expected to diminish the drain upon their supply of food; the surviving fish, with moroe food at their disposal, would grow faster. With faster growth, the whitefish would take less *time* to attain lengths at which plankton f ormed a small portion of their food. Hence, with faster growth, they would ingest copepods, bearing the infective stage of Triaenophorus, over a shorter period of time. Less

infestation would probably result. Because the object of the project is to reduce infestation by killing jackfish, it would add some complications to the results to introduce this new factor of increased growth rate of whitefish. The killing of suckers, which presumably compete with whitefish for a portion of their food, is also open 'to question.

Table 1. List of common and scientific names of fishes referred to in this report.

Whitefish	Coregonus clupeaformis
Jackfish	Esox lucius
Pickerel	Stizostedion vitreum
Sucker	Catostomus commersonnii
Trout perch	Percopsis omiscomaycus
Burbot	Lota Iota maculosa
Perch	Perca flavescens
Tullibee	Leucichthys sp.
Spot-tail minnow	Notropis hudsonius
Johnny darter	Boleosoma nigrum
Sculpin	Cottus cognatus
Brook stickleback	Eucalia inconstans
Nine-spined stickleback	Pungitius pungitius

Table 2;

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lal{e HEMING Range Tp

Province Manitoba Date March 2 to 10, 1945.

Number of cysts

Lengths	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Totals
12-12¾			1		1												2
13-13¾	14	8	2	2	1		1	1									29
14-14¾	9	5	3	6	8	2	4	3	1	1			1	2	2		
15-15¾	3	6	1	6	9	6	9	4	3	1	1	1	2	1		1	
16-16¾	1	3	3	1	1	1	2		1	2		2	1				
17-17¾		1															
18-18¾																	
19-19¾																	
20-20¾																	
21-21¾																	
22-22¾																	
23-23¾																	
24-24¾																	
Totals	27	23	26	15	20	9	16	8	5	4	1	3	4	3	2	1	
%								-									
No.cysts	0	23	52	45	80	45	96	56	40	36	10	33	48	39	28	15	

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Table 2.

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lake HEMING **Range** **Tp**

Province Manitoba Date March 2 to 10, 1945

Lengths	Number of c sts											
	16	17	19	22	23	25	26	30	31	40		Totals
12-12¾												2
13-13¾												29
14-14¾	1					1		1		1		51
15-15¾	1	1	1		1				1			75
16-16¾				1			J					20
17-17¾												
18-18¾												
19-19¾												
20-20¾												
21-21¾												
22-22¾												
23-23¾												
24-24¾												
Totals	2	1	1	1	1	1	1	'	1	1		178
%												
No.cysts	32	17	19	22	23	25	26	30	31	40		011

Table 4.

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lalce HEMING Range Tp"

Province Manitoba Date Sept. 6 to 10, 1945

Lengths	Number of cysts																
	0	1	2	3	4	5	6	7	8	9	10	11	13	14	16	17	Totals
11-11¾	1																
12-12¾			1														
13-13¾	4	7	5	1	3		1		1								
14-14¾	9	4	7	5	3	1	1		1			1		1		1	
15-15¾	2	7	5	1	2	2	1	2	1						1		
16-16¾	3	3		1			1		1	1			1		1		
17-17¾		2															
18-18¾																	
19-19¾																	
20-20¾																	
21-21¾																	
[illegible]																	
23-23¾																	
24-24¾																	
Totals	19	23	18	8	8	5	4	2	4	1		1	1	1	2	1	
%																	
No. cysts C	23	36	24	32	15	24	14	32	9		11	13	14. 32		17		

CONTINUED

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lake HEMING Range Tp

Province Manitoba Date Sept. 6 to 10, 1945

Lengths	25	26	28	2q	48	qq		Totals
11-11¾								1
12-12¾								1
13-13¾								22
14-14¾		1	1			1		37
15-15¾	1			1	1			27
16-16¾								12
17-17¾								2
18-18¾								
19-19¾								
20-20¾								
21-21¾								
22-22¾								
23-23¾								
24-24¾								
Totals	1	1	1	1	1	1		102
%								
No ocysts	25	26	28	20	48	qq'		551

Table 3.

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lake HEMING Range ... Tp ...

Province Manitoba Date March 2 to 10, 1945

Weights	Number of Fish	Number infested	%infested	Pounds	Number of cysts	Number of cysts/100 fish	Number of cysts/100 lbs
0-8 to 15	0						
1-0 to 17	.42	26	61.q	54.9	80	190.5	145.7
1-8 to 1-15	84	75	8q.3	144.'7	556	661.9	384.2
2-0 to 2-7	51	49	**96.1**	110.6	274	537.2	247.7
2-8 to 2-15	1	1		2.8	1		
3-0 to 3-7							
3-8 to 3-15							
4-0 to 4 '7							
4-8 to 4-15							
5-0 to 5-7							
5-8 to 5-15							
6-0 to 6-7							
6-8 to 6-15							
7-0 to 7 7							
17-8 to 7-15							
8-0 to 8-7							
8-8 to 8-15							
9-0 to 9-7							
9-8 to 9-15							
TOTALS	178	151	84 8	313 0	911	511.8	291.1

Table 5.

Central Biological Station, Winnipeg, Manitoba

Fisheries Research Board of Canada

Surveys of whitefish infestation

Lake HEMING Range Tp.

Province Manitoba Date Sept. 6 to 10, 1945

Weights	Number of Fish	Number infested	% infested	Pounds	Number of cysts	Number of cysts/100 fish	Number of cysts/100 Lbs.
0-8 to 15	0						
1-0 to 1-7	14	12	85.7	18.8	34	242.9	180.9
1-8 to 1-15	56	44	78.6	97.2	309	551.8	317.9
2-0 to 2-7	22	19	86.4	48.0	171	777.3	356.3
2-8 to 2-15	9	7		24.7	36		
3-0 to 3-7	1	1		3.1	1		
3-8 to 3-15							
4-0 to 4-2							
4-8 to 4-15							
5-0 to 5-7							
5-8 to 5-15							
6-0 to 6-2							
6-8 to 6-15							
17-0 to 7-7							
7-8 to 7-15							
8-0 to 8-7							
8-8 to 8-15							
9-0 to 9-7							
9-8 to 9-15							
TOTALS	102	83	81.4	191.8	551	540.2	287.3

Table 6. Infestation of whitefish from Heming Lake, Manitoba, by cysts of Triaenophorus crassus. The data are arranged according to age of fish, and for samples taken in March and September, 1945.

Annuli	Number fish	Number infested	%infested	Total weight pounds	Total number cysts	No. Cysts /100 lbs.	No. Cysts /100 fish
March 2-10, 1945							
4	22	9	40.9	28.2	15	53.2	68.1
5	19	14	73.7	26.2	44	167.9	231.6
6	13	12	92.3	20.3	81	399.0	623.1
7	20	18	90.0	33.6	92	273.8	460.0
8	41	39	95.1	74.7	295	394.9	719.5
9	40	36	90.0	80.0	232	290.0	580.0
10	22	22	100.0	47.1	151	320.6	686.4
11	2	2	190.0	6.1	5	82.0	250.0
TOTAL	179	152	84.9	316.2	915	289.4	511.1
September 6-10, 1945							
4	9	7	77.8	12.3	20	162.6	222.2
5	34	27	79.4	55.0	89	161.8	261.8
6	11	7	63.6	20.3	40	197.0	363.6
7	12	12	100.0	22.1	117	529.4	975.0
8	11	10	90.9	22.2	150	675.7	1363.6
9	14	11	78.6	33.1	99	299.1	707.1
10	8	6	75.0	18.8	33	175.5	412.5
11	2	2	100.0	5.2	3	57.7	150.0
TOTAL	101	82	81.2	189.0	551	291.5	545.5

Table 7, Fish caught and killed dUl'ing the jackfish control operations at Heming Lake, Manitoba, during 1945,

Date	Number of fish							
	Jack-fish	Suckers	White-fish	Pickerel	Burbot	Perch	Tull-ibee	Total
March 2		1	91	2				94
March 3		2	4	2				8
March 4			1					1
March 5			25					25
March 6	1		14					15
March 7	1						1	2
lv[arch 8	3	1	45	2				51
March 10	1	7	13	1				22
March 11	1	1	11					13
May 20	1			1				2
May 22	11	10	2	17				40
lvlay 23	5	22	5					32
May 25	10	13		3				26
May 26	6	13						19
May' 127	7	4						11
May 28	10	1	11	12				34
May 29	2	1	'7					10
May 30	15	14	3	9				41
May 31	49	19		15	4			87
June 1	39	11	5	3	2			60
June 2	14	6	10	19	1			50
June 3	22	11	17	10	2			62
June 4	23	13			2	1		39
June 5	47	27	7					81
June 6	67	32	13	40	1	3		156
June 7	54	18				1		73
June 8	61	10		71		1		143
June 9	. 19	31						50
June 10	10	5		43				58
June 11	15	13	8	3		1		40
June 14	24	79	3	7		4		117
June 15	9	24	1	7				41
June 16	6	23	11	52				92·

Continued

Table 7. (Continued)•

Date	Jack-fish	Suckers	White-fish	Pickerel	Burbot	Perch	Tu11ibee	Total
Aug. 28	9	21		6				36
Aug. 29	5	57	13	10				85
Aug. 30	3	26	19	4				52
Sept. 1	6	55	47	7	1			116
Sept. 2		9	2	3				14
Sept. 3	4	20	16	2				42
Sept. 4	3							3
Sept. 5	8	40	9	1				58
Sept. 6	4	43	18	20			3	88
Sept. 7	6	36	37	19			3	101
Sept. 8	3	10	7	1				21
Sept. 9				4				4
Sept. 10	3	42	54	27			4	130
Sept. 11	2	30	36	34				102
Sept. 13	1	25	20	11				57
Sept. 14	1	17	13	6				37
Total, fish killed	591	843	598	474	13	11	11	2541
Number of fish released alive	0	0	176	334	0	0	0	510
Total fish handled	591	843	774	808	13	11	11	3051
Weight, pounds	1323.2	1833	1087	697	59	2·	16	5017

Table 8.

Availability of jackfish to capture by gill nets and hoop nets at Heming Lake, Manitoba

Period 1945	Gill nets: No.nets lifted	Gill nets: No.of nets night	Gill nets: Jackfish caught (lbs)	Gill nets: Jackfish per net per night (lbs)	Hoop nets, mouth Heming Creek: No.nets lifted	Hoop nets, mouth Heming Creek: No.of nets night	Hoop nets, mouth Heming Creek: Jackfish caught (lbs)	Hoop nets, mouth Heming Creek: Jackfish per net per night (lbs)
Mar.2-11	20	23	29.7	1.3	0			
May 22-31	11	13	178.3	13.7	2	2	98.5	49.3
June 1-6	12	16	17.0	1.1	12.	12	318.9	26.6
June 7-13	5	6	30.8	5.1	12	12	226.8	18.9
June14-20	3	5	13.3	2.7	8	12	57.8	4.8
June 21-23	2	2	0.6	0.3				
Aug.28-31	11	11	27.1	2.5	6	6	10.3	1.7
Sept.1-6	19	27	115.0	4.3	8	12	0.0	0.0
Sept.7-14	26	35	73.2	2.1	4	10	0.0	0.0
Hoop nets elsewhere in Heming Lake								
Mar. 2-11	0							
May 22-31	0							
June 1-6	4	4	8.1	2.0				
June 7-13	2	4	24.6	6.2				
June 14-20	3	6	32.5	5.4				
June 21-23								
Aug. 28-31	2	3	4.1	1.4				
Sept. 1-6	3	6	14.2	2.4				
Sept. 7-14	2	6	1.9	0.3				

Date	Angling: No.rods	No.hours	Rod hrs.	Jackfish caught per rod per hour (pounds)
June 5	3	2	6	3.8
June 8	3	6	18	3.5
June 21	3	7	21	1.0

Table **9.**

Date, sex and ripeness of jackfish taken at Heming Lake, Manitoba between May 20 and June 15, 1945, showing progress of spawning. Ripe fish were spawning or about to do so; spent fish had completed spawning. Most of the fish were taken atthe mouth of Heming Creek, where a spawning migration occurs,

Date	Number of females' (ripe)	(spent)	Number of males (ripe)	(spent)
May 20	1			
May 22	6	3	1	
May 23	1	1		3
May 25	3	3	3'	1
May 26		5	1	
May 27	1	5	1	
May 28		6		2
May 29		1		1
May 30	2	5	3	5
May 31	1	5	11	14
June 1	1	27	3	7
June 5		17	6	7
June 8		37		23
June 9		1		2
June 14	1	11		6
June 15		5		1

Table 10. Data on lengths and maturity of 318 jackfish taken at Heming Lake, Manitoba, between May 23 and June 16, 1945.

Total length in inches	No. of females Ripe	Spent	Total	No. of Males Ripe	Spent	Total	Immature	Total number
6								0
7							4	4
8							3	3
9							1	1
10								0
11								0
12							2	2
13							2	2
14		1	1		1	1		2
15		2	2		1	1	1	4
16	1	3	4	1		1	1	6
17		16	16		5	5		21
18	2	23	25	4	17	21		46
19	1	43	44	6	13	19		63
20	1	25	26	8	17	25		51
21	5	20	25	4	14	18		43
22	3	17	20	3	3	6		26
23	1	9	10	1	1	2		12
24	1	10	11		2	2	1	14
25		2	2		1	1		3
26		1	1	1	2	3		4
27		2	2					2
28		2	2	1		1		3
29		1	1					1
30								0
31		2	2					2
32					2	2		2
33		1	1					1
TOTALS			195			108	15	318

Males : Females
1.00 : 1.81

Table **11.** Data on lengths and maturity of 57 jackfish taken at Heming Lake, Manitoba, between August 29 and September 13, 1945.

Total length, inches	Number of fish			Total
	Mature		Immature	
	Females	Males		
11			2	2
15	1	1		2
16	1	2		3
17	3	3		6
18	0	6		6
19	3	6		9
20	1	1		2
21	1	1		2
22	2	2		4
23	1	0		1
24				
25				
26	0	1		1
27	1	0		1
28	2	0		2
29	3	0		3
30	1	0		1
31	1	0		1
32	5	0		5
33	2	0		2
34	1	0		1
35				0
36	1	0		1
37	1	0		1
38	1	0		1
39				
TOTALS	32	23	2	57

Males	:	Females
1,00	:	1.39

Table 12. Data on lengths, maturity, and stomach contents of 6 jackfish taken at Heming Lake, Manitoba betweeen March 6 and 10, 1945.

Total length, inches	Number of fish			Stomach contents
	Mature		Immature	
	Female	Male		
16¾	1			4 trout perch 1¾"
18¾	1			empty
20¾	1			1 trout perch 1½"
				1 burbot 10"
23t	I			2 trout perch 1¾"
				1 sucker 5½"
29½	1			1 sucker 15½"
32½	1			empty
TOTALS	6	0	0	

Table 13.

Analysis of jackfish stomachs from fish taken between May 23 and June 9, 1945, at Heming Lake, Manitoba. Stomachs were examined from 65 fish, and 64 had contents; 59 of these fish were from 21 to 24 inches total length, and were taken at the mouth of Heming Creek. Stomachs were examined from 15 fish, and 13 had contents; half of these fish (8) were from 17 to 24 inches total length and were taken at scattered localities about Heming Lake proper.

Percentage volume of food item in jackfish stomachs

Food item	Mouth Heming Creek		Heming Lake	
Fishes:				
Sucker	0.4		19.2	
Spot-tail minnow	0.2		0.8	
Jackfish	3.3		17.6	
Trout perch	93.1		25.7	
Burbot	2.0		24.1	
Johnny darter			0.1	
Perch	0.3		0.5	
Pickerel			2.1	
Sculpin			0.5	
Fish remains	0.1	99.4	1.1	91.7
Other vertebrates:				
Toad				5.4
Crustaceans:				
Crayfish				
Amphipods		0.5		1.9
Insects:				
Mayfly nymphs	T			
Caddis larvae	T			0.4
Worms:				
Leech				0.1
Debris:		0.1		0.7
TOTAL		100.0		100.2

Table 14. The results of stomach analyses of 26 jackfish, 14 with contents, taken at Heming Lake, Manitoba, between August 29 and September 13, 1945. These fish were from 11 to 37 inches in total length, and were taken at scattered localities about the lake. Percentage volumes are given.

	Total length groups, inches								
	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	Total
No. starn. examined	2	1	14	3	2	3	0	1	26
No. stom. contents	1	1	8	1	2	1	0	0	14
Fishes:	100.0	50.0	64.8	0.0	100.0	52.6			86.1
Whitefish					67.6				53.4
Sucker					32.4				25.6
Spot-tail minnow	60.0		31.3			52.6			4.2
Perch		50.0							0.2
Brook Stickleback			2.2						0.2
Fish remains	40.0		31.3						2.5
Crustacea:									
Crayfish			33.5	100.0		42.1			13.4
Insects:									
Mayfly nymphs			5 0.0	1.8					0.3
Mollusca:									
Gastropod(p1anorbis)						5.3			0.2
TOTAL	100.0	100.0	100.1	100.0		100.0			100.0

Table 15. Length distribution of pickerel, according to sex and maturity, from Heming Lake, Manitoba in 1945.

Total length, inches	Females, mature			Males, mature			I=ature		Total
	Mar. 2-10	May28 - June16	Aug.28 - Sept10	Mar. 2-10	May28 - June16	Aug.28 - Sept10	May28 - June16	Aug.28 - Sept.10	
7							1	1	
8							-		
9							1		
10									
11							2		
12		1							
13		1			4	1			
14		6	2		14	2			
15		12	7		3	2			
16	4	15	7		1	1			
17	1	5	4						
18		3	4						
19		2							
TOTALS	5	45	24	0	22	6	4	1	107
				Females: 2.6		Males: 1			