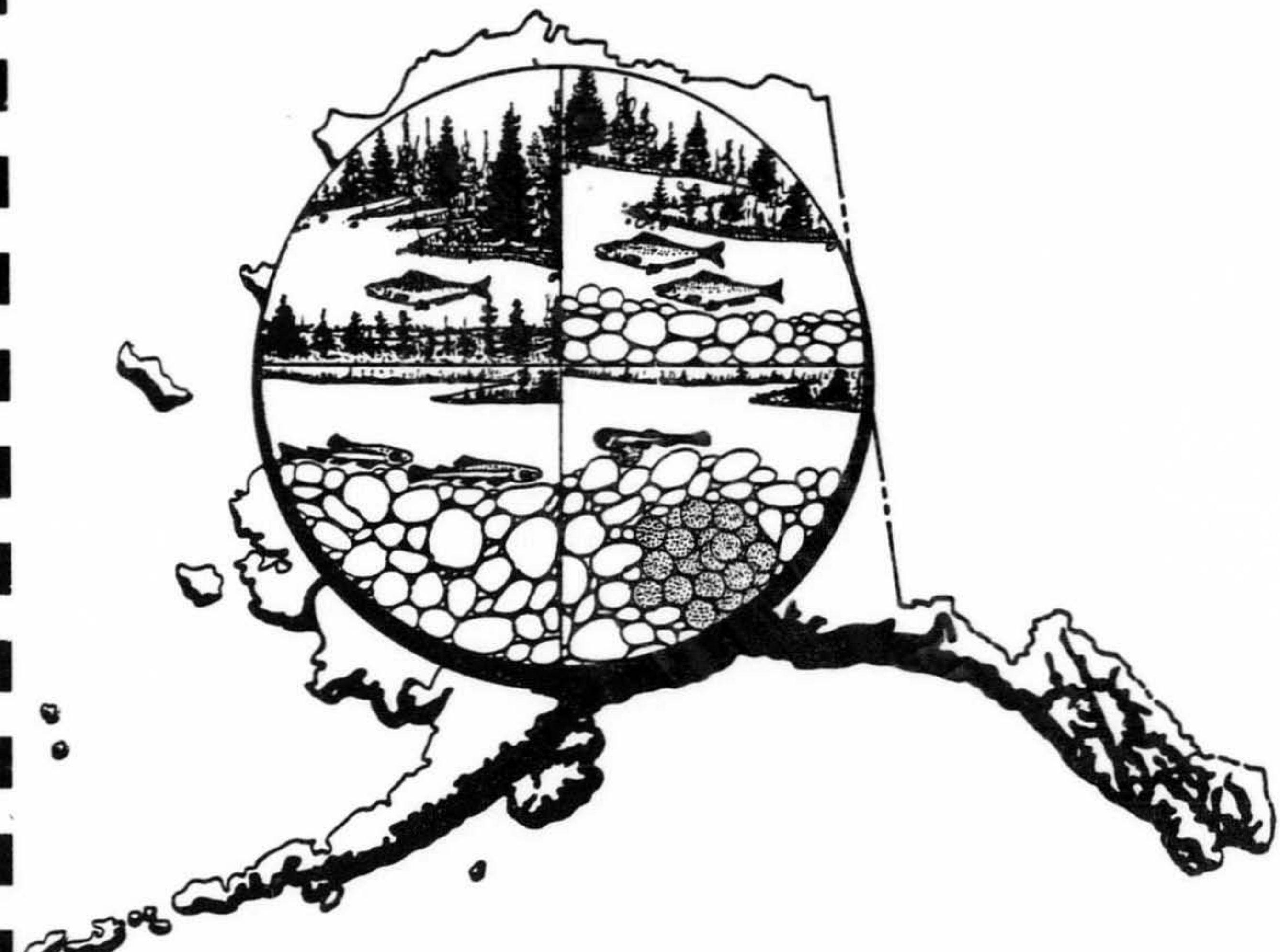
FRESHWATER HABITAT RELATIONSHIPS

ROUND WHITEFISH–*PROSOPIUM CYLINDRACEUM*



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ROUND WHITEFISH (*PROSOPIUM CYLINDRACEUM*)

By

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TABLE OF CONTENTS

Round Whitefish

I. INTRODUCTION

A. Purpose

This report presents available information on the freshwater habitat requirements of the round whitefish, Prosopium cylindraceum (Pallas), and evaluates the habitat parameters which are most important to the species or are most often critical to survival or limiting to production. The emphasis of this report is on habitat requirements, primarily those of a physical or chemical nature. Certain biological factors affecting the well being of the population such as feeding, predation, competition, parasites, and disease are not comprehensively treated.

This report is intended to support habitat evaluation activities by presenting a data base for the species and by pointing out where more data are needed. Although information has been gained from throughout the range of the species, emphasis is placed upon Alaska. While there appears to be wide differences in growth rates between different populations within the State, there is insufficient information to show that habitat requirements differ among the various populations.

The life history of the round whitefish is not well known. It is one of the least studied coregonids (Jessop and Power, 1973). Several good papers on the life histories of related species are presented in Biology of Coregonid Fishes edited by Lindsey and Woods (1970). Most studies of round whitefish have dealt with age and length; little is known of habitat tolerances, preferences, and requirements. The round whitefish appears to have fairly wide habitat tolerances. They are widely distributed in Alaska, except for the Aleutian Islands and Southeast, and occur in a variety of habitats including lakes and rivers.

B. Distribution

The round whitefish is distributed widely in Siberia and the northern part of North America. It is one of the most widespread and common species of northern waters (McPhail and Lindsey, 1970). In Siberia, it occurs in Arctic Ocean drainages from the Yenisei River east to the Bering Sea, south to northern Kamchatka, and is also found in drainages on the north side of the Sea of Okhotok. In North America, it occurs in New England, the Great Lakes (except for Lake Erie), in most of Canada (except for the southern part of the four western provinces and in the region of the Manitoba - Ontario boundary where there is a discontinuity) and in Alaska (McPhail and Lindsey, 1970; Scott and Crossman, 1973).

The round whitefish occurs throughout Alaska except for the Yukon - Kuskokwim delta, Aleutian Islands, Kodiak Island, and most of the southeast part of the State; although it does occur in the Chilkat, Alsek, and Taku drainages (R. Baxter, personal communication; McPhail and Lindsey, 1970; Morrow, 1980) (Figure 1.) It is most abundant in gravelly mountain streams and associated lakes (Alt, 1971; R. Baxter, personal communication; Berg, 1948; Krasikova, 1968; McCart et al., 1972).

C. Life History Summary

At least some populations of round whitefish apparently engage in spawning migrations but they are not as strong or directed as those of some of the other whitefish (Morrow, 1980). Movements have been observed in tributaries of the Sagavanirktok River in August and September prior to spawning season (McCart et al., 1972; Yoshirhara, 1972). In Newfound Lake, New Hampshire, fish move to the spawning area in the fall; the males usually arrive before the females (Normandeau, 1969). Craig and Wells (1975) reported aggregations of round whitefish in spring-fed sections

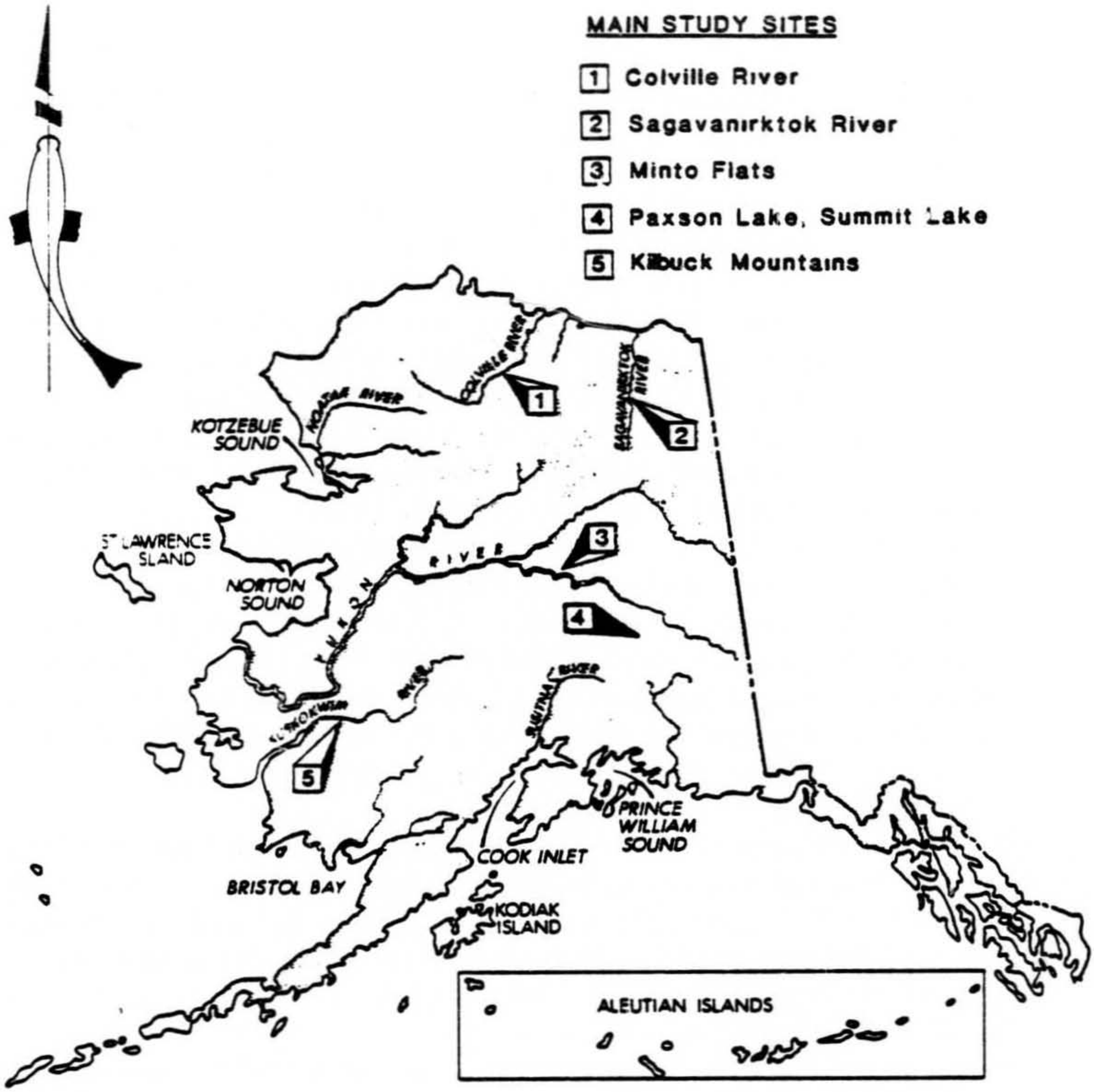

Figure 1. Distribution of Round whitefish in Alaska (R. Baxter, personal communication; Morrow, 1980) and main study sites

of the Chandalar River in the fall, which may indicate the existence of a spawning migration.

Spawning takes place in the fall in shallow, gravelled areas of lake shores or streams. Spawning in interior Alaska occurs in late September through October (Morrow, 1980). It may occur in northern Yukon Territory as early as late August (Bryan, 1973, cited by Bryan and Kato, 1975). November and December is the spawning season in the southern parts of the range (Scott and Crossman, 1973). Apparently there is little or no feeding during prespawning or spawning activities (Craig and Wells, 1975; Normandeau, 1969).

During spawning in Newfound Lake, males and females swim in pairs (Normandeau, 1969). Prior to spawning round whitefish on the spawning grounds in Aishihik Lake, Yukon Territory, slowly swam near the bottom in groups (Bryan and Kato, 1975). The eggs are broadcast over the substrate and settle into crevices in the gravel.

Fecundity ranges from about 2,000 - 14,000 eggs/female with large females producing up to 20,000 eggs; the average is around 5,000 - 10,000 eggs (Bailey, 1963; Craig and Wells, 1975; Furniss, 1974; Krasikova, 1968; McPhail and Lindsey, 1970; Normandeau, 1969). No parental care is provided for the eggs.

There are indications that in many areas, round whitefish, once mature, spawn every year (Craig and Wells, 1975; Krasikova, 1968; McCart et al., 1972); however, this is not the case in all areas (Jessop and Power, 1973).

In Newfound Lake, eggs incubate about 140 days (at 2.2°C) and hatch in April and May (Normandeau, 1969). The young hatch as sac fry and the yolk is absorbed in two or three weeks. The fry remain upon the bottom after hatching and seek shelter in rubble and boulders. They evidently leave the spawning grounds within a month. In the northern Yukon Territory, fry have been found over gravel areas of streams soon after spring breakup (Bryan, 1973, cited by Bryan and Kato, 1975).

There is little information on whether the young fish have rearing areas separate from the adults. A survey of streams in the Sagavanirktok River basin showed that fry were abundant in the main river and lower Atigun River, but not in other areas where juveniles and adults were present (McCart et al., 1972). Kogl (1971) believed the Colville River delta to be an important rearing area as young age groups were captured there. Rearing also takes place in the summer in the tributaries of the Colville River (Alt and Kogl, 1973). Krasikova (1968) stated that in Siberia the young feed in the upper reaches of streams and along the shores of lakes. Bailey (1963) stated that there may be a segregation by age during the summer in the Isle Royale area of Lake Superior.

The adult round whitefish is usually found in deep lakes in the southern part of its range and more often in rivers and streams in the northern parts (Scott and Crossman, 1973). In the Great Lakes, it is considered to be a shallow water species. Koelz (1929, cited by Scott and Crossman, 1973) stated that it is found at water depths less than 45.7 m and Dryer (1966, cited by Scott and Crossman, 1973) found them to be most abundant in western Lake Superior at water depths less than 36.6 m. The greatest water depth at which Dryer caught fish was 71.9 m. Scott and Crossman (1973) state that a U.S. Fish and Wildlife Service vessel caught one specimen in a bottom gillnet set in eastern Lake Superior at 218.9 m. In the Kuskokwim River area, round whitefish occur in lakes at least as deep as the hypolimnion (R. Baxter, personal communication).

The round whitefish has been reported to occur in brackish waters along the coastline of Hudson Bay and off the mouths of the Coppermine and Mackenzie rivers (Scott and Crossman, 1973). Evidently, it does not occur in brackish water in Alaska (Alt, 1971); at least it has not yet been captured in such areas.

The round whitefish is a bottom feeder, consuming primarily benthic invertebrates in shallow areas of streams and inshore areas of lakes. Food items include: mayfly larvae, caddisfly larvae and adults, chironomid larvae and pupae, gastropod and pelecypod molluscs, fish eggs and small fish, immature Diptera including blackfly and mosquito larvae, stonefly nymphs, and cladocerans (Furniss, 1974; Krasikova, 1968; McCart et al., 1972; Morrow, 1980; Normandeau, 1969; Scott and Crossman, 1973). Krasikova (1968) found that the feeding rate of round whitefish in July and August is considerably higher in streams than in lakes. Movement of round whitefish into tributary streams of the Sagavanirktok River apparently are summer feeding excursions (McCart et al., 1972).

The maximum length, weight, and age reported for the species is 56.1 cm total length, 2.0 kg (perhaps 2.3 kg) and age 22 (Craig and Wells, 1975; Furniss, 1974; Morrow, 1980; Scott and Crossman, 1973). MacKay and Power (1968) stated that the ultimate size for the species was 40 - 50 cm fork length. Round whitefish in Alaskan waters are usually less than 40 cm fork length and usually weigh less than 0.5 kg although specimens up to 52 cm and 1.5 kg have been taken (K. Alt, personal communication; R. Baxter, personal communication).

The fish reach sexual maturity at about age 4 or 5 in the southern part of their range and at age 6, 7 or 8 in northern parts (McPhail and Lindsey, 1970; Morrow, 1980; Peck, 1964). Similar differences exist between fast and slow growing populations in Siberia (Krasikova, 1968).

Growth rates vary considerably throughout the range (Bailey, 1963; Craig and Wells, 1975; Falk and Dahlke, 1974; Jessop and Power, 1973; Mraz, 1964; Peck, 1964; Whye and Peck, 1968). Lake Michigan fish reach a total length of 50 cm in 7 years; fish from a lake in the Brooks Range take 12 years to reach this length (Morrow, 1980). Krasikova (1968) believed that the differences in growth rates among areas resulted from differences in food production.

D. Ecological and Economic Importance

The round whitefish plays a minor role in lake ecosystems as a predator on the eggs of other fish but it primarily consumes benthic invertebrates. The round whitefish is a prey item for other species of fish, including lake trout and pike.

The round whitefish is a high quality food fish. In past years, it has supported a commercial fishery in the Great Lakes up to about 180 metric tons annually (Scott and Crossman, 1973). It is of some commercial importance in the USSR. In Alaska, subsistence fishermen take limited numbers of round whitefish.

The fish is sought by sport fishermen in New Brunswick (Scott and Crossman, 1973) and a limited sport fishery exists in Alaska (Alt, 1971).

II. SPECIFIC HABITAT REQUIREMENTS

A. Spawning

Round whitefish in Aishihik Lake, Yukon Territory, spawned when water temperatures were around 1 - 2°C (Bryan and Kato, 1975). Krasikova (1968) found them spawning in the Rybnaya stream of the USSR in early October when the water temperature was around 0°C. Lake Superior fish spawned at 4.5°C (Scott and Crossman, 1973). Round whitefish spawn in both lakes and streams. At the outlet of Aishihik Lake, Bryan and Kato (1975) observed them spawning in current velocities ranging from less than 31 cm/sec to 63 cm/sec. A sampling grid in the spawning area revealed that eggs were most dense in the faster water. However, they also spawn in still water (Koelz, 1929, cited by Bryan and Kato, 1975; Normandeau, 1969).

Round whitefish spawned in the outlet of Aishihik Lake at water depths ranging from 0.7 to 2.5 m (Bryan and Kato, 1975). Eggs were most abundant at depths less than 1 m. In Newfound Lake, New Hampshire, they were observed spawning at water depths of 0.15 to 2.0 m or more (perhaps down to 3.66 m) although most eggs were found at depths between 0.15 and 0.60 m (Normandeau, 1969). Spawning in the Great Lakes takes place at water depths of 4 to 15 m (Koelz, 1929, cited by Scott and Crossman, 1973). The substrate chosen by round whitefish for spawning in Newfound Lake was a rocky reef covered with gravel and rubble and a few large boulders. The bottom was kept free of silt by wind driven waves. Sandy areas were not used for spawning (Normandeau, 1969). Bryan and Kato (1975) found that the round whitefish of Aishihik Lake spawned at the outlet over a variety of substrates ranging from mud to gravel and boulders but that the eggs were most dense over gravel (particle size 2-250 mm). Other investigators have reported them spawning over gravel and boulders (Koelz, 1929, cited by Bryan and Kato, 1975), over gravel (ADF&G, unpublished

MS), and over cobble and gravel in widened stretches of small streams (Krasikova, 1968).

B. Incubation

The water temperature of Newfound Lake was 2.3°C during the incubation period of round whitefish eggs (Normandeau, 1969). Given that round whitefish in Alaska spawn in the fall at water temperatures around 0°C, the eggs must incubate at temperatures close to 0°C. Eggs of round whitefish which spawned in lakes would probably incubate at slightly higher temperatures.

No information is available on dissolved oxygen levels required during incubation but the oxygen levels encountered must be fairly high, given that the eggs are located on the surface of substrate and incubate at low water temperatures.

C. Juvenile Rearing

Little information is available on any habitat requirements or preferences that juveniles may have which are different from adults. Baxter (personal communication) has found that Age I and II fish live in the same areas as adults but in shallower waters. Peck (1964) compared the growth rates of round whitefish in Paxon and Summit Lakes and found that the young-of-the-year fish in Paxson Lake have a greater growth rate. Peck suggested that this was a result of an earlier warming of the waters in the spring and a greater food productivity in Paxson Lake.

D. Adults

In the western part of the North Slope, round whitefish are found in the summer in streams where the water temperature ranges from 3 - 16°C (Kogl, 1971). Fall migrations in the Sagavanirktok River drainage have been observed at water temperatures ranging from 0 - 13°C (McCart et al., 1972; Yoshihara, 1972). Round whitefish in Moosehead Lake, Maine, were distributed in August at water temperatures ranging from 13.9 - 17.5°C (Cooper and Fuller, 1945, cited by Ferguson, 1958). Round whitefish have been found overwintering in deep holes in the Colville, Kuparuk, and Sagavanirktok Rivers at water temperatures of 0 - 1°C (Bendock, 1977, 1979 and 1980).

Round whitefish in streams of the Kilbuck Mountains are generally found where the gradient is greater than 0.5 m/km (ADF&G, unpublished MS). They occur in North Slope streams where the gradient ranges from about 1 - 14 m/km and the current velocity ranges from about 24 - 274 cm/sec (Kogl, 1971). They may not actually be present in the higher current velocities, but do occur in streams which have these velocities. Berg (1948) and Krasikova (1968) stated that round whitefish in the USSR prefer swift currents.

Jones (197?) determined experimentally that the critical velocity for nine round whitefish with an average fork length of 30.4 cm was 42.5 cm/sec.

Round whitefish are found on the North Slope in the summer over substrates ranging from mud to cobble and boulders (Bendock, personal communication; Kogl, 1971). However, they seem to be found most commonly in streams with a gravel bottom (ADF&G, unpublished MS; Berg, 1948; Krasikova, 1968).

The turbidity of streams of the western North Slope where round whitefish are found in the summer ranges from clear to 15 ppm (Kogl, 1971). They apparently have a preference for clear streams (R. Baxter, personal communication; T. Bendock, personal communication; DeGraaf and Machniak, 1977).

In the Colville River, healthy appearing fish with food in their stomachs were taken from waters with dissolved oxygen concentrations ranging from 2.6 - 5.6 ppm (Bendock, 1980). In the Kuparuk and Sagavanirktok Rivers where round whitefish were taken, the dissolved oxygen saturation ranged from 49 - 100% (Bendock, 1977). Streams of the Kilbuck Mountains and Nulato Hills where they are found are well oxygenated throughout the year (ADF&G, unpublished MS).

III. SUITABILITY INDEX CURVES

No suitability index curves were drawn for the round whitefish because it was believed that there is not sufficient data to construct meaningful curves. The wide distribution of the species in a variety of habitats with broad ranges of habitat parameters further compounds the problem of describing optimum habitat. Tables I and II provide a general overview of certain parameters.

Table I: Round Whitefish Spawning

Parameter	Observed Values	Remarks	Location	Reference
Temperature °C	around 1 - 2		Aishihik Lake, Yukon Territory	Bryan and Kato, 1975
	around 0		Rybnaya River, USSR	Krasikova, 1968
	4.5		Lake Superior	Scott and Crossman, 1973
Current Velocity, cm/sec	0		Great Lakes	Koelz, 1929 (cited by Bryan and Kato, 1975)
	0		Newfound Lake, N. H.	Normandeau, 1966
	<31 - 63	eggs most abundant in faster water	outlet of Aishihik Lake, Yukon Terr.	Bryan and Kato, 1975
Water Depth, m	0.7 - 2.5	eggs most abundant at water depths <1 m	outlet of Aishihik Lake, Yukon Terr.	Bryan and Kato, 1975
	0.15 - 2.0 +	range	Newfound Lake, N. H.	Normandeau, 1969
	0.15 - 0.60	most eggs		
	4 - 15	range	Great Lakes	Koelz, 1929 (cited by Scott and Crossman, 1973)

Table II: Round Whitefish, Adult

Parameter	Observed Values	Remarks	Location	Reference
Temperature, °C	3 - 16	have been captured at these temperatures in the summer	Western North Slope	Kogl, 1971
	0 - 13	fall migrations	Happy Valley Crk. (trib. of Sagavanirktok R.)	McCart et al., 1972
	0 - 12	fall migrations	Lupine River (trib. of Sagavanirktok R.)	Yoshihara, 1972
	0 - 1	overwintering	Colville, Kuparuk and Sagavanirktok R.	Bendock, 1977 & 1980
	13.9 - 17.5	distribution in August	Moosehead Lake, Maine	Cooper and Fuller, 1945 (cited by Ferguson, 1958)
Dissolved Oxygen	2.6 - 5.6 mg/l	overwintering	Colville River	Bendock, 1980
	49 - 100% saturation	overwintering	Kuparuk and Sagavanirktok R.	Bendock, 1977

IV. DEFICIENCIES IN DATA BASE AND RECOMMENDATIONS

Because of the paucity of information, it is not possible to elaborate on specifics regarding the habitat tolerances, preferences and needs of the round whitefish. If the habitat of the round whitefish is to be adequately described in Alaska, more research is required. Studies needed range from basic descriptive life history studies to extensive measurements of habitat parameters to physiological experiments in the laboratory.

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