

R. D I O N, F. G. W H O R I S K E Y

LAKE WHITEFISH (*COREGONUS CLUPEIFORMIS*) PREDATION
ON THE EGGS OF LONGNOSE (*CATOSTOMUS CATOSTOMUS*)
AND WHITE (*C. COMMERSONI*) SUCKERSDepartment of Renewable Resources, Macdonald Campus of McGill University,
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ABSTRACT

Lake whitefish (*Coregonus clupeaformis*) from the Gouin Reservoir, Québec, followed suckers (*Catostomus catostomus* and *C. commersoni*) into their spawning stream and preyed on sucker eggs. The number of lake whitefish moving into the stream correlated positively and significantly with sucker abundance, and stomach contents of sampled fish were dominated by sucker eggs. Lake whitefish were not observed rooting in the gravel of the spawning areas where the eggs incubate, but rather fed on the large quantities of sucker eggs in the drift. Lake whitefish abundance was not correlated with measures of egg drift. All lake whitefish captured were large (>350 mm fork length), and would probably have matured the following fall. Sucker eggs were a predictable, energy rich food which could help lake whitefish recover from overwinter stress and provide energetic reserves for an early start to gonad development.

Key words: suckers, egg predation, whitefish

1. INTRODUCTION

Fish eggs are a nutritious and energetically rich food source for teleosts (Orlans, Janzen 1974, FitzGerald, Whoriskey 1992). Many fishes have short spawning seasons (Wootton 1984, Wolfert et al. 19??), which results in their eggs being available for predation only during brief time periods. Despite this brief availability, predators profit immensely from feeding on eggs. Frank and Leggett (1984) estimated that up to 23% of the annual growth of winter flounder was derived from feeding on the eggs of capelin during the capelin's one-month spawning season. Egg predation can also determine the population sizes of certain species (Orlans, Janzen 1974, Hyatt, Ringler 1989).

White sucker (*Catostomus commersoni*) and longnose sucker (*C. catostomus*) are abundant in lakes and rivers in Northern Canada (Scott, Crossman 1973). During their spawning season, thousands of these fishes crowd into flowing water areas where they spawn over gravel (Green et al. 1966). In the Gouin Reservoir system (Fig. 1), both sucker species use the outlet of Lac des Cinq Mille for spawning. During a three year investigation of the spawning of the suckers at this site, we noted that lake whitefish (*Coregonus clupeaformis*) concurrently moved into the stream with the spawning suckers, apparently to feed on sucker eggs. Here we describe this egg predation. Our objectives were to: 1) document residency patterns of lake whitefish in the outlet stream where the suckers spawned, 2)

* Biology and Management of Coregonid Fishes, Thomas N. Todd and Miroslaw Luczynski [editors].

determine the amount of eggs drifting in the stream which could be eaten by whitefish, 3) analyse lake whitefish stomach contents to determine the degree to which these fish fed on sucker eggs, and 4) record biological characteristics from the lake whitefish which moved into the stream. The early spring pulse of eggs provides an energy rich food source which could aid fall spawning lake whitefish to mature. We hypothesized that the lake whitefish moving into the stream would be potential adult spawners, and that more females than males would frequent the site because of the females' large energetic investment in gonads (Moreau 1981 Lambert, Dodson 1990).

2. MATERIALS AND METHODS

The outlet stream we studied connects Lac des Cinq Mille with the Gouin Reservoir (Fig. 1). The stream flows a total distance of about 2 km, and contains two areas of rapids and two large pools. Average depth was 1.5 m and substrate varied from boulders to sand depending on current velocity. Fish species which spawned in this stream included walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*), fallfish (*Semotilus corporalis*) and the two sucker species. These fishes were only present in the stream during their respective spawning seasons, and suckers numerically dominated the fish community at all times.

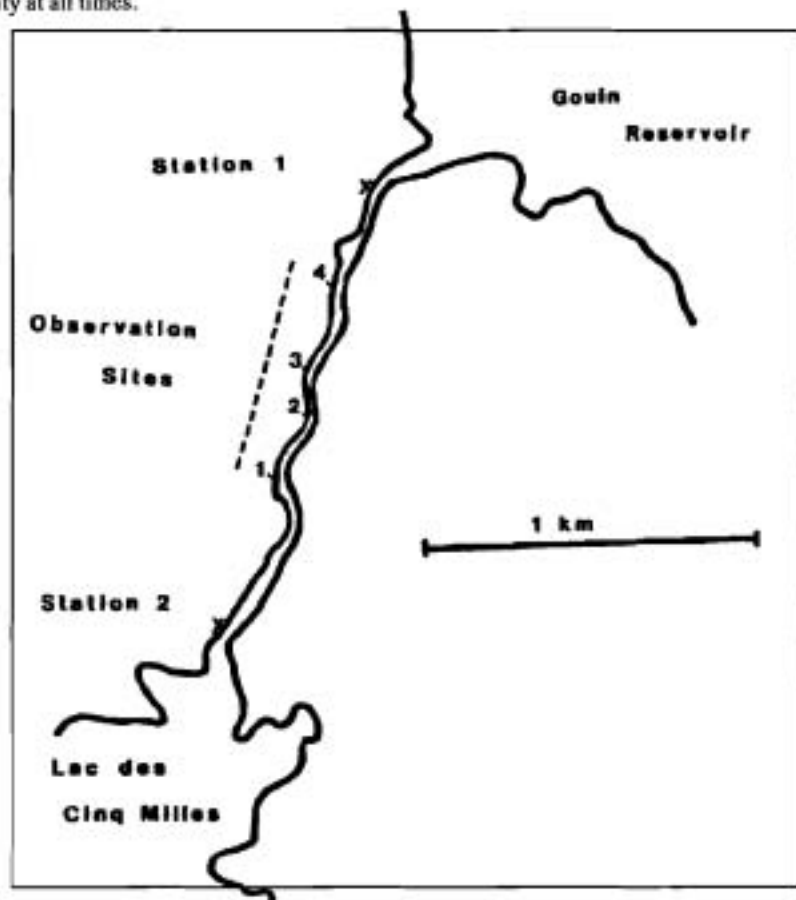


Fig. 1. The study site on the outlet stream connecting Lac des Cinq Mille and Gouin Reservoir, Québec

Experimental gill nets (monofilament, constructed of 8 panels of 7.6 m length and 2 m depth each, mesh sizes of 25, 38, 51, 63, 76, 102, 127, and 153 mm) were fished for 24-h periods in the Baie du Bouzanquet at the stream's junction with the Gouin Reservoir during the spawning season in 1986 (Fig. 1, Station 1). In 1987, gill nets were fished before, during and after the sucker spawning period. This permitted us to detect the timing of the first movements of suckers and lake whitefish to the stream. To quantify lake whitefish immigration and emigration to the sucker spawning area, a two-way trap was installed at the downstream entry of the spawning site in 1986 and 1987 and checked daily (Fig. 1, Station 2). Installation of the two-way trap in 1986 took place after the onset of spawning period and all captures of lake whitefish were made in the trap as they left the stream to return to the reservoir. In 1987, the trap was installed before sucker spawnings commenced and fished throughout the spawning period. Fish caught were measured (fork length), sex was determined from secondary sexual characteristics when possible, then released. Subsamples of the lake whitefish were sacrificed at the trap at intervals throughout the spawning period for evaluation of biological characteristics. The gill nets and trap were fished until the sucker spawning season had terminated.

In 1987, densities of suckers and lake whitefish at the spawning site were determined by direct counts twice a day (in the morning between 06:30 and 08:30 and in the evening between 19:00 and 21:00). Four areas of approximately 5 m x 5 m were monitored (Fig. 1, Sites 1-4). We identified the number of fish of all species present and where possible, their sex.

The intensity of spawning was determined in 1987 by setting drift nets (750 μ mesh) at the sites where visual counts were made. Drift nets were emptied at 12-h intervals and eggs were preserved in 4% formalin, then quantified volumetrically in the laboratory. Three 48-hour sets of the drift net were made, on 20 May, 25 May and 30 May.

Stomach contents were analysed from lake whitefish caught in the trap and gill nets. Length, weight, and sex were recorded for each fish, and the stomachs were preserved in 10% formalin for later analysis. The frequency of occurrence of insect larvae, sucker eggs, other teleost eggs, and vegetation debris in the diet were recorded. The number of empty stomachs was also noted. Volumetric determinations of each prey category were not done.

Non-parametric methods (Kendall's tau) were used to determine correlations between the abundance of suckers and lake whitefish on the spawning sites. Standard t-tests were performed to test if fish captured by the two methods, and during the two years, were of similar size. Deviations of the sex ratio from 1:1 were tested with a chi-square test.

3. RESULTS

Lake whitefish were present at the sucker spawning site in 1986 and 1987. They were first detected in the gill nets at the entry to the river on 4 May, 1987. Lake whitefish gill net catches increased and remained high during sucker spawning activity (Table 1). The trap catches, however, underestimate fish abundance as both lake whitefish and suckers succeeded in slipping under the wings of the net.

Both species of suckers spawned at all four sites observed. However, lake whitefish were present only at the site closest to the reservoir which was situated at the end of a rapid. This site had a depth of about 0.5 m, a current velocity of 0.51 m \cdot s⁻¹ and a substrate composed of boulders and gravel. Lake whitefish were never observed in the absence of suckers, and did not appear until sucker spawning had actually started (Fig. 2). The daily number of lake whitefish present correlated positively and significantly with sucker abundance (Kendall's tau = 0.40, $P < 0.001$). Sucker spawning intensity, as measured by egg drift data, peaked on May 28 while lake whitefish numbers were highest on May 23 and May 28 (Fig. 2). Lake whitefish abundance did not correlate with drifting egg numbers (Kendall's tau, $P > 0.18$).

Table I. Gill net and trapnet catches (number of fish caught per 24-h), for lake whitefish and suckers, in 1987

Date	Gill net		Trapnet	
	Whitefish	Suckers	Whitefish	Suckers
May 1-5	5	10	1	1
May 6-10	25	40	14	862
May 11-15	20	54	8	870
May 16-20	15	47	2	1,599
May 21-25	-	-	1	1,887
May 26-30	22	52	40	1,341
May 31-Jun 4	-	-	4	363

Lake whitefish of similar lengths were captured in 1986 and 1987 (t-test, $P > 0.05$). Specimens captured in the gill nets and the trap were also of similar lengths (t-test, $P > 0.40$). Size of the lake whitefish captured during the study ranged from 310 to 490 mm (fork length) and averaged 404 mm.

Significantly more females than males were caught in 1986 (26 females, 12 males; χ^2 , $P < 0.05$). However, in 1987, the sex ratio did not differ significantly from 1:1 (58 females and 51 males captured).

Lake whitefish captured in both the trap and the gill nets fed almost exclusively on eggs during the spawning period of the suckers in both years (Table II). Lake whitefish present at the mouth of the stream before the sucker spawning period (1987 only) fed on insect larvae and eggs of other fishes (Table II).

Table II. Lake whitefish stomach contents for 1986 and 1987. Data are the percentage of stomachs analysed containing the following items: insect larvae (IL), vegetation and debris (VD), sucker eggs (SE), other eggs (OE), and empty (O)

Period	IL	VD	SE	OE	O
Pre-spawning (before egg drift)					
1987 ($n = 56$)	69.6	41.0	0	33.0	5.4
Spawning (during egg drift)					
1986 ($n = 36$)	11.0	16.0	83.0	0	8.3
1987 ($n = 39$)	33.0	38.0	74.5	0	7.6
Post-spawning (after egg drift)					
1987 ($n = 20$)	0	35.0	90.0	0	10.0

4. DISCUSSION

Spawning suckers in the Gouin Reservoir provided lake whitefish with an abundant, energy rich food source in early spring. The availability of food in the period leading up to fall is a critical determinant of whether or not an individual

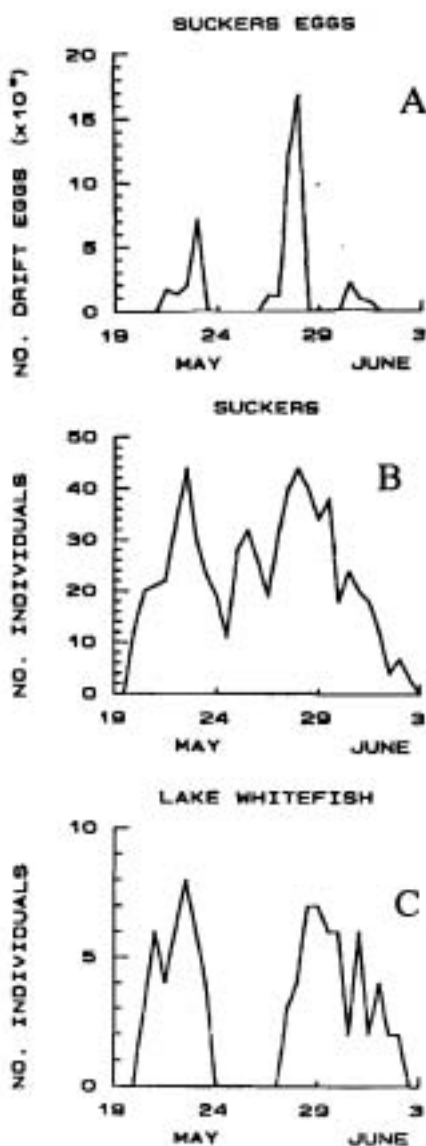


Fig. 2. Egg drift results (A), number of suckers present (B), and number of lake whitefish (C) present on the sucker spawning site

matures (e.g. Lambert, Dodson 1990). Many fish make a "decision" to mature based on feeding conditions well in advance of their spawning period (MacKinnon 1972, Potts, Wootton 1984, Wootton 1985). The importance of eggs to potential lake whitefish spawners is indicated by the fact that only large fish (>350 mm) with the capability to mature (Dumont 1977) moved into the stream to feed on the eggs. In 1986, more females than males were present feeding on eggs. The energetic investments of females in gonads exceed those of males (Moreau 1981, Lambert, Dodson 1990). This spring food pulse could be especially beneficial for females. However in 1987 equal numbers of males and females were present. A possible explanation is that food resources in the reservoir varied in these two years, and female-biased sex ratios in the stream occurred only when food supplies in the reservoir were poor.

It is not known what attracts the lake whitefish to the sucker spawning areas. Dumont (1977) reported that lake whitefish moved to inshore areas of lakes in the spring to feed. They may initially be attracted to the currents in streams where they can find an abundance of insect larvae (Hynes 1970), and then follow the suckers upstream. It is also possible that they detect the spawning activity of the suckers from odors brought downstream, although this is speculation. In our study, lake whitefish were found only at one of the four areas observed, even though suckers spawned at all sites. The lake whitefish concentrated at the base of the first rapid they encountered upon entering the stream. This may be a particularly good feeding area because the rapid concentrates the drifting eggs into a relatively small area.

Lake whitefish predation probably had marginal effects on recruitment patterns of the suckers. Lake whitefish were never observed feeding on eggs deposited in the gravel of the stream bottom and moved out of the stream when egg drift stopped. They fed on the abundant eggs drifting downstream, which having moved out of favorable areas for incubation, would probably have a lower survival rate. The large numbers of drifting eggs may "predator swamp" the whitefish and account for the lack of a correlation between whitefish abundance on the spawning site and egg drift, at least during peak spawning periods.

Sucker distribution overlaps with that of lake whitefish in large parts of North America, and suckers are often very abundant (Scott, Crossman 1973). It may be that at other sites lake whitefish also profit from feeding on sucker eggs. We noted that some lake whitefish had eggs from other fishes in their stomach. Different fish species use the outlet stream for spawning at different times (Dion, Whoriskey, unpublished data). It is possible that the lake whitefish from the Gouin Reservoir also follow these species into this stream to feed on their eggs.

ACKNOWLEDGEMENTS

We are grateful for the efforts of V. Réus, K. Southey, M. Simoneau, M. Richardson, and L. Roy for their help with the field work. We thank the O.M.C. Company (M. Savard) for providing the motor we used during our work. R. Golick of the "Club des Bonhommes de Gouin" gave us access to their camp facilities, and R. Robitaille provided air transport. Financial support for the research came from Les Fonds pour le Développement de Chercheurs et Aide à la Recherche (FCAR, Québec). Two anonymous reviewers provided useful comments on the manuscript.

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