THE COREGONID AND PIKE FISHERY IN MANITOBA: FACTORS INFLUENCING ABUNDANCE OF TRIAENOPHORUS CRASSUS FOREL IN LAKE WHITEFISH (COREGONUS CLUPEAFORMIS MITCHILL) IN COMMERCIALLY FISHED LAKES.

by

MUSA SAMBA SOWE

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in
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ABSTRACT

Temporal patterns in abundance of Triaenophorus crassus Forel in relation to patterns in abundance of species composition of pike (Esox lucius), lake whitefish (Coregonus clupeaformis Mitchill), and lake herring or cisco (Leucicthys tullibee Richardson) in 35 commercially fished Manitoba lakes were studied for the period 1973-1983. Patterns in fishing effort, annual production, differences in body size of lake whitefish, lake sizes and their geographical locations and differences in value between lake whitefish and walleye (Stizostedion vitreum vitreum) were also examined. It was concluded that changes in species composition, annual production levels, fishing effort, and differences in body size of lake whitefish affected abundance of T. crassus in lake whitefish. High flow rates from Churchill, Nelson, and Hayes watersheds were correlated with high annual catch levels. Overfishing or underfishing may have occurred in some of the lakes which may have affected recruitment and density and abundance of T. crassus due to an increase or decrease in smaller lake whitefish. Most of the lakes were located in the north and north-central regions of Manitoba. The southern lakes had lower abundances of T. crassus. Patterns in abundance of T. crassus could not be explained by lake size or location of lakes according to watershed. Although walleye was more valuable than lake whitefish, there was no evidence that they were fished preferentially, nor was there a direct correlation between harvest of lake whitefish and walleye and abundances of T. crassus. The general

trend was towards a change in lake classification to a lower category of lake whitefish i.e. higher abundances of *T. crassus*. However, inconsistent sampling of lakes for *T. crassus*, particularly lakes classified as high grade (i.e. with low abundances of *T. crassus*) such as Patridge Crop, Natawahunan, Guthrie, and Sabomin, contributed to the difficulty in predicting long term trends.

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I. INTRODUCTION

(a) Taxonomy

The genus Triaenophorus, Order Pseudophyllidea, contains at least three species common in Canadian lakes, namely Triaenophorus crassus Forel, Triaenophorus stizostediun Miller, and Triaenophorus nodulosus Pallas (Miller, 1945b and 1945c). The taxonomy of Triaenophorus crassus Forel is outlined in Appendix A.

(b) Life Cycle

Although there are three species of Triaenophorus common in Canadian fish, Triaenophorus crassus is the only one considered to be of economic importance (Ekbaum, 1936; Hjortland, 1927; Miller, 1943a, 1943b and 1943c).

Miller (1943a) showed that adults of the parasite occur in the intestine of pike (Esox lucius), the definitive host. Miller (1943a) further showed that the first larval stage, the procercoid, is found in the copepod (Cyclops bicuspidatus). The procercoid develops in a copepod and if then eaten by any one of the whitefish family, it develops into a plerocercoid (Miller, 1943a, 1943b, 1945b and 1952).

Miller (1943a, 1943b and 1945b) found that lake herring or cisco (Leucicthys tullibee Richardson) is the natural host for the plerocercoid which occurs as the familiar cyst stage in the flesh of coregonids. Appendix B shows the life cycle of T. crassus.

These cysts are pathogenically harmless to mammals but they are obnoxious and objectionable from a consumer's point of view (Bishop, 1968; Dechtair, 1972; Miller, 1952; Nicholson, 1932).

(c) Historical Background

T. crassus, was first described by Forel (1880) in Switzerland (Ekbaum, 1936). Cooper (1918) found cysts of the worm in the muscles of Leucicthys artedii LeSueur and adults in the intestine of pike from North America. The same species was reported later from Minnesota in cisco and pike (Hjortland, 1927). In a survey of Manitoba fishes, Newton (1932) reported cysts of T. crassus in cisco, Leucicthys zenthicus Jordan and Everman, Leucicthys nipigon Koelz, Leucicthys nigripinis Gill and lake whitefish (Coregonus clupeaformis Mitchill).

Wardle (1932) reported T. crassus and T. nodulosus but referred to them at the time as T. tricuspidatus, [Morpha megadentatus and Morpha microdentatus]. Nicholson (1932) investigated the pathogenicity of these worms from Lake Winnipeg and found them harmless to humans.

Ekbaum (1936 and 1937) studied Canadian material available up to that time and compared it with European descriptions. She concluded that the Canadian material was T. crassus and T. nodulosus. Miller (1945c) found Triaenophorus stizostedion Miller in fish from Lesser Slave Lake.

The economic importance of T. crassus led to the search for methods of control of the parasite. An experimental fishery was established at Heming Lake, Manitoba to determine if levels of T. crassus in coregonids could be controlled (Lawler, 1951a and c, 1952, 1953, 1954, 1960a, b, and c; Lawler and McBurney, 1952; Watson, 1963; Watson and Lawler 1965). Similar investigations were carried out at Lesser Slave Lake (Libin, 1953; Miller, 1952, 1953; Miller and Watkins, 1946) and at Square Lake (Miller and Johnson, 1952).

Rosen (1983) assessed factors affecting growth, differentiation and infectivity of procercoid by experimentally infecting Cyclops bicuspidatus thomasi and showed that the intensity of infection was a factor which influenced procercoid size, differentiation and infectivity to the second intermediate host.

The interrelationship of pike, coregonid fishes and Cyclops bicuspidatus is considered to be an important factor in determining the presence or absence of Triaenophorus infection in any particular lake (Miller, 1952). Miller and Johnson (1952) concluded that biological relationship between the three hosts are involved in the presence or absence of the parasites. Lawler (1951a) reported that lake whitefish infection with T. crassus was related to the abundance of pike.

(d) Objectives

The objectives of this study were:

1.) to describe spatial and temporal patterns in abundance and species composition of commercially exploited stocks of pike, lake whitefish and ciscoes in northern Manitoba lakes relative to different infection levels of T. crassus;

2.) to examine whether or not fishing effort by commercial fishermen affects infection trends;

3.) to examine whether or not differences in body size distributions of northern lake whitefish stocks are related to infection trends;

4.) to determine if the abundance of T. crassus in lake whitefish could be correlated with lake size, flow rates of rivers affecting the lakes and anthropogenic effects;

5.) to account for the economic importance of lake whitefish relative to yields of other economically important species, such as walleye.

The data were sufficient to enable me to study:

1.) various lakes in different watersheds for the same period of time;

2.) the *Triaenophorus* problem in a commercial setting.

This was made possible because the system of collection and compilation of data utilises uniform methods and is managed by a single agency for all of western Canada.

II. MATERIALS AND METHODS

(a) Location of Study Lakes

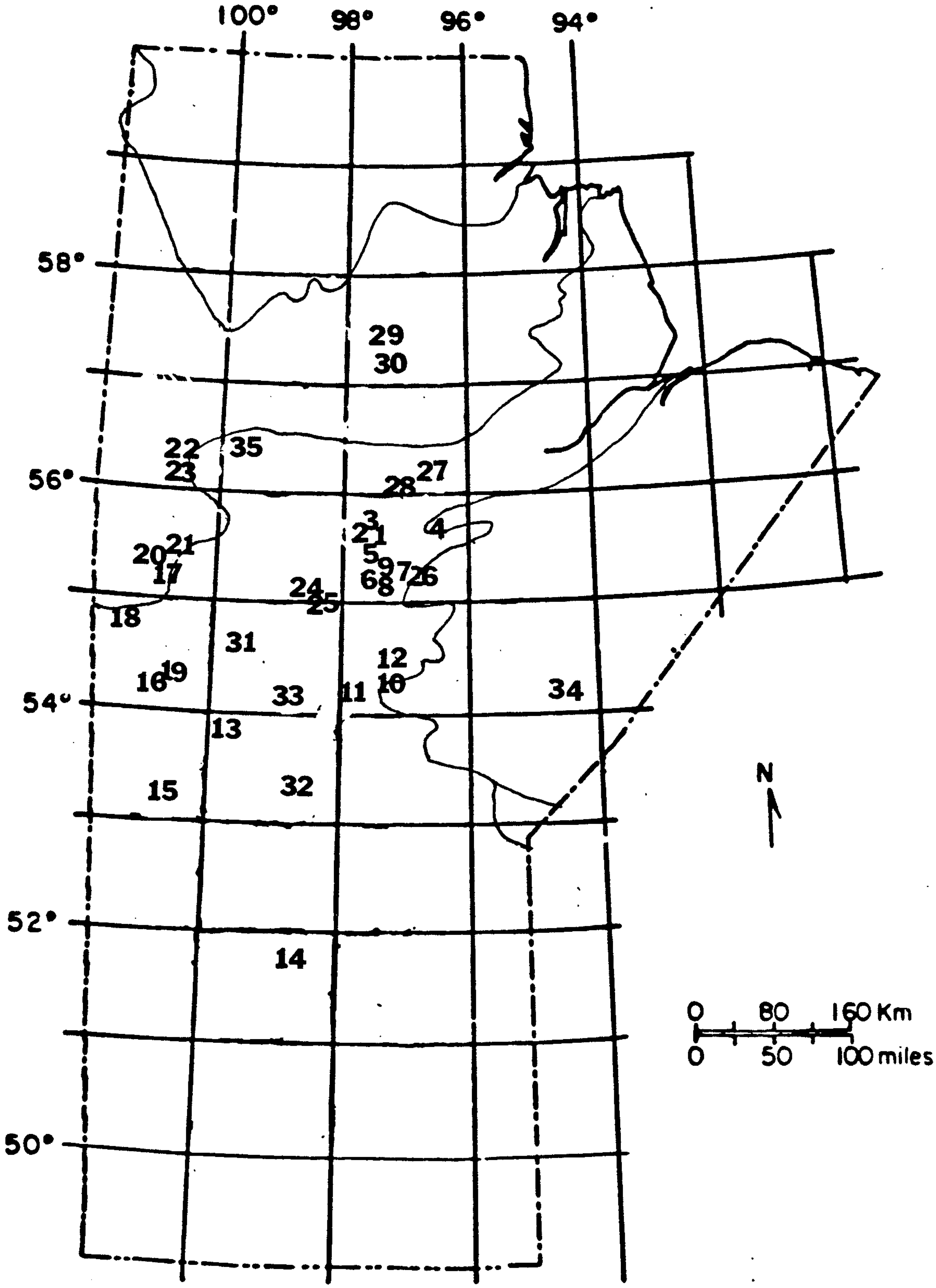
Thirty-five lakes were studied from three watersheds as follows:

Nelson River watershed:	Armstrong
	Bruneau
	Butterfly
	Cedar
	Cormorant
	Halfway
	Herblet
	Guthrie
	Kiski
	Landing
	Natawahunan
	Pakwa
	Patridge Crop
	Playgreen
	Setting
	Sipiwesk
	St. Martin
	Wekusko
	Walker
	William
	Wintering
	Witchai
	Wuskwatim
	Yawningstone
Churchill River watershed:	Barrington
	Granville
	Kipahigan
	Kisseynew
	Northern Indian
	Opachuanau
	Sisipuk
	Southern Indian
Hayes River watershed:	Dafoe
	Gods
	Sabomin

Lakes were chosen on the availability and consistency of pertinent data.

Figure 1. Distribution of lakes in study area.

Number in Figure 1	Lake Name	Location Latitude (0")	Location Longitude (0")
1	Armstrong	96° 55'	55° 43'
2	Bruneau	97° 33'	55° 01'
3	Landing	97° 26'	55° 171'
4	Dafoe	96° 15'	55° 44'
5	Patridge Crop	97° 29'	55° 38'
6	Sabomin	97° 15'	55° 18'
7	Natawahunan	97° 09'	55° 42'
8	Sipiwesk	97° 35'	55° 05'
9	Wintering	97° 43'	55° 23'
10	Butterfly	97° 16'	54° 26'
11	Playgreen	97° 58'	54° 16'
12	Walker	96° 57'	54° 42'
13	William	99° 21'	53° 54'
14	St. Martin	98° 20'	51° 40'
15	Cedar	100° 10'	53° 30'
16	Cormorant	100° 49'	54° 14'
17	Guthrie	100° 38'	55° 17'
18	Kisseynew	101° 35'	54° 58'
19	Yawningstone	100° 51'	54° 21'
20	Kipahigan	101° 55'	55° 20'
21	Sisipuk	101° 50'	55° 45'
22	Barrington	100° 15'	56° 55'
23	Granville	100° 30'	56° 18'
24	Halfway	98° 24'	55° 03'
25	Setting	98° 38'	55° 00'
26	Wuskwatim	98° 32'	55° 32'
27	Wekusko	96° 20'	56° 30'
28	Witchai	96° 50'	56° 00'
29	South Indian	98° 30'	57° 10'
30	North Indian	97° 20'	57° 20'
31	Herblet	99° 54'	54° 56'
32	Pakwa	98° 53'	54° 51'
33	Kiski	98° 55'	54° 16'
34	Gods	94° 15'	54° 40'
35	Opachuanau	99° 37'	56° 44'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(b) Data Sources

Commercial catch records for the period 1973-1983 were obtained from the Economics Branch and lake class (a randomly chosen fish sample is filleted and sliced to expose cysts, the number of which determine lake class) data from the Inspection and Surveys Branch, both of the Department of Fisheries and Oceans (DFO) in Winnipeg. Lake class data was not available by season.

Commercial catch records and lake parameters for the same lakes for the period 1973-1982 were obtained from the Province of Manitoba, Department of Natural Resources (Peters and Wall, 1983), and for the period 1977-1982 (Thompson, personal communication).

Spring monthly mean flow rates of the three major rivers (Nelson, Churchill and Hayes) were obtained from records published by the Waters Resource Branch, Environment Canada.

Summer "initial" prices ($/lb.) records for 1973-1983 were obtained from the Freshwater Fish Marketing Corporation (FFMC) (Popko, Personal Communication).

(c) Inspection of Commercial Catches

Lake whitefish and cisco from Canadian lakes are inspected by DFO for cysts of *T. crassus* prior to exporting to the USA, Europe and interprovincial markets.

Various procedures have been devised for the purpose of inspection of catches since 1946. Kennedy (1946) discussed the method used at the time. According to this method sample sizes were fixed and depended only on the size of the lake. Such a sampling plan was later considered unsatisfactory (Kennedy, 1946; Oakland, 1950). Consequently the idea of "sufficient" samples was proposed to eventually replace the fixed sample technique.

Kennedy (1946) defined a sufficient sample as one in which statistical analysis showed that there is not more than one chance in 100 that the rate of infection in the lake exceeds 50 cysts/100 pounds of fish. The maximum infection tolerance limit was set at 50 cysts/100 pounds for export lake whitefish. For this purpose, the average number of cysts/fish and the standard error were derived (Kennedy, 1946). The fiducial limits of the average for 99% were calculated for these data. These fiducial limits were multiplied by 100 and divided by the average weight of the fish in the sample to give an unbiased estimate of the fiducial limits of the average number of cysts/100 pounds of fish (Kennedy, 1946).

A "sufficient" sample, by definition, is one where the upper limit is less than 50 cysts/100 pounds of fish (Kennedy, 1946). With this method Kennedy (1946) noted that more than 50 cysts/100 pounds in the sample was "sufficient" to show that a lake was not suitable for providing fish for export. He also found that samples with 40 or more cysts/100 pounds of fish may not be sufficient unless it consisted of more than 200 fish. Kennedy (1946) noted that as the rate of infection approached 50 cysts/100 pounds of fish, the size of the required sample approached infinity.

Oakland (1949 and 1950) described the use of sequential sampling of fish to determine infection (Wald, 1945). This methodology was developed to determine infection levels in various sizes of lake whitefish and for lake whitefish that are marketed as fillets, dressed or round (total weight) fish (Oakland, 1949). The number of fish to be sampled from a shipment was read directly from charts for a lake whose infection rate was known. The fish selected at random were examined for the presence of *T. crassus*. If the number of cysts/fish extended beyond the upper rejection line, which was calculated according to Wald (1945), the lot was rejected. If the number of cysts/fish was below the lower acceptance line, the lot was accepted for export (Oakland, 1950). Oakland (1950) noted that to apply this sampling procedure, it was necessary to quantitatively describe the distribution of the parasite in the sample. The number of cysts/fish from a given sample was found to be distributed in a negative binomial fashion.

The inspection procedure in operation at the present time was devised in 1973 by the Inspection and Surveys Branch of the Department of Fisheries and Oceans (McGregor, personal communication). It is based on the number of samples rejected relative to the risk of rejection of a shipment of known size. The procedure requires that shipments of lake whitefish from Canadian freshwater lakes are to be sampled in order to determine infection rates at least once a year.

The number of fish to be sampled from any shipment depends on the total size of shipment (Table 1).

The required number of individual fish is "randomly" chosen from a shipment and each fish is filleted and sliced to expose cysts. The rate of infection (RI) is calculated as follows:

$$[1]\quad \text{RI (number of cysts/100 lbs. of lake whitefish)} = \frac{\text{total number of cysts}}{\text{total weight of the sample (lbs.)}} \times 100$$

These infection estimates are used to classify lakes as shown in Table 2.

Table 1. Sampling schedule used by the Inspection and Surveys Branch of the Department of Fisheries and Oceans.

Total Number of Containers	Sample Size (number of fish)
1	may be waived
2	2
3 - 10	3
11 - 50	5
51 - 100	8
101 - 201	12
201 and over	16

Source: Surveys and Inspection Branch, Department of Fisheries and Oceans, Winnipeg.

Table 2. RI values of lake classification.

Classification	RI
A "export"	≤ 40
B "continental"	40 - 80
C "cutter"	> 80

Source: Surveys and Inspection Branch, Department of Fisheries and Oceans, Winnipeg.

Fish produced from "export" lakes can be exported to the USA. Catches from these lakes are required to be sampled and inspected at least once a year. Fish produced from "continental" lakes can be shipped interprovincially or exported to Europe. For export of fish from continental to the lakes to the USA, each shipment from the lakes should be cut to ensure a cyst count of less than 40 cysts/100 lbs. of fish. Fish from "cutter" lakes are processed into fish meal.

The classification programme is intended to minimize sampling. Newly exploited lakes are sampled as often as possible until sufficient data to classify them are accumulated.

(d) Standardization of Data

The annual catch records obtained from the Economics Branch of the DFO were separated by fish species, seasonal records, and size categories of jumbo, large, medium and small whitefish. Size categories of "cutter" quality catches of lake whitefish were not recorded.

Summer season catches of a particular year, winter season catches of the same year and winter season catches of the following year were treated as catches of one year. For example, catches of the year 1973 include catches of the summer 1973, winter 1973-74 (November and December 1973 and January to March 1974).

Due to minor discrepancies between lake class and commercial catch data from DFO and the Fisheries Branch, Province of Manitoba, Department of Natural Resources, lake classifications of DFO were used for the sake of consistency.

All catch records were converted to metric units. Except for the commercial catch records obtained from the Fisheries Branch, Department of Natural Resources, all other commercial catch records were converted to round weight. For this purpose, the marketed values were multiplied by conversion factors according to the Manitoba Fisheries Fact Book (Peters and Wall, 1983). The factors were derived from results from FFMC processing or provincial regulations. They are the same factors used by DFO.

Jumbo, large, medium and small size classes of lake whitefish were used as a measure of size distributions.

Abundance of *T. crassus*:

The term abundance is used here as the product of prevalence x mean intensity, according to Margolis *et al.*, (1982).

(e) Calculations

Routine statistical analysis were performed according to Snedecor and Cochran (1967).

Ratios of lake whitefish size classes from individual lakes and means of large and medium size classes of lake whitefish for the three watersheds (Nelson, Churchill and Hayes) were determined.

Fishing effort, yield/unit of surface area and catch/effort (CUE) were calculated as follows:

i) Fishing Effort:

$$[2]\ \text{Fishing effort} = \frac{\text{total number of deliveries}}{\text{total number of fishermen}}$$

$$\frac{(\text{no. of deliveries})}{(\text{no. of fishermen})} \quad \left(\frac{\text{N.D.}}{\text{F}}\right)$$

Example: Armstrong Lake, for the year 1973:

Number of deliveries = 23
Number of fishermen = 1

$$\text{Fishing effort} = \frac{23}{1} \quad \frac{\text{N.D.}}{\text{F}}$$

A delivery is a transaction completed by a fisherman in a particular period, usually one week. The number of deliveries is the only available index of fishing effort. The number of deliveries is divided by the number of fishermen in order to account for the number of operating fishermen. In northern

Manitoba lakes, this index approximates the effort of a fisherman who sets 1400 meters of 108 and/or 134 mm mesh gill nets each day for one week (Anon., 1981); 4¼ inch and 5¼ inch mesh nets are used by all fishermen.

ii) Yield per Unit of Surface Area of Lake (yield/surface area):

[3] $\text{Yield/surface area} = \frac{\text{total catch}}{\text{surface area of lake}} \quad \frac{\text{kg}}{\text{ha}}$

Example: Armstrong Lake, for the year 1973:

Total catch = 6,875 kg
Surface area of lake = 2,859 ha

$\text{Yield/surface area} = \frac{6,875}{2,859} = 2.4 \ \frac{\text{kg}}{\text{ha}}$

iii) Catch per Unit Effort (CUE):

[4] $\text{CUE} = \frac{\text{total catch}}{\text{fishing effort}} \quad \frac{\text{kg}}{\text{no. of del./fisherman}} \quad (\text{kg/N.D/F})$

Example: Armstrong Lake, for the year 1973:

Total catch = 6,875 kg
Fishing effort = 23 N.D.

$\text{CUE} = \frac{6,875}{23} = 298.9 \ \text{kg/ND/F}$

(f) Temporal Changes in Relative Proportions of Lake Whitefish and Walleye in Commercial Catches and Landed Values

Initial prices for summer catches were used and were the prices first paid to the fishermen before the final sale of their fish by FFMC. Summer prices were more stable and the majority of catches were delivered to Freshwater Fish Marketing Corporation during this time.

III. RESULTS

(a) Species Composition of Cisco, Lake Whitefish and Pike in Commercial Catches of Lakes

Table 3 lists classifications of all lakes used in this analysis. Table 4 lists lakes according to geographical location (northern, north-central and southern regions). Appendix C gives annual production of cisco, lake whitefish and pike for the period 1973-1983. Appendices D, F, G, H indicate temporal changes of cisco, lake whitefish and pike over time. Appendix E lists lakes according to size categories of small (lakes with areas less than 10,000 ha), intermediate (lakes with areas between 10,000 and 30,000 ha) and large (lakes with areas above 30,000 ha) lakes.

Appendices C and D, and Table 3 showed that increase in levels of *T. crassus*, as indicated by a change of lake class from "B" class to "C" class, occurred with the presence of cisco in 37.1% (13 lakes) of the lakes (Armstrong, Bruneau, Cormorant, Kiski, Landing, Pakwa, Setting, Granville, Kipahigan, Opachuanau, Kisseynew, South Indian and Walker). Of these lakes nine (Armstrong, Bruneau, Cormorant, Kiski, Landing, Pakwa, Setting and Walker) were located in the north-central region of the Nelson River watershed, three lakes (Granville, Opachuanau and South Indian) were in the northern region and Kisseynew was in the southern region of the Churchill River watershed (Table 4). Six of the lakes (Armstrong, Bruneau, Granville, Kisseynew, Opachuanau and Pakwa) were small lakes. Five others (Kipahigan, Landing, Kiski, Setting and Walker) were intermediate lakes and two lakes (Cormorant and South Indian) were large lakes (Appendix E).

In 37.7% (13 lakes) of the lakes (Butterfly, Cedar, Guthrie, Halfway, Natawahunan, North Indian, Playgreen, Sabomin, Sipiwesk, Sisipuk, Wekusko, Wintering and Wuskwatim) abundance of T. crassus did not change with the presence of cisco in commercial catches (Appendix F; Table 3). Eight of these lakes (Butterfly, Halfway, Guthrie, Natawahunan, Playgreen, Sipiwesk, Wintering and Wuskwatim) were located in the north-central and one lake (Cedar Lake) in the southern region of the Nelson River watershed. North Indian Lake was located in the northern region of Churchill River watershed and Sabomin was in the north-central region of Hayes River watershed (Appendix E).

Change in abundance of T. crassus occurred with absence of cisco in commercial catch records in 11.43% (4 lakes) of the lakes (Barrington, Dafoe, Gods and Herblet) (Appendix G). Barrington was located in the northern region of Churchill, and Dafoe and Gods were in the north-central region of Hayes River watershed. Herblet was in the north-central region of Nelson River watershed (Table 4). Herblet and Dafoe were small lakes, Barrington an intermediate lake and Gods a large lake (Appendix E).

Abundance of T. crassus remained unchanged (lake classes remained "A") with absence of cisco in 14.29% (5 lakes) of the lakes (Patridge Crop, St. Martin, William, Witchai and Yawningstone) (Appendix H). William, St. Martin and Yawningstone were located in the southern region, Witchai in the northern region and Patridge Crop in the north-central region of the Nelson River watershed (Table 4). Three of the lakes (Patridge Crop, Yawningstone, and Witchai) were small lakes, one lake (William) was intermediate and the size of St. Martin Lake was not known (Appendix E).

Table 3. Annual production of all species (kg round weight), fishing effort (ND/F),[1] CUE,[2] (kg/ND/F),[3] yield unit surface (kg/ha) for the period 1973-1983.

Watershed	Lake	Year	Lake Class	Total Catch (kgs)	Fishing Effort (ND/F)	CUE kg/effort (kg/ND/F)	Yield area (kg/hect)
Nelson	Armstrong	1973		6,875	23	289.90	2.0
		1974		17,808	25	712.32	6.0
		1975	B	4,574	8	571.75	2.0
		1976		7,048	8	881.00	3.0
		1977	B	-	-	-	-
		1978	B	1,168	5	232.00	0.4
		1979		11,131	23	483.00	4.0
		1980	B	10,824	27	400.00	4.0
		1981	B	8,756	17	515.00	3.0
		1982	C	6,999	16	437.30	2.0
		1983	C	2,774	16	483.89	1.8
		Mean		7,796	16	483.89	2.4
	Bruneau	1973		5,943	19	321	4.0
		1974	B	8,625	14	602	6.0
		1975	B	6,156	7	879	4.0
		1976		4,870	19	256	3.0
		1977	C	3,885	13	299	3.0
		1978	C	971	6	162	1.0
		1979		5,014	9	557	4.0
		1980	B	7,819	10	782	5.0
		1981	C	2,508	8	334	2.0
		1982	C	3,615	10	381	3.0
		1983	C	1,874	12	156	1.0
		Mean		4,661	11		3.0
	Butterfly	1973		-	-	-	-
		1974		3,524	10	352.4	2.0
		1975		5,080	8	635.0	3.0
		1976		10,393	14	742.4	6.0
		1977	A	5,404	16	337.8	3.0
		1978	A	952	4	238.0	0.5
		1979	A	13,797	28	492.8	7.0
		1980	A	4,702	16	293.8	3.0

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Table 3. Annual production of all species (kg round weight), fishing effort (ND/F),[1] CUE,[2] (kg/ND/F),[3] yield unit surface (kg/ha) for the period 1973-1983.

Watershed	Lake	Year	Lake Class	Total Catch (kgs)	Fishing Effort (ND/F)	CUE kg/effort (kg/ND/F)	Yield area (kg/hect)
Nelson	Butterfly	1981	A	3,458	10	345.8	2.0
		1982	A	6,172	19	324.8	3.0
		1983		-	-	-	-
		Mean		5,942	14	418.0	3.3
	Cedar	1973		582,024	3.85	151,175	0.5
		1974		685,162	19.18	35,722	5.4
		1975	A	608,705	50.91	11,956	5.0
		1976	A	781,223	50.88	15,354	6.2
		1977	A	838,731	41.98	19,979	7.6
		1978	A	963,296	40.69	23,764	7.7
		1979		976,444	43.88	22,293	8.3
		1980	A	1,047,135	49.79	21,031	6.9
		1981	A	875,174		-	
		1982	A	592,026	25.00	23,681	4.5
		1983		536,336	29.16	18,392	4.2
		Mean		771,478	33	34,326	5.6
	Cormorant	1973		19,278	8.0	1,752	0.6
		1974		17,870	18.0	993	0.5
		1975	B	7,224	6.0	1,204	0.2
		1976		12,525	17.0	737	0.4
		1977	C	12,657	15.0	844	0.4
		1978	C	14,007	25.0	560	0.4
		1979		42,594	46.0	926	1.3
		1980	C	77,889	44.0	1,770	2.0
		1981	C	21,198	32.0	662	0.6
		1982	C	41,334	29.0	1,450	1.0
		1983	C	-	-	-	-
		Mean		26,657	24.0	1,089	0.74

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Table 3. Annual production of all species (kg round weight), fishing effort (ND/F),[1] CUE,[2] (kg/ND/F),[3] yield unit surface (kg/ha) for the period 1973-1983.

Watershed	Lake	Year	Lake Class	Total Catch (kgs)	Fishing Effort (ND/F)	CUE kg/effort (kg/ND/F)	Yield area (kg/hect)
Nelson	Guthrie	1973		14,128	15	942	4
		1974		13,965	15	931	4
		1975	A	16,930	17	996	5
		1976		15,838	11	1,439	5
		1977	A	20,155	4	4,742	6
		1978	A	18,985	5	3,797	5
		1979		17,161	15	1,144	5
		1980	A	15,243	12	1,270	4
		1981	A	11,513	18	639	3
		1982	A	6,407	18	356	2
		1983	A	6,629	9	737	2
		Mean		14,629	13	1,545	4
	Halfway	1973		39,819	16	2,568	14
		1974		33,348	60	556	11
		1975	A	19,649	34	578	7
		1976	A	32,396	31	1,045	11
		1977	A	20,561	10	2,056	7
		1978	A	4,302	9	478	2
		1979		19,323	45	429	7
		1980	A	19,749	18	1,097	7
		1981	A	14,607	25	584	5
		1982	A	17,502	13	908	6
		1983	A	16,507	7	229	6
		Mean		21,615	24	957	8
	Herblet	1973		5,090	6	848	2
		1974		6,259	8	782	2
		1975	B	9,947	11	904	3
		1976		11,408	12	950	4
		1977	B	12,526	8	1,002	4
		1978	B	13,493	15	899	5
		1979		11,196	11	1,007	4
		1980	A	11,980	11	1,089	4

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Table 3. Annual production of all species (kg round weight), fishing effort (ND/F),[1] CUE,[2] (kg/ND/F),[3] yield unit surface (kg/ha) for the period 1973-1983.

Watershed	Lake	Year	Lake Class	Total Catch (kgs)	Fishing Effort (ND/F)	CUE kg/effort (kg/ND/F)	Yield area (kg/hect)
Nelson	Herblet	1981	A	16,925	15	1,128	6
		1982	B	231	1	231	5
		1983	C	15,450	8	2,017	5
		Mean		10,409	10	1,806	4
	Kiski	1973		7,039	9	782	0.3
		1974	B	9,662	15	644	0.4
		1975	B	6,818	12	593	0.3
		1976	B	4,119	10	412	0.2
		1977	B	6,058	8	757	0.3
		1978	B	4,609	7	709	0.8
		1979		8,986	4	2,075	0.4
		1980	B	-	-	-	-
		1981	C	4,007	6	667	0.1
		1982		-	-	-	-
		1983		6,480	8	2,492	0.1
		Mean		6,420	9	1,015	0.32
	Landing	1973		29,371	14	2,077	3.0
		1974		26,477	13	2,106	2.0
		1975		25,776	12	2,216	2.0
		1976		1,217	2	608	0.1
		1977	B	24,607	11	2,237	2.0
		1978	C	10,279	4	2,705	0.1
		1979		25,263	8	3,008	2.1
		1980	C	9,937	7	1,526	0.8
		1981	C	19,126	7	2,694	1.6
		1982	C	41,192	6	7,245	3.4
		1983	C	19,585	8	2,382	1.6
		Mean		21,166	8	2,619	1.7

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