APPENDIX 17

LIFE HISTORY DESCRIPTIONS OF FISH AND FISH HABITAT KEY INDICATOR RESOURCES

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION

Potential effects of the Voyageur South Project on Key Indicator Resources (KIRs) fish species were assessed in relation to their various life stages and habitat requirements. The following provides a summary of the habitat requirements of the selected KIR species or guilds. Life stages and associated habitat categories include:

Life Stage	Habitat Category
adult	spawning
fry	nursery
juvenile	rearing
adult	feeding
all	overwintering and migration

Much of the information for sport and non-sport species was provided by the Cumulative Environmental Management Association (CEMA) investigations of key fish species in the Regional Sustainable Development Strategy (RSDS) study area (Westworth Associates 2002) and overwintering habitat preferences (RL&L / Golder 2003). Information provided by on-going Regional Aquatics Monitoring Program (RAMP) monitoring of fish populations in the Athabasca River and its tributaries is also included.

The distribution and habitat use for the life stages of the KIR species in watercourses and waterbodies in the Voyageur South Project Aquatics Study Area (ASA) is provided by the CEMA In-Stream Flow Needs (IFN) scoping study (Golder 2004), as well as the Voyageur South Project Fish and Fish Habitat Environmental Setting Report (Golder 2007).

1.1 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 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 dissolved oxygen (DO) concentrations >3 mg/L. Low DO levels (2 mg/L) can be tolerated for short periods. Cover is also a major aspect of walleye habitat and includes sunken trees, large substrate material, submerged vegetation, turbidity and thick layers of

ice/snow. Walleye found in clear water use submerged cover during the day and restrict feeding to twilight or dark periods.

Walleye is one of the key sport fish species in the lower Athabasca River and is one of the most abundant large-bodied fish in the Athabasca River within the ASA (Golder 2003). Walleye abundance is typically highest in the spring, with decreasing abundance through the summer, fall and winter. Regional Aquatics Monitoring Program studies indicate year-to-year variability in walleye abundance and some population parameters (e.g., length, frequency and growth), but no specific trends to indicate any population changes over the monitoring period (1997 to 2005).

Walleye spawn in the spring, typically at water temperatures between 6.7 to 8.9°C, and may migrate significant distances between overwintering sites and spawning sites. In general, walleye begin migration in early spring, with spawning occuring shortly after ice break-up. In the Athabasca River, walleye migrate into the ASA from Lake Athabasca or overwintering sites in the Athabasca River in late April or early May. Spawning has not been documented in the Athabasca River in the Oil Sands Region, but it is suspected to occur based on the spring migration and the presence of fry later in the year. Potential walleye spawning grounds are considered to occur in the Athabasca River upstream of the ASA, at Mountain and Cascade rapids, and in some of the larger tributary watercourses (e.g., the Clearwater River).

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, so no spawning nests are built and the eggs fall into crevices in the rocky substrate. Highest embryo survival occurs in spawning habitat with clean (i.e., sediment free) gravel or rubble substrate and DO levels >5 mg/L.

Walleye eggs hatch in 12 to 18 days, and the fry subsist for the first 10 to 15 days after hatching by absorbing the egg yolk sac. The fry then begin feeding and are dependent on an abundant zooplankton food source. As fry grow, they switch to feeding on aquatic invertebrates and then to a fish diet when they are still <50 mm in length. Although some fry drift downstream to nursery areas, likely to the very lower Athabasca River or Lake Athabasca, use of the Athabasca River in the ASA as nursery habitat is common during the spring and summer. Walleye nursery activity in the Athabasca River has been noted in shallow slow water habitats and in tributary mouths. Downstream movement of fry out of the ASA begins in late summer, although some fry remain in the area into October.

Juvenile and adult walleye feed on all available fish species, but are dependent on an abundant forage fish food source. Walleye survival, growth and productivity are directly related to the abundance and availability of forage fish. During the open-water period, juvenile rearing and adult feeding activity occurs in both the Athabasca River in the ASA and some of its larger tributaries. The spring migration from Lake Athabasca to the ASA consists of both juvenile and adult fish. Although some fish return downstream after the spawning period, many fish remain for the spring, summer and fall. Some walleye rear and feed in the Athabasca River while others enter tributary streams in the spring. Migrations into tributary watercourses consist primarily of juvenile fish and post-spawning males. In addition, telemetry studies suggest there may be an upstream movement of walleye in the Athabasca River in the fall, which may be a feeding movement associated with walleye following the large lake whitefish fall migration.

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. Downstream movements of walleye out of the ASA occur throughout the spring, summer and fall, with a portion of the population overwintering in downstream areas. However, some fish remain to overwinter in the Athabasca River. Sites in the Athabasca River used by overwintering walleye were characterized by shallow water depths, slow velocities and fine substrates.

1.2 NORTHERN PIKE

Northern pike is a cool-water species that prefers heavily vegetated habitats in shallow, clear waterbodies or bays of larger lakes, or streams with slow to moderate current. Northern pike 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 is one of the key sport fish species of the lower Athabasca River, but occurs in relatively low abundance compared to the most abundant species such as walleye, goldeye and lake whitefish (Golder 2003). Regional Aquatics Monitoring Program studies indicate little year-to-year variability in northern pike abundance. While there is variability in some population parameters, no specific trends were identified to indicate any population changes over the monitoring period (1997 to 2005).

Northern pike spawn in the spring at water temperatures in the range of 4.4 to 11.1ºC, with the critical time for spawning in the Athabasca River and some of its tributaries identified as the last half of May. It is presumed that there is a

spring migration of northern pike from overwintering areas in Lake Athabasca into the Athabasca River. These fish, in combination with northern pike that overwinter in the Athabasca River, are present in the ASA in the spring. Spring migrations have been recorded in several Athabasca River tributaries. Some of these migrations were determined to be feeding movements by juveniles and post-spawning adults, while some include spawning adults. Suitable northern pike spawning habitat is sparse in the Athabasca River and spawning activity has not been documented in the mainstem of the river. All documented spawning by this species has been located in tributary watercourses.

Northern pike eggs are adhesive and attach to vegetation during spawning. Preferred spawning habitat consists of heavily vegetated areas in marshes, lake bays and slow-moving rivers. These tend to be shallow areas (<1 m), with slow-moving water that are sheltered from the wind. The type of vegetation is not critical and northern pike have been reported to use emergent and submergent aquatic plants as well as flooded terrestrial vegetation (e.g., grasses). 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.

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 six 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, but fry have also been recorded in the Athabasca River irregularly and in low abundance.

Juvenile northern pike typically remain along shorelines or in shallow areas with adequate food and cover at depths <2 m, preferring areas with submerged vegetation. The adults also prefer shallow, but somewhat deeper (<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 being 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 use the Athabasca River in the ASA and its tributaries as 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 DO to provide

overwintering habitat. They remain active and feed through the winter. In the ASA, northern pike from tributary watercourses move to the Athabasca River or Lake Athabasca in the fall. Recent studies indicate that there is a greater degree of overwintering in the river, relative to the lake, by northern pike than by other sport species, and homing to overwintering sites has been recorded for some fish. Northern pike that overwinter in the Athabasca River select areas with shallow depths, slow velocities and fine substrates, but also show some selection of areas with coarser substrates. Northern pike appear to select shallower and slower habitats during the winter than other sport species.

1.3 LAKE WHITEFISH

Lake whitefish is a cold-water species, preferring deep, well-oxygenated waters and is usually found in large lakes, with occasional occurrences in rivers. Lake whitefish, a schooling species that is typically a bottom dweller, feed on benthic organisms such as insect larvae, clams, snails and amphipods. The lake whitefish population in the Oil Sands Region is primarily associated with Lake Athabasca, but a portion of the population uses the Athabasca River for specific life stage requirements (primarily spawning).

Lake whitefish is one of the key sport fish species in the lower Athabasca River and is one of the most abundant large-bodied fish in the Athabasca River within the ASA (Golder 2003). However, lake whitefish abundance is low in all seasons except the fall, when it is the most abundant large-bodied species in the river. Regional Aquatics Monitoring Program studies indicate year-to-year variability in lake whitefish abundance and some population parameters, but no specific trends to indicate any population changes over the monitoring period (1997 to 2005).

Lake whitefish spawn in the fall, at which time they move to suitable spawning areas in shallow lake habitats or in tributary watercourses. In the Oil Sands Region, a large migration of lake whitefish occurs between Lake Athabasca and known spawning grounds at Mountain and Cascade rapids located upstream of the ASA.

The migration typically begins in late August and peaks in mid-September, at which time lake whitefish comprise the most abundant, large-bodied species in the Athabasca River. Spawning tends to occur in mid-October, with the post-spawning downstream migration beginning in late October. The spawning period may be extended in years of warm fall weather, as evidenced by lake whitefish remaining at the spawning grounds into December of such years. However, most fish return back to Lake Athabasca quickly after initiating downstream movements.

Lake whitefish spawn either in shallow waters of lakes, such as shoals or rocky ledges, or in tributary watercourses. Spawning usually takes place in shallow water (<7.6 m) over a hard bottom of rock or sand, although preferred spawning substrate is boulder, cobble, rubble and gravel. Ideal spawning water temperatures are between 0.5 and 7.8ºC, with peak activity at 2ºC. Lake whitefish are broadcast spawners and the eggs settle to incubate in interstitial areas of the substrate.

Lake whitefish eggs remain on the spawning grounds through the winter months, hatching in the early spring, usually in April or May. When fry first hatch they are attracted to light and are found at depths of 2 m or less. At this time they are planktivorous, feeding on small crustaceans. Later in the summer, larger fry inhabiting lakes leave the shallow inshore waters and move to areas with depths between 5 and 10 m and substrates of boulder, cobble, gravel and sand. Their diet changes at this time and they begin to feed on benthic organisms. Most lake whitefish fry that hatch in the Athabasca River appear to drift downstream to nursery areas in Lake Athabasca; drifting fry have been recorded moving downstream in the ASA under the river ice in early April. A small amount of nursery activity has been recorded in the Athabasca River and is primarily associated with the mouths of a few tributaries.

Rearing habitat for juvenile lake whitefish includes deeper areas of lakes, up to and sometimes exceeding 10 m. They prefer areas of boulder, cobble, rubble and gravel substrates and pelagial (deep water) areas. Juvenile and adult lake whitefish are primarily bottom feeders and consume a wide variety of benthic invertebrates including aquatic insect larvae, molluscs and amphipods. The diet may also include planktonic organisms, terrestrial insects and small fish. The abundance of juvenile and adult lake whitefish is very low in the Athabasca River other than during the fall spawning migration. A small amount of rearing and feeding activity occurs for this species in selected habitats in the Athabasca River or in the lower portions of some of the larger tributaries.

Lake whitefish seek out deep waters during the winter and remain relatively active. Most lake whitefish overwinter in Lake Athabasca, but a small number of fish spend all or part of the winter in the Athabasca River.

1.4 ARCTIC GRAYLING

Arctic grayling is a cold-water species generally found in clear, cold waters of large rivers, rocky creeks and lakes. Their preferred habitats include areas with rocky substrates, such as boulders, cobble and gravel, and areas with cover provided by large substrate and submerged features such as logs. They 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. The Arctic grayling population in the Athabasca River is considered a 'mainstem river' population, with spawning occurring in smaller tributaries and fish remaining in tributaries to feed during the summer to avoid turbid mainstem river conditions. Arctic grayling use the Athabasca River mainly in the winter months.

Regional Aquatics Monitoring Program studies indicate that Arctic grayling comprise a minor component of the Athabasca River fish population during the open-water period (Golder 2003). Population trends for this species are unclear. Monitoring of fish migrations in one tributary watercourse, the Muskeg River, indicates a distinct decline in Arctic grayling use of this watercourse. In contrast, Arctic grayling abundance in the Steepbank River remains high, and has increased slightly over the past few years.

Arctic grayling spawn in the spring and generally prefer to spawn in riverine habitat, although lake spawning does occur. Spring migrations have been recorded for fish moving from the Athabasca River into several tributary watercourses. Spawning migrations occur in the early spring, with spawning taking place as the ice is first breaking up. Arctic grayling have been recorded entering Athabasca River tributaries in late April and early May immediately after ice-out, although it is suspected that they begin migrating earlier.

Preferred spawning habitat is riverine and includes gravel or rocky substrates (<20% fines) 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. 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.

The incubation period is relatively short and eggs hatch in 13 to 18 days at water 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. Arctic grayling fry initially feed on zooplankton, but gradually shift to insect larvae. The young of 'mainstem river' populations tend to remain in natal tributaries for the first year-and-a-half. Nursery activities in the ASA occur in the spawning tributaries.

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 behaviour that can result in competitive and intense feeding. Rearing and feeding activities in the ASA occur in pool and run habitats in tributary watercourses.

Arctic grayling are reported to avoid turbid rivers, except in the fall when they will enter large rivers prior to freeze-up. 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. Such fall out-migrations have been recorded in some Athabasca River tributaries and the abundance of Arctic grayling has been observed to increase in the Athabasca River starting in October, particularly near tributary confluences. Overwintering has recently been documented to occur in the Athabasca River for some Arctic grayling. In contrast, the extent of overwintering in tributary streams, if any life stages do so, has not been determined.

1.5 GOLDEYE

Goldeye is a cool-water species that occurs in lakes and connected ponds and marshes, as well as large rivers with high turbidity. The muddy shallows of large lakes are also ideal habitat. In general, goldeye diets consist primarily of zooplankton, and aquatic and terrestrial insects. Goldeye also feed on other fish and aquatic animals such as shrews and amphibians, with diet reflecting the size of the fish.

Goldeye is one of the key sport fish species in the lower Athabasca River and is one of the most abundant large-bodied fish in the Athabasca River within the ASA (Golder 2003). Regional Aquatics Monitoring Program studies indicate year-to-year variability in goldeye abundance and some population parameters, but no specific trends to indicate any population changes over the monitoring period (1997 to 2005).

Goldeye spawn in the spring, moving from deep areas of lakes and rivers to shallow, firm-bottomed substrate. Some goldeye populations undergo lengthy migrations to move to spawning areas. Spawning occurs in the last half of May in northern Alberta with spawning water temperatures reported to be between 10 and 13ºC. There is a major upstream movement of juvenile and adult goldeye in the Athabasca River from Lake Athabasca in the spring. Based on the presence of adult fish in the spring, it is possible that some goldeye spawning occurs in the river. However, spawning by this species has never been investigated in the Athabasca River, but is known to occur downstream in the Peace-Athabasca Delta.

Goldeye spawning habitat is generally reported as muddy, turbid rivers or backwater lakes and ponds of rivers. The fertilized eggs are semi-buoyant, likely an adaptation to spawning over sediments. Once hatching occurs, goldeye fry float to the surface. Goldeye fry have rarely been recorded in the Athabasca River, either due to lack of spawning or to downstream drift of the eggs or fry. Nursery activity has been recorded downstream in the Peace-Athabasca Delta.

Juvenile and adult goldeye have similar habitat requirements but may use different areas. For some populations, adult fish are known to move from spawning areas to other locations for summer feeding. In the ASA, both juvenile and adult goldeye rear and feed extensively in the Athabasca River during the open-water period, primarily using large backwaters and other low-velocity habitats or, less frequently, the lower portions of some of the larger tributaries.

Overwintering for goldeye occurs primarily in Lake Athabasca although some fish remain to overwinter in the Athabasca River. Goldeye abundance in the Athabasca River declines in the fall with most fish moving downstream in October and November.

1.6 YELLOW PERCH

Yellow perch is a cool-water species that occurs in a wide range of aquatic habitats, from large lakes or ponds to slow-moving rivers. Yellow perch are most abundant in the open water of clear lakes with a moderate amount of vegetation and a bottom of organic material, fines, sand and gravel, and less abundant in habitats with increased turbidity or decreased vegetation. Yellow perch feed primarily on immature insects, larger invertebrates and fishes, taken in open water or off the bottom. Yellow perch are usually found at water temperatures of 19 to 21ºC and appear to move seasonally to follow the 20ºC isotherm in the waterbodies they inhabit. Yellow perch are considered a shallow water fish in lakes, usually remaining above 30 m, but they have been recorded to 150 m.

Yellow perch are relatively uncommon in the lower Athabasca River, being occasionally recorded in the Athabasca River or the lower portions of some of its tributaries.

Yellow perch spawn in the spring, moving into the shallows of lakes or into tributary rivers to spawn. Spawning takes place in late April or in May at water temperatures ranging from 6.7 to 12.2ºC. Yellow perch are present in low abundance where they occur in the ASA. Spawning activity by yellow perch has not been documented in the ASA, except in the Poplar Creek Reservoir, where a stocked population was present at one time.

Spawning usually takes place near rooted aquatic vegetation or submerged terrestrial vegetation, but sometimes over sand or gravel. Yellow perch eggs are extruded by the female in a unique transparent, gelatinous, accordion-folded mass that is tube shaped. The mass adheres to submerged vegetation, where present, or to the bottom. The egg mass is semi-buoyant and undulates with water movement so that the eggs are aerated by water circulating through holes and a central canal in the mass.

Yellow perch eggs hatch in eight to 10 days and the newly emerged fry are inactive for about five days during absorption of the yolk sac. Fry initially feed on plankton but also on aquatic invertebrates such as chironomid (midge) larvae. Early growth can be rapid but is extremely variable depending on population size and habitat conditions. Fry are gregarious and may form large, compact schools.

Yellow perch adults and young are also gregarious, often foraging in loose aggregations segregated by size, with juveniles in shallower water and nearer shore than the adults. Juveniles feed mainly on invertebrates, but small fishes may form up to 30% of the diet. Invertebrates in the juvenile diet include midge larvae, dragonfly and mayfly nymphs, molluscs and ostracods. Adult fish also feed on invertebrates, but small fishes form a greater portion of their diet. Yellow perch prey on the eggs and young of a wide variety of fishes. Length stunting often occurs for this species in crowded populations, with adults never exceeding 152 mm in length.

Yellow perch are active all winter under the ice, but overwintering activities in the ASA are largely unknown. The stocked population of yellow perch in Poplar Creek Reservoir initially overwintered there, but lack of DO in March 2003 resulted in the loss of this population due to winterkill.

1.7 LONGNOSE SUCKER

Longnose sucker is a widely distributed species and occurs in most locations with clear, cold water. It is a benthic species that inhabits the bottoms of lakes or tributary watercourses, but prefers larger waterbodies, being most abundant in deep, oligotrophic lakes. As benthic feeders, longnose sucker feed almost entirely on invertebrates, although the young may feed on aquatic vegetation. In lakes, they are generally found at depths >10 m and have a high affinity for submerged cover and vegetated areas associated with gravel, sand or fine substrates.

Longnose sucker is one of the most abundant large-bodied fish in the Athabasca River within the ASA (Golder 2003). Regional Aquatics Monitoring Program studies indicate year-to-year variability in longnose sucker abundance and some

population parameters, but no specific trends to indicate any population changes over the monitoring period (1997 to 2005).

Longnose sucker spawn in the spring, moving to tributary watercourses to spawn after ice-out when water temperatures reach 5ºC. Although spawning usually occurs in watercourses, it may also take place in shallow areas of lakes. Spawning usually occurs in May or June. There is a large upstream movement of longnose sucker from Lake Athabasca into the Athabasca River in the spring. This migration is, in part, a spawning run that includes fish that spawn in the Athabasca River (at the rapids upstream of the ASA) and fish that spawn in tributary watercourses.

Longnose sucker spawning typically occurs in riffle habitat at depths of ≤1.0 m, with velocities of 0.3 to 0.45 m/s over gravel substrate. Spawning is also known to occur in deeper and faster water with larger substrate. No nests are built and the demersal eggs sink to the bottom and adhere to the substrate.

Longnose sucker eggs hatch in about two weeks and the newly hatched fry remain inactive in the substrate for another week or two before emerging. After emergence, fry spawned in rivers remain for most of their first summer in shallow, quiet waters with aquatic vegetation for cover, or around boulders and cobbles in depths up to 1.0 m. Longnose sucker are planktivorous as fry but switch to a benthic feeding habit as they grow. Spawning tributaries provide important nursery areas.

Rearing habitat for juvenile longnose suckers in rivers includes quiet waters with vegetation or some other form of cover, while in lakes it includes shallow (<5.0 m), vegetated areas. Adult feeding habitat includes deeper portions of lakes and rivers. Food items for juveniles and adults vary depending on location and season, but are limited to benthic invertebrates such as amphipods, insect larvae and small crustaceans. The Athabasca River and its tributaries provide important rearing areas and, to a lesser extent feeding areas, but some adults return downstream to larger systems for summer feeding.

Overwintering for longnose sucker occurs in lakes and quiet areas of large rivers. Most longnose sucker that use the ASA overwinter in Lake Athabasca, but a small amount of overwintering has also been recorded in the Athabasca River.

1.8 WHITE SUCKER

White sucker occur in rivers and shallow lakes or shallow (i.e., <10 m) portions of deep lakes, and are tolerant of a wide diversity of environments (Nelson and Paetz 1992). They are bottom feeders and primarily consume benthic invertebrates.

White sucker is one of the most abundant large-bodied fish in the Athabasca River within the ASA (Golder 2003). Regional Aquatics Monitoring Program studies indicate year-to-year variability in white sucker abundance and some population parameters, but no specific trends to indicate any population changes over the monitoring period (1997 to 2005).

White sucker are spring spawners and typically spawn from mid-May to June. They migrate from lakes to gravel-bottomed streams or lake margins when water temperatures reach 10°C. White suckers in the Oil Sands Region migrate from Lake Athabasca into the Athabasca River and are known to migrate into several of the tributary watercourses to spawn.

White sucker spawn primarily in watercourses, but can spawn in lake shallows. Spawning habitat is usually shallow water over a gravel bottom. No nest is built and the eggs are scattered and adhere to the bottom substrate.

The eggs hatch in eight to 11 days at water temperatures of 10 to 15°C. The newly hatched fry remain in the gravel for a period of one to two weeks absorbing the yolk sac. Young fry initially feed at 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.

Juvenile and adult white suckers are bottom feeders and consume molluscs, insect larvae and algae. Rearing and feeding activities during the summer occur in the Athabasca River and in some tributary watercourses.

Most white sucker return to Lake Athabasca over the summer or fall and overwintering primarily occurs in the lake. A small number of fish have been captured in the Athabasca River in the winter months, indicating a limited amount of overwintering also occurs in the river.

1.9 FORAGE FISH GUILD

The forage fish guild is an association of small-bodied fish species, which for the Oil Sands Region consists of minnows (family Cyprinidae), trout-perch

(Percopsidae), stickleback (Gasterosteidae) and sculpins (Cottidae). The specific species included in the forage fish guild for the EIA varies for each watercourse or waterbody, depending on the species present. For all areas combined, forage species selected as KIRs include brook stickleback, pearl dace, brassy minnow, fathead minnow, lake chub, slimy sculpin, spoonhead sculpin and trout-perch.

Brook stickleback occur in or near aquatic vegetation in streams, bogs, beaver ponds and lakes and is the most abundant fish in many small lakes and ponds, and habitats devoid of larger piscivores. This species has a high tolerance to low DO levels and often occurs in areas where other fish cannot survive (Nelson and Paetz 1992). 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. 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.

Pearl dace occur in slow-flowing streams and in lakes along the shallow margins near cover. In the northern portion of their range, pearl dace are found in bog drainage streams, ponds, small lakes and beaver impoundments. They are often found in association with brook stickleback and can be very abundant. Spawning takes place in the spring, probably in May or June (Nelson and Paetz 1992). Males maintain spawning territories and spawning takes place on sand or gravel (Scott and Crossman 1998). In streams, spawning occurs in weak or moderate current. Pearl dace feed primarily on zooplankton and small benthic invertebrates, as well as algae. Pearl dace are widely distributed in the Oil Sands Region, particularly in small watercourses in tributary watersheds and in lakes and ponds.

Brassy minnow occur in slow streams, boggy lakes and shallow bays (McPhail and Lindsey 1970). They have also been reported to prefer clear slow streams with sandy bottoms (Brown 1971). Spawning occurs in spring or summer, in May to July (Brown 1971; Scott and Crossman 1998; Nelson and Paetz 1992), with the eggs being deposited in quiet water, over a silt bottom, vegetation or debris. Brassy minnows feed primarily on plant material, including algae that is scraped from the bottom and phytoplankton; some zooplankton and aquatic insects may also be consumed (Brown 1971; Scott and Crossman 1998).

Fathead minnow occur in large numbers in muddy creeks, ponds and lakes. Individuals are often found with brook stickleback and are quite tolerant to extremes in pH and salinity, and can often survive in areas where other fish species could not (Nelson and Paetz 1992). Preferred habitat includes still waters of ponds, and they are generally found at depths <2 m (Lane et al. 1996). Spawning is prolonged and occurs from June to August. The male selects a spawning site on the underside of a log, branch, or rock in water <1 m deep. The female is then attracted to the site, upon which she deposits adhesive eggs to the underside of the chosen object. The male cares for and guards the eggs until hatching occurs 4.5 to 6 days later. Fathead minnows consume larval insects, vegetation and detritus (Scott and Crossman 1998). Fathead minnows are widely distributed in the Oil Sands Region, particularly in small waterbodies and tributary watersheds.

Lake chub commonly inhabit lakes, rivers and small creeks (Scott and Crossman 1998) featuring clear to turbid water (McPhail and Lindsey 1970) and have been recorded in a wide variety of habitat independent of substrate type (Brown 1969). This species is often extremely abundant. Spawning occurs in the late spring or early summer, from June to mid-August (Nelson and Paetz 1992) and occurs mainly in watercourses, although this species is also known to spawn in lakes over shallow rocky shoals and shorelines and will also use vegetation when rocky substrate is not present (Golder 1998).

Lake chub spawning can occur over a wide variety of substrates including silt, gravel, cobble or boulder, with no nests built (Bradbury et al. 1999). Lake chub fry stay near the water surface for the first month following hatching, then move to deeper water in low-velocity habitats (Golder 1998). Juvenile and adult fish are found in a wide variety of habitats but prefer rocky areas with moderate vegetation (Brown 1969) and feed on aquatic insects, crustaceans and algae. Lake chub are widely distributed in the Oil Sands Region, particularly in tributary watersheds.

Slimy sculpin occur in lakes and cool, rocky streams (Nelson and Paetz 1992). This species is a bottom dweller and typically lives between or under rocks. Slimy sculpin spawn in the late spring (May to June). During spawning, the male prepares a nest site under a submerged object, such as a rock, and the female deposits the adhesive eggs (Scott and Crossman 1998). The male guards the incubating eggs and the newly hatched fry until they become free-swimming. Slimy sculpin feed primarily on bottom fauna, consuming aquatic insects, crustaceans, plants and sometimes small fish (Nelson and Paetz 1992). Slimy sculpin occur in the Athabasca River and several tributary watercourses.

Spoonhead sculpin occur in lakes, in both shallow and deep water, but are most abundant in streams (Nelson and Paetz 1992). They are a bottom dweller that lives under or among rocks. Spoonhead sculpin spawn in the spring (April to May). Like other sculpin species, the male prepares a nest site under an object and the female deposits the adhesive eggs, after which the male guards the incubating eggs and newly hatched fry. Spoonhead sculpin feed on aquatic insects and crustaceans. This species occurs in the Athabasca River and some of its tributaries watercourses.

Trout-perch commonly occur in lakes and slow rivers at depths ranging up to 10 m (Lane et al. 1996; Nelson and Paetz 1992). This species spawns in the spring or summer (May to July) in shallow rocky streams or lake shallows over substrates of cobble, gravel, sand and silt (Nelson and Paetz 1992). Spawning is generally associated with the presence of in-situ cover (Carlander 1969; Lane et al. 1996). Trout-perch are known to remain under cover during the day, coming out to feed at night in shallow areas. They are generally recorded over sandy or rocky substrates, but occasionally in areas with submergent vegetation (Sawchyn 1973). They feed on crustaceans and aquatic insects such as midge and mayfly larvae. Trout-perch is a common species in the Oil Sands Region, particularly in the mainstem Athabasca River where large schools occur along shoreline areas and in tributary mouths. This species is also distributed throughout some of the larger tributary watercourses.

1.10 BENTHIC INVERTEBRATES

Benthic invertebrates were identified as a KIR for all watercourses and waterbodies. This 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.

Benthic invertebrate communities occur in a wide variety of habitats and reflect the physical and chemical characteristics of their surroundings. Therefore, there are no specific habitat requirements for this KIR other than a basic aquatic environment, including 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). However, 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.

Details on the benthic invertebrate communities in the ASA are provided in Section 4.2.2 of the Voyageur South Project Fish and Fish Habitat Environmental Setting Report (Golder 2007).

2 GLOSSARY

Telemetry Study Study conducted to monitor fish movements through the use of a remote tracking device, such as a radio transmitter, attached to the fish.

Omnivorous Carnivore A fish species with a diet that consists primarily of other fish, with no particular selectivity for a specific prey item.

Isotherm A zone or portion of a waterbody with the same water temperature.

3 REFERENCES

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.

Brown, J.H. 1969. The Life History and Ecology of the Northern Lake Chub (*Couesius plumbeus*) in the La Ronge Region of Saskatchewan. Master of Science Thesis. University of Saskatchewan. Saskatoon, SK.

Brown, C.D. 1971. Fishes of Montana. Big Sky Books. Bozeman, Montana.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology. Vol. 1. Iowa State University Press. Ames, IA.

Golder. (Golder Associates Ltd.). 1998. Oil Sands Regional Aquatics Monitoring Program (RAMP). 1997 Report. Prepared for Suncor Energy Inc., Shell Canada Limited and Syncrude Canada Ltd. Fort McMurray, AB. 148 pp. + Appendices.

Golder. 2003. Oil Sands Regional Aquatics Monitoring Program (RAMP) - 2002. Submitted to the RAMP Steering Committee. Calgary, AB. 825 pp.

Golder. 2004. Athabasca River Instream Flow Needs Study Scoping Study. Submitted to the Cumulative Environmental Management Association, Surface Water Working Group. Fort McMurray, AB. 130 pp.

Golder. 2007. Fish and Fish Habitat Environmental Setting Report for the Suncor Voyageur South Project. Prepared for Suncor Energy Inc. March 2007. Calgary, AB.

Lane, J.A., C.B. Portt and C.K. Minns. 1996. Spawning Habitat Characteristics of Great Lakes Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2368. Burlington, ON.

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

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

RL&L and Golder (RL&L Environmental Services Ltd. and Golder Associates Ltd.). 2003. Fish Overwintering Use of the Lower Athabasca River 2001 to 2003. Prepared for CEMA Water Working Group. Report Number 012-7014. Edmonton, AB. 113 pp.

Sawchyn, W.W. 1973. Environmental Survey of Wollaston Lake, Saskatchewan. Saskatchewan Research Council, Chemistry Division.

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

Westworth Associates (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, Alberta. 304 pp.