# APPENDIX 4-I

# DESCRIPTIONS OF THE LIFE STAGES AND HABITAT REQUIREMENTS FOR FISH AND FISH HABITAT KEY INDICATOR RESOURCES

## TABLE OF CONTENTS

**SECTION** **PAGE**



## LIST OF TABLES

# 1 INTRODUCTION

The potential effects from the MEG Energy Corp. (MEG) Christina Lake Regional Project – Phase 3 (the Project) on Key Indicator Resources (KIRs) fish species are assessed in relation to the various life stages and their habitat requirements. This appendix provides a summary of the habitat requirements of the selected KIR species or guilds.

The rationale for KIR selection for the fish and fish habitat component is discussed in Volume 4, Section 2.2.6 of the Environmental Impact Assessment (EIA) and includes consideration of previously established KIRs used for EIAs in the Oil Sands Region. It also includes consideration of recommendations of regulatory agencies and multi-stakeholder groups that have been established to address environmental issues associated with oil sands development in the region. The KIRs that have been selected for the assessment differ among the different watercourses and waterbodies, which is reflective of the differences in habitat conditions, species composition and trophic complexity found within the different aquatic systems. The KIRs for the fish and fish habitat component are key fish species (or guilds), benthic invertebrate populations and their respective habitats. Fish species selected as KIRs for the Project include:

- arctic grayling;
- northern pike;
- walleye;
- white sucker; and
- brook stickleback.

For fish species, the habitat components shown in Table 1 were considered when evaluating habitat conditions and their suitability for use by different fish life stages.

**Table 1 Fish Life Cycle Stages and Habitat Components**

| Life Cycle Stage | Habitat Component |
|---|---|
| spawning adult | spawning habitat |
| fry (young-of-the-year) | nursery habitat |
| juvenile | rearing habitat |
| adult | feeding habitat |
| all stages | overwintering habitat |
| all stages | migration routes |

The information for fish species was compiled primarily from the following references: McPhail and Lindsey (1970), Nelson and Paetz (1992), Ford et al. (1995), Scott and Crossman (1998), Bradbury et al. (1999), Langhorne et al. (2001), Westworth (2002), Rhude (1976), Lowe and Moller (1975), McDonald (1967) and FRM Environmental Consulting Ltd. (FRM 1994, 1995a, 1995b, 1996, 1998). The distribution and habitat use for the life stages of the KIR species in waterbodies and watercourses in the Aquatic Resources Local Study Area (LSA) for this Project is provided in the Fish and Fish Habitat Baseline Report (Appendix 4-V) and summarized in the Existing and Approved Case Section of the EIA (Volume 4, Section 4.4).

## 1.1 ARCTIC GRAYLING

Arctic grayling is a cold-water fish species generally found in clear, cold waters of large rivers, rocky creeks and lakes. Arctic grayling have been reported in Winefred River (Rhude 1976) that flows northeast from Winefred Lake, located southeast of the LSA. Arctic grayling have also been report in Christina River that flows northeast of the Regional Study Area (RSA) (FRM 1994, 1995a, 1995b, 1996, 1998) and Christina Lake (Mitchell and Prepas 1990; Alberta Sustainable Resource Development (ASRD) 2007). Their preferred habitats include areas with rocky substrates, such as boulders, cobble and gravel, and with cover provided by large substrate and submerged features such as logs. Arctic grayling feed primarily on aquatic and terrestrial insects, secondarily on bottom organisms and plants, and rarely on fish and small aquatic animals. Arctic grayling can tolerate water temperatures up to 20ºC, but become stressed at temperatures higher than 16ºC.

Arctic grayling spawn in the spring and generally prefer to spawn in riverine habitat, although lake spawning does occur, with spawning migrations occurring as ice-out begins. Lake spawning areas are usually associated with lake inlets, outlets or margins of lakes at depths up to 10 m. During ice break-up, adult Arctic grayling (generally six to nine years of age; minimum of three years) have been observed to migrate from ice-covered lakes and rivers to spawn in gravel to rocky parts of surrounding tributaries.

Preferred spawning habitat is riverine and includes gravel or rocky substrates (less than 20% fine sediments) in riffle areas with moderate to high gradients and velocities ranging from 0.34 to 1.46 m/s. Water temperatures associated with spawning have been reported to be between 7 and 10ºC (Scott and Crossman 1998). Males select and defend spawning territories but no redd or nest is built. The adhesive eggs fall to the bottom and become coated with sand and small gravel. In the Christina Lake watershed, Arctic grayling are known to spawn in the Jackfish River near the outlet of Christina Lake.

The incubation period is relatively short and eggs hatch in 13 to 18 days at temperatures of 7 to 11ºC. The newly hatched fry remain inactive, absorbing the yolk sac for 11 to 12 days, after which they become free-swimming. Fry are typically found at depths of up to 1 m and nursery habitat includes quiet backwater areas, or rocky habitats where interstitial spaces and boulder shadows provide hiding cover and velocity shelters. Fry are infrequently found in lakes unless they are spawned there. Arctic grayling fry initially feed on zooplankton, but gradually shift to insect larvae. Juvenile and adult Arctic grayling are opportunistic feeders and consume food primarily in stream drift, such as aquatic and terrestrial insects, as well as snails, small fish and even small mammals. Arctic grayling school, a practice that can result in competitive and intense feeding.

Arctic grayling are reported to avoid turbid rivers, except in the fall when they will enter large rivers before freeze-up (Scott and Crossman 1998). Although fry may remain in natal tributaries over the winter, winter flows are usually insufficient to provide pool habitat for larger fish and migratory populations move downstream to overwinter in mainstem rivers.

## 1.2 NORTHERN PIKE

Northern pike is a cool-water species that prefer heavily vegetated habitats in shallow, clear waterbodies or bays of larger lakes, or streams with slow to moderate current. Northern pike have been reported in Winefred Lake (McDonald 1967; Lowe and Moller 1975; Rhude 1976), Christina River (FRM 1994, 1995a, 1995b, 1996, 1998) and Christina Lake (Mitchell and Prepas 1990, ASRD 2007), as well as several unnamed waterbodies and watercourses within the Project area (Golder 2005; Appendix 4-V). They cannot cope with strong currents and prefer the interface between vegetation and open water. Their diet is largely made up of fish, invertebrates and small aquatic animals.

Northern pike move from deep areas of lake systems, where they spend their winters, to shallow marshes connected to lakes or flooded vegetation in shallow bays to spawn. Northern pike spawn in the early spring before the ice has completely left the lakes. Maturation age is generally two years for males and three years for females. The water temperatures during spawning are generally between 4 and 12ºC. The adult pike move out of the spawning areas immediately after spawning, but remain in shallow, vegetated areas of lakes with adequate cover.

Northern pike eggs are adhesive and attach to vegetation during spawning. The preferred spawning habitat consists of heavily vegetated areas in marshes, lake bays and slow-moving rivers. These areas tend to be shallow (less than 1 m), with slow-moving water that are sheltered from the wind. The type of vegetation is not critical and they have been reported to use emergent and submergent aquatic plants as well as flooded terrestrial vegetation (e.g., grasses) (Scott and Crossman 1998). Spawning also occurs on river floodplains, when water levels permit, but fluctuations in water level during the incubation period can result in significant egg or fry mortalities (Inskip 1983).

Northern pike eggs hatch in 12 to 17 days in optimal water temperatures (9 to 11ºC). The newly hatched fry are inactive and remain attached to the vegetation by adhesive glands for 6 to 10 days, until yolk sac absorption is complete. The fry then become free swimming, frequenting shallow water (up to 1 m) and using vegetation as cover for protection from predators. Submerged vegetation and stable water levels are important characteristics of nursery habitat. Fry begin feeding on zooplankton and aquatic insects, then gradually switch to a diet consisting mainly of fish when they are about 50 mm long. Nursery activity for northern pike occurs mainly in the spawning tributaries.

Juvenile northern pike typically remain along shorelines or in shallow areas with adequate food and cover at depths less than 2 m, preferring areas with submerged vegetation. Juvenile northern pike were captured during summer surveys in Unnamed Watercourse WC 4-07 and observed in “Sawbones Creek” (Appendix 4-V; Golder 2005), indicating that these watercourses are used for juvenile rearing. The adults also prefer shallow, but somewhat deeper (less than 5 m), habitats and are generally found along the margins of vegetated areas or areas with some other cover such as logs, stumps, shoals and boulders. The amount of fish in the northern pike diet increases as they grow, with adults becoming omnivorous carnivores with a typical diet of over 90% fish. As such, a healthy forage fish base is required for rearing and feeding habitat.

Northern pike typically move during the winter into larger areas with deeper waters, such as large rivers and lakes with adequate depth and Dissolved Oxygen (DO) to provide suitable overwintering habitat. They remain active and feed through the winter. Northern pike appear to select shallower and slower habitats during the winter than other sport fish species.

## 1.3 WALLEYE

Walleye is a cool-water fish species that prefers large, moderately fertile lakes and large streams or rivers that are deep or turbid. Walleye were reported in

Winefred Lake (McDonald 1967; Low and Moller 1975; Rhude 1976) and Winefred River (Rhude 1976) Christina River (FRM 1994, 1995a, 1995b, 1996, 1998) and Christina Lake (Mitchell and Prepas 1990, ASRD 2007), as well as the lower reach of "Sawbones Creek" (Golder 2005). Walleye feed mostly on fish and aquatic invertebrates and are photosensitive, seeking dim light.

Optimum conditions for walleye include maximum summer temperatures of 20 to 23ºC, low light penetration, abundant food sources and DO concentrations greater than 3 mg/L. Low DO levels (2 mg/L) can be tolerated for short periods. Cover availability is a major aspect of walleye habitat and includes sunken trees, large substrate material, submerged vegetation, turbidity and thick layers of ice and snow. Walleye found in clear water use submerged cover during the day and restrict feeding to twilight or dark periods.

Walleye typically spawn shortly after ice break-up at water temperatures between 6.7 and 8.9ºC (Scott and Crossman 1998). Preferred walleye spawning habitat is characterized by rocky substrate and good water circulation associated with wave action or currents. Spawning grounds range from shallow rocky shoals and shorelines in lakes to rocky areas in white water sections of rivers. Walleye are broadcast spawners, meaning they swim above the substrate, releasing their eggs and sperm into the water. Fertilized eggs then fall into crevices in the substrate below. Highest embryo survival occurs in spawning habitat with clean (i.e., sediment free) gravel or rubble substrate and oxygen levels greater than 5 mg/L.

Walleye spawning is known to occur in the spring in the small bay at the north shore of Christina Lake ("Sawbones Bay") into which "Sawbones Creek" flows (Appendix 4-V). In the past, walleye were caught in this bay in great numbers during the spring spawning season (Herdman 1984). "Sawbones Creek" is the primary walleye spawning stream in the Christina Lake watershed (C. Davis 2004, Pers. Comm.); adult walleye were captured in the lower reach of "Sawbones Creek" during spring sampling (Golder 2005).

Walleye eggs hatch in 12 to 18 days and newly hatched fry remain in the yolk sac stage for the first 10 to 15 days. After yolk sac absorption, fry begin feeding on zooplankton. As they grow, their diet switches to aquatic invertebrates and then to a fish diet before they reach 50 mm in length. The fry are found in open water at depths up to 5 m and frequenting low-flow, shallow embayments of lakes and large rivers.

Juvenile and adult walleye feed on all available fish species and are dependant on an abundant forage fish source. Adults and juveniles prefer depths up to 5 m in littoral areas year-round, with a high occurrence in the summer at depths of 5 to 10 m. Walleye survival, growth and productivity are related to the abundance and availability of forage fish.

Overwintering habitat for walleye includes areas with adequate depth to avoid freezing, adequate DO levels and no strong currents. Walleye actively feed during the winter.

## 1.4 WHITE SUCKER

White sucker occur in rivers and shallow lakes or shallow (i.e., less than 10 m) portions of deep lakes, and are tolerant of a wide diversity of environments. White sucker were reported in Winefred Lake (McDonald 1967; Lowe and Moller 1975; Rhude 1976), Winefred River (Rhude 1976), Christina River (FRM 1994, 1995a, 1995b, 1996, 1998), and Christina Lake (Mitchell and Prepas 1990; ASRD 2007), as well as “Sawbones Creek” and the tributary to the east shore of Christina Lake (Golder 2005).

White sucker mature at the age of five or six years. They are spring spawners and typically spawn from mid May to June. They migrate from lakes to gravel-bottomed streams or lake margins when temperatures reach 10ºC. Spawning habitat is usually shallow water (i.e., less than 1 m), gravel riffle section of streams, and less frequently along lake margins that have substrates of gravel, sand, silt and clay. No nest is built and the eggs are scattered and adhere to the bottom substrate.

The eggs hatch in 8 to 11 days at temperatures of 10 to 15ºC. The newly hatched fry remain in the gravel for a period of one to two weeks absorbing the yolk sac. Fry migrate back to the lakes one month after spawning occurs. Young fry initially feed at the surface on plankton and small invertebrates, then the mouth moves from the front (terminal) to the bottom (ventral) of the head and they shift to a bottom-feeding habit. In lakes, the young-of-the-year are found in shallow water along the shore to depths up to 5 m, and occasionally in the pelagic zone.

Juvenile and adult white suckers are bottom feeders and consume molluscs, insect larvae and algae. Rearing and feeding activities occur in lakes and tributary watercourses during the summer. White sucker, including juveniles, were captured in the Winefred River at Site WC 5-07 during the spring and summer (Volume 4, Appendix 4-V) indicating that this river is used for rearing and likely spawning. Overwintering primarily occurs in lakes.

## 1.5 BROOK STICKLEBACK

Brook stickleback occur in or near aquatic vegetation in streams, bogs, beaver ponds and lakes and are often the most abundant fish in small lakes and ponds and habitat devoid of larger piscivores. This species has a high tolerance for low DO levels and is often found in areas where other fish cannot survive (Nelson and Paetz 1992). The preferred habitats are small streams, springs, bogs or lakes where aquatic vegetation and debris are found. In the summer, adults are found in depths of less than 2 m, whereas throughout the rest of the year they are found throughout the entire water column.

Brook stickleback spawn in the late spring or early summer (late May to early July). The males are territorial during spawning and build and defend a nest made primarily of algae and leaves of rooted aquatic plants. The brook stickleback nest is held together by a threadlike substance secreted from the kidney and is built on rooted plants, submerged logs or on the bottom of the watercourse or waterbody. During incubation, the male cares for the eggs and fans them with his pectoral fins. Juvenile and adult fish form schools and feed on small aquatic invertebrates, crustaceans and sometimes algae.

Brook stickleback are widely distributed in the Oil Sands Region, particularly in small watercourses in tributary watersheds and in lakes and ponds. Brook stickleback are resident species, with these watercourses or waterbodies providing year-round habitat for this species, including spawning, rearing, feeding and overwintering.

Brook stickleback are present throughout the LSA, with their distribution extending into the upper reaches of the Christina and Winefred rivers, being captured a numerous sites in unnamed waterbodies and watercourses throughout the study area (Golder 2005; Appendix 4-V).

## 1.6 BENTHIC INVERTEBRATES

Benthic invertebrates were identified as a KIR for all watercourses and waterbodies in the RSA. The benthic invertebrate KIR includes the benthic invertebrate communities present as well as the drift component that, in watercourses, serves as a food resource for fish populations in downstream habitats. The benthic invertebrate communities in the MEG LSA are described in Appendix 4-V.

Benthic invertebrate communities occur in a wide variety of habitats and reflect the physical and chemical characteristics of their surroundings. General habitat requirements include the presence of substrate, DO and a food source, as well as the absence of acute toxicity and extreme physical conditions (e.g., extremes of scouring, water level fluctuations, temperature). There are two general habitat types that determine the characteristics of the benthic invertebrate community that will be present: depositional habitats and erosional habitats.

Depositional habitats consist of still or slow-moving water where the substrate, or bottom material, consists of fine sediments such as sand, silt or clay. Organisms that live in these environments mostly live on top of the substrate or burrow into it. Depositional habitats are usually the dominant habitat type in waterbodies and slow-flowing watercourses, but may also occur in specific habitats in swifter watercourses, such as backwaters and pools. Erosional habitats are characterized by swift-flowing water with substrates that consist of coarser material such as gravel, cobble or boulder-sized particles. Organisms that live in erosional environments usually live on top of the substrate or in the spaces between the rocks. Erosional habitats are usually the dominant habitat type in high-gradient watercourses with swift-flowing water, but may also occur in slower flowing watercourses in specific habitat types such as riffles.

# 2 REFERENCES

ASRD (Alberta Sustainable Resource Development). 2007. Fisheries Management Information System. Accessible through Alberta Sustainable Resource Development, Fish & Wildlife Division, Fisheries Management Branch, Edmonton Alberta.

Bradbury, C., M.M. Roberge and C.K. Minns. 1999. Life History Characteristics of Freshwater Fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Lake Habitat Requirements. Canadian Manuscript Report of Fisheries and Aquatic Science.

Ford, B.S., P.S. Higgins, A.F. Lewis, K.L Cooper, T.A. Watson, M.C. Gee, G.L. Ennis and R.L Sweeting. 1995. Literature Reviews of the Life History, Habitat Requirements and Mitigation/Compensation Strategies for Thirteen Sport Fish Species in the Peak, Liard and Columbia River Drainages of British Columbia. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2321.

FRM (FRM Environmental Consulting Ltd.). 1994. Stream Inventory of the Alberta Pacific Forest Management Area, 1993. Prepared for Alberta Pacific Forest Industries Inc.

FRM. 1995a. Stream Inventory of the Alberta Pacific Forest Management Area, 1994. Prepared for Alberta Pacific Forest Industries Inc.

FRM. 1995b. Stream Inventory of the Alberta Pacific Forest Management Area, 1995. Prepared for Alberta Pacific Forest Industries Inc.

FRM. 1996. Stream Inventory of the Alberta Pacific Forest Management Area, 1996. Prepared for Alberta Pacific Forest Industries Inc.

FRM. 1998. Stream Inventory of the Alberta Pacific Forest Management Area, 1997. Prepared for Alberta Pacific Forest Industries Inc.

Golder (Golder Associates Ltd.). 2005. Christina Lake Regional Project – Fish and Fish Habitat Environmental Setting Report. Prepared for MEG Energy Corp., Calgary, AB.

Herdman, M. 1984. Sports Fishing at Christina Lake: A Creel Census Report About Data Collected During the Summer of 1983. Alberta Energy and Natural Resources, Fish and Wildlife Division. June 1984.

Inskip, P.D. 1982. Habitat Suitability Index Models: Northern Pike. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.17. 40 pp.

Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet and C. K. Minns. 2001. Life History Characteristics of Freshwater Fishes Occurring in Manitoba, Saskatchewan and Alberta, With Major Emphasis on Lake Habitat Requirements. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2579. 182 pp.

Lowe, D.R. and K.M. Moller. 1975. Winefred Lake netting survey in December 1974.

McDonald, D. 1967. Winefred Lake (Twp. 75, Rge. 4, W4th). Fish and Wildlife Division, Government of Alberta.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater Fishes of Northwestern Canada and Alaska. Fisheries Research Board Canadian Bulletin. 173:243-245.

MEG. (MEG Energy Corporation). 2005. Application for Approval of the Christina Lake Regional Project. Volumes 1 to 5. Submitted to Alberta Environment and Alberta Energy and Utilities Board. Calgary, AB. Submitted August, 2005.

Mitchell P. and E. Prepas. 1990. Atlas of Alberta Lakes. University of Alberta Press.

Nelson, J.S. and M.J. Paetz. 1992. The Fishes of Alberta. 2nd Edition. University of Calgary Press. Calgary, AB.

Rhude, L. 1976. Preliminary Fisheries Survey of the Lakes and Rivers Found in the Winefred Lake Study Area. Recreation, Parks and Wildlife. Fish and Wildlife Division, Alberta, Environment.

Scott, W.B. and E.J. Crossman. 1998. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Bulletin 184. 966 pp.

Westworth (Westworth Associates Environmental Ltd.). 2002. A Review and Assessment of Existing Information for Key Wildlife and Fish Species in the Regional Sustainable Development Strategy Study Area: Volume 1 Wildlife. Prepared for the Cumulative Environmental Management Association (CEMA) Wildlife and Fish Working Group (WFWG). Prepared by Westworth Associates Environmental, Edmonton, AB. 304 pp.

## 2.1 PERSONAL COMMUNICATIONS

Davis, C. 2004. Area Fisheries Biologist, Alberta Sustainable Resource Development. Lac La Biche, Alberta. December 2, 2004.