SECTION 5.3

BIOLOGICAL ENVIRONMENT

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5.3 BIOLOGICAL ENVIRONMENT

This Section describes the biological aspects of the Project setting that could be affected by Project development. This includes baseline conditions for fisheries and aquatic resources; vegetation; wildlife and habitat; and biodiversity.

5.3.1 Fisheries and Aquatic Resources

This Section of the Environmental Impact Statement (EIS) describes the existing (baseline) conditions for fish and aquatic resources in the vicinity of the Star-Orion South Diamond Project (Project). The fish and aquatic baseline data presented here is derived from field studies conducted from 2006 to 2008.

5.3.1.1 Introduction

From 2006 to 2008, extensive aquatic baseline studies were conducted in the Project Local Study Area (LSA). The LSA for the fish and aquatic resources studies included streams that may be affected by the Project either indirectly (e.g., by groundwater draw down) or directly (e.g., lost due to Project development), and areas of the Saskatchewan River approximately 100 m upstream and 200 m downstream of each stream (Figure 5.3.1-1). In the streams, the study areas included a reach of approximately 500 m upstream of the Saskatchewan River, as well as upper reaches of streams in areas within the Project footprint, or in other representative reaches. The upper reaches studied included the following:

- 101 Ravine;
- West and East ravines;
- Duke Ravine; and
- Wapiti Ravine.

An access road corridor encompassing a roadway, communication lines, and a natural gas pipeline is proposed which would cross the White Fox River at the northern boundary of the forest (Figure 5.3.1-1). However, since development plans include widening the existing clear span bridge at the White Fox River crossing, aquatic assessments were not necessary as assessment was completed previously.

The majority of the aquatic investigations were completed in 2007 and 2008 and detailed results are provided in CanNorth (2010a). In 2007, aquatic assessments were focused in Caution Creek, 101 Ravine, West Perimeter Ravine, West Ravine, East Ravine, and English Creek, as well as regions of the Saskatchewan River surrounding these streams. In 2008, assessments were conducted in Duke Ravine, FalC Ravine and Wapiti Ravine. In addition, some aquatic studies were completed in selected streams in May 2006 (Golder 2006).

The objective of these baseline investigations was to characterize the biological environment in the LSA, with a particular focus on fish and fish habitat, prior to development of the Project in preparation for the EIS. The information collected included documenting benthic invertebrate and fish community composition, fish species abundance, fish spawning, fish chemistry, and the quantity and quality of critical aquatic habitat in the nine streams and areas of the Saskatchewan River located in the LSA. Baseline information is summarized below.

5.3.1.2 Information Sources and Methods

Field studies for benthic invertebrate community assessments, fish surveys, and aquatic habitat assessments are described in this Section.

Benthic Invertebrates

Benthic invertebrate communities were sampled as they are good indicators of changes in the quality of aquatic habitat and they provide a food source for many fish species. Benthic invertebrates were sampled in the lower reaches of eight of the nine streams (Wapiti Ravine was not sampled due to an early freeze-up in 2008) and in regions of the Saskatchewan River downstream of each stream and upstream from the mouth of Caution Creek (Figure 5.3.1-2). Samples were collected in either October 2007 or November 2008 during periods of low benthic invertebrate emergence. In each sampling area, five replicate stations spaced a minimum of 20 m apart were established. At each station, benthic invertebrate samples were collected as well as site characterization information including channel width and depth, stream flow, and general descriptions of substrate composition. Differences in physical habitat characteristics between the streams were controlled for, to the extent possible. Sediment particle size data were collected at the Saskatchewan River benthic invertebrate sampling stations (Section 5.2.8).

Sampling methods and the habitat types sampled differed between the streams and the Saskatchewan River in order to sample the dominant habitat in each study area. In the Saskatchewan River, benthic invertebrate samples were collected from near-shore areas at depths of less than 1 m in sand/silt substrates using an Ekman dredge (0.052 m^2) and rinsed through a 500 μm mesh. Each sample was a composite of three dredges to ensure that a representative number of taxa was obtained. In the streams, benthic invertebrate samples were collected from riffle habitats using a Neill cylinder (0.1 m^2) sampler equipped with a 210 μm mesh. A single cylinder sample was collected at each station, and the sample was filtered through 500 μm mesh before analyses to be consistent with Environmental Effects Monitoring (EEM) methodology (Environment Canada 2002). In 2008, the water depth in FalC Ravine was too shallow to use a Neill Cylinder sampler (all suitable substrate areas were dry) therefore, a 500 μm kick-net sampling method was used to collect the benthic invertebrate samples.

The benthic invertebrate samples were submitted to a qualified taxonomist who identified organisms to the lowest practical taxonomic level and provided biomass estimations. The taxonomic keys used and quality assurance/quality control procedures followed are detailed in CanNorth (2010a).

Benthic invertebrate communities from each sampling area were assessed in terms of density (number of organisms/m^2), richness, biomass, Simpson's diversity, Simpson's evenness, and EPT%[1]. All indices were calculated at the taxonomic level of family as recommended in the Metal Mining Guidance Document for EEM (EC 2002). Each metric was compared between study areas in the Saskatchewan River and between streams with the use of Analysis of Variance (ANOVAs) and Tukey's post-hoc tests. The significance of differences was determined using alpha = 0.10.

Fish

Fish surveys conducted in the LSA consisted of summer community assessments (2007 and 2008) as well as spring and fall spawning surveys (2006 to 2008). The summer fish community surveys were performed using minnow traps and backpack electrofishing in the streams, and boat electrofishing in the Saskatchewan River, maximizing the capture of a diversity of species and body sizes across a range of habitat types. Electrofishing effort in the Saskatchewan River included making two passes of each study area (100 m upstream and 200 m downstream from stream mouths); block nets were not used due to the large width of the river. The methods of fish capture utilized during the spring and fall spawning surveys included hoop nets, spawning nets (short-length gill nets), and boat electrofishing (in the Saskatchewan River only). Table 5.3.1-1 summarizes the sampling methods used in each stream during each survey since the level of effort differed depending on the size and water level in the stream at the time of the survey. Fish assessments were not conducted in the upper reach of Wapiti Ravine within the CPKP because no water was present.

[1] EPT% = percentage of the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) found in the study area.

Table 5.3.1-1: Summary of the Fishing Methods Used During Each Survey Conducted in the Streams in the Project Local Study Area

Study Area	Season/Year	Methods[1]	Type of Survey
Caution Creek	Spring 2006	HN and SP	Spring spawning
	Summer 2007	BP and MT	Fish community
101 Ravine	Summer 2007	BP and MT	Fish community
101 Ravine in Overburden Pile	Summer 2008	BP and MT	Fish community
West Perimeter Ravine	Fall 2007	MT	Fish community
West Ravine	Spring 2007	HN	Spring spawning
	Summer 2007	BP and MT	Fish community
West Ravine in Star pit	Summer 2008	BP and MT	Fish community
East Ravine	Spring 2006	HN	Spring spawning
	Spring 2007	HN	Spring spawning
	Summer 2007	BP and MT	Fish community
East Ravine in Star pit and Water Management Reservoir	Summer 2008	BP and MT	Fish community
Duke Ravine	Summer 2008	BP and MT	Fish community
Duke Ravine in PKCF	Summer 2008	BP and MT	Fish community
FalC Ravine	Summer 2008	BP	Fish community
Wapiti Ravine	Summer 2008	BP and MT	Fish community
English Creek	Spring 2006	HN and SP	Spring spawning
	Spring 2007	HN and SP	Spring spawning
	Summer 2007	BP and MT	Fish community
	Fall 2007	HN	Fall spawning

Notes: [1] HN = hoop net, SP = spawning net, MT = minnow trap, BP = backpack electrofisher.

During the spring and fall spawning surveys, egg searches were conducted in rocky habitats using a kick-net in the streams and egg-suctioning in the Saskatchewan River to confirm spawning habitat utilization[2]. Since cisco were the only large-bodied fish species captured in the Project LSA that spawn in the fall, the fall spawning survey largely focussed on egg searches in the Saskatchewan River for cisco eggs.

Captured fish were identified, measured, and visually assessed for external health. Fish measurements included length and weight for all large-bodied fish and length for a subsample of small-bodied fish. The relative abundance of fish species was assessed using

[2] Aquatic vegetation was not present in which to complete net sweeps for northern pike or yellow perch eggs.

catch per unit effort (CPUE) data from electrofishing collected during the spring and fall spawning surveys and the summer community surveys in 2007 and 2008. Boat electrofishing was conducted in the Saskatchewan River, while backpack electrofishing was conducted in the streams. As a result, direct comparisons between the Saskatchewan River and the streams were complicated by potential gear bias and associated sampling efficiencies.

Five composite lake chub samples were collected from each of 101 Ravine, East Ravine, and English Creek, and five composite juvenile white sucker samples were collected from each of East Ravine, Duke Ravine, and English Creek for chemical analyses of ions, metals, and trace elements. These species were chosen since they were abundant in the LSA and they provide baseline data from different feeding guilds. Multiple fish had to be composited per sample in order to obtain adequate sample weight to complete chemical analyses.

Otoliths were removed from individuals retained for chemical analyses to determine age. Age analysis was completed by North/South Consultants Inc. in Winnipeg and chemical analysis was completed by the Saskatchewan Research Council in Saskatoon.

Differences in fish chemistry, morphology, and age between streams were assessed with the use of ANOVAs (or non-parametric ANOVAs if assumptions of parametric ANOVAs could not be met) and Tukey's post-hoc tests. The significance of differences was determined with the use of alpha = 0.05.

Lake sturgeon monitoring data collected by the Saskatchewan Watershed Authority (SWA) from 2007 and 2010 was used to provide specific information on the occurrence of this species in the Project LSA. Between August 9th and 22nd, 2007, SWA fished for lake sturgeon in four areas of the Saskatchewan River system, including near English Creek, using deadline and angling (SWA 2008a). The length and weight of all lake sturgeon captured was recorded. Between early May and mid-August 2008, lake sturgeon fishing was completed at 16 sites on the Saskatchewan River system using hook and line angling from shore (SWA 2008b). Captured specimens were measured, weighed, tagged using passive integrated transponder tags to identify and monitor their movements, and then further marked using two external Floy tags. In 2009, SWA commenced a comprehensive, multi-partner, three year study examining habitat availability, selection, and population health of lake sturgeon in the Saskatchewan River system (SWA 2009). To investigate habitat use and migration, 37 adult lake sturgeon were captured using either angling or set lines near the Forks[3] and were tagged with radio transmitters. Tagged sturgeon are tracked via remote passive towers, aerial tracking, and ground tracking. One of the passive tower sites, the FalC tower, is located approximately 2.5 km upstream of 101 Ravine on the south

[3] The Forks is where the North Saskatchewan River (NSKR) and South Saskatchewan River (SSKR) converge to form the Saskatchewan River (SKR).

side of the Saskatchewan River and is therefore within the Project LSA. Tracking began in October 2009 and will continue until 2012, thus only preliminary data are available at this time.

Aquatic Habitat

Detailed assessments of the quantity and quality of critical fish habitat in the Project LSA were conducted in 2006, 2007, and 2008 (CanNorth 2010a; Golder 2006). These detailed assessments have been summarized for this Section to provide an overview of the fish habitat available. The study areas in the Saskatchewan River were assessed from 100 m upstream to 200 m downstream of the mouth of each stream. Each stream was assessed for approximately 500 m upstream of the Saskatchewan River as well as in the areas within the Project footprint, based on the understanding of the footprint at the time of survey. These habitat assessments represent a snap shot in time, since frequent changes in habitat types are likely to occur naturally due to changes in seasons and physical barriers such as beaver dams.

The assessment of potential critical fish habitat was modified for the Project based on the habitat evaluation procedure developed by the U.S. Fish and Wildlife Service (USFWS 1980) and guidance documents (e.g., Fisheries and Oceans Canada (DFO) and BC Ministry of Environment and Parks 1987; Langhorne et al. 2001; Ontario Ministry of Natural Resources (OMNR) 1989; Orth 1989) recommended in the Metal Mining Guidance Document for EEM (Environment Canada 2002). Each study area was divided into a series of Habitat Sections (HS) based on physical characteristics. The upland, riparian, and in-stream/littoral zones of each HS were described in the field and photographs were taken for reference. In the streams, the in-stream habitat was characterized by recording percent composition of each substrate type (silt/clay, sand, gravel, cobble, boulder, or organic), the density of emergent, floating leaf, or submergent aquatic vegetation, the amount and type of fish cover, the dominant habitat types (percentage of pools, riffles, runs, or glides), channel characteristics including wetted width, bank width, bank depth, mean center depth, maximum depth, braided channels, and the presence of obstructions. Similar information was obtained from each HS in the Saskatchewan River, however, complete channel characteristics were not measured and the gradient of the littoral zone was estimated by measuring water depth 5 m from shore.

These descriptions were used to determine the spawning suitability of each HS for key fish species captured in the Saskatchewan River and streams during the 2006, 2007, and 2008 fish surveys[4]. Key fish species included in the Saskatchewan River assessments were lake sturgeon, northern pike, yellow perch, walleye, sauger, white sucker, longnose sucker, and

[4] Although lake sturgeon were not captured during the baseline surveys, they are known to reside in the LSA and were included in the spawning assessments due to their conservation status as a rare (provincially) and endangered (federally) species

shorthead redhorse. The determination of suitability was based on known spawning habitat characteristics that have been described in the literature (Block 2001; Bruch and Binkowski 2002; Busch et al. 1975; Casselman and Lewis 1996; Chen 1980; Chevalier 1977; Chiasson et al. 1997; Edwards 1983; Geen et al. 1966; Harris 1962; Inskip 1982; Johnson 1961; Kempinger 1988; Kempinger 1996; Kreiger et al. 1983; Langhorne et al. 2001; Manny and Kennedy 2002; McMahon et al. 1984; Minns et al. 1996; Peterson et al. 2007; Scott and Crossman 1998; Twomey et al. 1984) and are provided below.

Lake Sturgeon

Not Suitable (0)	an area with an organic or silt bottom substrate, particularly with aquatic plant debris and little or no current;
Marginal (1)	areas with sand and/or silt bottom substrate but free of aquatic plant debris, particularly with some current;
Moderate (2)	areas with clean gravel, cobble, and boulder substrate, in >0.6 m of water, especially with void spaces or crevices between the rock (>30 cm) and good current; and
Most Suitable (3)	areas similar to “moderately suitable” but substrate layered and found in riffles with a moderate to strong current (in excess of 0.5 m/s).

Northern Pike

Not Suitable (0)	an area that does not support aquatic plant growth and predominantly consists of a rock and/or sand substrate;
Marginal (1)	an area supporting a sparse growth of aquatic plants, usually Carex;
Moderate (2)	an area that supports moderate to dense aquatic plant growth; and
Most Suitable (3)	an area similar to 2 but the substrate is found in water <0.5 m in depth with little or no current covered with aquatic plant material, particularly “feather” moss but also senesced aquatic plants.

Walleye and Sauger

Not Suitable (0)	an area with an organic or silt substrate, particularly with aquatic plant debris;
Marginal (1)	an area with a sand and/or silt substrate but free of aquatic plant debris;
Moderate (2)	an area with a clean gravel, cobble, and boulder substrate, in <1.5 m of water, particularly with spaces or crevices between the rock; and
Most Suitable (3)	an area similar to 2 but found in a shoal or reef area of a lake or riffle of a stream with good water circulation or movement from wave action or current.

White Sucker, Longnose Sucker, and Shorthead Redhorse

Not Suitable (0)	an area with an organic, silt, and/or sand substrate, particularly with aquatic plant debris;
Marginal (1)	an area with a predominantly sand and/or silt substrate with some gravel and/or cobble but free of aquatic plant debris;
Moderate (2)	an area with a clean gravel and/or cobble substrate, in <0.5 m of water with some water movement; and
Most Suitable (3)	an area, particularly in a stream, with a clean gravel substrate, in <0.3 m of water with good water movement due to currents.

Yellow Perch

Not Suitable (0)	an area that does not support aquatic plant growth and consists of a cobble or boulder substrate, especially with a moderate or strong current;
Marginal (1)	a relatively shallow area that does not support aquatic plant growth and consists of a sand or gravel substrate with little or no current;
Moderate (2)	an inshore area that supports sparse rooted aquatic plant growth, particularly with some submerged brush and/or fallen trees and little or no current; and
Most Suitable (3)	an inshore area that supports moderate to dense rooted aquatic plant growth, particularly with significant amounts of submerged brush and/or fallen trees and little or no current.

General assessments of nursery, rearing, feeding, and overwintering habitats were based on known habitat utilization characteristics for different life stages of each key species. The quality and quantity of suitable spawning habitat within the study area was generally indicative of the nursery and rearing habitat available, however, habitat preferences do differ between these life stages for some species and these were considered in the assessment. The presence of suitable prey largely determined feeding habitat. The quality and quantity of overwintering habitat was assessed based on habitat type and depth of each waterbody.

5.3.1.3 Results

Benthic Invertebrates

The results of the benthic invertebrate sampling program including on site characterization, the Saskatchewan River benthic invertebrate communities, and the stream benthic invertebrate communities are summarized below.

Site Characterization

The stations sampled in the Saskatchewan River located upstream and downstream of Caution Creek and downstream of 101 Ravine, West Ravine, East Ravine, and Duke Ravine contained predominantly fine sand with means between 53.2 to 73.6%. In the Saskatchewan River downstream of West Perimeter Ravine, FalC Ravine, Wapiti Ravine, and English Creek, the substrate composition contained approximately 40% fine sand and 40% silt, although there was variability in substrate composition between sampling stations at most streams. Refer to Section 5.2.8, Appendix 5.2.8-B, Table 13 for more information.

Erosional habitats were sampled in the streams which were comprised mostly of sand/gravel substrate, however, there were differences between sampling stations within each stream. Table 5.3.1-2 provides a general description of the substrate composition documented at the benthic invertebrate sampling stations in each stream and provides a summary of the mean station depths, the creek widths at the sampling locations, and mean velocity measurements. As the table illustrates, the sampling depths were shallow (<0.2 m) and the mean velocity ranged from 0.25 to 0.57 m/s.

Table 5.3.1-2: Summary of Site Characterization Information Taken at the Benthic Invertebrate Stations Sampled in the Streams in the Project Local Study Area, October 2007 and November 2008

Tributary	Mean Station Depth (m)	Mean Channel Width (m)	Mean Velocity (m/s)	Substrate Description
Caution Creek	0.189	3.80	0.570	73.8% gravel, 20% sand, 5.8% cobble
101 Ravine	0.150	1.86	0.246	64% sand, 30% gravel, 3% cobble, 3% organics
West Perimeter Ravine	0.077	1.30	0.292	65% gravel, 22% sand, 9% cobble, 4% organics
West Ravine	0.163	0.87	0.295	47% sand, 42% gravel, 9% organics, 2% silt/clay
East Ravine	0.142	1.82	0.509	75% gravel, 22% sand, 2% organics, 1% cobble
Duke Ravine	0.176	1.14	0.313	56% cobble, 33.6% gravel, 10.4% sand
FalC Ravine	0.036	0.49	N/A[1]	53% gravel, 42% sand, 5% cobble
English Creek	0.185	3.80	0.333	78.6% gravel, 10% sand, 9.4% cobble, 2% silt/clay

Notes: [1] Tributary was too shallow to measure velocity.
At each station, two measurements of depth and velocity were taken, thus the values presented are the means of ten measurements taken in each tributary.

Saskatchewan River

The enumeration analyses for the benthic invertebrate samples collected in the Saskatchewan River demonstrated that, overall, the Family Chironomidae (larval non-biting midges) in the Order Diptera (true flies) dominated the benthic invertebrate communities sampled (Figure 5.3.1-3; Appendix 5.3.1-A, Table 1). This family was the dominant taxa and comprised greater than 65% of the community composition at five of the stations, upstream of Caution Creek and downstream of Caution Creek, 101 Ravine, West Perimeter Ravine, and West Ravine. It was also the dominant taxa in the community sampled downstream of East Ravine, however, the Family Sphaeriidae (Class Pelecypoda (clams)) was also prevalent comprising 31% of the total composition. At the stations located downstream of Duke Ravine, FalC Ravine, Wapiti Ravine, and English Creek, the Family Tubificidae (oligochaete worms) was the dominant taxon, comprising greater than 40% of the sample composition on average.

Benthic invertebrate community metrics are summarized in Table 5.3.1-3. Mean (± standard deviation) density of benthic invertebrates ranged from a low of 83 ± 72 organisms/m^2 downstream from 101 Ravine to a high of 15,381 ± 14,491 organisms/m^2 downstream from Wapiti Ravine. Biomass followed similar trends as density, with low and high values of 1.1 ± 1.92 g/m^2 and 125 ± 136 g/m^2 found downstream of 101 Ravine and West Perimeter Ravine, respectively. Statistical differences were found between Saskatchewan River study areas with the stations located downstream of 101 Ravine and East Ravine containing significantly lower densities and biomass than most other stations (Table 5.3.1-4).

Table 5.3.1-3: Summary of Benthic Invertebrate Community Metrics from the Saskatchewan River in the Project Local Study Area, October 2007 and November 2008

Sampling Area	Density (#/m²)	Richness (#families)	Simpson's Diversity	Simpson's Evenness	Biomass (g/m²)	%EPT
Upstream of Caution Creek						
Mean	2562	7.2	0.438	0.339	10.630	4.506
Standard deviation	2040.8	2.77	0.2159	0.2263	8.0558	6.3141
Minimum	205	3	0.09	0.14	2.43	0.46
Maximum	5628	10	0.67	0.65	23.98	15.63
Downstream of Caution Creek						
Mean	713	4.6	0.369	0.428	13.623	1.083
Standard deviation	723.7	1.82	0.1448	0.2666	0.9335	1.1678
Minimum	19	2	0.26	0.27	0.08	0
Maximum	1891	7	0.59	0.90	2.59	2.44
Downstream of 101 Ravine						
Mean	83	2.8	0.261	0.617	1.075	7.292
Standard deviation	72.2	1.64	0.2177	0.2346	1.9157	14.620 5
Minimum	13	1	0.00	0	0	0
Maximum	205	5	0.52	1.00	4.48	33.33
Downstream of West Perimeter Ravine						
Mean	6760	7.0	0.398	0.245	125.475	2.434
Standard deviation	4446.2	1.22	0.1093	0.0345	136.3041	2.0748
Minimum	1353	5	0.22	0.21	9.06	1.05
Maximum	11968	8	0.52	0.30	350.58	6.11
Downstream of West Ravine						
Mean	1112	5.4	0.261	0.272	4.325	12.346
Standard deviation	1046.5	1.67	0.2225	0.0288	3.8632	12.505 7
Minimum	474	4	0.01	0.25	1.51	0.22
Maximum	2968	8	0.60	0.31	11.03	31.68
Downstream of East Ravine[1]						
Mean	213	4.7	0.546	0.616	2.716	2.915
Standard deviation	196.5	2.34	0.2164	0.2395	5.6990	5.6336
Minimum	45	2	0.19	0.25	0.08	0
Maximum	571	9	0.74	0.82	14.31	14.29

Sampling Area	Density (#/m²)	Richness (#families)	Simpson's Diversity	Simpson's Evenness	Biomass (g/m²)	%EPT
Downstream of Duke Ravine						
Mean	1003	4.6	0.481	0.572	3.239	0.039
Standard deviation	1301.8	2.88	0.1492	0.3058	3.9817	0.0879
Minimum	19	2	0.27	0.25	0.03	0
Maximum	3263	9	0.67	1.00	10.05	0.20
Downstream of FalC Ravine						
Mean	8235	4.8	0.503	0.494	27.901	0.130
Standard deviation	7841.8	1.48	0.1458	0.2551	25.6355	0.2904
Minimum	2955	3	0.26	0.27	7.98	0
Maximum	21487	7	0.63	0.90	68.76	0.65
Downstream of Wapiti Ravine						
Mean	15381	5.8	0.410	0.335	37.376	0.569
Standard deviation	14491.4	2.17	0.2031	0.0778	34.9960	1.2314
Minimum	481	3	0.20	0.21	2.26	0
Maximum	35051	9	0.66	0.42	88.76	2.77
Downstream of English Creek						
Mean	4173	5.2	0.384	0.338	16.926	1.032
Standard deviation	2738.4	1.30	0.1766	0.0742	11.1469	1.7337
Minimum	1269	4	0.19	0.24	3.5	0
Maximum	6885	7	0.61	0.43	30.53	4.07

Notes: [1] Sample size n = 5, with the exception of Downstream of East Ravine where n = 6.

Table 5.3.1-4: Summary of ANOVA Results Comparing Benthic Invertebrate Community Metrics between Study Areas in the Saskatchewan River and between the Streams, October 2007 and November 2008

Study Area	Metric	F	df	P	Outcome of Statistical Analyses
SKR	Density	8.97	9, 41	**<0.0000005**	Downstream Caution and Duke < Downstream FalC, Wapiti, West Perimeter
					Downstream 101 < Downstream English, FalC, West Perimeter, Wapiti, West, and upstream Caution
					Downstream East < Downstream English, FalC, West Perimeter, Wapiti, and upstream Caution
	Taxa Richness	2.00	9, 41	**0.065**	Downstream 101 < Downstream West Perimeter and upstream Caution
	Evenness	2.51	9, 41	**0.024**	Downstream East > Downstream West Perimeter
	Diversity	1.36	9, 41	0.24	no significant differences
	Biomass	7.61	9, 41	**0.000002**	Downstream 101 < Downstream English, FalC, West Perimeter, Wapiti, and upstream Caution
					Downstream East < Downstream English, FalC, West Perimeter, and Wapiti
					Downstream West Perimeter > Downstream Caution, 101, Duke, and East
Tributaries					
	Density	2.29	6, 29	**0.063**	Caution Creek < West Perimeter
	Taxa Richness	1.75	6, 29	**0.016**	East > 101
	Evenness	1.19	6, 29	0.34	no significant differences
	Diversity	1.07	6, 29	0.41	no significant differences
	Biomass	1.81	6, 29	0.13	no significant differences
	% EPT	5.45	6, 29	**0.00071**	Duke < Caution, East, and English
					English > Duke, West Perimeter, and West

Notes: FalC Ravine not included in tributary analyses because of different sampling methodology that makes results non-comparable with other tributaries.
Alpha = 0.10 used due to sample size of n=5 per site; bold values indicate significant differences. SKR: Saskatchewan River

In terms of richness, evenness, and diversity, there were few statistical differences between sampling areas within the Saskatchewan River, perhaps as a result of high variability between stations within sampling areas (Table 5.3.1-4). Locations where habitat was determined for each stream are shown in Appendix 5.3.1-A, Figures 1 to 14. Family richness downstream from 101 Ravine (2.8 ± 1.64 families) was significantly lower than upstream of Caution Creek (7.2 ± 2.77 families) and downstream of West Perimeter Ravine (7.0 ± 1.22 families). Simpson's diversity index ranged from 0.26 ± 0.22 (downstream from 101 Ravine) and 0.26 ± 0.22 (downstream from West Ravine) to 0.55 ± 0.22 downstream from East Ravine and there were no significant differences between sampling areas. Simpson's evenness index was significantly higher downstream of East Ravine (0.62 ± 0.24) than downstream of West Perimeter Ravine (0.25 ± 0.03). Overall, the study area in the Saskatchewan River sampled downstream of East Ravine contained higher benthic invertebrate diversity and evenness measures than the other study areas, which is reflected in its community composition (Appendix 5.3.1-A, Figure 3). EPT percentage was not compared statistically between study areas because of the low abundance of these taxa in the Saskatchewan River (Table 5.3.1-3).

Streams

Benthic invertebrate taxonomic enumeration results illustrated differences in the community composition between streams, however, overall, the communities within the streams were largely composed of members from the families Simulidae (Order Diptera), Capniidae (Order Plecoptera), and Baetidae (Order Trichoptera) (Figure 5.3.1-4; Appendix 5.3.1-A, Table 2). Community composition was dominated by the Family Simulidae in West Perimeter Ravine, West Ravine, and Duke Ravine, where the percent composition measured greater than 57%. The Family Capniidae dominated in 101 Ravine, East Ravine, and English Creek; the Family Glossomatidae (Order Trichoptera) dominated in Caution Creek; and the families Baetidae and Chironomidae dominated in FalC Ravine.

Benthic invertebrate community metrics are summarized in Table 5.3.1-5. Results of the statistical analyses[5] comparing community metrics between streams are provided in Table 5.3.1-4. Mean density varied greatly among streams, but due to high variability in density between stations within streams, the only statistically significant difference was between Caution Creek (1,240 ± 901 organisms/m^2) and West Perimeter Ravine (11,278 ± 13,450 organisms/m^2). Similarly, although there were large differences in mean biomass between streams, high inter-station variability within streams led to no significant differences, even between the lowest (1.2 ± 1.19 g/m^2, 101 Ravine) and highest (6.3 ± 5.60 g/m^2, West Perimeter Ravine) means.

[5] FalC Ravine was not included in the statistical analyses because a different sampling method was used.

Table 5.3.1-5: Summary of Benthic Invertebrate Community Metrics from the Streams in the Project Local Study Area, October 2007 and November 2008

Tributary	Density (#/m^2)	Richness (#families)	Simpson's Diversity	Simpson's Evenness	Biomass (g/m^2)	%EPT
Caution Creek						
Mean	1240	11.0	0.768	0.442	4.857	80.232
Standard deviation	900.6	2.45	0.0933	0.1164	5.8444	10.1523
Minimum	360	9	0.62	0.24	0.27	69.44
Maximum	2430	15	0.87	0.52	13.10	95.31
101 Ravine						
Mean	1886	8.2	0.627	0.356	1.180	66.250
Standard deviation	1143.3	0.84	0.1257	0.1078	1.1872	28.9876
Minimum	870	7	0.45	0.26	0.30	15.89
Maximum	3180	9	0.75	0.50	2.83	87.80
West Perimeter Ravine						
Mean	11278	9.4	0.625	0.312	6.319	54.910
Standard deviation	13449.6	0.89	0.1401	0.0910	5.5982	29.9877
Minimum	3230	8	0.38	0.16	2.49	12.94
Maximum	34940	10	0.72	0.40	15.97	89.27
West Ravine[1]						
Mean	4113	10.2	0.571	0.336	4.149	53.368
Standard deviation	5613.3	4.02	0.2805	0.1744	2.9159	28.4225
Minimum	840	4	0.19	0.12	0.11	6.34
Maximum	15450	14	0.83	0.60	8.97	90.48
East Ravine						
Mean	2658	12.6	0.700	0.280	4.808	87.682
Standard deviation	1032.6	1.14	0.0706	0.0857	4.0939	6.9069
Minimum	1250	11	0.61	0.23	1.49	80.00
Maximum	3490	14	0.81	0.43	9.74	95.40
Duke Ravine						
Mean	5108	10.2	0.581	0.274	2.300	32.943
Standard deviation	8830.6	2.59	0.1789	0.1119	3.8938	15.0614
Minimum	460	7	0.28	0.15	0.17	15.96
Maximum	20870	14	0.75	0.40	9.23	53.85
FalC Ravine[2]						
Mean	309	11.0	0.797	0.473	0.262	47.432
Standard deviation	240.7	2.92	0.0313	0.0986	0.1526	8.8500
Minimum	54	8	0.75	0.39	0.14	39.02
Maximum	597	15	0.83	0.62	0.52	59.34

Tributary	Density (#/m²)	Richness (#families)	Simpson's Diversity	Simpson's Evenness	Biomass (g/m²)	%EPT
Wapiti Ravine	Not sampled due to tributary freezing solid during early freeze up in 2008					
English Creek						
Mean	4866	10.4	0.664	0.306	3.673	92.532
Standard deviation	2943.9	1.52	0.0614	0.1063	1.1209	5.2345
Minimum	860	9	0.61	0.22	2.37	85.67
Maximum	8410	12	0.77	0.47	5.03	97.98

Notes: [1] Sample size n = 5, with the exception of West Ravine where n = 6.
[2] Sampled using a different method than the remainder of the tributaries.

Of the three diversity indices, richness, evenness, and diversity, only family richness differed significantly between streams (Table 5.3.1-4). The mean richness in 101 Ravine (8.2 ± 0.84 families) was significantly lower than in East Ravine (12.6 ± 1.14 families). Simpson's diversity indices were relatively high in all streams ranging between 0.57 ± 0.28 (West Ravine) and 0.77 ± 0.09 (Caution Creek). Conversely, evenness values were relatively low and were similar between streams (Table 5.3.1-5).

The EPT% found in each study area was mostly greater than 50%, on average, with the exception of Duke Ravine (32.94 ± 15.06%) and FalC Ravine (47.43 ± 8.85%). The highest EPT% (92.53 ± 5.23% in English Creek) was significantly greater than in Duke Ravine, West Perimeter Ravine, and West Ravine. Conversely, the EPT% in Duke Ravine was significantly lower than in Caution Creek, East Ravine, and English Creek (Table 5.3.1-4). This index is calculated because these taxa are generally considered more pollution sensitive and can be used in the future as bioindicators of changes in environmental quality (Rosenberg et al. 2008).

Fisheries

The results for fish are described in terms of species presence, relative abundance, spawning investigations, chemistry, and lake sturgeon.

Species Presence

A summary of fish species captured during the 2006, 2007, and 2008 aquatic investigations, along with other species not caught during the study but known to occur in the region, is provided in Table 5.3.1-6. Seventeen species were captured in the Saskatchewan River study area in 2007 and 2008 and another six species are known to occur in the Saskatchewan River. The most abundant species captured in the Saskatchewan River was emerald shiner (51.4% of total catch), followed by shorthead redhorse (9.6%), sauger (8.6%), spottail shiner (8.3%), and white sucker (7.8%). The least abundant species included brook stickleback, cisco, flathead chub, goldeye, longnose dace, northern redbelly dace, trout-perch, walleye, and yellow perch, with each representing <1% of the total catch. Details on which species were captured near each stream are provided in CanNorth (2010a), however, it should be noted that many of these species have large home ranges thus their point of capture does not necessarily mean that is where they spend the majority of their time.

The most species-rich streams were English Creek (10 species captured or known to occur), East Ravine (a total of 8 species captured in the 3 sections assessed), and Duke Ravine (a total of 5 species captured in the 2 sections assessed) (Table 5.3.1-6). In 101 Ravine, lake chub were captured near the Saskatchewan River, while lake chub, fathead minnow, and northern redbelly dace were captured in the upper reach within the overburden pile area. No fish were captured in West Perimeter Ravine, the area of West Ravine within the Star pit, FalC Ravine, and Wapiti Ravine; one lake chub was captured in West Ravine near the Saskatchewan River; and two brook stickleback were captured in Caution Creek. Lake chub was the most widely distributed fish species captured in the streams, followed by northern redbelly dace and white sucker. The upper reaches of 101 Ravine and East Ravine contained particularly high densities of northern redbelly dace (Table 5.3.1-6).

The only streams in which large-bodied fish were captured during the baseline assessments were East Ravine (walleye and white sucker), Duke Ravine (white sucker), and English Creek (longnose sucker, white sucker, and walleye). With the exception of fish caught near the mouths of East Ravine and English Creek during the spring spawning surveys (see below), all large-bodied fish species captured in these three streams were juveniles and measured <15 cm in length.

Table 5.3.1-6: Summary of Number of Fish Captured in 2006, 2007, and 2008 in the Saskatchewan River and Each Stream in the Project Local Study Area

Common Name	Species Name	Provincial Status[3]	Waterbody[1,2]										
			Saskatchewan River	Caution Creek	101 Ravine	101 Ravine in Overburden Pile	West Ravine	East Ravine	East Ravine in Star pit	East Ravine -upper reaches	Duke Ravine	Duke Ravine in PKCF	English Creek
Brook stickleback	*Culaea inconstans*	S5	3	2									24
Brook trout	*Salvelinus fontinalis*	SNA											✓[4]
Burbot	*Lota lota*	S5						2					
Central mudminnow	*Umbra lima*	S2S3	✓[4]										
Cisco	*Coregonus artedi*	S5	2										
Emerald shiner	*Notropis atherinoides*	S5	317					2					7
Fathead minnow	*Pimephales promelas*	S5	33			4					23	48	2
Flathead chub	*Platygobio gracilis*	S3S4	2										
Goldeye	*Hiodon alosoides*	S4S5	1										
Lake chub	*Couesius plumbeus*	S5			42	217	1	34	246	6	3	5	66
Lake sturgeon	*Acipenser fulvescens*	S2	✓[4]										
Longnose dace	*Rhinichthys cataractae*	S5	4								9	11	
Longnose sucker	*Catostomus catostomus*	S5	20										1
Mooneye	*Hiodon tergisus*	S3	✓[4]										
Northern pike	*Esox lucius*	S5	7										

Common Name	Species Name	Provincial Status[3]	Waterbody[1,2]										
			Saskatchewan River	Caution Creek	101 Ravine	101 Ravine in Overburden Pile	West Ravine	East Ravine	East Ravine in Star pit	East Ravine -upper reaches	Duke Ravine	Duke Ravine in PKCF	English Creek
Northern redbelly dace	*Phoxinus eos*	S3S4	2			479			194	545	8	195	✓[5]
Pearl dace	*Semotilus margarita*	S5							4				✓[4]
Quillback	*Carpiodes cyprinus*	S3S4	✓[4]										
River shiner	*Notropis blennius*	S3S4							2	4			
Sauger	*Sander canadensis*	S5	53										
Shorthead redhorse	*Moxostoma macrolepidotum*	S4S5	59										
Silver redhorse	*Moxostoma anisurum*	S3S4	✓[4]										
Spoonhead sculpin	*Cottus ricei*	S5	✓[4]										
Spottail shiner	*Notropis hudsonius*	S5	51										
Trout-perch	*Percopsis omiscomaycus*	S5	4										
Walleye	*Sander vitreus*	S5	5					3					2
White sucker	*Catostomus commersoni*	S5	48					41[6]	13	9	48		49[6]
Yellow perch	*Perca flavescens*	S5	4										

Notes: [1] West Perimeter Ravine, the portion of West Ravine in Star pit, FalC Ravine, and Wapiti Ravine are not shown because no fish were captured in these regions. The portion of Wapiti Ravine within Coarse PK pile was not sampled because the tributary was dry.
[2] PKCF = Processed Kimberlite Containment Facility.
[3] Refer to Section 5.3.1.6 for status definitions.
[4] Not caught in 2007 or 2008, but known to exist within the waterbody
[5] Northern redbelly dace (n = 25) were captured in an upstream location of English Creek surveyed for the previous location of the Coarse PK pile in August 2008.
[6] Fish captured during the 2006 study, six white sucker in East Ravine and two white sucker in English Creek, were included in the fish count.

Relative Abundance

The study areas in the Saskatchewan River were surveyed during all three seasons. In the spring, emerald shiner, sauger, shorthead redhorse, and white sucker were the most abundant species captured in the Saskatchewan River (Table 5.3.1-7). Fish were most abundant in the area near the mouth of Duke Ravine (256.1 fish captured/hr; predominantly emerald shiner), followed by the study areas near the mouths of West Perimeter Ravine (96.6 fish captured/hr; mostly emerald shiner, shorthead redhorse, and sauger), East Ravine (92.9 fish captured/hr; predominantly emerald shiner, fathead minnow, and spottail shiner), and English Creek (91.2 fish captured/hr; mostly sauger and white sucker). In the summer, CPUE in the Saskatchewan River study areas near the mouths of West Ravine and Wapiti Ravine were higher than spring due to higher densities of emerald shiner captured. Conversely in East Ravine and English Creek, total CPUE was lower in the summer than in the spring (Table 5.3.1-7). Of the sites along the Saskatchewan River surveyed in the summer, the area near the mouth of East Ravine had the lowest abundance of fish (20.1 fish captured/hr). The capture of certain spring spawning species, including white sucker and sauger, was lower in the summer than in the spring. During the fall spawning survey in the Saskatchewan River, only northern pike were captured in two areas; near the mouths of West Ravine (3.52 fish captured/hr) and English Creek (3.01 fish captured/hr).

Summer fish community surveys were conducted in the streams and included regions within 500 m of the Saskatchewan River and regions within the Project area. In the sites close to the Saskatchewan River, fish abundance was greatest in Duke Ravine (86.2 fish captured/hr, predominantly white sucker, northern redbelly dace, and fathead minnow) and English Creek (82.2 fish captured/hr, predominantly lake chub and white sucker). No fish were captured by electrofishing in Caution Creek, FalC Ravine, or Wapiti Ravine. In the proposed development areas, fish abundance was highest in upper reaches of East Ravine (145.3 fish captured/hr, predominantly northern redbelly dace). The regions of Duke Ravine within the PKCF (105.2 fish captured/hr), East Ravine within the Star pit (63.0 fish captured/hr), and 101 Ravine within the overburden and rock storage pile (45.8 fish captured/hr) also had relatively high fish abundances. No fish were captured in the region of West Ravine within the Star pit.

Table 5.3.1-7: Catch per Unit Electrofishing Effort for the Fish Species Captured in the Project Local Study Area, May 2007 to November 2008

Season	Waterbody[1]	Species																			Total	Effort (hrs)
		Burbot	Brook Stickleback	Cisco	Emerald Shiner	Fathead Minnow	Flathead Chub	Goldeye	Lake Chub	Longnose Dace	Longnose Sucker	Northern Pike	Northern Redbelly Dace	Sauger	Shorthead Redhorse	Spottail Shiner	Trout Perch	Walleye	White Sucker	Yellow Perch		
Spring	SKR at Caution Creek	-	2.06	2.06	6.17	2.06	-	-	-	-	6.17	-	-	-	8.23	-	2.06	-	16.47	-	45.28	0.486
	SKR at 101 Ravine	-	1.37	-	17.79	12.32	-	-	-	-	-	-	-	2.74	1.37	2.74	-	-	4.11	-	42.43	0.731
	SKR at West Perimeter Ravine	-	1.89	-	45.47	3.79	3.79	-	-	3.79	-	-	-	11.37	20.84	1.89	-	-	3.79	-	96.63	0.528
	SKR at West Ravine	-	-	-	-	-	-	-	-	-	2.74	-	-	10.97	2.74	-	-	-	1.37	-	17.83	0.729
	SKR at East Ravine	-	-	-	33.67	24.38	-	-	-	-	-	-	-	4.64	3.48	18.57	-	-	8.13	-	92.87	0.861
	SKR at Duke Ravine	-	-	-	207.42	-	-	-	-	-	1.57	-	-	3.14	3.14	33.00	3.14	-	4.71	-	256.13	0.636
	SKR at FalC Ravine	-	-	-	12.59	-	-	-	-	-	3.60	-	-	5.40	7.20	9.00	-	-	5.40	1.80	44.98	0.556
	SKR at Wapiti Ravine	-	-	-	19.53	-	-	-	-	-	1.95	-	3.91	1.95	3.91	5.86	-	-	7.81	-	44.93	0.512
	SKR at English Creek	-	-	-	-	-	-	-	-	3.96	-	-	-	43.61	-	7.93	-	-	35.68	-	91.19	0.252
Summer	SKR at Caution Creek	-	-	-	18.90	-	-	-	-	-	3.15	1.57	-	12.60	7.87	-	-	-	3.15	-	47.24	0.635
	SKR at 101 Ravine	-	-	1.29	-	-	-	1.29	-	1.29	3.87	2.58	-	10.33	11.62	-	-	-	1.29	-	33.56	0.775
	SKR at West Ravine	-	-	-	37.55	-	-	-	-	-	-	-	-	-	2.50	-	2.50	-	-	-	42.56	0.399
	SKR at East Ravine	-	-	-	12.73	-	-	-	-	-	2.68	-	-	-	2.68	0.67	-	-	1.34	-	20.09	1.493
	SKR at Duke Ravine	-	-	-	173.08	-	-	-	-	-	17.31	-	-	-	17.31	-	-	-	-	-	207.69	0.116
	SKR at FalC Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	30.87	-	-	-	12.35	-	43.22	0.162
	SKR at Wapiti Ravine	-	-	-	132.11	-	-	-	-	-	-	-	-	-	-	-	-	13.21	-	-	145.32	0.151
	SKR at English Creek	-	-	-	22.73	-	-	-	-	-	-	1.75	-	-	1.75	-	-	5.25	1.75	5.25	38.47	0.572
	Caution Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.438
	101 Ravine	-	-	-	-	-	-	-	4.82	-	-	-	-	-	-	-	-	-	-	-	4.82	0.415
	101 Ravine in Overburden Pile	-	-	-	-	-	-	-	-	-	-	-	45.79	-	-	-	-	-	-	-	45.79	0.633
	West Ravine	-	-	-	-	-	-	-	3.39	-	-	-	-	-	-	-	-	-	-	-	3.39	0.295
	West Ravine in Star pit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.288
	East Ravine	1.43	-	-	-	-	-	-	22.96	-	-	-	-	-	-	-	-	-	10.04	-	34.44	0.697
	East Ravine in Star pit	-	-	-	-	-	-	-	33.89	-	-	-	4.84	-	-	-	-	-	24.21	-	62.95	0.413
	East Ravine in Water Management Reservoir	-	-	-	-	-	-	-	-	-	-	-	141.33	-	-	-	-	-	3.93	-	145.26	0.255
	Duke Ravine	-	-	-	-	19.59	-	-	-	3.92	-	-	23.50	-	-	-	-	-	39.17	-	86.18	0.255
	Duke Ravine within PKCF	-	-	-	-	97.08	-	-	-	8.09	-	-	-	-	-	-	-	-	-	-	105.17	0.124
	FalC Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.138
	Wapiti Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.153
	English Creek	-	12.71	-	5.23	1.50	-	-	41.11	-	0.75	-	-	-	-	-	-	1.50	19.44	-	82.23	1.338
Fall	SKR at Caution Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.261
	SKR at 101 Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.136
	SKR at West Perimeter Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.139
	SKR at West Ravine	-	-	-	-	-	-	-	-	-	-	3.52	-	-	-	-	-	-	-	-	3.52	0.284
	SKR at East Ravine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.325
	SKR at English Creek	-	-	-	-	-	-	-	-	-	-	3.01	-	-	-	-	-	-	-	-	3.01	0.332
	Caution Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.175
	English Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.143

Notes: [1] SKR = Saskatchewan River, PKCF = Processed Kimberlite Containment Facility. Backpack electrofishing was used in the tributaries and boat electrofishing was used in the Saskatchewan River.

Spawning Investigations

Fish spawning investigations were conducted in the Saskatchewan River and streams; the results of these investigations are presented below.

Saskatchewan River

Spring spawning surveys conducted in 2007 and 2008 in the Saskatchewan River study areas revealed evidence of adult white sucker in spawning condition in the vicinities of Caution Creek (one female), West Ravine (one male), East Ravine (one male and two females), Duke Ravine (three females), FalC Ravine (two males), Wapiti Ravine (two males and two females), and English Creek (two males and four females). Egg searches conducted in the Saskatchewan River study areas resulted in a single confirmed white sucker spawning area; four white sucker eggs were found in the Saskatchewan River upstream from the mouth of 101 Ravine in May 2007. The habitat in the area was rated as moderate in terms of spawning suitability for white sucker, as the water depth was 0.45 m and the substrate was predominantly comprised of gravel, cobble, or boulder.

There were no fall spawning species captured during fishing efforts in the Saskatchewan River study areas during the fall spawning survey and no eggs were located. These data suggest that any spawning use in the LSA by cisco is low, but does not necessarily indicate that no cisco spawning occurs in the LSA.

Streams

Fish capture results for the hoop nets set in Caution Creek, East Ravine, and English Creek during the spring spawning survey conducted in April/May 2006 are provided in Table 5.3.1-8. No fish were captured in Caution Creek, six white sucker were captured in East Ravine (none in spawning condition), and no fish were captured in English Creek. However, a gill net set in English Creek resulted in the capture of two white sucker; one was in ripe spawning condition and one was spent (finished spawning). Egg searches were conducted in English Creek and no eggs were located.

In May 2007, hoop nets were set in West Ravine, East Ravine, and English Creek (Table 5.3.1-8). A total of two juvenile white sucker were captured in English Creek and no fish were captured in West Ravine. In East Ravine, three juvenile walleye and 11 adult white sucker were captured. The white sucker were all captured on the same day (May 9th, 2007) and consisted of four females in ripe spawning condition, one female and five males in ripe and running spawning condition, and one female in spent spawning condition. In addition, white sucker were observed in suitable spawning habitat located approximately 50 to100 m upstream from the mouth of East Ravine. Kick-netting egg search efforts conducted within the streams of Caution Creek and East Ravine in May 2007 did not result in the location of any eggs. However, in English Creek, three sucker eggs were located in one search area located approximately 70 m upstream of the creek mouth, confirming its use as a spawning ground. The water depth in the English Creek search area was 0.3 m and the substrate consisted of sand (30%), gravel (35%), cobble (30%), and boulder (5%).

Table 5.3.1-8: Fish Capture Results during the Spring and Fall Fish Spawning Surveys in the Project LSA, Spring 2006 to Fall 2007

Tributary	Season/Year	Method	Species	Number Caught	Spawning Condition[1]
East Ravine	Spring 2006	Hoop net	White Sucker	6	6 PR
	Spring 2007	Hoop net	White Sucker	11	4 R, 1 ST, 6 SP
	Spring 2007	Hoop net	Walleye	3	3 U
English Creek	Spring 2006	Spawning net	White Sucker	2	1 SP, 1 R
	Spring 2007	Hoop net	White Sucker	2	2 U
	Fall 2007	Hoop net	Northern Pike	1	1 U

Notes: [1]PR = pre-spawning, R = ripe, SP = running ripe, ST = spent, U = unknown.

A hoop net was set in English Creek during the fall spawning survey conducted in October/November 2007 and the only fish captured was one juvenile northern pike (Table 5.3.1-8). Furthermore, kick-netting egg searches conducted within the streams of Caution Creek, 101 Ravine, East Ravine, West Perimeter Ravine, and West Ravine in November 2007 did not result in the capture of any cisco eggs.

Chemistry

Summary statistics of the lengths, weights, and ages of the lake chub and white sucker retained for chemical analyses from select streams are presented in Table 5.3.1-9. All ten of the lake chub collected from English Creek were determined to be two years old while those collected from 101 Ravine and East Ravine ranged in age from two to four years (mean = 2.8 ± 0.79 yrs) and one to four years (mean = 2.5 ± 0.85 yrs), respectively. On average, the lake chub collected from English Creek were significantly smaller (shorter and weighed less) and younger than those collected from 101 Ravine and East Ravine.

The white sucker lengths were significantly different between Duke Ravine (5.7 ± 0.91 cm), East Ravine (8.7 ± 1.58 cm), and English Creek (11.5 ± 3.34 cm). However, no significant differences were observed for weight or age. No white sucker weights were collected for Duke Ravine. High variability in the English Creek sampling (19.3 ± 13.04 g) resulted in a lack of significant difference from East Ravine white sucker (6.78 ± 3.29 g). The white sucker captured in East Ravine (3.7 ± 0.71 yrs) and English Creek (3.3 ± 0.82 yrs) ranged in age from three to five years, and those from Duke Ravine (3.3 ± 1.15 yrs) ranged from two to six years.

Table 5.3.1-9: Morphology and Aging Results for Fish Retained for Tissue Chemistry Analyses from the Project LSA, August 2007 and 2008

Species	Waterbody[1]	Statistic	Length (cm)	Weight (g)	Age (yr)
Lake chub	101 Ravine	N	10	10	10
		Mean	5.5	1.61	2.8
		SD	0.48	0.448	0.79
		Minimum	4.6	0.87	2
		Maximum	6.2	2.23	4
	East Ravine	N	10	10	10
		Mean	5.5	1.48	2.5
		SD	0.46	0.369	0.85
		Minimum	4.6	0.85	1
		Maximum	6.1	2.08	4
	English Creek	N	10	10	10
		Mean	4.6	0.78	2
		SD	0.33	0.174	0
		Minimum	3.9	0.47	2
		Maximum	4.9	1.13	2
White sucker	East Ravine	N	9	9	9
		Mean	8.7	6.78	3.7
		SD	1.58	3.285	0.71
		Minimum	6.5	2.2	3
		Maximum	11.5	12.5	5
	Duke Ravine	N	27	0	27
		Mean	5.7	-	3.3
		SD	0.91	-	1.15
		Minimum	4.5	-	2
		Maximum	8.4	-	6
	English Creek	N	6	6	6
		Mean	11.2	19.30	3.3
		SD	3.34	13.038	0.82
		Minimum	5.3	3.65	3
		Maximum	14.6	40.16	5

Notes: [1] All fish from 101 Ravine, East Ravine, and English Creek were collected in 2007; those from Duke Ravine were collected in 2008.
SD = standard deviation.

Summaries of the fish chemistry results are presented in Appendix 5.3.1-A, Table 3 (lake chub) and Appendix 5.3.1-A, Table 4 (white sucker). Of the 31 analytes measured, 13 and 9 could not be compared between streams for lake chub and white sucker, respectively, as some samples contained concentrations below the laboratory detection limit.

A total of 16 analytes in lake chub samples were found to have significantly different concentrations between streams (Appendix 5.3.1-A, Table 3). Of these 16, the concentrations of 11 (magnesium, aluminum, arsenic, barium, cobalt, iron, lead, manganese, titanium, vanadium, and phosphorus) were greatest in fish from English Creek. Calcium concentrations were significantly higher than 101 Ravine in both East Ravine and English Creek, and mercury and moisture were highest in fish samples from East Ravine. Selenium and copper concentrations were greatest in lake chub from 101 Ravine.

Compared with lake chub, there was less consistency in white sucker fish chemistry with respect to which stream had fish with the highest analyte concentrations (Appendix 5.3.1-A, Table 4). Of the 10 analytes that differed significantly between streams, the levels of five were highest in samples of white sucker from Duke Ravine (copper, selenium, strontium, zinc, and moisture). Aluminum, iron, and manganese concentrations were greatest in both East Ravine and English Creek, and titanium and mercury levels were highest in East Ravine.

Lake Sturgeon

Summarized below is the relevant lake sturgeon capture information compiled from the monitoring programs conducted by SWA between 2007 and 2010.

On August 22nd, 2007, three lake sturgeon were captured in the Saskatchewan River at English Creek using a deadline and their mean length and weight were 124.3 ± 3.06 cm and 16.3 ± 2.31 kg, respectively (SWA 2008a). In addition, seven lake sturgeon were captured at La Colle Falls (located on the Northern Saskatchewan River just upstream of the Forks), one lake sturgeon was captured at the Forks, and one lake sturgeon was captured at the Cecil Ferry (located on the Northern Saskatchewan River upstream of La Colle Falls) in August 2007 (SWA 2008a). These areas are all located outside of the Project LSA.

In 2008, no lake sturgeon were captured in the Project LSA (SWA 2008b). However, between May 27th and June 20th, a total of 13 lake sturgeon were captured in six areas located on the Northern Saskatchewan River and Southern Saskatchewan River at the Forks, and upstream of the Forks. The captured specimens ranged in size from 43 to 110 cm in length (SWA 2008b).

In 2009, a three year program began where 37 lake sturgeon captured near the Forks were implanted with radio telemetry tags to track their movements and over 100 fish were tagged to conduct a mark and recapture study. Preliminary data from October 2009 to March 2010 found that 92% of the 620 targets were located within 7 km of the tagging location (the Forks) upstream of the Project LSA (SWA 2009). However, approximately 8% of the targets were located near the FalC tower, providing further evidence that lake sturgeon utilize the Saskatchewan River within the Project LSA (SWA 2010).

Aquatic Habitat

Results of the habitat assessments, including spawning suitability indexes, are presented in Appendix 5.3.1-A, Table 5 for the Saskatchewan River study areas and in Appendix 5.3.1-A, Table A6 for the streams in the LSA. The location of each HS is shown in Appendix 5.3.1-A, Figures 1 to 14. Photographs of the aquatic environment in the Project LSA are provided in Appendix 5.3.1-B for the Saskatchewan River study areas and in Appendix 5.3.1-C for the streams.

A particular focus of this Section is on critical habitat in the Project LSA for lake sturgeon. Lake sturgeon typically reside in deeper waters, are bottom feeders, and are capable of migrating over great distances in search of food, suitable spawning habitat (shallow riffle areas), or to avoid unfavourable conditions (Peterson et al. 2007). The streams in the Project LSA are too small and shallow, and too full of obstructions to provide critical habitat for lake sturgeon. Thus, only the Saskatchewan River study area was included when determining potential critical habitat for different life stages of lake sturgeon.

Saskatchewan River

The upland zone along the Saskatchewan River within the study area consisted of mature forest with mixed or deciduous canopies and slopes varying from gentle to steep. The riparian zone consisted of transitional area with overall gentle and slightly unstable slopes that were vegetated by grasses, sedges, and commonly shrubs. It is noted that whether the vegetation extended to the waterline depended on the time of year and the water level of the river. Provided below are descriptions of the littoral zones in the Saskatchewan River study areas surrounding each stream and descriptions of spawning habitat, nursery and rearing habitat, feeding habitat, and overwintering habitat in the Saskatchewan River LSA.

Habitat Description

Descriptions of the littoral zone habitat in the Saskatchewan River in the vicinity of Caution Creek, 101 Ravine, West Perimeter Ravine, West Ravine, East Ravine, Duke Ravine, FalC Ravine, Wapiti Ravine, and English Creek are described below.

Saskatchewan River at Caution Creek

The habitat assessment conducted in Caution Creek in August 2007 identified a mixture of habitat types with three HSs consisting mostly of silt/clay and sand substrate (Appendix 5.3.1-B, Photos 1 and 4), and three HSs containing a mixture of silt/clay, sand, gravel, cobble, and boulder substrate (Appendix 5.3.1-B, Photos 2, 3, and 5). The rocky substrate in the study area was not layered and was mostly covered in fines. The exception was right at the creek mouth (HS4; Appendix 5.3.1-B, Photo 3) where flows were higher and clean gravel/cobble substrate was present. The study area was devoid of aquatic vegetation and fish cover, and the bottom slope was gentle (<0.8 m at a depth of 5 m from shore).

Saskatchewan River at 101 Ravine

Similar to Caution Creek, the habitat in the Saskatchewan River study area surrounding 101 Ravine consisted of HSs dominated by sand interspersed with HSs containing cobble/boulder substrate (Appendix 5.3.1-B, Photos 6 to 11). Some fish cover was provided by boulders, and sparse densities of emergent vegetation (horsetail) were found along the shoreline in HS1. The bottom slope gradient varied from gentle (0.4 to 0.6 m at a depth of 5 m from shore) to steep (>1 m at a depth of 5 m from shore).

Saskatchewan River at West Perimeter Ravine

The Saskatchewan River study area at West Perimeter Ravine was assessed in May 2007. Two HSs were identified and both contained a mixed substrate composition of silt/clay, sand, gravel, cobble, and boulder (Appendix 5.3.1-B, Photos 12 and 13). However, similar to the other study areas in the Saskatchewan River, the rocky substrate was sporadic and not clean. The study area was largely devoid of vegetation and fish cover.

Saskatchewan River at West Ravine

The Saskatchewan River study area at West Ravine consisted of silt/clay and sand substrate with gentle to moderate bottom slope, and no vegetation or fish cover (Appendix 5.3.1-B, Photos 14 and 15). However, immediately upstream of the study area was a large sand bar that extended into the river and provided some rocky habitat. Photos of the sand bar taken in August and October, 2007 are shown in Appendix 5.3.1-B, Photos 16 and 17 to illustrate the difference in the appearance of the study area under different water levels. A shallow, backwater area was present near the mouth of West Ravine during the fall survey.

Saskatchewan River at East Ravine

A total of six HSs were identified in the Saskatchewan River study area at East Ravine in August 2007, however, only minor differences were found between the sections. The HSs all contained varying densities of silt/clay, sand, gravel, and cobble, with HSs 2 and 3 also containing a small boulder content (<10%). Sparse densities of horsetail were found growing along the shoreline and sparse densities of moss/algae were present in all HSs. Bottom slopes were gentle in all HSs ranging from 0.2 to 0.6 m at a distance of 5 m from shore. Appendix 5.3.1-B, Photos 18 and 22 illustrate the typical substrate found, which was a suitable size for many spring spawning species, but lacked the flow required to keep it clear of silt/clay and moss/algae.

Saskatchewan River at Duke Ravine

The mouth of Duke Ravine was surrounded by a large, shallow riffle area that extended well into the Saskatchewan River. Numerous HSs were described that contained varying densities of silt/clay, sand, gravel, cobble, and boulder, as well as changes in littoral zone depth (Appendix 5.3.1-B, Photos 23 to 34). The area was void of aquatic vegetation with the exception of varying densities of moss/algae. Fish cover was considered to be absent in the near shore area due to the embedded nature of the rocks, however, larger boulders located further towards the middle of the river would provide some cover. Appendix 5.3.1-B, Photo 35 shows a picture of the mouth of Duke Ravine looking towards the river in May 2008 during the spring spawning survey. Detailed bathymetric mapping and hydrodynamic modelling is available in AMEC (2010) for a stretch of the Saskatchewan River extending 8 km downstream of Duke Ravine.

Saskatchewan River at FalC Ravine

FalC Ravine is located in close proximity to Duke Ravine and the riffle area described above extends over both study areas. However, the substrate near FalC Ravine contained larger rock sizes (i.e., more cobble and boulder) than the Duke Ravine study area, thus more fish cover was provided (Appendix 5.3.1-B, Photos 36 to 38). The bottom slope was consistent between HSs measuring approximately 0.5 m at a depth of 5 m from shore. The only aquatic vegetation present was sparse densities of moss/algae.

Saskatchewan River at Wapiti Ravine

The habitat was variable in the Saskatchewan River study area surrounding Wapiti Ravine. The area downstream of the creek contained cobble/boulder substrate with moderate densities of moss/algae and a gentle bottom slope (Appendix 5.3.1-B, Photo 39). The area upstream of the creek contained silt/clay/sand substrate and the bottom slope was steep (Appendix 5.3.1-B, Photo 41). Similar to the other study areas in the Saskatchewan River, there was little fish cover or vegetation present.

Saskatchewan River at English Creek

The habitat was relatively consistent throughout the Saskatchewan River study area at English Creek. The substrate was predominantly silt/clay/sand, there was no aquatic vegetation or fish cover, and the bottom slopes were mostly moderate (~0.7 m at a depth 5 m from shore) (Appendix 5.3.1-B, Photos 42 to 47). At the end of the upstream portion of the study area (HS6), the substrate differed and contained small quantities of gravel, cobble, and boulder (Appendix 5.3.1-B, Photo 47).

Spawning Habitat

Within the Saskatchewan River study areas, no suitable spawning habitat for northern pike or yellow perch was identified. This was due to the absent to sparse distribution of emergent aquatic vegetation and large woody debris. No HSs were identified as providing highly suitable spawning habitat for any of the other large-bodied species assessed: walleye, sauger, white sucker, longnose sucker, and shorthead redhorse. All regions of the Saskatchewan River, except in the vicinities of West Ravine and English Creek, contained one or more HSs moderately suitable for walleye/sauger spawning. Two HSs near Duke Ravine and one HS in each of the regions near Caution Creek, 101 Ravine, West Ravine, and East Ravine were rated moderately suitable for white sucker, longnose sucker, and shorthead redhorse spawning.

Lake sturgeon spawn in shallow areas (<5 m) with swift currents over clean rocky substrate (Block 2001; Bruch and Binkowski 2002; Langhorne et al. 2001; Peterson et al. 2007; Scott and Crossman 1998; SWA 2008b). The majority of the rocky substrate present in the Saskatchewan River study area was somewhat embedded and contained a layer of silt/clay and/or algae moss clogging interstitial crevices. Thus no highly suitable spawning habitat for lake sturgeon was identified within the assessed regions of the Saskatchewan River. One HS near Duke Ravine was identified as being moderately suitable habitat for spawning, and a total of 16 HSs were rated as marginally suitable lake sturgeon spawning habitat. The riffle area near the Duke and FalC ravines contains the greatest potential as lake sturgeon spawning habitat in the regions assessed within the Saskatchewan River.

Nursery and Rearing Habitat

The absence of suitable spawning habitat for northern pike and yellow perch suggests a similar absence of nursery and rearing habitat for these two species in the assessed regions of the Saskatchewan River since the habitat requirements are similar between these life stages.

Most study areas in the Saskatchewan River contained HSs considered suitable for walleye/sauger, white sucker, longnose sucker, and shorthead redhorse nursery and rearing habitat since the flows were not high and diverse habitat types were available. However, there was a general lack of cover and backwater areas for fry or juvenile fish to seek shelter and avoid predation. The capture of juvenile sauger and sucker in many regions of the Saskatchewan River study area confirmed that several areas are being utilized as nursery and rearing habitat by these species.

Lake sturgeon larvae that are newly hatched are pelagic, negatively phototactic, and actively move within the interstitial spaces of the rocky substrates where they were spawned (Peterson et al. 2007). Approximately two weeks after hatching, lake sturgeon fry emerge from the substrate and drift downstream before settling again on the river bottom to begin active feeding on benthic invertebrates (Block 2001; Peterson *et al*. 2007). Thus, rearing habitat for lake sturgeon is generally correlated with an abundance of preferred invertebrate prey. Chiasson *et al*. (1997) found that the largest concentration of juvenile sturgeon was adjacent to substrate dominated by sand and clay which contained the highest densities of benthos in the river systems they studied. The sandy areas of the Saskatchewan River from which benthic invertebrate samples were obtained contained a wide variation in density and diversity of benthic invertebrate taxa. Therefore it is difficult to predict the specific zones in the Saskatchewan River that provide key lake sturgeon rearing habitat. In general, lake sturgeon nursery habitat in the Project LSA is limited due to the lack of quality spawning habitat, however, rearing habitat is potentially abundant based on information collected during the habitat assessments and benthic invertebrate community survey. It is important to note that, the predominant habitat type in the Saskatchewan River study area (silt/clay/sand substrate interspersed with rocky areas, a lack of aquatic vegetation, gentle/moderate bottom slope, and moderate flow) is not unique to the study area, and is found throughout the river system.

Feeding Habitat

The abundance of small-bodied fish and juvenile large-bodied fish captured in the Saskatchewan River study area during the fish surveys suggest high quality feeding habitat exists for the large-bodied predatory fish species present in the Saskatchewan River within the LSA, such as northern pike, walleye, and yellow perch. The relatively dense and diverse benthic invertebrate communities that were observed confirmed that feeding habitat was available for the fish species that feed on benthos, such as sucker and many small-bodied fish species.

Lake sturgeon are bottom dwellers and they prefer to forage in soft-bottomed substrate containing silt, clay, or sand (Langhorne et al. 2001; SWA 2008b). Lake sturgeon use their protrusible, tubelike mouth to consume food off the river bottom, thus food types range widely and composition depends on availability (Peterson et al. 2007; Scott and Crossman 1998). However, their primary food source is benthic invertebrates and thus the most suitable habitats include areas with high productivity (Chiasson et al. 1997). As discussed above, silt/clay/sand substrate is abundant in the Saskatchewan River within the Project LSA suggesting that suitable feeding habitat for lake sturgeon exists. However, the LSA does not provide important critical feeding habitat that is not present elsewhere in the river system.

Overwintering Habitat

The Saskatchewan River provides suitable overwintering habitat for large-bodied and small-bodied fish species because it is a large flowing river with adequate depth that does not freeze to near the bottom in the winter.

Streams

Detailed habitat information for each stream is provided in Appendix 5.3.1-A (Table 6) and is summarized below. The region of Wapiti Ravine within the PKCF was not assessed because at the time of the survey (August 2008) the streambed was dry and full of terrestrial vegetation, suggesting it had been dry for some time (Appendix 5.3.1-C, Photo 1).

The upland zones along the streams were predominantly forested with mature mixed canopies and generally had moderate slopes. Because of this consistency, the upland zones are not discussed below for individual streams. Provided below are descriptions of the in-stream habitat and descriptions of spawning habitat, nursery and rearing habitat, feeding habitat, and overwintering habitat for the streams located in the LSA.

Habitat Description

Habitat assessments of the streams were challenging due to habitat types changing frequently and seasonally, the high abundance of external factors that altered habitat types (e.g., beavers building dams, deadfall, logjams), and the accessibility of the streams to the surveyors. The descriptions presented below reflect the conditions at the time of the surveys, but habitat types were found to change seasonally and yearly.

Caution Creek

The habitat assessment in Caution Creek near the Saskatchewan River was completed in August 2007. The riparian zone varied between forested with trees/shrubs and transitional vegetation with grasses and sedges. The bank was predominantly steep and consistently slightly unstable. Among the seven HSs, the substrate composition of the stream bed ranged from silt/clay and sand to gravel, cobble, and boulder, and consistently lacked organic material. Cover for fish was variable, with sparse distributions of rock and undercut and sparse to moderate overhanging vegetation present in most HSs. There was a consistent absence of aquatic vegetation. In terms of habitat types, riffles and runs were dominant. Another prevalent feature throughout were obstructions in the forms of waterfalls, chutes, and logjams. Mean wetted width varied between 2.0 and 3.0 m and maximum depth was approximately 0.54 m. Fish passage from the Saskatchewan River was somewhat limited by fast flow and small obstructions such as boulders (for example, Appendix 5.3.1-C, Photos 2 and 3).

101 Ravine

The habitat assessment in 101 Ravine near the Saskatchewan River was completed in August 2007. Overall, the riparian zone was forested and had steep slightly unstable slopes that were vegetated with trees and shrubs. The substrate lacked silt/clay and organic matter and varied between almost completely sand to predominantly cobble and boulder. There was a general absence of aquatic vegetation. Cover, mostly in the form of large woody debris or overhanging vegetation, was present in sparse to moderate amounts in all eight HSs. Habitat type was dominated by riffles and runs, and the channel's wetted width and maximum depths ranged from 0.95 to 2.60 m and 0.20 to 0.42 m, respectively. Prevalent throughout the HSs were logjams, present in five of the eight HSs. In HS1 located near the mouth of the stream, there was a large waterfall/log jam that would severely limit fish passage from the river into the stream that was present throughout all the surveys conducted in 101 Ravine (Appendix 5.3.1-C, Photos 7 and 8).

101 Ravine within the Overburden Pile

The habitat assessment in 101 Ravine within the Overburden Pile was completed in August 2008. The riparian zone was, for the most part, wetland with moderate to gentle slopes and stable banks vegetated by shrubs, grasses, and sedges. The substrate of the stream bed was predominantly organic material (80%) with some silt/clay (20%). Moderate to dense aquatic vegetation, sparse large woody debris, and patches of overhanging vegetation provided fish cover in each of the 16 HSs. The aquatic vegetation was diverse, consisting of emergent vegetation (such as *Carex* sp. and *Typha* sp.), floating leaf vegetation (such as *Nuphar lutea*), submergent vegetation, and aquatic moss. Throughout this section of 101 Ravine, the habitat type was classified as pool (Appendix 5.3.1-C, Photos 13 to 19). The pools were likely the result of several beaver dams that created the formation of the two large wetlands (mean wetted width was often 40 to 90 m), which were joined by a stretch of narrower waterway (mean wetted width <1 m).

West Perimeter Ravine

The habitat assessment in West Perimeter Ravine near the Saskatchewan River was completed in October 2007. The riparian zone had steep and unstable slopes that were vegetated with shrubs, grasses, and sedges. In terms of substrate composition, there was a complete absence of organic material and silt/clay was frequently absent. The substrates contained variable mixtures of sand, gravel, cobble, and boulder. Fish cover was largely absent or sparse, with moderate amounts of large woody debris observed in two of the six HSs. There was a general lack of aquatic vegetation. The habitat throughout the stream was mostly riffles and runs, with some pools. Mean wetted width ranged between 0.5 and 15.0 m and maximum depth varied between 0.05 and 0.3 m. Logjams were present in four HSs. Fish passage from the Saskatchewan River into West Perimeter Ravine would not be possible due to a large log/rock jam near the mouth creating a steep gradient below which water flow was minimal (depth = 0.03 m; Appendix 5.3.1-C, Photos 20 and 21).

West Ravine

The habitat assessment in West Ravine near the Saskatchewan River was completed in August 2007. The riparian zone was largely forest with steep and slightly unstable banks that were vegetated by trees and shrubs. The substrate of the stream was predominantly sand; gravel and cobble were common, boulder was dominant in one HS, silt/clay was uncommon, and organic matter was completely absent. Large woody debris, rock, overhanging vegetation, or undercut provided fish cover in all nine HSs. Throughout the area assessed, there was a complete absence of aquatic vegetation. The habitat type was dominated by riffles and runs. Mean wetted width ranged from 0.38 to 1.00 m and maximum depth varied between 0.14 and 0.37 m. Waterfalls and/or chutes created obstructions in six HSs (for example, Appendix 5.3.1-C, Photo 29). West Ravine runs underground for approximately 7 m at a location approximately 100 m upstream from the mouth of the Saskatchewan River. This subsurface flow prohibits fish passage (Appendix 5.3.1-C, Photo 31).

West Ravine within the Star pit

The habitat assessment in West Ravine within the Star pit was completed in August 2008. The riparian zone was evenly split between two distinct categories: 1) forest with moderately steep and slightly unstable banks that were vegetated with shrubs, grasses, and sedges, and 2) wetland with gently-sloped slightly unstable banks vegetated with shrubs, grasses, and sedges. The substrate throughout this section of West Ravine consisted of a complex of sand, silt, clay, and organic matter. All 16 HSs contained fish cover in the forms of sparse to dense large woody debris, sparse to dense aquatic vegetation, or sparse to moderate overhanging vegetation. Aquatic vegetation was consistently absent in the upstream HSs, but predominantly dense throughout the downstream HSs. While all categories of aquatic vegetation were present, submergent and emergent vegetation were the most common. The habitat type varied, with each of riffle, run, glide, or pool habitat dominating one or more HSs. In addition to having less vegetation and overall more riffles and run habitat, the upper section was much narrower (mean wetted width <1 m; Appendix 5.3.1-C, Photos 33 to 36) than the downstream section (mean wetted width generally >15 m; Appendix 5.3.1-C, Photos 37 to 39). The greater width downstream was associated with beaver dams.

East Ravine

The habitat assessment in East Ravine near the Saskatchewan River was completed in August 2007. Throughout the downstream portion of the assessed area of East Ravine, the riparian zone was predominantly forested with steep and slightly unstable slopes that were vegetated with shrubs and/or trees. The riparian zone along the wetland present in the upstream half of the assessed area was vegetated by grasses, sedges, shrubs, and trees. In the wetland HS and the two HSs closest to the mouth of East Ravine, the substrate was mostly or completely sand. In the remaining six HSs, substrate composition contained varying proportions of sand, gravel, cobble, and boulder, with very little silt/clay and no organic matter. Eight of the nine HSs contained fish cover, with sparse to dense large woody debris, sparse to dense overhanging vegetation, sparse undercut, or sparse distributions of rocks. There was almost a complete lack of aquatic vegetation, with only a sparse amount of algae observed in one HS. The habitat type was dominated by riffles and runs, and obstructions (waterfalls, chutes, logjams, and beaver dams) were present in six

HSs. Mean wetted width ranged from 1.0 to 2.1 m and maximum depth ranged between 0.22 and 0.54 m. It is noted that after the spring spawning survey conducted in May 2007, two large beaver dams were built near the mouth of East Ravine which would temporarily prevent fish passage and modified the habitat type (Appendix 5.3.1-C, Photo 41).

East Ravine within the Star pit

The habitat assessment in East Ravine within the Star pit was completed in August 2008. This region of East Ravine contained three major sections: west (5 HSs) and east (13 HSs) branches upstream of their confluence, and the section downstream from their confluence into a single stream (7 HSs). Wetlands with stable or slightly unstable banks vegetated with shrubs, grasses, and sedges dominated the eastern branch of the stream upstream of the confluence. The shorter western branch had forest or transitional vegetation (shrubs, grasses, and sedges) on its gentle to moderate slopes, with the forested banks being stable and the banks with transitional vegetation being highly unstable. Downstream of the confluence, the riparian zone was forested, with predominantly steep slightly unstable slopes vegetated with trees, shrubs, grasses, and sedges.

In all three major sections, the substrate consisted of sand and silt/clay, generally lacked gravel and organic matter, and completely lacked cobble/boulder. Large woody debris, aquatic vegetation, overhanging vegetation, and/or undercut provided fish cover in all but one HS. Aquatic vegetation was dominated by sparse to dense distributions of emergent species, but sparse to dense patches of floating leaf vegetation, submergent vegetation, and moss/algae were also present in mostly the west branch.

Habitat type was variable, with the west branch dominated by riffles and pools (Appendix 5.3.1-C, Photos 50 to 52), the east branch dominated by runs and pools (Appendix 5.3.1-C, Photos 53 to 56), and the section downstream of the confluence of the west and east branches contained predominantly glides (Appendix 5.3.1-C, Photos 57 to 59). Eleven of 25 HSs contained beaver dams and another two HSs had logjams. In all three major sections, the presence of beaver dams was correlated with pools and flooded areas with mean wetted widths ranging from 15 to 60 m. In non-flooded HSs, mean wetted width varied between 0.5 and 1.8 m.

Upper Reaches of the East Ravine

The habitat assessment in the upper reaches of the East Ravine was completed in August 2008. The riparian zone was predominantly wetland with gentle stable slopes vegetated with shrubs, grasses, and sedges. Five of the 19 HSs were forested with moderate to steep slopes and slightly unstable banks. The substrate was quite consistent throughout, consisting of silt/clay and organic matter, with some sand also present in three HSs. Fish cover was available in all HSs, mostly from moderate to dense distributions of aquatic vegetation, which was supplemented by large woody debris and overhanging vegetation.

All HSs contained aquatic vegetation, which was dominated by emergent vegetation. The habitat type varied considerably throughout the area assessed, but pools and glides were the most common habitat types observed (Appendix 5.3.1-C, Photos 60 to 66). The eight HSs dominated by pools had wetted mean widths ranging from 15 to 80 m, and they either contained a beaver dam or were adjacent to a HS that contained a beaver dam.

Duke Ravine

The habitat assessment in Duke Ravine near the Saskatchewan River was completed in August 2008. The riparian zone of Duke Ravine was mostly forested with steep stable slopes vegetated with trees, shrubs, and sedges. The substrate in the assessed area was variable, except for a complete lack of organic material and common absence of silt/clay throughout the 11 HSs. Gravel and cobble comprised the majority of the substrate, but sand and/or boulders were also common. All but one HS had a sparse to moderate amount of fish cover from large woody debris, rock, overhanging vegetation, or aquatic vegetation. Overall, aquatic vegetation was not prevalent; a sparse amount of emergent vegetation was observed in three HSs and a sparse amount of algae was also reported in one of these three HSs. The habitat type was dominated by riffles, except at the upstream end of the habitat assessment where glides were the dominant habitat type. Mean wetted width ranged from 0.1 to 4.0 m and maximum depth was <0.25 m. Obstructions (logjams and waterfalls) were observed in three HSs. The steep gradient and shallow depths (0.1 m) of Duke Ravine near the mouth of the Saskatchewan River would make fish passage from the Saskatchewan River into the stream difficult (Appendix 5.3.1-C, Photos 67 and 73).

Duke Ravine within the PKCF

The habitat assessment in Duke Ravine within the PKCF was completed in August 2008. The riparian zone was consistently forested with gentle to steep stable slopes vegetated by trees, shrubs, grasses, and sedges. The stream substrate was consistent, dominated by either sand or organic matter, with some silt/clay. All HSs contained large woody debris for fish cover and four HSs also contained cover from overhanging vegetation. Aquatic vegetation was predominantly absent, however, flooded terrestrial vegetation was observed. Pools and glides were the dominant habitat types (Appendix 5.3.1-C, Photos 74 to 78). HSs with pools (mean wetted width ≥ 30 m) either contained or were adjacent to a HS that contained a beaver dam. Maximum depth ranged from 0.2 to 1.5 m. Beaver dams were present in three HSs and logjams were present in two HSs.

FalC Ravine

The habitat assessment in FalC Ravine near the Saskatchewan River was completed in August 2008. The riparian zone consisted of forested, gentle to moderately sloped stable banks vegetated by trees and shrubs, along with grasses and sedges in about half of the 16 HSs. The stream substrate bed was variable; sand and gravel were the dominant components, but patches of silt/clay, cobble, and boulder were observed. Organic matter was largely absent. In general, fish cover consisted of sparse amounts of large woody debris. No aquatic vegetation was observed throughout the assessed region of the FalC Ravine. Habitat type was predominantly riffles and glides with some runs. Mean wetted width ranged from 0.2 to 1.0 m, but was usually <0.4 m. Maximum depth was generally <0.05 m. In terms of obstructions to fish movement, 7 of the 16 HSs contained either a waterfall, a logjam, or went underground (Appendix 5.3.1-C, Photos 83 and 84). Due to the steep gradient, shallow depths, and obstructions, fish passage from the Saskatchewan River into FalC Ravine would not be possible (Appendix 5.3.1-C, Photos 79 to 81).

Wapiti Ravine

The habitat assessment in Wapiti Ravine near the Saskatchewan River was completed in August 2008. The riparian zone was predominantly forested with steep stable slopes vegetated by trees and shrubs. The stream substrate consisted of a mix of sand, gravel, cobble, and boulder with small amounts of sand and no organic matter. All 13 HSs provided fish cover, largely in the form of sparse to moderate amounts of large woody debris, with some rock and two dense patches of overhanging vegetation. Sparse distributions of aquatic vegetation were found in only one HS. Habitat type consisted of glides and runs, although riffles were dominant near the mouth of the stream due to the slope. Mean wetted width was usually <0.6 m and maximum depths ranged from 0.03 to 0.4 m. Logjams in three HSs were observed. Similar to Duke and FalC ravines, the area of Wapiti Ravine located near the mouth was a narrow, shallow channel with a steep gradient and contained obstructions to fish movement (Appendix 5.3.1-C, Photo 88).

English Creek

The habitat assessment in English Creek near the Saskatchewan River was completed in August 2007. The riparian zone was predominantly forested with moderate and steep slightly unstable slopes vegetated by trees and shrubs. In terms of substrate composition, the stream bed was variable throughout. The substrate of English Creek was generally a mix of sand, gravel, and cobble with some boulders and silt/clay, with all HSs lacking organic material. Sparse amounts of large woody debris, overhanging vegetation, undercut, or aquatic vegetation provided fish cover in 10 of the 11 HSs. The only aquatic vegetation observed was a sparse amount of moss/algae in three HSs. The habitat type was predominantly riffles and runs, but glides and pools were also present. Mean wetted width ranged from 2.0 to 8.0 m and maximum depths varied between 0.2 and 0.8 m. Waterfalls and logjams created barriers to fish movement in two HSs and impediments to fish movement in the form of beaver dams were present in another two HSs. Fish passage from the Saskatchewan River to English Creek was possible in the lower reach (Appendix 5.3.1-C, Photos 95 and 96), however, the presence of some larger beaver dams located further upstream would hinder migration potential (Appendix 5.3.1-C, Photo 99).

Spawning Habitat

Fish access to spawning grounds within Caution Creek, 101 Ravine, West Perimeter Ravine, West Ravine, FalC Ravine, and Wapiti Ravine was deemed unlikely and large-bodied fish species were not captured in these streams during the fish surveys. Therefore, spawning suitability indices were not completed for these streams.

Based on the results of the fish community and spawning surveys, as well as the habitat assessments, spawning habitat suitability indices were completed for East Ravine, Duke Ravine, and English Creek. The focus of the assessments was on potential sucker spawning habitat in the streams, since it is considered unlikely that other large-bodied fish species are ascending them to spawn and evidence of sucker spawning was found in East Ravine and English Creek. However, spawning suitability indices for walleye were provided for the lower reaches of East Ravine and English Creek because juvenile walleye were captured there during the fish surveys.

In the section of East Ravine near the Saskatchewan River, HSs were rated unsuitable (seven HSs) or unsuitable to marginally suitable (two HSs) for walleye spawning largely because water depths were too shallow (Appendix 5.3.1-A, Table 6). The only walleye observed in East Ravine were three juveniles captured in the hoop net set at the mouth of the creek during the 2007 spring spawning survey. Four of the nine HSs were rated moderately suitable for white sucker spawning. The remaining five HSs were not suitable for white sucker spawning due to shallow water depths and obstructions that limited accessibility (Appendix 5.3.1-A, Table 6). The 2007 spring spawning survey provided evidence that white sucker were using the lower reach of East Ravine for spawning, however, as mentioned above, after the spring spawning survey beaver dams were constructed which would temporarily prohibit fish movement and changed the habitat in the stream.

The sections of East Ravine were rated as unsuitable for white sucker spawning (Appendix 5.3.1-A, Table 6). This unsuitability was due to the silt/clay and sand substrate (in the Star pit region) and silt/clay and organic matter substrate (in upper reaches), along with the abundance of large pools created by beaver dams. It is noted that only juvenile white sucker (<13.4 cm in length) were captured during the fish community assessments and it is highly unlikely that adult white sucker could migrate to these areas to spawn.

Six of the eleven Duke Ravine HSs were rated marginally to moderately suitable for white sucker spawning because of the habitat they provide (Appendix 5.3.1-A, Table 6). However, HSs located closer to the mouth of the stream were rated as unsuitable for white sucker spawning because of very shallow water depths and steep gradient. It is considered highly unlikely that adult white sucker could migrate up this stream to spawn.

In English Creek, five of the eleven HSs were moderately suitable for walleye spawning; the remaining five HSs were unsuitable or unsuitable to marginally suitable. Two HSs were rated moderately suitable for longnose sucker and white sucker spawning (Appendix 5.3.1-A, Table 6). English Creek was the largest creek in the study area and unlike the other streams, it provided good quality spawning habitat for walleye and sucker in the lower reaches that could be accessed by these species. Evidence of white sucker spawning was found approximately 70 m upstream from the creek mouth during the 2007 spring spawning survey.

Nursery and Early Life Stage Rearing Habitat

Larval and juvenile white sucker are known to rear in shallow backwaters, riffles with moderate water velocity, and sand-rubble substrates in streams (Twomey et al. 1984). Juvenile white sucker were captured throughout the study areas in East Ravine, Duke Ravine, and English Creek demonstrating that these streams provide nursery and early life stage rearing habitat for this species. As discussed above, the study areas of these streams contain a variety of habitat types including riffles, runs, and glides and substrate that is dominated by sand, gravel, and cobble. The white sucker captured in the streams were all <15 cm in length and the fish retained for chemical analyses were <6 years old[6]; it is likely these fish move downstream to the Saskatchewan River once adulthood is attained. In addition, two juvenile walleye were captured in English Creek indicating that adequate cover was present to meet the habitat requirement of this species since they are known to be photosensitive (Ryder 1977).

Feeding Habitat

Sucker sac-fry feed on plankton, however, once the mouth moves from a terminal to a ventral position, and an associated shift to bottom feeding occurs and the diet of juvenile and adult sucker consists of benthic organisms (Scott and Crossman 1998; Siefert 1972). The diet of juvenile and adult walleye consists primarily of fish, but aquatic invertebrates may be locally or seasonally important (Scott and Crossman 1998). The presence of small-bodied fish and juvenile large-bodied fish in East Ravine, Duke Ravine, and English Creek indicate feeding habitat is available for predatory species such as walleye. The results of the benthic invertebrate survey illustrated that these streams contain relatively high densities and diversities of benthic invertebrates, which confirms that feeding habitat is available for the sucker species. However, adult white sucker and walleye generally reside in large river systems and these creeks are too small to support anything but the occasional stray adult and are more suited to providing rearing habitat for these species.

[6] Age of sexual maturity varies over the range from 5 to 8 years old (Scott and Crossman 1998).

Overwintering Habitat

The streams do not contain an abundance of suitable overwintering habitat for fish, particularly near the Saskatchewan River. The lower reaches would mostly freeze solid in the winter due to the shallow water depths. Some of the pools located in the upper reaches, or backwaters with slightly greater water depths and flow, may contain some overwintering habitat for small-bodied fish and for juvenile large-bodied species.

5.3.1.4 Rare and Listed Species

All fish species captured or known to exist within the Project LSA (Table 5.3.1-6), with the exception of lake sturgeon, have a global conservation status of G5 (secure, common, widespread, and abundant), and are not federally listed as species of concern (SKCDC 2009). Lake sturgeon has a global status of G3G4 (vulnerable, uncommon and at moderate risk for extinction), and the Saskatchewan River population was federally ranked as endangered by the Committee on the Status of Wildlife in Canada in November 2006 (COSEWIC 2010). The Species at Risk Public Registry currently has no schedule or status for the Saskatchewan River lake sturgeon population (Government of Canada 2010), however, a schedule and status are under development (SWA 2009). As such, a recovery plan for the Saskatchewan River lake sturgeon population has not yet been developed.

In terms of provincial conservation status, the fish species captured or known to occur in the LSA ranged from S2 (rare and imperilled) to S5 (common and presently secure, but species could be rare in parts of its distribution and/or could be of long-term concern) (SKCDC 2009). The most imperilled species were lake sturgeon (S2) and central mudminnow (S2S3; rare to rare-uncommon, imperilled, and possibly susceptible to extirpation due to a factor of its biology and/or large-scale disturbances). Species rated as uncommon to rare-common included mooneye (S3; vulnerable to extirpation by large-scale disturbances), and the S3S4-ranked flathead chub, northern redbelly dace, river shiner, quillback, and silver redhorse (susceptible to extirpation by large-scale disturbances in parts of their range within Saskatchewan, while in other parts they may be abundant). Goldeye and shorthead redhorse have a provincial ranking of S4S5, designating the species as common to very common, therefore, they are considered overall to be secure. The remaining species are ranked S5 (Table 5.3.1-6).

It is noted that although central mudminnow, mooneye, quillback, and silver redhorse are known to occur in the Saskatchewan River, they were not captured during the fish surveys conducted in the Project LSA. Northern redbelly dace were commonly found in high abundances in the streams, while river shiner and flathead chub were captured in low abundances in the streams and Saskatchewan River, respectively.

5.3.1.5 Summary

The investigations conducted between 2006 and 2008 provide a comprehensive baseline inventory of the aquatic resources in the Project LSA prior to development of the mine. The benthic invertebrate communities assessed in all streams, as well as areas of the Saskatchewan River surrounding each stream, illustrate a high degree of natural variability in density, diversity, and biomass in the LSA. The fish surveys also showed differences between study areas in fish community composition, relative abundance, and chemistry.

Seventeen of the 23 fish species known to occur in the Saskatchewan River were captured in the LSA during the fish surveys. In addition, studies conducted by SWA between 2007 and 2010 located lake sturgeon in the Project LSA.

There was some evidence of spring spawning species using the Saskatchewan River study area for spawning as numerous adult sauger, white sucker, longnose sucker, and shorthead redhorse were captured in the spring, some of the white sucker captured were in ripe spawning condition, and white sucker eggs were located near to 101 Ravine.

The predominant habitat type in the Saskatchewan River study area was silt/clay/sand substrate interspersed with rocky areas, a lack of aquatic vegetation, gentle/moderate bottom slope, and moderate flow. The majority of the rocky substrate present in the Saskatchewan River study area was somewhat embedded and contained a layer of silt/clay and/or algae moss clogging interstitial crevices. Thus no highly suitable spawning habitat for lake sturgeon was identified within the assessed regions of the Saskatchewan River. The riffle area surrounding Duke and FalC ravines contains the greatest potential as lake sturgeon spawning habitat in the regions assessed within the Saskatchewan River. Although suitable rearing and feeding habitat for lake sturgeon is present within the Project LSA, it is important to note that this type of habitat is abundant throughout the river system.

No fish were captured during the baseline fish surveys in West Perimeter Ravine, FalC Ravine, and Wapiti Ravine. Additionally, only one lake chub and two brook stickleback were captured in West Ravine and Caution Creek, respectively. The aquatic habitat assessments conducted in these creeks identified numerous barriers to fish movement including steep gradients, shallow water depth, and obstructions.

101 Ravine and Duke Ravine both contained several species of small-bodied fish and Duke Ravine also contained juvenile white sucker (<10 cm in length). However, access to these streams from the Saskatchewan River is hindered by obstructions located near the mouths of the streams. The upper reaches of these two streams within the overburden pile (101 Ravine) and the PKCF (Duke Ravine) contained predominantly wetland habitat and a high abundance of small-bodied fish were captured.

East Ravine and English Creek contained the highest number of fish species, 8 and 10 respectively, in the Project LSA. Spring spawning surveys conducted in 2006 and 2007 provided evidence that these streams were being used by white sucker for spawning. In addition, aquatic habitat assessments identified several areas of East Ravine and English Creek considered suitable for sucker spawning. However, as noted previously, beaver dams constructed near the mouth of East Ravine in the summer of 2007 would temporarily prevent sucker movement up the creek and altered the habitat available. This illustrates the frequent seasonal changes these small streams undergo and the challenges associated with establishing the quantity and quality of critical fish habitat they provide.

5.3.2 Vegetation and Plant Communities

This Section describes the existing (baseline) distribution, abundance and composition of vegetation communities and the distribution and abundance of rare plants in the vicinity of the Star-Orion South Diamond Project (the Project).

5.3.2.1 Introduction

Specific vegetation communities are described within this Section including old growth forest, riparian habitat, and communities with high rare plant or historical use plant potential. These communities are of particular importance for wildlife, species at risk, and maintenance of biological diversity and ecosystem processes.

Vegetation communities and rare plants are described within two study areas; a Local Study Area (LSA) in which vegetation communities and rare plants may be directly affected by Project activities, and the Regional Study Area (RSA) defined by the Fort à la Corne (FalC) forest in which vegetation communities and rare plants may be indirectly affected by the Project. The LSA includes the Project footprint and a buffer area of approximately 500 m around the Project footprint. The FalC forest is an island forest in the Boreal Transition Ecoregion of central Saskatchewan surrounded by lands that are predominantly used for agriculture. It was chosen as a suitable RSA for the vegetation component of this study since it represents an area of similar land use compared to the landscape that surrounds it.

5.3.2.2 Information Sources and Methods

This Section describes the existing data sources reviewed and the original field data collected in order to complete the baseline assessment of vegetation distribution.

Data Review and Compilation

Recent and historical reports summarizing detailed vegetation and rare plant surveys conducted in the LSA and RSA were reviewed and compiled in order to prepare this baseline report. Copies of historical reports are attached in Appendix 5.3.2-A. Table 5.3.2-1 summarizes the data from each report that was incorporated into the baseline report.

Table 5.3.2-1: Information Sources Vegetation Communities and Rare Plants

Author	Description of Data	Date of Surveys	Report Reference
AMEC Earth & Environmental (AMEC)	Species list from 26 rare plant survey locations. Species list and abundance estimates from 14 detailed vegetation plots.	June to August 2009	Information included in this report
EcoDynamics Consulting Inc. (Ecodynamics)	Species list and community description from 51 rare plant survey locations. Species list and abundance estimates from 166 detailed vegetation plots.	August 2007 to November 2008	EcoDynamics Consulting Inc. (2009)
Canada North Environmental Services (CanNorth)	Descriptions and locations of rare plants encountered in upland, ravine slope and riparian vegetation communities surveyed.	July 2006	Canada North Environmental Services Ltd. (2007)
CanNorth	List of three rare plants and exotic species found during surveys.	August 8 to 10 2005	Canada North Environmental Services Ltd. (2005)
Golder Associates	List, approximate location and habitat of three rare plants found during surveys.	2004 to 2005	Golder Associates (2006)
Saskatchewan Ministry of Environment (SMOE) Forest Service	Species list and abundance estimates from 29 detailed vegetation plots established as part of the provincial Forest Ecosystem Classification (FEC) program as described in Jiricka et al. (2002).	1999 to 2000	Information included in this report

In addition to previous reports, spatial data sources were reviewed. To facilitate vegetation community mapping, the Saskatchewan Forest Vegetation Inventory (SFVI) was acquired from the SMOE Forest Service for the FalC forest. SFVI is based on the interpretation of stereo (1:15,000) black and white infrared aerial photographs combined with information from ground investigation, aerial reconnaissance and other information sources. The SFVI obtained is based on the interpretation of 2004 aerial photography and includes information on many forest stand characteristics including tree species, height, density, wetland classification, soil moisture regime and landform. Characteristics of the SFVI are described in the manual published by the Saskatchewan Environment Forest Service (2004a). Aerial photography between 2004 and 2010 was used to establish current baseline disturbance features (roads, etc.) on the landscape. Forest harvest activities of clear cut, salvage, or partial cutting greater than 30 years old were assigned to a “Regeneration” category, while areas logged within the last 30 years were assigned to a “Forest Harvest” category.

5.3.2.3 Field Surveys

A total of 326 detailed vegetation and rare plant inspection points was established in the RSA between 1999 and 2009. The methods used at the detailed and rare plant inspection points are summarized in the following sections.

Detailed Vegetation Inspections

Detailed vegetation inspections involved the establishment of 10 m by 10 m plots to evaluate plant species composition, abundance, and structure within representative ecosystems. A total of 209 detailed vegetation inspections were established in the RSA between 1999 and 2009 that were used to prepare the description of vegetation communities.

In general, detailed vegetation inspections involved the establishment of two 2 m by 2 m subplots in opposite corners of the main 10 m by 10 m plot to estimate species abundance and ecosystem structure (Table 5.3.2-2). A range of values was used to describe estimated species abundance (e.g., 5-10% cover). The structure of the plant community was also evaluated by estimating the cover of each species within a particular height class (e.g., canopy). Additional plant species occurring within the main plot were recorded. In some years, the abundance of tree and shrub species greater than 2 m in height was also estimated.

Table 5.3.2-2: Summary of Procedures at Detailed Vegetation Inspection Locations

Parameter	AMEC	Ecodynamics[y]	SMOE[z]
Date of Data Collection	2009	2007 to 2008	1999 to 2000
Main Plot Dimensions	10 m by 10 m	10 m by 10 m	10 m by 10 m
Sub-Plot Dimensions	Two 2 m by 2 m plots in opposite corners of main plot.	2 m by 2 m plots in SW and NE corners of main plot.	2 m by 2 m plots in SW and NE corners of main plot.
Vegetation Inspection Procedures	Cover abundance class of all vegetation species falling within the vertical projection of each sub-plot recorded. Additional species occurring outside the sub-plots but within the main plot recorded as present. Bryophytes and lichens not collected or identified.	Cover abundance class and layer class of all vegetation species falling within the vertical projection of each subplot recorded. Cover abundance class for woody debris, leaf litter, needles, exposed rock, exposed soil and exposed water in each sub-plot recorded. Additional species and/or additional layer classes of the same species within the 10 m by 10 m plot recorded. Cover abundance class and layer class of all tree and shrub species > 2 m in height also recorded within the main plot.	Cover abundance class and layer class of all vegetation species falling within the vertical projection of each sub-plot recorded. Cover abundance class for woody debris, leaf litter, needles, exposed rock, exposed soil, and exposed water in each sub-plot recorded. Bryophytes and lichens collected in the main plot and identified by specialists. Additional species and/or additional layer classes of the same species within the 10 m by 10 m plot recorded.

Notes: [y] The data provided by Ecodynamics were collected as part of baseline surveys in the FalC forest in 2007 and 2008. Plot establishment and data collection methodology are described in detail in Ecodynamics (2009).

[z] The data provided by the SMOE were collected as part of the Forest Ecosystem Classification (FEC) program carried out by the Forest Ecosystems Branch from 1999 to 2000. Plot establishment and data collection methodology are described in detail in Jiricka et al. (2002).

Rare Plant Inspections

A rare plant is defined as "any native species that, because of its biological characteristics or because it occurs at the fringe of its range, or for some other reason, exists in low numbers or in very restricted areas in Saskatchewan or in Canada" (Native Plant Society of Saskatchewan (NPSS) 1998). Rare plants generally refer to plant species at risk and rare or uncommon plants. Existing data and original field investigations were used to gather information on rare plants for this assessment.

Prior to completing the field surveys, rare plants with the potential to occur in the study areas were identified through review of Saskatchewan Conservation Data Centre (SKCDC) 2010a, SKCDC 2010b, SKCDC 2010c, and the W.P. Fraser Herbarium (SASK Herbarium) database at the University of Saskatchewan, Saskatoon. The habitat types for the potential rare plants identified through this process were defined using several references (e.g., Looman and Best 1987; Moss and Packer 1994; Kershaw et al. 2001; University of Saskatchewan 2010). These habitat types were summarized and used to target specific vegetation types for field survey.

A total of 117 rare plant inspection points were established in the RSA. Rare plant inspections used a random meander method as outlined in SKCDC (2010d). The route traversed plus 1 m on either side of the route was considered to be actively searched, and was completed at a pace that allowed observation of all species present. Particular attention was paid to micro-habitats, wet areas, ecotones, seepage areas, and disturbances, which typically have a greater probability of hosting rare plant species.

In rare plant inspections established in 2008 and 2009, each inspection point was visited twice; once between mid June and early July and again in early to mid August. Two inspections allowed identification of both early and late flowering plant species, as outlined in SMOE (2009). A complete list was compiled of vascular plant species and common bryophyte and lichen species encountered. Unknown vascular species were collected if there was a sufficient population present (NPSS 1998) and specimens were identified at the SASK Herbarium. Unknown non-vascular species were not collected or identified to a species level.

Plant species at risk included species listed as At Risk under the *Wildlife Act* (1998) (SMOE 2010) and those listed on Schedule 1 of the federal *Species at Risk Act* Public Registry (SARAPR 2010). Rare or uncommon plants included species assigned a provincial rank of S1, S2 or S3 by the SKCDC (2010e). Species listed as S1 (5 or fewer occurrences in Saskatchewan) and S2 (6 to 20 occurrences in Saskatchewan) by the SKCDC are defined as rare, whereas species listed as S3 (21 to 100 occurrences in Saskatchewan) are defined as rare to uncommon (SKCDC 2010f).

If a rare plant was observed, representative photographs were taken of both the habitat and the rare plant. The geographic location was then recorded with a handheld Global Positioning System (GPS). Voucher specimens were collected where such collection did not endanger the local population.

5.3.2.4 Classification of Vegetation Types

Within the RSA, an ecological land classification (ELC) approach was used to map vegetation types, as described in Ecodynamics (2009). This Ecodynamics (2009) report is included as Appendix 5.2.2-A within the soils baseline (Section 5.2.2). Forest polygons mapped by the SFVI were converted to vegetation types based on the dominant canopy species and soil moisture regime outlined in the SFVI in addition to field survey data. Vegetation type boundaries were not modified from those presented in the SFVI. For comparison, vegetation types in this document were correlated to the ecosites presented in Beckingham et al. 1996 (Appendix 5.3.2-B).

5.3.2.5 Species Composition and Abundance

The characteristics of vegetation cover types occurring within the study areas were identified through 286 inspection points taken from the sources described above. Uncommon and sensitive vegetation types are also discussed. Species composition was summarized for each vegetation type by compiling the list of the species present in the detailed and rare plant survey inspection points. The total number of species within the following growth form categories was also determined: trees, shrubs, forbs, graminoids, mosses and liverworts, and lichens. The average number of species identified in each vegetation type was calculated (Appendix 5.3.2-B).

For the purposes of this report, weed species were considered to be non-native species, including noxious weeds and invasive species identified by the SKCDC (2010g, 2010h). Noxious weed species in Saskatchewan are currently regulated under the *Noxious Weed Act*, and are identified under the *Noxious Weed Designation Regulations*. Native species can become weeds due to their high dispersal and migration rates (e.g., spreading dogbane (*Apocynum androsaemifolium*) and common cattail (*Typha latifolia*)), but were not considered in this report.

Combined taxonomic groups of species (e.g., sedges) in the dataset were counted as a single species. This approach conservatively estimated the total number of species encountered within the growth habit groups. Non-vascular species including mosses, liverworts and lichens were only identified in the SMOE dataset.

5.3.2.6 Old Growth Forest

Old growth forest (>120 years of age) in the study areas was mapped based on the year of origin indicated for each forest stand in the SFVI. Those forest stands with a year of origin of 1890 or earlier were considered old growth forests, regardless of tree species. Very small, localized old growth forest within younger forest stands that were not mapped at the SFVI scale of 1:15,000 are not included in the old growth forest inventory.

5.3.2.7 Riparian Habitat

Riparian areas are recognized for their importance for ecosystem function and as habitat for wildlife, vegetation, and rare species (e.g., Korol 1995; Lee et al. 2004). Riparian areas are heterogeneous transition zones between terrestrial and aquatic ecosystems that are generally influenced by elevated water tables or frequent flooding (Saskatchewan Environment Forest Service 2004b; Naiman and Decamps 1997). Korol (1995) defined the riparian zone as that area containing a distinct vegetation community and structure located directly adjacent to a waterbody. Based on these definitions, riparian areas were mapped within the study areas as those forest polygons in the SFVI directly adjacent to watercourses and waterbodies with an assigned soil moisture regime of either moist, very moist, moderately wet, wet, or very wet.

5.3.2.8 Riparian Management Areas

Riparian areas can also be managed as distinct forestry units (Saskatchewan Environment Forest Service 2004b). Riparian area management in forested regions has typically included the implementation of buffers within which no harvesting shall occur. Typical riparian buffer widths that may be observed in the RSA were referenced from Weyerhaeuser (2009) based on the recommendation of SMOE Forest Service (2010). The riparian buffer width is defined based on waterbody and watercourse characteristics as outlined in Table 5.3.2-3.

Table 5.3.2-3: Riparian Management Area Widths[Z]

Waterbody Description	Riparian Buffer Width (m)
Lakes and streams not capable of supporting fish and not connected to recognizable stream system	0
Small stream that is part of recognizable stream system but does not support permanent or seasonal populations of fish	15
Lakes and streams with seasonal populations of fish	30
Lakes and streams with permanent fish populations or capable of supporting a fish population introduced by stocking	90

Note: [Z] Adapted from Weyerhaeuser (2009).

All watercourses examined in the Fisheries and Aquatic Resources section of this EIA (Section 5.3.1) contained either fish or fish habitat of varying quality. Significant barriers existed for some watercourses (e.g., Wapiti, FalC, and West Ravines) such that fish would likely not use the length of the watercourse. Nonetheless according to the definitions provided in Table 5.3.2-3, all watercourses were assigned a 90 m buffer to make the most conservative estimation of the available riparian management area.

5.3.2.9 Rare Plant Potential

Sixty-two rare vascular plant species were identified as having the potential to occur in the study area (Appendix 5.3.2-C). Of these species, none are listed as plant species at risk under the federal *Species at Risk Act* (SARA) or the provincial *Wildlife Act*. Five species are identified as extremely rare (S1) by the SKCDC including common moonwort (*Botrychium lunaria*), prickly sedge (*Carex echinata* ssp. *echinata*), ram's head lady's slipper (*Cypripedium arietinum*), slenderleaf sundew (*Drosera linearis*), and northern twayblade (*Listera borealis*). Potentially occurring non-vascular species were not identified as part of this review due to their microsite specificity.

Based on a review of rare plants with the potential to occur in the study areas as described above and the rare plants identified during the field surveys, specific vegetation types with low, medium, and high rare plant potential were delineated. Rare plant potential was assigned to vegetation types based on the proportion of rare species found compared to the number of sample sites within that vegetation type (Appendix 5.3.2-C).

5.3.2.10 Historical Use Plant Potential

Inspection data were used to rank vegetation types for their potential to contain known plant species historically used for food or other purposes (Clavelle 1997). The method used to rank each vegetation type combined measures of mean richness (mean number of species occurrences per plot in a given ecosite phase), total richness (number of distinct species found in an ecosite phase), and unique and uncommon species of such plants in order to determine an overall ranking (Appendix 5.3.2-C). Similarly ranked vegetation types were combined into historical use plant potential classes to determine their relative distribution within the study areas for the Baseline Case.

5.3.2.11 Baseline Conditions

This Section describes the vegetation categories present in the LSA and RSA in the baseline case.

Ecological Setting

The LSA and RSA occur in the La Corne Plain Landscape Area of the Boreal Transition Ecoregion (Acton et al. 1998). The La Corne Plain is described as an undulating fluviallacustrine plain with gently sloping topography. Hummocks occur in sandy areas reworked by wind. The Boreal Transition Ecoregion is characterized by several types of vegetation including agricultural land, aspen forest, mixed wood forest, jack pine forest, grasslands, peatlands, and boreal wetlands (Acton et al. 1998).

Vegetation Types

The area and proportion of each vegetation type occurring within the LSA and RSA are presented in Table 5.3.2-4. Descriptions of each vegetation type based on vegetation inspection data are presented in Appendix 5.3.2-D. General descriptions of the upland and wetland vegetation types are also provided in Ecodynamics Consulting Inc. (2009). The influence of forestry activities in the study areas is shown in Table 5.3.2-5. Forest Harvest indicates the area of the LSA or RSA influenced by recent (<30 years) clearcut or salvage harvesting, and Regeneration indicates the area influenced by old (>30 years) clearcut, salvage, or partial cut harvesting. Approximately 2,000 ha of the forest harvest occur within the Jack-Pine Dry to Fresh vegetation type in the LSA, and approximately 8600 ha occur within the same vegetation type in the RSA.

Table 5.3.2-4: Vegetation Types in the Study Areas

Vegetation Type	LSA (ha)	LSA (%)*	RSA (ha)	RSA (%)*
Upland Vegetation Types				
Balsam Poplar - Spruce: Moist**	81	1	819	1
Balsam Poplar - Trembling Aspen : Moist**	204	2	1,991	1
Black Spruce: Moist**	30	<1	3,058	2
Jack Pine - Trembling Aspen : Dry to Fresh	899	7	10,835	8
Jack Pine : Dry to Fresh	6,074	50	40,088	30
Trembling Aspen - Spruce : Fresh	2,586	21	33,791	25
Trembling Aspen : Dry to Fresh	435	4	6,773	5
Trembling Aspen : Moist**	72	1	1,298	1
White Spruce : Fresh**	168	1	5,079	4
White Spruce : Moist**	56	<1	2,250	2
Brushland/Grassland Complex	325	3	2,447	2
Total Upland Vegetation Types	*10,930*	*90*	*108,429*	*82*
Wetland Vegetation Types				
Marsh**	2	<1	1,275	1
Treed Bog**	44	<1	917	1
Treed, Shrubby and Open Fen**	45	<1	3,209	2
Treed Swamp**	181	1	8,794	7
Shrubby Swamp	364	3	7,051	5
Unclassified Wetland - Non-Forested	20	<1	137	<1
Total Wetland Vegetation Types	*656*	*5*	*21,383*	*16*
Other Cover Types				
Agricultural Land	0	0	330	<1
Human Disturbance	255	2	1,625	1
Lakes, Rivers and Flooded Land	375	3	1,009	1
Total Other Cover Types	*630*	*5*	*2,964*	*2*
Total	***12,218***	***100***	***132,776***	***100***

Notes: *Rounded to the nearest integer.
**Uncommon vegetation types.

Table 5.3.2-5: Forestry within the Study Areas

Vegetation Type	LSA (ha)	LSA (%)*	RSA (ha)	RSA (%)*
Forest Harvest (<30 years old)	2,562	21	19,740	15
Regeneration (>30 years old)	801	7	7,545	6

Note: *Rounded to the nearest integer.

Figures 5.3.2-1 and 5.3.2-2 show the vegetation types in the LSA and RSA, respectively. Figure 5.3.2-3 shows the distribution of inspection locations across the LSA and RSA. Upland vegetation types are dominant in the LSA and RSA, with the Jack Pine: Dry to Fresh and Trembling Aspen - Spruce: Fresh communities being the most common of the upland vegetation types.

Uncommon Vegetation Types

Uncommon vegetation types are defined as those with a total mapped area of ≤1% of the LSA and/or ≤1% of the RSA at baseline. These vegetation types are considered more vulnerable to losing species diversity if disturbed since a greater proportion of their area would be lost even with small disturbances. Nine vegetation types occupy ≤1% each of the LSA at baseline and are therefore considered locally uncommon (Table 5.3.2-4). Five vegetation types are considered uncommon at the regional level. Uncommon vegetation types cover a combined area of 679 ha (6%) of the LSA and 6300 ha (5%) of the RSA. Figures 5.3.2-1 and 5.3.2-2 include the baseline distribution of these uncommon vegetation types within the LSA and RSA. Five vegetation cover types considered uncommon in the LSA are proportionally more common in the RSA (i.e. >1 % of the RSA). One natural vegetation cover type, Balsam Poplar - Trembling Aspen: Moist, is considered proportionally less common in the RSA than it is in the LSA (Table 5.3.2-4).

Sensitive Vegetation Types

Sensitive vegetation types are susceptible to ecological changes resulting from project development. Stresses associated with direct project disturbances might indirectly affect vegetation resources. Such stresses may include air emissions, and changes in surface and ground water quality and quantity. Bogs, fens and any vegetation types on sandy soils represent the most sensitive vegetation types in the study areas.

Treed bogs cover 44 ha or <1% of the LSA and 917 ha or 1% of the RSA. Bogs are nutrient poor and acidic with low pH values (Halsey and Vitt 1997). Bogs are also characterized by stagnant (precipitation fed) waters with high water tables. Plant species in bogs are uniquely adapted to these conditions. Alterations to the water table, including drawdown and/or impoundment, may result in changes in water chemistry and plant communities.

Fens occupy 45 ha or <1% of the LSA and 3,209 ha or 2% of the RSA. Fens receive inputs from surface and groundwater flows. Changes to incoming water quantity or quality will influence the species composition and growth characteristics of these wetlands.

Vegetation types that occur on sandy soils are sensitive to groundwater changes due to the low moisture holding capacity in the soil. Sandy soils do not buffer the effects of drought and dry periods during the growing season, consequently any changes in groundwater levels that may increase or decrease available water within the root zone can over time cause changes in vegetation composition. The most sandy vegetation types include the Jack Pine – Trembling Aspen: Dry to Fresh and the Jack Pine: Dry to Fresh vegetation types, which collectively cover 6,973 ha or 57% of the LSA and 50,923 ha or 38% of the RSA.

Species Composition

The total and average numbers of species identified during field surveys for each vegetation type are provided in Appendix 5.3.2-B. The total numbers of trees, shrubs, forbs, graminoids, mosses and liverworts and lichens identified in each vegetation type and the equivalent ecosite outlined by Beckingham et al. (1996) are also provided in Appendix 5.3.2-B. Tables presenting the frequency and abundance of species identified within each vegetation type are presented in Appendix 5.3.2-B as Tables 3 (Upland Vegetation Types) and 4 (Wetland Vegetation Types).

Twenty-eight weeds were identified during the vegetation inspections. Weedy plant species were more abundant in the wetland vegetation types in comparison to the upland vegetation types (Table 5.3.2-6).

Table 5.3.2-6: Weeds in the Study Areas

Scientific Name	Common name	Provincial Rank[z]	Noxious Species	Invasive Species	Occurs in Upland Vegetation	Occurs in Wetland Vegetation
Forbs						
Chenopodium album var. album	lamb's-quarter's	SNA	No	Yes	Yes	Yes
Cirsium arvense	Canada thistle	SNA	Yes	Yes	Yes	Yes
Crepis tectorum	annual hawksbeard	SNA	No	Yes	Yes	Yes
Daucus carota	wild carrot	SNA	No	Yes	Yes	
Descurainia sophia	flixweed	SNA	No	Yes	Yes	
Galeopsis tetrahit	hemp-nettle	SNA	No	Yes	Yes	Yes
Kochia scoparia	summer-cypress	SNA	No	Yes		Yes
Matricaria perforata	scentless chamomile	SNA	Yes	Yes	Yes	
Medicago lupulina	black medic	SNA	No	Yes		Yes
Medicago sativa	alfalfa	SNA	No	No		Yes
Melilotus alba	white sweet-clover	SNA	No	No	Yes	Yes
Melilotus officinalis	yellow sweet-clover	SNA	No	Yes		Yes
Plantago major	common plantain	SNA	No	Yes	Yes	Yes
Polygonum convolvulus	wild buckwheat	SNA	Yes	Yes	Yes	Yes
Polygonum persicaria	lady's-thumb	SNA	No	Yes		Yes
Senecio vulgaris	common groundsel	SNA	No	Yes		Yes
Sonchus arvensis ssp. arvensis	field sow-thistle	SNA	Yes	Yes	Yes	Yes
Sonchus asper	prickly sow-thistle	SNA	No	Yes	Yes	
Tanacetum vulgare	tansy	SNA	No	Yes		Yes

Scientific Name	Common name	Provincial Rank[Z]	Noxious Species	Invasive Species	Occurs in Upland Vegetation	Occurs in Wetland Vegetation
Taraxacum officinale ssp. officinale	common dandelion	SNA	Yes	Yes	Yes	Yes
Thlaspi arvense	stinkweed	SNA	Yes	Yes	Yes	
Trifolium hybridum	alsike clover	SNA	No	Yes		Yes
Trifolium pratense	red clover	SNA	No	Yes		Yes
Vicia cracca	tufted vetch	SNA	No	Yes		Yes
Graminoids						
Elytrigia repens	creeping wild rye	SNA	Yes	Yes	Yes	Yes
Hordeum jubatum ssp. jubatum	fox-tail barley	SNA	No	Yes	Yes	Yes
Phleum pratense	timothy	SNA	No	Yes	Yes	
Setaria viridis	green foxtail	SNA	Yes	Yes		Yes

Note: [Z] Definitions of provincial S ranks are as follows: SNA –conservation status not yet applicable to the species.

Old Growth Forest

Old growth forest (>120 years of age) occupies approximately 24 ha (<1%) of the LSA and 5901 ha (4%) of the RSA (Table 5.3.2-7).

Three vegetation types in the LSA contain old growth; the Jack Pine: Dry to Fresh vegetation type, occupying approximately 15 ha (<1%), the Trembling Aspen – Spruce: Fresh vegetation type occupying 1 ha (<1%), and the Treed Swamp vegetation type, occupying approximately 8 ha (<1%). In the RSA, old growth forest occurs in 12 vegetation types over 5,901 ha (4%) of the RSA, with 36% (2,127 ha) of the old growth occurring in the Treed Swamp vegetation type.

Figures 5.3.2-4 and 5.3.2-5 display areas of old growth forest, in the LSA and RSA.

Table 5.3.2-7: Old Growth Forest in the Study Areas

Age	Forest Type	LSA (ha)	LSA (%)*	RSA (ha)	RSA (%)*
Old Growth Year of Origin 1850-1890	**Upland Vegetation Types**				
	Balsam Poplar - Spruce : Moist	0	0	31	<1
	Balsam Poplar - Trembling Aspen : Moist	0	0	4	<1
	Black Spruce : Moist	0	0	573	<1
	Jack Pine - Trembling Aspen : Dry to Fresh	0	0	127	<1
	Jack Pine : Dry to Fresh	15	<1	571	<1
	Trembling Aspen - Spruce : Fresh	1	<1	214	<1
	Trembling Aspen : Dry to Fresh	0	0		
	Trembling Aspen : Moist	0	0	26	<1
	White Spruce : Fresh	0	0	819	1
	White Spruce : Moist	0	0	523	<1
	Wetland Vegetation Types				
	Treed Bog	0	0	418	<1
	Treed and Open Fen	0	0	469	<1
	Treed Swamp	8	<1	2,127	2
Total Old Growth		***24***	**<1**	***5,901***	***4***

Note: *Rounded to the nearest integer.

Riparian Habitat

Riparian areas occupy approximately 576 ha (5%) of the LSA and 8,642 ha (7%) of the RSA (Table 5.3.2-8). The dominant vegetation type associated with riparian areas is the shrubby swamp vegetation type, occupying approximately 312 ha (3%) of the LSA and 2,781 ha (2%) of the RSA. Figures 5.3.2-6 displays riparian habitat in the LSA.

Table 5.3.2-8: Riparian Area Vegetation Types in the Study Areas

Riparian Area Vegetation Type	LSA (ha)	LSA (%)*	RSA (ha)	RSA (%)*
Balsam Poplar - Spruce : Moist	32	<1	339	<1
Balsam Poplar - Trembling Aspen : Moist	46	<1	222	<1
Black Spruce : Moist	19	<1	187	<1
Jack Pine - Trembling Aspen : Dry to Fresh	24	<1	90	<1
Marsh	2	<1	995	1
Shrubby Swamp	312	3	2,781	2
Treed Bog	9	<1	113	<1
Treed Swamp	83	1	2,258	2
Treed and Open Fen	26	<1	1,466	1
Trembling Aspen - Spruce : Fresh	0	0	2	<1
Trembling Aspen : Dry to Fresh	0	0	14	<1
Trembling Aspen : Moist	4	<1	21	<1
White Spruce : Moist	19	<1	154	<1
Total Riparian Area	*576*	*5*	*8,642*	*7*
Total Area	**12,218**	**100**	**132,769**	**100**

Note: *Rounded to the nearest integer.

Riparian Management Areas

Riparian management areas occupy approximately 1,894 ha (15%) of the LSA and approximately 13,042 ha (10%) of the RSA. The riparian management areas are made up of several vegetation types (Table 5.3.2-9), not all of which are classified in this document as part of ecologically riparian areas (Table 5.3.2-8). Rather, riparian management areas are defined by forestry management criteria as discussed in the section above. The dominant vegetation type within the riparian management areas overlapping the EIA study areas is the Trembling Aspen - Spruce: Fresh vegetation type, occupying 396 ha (3%) of the LSA and 2951 ha (2%) of the RSA. This vegetation type commonly occurs in close proximity to ecologically defined riparian areas.

Table 5.3.2-9: Vegetation Types in Riparian Management Areas in the Study Areas

Riparian Management Area Vegetation Type	LSA (ha)	LSA (%)	RSA (ha)	RSA (%)
Balsam Poplar - Spruce : Moist	22	<1	136	<1
Balsam Poplar - Trembling Aspen : Moist	58	<1	355	<1
Black Spruce : Moist	12	<1	172	<1
Jack Pine - Trembling Aspen : Dry to Fresh	96	1	436	<1
Jack Pine : Dry to Fresh	206	2	1,039	1
Trembling Aspen - Spruce : Fresh	396	3	2,951	2
Trembling Aspen : Dry to Fresh	98	1	646	<1
Trembling Aspen : Moist	13	<1	118	<1
White Spruce : Fresh	128	1	1,196	1
White Spruce : Moist	37	<1	390	<1
Brushland / Grassland	100	1	287	<1
Marsh	2	<1	831	1
Treed Bog	7	<1	95	<1
Treed and Open Fen	18	<1	551	<1
Treed Swamp	48	<1	1,176	1
Shrub Swamp	272	2	1,609	1
Unclassified Wetland - Non-Forested	1	<1	9	<1
Agricultural Land	0	0	29	<1
Unclassified Human Disturbance	1	<1	17	<1
Lakes, Rivers and Flooded Land	375	3	999	1
Total Riparian Management Area	*1,894*	*15*	*13,042*	*10*
Total Area	**12,218**	**100**	**132,776**	**100**

*Rounded to the nearest integer.

5.3.2.12 Species at Risk

Rare Plant Potential

The analysis for rare plant potential (Section 5.3.2.9 and Appendix 5.3.2-C) resulted in 6,392 ha of the LSA (52%) and 54,190 ha of the RSA (41%) being delineated as having high potential for rare species (Table 5.3.2-10). This result reflects the relatively high number of rare plants found in the study areas in part due to a high search effort and in part due to the proportionally large area of the Jack Pine: Dry to Fresh vegetation type which occupies 50% of the LSA (Table 5.3.2-4) and, in which, 50 occurrences of 15 rare species were documented during field inspections.

Common moonwort (*Botrychium lunaria*), prickly sedge (*Carex echinata ssp. echinata*), ram's head lady's slipper (*Cypripedium arietinum*), slenderleaf sundew (Drosera linearis), and northern twayblade (Listera borealis), the species ranked as S1 by the SKCDC (Appendix 5.3.2-C) and having the potential to occur within the study areas (but not recorded during vegetation inspections used for this Project), may be found within this area of high rare plant potential, but may also be found in areas classified as low rare plant potential (i.e. Shrubby swamp, marsh, unclassified wetland - non-forested vegetation types). This result emphasizes that while rare plant search efforts generally focus on areas with high potential, certain species may be found in less likely locations. Similarly high rare plant potential rankings do not necessarily indicate actual occurrence of rare plants.

Table 5.3.2-10: Ranked Areas of Rare Plant Potential

Rare Plant Potential Rank	Vegetation Type	LSA Area (ha)	% of LSA	RSA Area	% of RSA
High	Black Spruce: Moist Jack Pine: Dry to Fresh White Spruce: Moist Treed Swamp	6,392	52	54,190	41
Medium	Balsam Poplar - Trembling Aspen: Moist Jack Pine - Trembling Aspen: Dry to Fresh Trembling Aspen - Spruce: Fresh Trembling Aspen: Moist Treed, Shrubby, and Open Fen	3,805	31	51,124	39
Low	Balsam Poplar - Spruce: Moist Trembling Aspen: Dry to Fresh White Spruce: Fresh Brushland/Grassland Complex Marsh Shrubby Swamp Unclassified Wetland - Non-Forested	1,396	11	23,580	18
Not Ranked	Treed Bog Agricultural Land Human Disturbance Forest Harvest Regeneration Lakes, Rivers, and Flooded Land	674	6	3,881	3
Total		**12,218**	**100**	**132,776**	**100**

Rare Plants

Forty-five rare plant species were identified in the study areas, including 23 non-vascular plant species. Of the rare plants identified, five extremely rare (S1) non-vascular species were identified including dragon cladonia (*Cladonia squamosa*) brown-eyed rim lichen (*Lecanora allophana*), camouflage lichen (*Melania exasperata*), dotted ramalina (*Ramalina farinacea*), and beard lichen (*Usnea scabiosa*). Locations of the rare plants identified during field inspections are shown on Figures 5.3.2-7 (LSA) and 5.3.2-8 (RSA), and are summarized in Table 5.3.2-11. Potential rare plants as identified by the SKCDC and the literature are not shown, as specific locations of those rare plants are considered confidential.

In addition to the locations outlined below, a previous study (Golder Associates 2006) summarized two locations of leathery grape fern (*Botrychium multifidum*), two locations of pink fringed milkwort (*Polygala paucifolia*), and four locations of heart leaved twayblade (*Listera cordata var*. *cordata*), however specific geographic locations were undisclosed.

Table 5.3.2-11: Rare Plants Found During Field Inspections

Common Name	Scientific Name	Provincial Rank[z]	Growth Form	Vegetation Type
comma lichen	*Arthonia patellulata*	S2	Lichen	Jack Pine : Dry to Fresh
leathery grape-fern	*Botrychium multifidum*	S3	Forb	Jack Pine : Dry to Fresh
pale-footed Horsehair lichen	*Bryoria fuscescens*	S3	Lichen	Black Spruce: Moist, Jack Pine: Dry to Fresh, Treed Swamp
horsehair lichen	*Bryoria simplicior*	S3	Lichen	Jack Pine: Dry to Fresh, Balsam Poplar - Trembling Aspen: Moist
lapland reed-grass	*Calamagrostis lapponica*	S2S3	Graminoid	Open Fen
marsh bellflower	*Campanula aparinoides*	S2S3	Forb	Black Spruce: Moist, Treed Fen
large northern aster	*Canadanthus modestus*	S2	Forb	Treed Fen
porcupine sedge	*Carex hystericina*	S2	Graminoid	Open Fen, Treed Swamp
cyperus-like sedge	*Carex pseudocyperus*	S2S3	Graminoid	Shrub Swamp, Treed Swamp
dry goosefoot	*Chenopodium pratericola*	S2	Forb	Jack Pine : Dry to Fresh
powdered funnel lichen	*Cladonia cenotea*	S3	Lichen	Black Spruce: Moist
common powderhorn	*Cladonia coniocraea*	S2	Lichen	Black Spruce: Moist, Jack Pine : Dry to Fresh, Trembling Aspen - Spruce : Fresh
organ-pipe lichen	*Cladonia crispata*	S3	Lichen	Jack Pine : Dry to Fresh

Common Name	Scientific Name	Provincial Rank[z]	Growth Form	Vegetation Type
british soldiers	*Cladonia cristatella*	S3	Lichen	Jack Pine : Dry to Fresh
lipstick powderhorn	*Cladonia macilenta*	S2	Lichen	Jack Pine : Dry to Fresh
dragon cladonia	*Cladonia squamosa*	S1	Lichen	Jack Pine: Dry to Fresh
long-bracted green bog orchid	*Coeloglossum viride var. virescens*	S3S4	Forb	Shrub Swamp, Treed Swamp - Treed Fen
small yellow lady's slipper	*Cypripedium parviflorum var. makasin*	S2S4	Forb	Treed Fen, Trembling Aspen : Moist
sand-dune wheatgrass	*Elymus lanceolatus ssp. psammophilus*	S2	Graminoid	Trembling Aspen - Spruce : Fresh
tall blue lettuce	*Lactuca biennis*	S2	Forb	Shrub Swamp
brown-eyed rim-lichen	*Lecanora allophana*	S1	Lichen	Jack Pine : Dry to Fresh
large white-flowered ground-cherry	*Leucophysalis grandiflora*	S2	Forb	Treed Fen, Jack Pine - Trembling Aspen: Dry to Fresh, Jack Pine: Dry to Fresh
western red lily	*Lilium philadelphicum var. andinum*	S3S4	Forb	Balsam Poplar - Trembling Aspen : Moist, Black Spruce: Moist, Jack Pine - Trembling Aspen : Dry to Fresh, Jack Pine : Dry to Fresh, Treed Swamp, Trembling Aspen : Dry to Fresh, Trembling Aspen: Moist White Spruce: Fresh, White Spruce: Moist,

Common Name	Scientific Name	Provincial Rank[z]	Growth Form	Vegetation Type
heart-leaved twayblade	*Listera cordata var. cordata*	S2	Forb	Treed Swamp, White Spruce: Moist
swamp fly honeysuckle	*Lonicera oblongifolia*	S2	Shrub	Jack Pine - Trembling Aspen : Dry to Fresh, Trembling Aspen - Spruce : Fresh
powder-rimmed camouflage lichen	*Melanelia albertana*	S3	Lichen	Jack Pine : Dry to Fresh
camouflage lichen	*Melanelia exasperata*	S1	Lichen	Balsam Poplar - Trembling Aspen : Moist
abraded camouflage lichen	*Melanelia subaurifera*	S2S3	Lichen	Jack Pine : Dry to Fresh
purple lousewort	*Pedicularis macrodonta*	S2	Forb	Treed Fen
veinless pelt	*Peltigera malacea*	S3	Lichen	Jack Pine : Dry to Fresh
many-fruited pelt	*Peltigera polydactylon*	S2	Lichen	Black Spruce: Moist
star rosette lichen	*Physcia stellaris*	S3S4	Lichen	Trembling Aspen : Dry to Fresh
pink fringed milkwort	*Polygala paucifolia*	S2S3	Forb	Black Spruce: Moist, Brushland
seneca snakeroot	*Polygala senega*	S3S4	Forb	Jack Pine - Trembling Aspen : Dry to Fresh, Trembling Aspen: Moist
punctured ramalina	*Ramalina dilacerata*	S3	Lichen	Jack Pine : Dry to Fresh
dotted ramalina	*Ramalina farinacea*	S1	Lichen	Black Spruce: Moist

Common Name	Scientific Name	Provincial Rank[z]	Growth Form	Vegetation Type
white beaked-rush	*Rhynchospora alba*	S2S3	Graminoid	Shrubby Fen, Treed Swamp – Treed Fen
pale bulrush	*Scirpus pallidus*	S2	Graminoid	Treed Swamp
sand chickweed	*Stellaria longipes*	S2/S3	Forb	Treed Fen
western meadow-rue	*Thalictrum occidentale var. occidentale*	S1S2	Forb	White Spruce : Fresh
fringed wrinkle-lichen	*Tuckermannopsis americana*	S3	Lichen	Black Spruce: Moist, Jack Pine: Dry to Fresh, Trembling Aspen: Dry to Fresh
powdered beard lichen	*Usnea lapponica*	S3	Lichen	Black Spruce: Moist, Jack Pine: Dry to Fresh
beard lichen	*Usnea scabiosa*	S1	Lichen	Jack Pine : Dry to Fresh, Black Spruce: Moist
beard lichen	*Usnea subfloridana*	S3S4	Lichen	Trembling Aspen : Dry to Fresh
shrubby sunburst lichen	*Xanthoria candelaria*	S3	Lichen	Balsam Poplar - Trembling Aspen : Moist

Notes: [Z] Definitions of provincial S ranks are as follows: S1 – extremely rare - 5 or fewer occurrences in Saskatchewan, or very few remaining individualsS2 – rare – 6 to 20 occurrences in Saskatchewan, or few remaining individuals; S3 – rare to uncommon - 21 to 100 occurrences in Saskatchewan; may be rare and local throughout province or may occur in a restricted provincial range (may be abundant in places).

Rare ecological Communities

The Saskatchewan Conservation Data Centre does not currently track rare plant communities, therefore no assessment could be made regarding their status (SKCDC 2010i).

5.3.2.13 Historical Use Plant Potential

Based on the list of species of Clavelle (1997) and the field data collected from the vegetation inspection locations for the LSA and RSA, 871 ha (7%) of the LSA and 15,122 ha (11%) of the RSA were ranked high for historical use plant potential (Table 5.3.2-12). Methods for determining historical use plant potential are further described in Section 5.3.2.10 above and Appendix 5.3.2-C. Historical use plant potential is also affected by the existing forestry activity. It is possible, for example, that some berry producing species (e.g., blueberry) may be more prolific on regenerating sites.

Table 5.3.2-12: Ranked Areas of Historical Plant Potential

Historical Use Plant Potential Rank	Vegetation Type	LSA Area (ha)	% of LSA	RSA Area	% of RSA
High	Trembling Aspen: Dry to Fresh Trembling Aspen: Moist Shrubby Swamp	871	7	15,122	11
Medium	Balsam Poplar Spruce: Moist Balsam Poplar - Trembling Aspen : Moist Black Spruce: Moist Jack Pine - Trembling Aspen: Dry to Fresh Jack Pine: Dry to Fresh Trembling Aspen - Spruce: Fresh White Spruce: Fresh White Spruce: Moist Marsh Treed, Shrubby and Open Fen Treed Swamp	10,328	85	111,190	84
Low	Brushland/Grassland Complex Unclassified Wetland - non-Forested	345	3	2,583	2
Not Ranked	Treed Bog Agricultural Land Human Disturbance Lakes, Rivers, and Flooded Land	674	6	3,881	3
Total		***12,218***	***100***	***132,776***	***100***

5.3.2.14 Summary

Twenty vegetation types were identified in the LSA and RSA, including uplands, wetlands, developed lands, and water bodies. The upland vegetation types occupying 90% of the LSA include productive forest primarily consisting of jack pine and/or trembling aspen growing on soils with varying moisture regimes. Other upland vegetation sites include balsam poplar, black spruce, jack pine, trembling aspen and white spruce dominated forests in addition to brushland and grassland vegetation types. The wetland vegetation types occupying 5% of the LSA include marshes, bogs, fens and swamps of varying canopy structure (e.g., treed, shrubby, or open).

Both the LSA and RSA are strongly influenced by forest harvesting activity and fire, with 21% of the LSA and 15% of the RSA having been clear cut, salvage cut or burned within the last 30 years. An additional 7% of the LSA and 6% of the RSA can be categorized as regenerating, having experienced some forest harvest activity or fire more than 30 years ago. The Jack Pine: Dry to Fresh forest in the LSA and Treed Swamp in the RSA are the most common vegetation types in the old growth stage of succession.

Riparian habitat occupies approximately 5% of the LSA and approximately 7% of the RSA. The shrubby swamp vegetation type characterized by willows (*Salix spp.*), sweet-scented bedstraw (*Galium triflorum*), and wild mint (*Mentha arvensis*) is most common in the riparian area. In contrast, the Riparian Management Areas primarily defined for forest harvesting operations occupy 15% of the LSA and 10% of the RSA, but don’t necessarily overlap with riparian habitat. Riparian Management Areas include both upland and wetland vegetation types, the most common being the Trembling Aspen - Spruce: Fresh vegetation type.

Vegetation types ranked high for rare plant potential occupy approximately half of the LSA and 41% of the RSA. The 42 rare species found included 20 rare non-vascular plant species, of which 4 are ranked as extremely rare (S1): brown-eyed rim lichen, camouflage lichen, dotted ramaline, and one of the beard lichens.

Approximately 5% of the LSA and 7% of the RSA were considered to have high potential for historical use plants, and another 84% of the LSA and to 85% of the RSA were considered to have medium potential. Actual occurrence of historical use species is influenced by forest harvesting and fire.

5.3.3 Wildlife and Habitat

This Section of the EIS describes the existing (baseline) wildlife and wildlife habitat conditions in the vicinity of the Star-Orion Diamond Project (the Project). The wildlife baseline data presented in this chapter is derived from field studies conducted in 2007 and 2008 by EcoDynamics (Appendix 5.2.2-A, EcoDynamics 2009). There are no parks or protected areas within the FalC Provincial Forest other than the island forest itself, which is a Wildlife Management Unit (WMU). This means that the WMU may be managed for wildlife differently and separately from the surrounding Wildlife Management Zones (WMZ).

5.3.3.1 Introduction

The purpose of the wildlife and habitat section is to provide data for assessment of potential development impacts on wildlife species and their habitats. The general objectives of this component were to:

- determine wildlife species occurrence, distribution, relative abundance, and habitat use based on the results of specific field surveys and existing information sources;
- identify species of concern (rare, threatened or endangered) in the Project and surrounding area; and
- identify areas of important wildlife habitat, including movement corridors.

5.3.3.2 Information Sources and Methods

The information sources and methods including wildlife delineation and the field surveys are described in this section.

Existing Information

In addition to baseline information provided in EcoDynamics 2009, existing information on wildlife species and habitat for the LSA and RSA (FalC forest) was obtained from literature sources and through contact with local wildlife and environmental personnel. Existing wildlife information for FalC forest included, but was not limited to, wildlife agency reports and records, historical baseline studies for hydroelectric developments in the area, and preliminary baseline surveys listed below:

- *Baseline Vegetation and Wildlife Studies for the Fort à la Corne Joint Venture Advanced Exploration Program 2004-2005* (Golder 2006);
- *Disturbance Impact Thresholds: Recommended Land Use Guidelines for Protection of Vertebrate Species of Concern in Saskatchewan* (Arsenault 2009);
- *Large mammal aerial survey of Fort à la Corne (FalC), February 2006* (Saskatchewan Environment (SE) 2007);
- Saskatchewan Elk *(Cervus elaphus)* Management Strategy (Arsenault 1998);
- Status and Management of Moose *(Alces alces)* in Saskatchewan (Arsenault 2000);
- Saskatchewan Elk *(Cervus elaphus)* Management Plan – Update (Arsenault 2008);
- Provincial trapping records, 2002-2009 (SMOE 2010a);
- Status and Management of Wildlife in Saskatchewan, 2002 and 2003 (Arsenault 2005);
- Fort à la Corne Wildlife Study: Final Report (Froc et al. 1985);

- SaskPower's proposed Forks hydroelectric project (Pipe 1982); and
- Baseline studies for the Nipawin Hydroelectric Project (Blood et al. 1977).

Wildlife Habitat Delineation

The vegetation cover map (refer to Section 5.3.2 Vegetation Communities and Rare Plants) was used as the basis for wildlife habitat delineation. Vegetation communities were combined into wildlife habitat types or broad habitat types for wildlife surveys and/or data presentation purposes as wildlife typically do not distinguish habitat based on the level of detail for vegetation mapping. Sampling effort for terrestrial surveys on the whole reflected the proportion of habitat types available, and thus vegetation communities with very limited extent were not included in the field surveys.

Field Surveys

Wildlife surveys provide information on the presence, relative abundance, and distribution of wildlife in relation to the Project. Field surveys were conducted to supplement baseline information of wildlife and wildlife habitat. Surveys completed for the Project included the 2007 and 2008 baseline program conducted by EcoDynamics (2009):

- fall small mammal snap trap transect survey (August, September and November, 2007);
- winter ungulate transect aerial surveys (December 2007; January and March, 2008);
- winter ungulate browse surveys (December, 2007; March, 2008);
- winter track count surveys (March, 2008);
- spring amphibian and owl reconnaissance surveys (May, 2008);
- spring waterfowl aerial and ground surveys (May, 2008); and
- upland breeding bird survey (June, 2008).

Wildlife surveys were conducted mainly in the LSA as well as in a buffer of approximately 5 km surrounding the LSA, referred to in this report as the Wildlife Core Survey Area (WCSA). The WCSA encompasses an area in which the majority of Project regional effects on wildlife are anticipated to occur. Some survey locations extended beyond the WCSA within the RSA (the FalC forest).

The data from specific surveys were supplemented by incidental observations of wildlife in the FalC forest from 2006-2008.

Small Mammal Survey

A small mammal survey was conducted during late August, early September and early November 2007. A series of 22 transects were established in a variety of upland and wetland habitats within the FalC forest. Transects were located in representative habitat, while having a random orientation to minimize bias. Fifty Victor snap traps were set at approximately 2 m intervals along each transect and baited with peanut butter. Each transect was trapped for four consecutive nights, and traps were checked daily to reduce the likelihood of animals being removed by scavenging birds or mammals. Identification of species was conducted in the field, except for shrews which were frozen for subsequent laboratory examination and identification.

Ungulate Aerial Surveys

Three ungulate transect aerial surveys were flown within the FalC forest, encompassing the LSA and WCSA during the winter of 2007/08 (December, 2007; January 2008; March, 2008). Surveys were undertaken to provide density and population estimates of elk, moose and deer within the area. Surveys were conducted using a Cessna 182 fixed wing aircraft with two trained observers seated in the rear of the plane, and a navigator/recorder seated in the front next to the pilot. Transects were flown in an east-west orientation, spaced at 800 m intervals at an altitude of approximately 100-125 m. The navigator/recorder used a tablet PC equipped with a Garmin 60CSX GPS and OziExplorer™ mapping software for navigation and data input. The locations of all observations were recorded on the map display, while detailed records were kept on data sheets.

Observers recorded ungulate sightings, tracks and feeding craters along each transect. Ungulates observed within 200 m of the side of the aircraft were considered “on transect”, while other animals were noted, but recorded as “off transect”. The sex of animals and the presence of young-of-the-year were recorded whenever possible. Sightings and tracks/signs of larger furbearers (e.g., wolves, coyotes) were also recorded, as were stick nests, which represent potential raptor nests.

Additionally, during the late-winter survey (March), a reconnaissance-level 25% coverage survey (i.e., 1 mile transect interval) was also flown for those portions of FalC forest outside of the WCSA to examine late winter movement of ungulates.

Ungulate Food Habit Surveys

An ungulate winter browse survey was conducted concurrent with the early winter aerial ungulate survey in early December 2007. The purpose of the browse survey was to identify winter foods consumed by ungulates.

Fresh tracks of moose, elk and deer were located and followed for several hundred metres from the edge of roads and trails, with stops wherever the animal had browsed. At each stop the number of twigs consumed of each browse species was recorded and the relative abundance of browse species estimated. Habitat descriptions, including information on tree species, height and density; and percentage cover of shrub species, were also made at the beginning of transects and wherever there was an apparent change in habitat.

Winter Track Counts

Winter track counts were conducted to assess winter habitat use by ungulates, carnivores, smaller herbivores, and upland game birds within the study area. Linear transects were established in a variety of accessible habitats across the WCSA during the first week of March 2008 using a stratified random sampling technique.

Surveys were initiated two days following a snowfall, allowing time for wildlife to move within the area. The number and location of tracks were recorded along each measured transect using a hand-held GPS. Animal sightings, bedding sites, pellet groups, and other incidental observations were also recorded.

A standard index (tracks/km-track day) of abundance was calculated for each species in broad habitat types where:

$$\text{Tracks/km-day} = \frac{\Sigma \text{ no. tracks}}{\Sigma(\text{transect length}) \times (\text{days since last snowfall})}$$

Owl and Raptor Survey

A reconnaissance level 'listening' owl survey was conducted on May 8, 2008. At each survey station, calling owls were identified to species and their location estimated using a compass bearing and a subjective assessment of distance from the survey site. General weather conditions were also recorded.

Raptor stick nest locations were noted during the ungulate aerial surveys. Most nests were subsequently surveyed during the spring waterfowl survey to determine raptor use and occupancy.

Water Birds and Shorebirds; Aerial and Ground Surveys

An aerial survey was conducted on May 14, 2008 to obtain spring population counts of water birds (waterfowl, swans, loons, grebes, gulls, bitterns, and cranes) and shorebirds. The survey included the sloughs, tributary streams, and beaver ponds located within the WCSA, as well as the section of the Saskatchewan River valley lying within the WCSA. Water bodies along the proposed north and south infrastructure corridors were also examined during the survey.

Surveys were conducted with a single-engine fixed-wing Cessna 182 aircraft, a pilot, navigator/recorder, and two observers. During low altitude passes of water bodies, the number and species of observed water birds were recorded, as was general habitat information and location.

Ground surveys for water birds were conducted in conjunction with the spring 2008 amphibian survey of East Ravine, English Creek, and a pond located in the Orion area.

Upland Breeding Bird Survey

An upland breeding bird survey was conducted in June, 2008 in the LSA and selected portions of the proposed infrastructure corridors using a standard point count method (Ralph et al. 1993). The survey was used to obtain data on breeding avifauna in representative forest cover types and to assess the presence of *Species at Risk Act* (SARA)-designated species-at-risk.

Sampling was stratified by forest cover type, and consisted of 118 point counts distributed among the LSA (58), the proposed northern access corridor (39), and the proposed southeast transmission line corridor (21). Sampling points were set a minimum of 250 m apart to avoid double counting of birds, and a minimum of 50 m from the edge of a given habitat type to ensure that birds inhabiting other adjacent types were not inadvertently counted.

Surveys were conducted from 0.5 hour before sunrise to approximately 10:00 am, the period when birds are vocalizing the most (Bibby et al. 1992). Surveys were conducted under low wind conditions with no significant precipitation to ensure that bird vocalizations and the ability of observers to detect birds were not affected by weather (Robbins 1981; Ralph et al. 1993). Once at the survey point, a 2-minute quiet down period was followed by a 5-minute listening and observation period. All birds observed or heard within a 50 m radius were recorded separately from those observed or heard outside the 50 m radius or flying over the plot. A description of general forest cover and vegetation was recorded at each site to allow correlation with ecological mapping.

Amphibian Survey

Amphibian call surveys were conducted on May 8 and May 22 to 23, 2008 during the breeding season for frogs and toads. Amphibian call survey stations were established at ground accessible locations within the WCSA in areas expected to contain amphibian habitat, with a focus on ravines and wetlands. Sites were surveyed during evenings when air temperature was above 5^{o} C. At each survey site a 1 minute “quiet down” was followed by a 2 minute listening period. Calls were identified to species, with a qualitative assessment of relative abundance made using the Amphibian Calling Index (USGS 2008) which includes:

- individual amphibians counted (no overlapping calls);
- individual amphibians distinguished (some calls overlap); and
- full chorus (calls are constant, continuous, and overlapping).

Reptile Reconnaissance Survey

Sand and gravel covered roads and trails were surveyed for signs of red-sided garter snakes during the fall 2007 small mammal trapping and spring 2008 amphibian surveys.

Incidental Observations

Incidental observations of wildlife were recorded on an ongoing basis by the various biophysical field teams, as well as Shore staff. Incidental observations were used to supplement species data from systematic and reconnaissance level surveys and provide additional information on distribution and habitat associations of some species.

5.3.3.3 Field Program Results and Baseline Conditions

The field program results and baseline condition for wildlife habitat, mammals, wildlife harvest, birds, amphibians, reptiles, and species-at-risk are described in this section.

Wildlife Habitat

The LSA is located within one of the least complex areas of the FalC forest. Habitat types within the LSA are well-represented in other portions of the FalC forest. Regenerating forest (0-30 years) comprises the majority of LSA, and jack pine cover types dominate this area. The area exhibits various degrees of disturbance including fire, cut blocks, access roads, and mineral exploration activity.

The numerous ravines which extend into the Saskatchewan River valley and the valley itself are the most sensitive features of the LSA and are important wildlife habitats. The ravines are characterized by a complex of habitats including beaver ponds, marsh, fen, dense conifer and mixed woods forests in various stages of succession, and pockets of grassy south-facing slopes. This complex of habitats provides a variety of foraging habitats, escape terrain, and thermal cover. Mineral springs present in the ravines are also a source of minerals for ungulates. The ravines exhibit signs of intensive use by ungulates, bears, and beaver. Based on aerial surveys, the southwest corner of the LSA is an area of concentrated winter moose activity. This area is characterized by a spatially complex mosaic of ravine, wetland, and upland habitats. The English Creek valley along the east side of the LSA also provides important habitat for a variety of wildlife species and appears to act as a ‘spatial buffer’ from adjacent exploration activities.

River valleys and riparian habitat function as wildlife movement corridors. The Saskatchewan River valley likely represents a major wildlife movement corridor within the FalC forest, providing connectivity to habitats outside of this forest. The ravines in the FalC forest likely also function as wildlife travel corridors, connecting areas north of the LSA with the Saskatchewan River valley. English Creek valley appears to be the most important north-south travel corridor in the area (EcoDynamics 2009).

Old growth forests are widely distributed in the FalC forest, but are limited in area. Old growth forest comprises only 0.2% of the LSA (0.1% jack pine – trembling aspen and 0.1% treed swamp), and about 4% of the FalC forest. Although old growth forest was not targeted during wildlife surveys because of their limited extent, these areas represent important habitat for old growth dependent species, such as marten and black-backed woodpeckers.

Wetlands in the LSA (6.3% area) and the FalC forest (9.1% area) are also limited in distribution and extent, and within the LSA are mainly associated with the ravines and other drainages. The Saskatchewan River, which forms the southern border of the LSA, provides habitat to migrating water birds. Wetlands and riverine habitats support considerable overall bird species richness.

Table 5.3.3-1 summarizes the extent of wildlife habitat with respect to vegetation types and Figure 5.3.3-1 illustrates the distribution of vegetation types in the LSA and FalC forest. Early succession jack pine and aspen regeneration are distributed over much of the LSA and the eastern portion of FalC forest. Mature jack pine and aspen/balsam habitat are also well represented in the west portion of the LSA and along the north boundary of the LSA, respectively.

Table 5.3.3-1: Wildlife Habitat in the FalC Forest and LSA

Wildlife Broad Habitat Type	Wildlife Habitat Type	Vegetation Cover Type	FalC Forest		LSA	
			ha	%	ha	%
Mature or Maturing Forest >30 yrs	Conifer >30yrs	Jack Pine: Dry to Fresh	27,477	20.7	2,782	22.8
		Black Spruce: Moist	2,980	2.2	31	0.2
		White Spruce: Fresh White Spruce: Moist	7,348	5.5	223	1.8
		Total	37,806	28.5	3,037	24.9
	Mixedwood >30yrs	Trembling Aspen - Spruce: Fresh Balsam Poplar - Spruce : Moist	2,855	2.2	51	0.4
		Jack Pine - Trembling Aspen: Dry to Fresh	5,233	3.9	243	2.0
		Total	8,088	6.1	294	2.4
	Deciduous >30yrs	Trembling Aspen: Dry to Fresh	26,751	20.1	1,416	11.6
		Trembling Aspen: Moist	770	0.6	30	0.2
		Balsam Poplar - Trembling Aspen: Moist	1522	1.1	72	0.6
		Total	29,043	21.9	1,518	12.4
		Mature or Maturing Forest Total	74,937	56.5	4,849	39.7
Regenerating Forest <30 yrs	Conifer Regeneration	Jack Pine: Dry to Fresh	13,259	10.0	3,469	28.4
		Black Spruce: Moist	87	0.1	0	0.0
		White Spruce	5	<0.1	2	<0.1
		Total	13,351	10.1	3,471	28.4
	Mixedwood Regeneration	Balsam Poplar – Spruce Trembling Aspen-Spruce	391	0.3	71	0.6
		Jackpine-Trembling Aspen	5,764	4.3	674	5.5
		Total	6,155	4.6	745	6.1
	H Regeneration	Balsam Poplar – Trembling Aspen	482	0.4	135	1.1
		Trembling Aspen <30 yrs	12,233	9.2	1,634	13.4
		Total	12,715	9.6	1,769	14.5
		Regenerating Forest Total	32,220	24.3	5,985	49.0
Forested wetlands	Treed Fen Shrubby Fen	Treed and Open Fen	3,218	2.4	45	0.4
	Treed Conifer Swamp	Treed Swamp, Treed Bog	9,737	7.3	226	1.8
		Total	12,955	9.8	271	2.2
Willow swamp	Willow Swamp	Shrub Swamp	7,078	5.3	366	3.0
Open	Marsh	Marsh	1,278	1.0	2	<0.1
	Shrub / Grassland Complex	Brushland/Grassland	2,518	1.9	333	2.7
		Total	3,796	2.9	335	2.7

Wildlife Broad Habitat Type	Wildlife Habitat Type	Vegetation Cover Type	FalC Forest		LSA	
			ha	%	ha	%
Riparian[1]	Riparian[1]	Cover Types Occurring Adjacent to Watercourses and Wetlands	8,512	6.4	578	4.7
	Beaver Pond Complex	Unclassified Wetlands	137	0.1	20	0.2
Water	Water	Lakes, rivers, flooded land	1,009	0.8	375	3.1
Disturbance	Disturbance	Human disturbance, agricultural land	637	0.5	19	0.2
TOTAL			132,769		12,218	

Note: [1] not separated from other habitat values.

Overall, the RSA has a greater proportion of older forest (56.5%) relative to the LSA (39.7%) and less regenerating forest (25.3%) relative to the LSA (49.0%). Open upland habitat (brushland/grassland) is relatively uncommon, comprising about 3% of upland habitat in both the RSA and LSA. In comparison to upland habitats, wetland habitat types are limited in distribution and extent within the LSA (<5% area) and are generally located along or in proximity of the major ravines. Wetland communities are best represented by forested wetlands (treed swamp and bogs; 41% wetland area) and shrub (willow) swamps (55.7% wetland area). Fens, marshes and ponds comprise 3.3% of wetland area.

Riparian habitat, habitats bordering the edges of streams and wetlands, constitutes approximately 5% of the LSA and 6% of FalC forest. The vast majority of riparian habitat is comprised of willow shrubland.

Mammals

Based on a review of the literature, a total of 51 mammal species are potentially found in FalC forest and adjacent farmlands (Appendix 5.3.3-A, Table 1) (Pipe 1982; Blood et al. 1977; Banfield 1974; Maher 1969; Beck 1958). Of these species, 33 species were recorded during baseline surveys and incidental observations, including four ungulates, 13 carnivores, and 16 other species, including small herbivores and small mammals.

Small Mammal Trapping

Small mammals were trapped on 22 transects in 11 habitat types during fall 2007; the location of transects is depicted in Figure 5.3.3-2. A total of 119 small mammals were trapped, for an overall trap success of 2.8 captures per 100 trap-nights (TN). Four species of mice and voles (deer mouse, Gapper's red-backed vole, meadow vole, and western jumping mouse) and three species of shrews (masked shrew, American water shrew, vagrant shrew) were trapped. The deer mouse and Gapper's red-backed vole were the most abundant and widespread species, occurring on 64% and 46% of the trapping transects, and comprising 53% and 25% of the total individuals captured, respectively (Table 5.3.3-2). The masked shrew (27% transects) was the most abundant shrew, while the western jumping mouse and meadow vole were encountered at 14% of transects. Two other species, the American water shrew and vagrant shrew, were present at 9% of transects.

The relative abundance of small mammals was highest in aspen regeneration forest (6.25/100 TN), followed by willow swamp and open fen/marsh complex (3.5/100 TN), jack pine (3.25/100 TN), and trembling aspen (3.0/100 TN) (Table 5.3.3-3). Deer mouse was most frequently trapped in aspen regeneration habitat, as was red-backed vole in jack pine and aspen. The American water shrew was only associated with marsh complex habitats and the vagrant shrew with willow swamp habitats.

Previous studies in the FalC forest region (Pipe 1982; Blood et al. 1977) also found deer mouse and Gapper's red-backed vole to be the most abundant small mammals. Vagrant and water shrews had not been previously recorded in the area.

Table 5.3.3-2: Occurrence and Relative Abundance of Small Mammals

Species	Transects with Species (n = 22)	Percent Occurrence Transects	Number Trapped	Percent of Individuals Trapped
Deer Mouse (*Peromyscus maniculatus*)	14	63.6	63	53
Western Jumping Mouse (*Zapus princeps*)	3	13.6	3	2.5
Gapper's Red-backed Vole (*Clethrionomys gapperi*)	10	45.5	30	25
Meadow Vole (*Microtus pennsylvanicus*)	3	13.6	12	10
Masked Shrew (*Sorex cinereus*)	6	27.3	6	5
American Water Shrew (*Sorex palustris*)	2	9.1	3	2.5
Vagrant Shrew (*Sorex vagrans*)	2	9.1	2	2

Table 5.3.3-3: Relative Abundance of Small Mammals within Habitat Types

Vegetation Cover Type	Trap Nights	Deer/Mouse		Western Jumping Mouse		Red-backed Vole		Meadow Vole		Masked Shrew		American Water Shrew		Vagrant Shrew		Totals	
		#	#/100 TN	#	#/100 TN	#	#/100 TN	#	#/100 TN	#	#/100 TN	#	#/100 TN	#	#/100 TN	#	#/100 TN
Black Spruce	200	1	0.50	0	0	2	1.00	0	0	0	0	0	0	0	0	3	1.50
Jack Pine - Aspen	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jack Pine	400	4	1.00	0	0	8	2.00	0	0	1	0.25	0	0	0	0	13	3.25
Regenerating Jack Pine	1200	22	1.83	1	0.08	4	0.33	0	0	2	0.17	0	0	0	0	29	2.42
Open Fen - Marsh Complex	200	3	1.5	1	0.50	0	0	1	0.50	0	0	2	1.00	0	0	7	3.5
Willow Swamp	400	1	0.25	0	0	2	0.50	10	2.50	0	0	0	0	1	0.25	14	3.50
Willow Swamp - Marsh Complex	400	0	0	0	0	0	0	0	0	0	0	1	0.25	1	0.25	2	0.50
Aspen - Spruce	200	5	2.50	0	0	1	0.50	0	0	0	0	0	0	0	0	6	3.00
Aspen/Balsam Poplar	600	5	0.83	0	0	11	1.83	0	0	2	0.33	0	0	0	0	18	3.00
Regenerating Aspen	400	22	5.50	0	0	2	0.50	0	0	1	0.25	0	0	0	0	25	6.25
White Spruce	200	0	0	1	0.50	0	0	1	0.50	0	0	0	0	0	0	2	1.00

Aerial Surveys

Ungulates

Aerial survey coverage in the WCSA and FalC forest is illustrated in Figure 5.3.3-3. Four species of ungulates were observed within the FalC forest: elk, moose, white-tailed deer and mule deer. Mule deer in FalC forest are at the north-eastern edge of their distribution (Banfield 1974) and occur in low numbers, and are thus grouped with white-tailed deer for reporting. Ungulate observations recorded during the three winter aerial surveys of the WCSA are illustrated in Figures 5.3.3-4 to 5.3.3-6.

Ungulate density estimates derived from these surveys are provided in Table 5.3.3-4, as are estimates from historical surveys conducted in the FalC forest. Overall, density results in the WCSA are within the range of variation from previous surveys of the FalC forest area (Arsenault 2008, Arsenault 2000, Arsenault 1998). Elk and moose densities from the current survey are slightly lower than the overall average from the 2006 Saskatchewan Environment survey (SE 2007), which yielded 0.30 elk/km^2 and 0.22 moose/km^2. However, using only those Saskatchewan Environment survey blocks contained within the WCSA provided more comparable results.

Table 5.3.3-4: Ungulate Densities within FalC Forest

Study Area	Source	Time Period	Ungulate Density (animals/km^2)		
			Elk	Moose	White-tailed Deer
WCSA (575 km^2 portion of FalC)	Project study	Dec. 2007	0.14	0.19	0.31
		Jan. 2008	0.23	0.16	0.19
		Mar. 2008	0.11	0.11	0.09
Saskatchewan Environment survey blocks within the WCSA	SE (2007)	February 14-18, 2006	0.19	0.20	-
FalC + farmland (2,113 km^2)	SE (2007)	February 14-18, 2006	0.30	0.22	-
FalC (Population Management Unit)	Arsenault (1998) Arsenault (2000) Arsenault (2008)	Winter, 1980 Winter, 1981 Winter, 1982 Winter, 1983 Winter, 1987 Winter, 1988 Winter, 1989 Winter, 1994 Winter, 2005 Long-term (1976-2008) Mean	0.15 0.15 - 0.26 0.22 0.18 0.16 0.17 0.30 0.24	- - 0.27 - 0.30 - - - 0.22 0.27	- - - - 0.34 - - - - -
FalC (entire)	Pipe 1982	Dec 17-19, 1979	0.23	0.21	0.24
		Jan 29-31, 1980	0.27	0.14	0.18
		Feb 19-21, 1980	0.22	0.18	0.10
		Mar 31-April 1, 1980	0.05	0.03	0.01
FalC (entire)	DTRR (reported in Blood et al. 1977; Froc et al. 1985)	76/77 winter average	0.25	0.21	-
FalC (entire)	DTRR (reported in Blood et al. 1977; Froc et al. 1985)	10-yr. (1965-1975) Mean	0.23	0.13	0.24

Notable concentrations of elk and deer were observed along English Creek during aerial surveys, only a few kilometres from exploration activities. The English Creek ravine complex provides a diversity of habitats and may act as an important terrain buffer to exploration activity, as well as an important travel corridor.

The area east of Highway 6 is known historically to yield the highest elk concentrations (Blood et al. 1977; Froc et al. 1985). This continued to be the trend in the 2006 survey (SE 2007), in spite of significant habitat changes over the last 40 years due to fire and other disturbances. The 2006 survey yielded density numbers as high as 2.23 elk/km^2 in eastern FalC forest, nearly eight times their FalC forest average of 0.28 elk/km^2 (SE 2007).

Ungulate population estimates for the WCSA (575 km^2) were based on the actual highest counts from the three aerial surveys conducted between December 2007 and March 2008. Population estimates were determined from “on transect” data. Coverage was assumed to be 50%, necessitating the use of a 2x correction factor (i.e., double the observations). Sightability correction factors (Steinhorst and Samuel 1989, Samuel et al. 1987) to compensate for “missed” animals due to various factors, such as dense forest cover, weather, and species behaviour were not used to adjust the total number of animals observed. This allowed for a more direct comparison with historical data.

Population estimates for the LSA (122 km^2) were derived from density values (animals/km^2) from the WCSA survey coverage. Based on 2007 – 2008 baseline aerial surveys, white-tailed deer are the most abundant ungulate in the study areas, followed by elk and moose (Table 5.3.3-5). The total population estimate for the LSA was 89 ungulates in 2007/2008.

Table 5.3.3-5: Ungulate Population Estimates

Species	WCSA	LSA
White-tailed Deer	180	38
Elk	134	28
Moose	110	23

The March 2008 reconnaissance survey of portions of FalC forest outside the WCSA did not indicate any clear late-winter movements of ungulates other than a concentration of moose along the Saskatchewan River in the east portion of FalC forest.

Carnivores

Gray wolf individuals and packs of up to seven were observed during the winter aerial ungulate surveys. Several wolf kill sites were also observed during the March survey.

Three to four packs, totalling 15 to 20 wolves, were estimated to exist in FalC forest with at least one pack occupying the LSA (EcoDynamics 2009) during the survey.

Winter Track Counts

Winter track counts were conducted along 68 transects from March 6 to 9, 2008, 2 to 5 days after the last snowfall, respectively. The allocation of transects within broad habitat types is summarized in Table 5.3.3-6 and depicted in Figure 5.3.3-7. In total, approximately 14.7 km of transects were surveyed in eight broad habitat types. The total transect length in open habitat was relatively short, thus the data for that habitat is limited.

Table 5.3.3-6: Winter Track Count Effort

Broad Habitat Type	**No. Transects**	**Transect Length (m)**
Riparian	22	3801
Conifer	14	3481
Mixedwood	5	809
Deciduous	8	1393
Regeneration	7	1997
Open	3	128
Forested Wetland	2	1368
Willow Swamp	7	1759
Total	68	14736

A total of 705 tracks of 13 species were counted, with snowshoe hare comprising 35% of the tracks (Table 5.3.3-7). White-tailed deer (27% tracks) and red squirrel (16% tracks) were also relatively abundant in the area. Tracks of moose, elk, muskrat, and larger carnivores were infrequently encountered during the survey. Track frequencies, on average, were highest in regeneration habitat (26.44 tracks/km-track day), followed by riparian complex (13.79 tracks/km-track day), and fen/wetland habitats (12.31 tracks/km-track day). Track frequencies were lowest in mixedwood (6.34 tracks/km-track day) and deciduous (7.42 tracks/km-track day) habitats.

Mammalian species richness was highest in willow-swamp and riparian complex habitats, and lowest in open habitat where sampling effort was low.

Table 5.3.3-7: Relative Abundance and Habitat Associations of Wildlife during Track Counts

Species	No. of Tracks	% Total	No. Tracks/km-track day							
			Riparian	Conifer	Mixedwood	Deciduous	Regeneration	Open	Forested Wetland	Willow Swamp
			n=22	n=14	n=5	n=8	n=7	n=3	n=2	n=7
Deer	193	27.4	1.60	6.29	1.35	0.77	1.27	6.60	7.65	0.29
Moose	1	<1	0	0	0	0	0	0	0	1.39
Elk	3	<1	0	0	1.04	0	0	2.20	0	0.05
Coyote	5	<1	0.24	0	0	0	0.13	0	0	0
Red Fox	1	<1	0.22	0	0	0	0	0	0	0
Lynx	4	<1	0	0.2	0	0.13	0	0	0	0.06
Otter	12	1.7	0.67	0	0	0	0	0	0	0
Fisher	5	<1	0	0	0	0	0	0	0.25	0.36
Weasel	59	8.4	0.13	0.20	0.60	1.19	5.89	0	1.02	2.29
Snowshoe Hare	246	35.9	9.88	1.17	1.22	4.02	10.72	0	1.19	5.54
Red Squirrel	111	15.7	0.43	1.61	0.40	0.20	5.78	0	1.97	0
Muskrat	2	<1	0	0	0	0	0	0	0	0.29
Grouse	44	6.2	0.07	0.07	0.25	0.52	2.65	0	0	0.18
Total no. tracks/km-track day			13.79	9.67	6.34	7.42	26.44	8.80	12.31	10.57
Total number of mammal species			7	5	5	5	5	2	5	8

Ungulates

Deer were the most frequently encountered ungulate during winter track surveys, comprising 98% of ungulate tracks and 27% of total tracks. Deer tracks were noted in all of the cover types, but were most abundant in the forested wetlands (7.65 tracks/km-track day), open clearings (6.60 tracks/km-track day), and conifer (6.29 tracks/km-track day) habitats.

Elk and moose tracks were infrequently encountered during the survey. One elk track was observed in each of mixedwood, open, and willow swamp habitats. One moose track was observed in willow swamp.

Carnivores

Weasels (tracks not distinguished to species) were the most common and widely distributed carnivore encountered during track surveys, comprising 8.4% of the all tracks and occurring in 7 of 8 habitat types. The highest frequency of weasel tracks were recorded in regeneration (5.89 tracks/km-track day), willow swamp (2.29 tracks/km-track day), and deciduous forest (1.19 tracks/km-track day).

River otter tracks (12) were encountered on two transects in riparian complex habitat for a track frequency of 0.67 tracks/km-track day. Otter tracks were not observed in other habitats. Previous studies in the FalC forest reported infrequent otter tracks along the edge of the Saskatchewan River and along various creeks and beaver ponds (Pipe 1982; Blood et al. 1977).

Canid tracks were infrequently encountered on track transects, comprising approximately 1% of all tracks. Coyote tracks were observed in riparian (0.24 tracks/km-track day) and regeneration (0.13 tracks/km-track day) habitats. Survey crews also reported several sightings, including a single coyote that frequented the Shore camp area. One red fox track was observed in riparian complex habitat, although incidental sightings were associated with roads and along frozen creeks. Wolf tracks were not observed during track surveys, although wolves were observed during ungulate aerial surveys and other ground surveys.

Lynx tracks were observed in conifer (0.2 tracks/km-track day), deciduous (0.13 tracks/km-track day), and willow swamp (0.06 tracks/km-track day) habitats. Shore camp and environmental personnel reported observations of lynx, including a female with two kittens just outside the main gate of the Star site (2007), an adult lynx at the intersection of the Division Road with the Shipman Trail (2008), and an active den west of the Star facilities (2008).

Fisher tracks were relatively uncommon; they were observed in willow swamp (0.36 tracks/km-track day) and forested wetland (0.25 tracks/km-track day), as well as incidentally in deciduous and conifer areas within the LSA. A single fisher was also incidentally sighted north of the LSA during late fall fieldwork in 2008. The fisher is less specific in its preferred habitat than the marten, and is expected to be widely distributed in the FalC forest. Marten tracks were not observed during the track survey, but a single marten was observed in the fall of 2008 in riparian mixedwood forest south of the LSA. The marten may occur in small numbers across FalC forest, particularly in areas with an abundance of red squirrel, the marten's primary food source. Mink tracks were also not encountered during the track surveys. Mink have been previously recorded along the Saskatchewan River, tributary creeks and the edge of beaver ponds (Pipe 1982; Blood et al. 1977).

Small Herbivores

Snowshoe hare and red squirrel were relatively abundant and widespread in the study area. Snowshoe hare tracks were encountered in all habitats except open, with highest track frequencies occurring in regeneration (10.72 tracks/km-track day) and riparian complex (9.88 tracks/km-track day) habitats. Red squirrel track frequencies were highest in regeneration (5.78 tracks/km-track day), forested wetland (1.97 tracks/km-track day), and conifer (1.61 tracks/km-track day) habitats. Red squirrel tracks were not observed in open and willow swamp habitats. Red squirrel were frequently observed and heard during terrestrial surveys, particularly in trembling aspen forests with a dense hazel shrubs and in mature coniferous forests.

Muskrat tracks were observed twice in willow swamp habitat. Muskrat push-ups and houses were also incidentally observed in pond areas along several ravines and wetlands across the study area. A few individual muskrats were also observed during fall and winter surveys traveling overland, presumably in search of more suitable water-bodies (EcoDynamics 2009). In winter, muskrat require ponds which will not freeze to the bottom and emergent marsh vegetation such as cattails, bulrushes, and sedges for forage.

Ungulate Food Habit Transects

Elk winter food habits were examined along 1154 m of trail within five habitats, moose along 1234 m of trail within six habitats, and deer along 1824 m of trail in five habitats (Figure 5.3.3-8). At least 18 species of trees, shrubs and forbs were utilized as winter browse/forage by ungulates (Table 5.3.3-8).

A variety of plants were taken by the three species, however, elk and deer tended to be closer in their food habits. Deer and elk relied more heavily on a mixture of forbs and shrubs and frequently consumed Saskatoon, choke cherry, pincherry, and red-osier dogwood. Moose, which rely almost exclusively on woody browse during winter, consumed willow, trembling aspen, dwarf/bog birch, and choke cherry.

The most concentrated feeding noted for elk was in mature deciduous stands and willow swamps, while that for moose was in willow swamp habitat. White-tailed deer fed most heavily on low forbs and shrubs in regenerating jack pine stands. While regenerating jack pine forest had relatively low browse production, most available browse was heavily utilized. These areas also had an abundance of herbaceous species (e.g., sweet clover, aster, and wormwood).

Table 5.3.3-8: Browse / Forage Species Consumed within Habitat Types

Species	General Cover Type	Number of Transect Segments	Average Segment Length (m)	Stops per 100m	Stems Browsed per 100m	Browse/ Forage Species Consumed (Order of Preference)
Elk	*Regeneration (jack pine)*	10	131	11.8	65.0	***Forbs:*** *Artemesia spp., Aster spp., Melilotis spp., graminoids;* ***Shrubs:*** *Amelanchier alnifolia; Prunus virginiana, P. pensylvanica, Populus tremuloides, Salix spp., Rosa spp., Alnus viridus*
	Regeneration (aspen)	2	93	14.7	92.4	***Forbs:*** *variety including Aster spp.;* ***Shrubs:*** *Prunus viginiana, Amelanchier alnifolia, Populus tremuloides*
	Deciduous	3	133	12.1	181.0	***Shrubs:*** *Cornus sericea, Corylus cornuta, Amelanchier alnifolia, Prunus virginiana, Populus tremuloides, Salix spp.*
	Willow Swamp	2	201	11.1	137.9	***Forbs:*** *variety including Aster spp.;* ***Shrubs:*** *Salix spp., Populus balsamifera, Rubus sp.*
	Forested Wetland	1	37	3.0	3.0	***Shrubs:*** *Populus balsamifera (regen)*
Moose	*Regeneration (jack pine)*	1	43	12.0	12.0	***Forbs:*** *Artemesia spp.*
	Regeneration (aspen)	1	170	5.3	33.5	***Shrubs:*** *Prunus viginiana, Populus tremuloides*
	Deciduous	5	98	0.0	0.0	*No browsing observed.**
	Conifer (white spruce)	1	22	0.0	0.0	*No browsing observed.*

Species	General	Number	Average	Stops	Stems	Browse/ Forage Species Consumed (Order of Preference)
	Willow Swamp	2	92	6.1	147.9	***Forbs:*** *variety including Aster spp.;* ***Shrubs:*** *Salix spp, dwarf/bog birch*
	Forested Wetland	5	65	0.0	0.0	*No browsing observed.*
	Regeneration (jack pine)	4	110	8.0	45.6	***Shrubs:*** *Prunus virginiana, Amelanchier alnifolia, Prunus pensylvanica, Rosa spp., Betula pumila;* ***Forbs:*** *Artemesia spp., Aster spp., Melilotis spp.*
	Conifer (jack pine)	4	84	4.8	19.1	***Shrubs:*** *Amelanchier alnifolia, Prunus virginiana, Rosa spp., Populus tremuloides, Salix spp., Betula papyrifera*
	Regeneration (aspen)	2	206	2.0	12.0	***Shrubs:*** *Cornus sericea,Corylus cornuta, Viburnum edule, Prunus virginiana, P. pensylvanica, Amelanchier alnifloia, Alnus viridis*
	Mixedwood	3	116	5.6	16.9	***Shrubs:*** *Cornus sericea, Amelanchier alnifloia, Viburnum edule, Rosa spp., Populus tremuloides, Populus balsamifera, Salix spp.*
Deer	*Forested Wetland*	4	72	0.0	0.0	*No browsing observed.*

Incidental Mammal Observations

Black bear sign was frequently noted during baseline surveys, particularly along the Saskatchewan River valley and tributary stream ravines where plant and animal diversity was high. Bear activity was also noted to be relatively high in areas of abundant dead-fall (e.g., regenerating jack pine burns), which would support larger ant and grub populations. Black bears were also sighted on a number of occasions including a sow with two cubs during the spring waterfowl survey and a sow with a single cub during the spring amphibian survey. Black bear are hunted during spring and fall within the FalC forest.

Cougar tracks, adult and young, were observed north of Saskatchewan River and west of the LSA during baseline surveys. Signs and sightings of cougars in the FalC forest were also reported by Pipe (1982).

Beaver were historically common along the creeks, in most of the larger ponds, and along the Saskatchewan River (Pipe 1982; Blood et al. 1977), and are still abundant based on incidental observations. Beaver activity was observed in all tributary ravines, as well as the Saskatchewan River valley during the course of various air and ground surveys. Intensive beaver activity was observed in both the East and West Ravines flanking the Star site in 2008. A food cache was also noted along the Saskatchewan River southeast of the Star site in the fall of 2007. Both traditional lodges and bank lodges were observed, with the latter being more common.

Northern flying squirrel, a nocturnal species, was only observed once. The northern flying squirrel generally requires mature to old growth forests with abundant decaying trees suitable for cavity nesting. Suitable mature and old growth forests are uncommon in the WCSA.

Woodchuck was recorded on two occasions within the FalC forest. The woodchuck is generally restricted to the Saskatchewan River Valley and surrounding farmland.

Porcupine foraging evidence was noted at several locations, including in dense willow cover.

Northern pocket gopher mounds were noted on several occasions, including the picnic area on the west side of the English Creek crossing on Division Road. A single pocket gopher was observed near an ecological plot south of the LSA in the proposed powerline corridor.

Least chipmunk, a common boreal forest resident, was observed in the WCSA.

Raccoon were not observed during the baseline surveys, but tracks were noted along the Saskatchewan River and along English Creek.

Striped skunk, although not detected, is expected to occur in the FalC forest. Skunks often frequent edges of wetlands and areas with an abundance of amphibians and small mammals.

The breeding ranges of six species of bats overlap the FalC forest: brown bat, Keen's bat, silver-haired bat, big brown bat, red bat, and hoary bat (Pipe 1982). Some of these species are expected to occur in the LSA, although the expanse of regenerating forest may limit suitable roosting / nursery habitat.

In October and November 2009, Shore staff noted a wild boar north of Division Road. This individual likely escaped from a farming operation.

Wildlife Harvest

Big Game

White-tailed deer, moose, elk, and black bear are hunted within the FalC forest, with deer and bear being open season. Harvest statistics are not available for the forest for 2005-2010. Records from 1984 to 2004 indicate that white-tailed deer are abundant in the area, with annual harvest averaging 509 animals (SMOE 2010b). Total black bear mean harvest (1996-2005) was 41 animals. Moose are harvested on a draw license system with mean annual harvest (1993-2003) of 58 for the FalC Moose Management Unit (Wildlife Management Zone 50) (Arsenault 2005). Mean elk harvest (1997-2006) for the FalC Elk Management Unit (Wildlife Management Zones 50 and 43) was 238 animals (Arsenault 2008).

Fur Harvest

The Project area is located in fur block P-85 (FalC Fur Block). The wild fur harvest taken for the years 1999-2009 are summarized in Table 5.3.3-9 (SMOE 2010b). Eleven species were harvested since 1999, with considerable variation in species and numbers taken among years. Fewer pelts were harvested during 2007-08 and 2008-09 compared to previous years. Overall, beaver, muskrat and squirrel were the most frequently trapped species in P-85 from 1999 to 2009. Historical fur harvest records also indicate the presence of mink, wolf, raccoon, and badger in the FalC forest area (Froc et al.1985). Badgers were most likely harvested at the interface of the forest and surrounding farmland. Fur-bearer harvest is influenced by trapping effort and pelt price, and thus do not accurately reflect species' relative abundance.

Table 5.3.3-9: Trapping Statistics for P-85 - Fort-à-la-Corne Fur Block (1999-2009).

Year	Aquatic and Semi-aquatic Fur-bearers				Terrestrial Fur-bearers						
	Beaver	Muskrat	Mink	Otter	Black Bear	Coyote	Fisher	Red Fox	Squirrel	Weasel	Lynx
99/00	54	48		4							
00/01	88	6	4	1	3		1				
01/02	16										
02/03	58					24		11	36		
03/04	12			1			1	1	53	3	
04/05*											
05/06	54	29		7		5	1	2	3		1
06/07	5	71				6		3		4	
07/08	9	17									
08/09	28			1	1	1					
Total	**324**	**171**	**4**	**14**	**4**	**36**	**3**	**17**	**92**	**7**	**1**

Notes: * no statistics provided for 2004-05.

Livestock Predation

Recently reported wolf predation problems outside the FalC forest suggest that there was recent wolf range expansion into the surrounding farmland, likely in response to winter deer mortality. During the winter of 2008-09 SMOE issued special trapping permits to address complaints of wolf predation on domestic livestock in farmland areas adjacent to the FalC forest. Twenty-nine wolves were taken from the area in 2008/2009, and five in 2009/2010 (SMOE 2010a), indicating the population had been significantly reduced.

Chronic Wasting Disease

Chronic wasting disease (CWD) is a fatal neurological disease that can affect white-tailed deer, mule deer, elk, and moose. In 2005 CWD was detected in the white-tailed deer population in Wildlife Management Zone (WMZ) 50, which encompasses most of FalC forest (SMOE 2008). A total of 36 cases of CWD in white-tailed deer have been reported to date within WMZ 50 and one within WMZ 43, which contains the area of FalC forest south of the Saskatchewan River (SMOE 2010c). However, only two cases of CWD were from white-tailed deer taken in FalC forest (eastern edge). Cases were concentrated in farmland areas east and north east of the FalC forest, with one case in the Smeaton area to the north of the forest and one case along Highway 6 near the southeast edge of the forest (SMOE 2008). In April 2008, two cases of CWD in elk were also reported in the area between east FalC forest and the town of Nipawin (SMOE 2008).

Birds

Based on the results of previous surveys (Blood et al. 1977; Pipe 1982; Golder 2006) and the Saskatchewan Bird Atlas (Smith 1996), 251 bird species are thought to occur in the FalC forest region (Appendix 5.3.3-A, Table 2). Over 100 of these species were observed during the baseline study, these likely representing only a portion of those species occurring within the FalC forest. Baseline surveys by Golder (2006), which were conducted in a portion of the WCSA study area, reported 83 bird species, with 66 species being the same between studies.

Raptors

Seventeen species of eagles, hawks, falcons, and vultures have been recorded in the FalC forest based on data from all baseline surveys and historical sources (Appendix 5.3.3-A, Table 2). Nine of these species, American kestrel, merlin, red-tailed hawk, sharp-shinned hawk, northern goshawk, northern harrier, bald eagle, osprey, and turkey vulture were observed during the current study. One active nest, a bald eagle nest with young, was found overlooking the Saskatchewan River along the eastern side of the LSA. Other stick nests noted during the ungulate aerial surveys (Figure 5.3.3-9) and rechecked during the spring waterfowl survey were not being used.

Four of ten species of owls previously recorded in the area (Appendix 5.3.3-A, Table 2) were observed during the study: great horned owl, great gray owl, barred owl, and snowy owl. Two great-horned owls were recorded during the nocturnal owl survey at the survey site in the LSA (Figure 5.3.3-9). Owls were not detected at the four other survey sites in the WCSA. Unfavourable weather limited the extent of surveys in the study area. Two great gray owls were incidentally observed on two occasions in the WCSA in September. Nesting habitat for great gray owls appears to be limited in the LSA, although more suitable habitat likely occurs in the northern portion of the FalC forest. A barred owl was sighted just south of the LSA in December 2006 (Shore pers.com.), and a snowy owl was observed during the winter aerial ungulate surveys 2007/2008. In addition, a gyrfalcon was recorded north of the Star site adjacent to Shore Road in December 2009 (Shore pers. com.). Other species, such as northern saw-whet owl and long-eared owl, have been historically observed in the general area, and are expected to occur in the study area.

Water Birds and Shorebirds

Thirty-three species of water birds and shorebirds were recorded during the Project baseline surveys (Appendix 5.3.3-A, Table 2). At least 286 individuals of 19 species were observed during the aerial survey, as were 10 unidentified ducks and 16 unidentified shorebirds (Table 5.3.3-10, Figure 5.3.3-10 and Figure 5.3.3-11). The remaining species were recorded during ground surveys.

Waterfowl were the most common water bird group recorded during spring aerial surveys, and dabbling ducks were more common than divers. The most abundant water birds were American coot, mallard, and Canada goose. Few individuals of grebes, mergansers, pelicans, herons, and cranes were observed.

Several additional species of waterfowl and shorebirds identifiable during aerial and ground surveys are listed in Table 5.3.3-10.

Table 5.3.3-10: Water Birds Recorded during Aerial and Ground Surveys

Species	Aerial Survey	Ground Survey	Species	Aerial Survey	Ground Survey
Waterfowl			**Shorebirds/Gulls**		
Divers			Greater yellowlegs		X
Bufflehead	28	X	Killdeer		X
Canvasback	1		Ring-billed gull		X
Common goldeneye	36		Solitary sandpiper		X
Common merganser	2		Spotted sandpiper		X
Eared grebe		X	Gull spp.		12
Horned grebe		X	Wilson’s snipe		X
Lesser scaup		X	Yellowlegs spp.		X
Pied billed grebe		X	Unidentified shorebirds.	16	
Red-necked grebe	1	X			
Ring-necked duck		X	***Other***		
Scaup spp.	21		American bittern	1	
Western grebe	1		American white pelican	10	2
Dabblers			Double-crested cormorant	2	1
American coot	61-70		Great blue heron	1	3
American wigeon	4		Sandhill crane	1	3
Blue-winged teal	7	X	Sora		X
Canada goose	45	X			
Green-winged teal	4	X			
Mallard	56	X			
Northern pintail		X			
Northern shoveler	4	X			
Ruddy duck		X			
Wood duck		X			
Unidentified ducks	10				

Waterfowl habitat in the WCSA is restricted to a short stretch of the Saskatchewan River, tributary creeks, and several ponds or small lakes. The primary waterfowl habitat in the LSA is beaver impoundments along the tributary drainages feeding into the Saskatchewan River. The paucity of water bodies in the area and limited suitable nesting habitat limits waterfowl productivity.

Upland Breeding Birds

A total of 59 bird species, including 49 songbird species, were recorded at 118 survey plots in 13 habitat types during the upland breeding bird survey (Table 5.3.3-11, Figure 5.3.3-12). Eleven other species were recorded as additional or as incidentals during the survey. Several other bird species were also noted incidentally during other wildlife surveys and are included in Appendix 5.3.3-A, Table 2. Raptors and waterfowl occurrences were removed from the data prior to determining species richness and relative abundance for habitat types.

The most widespread songbirds recorded during point count surveys were the red-eyed vireo (44.9% of plots), white-throated sparrow (33.1% of plots), chipping sparrow (23.7% of plots), dark-eyed junco (21.2% of plots), common yellowthroat (16.9% of plots), and least flycatcher (14.4% of plots).

The total number of species within each habitat ranged from 5 to 28, and was highest for jack pine regeneration and deciduous (28 species) and lowest for treed fen, white spruce, shrubby fen, black spruce, treed conifer swamp, and river shoreline habitats. The lower sampling level within the latter communities may have contributed to lower species richness. Relative abundance of birds (average individuals/count and territorial male songbirds/ha) was highest in riparian (river shoreline) (8.5 individuals/count, 10.2 males/ha), beaver pond complex (6.7 individuals/count, 7.4 males/ha), treed conifer swamp (5.3 individuals/count, 5.1 males/ha), and aspen-white spruce (4.5 individuals/ count, 5.7 males/ha) habitats. Lower relative abundances of birds were associated with jack pine, spruce, and shrub habitat types.

Table 5.3.3-11: Bird Species Relative Abundance (Number per Count) by Habitat

Species	Jack Pine Regeneration n=27	Jack Pine n=16	Black Spruce n=6	White Spruce n=2	Aspen -White Spruce n=6	Aspen n=27	Aspen Regeneration n=8	Treed Fen n=3	Shrubby Fen n=2	Treed Conifer Swamp n=6	Willow Swamp n=7	Beaver Pond Complex n=6	Riparian n=2	Occurrence (% Plots)
Songbirds														
American crow						0.04							1.00	<1
American goldfinch	0.07			0.50		0.04	0.13				Inc		2.00	6.8
American redstart		0.13				0.11								3.4
Barn swallow	0.07													<1
Belted kingfisher												0.33		<1
Black & white warbler		0.06												1.7
Black-capped chickadee	0.04				0.17		0.25							2.5
Blue jay	0.07	0.06			Inc	0.15	0.13			Inc				5.9
Boreal chickadee	0.04													<1
Brewer' Blackbird												0.33		<1
Brown creeper		0.06												<1
Cedar waxwing		0.13	Inc											<1
Chest-nut sided warbler						0.15								1.7
Chipping sparrow	0.44	0.19			0.67	0.26		1.33	0.50	0.50				23.7
Clay-colored sparrow	0.11					0.04	0.13		Inc		0.14			5.9
Common nighthawk	Inc													
Common raven	Inc	Inc				0.04	Inc		Inc					<1
Common yellowthroat	Inc	0.06	0.17	0.50		0.30			0.50	0.17	0.71	0.33	0.50	17.0
Crossbill spp.										Inc				
Dark-eyed junco	0.33	0.44	0.17		0.33	Inc	0.25			0.83				21.2
Eastern phoebe						0.04								<1

Species	Jack Pine Regeneration n=27	Jack Pine n=16	Black Spruce n=6	White Spruce n=2	Aspen -White Spruce n=6	Aspen n=27	Aspen Regeneration n=8	Treed Fen n=3	Shrubby Fen n=2	Treed Conifer Swamp n=6	Willow Swamp n=7	Beaver Pond Complex n=6	Riparian n=2	Occurrence (% Plots)
Evening grosbeak			0.33											<1
Gray catbird						0.04								<1
Gray jay	Inc		Inc		0.33									<1
Hairy woodpecker		0.06												<1
Least Flycatcher	0.07		0.17			0.07	0.38		0.50		0.86	1.00	0.50	14.4
Magnolia warbler		0.06				0.07								2.5
Marsh wren											0.14			<1
Mountain bluebird	0.04													<1
Mourning dove	0.04	0.13				0.04			Inc	Inc	Inc			2.5
Northern flicker	0.07					Inc								1.7
Olive-sided flycatcher												0.17		<1
Ovenbird		0.06		0.50	0.33	0.41							0.50	11.0
Philadelphia vireo		0.06				0.04								1.7
Pileated woodpecker				Inc	Inc									
Pine siskin	0.04				0.17						0.57			3.4
Red-breasted nuthatch					0.17									<1
Red-eyed vireo	0.44	0.56		0.50	0.50	0.78	0.75		Inc		0.57	0.67	0.50	44.9
Red-winged blackbird												0.67		<1
Rose-breasted grosbeak	Inc					0.04								<1
Ruby-crowned kinglet	0.04	0.06	0.50	0.50	0.17					0.67	0.14	Inc		9.3
Sedge wren								0.67			0.14			1.7
Song sparrow	0.04					0.11	0.13				0.14	0.50	2.50	10.2
Swainson's thrush	0.11	0.19			0.50	0.19	0.13					Inc		11.0

Species	**Jack Pine Regeneration n=27**	**Jack Pine n=16**	**Black Spruce n=6**	**White Spruce n=2**	**Aspen -White Spruce n=6**	**Aspen n=27**	**Aspen Regeneration n=8**	**Treed Fen n=3**	**Shrubby Fen n=2**	**Treed Conifer Swamp n=6**	**Willow Swamp n=7**	**Beaver Pond Complex n=6**	**Riparian n=2**	**Occurrence (% Plots)**
Tennessee warbler								0.33						<1
Tree swallow	0.11											0.33		2.5
Western tanager			Inc											
White-breasted nuthatch						0.04								1.7
White-crowned sparrow	Inc													
White-throated sparrow	0.48	0.31	0.50	0.50	0.50	0.41	0.38		1.00	0.17	0.43	1.17	0.50	33.1
Winter wren								0.67						
Woodpecker spp	Inc									Inc				
Yellow warbler		0.06			0.17	0.19	0.13					0.33		10.2
Yellow-bellied sapsucker	Inc					0.04								1.7
Yellow-rumped warbler	0.04						0.25			0.17				2.5
Unidentified	0.04	0.19	0.17		0.17	0.19				0.17	0.71			
Others														
American white pelican							Inc							
Canada goose	Inc									Inc		Inc		
Common merganser												0.33		<1
Cooper's hawk							0.25							<1
Gull spp							Inc							
Great blue heron	Inc													
Mallard											0.29	0.33		<1
Red-necked grebe											0.14			
Red-tailed hawk	Inc					0.07								1.7
Ring-billed gull						Inc								

Species	Jack Pine Regeneration n=27	Jack Pine n=16	Black Spruce n=6	White Spruce n=2	Aspen -White Spruce n=6	Aspen n=27	Aspen Regeneration n=8	Treed Fen n=3	Shrubby Fen n=2	Treed Conifer Swamp n=6	Willow Swamp n=7	Beaver Pond Complex n=6	Riparian n=2	Occurrence (% Plots)
Ruddy duck											0.29			<1
Ruffed grouse	Inc				Inc	Inc	Inc				Inc			
Sora											0.14			<1
Spotted sandpiper						Inc	0.13					0.17	0.50	1.7
Turkey vulture	0.04													<1
Wilson's snipe								1.33			0.14			3.4
Total # Species	28	19	9	7	15	28	15	5	8	10	15	14	9	
Average Species/Count	2.57	2.5	2.0	3.0	3.5	3.69	2.88	3.33	2.33	3.5	2.5	4.67	5.5	
Average Individuals/ Count	2.93	2.81	2.4	3.0	4.5	4.12	3.38	4.33	2.67	5.13	2.5	6.67	8.5	
Territorial Male Songbirds / ha	3.68	3.58	3.05	3.82	5.73	4.99	3.82	3.82	3.39	5.09	3.18	7.42	10.18	

Notes: Inc = incidental observation.

Species of interest recorded in the FalC forest included a hoary redpoll in a large flock of common redpolls, numerous sightings of pileated woodpeckers, and a single sighting of northern shrike.

Upland Game Birds

Three upland game birds, ruffed grouse, spruce grouse, and sharp-tailed grouse, were observed in the study areas. Ruffed grouse were observed in trembling aspen forests of all ages. Spruce grouse were observed in dense upland black spruce and white spruce forests. Sharp-tailed grouse were most frequently observed in areas of sparse and low density regenerating jack pine forest, which often has a grass and shrub-rich understory. During winter track surveys, grouse tracks were observed in 6 of 8 habitat types, with track frequency being highest in regenerating forest cover types (26.44 tracks/km-track day) (Table 5.3.3-7).

Willow ptarmigan are expected to occasionally winter in the area. Two willow ptarmigan were observed in riparian willow habitat near the Shipman Trail bridge in early December 2008. A small flock of ptarmigan was also documented in the RSA by Pipe (1982) along the Saskatchewan River during winter fieldwork.

Amphibians and Reptiles

Amphibians and reptiles expected or known to occur in the FalC forest are listed in Appendix 5.3.3-A, Table 3. Amphibian presence and abundance was assessed at seven survey stations in early May and 20 stations in late May. Locations of survey stations are illustrated in Figure 5.3.3-13. Three species of amphibians were detected during the amphibian surveys: boreal chorus frog, wood frog, and Canadian toad. The early May surveys were truncated due to the unseasonably cold temperatures that inhibited amphibians from calling; only one wood frog was heard during the survey. In latter May, boreal chorus frogs were heard at 35% of listening stations and were relatively abundant based on the calling index (Table 5.3.3-12). Canadian toad was calling at only two stations, and wood frog was not detected.

Boreal chorus frog, wood frog, and Canadian toad were also incidentally detected at a few locations during other field surveys. Tiger salamander was encountered on one occasion along English Creek, and is also expected to occur in the more permanent wetlands in the study area.

The northern leopard frog, whose range encompasses the study areas, was not detected during baseline surveys and has not historically been identified in the area. Based on wetland habitats, however, there is potential for this species to occur in the area.

Table 5.3.3-12: Relative Abundance of Breeding Amphibians during May Surveys

Species Detected	May 8, 2008					May 22-23, 2008				
	Stations Detected (stations = 7)		Calling Index % of Stations with Detections			Stations Detected (stations = 20)		Calling Index % of Stations with Detections		
	#	%	1	2	3	#	%	1	2	3
Boreal chorus frog	0	0	-	-	-	7	35	14	14	71
Wood frog	1	14	0	0	100	0	0	-	-	-
Canadian toad	0	0	-	-	-	2	10	0	0	100

While red-sided garter snakes are known to occur regionally (Pipe 1982; Blood et al. 1977), this species was not detected during the Project baseline surveys. Garter snakes are uncommon, and live near ponds, lakes, marshes, dugouts, and streams (Russell and Bauer 2000). The red-sided garter snake is most likely to occur along the Saskatchewan River valley where suitable hibernacula (e.g., loose gravel deposits, fractured rock) potentially exist, or in the farmlands surrounding the FalC forest.

Species-at-Risk

The ranges of 10 wildlife species-at-risk overlap the study area (Arsenault 2009, COSEWIC 2009a) (Table 5.3.3-13). Historical records indicate 5 threatened bird species (common nighthawk, olive-sided flycatcher, Canada warbler, whip-poor-will, and chimney swift) have been recorded in the FalC forest region. Two of these species (common nighthawk and olive-sided flycatcher) were recorded during baseline surveys and by Golder (2006). Golder (2006) also reported the occurrence of whip-poor-will. Two species of Special Concern were documented in the FalC forest area during baseline surveys (horned grebe) or from historical records (short-eared owl). There is potential for northern leopard frog, rusty blackbird, and yellow rail to occur in wetland habitats, although these species were not detected in baseline surveys or from historical records.

Common nighthawk was recorded on one occasion in jack pine regeneration habitat during the upland breeding bird survey, and once as an incidental observation. Golder (2006) reported common nighthawk in cutover areas. Common nighthawk breeds throughout Saskatchewan making use of open habitats, including forest openings, recent burn-over areas, forest clearings, open forests, peatlands, dune complexes, shortgrass prairies, rocky outcrops, lake shores and river banks, as well as anthropogenic areas (urban parks, mine tailings, quarries, forest cutovers, pastures) (Arsenault 2009; COSEWIC 2007a).

Olive-sided flycatcher was observed twice near beaver ponds during the upland breeding bird survey. Golder (2006) also heard this species south of English Cabin tower. Olive-sided flycatcher populations tend to have a patchy local distribution. They are most often associated with natural forest openings, forest edges near natural openings, or open to semi-open forests of conifer and mixedwood types, often near water or wetlands (Arsenault 2009; COSEWIC 2007b). In boreal habitat olive-sided flycatchers may be particularly associated with open habitat of muskeg, bogs, and swamps dominated by spruce and tamarack. Olive-sided flycatchers are less common in deciduous dominated forests, or where dense young second-growth forest has developed after fires (Erskine 1992), which characterizes much of the study area.

Canada warbler was previously reported in the general area by Blood et al. (1977) and Pipe (1982) and is expected to occur within the study area. The breeding range in Saskatchewan corresponds closely with the boreal plain ecozone (Arsenault 2009). Canada warbler occurs in a variety of forest habitats, but is most commonly associated with wet mixedwood forest with a well-developed shrub layer (Conway 1999), including shrub marshes, black spruce swamps, and riparian woodlands along rivers and lakes (COSEWIC 2008a). They have a degree of tolerance and adaptability to human disturbances such as fragmented forests and regenerating cutovers (Hobson and Schieck 1999).

Whip-poor-will was recorded in the vicinity of the LSA by Golder (2006), although no association with habitat was provided. The whip-poor-will's range fingers into central east Saskatchewan, near the FalC forest (Arsenault 2009, COSEWIC 2009b). In this region, whip-poor-wills are considered to be sparse breeders. This species will nest in rock barrens with scattered trees, old burns, or other disturbed sites in a state of early to mid-regeneration (COSEWIC 2009b).

Chimney swift is a confirmed breeder in Nipawin (COSEWIC 2007c), which is at the western edge of the chimney swift's range in Saskatchewan (Arsenault 2009). In natural areas, the chimney swift is associated with large hollow trees, which may be limited in the FalC forest. This species was not recorded during recent baseline surveys.

The horned grebe was observed at a wetland during the spring waterfowl survey. It has previously been recorded in the area by Golder (2006), Pipe (1982), and Blood et al. (1977). Horned grebe will nest on small ponds, marshes, and shallow bays of lakes where open water and emergent vegetation are present (COSEWIC 2009c).

Short-eared owl range encompasses the study area. They are ground nesters and are generally rare breeders in Saskatchewan except in the Quill Lakes and Last Mountain Lakes areas (Smith 1996). This species was not observed during current baseline surveys, but was reported by Pipe (1982). The short-eared owl breeds in open habitats, such as grasslands, bogs, marshes, clear cuts, and old pastures (COSEWIC 2008b). It is nomadic species whose distribution and abundance closely follow that of cyclic small mammal populations, particularly meadow voles (Holt 1993; Ims and Anderson 2000).

Rusty blackbird is closely associated with boreal forest wetland areas, including bogs, swamps, beaver ponds, slow moving streams, marshes, and sedge meadows (COSEWIC 2006). Suitable habitat for this species is more abundant in the northern portion of the FalC forest as compared to the LSA. The rusty blackbird has not been previously recorded in the area.

Yellow rail is an uncommon local resident of Saskatchewan. There are no confirmed breeding records for Saskatchewan since 1956 (Arsenault 2009). They prefer to nest in moist areas, with little or no standing water such as the drier parts of marshes. Their preferred summer habitat includes marshy areas with low ground cover, grassy flood plains, wet meadows, and bog areas with low vegetation, which are limited in extent within the study areas.

Northern leopard frog was not detected during field surveys, nor was it recorded in previous surveys. The range of the leopard frog encompasses the study area and it will use a variety of wetlands for breeding, including beaver ponds, quiet backwaters, and marshes, thus there is some potential for this species to be present.

Provincially Tracked Species

Several tracked species (SKCDC 2010a) that have been recorded in the area or have potential to occur in the area are also listed in Table 5.3.3-13. Observations of tracked species are summarized below.

A great blue heron was observed in a marsh adjacent to English Creek Bridge in 2007, and a second heron was observed flying across the Division Road approximately 4 km east of English Creek. A single heron was again observed at the English Creek Bridge during the spring amphibian survey in 2008. Marshes associated with major tributary drainages such as English Creek and the Saskatchewan River may provide some foraging habitat for this species. Nesting colonies were not observed within the study area, although one nesting colony was found in the Saskatchewan River valley during the wildlife study for the Nipawin dam (Blood et al. 1977).

Two American white pelicans were observed on the Saskatchewan River during upland breeding bird surveys. Pelicans do not nest in the LSA, and are expected to only use the river.

Table 5.3.3-13: Species of Concern Known or Potentially Occurring in FalC Forest

Species	Scientific Name	SKCDC 2010	COSEWIC 2009a	SARA Schedule	Current Study	Golder (2006)	Pipe (1982)	Blood et al. (1977)	Historical Record
				Birds					
American white pelican	*Pelecanus erythrorhynchos*	S3B			X		X	X	X
Bald eagle	*Haliaeetus leucocephalus*	S5B,S4M,S4N			X		X	X	X
Barred owl	*Strix varia*	S3B,S3N							X
Canada warbler	*Wilsonia canadensis*	S5B	Threatened	1			X	X	X
Caspian tern	*Sterna caspia*	S2B, S2M					X	X	X
Chimney swift	*Chaetura pelagica*	S2B	Threatened	1					X
Common nighthawk	*Chordeiles minor*	S4S5B,S4S5M	Threatened	1	X	X	X	X	X
Connecticut warbler	*Oporornis agilis*	S2B				X	X	X	X
Cooper's hawk	*Accipiter cooperii*	S4B,S2M,S2N					X	X	X
Great blue heron	*Ardea herodias*	S3B			X		X	X	X
Great gray owl	*Strix nebulosa*	S3B,S3N			X	X	X	X	X
Horned grebe	*Podiceps auritus*	S5B	Special Concern	No schedule	X	X	X	X	X
Loggerhead Shrike		S4B	Threatened	1				X	X
Northern hawk owl	*Surnia ulula*	S3B,S5N					X		X
Northern shrike	*Lanius excubitor*	S1B,S4N							X
Olive-sided flycatcher	*Contopus borealis*	S4B, S4M	Threatened	1		X	X	X	X
Pileated woodpecker	*Dryocopus pileatus*	S4B,S3N			X	X	X	X	X
Pine grosbeak	*Pinicola enculeator*	S2B,S4N							
Piping Plover	*Charadrius melodus circumcinctus*	S3B	Endangered	1				X	X
Rusty blackbird	*Euphagus carolinus*	S4B	Special Concern	1					X

Species	Scientific Name	SKCDC 2010	COSEWIC 2009a	SARA Schedule	Current Study	Golder (2006)	Pipe (1982)	Blood et al. (1977)	Historical Record
Sandhill crane	*Grus canadensis*	S2B,S4M							
Short-eared owl	*Asio flammeus*	S3B,S2N	Special Concern	3			X		X
Sprague's pipit	*Anthus spragueii*	S4B	Threatened	1			X	X	X
Turkey vulture	*Cathartes aura*	S2S3B,S2M,S2N			X		X	X	X
Whip-poor-will	*Caprimulgus ociferus*	S3B	Threatened	No schedule			X		X
Whooping crane	*Grus americanus*	SXB, S1M	Endangered	1					X
Yellow rail	*Coturnicops noveboracensis*	S3B,S2M	Special Concern	1					
Mammals									
Cougar	*Puma concolor*	S2S3			X				X
American badger	*Taxidea taxus*	S3S4							X
Amphibians and Reptiles									
Northern leopard frog	*Rana pipiens*	S3	Special Concern	1					

Notes: Federal Status: (COSEWIC 2009a): Threatened = a wildlife species likely to become endangered if limiting factors are not reversed; Special Concern = A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats; Not at Risk = Species has been evaluated and found to be not at risk of extinction given the current circumstances; Blank cell = not listed.

A pair of sandhill cranes with a juvenile was observed a few hundred metres northeast of the Shipman Bridge on the northern edge of FalC forest. Sandhill cranes utilize wetland complexes for nesting and summer feeding; this habitat is limited in extent in the LSA.

Bald eagles were observed in the vicinity of Poplar Creek, English Creek, and the Saskatchewan River valley, as well as jack pine habitat. An active nest was located in the river valley in May 2008.

Turkey vultures were observed on three occasions, once feeding on a deer carcass in regenerating jack pine during the June 2008 upland breeding bird survey, and twice in fall flying over a burn area and along the river.

Great gray owls were observed during the fall of 2007. One was observed in a snag in a burn west of Kitchen road and one was observed in the vicinity of the turnoff on Shipman Trail. The habitat complex to the north of the LSA likely provides more suitable breeding habitat for this species.

A barred owl was observed south of the proposed Star site along the Saskatchewan River bank, December 2006.

Northern hawk owls were sighted just off of Highway 6 in the eastern FalC forest.

Two Cooper's hawks were observed in a drill site clearing in dense aspen regeneration during upland breeding bird surveys in June 2008.

Pileated woodpeckers or their sign were noted at a number of locations during surveys. The pileated woodpecker typically requires old growth forest for cavity nesting, little of this habitat is available in the LSA.

Northern shrike was observed in the area in April 2007. This species breeds in northern Saskatchewan, but may winter in the FalC forest area.

Connecticut warbler was not observed during baseline surveys, but was noted in the LSA by Golder (2006).

Trumpeter swan was historically recorded at wetlands near the south edge of the FalC forest (SKCDC 2010b). Trumpeter swans were not observed during the aerial spring water bird survey. Wetlands in the LSA are likely unsuitable breeding habitat for this species.

Cougar tracks of a female with 2 kittens were observed on a sandy stretch of road approximately 3 km north of the Saskatchewan River and west of the LSA. A single cougar was also observed in a tree by bear hunters in the FalC forest south of the Saskatchewan River in 2008 (EcoDynamics 2009).

Badger was historically reported in the FalC forest, although it is more likely to occur near the forest edge or surrounding agricultural area than in the vicinity of the LSA.

5.3.3.4 Summary

FalC is an island forest complex, surrounded by agricultural land and close to several larger urban communities. The forest size and diversity of vegetation communities supports a richness of wildlife species. The LSA occurs in one of the least complex areas of the FalC forest in terms of vegetation cover, however, the ravines and Saskatchewan River valley provide important upland and wetland habitats and function as movement corridors.

White-tailed deer is the most common ungulate in the FalC forest and LSA. Moose and elk are also common in the area, and mule deer are present although not common. Chronic wasting disease, evident in ungulates in surrounding areas, appears to be limited to the eastern edge of the FalC forest at present.

FalC forest supports resident large carnivores including black bear, lynx, cougar, coyote and grey wolf. Several other furbearers, including beaver, muskrat, weasels, otter, mink, marten, red squirrel and snowshoe hare are also present in the area. Many of these species are regularly hunted / trapped. Aerial surveys indicated the grey wolf population was relatively high in 2007/2008. However, trapping of wolves in 2008/2009 and 2009/2010 to reduce predation of livestock in surrounding agricultural lands has reduced grey wolf numbers.

The ranges of 251 species of birds overlap the FalC forest; of these over 130 species have been recorded in the area. Nine species of eagles, hawks, falcons, and vultures, and four species of owls were recorded during baseline surveys or incidentally, and several other species are known to occur in the area. Thirty-three species of water birds/shorebirds were recorded during spring baseline surveys, with American coot, mallard, and Canada goose being the most common species. Of the 59 species recorded during the upland breeding bird survey, 49 species of songbirds were present, with red-eyed vireo, white-throated sparrow, chipping sparrow, dark-eyed junco, common yellowthroat, and least flycatcher being the most frequently recorded species. The highest species richness was associated with regenerating jack pine and deciduous forest types, while the highest relative abundance of birds was associated with river shoreline, beaver pond, treed conifer swamp, and aspen-white spruce habitats.

Amphibians detected in the FalC forest include boreal chorus frog (most common species), wood frog, Canadian toad, and tiger salamander. Red-sided garter snake is the only reptile expected to occur in the FalC forest that was not observed during surveys.

Ten species-at-risk were recorded in the FalC forest region, including five bird species (common nighthawk, olive-sided flycatcher, Canada warbler, whip-poor-will, and Chimney swift) designated as Threatened by COSEWIC, and two bird species (horned grebe, short-eared owl) designated as Special Concern. There is potential for northern leopard frog, yellow rail, and rusty blackbird to also occur in wetland areas. Several other wildlife species on Saskatchewan's vertebrate tracking list have also been recorded or have potential to occur in the FalC forest.

5.3.4 Biodiversity

This Section of the EIS describes the existing (baseline) biodiversity conditions in the vicinity of the Star-Orion South Diamond Project (the Project). The baseline assessment examines the current state of biodiversity within the Fort-a-la-Corne Forest, which was selected as the Regional Study Area (RSA) for the Project and within the Local Study Area (LSA) chosen for terrestrial environmental assessment. Indicators of biodiversity encompass species, ecosystem and landscape levels of organization. Rare or endangered species are of particular interest, and are considered likely to be more vulnerable to habitat changes associated with development of the Project.

5.3.4.1 Introduction

Biodiversity is defined as the natural state of variability among living organisms and within the ecological systems they occupy. This variability includes the composition, structure and distribution of biotic and abiotic resources. Biodiversity may be studied by examining patterns of species richness and abundance and relating these to ecosystem availability, structure, and function.

The number and types of species present in a given area are a product of the larger regional distribution or species pool for a given biome, the recent history (e.g., fire and anthropogenic disturbance), the variety of landscapes and ecological land systems present, and the types, amounts, structures and functions of habitats (i.e. ecosystems).

Conservation of biodiversity is an important issue for the public, governments and Aboriginal and stakeholder groups. Due to these concerns, policies to protect biodiversity have been developed at several political levels. The UN Convention on Biodiversity (United Nations 1993), the Canadian Biodiversity Strategy (Biodiversity Working Group 1994) and the Saskatchewan Biodiversity Action Plan (Government of Saskatchewan 2004) address the need to understand, conserve and share the benefits from the use of biotic resources.

Approach

An indicator approach was used to assess valued components of biodiversity. Biodiversity assessment draws on the information learned in other disciplines including soils and terrain, hydrology, vegetation and wetlands, and aquatic ecology. Information on species distributions and ecology was collected from local field studies and from government and literature sources. This background information was used to develop indicators to quantify biodiversity in the RSA and LSA.

5.3.4.2 Background

Biodiversity Policies

Over the last two decades, policies and procedures have been developed to guide how societies should understand, interpret and protect biological diversity. In 1993, the United Nations developed the Convention on Biological Diversity (the Convention) (United Nations 1993). The main objectives of the Convention are:

- the conservation of biodiversity;
- the sustainable use of biological resources; and

the fair and equitable sharing of the benefits from the use of biological resources.

In response to the Convention, the Canadian Biodiversity Strategy (Biodiversity Working Group 1994) was developed. The Canadian Biodiversity Strategy outlines several long-term goals to provide a national strategic direction to promote the conservation of biodiversity and sustainable use of biological resources (Biodiversity Working Group 1994). The strategy also recognizes that the conservation of biodiversity and the sustainable use of biological resources are fundamental to Canada's indigenous communities.

In 2004, the Government of Saskatchewan released Caring for Natural Environments: A Biodiversity Action Plan for Saskatchewan’s Future. This document provides a framework to achieve long-term conservation of biodiversity and to study or maintain essential ecological processes and life support systems. The goals outlined in the provincial biodiversity action plan are:

- use biological resources in a sustainable manner, which maintains biodiversity;
- improve our understanding of ecosystems and our resource management capacity;
- promote the need to conserve biodiversity when using biological resources;
- develop incentives and legislation to support the conservation of biodiversity; and

co-operate with other jurisdictions to conserve biodiversity.

Generally, two approaches are encouraged to meet these goals: a coarse filter approach directed towards the conservation of a sample of ecosystems within a landscape, and a fine filter approach directed towards conservation of species (Government of Saskatchewan 2004).

Biodiversity Research Review

Biological diversity can be hierarchically organized into four levels including landscape, habitat or ecosystem, species, and genetic diversity (Noss 1990). Landscape (broad scale, regional level) and habitat (finer scale, local level) diversity describe the ecosystems in which species exist. Species diversity includes the number and types of species present, their relative abundances, and interactions among species (Chapin et al. 1998). Genetic diversity covers genotypic and phenotypic variation within populations and is outside of the scope of most studies. Characterization of diversity within each of these levels generally includes a description of composition (the parts of each biodiversity component in a given area), structure (the physical characteristics supporting composition), and function (ecological processes affecting structure) (Noss and Cooperrider 1994).

Landscape Diversity and Fragmentation

Landscape diversity encompasses the types, areas, and relative proportions of landscape elements within a regional area, as well as patchiness and edge effects due to anthropogenic fragmentation, and the manner in which habitats and species interact. In most cases, the landscape is defined as an interacting mosaic of patches (McGarigal and Marks 1995); a patch is a relatively homogeneous area that differs from its surroundings (Forman 1995). Spatial arrangement of landscape patches may influence habitat quality, movement patterns, gene flow and other ecological processes, such as fire and insect outbreaks (Baker 1992, McGarigal and McComb 1995, Eng 1998).

Fragmentation is the breaking of contiguous patches into smaller, isolated patches (Morrison et al. 1998). The effects of fragmentation include (Haila 1999):

- reducing the area of patches;
- increasing isolation of the patches from each other (i.e., reduced connectivity); and

increasing effects of disturbances adjacent to the patches (e.g., edge effects).

Fragmentation and other changes to landscape structure may have positive, negative or neutral effects on biological interactions within a system (e.g., species dispersal) (Matlack and Litvaitis 1999); or on ecosystem processes (e.g., nutrient cycling and decomposition). Fragmentation of contiguous habitat may reduce suitability for species occupying large home ranges (Forman and Godron 1986, Wilcove et al. 1986). Fragmentation effects on biodiversity may be subtle or large, and many effects do not occur immediately. Effects will change over time, as the patch and edge characteristics develop during vegetation succession.

Usually, the ecological effects of habitat fragmentation on species or biodiversity are considered negative (Wiens 1994), but some species show no effects or even positive effects with increasing fragmentation. Bayne (2003) investigated forest birds in Alberta and showed three different patterns in relation to habitat use in areas with seismic lines. In the first pattern, seismic lines were neither selected for use nor avoided (e.g., Tennessee warbler). In the second pattern, seismic lines were avoided and territories were set up only in intact habitat blocks (e.g., ovenbird). In a third pattern, territories were more common near seismic lines (e.g., mourning warbler).

Fragmentation effects on species may be difficult to quantify because loss of habitat occurs simultaneously with the changes to edges and patches. Villard et al. (1999) demonstrated for forest bird species that loss of area has the greatest effect on species, however, increasing edge to area ratio had additional effects. Hairy woodpecker and least flycatcher were negatively affected by increasing edge and effectively disappeared over the edge to area ratio of 2.4 to 3.2 km/km^2, even when otherwise suitable habitat remained. Veery decreased from 2.9 to 3.5 km/km^2 and white throated sparrow increased between 1.6 and 2.7 km/km^2. Veery, ovenbird and scarlet tanager also showed weak positive relationships between patch number and number of individuals present, and scarlet tanager showed a negative relationship between mean nearest neighbour distance and population size.

Edge effects occur along the boundary between distinctly different natural habitats (e.g., forest and meadow) and between natural and anthropogenically-modified habitats (Bannerman 1998). Edge effects occur as a result of microclimatic differences (e.g., increased temperature, solar radiation, wind speed, and reduced soil moisture) in the ecotone or biotic edge zone, and may extend from the edge boundary several (tens to hundreds of) metres into the adjacent community. Negative biotic effects along edges include dispersal of non-native invasive species, nest predation, and reductions in survival or occupancy of interior forest-dwelling species. Marten avoid edge habitat and instead seek the interior forest stands (Hargis et al. 1999). Edges also represent areas where invasive species, such as brown-headed cowbirds, can gain access to nests of forest-dwelling birds.

Edge effects are considered more pronounced in areas with abundant mature or old-growth forests; in areas where the recent fire history has resulted in a matrix of young forests the effects are likely reduced. The positive effects of edges are: edge areas may provide foraging habitat adjacent to cover habitat in undisturbed forests, and may benefit species such as deer, moose, and black bear, some rodents, and small to medium sized carnivores. Herbivorous and omnivorous species often benefit from the abundant berry-producing and browse shrubs along edges. The increase in small species like deer mice can subsequently provide increased food for carnivores (Bayne and Hobson 1998). Some of these benefits, however, may be balanced by other effects such as increased wildlife-vehicle collisions and altered predator-prey dynamics.

Along with fragmentation and edge effects, linear disturbances provide access for invasive/non-native species to penetrate into the forest and colonize new ecosystems. Access may also result in increased recreational or consumptive human use of ecological areas leading to additional impacts (habitat change, harassment, displacement, overharvest) on species. Linear disturbance ratio (length of disturbance per area of habitat) relates to the quality of habitat for higher-order species, therefore linear disturbance ratio is considered to be a primary attribute of landscape ecology (Bayne 2004).

Ecosystem Diversity

Ecosystem or habitat structure is the collective arrangement of all biotic and abiotic elements within a defined area. Structure affects the potential for any ecosystem to support vegetation and wildlife species. Key elements of structure are thermal shelter, hiding cover, living space, food, and other resources needed to maintain living organisms.

Maintenance of species diversity requires that appropriate habitat or ecosystem diversity is also maintained. Certain habitats support high plant or wildlife species diversity, as well as uncommon, rare, or other species considered beneficial for humans. A wide range of age classes among ecosystems is also necessary to maintain species better suited to young, mature and old stands (Stelfox et al. 1995).

Ecosystems are generally composed of several microhabitats and associated communities which differ in terms of dominant species composition. Developing a wide range of habitats and microhabitats is especially important in the reclamation planning for a project. Projects may attempt to redevelop habitat diversity by reclaiming in a manner resulting in a range of moisture, nutrient, soil and site conditions.

Aquatic and Riparian Habitat Diversity

Open water and riparian areas provide core use areas and/or occasional habitats for several species groups including furbearers, ungulates, shorebirds, waterfowl, songbirds, raptors, fish, amphibians, aquatic and riparian plants, including several species at risk. Species classified as obligate aquatic species (e.g., fish, benthos, algae, macrophytes) or semi-aquatic species (e.g. waterfowl, shorebirds, beavers, otters, muskrats) are dependent on these habitats for survival. Several other species use these habitats occasionally, diurnally, or seasonally for foraging, to obtain water or minerals, or as protective/escape terrain.

Riparian habitat is often highly productive, providing ample food and cover resources, which are not otherwise found in abundance on the landscape. In addition, riparian habitats provide landscape connectivity and act as travel corridors between habitats.

Species occupying watercourses may be at risk from diversions, blockages or other broad habitat changes caused by developments. Loss of aquatic connectivity, such as restricted movement at culverts, and increased access to anglers may also affect stream and riparian area biodiversity (Dane 1978, Furniss et al. 1991, Eaglen and Hubert 1993, Harper and Quigley 2000). The fragmentation of streams by linear disturbance crossings has the potential to affect fish and benthic invertebrate populations by influencing the quality and quantity of habitat. Scrimgeour et al. (2003) showed that bull trout in northwestern Alberta were reduced in number as the cumulative disturbance of watersheds and the number of creek crossings increased. Other species, notably sculpin, were shown to increase in density in relation to the level of disturbance.

Project activities often result in the development of storage ponds and backwater areas that may, in the long-term, increase the amount of habitat for waterfowl, shorebirds or amphibians. Puchniak (2002) compared restored wetlands to natural wetlands in Alberta, and found that species richness, abundance and composition of birds, amphibians and plants were similar when constructed appropriately. However, this habitat may not be as useful as natural waterbodies if the water quality is poor or if there is not a variety of habitat classes available for different life stages. For example, dabbling ducks require shallow water areas for mating, dense upland cover for nesting, shallow water with emergent vegetation for brood-rearing and large areas of open water for molting and staging (Austin and Serie 1994, Bethke and Nudds 1995). Man-made reservoirs often have a large open water area and little shoreline or marsh development. Therefore it is important for restored wetlands and reservoirs to be designed to provide habitat variability.

Species Diversity

Species requiring a specific habitat may be at risk from habitat loss caused by clearing and subsequent reclamation activities. Native plant and animal diversity is an indicator of a healthy ecosystem; abundant non-native species are indicators of poor/unhealthy ecosystems.

Diversity of various taxonomic groups may be affected differently by landscape change or developments. Lawton et al. (1998) demonstrated that each taxonomic group responds differently to change. Ideally, to understand ecosystem changes, several species groups should be examined. Most studies focus on a few groups of species where information is available, including plants, breeding birds, and mammals.

5.3.4.3 Biodiversity Indicator Selection

In this baseline assessment, an indicator approach was used to examine terrestrial and aquatic biodiversity for Valued Components (VCs) at the landscape, community and species levels. Collectively, these indicators were used to characterize and assess biodiversity.

Initially a large list of potential indicators was compiled. Based on available data, information learned from regulator and stakeholder meetings, and a review of biodiversity assessments in other jurisdictions, a final set of indicators was determined. This list is provided in Table 5.3.4-1. A description and rationale of each indicator follows in the text below.

Table 5.3.4-1: Biodiversity Valued Components and Indicators

Biodiversity Level	Valued Components	Indicators
Landscape Diversity	Landscape Composition	L1. Area (ha) and Distribution of Landscape Classes
	Landscape Intactness	L2. Disturbance Area (ha) by Landscape Class L3. Density of Linear Disturbances (km/km^2) by Landscape Class L4. Aquatic Connectivity (Stream Crossings per km)
	Landscape Spatial Structure	L5. Patch Number and Size Class Distribution
	Landscape Disturbance Regimes	L6. Forest Harvest and Natural Disturbance Areas (ha)
Habitat Diversity	Habitat Composition	H1. Ecosite Area (ha)
	Forest Structure	H2. Forest Age Classes (including old-growth forest) H3. Structure within Ecosites
	Habitat Intactness	H4. Anthropogenic Edge to Area Ratio (km/km^2) among Ecosites
Species Diversity	Species at Risk	S1. Species at Risk within Taxonomic Groups: Vascular Plants Birds Butterflies Fish
	Species Richness	S2. Species richness and habitat rating areas (ha) within taxonomic groups: Breeding Birds Vascular Plants Non-vascular Plants
	Taxonomic Groups of Interest	S3. Habitat Associations for Taxa of Interest: Ungulates Carnivores Furbearers Waterfowl Amphibians
	Native Species Diversity	S4. Distribution of Non-native Species

L1. Area and Distribution of Landscape Classes

Landscape Classes were the basic unit of assessment at the Landscape Level. In the RSA, there were three primary landscape classes: uplands (i.e. moderate to high relief lands), lowlands (i.e. low relief lands) and riparian areas:

- uplands were defined as undulating to hilly areas with slopes typically in excess of 1%; in these areas natural drainage was expected to result in dry to mesic forest classes on modal sites with moist forests and wetlands in the seepage areas at the base of hills;
- lowlands were defined as areas with typically low slope (<1%) where surface and subsurface water flow may become impeded resulting in the formation of large wetlands; however, where these areas have coarse to medium textured soils without impeded drainage, forests or agricultural lands may occur; and,

riparian areas were areas where past and present water flow resulted in landscapes including floodplains, terraces, cutbanks, or gullies, with occasional flooding and/or climatic and soil conditions resulting in the growth of riparian vegetation; riparian vegetation often includes forests with trees taller than those in adjacent landscapes, shrublands, and marshes or beaver dam flats.

L2. Disturbance Area (ha) by Landscape Class

This indicator examined the total area impacted by past developments and examined the patterns of land use among Landscape classes. As the area of disturbance increases, the loss of habitat and potential loss of species also increases. The pattern of development among landscapes reflects past human uses in an area. In general, upland sites (or well drained lowland sites) are preferred for construction of roads and facilities, due to good drainage and high stability of the soil layers. Some land uses, like forestry, and agriculture are also concentrated in uplands or in well drained lowlands. In contrast, riparian areas are often avoided due to steep slopes, flooding and unstable terrain features. However, riparian areas must be crossed to access resources. Various policies may affect the development pattern among Landscape Classes. Provincial setbacks for the protection of rivers, lakes, riparian areas and wetlands are designed to reduce effects on these landscapes, due to the high values placed on these areas.

L3. Density of Linear Disturbances (km/km^2) by Landscape Class

This indicator provides a relative measure for comparison of the rate of development among study areas. In large regions, the level of linear density may be correlated with changes to species distributions (e.g., Fahrig 1999). Linear disturbances allow generalist wildlife species (coyotes, crows, and moose) into intact forest areas, which may displace, through competition or predation, boreal specialists like wolves and native songbirds (Bayne 2004).

For vegetation, linear developments allow for greater infiltration of non-native and weed species into undisturbed habitat (McFarlane 2003).

L4. Aquatic Connectivity (Stream Crossings per km)

The installation of creek crossings can result in changes to the biodiversity of watercourses through siltation, increased access for humans and wildlife, and direct fragmentation of riparian habitat corridors (Dane 1978; Furniss et al. 1991; Eaglen and Hubert 1993; Harper and Quigley 2000). Creek crossings include culverts and bridges on roads and also open cuts along utility corridors, pipelines and trails. The habitat at a crossing site is often altered and may affect downstream aquatic habitats. Poorly designed culverts or other blockages at crossing sites may restrict aquatic species movements.

L5. Patch Number and Size Class Distribution

Large contiguous patches of natural habitat are able to support species requiring protective forest cover and isolation from predators. Some species may avoid small patches of habitat if the patches are not able to provide enough food or cover. As the size of natural patches decreases, the ability of the landscape to maintain these species may decrease at the expense of habitat generalists that use a wide range of habitat classes.

L6. Forest Harvest and Natural Disturbance Areas (ha)

The FalC forest has been affected by large recent burns, many of which were salvage logged, and other areas were partially or completely harvested within patch-cuts. Other disturbances include dwarf mistletoe infestation of pine forests, and insect damage. This past forest history affects the current species and habitat distribution. The level of Project disturbance is discussed in the context of these disturbances for comparison.

H1. Ecosite Area

Ecosystems must be mapped at an appropriate scale and over an area large enough to allow assessment of effects from project disturbances and predicted alterations. Ecosites are the ecosystems that provide living space and habitats for species. Ecosites are distributed among Landscape Classes, due to differences in substrates, climate, soil moisture and nutrients, and past history. Ecosites reflect the past disturbance and successional state of the forest area, and may change in distribution from natural development or industrial activities. Ecosystems of concern include ecosites assessed as regionally uncommon based on the measured distribution of ecosites within the RSA. Uncommon ecosites are considered more vulnerable to losing species diversity since a greater proportion of their area would be lost even with small disturbances. In addition to species/habitat concerns, ecosystem functions (e.g., water infiltration following precipitation events) may be altered if a substantial proportion of natural habitat classes are removed or replaced with cleared areas.

H2. Distribution of Forest Age Classes (including Old-growth Forest)

The structure of ecosites defines the state of succession of a forest area and the greater the range of age classes the greater the classes of microhabitats and the number of species likely to be present. The range of variability among age classes is often large, even when examined at regional scales. Old-growth forests are a sensitive resource; conditions in old-growth forests, such as tall trees, multi-aged canopies, an abundance of downed logs and dead trees, and an abundance of forest gaps provide unique habitat conditions for a variety of species. Old-growth forests often support high species richness among taxonomic groups, and may help maintain species of concern.

H3. Structure within Ecosites

This indicator provides a measure of the baseline habitat structure within each ecosite, using project data from forest and vegetation surveys. Measures include tree height, tree, shrub and ground vegetation cover, and cover of downed wood. This indicator provides a snapshot of conditions present in the baseline and may help to quantify habitat conditions for forest dwelling species.

H4. Anthropogenic Edge Effects within Habitat Classes

The final habitat diversity indicator examines the relative influence of disturbances on natural ecosites. The edge to area ratio indicates the relative risk of indirect impacts on ecosites by edge effects. As the level of edge increases, the risk for loss of native species and displacement by non-native species increases.

S1. Species at Risk within Taxonomic Groups

Species at risk may be defined as native species, due to biological or geographical characteristics, are found in restricted areas, at the edge of their range, or in low numbers within a given area or jurisdiction. In Canada, species at risk are listed both federally and provincially. Under the Federal Species at Risk Act (SARA) (Schedule 1) wildlife species, including plants may be defined as Endangered, Threatened or Special Concern. The Saskatchewan Conservation Data Centre (SKCDC) ranks species using the Nature Conservancy Ranking System, providing an S Rank (State Ranking) and a G Rank (Global Ranking) for each species. Those species listed as S1 or S2 are considered rare, and those listed as S3 are considered uncommon. In most cases the current distribution of plant species at risk are poorly understood. Each known occurrence may be one of up to 20 known locations within a given jurisdiction, and direct loss of any one of these occurrences may represent a significant provincial, national, or even global population effect.

Plant and wildlife species at risk are best understood through relationships with habitat; for example, several species may occur in limited habitat classes. These habitats may be affected directly by clearing or indirectly by fragmentation. Assessing the risk of species loss requires an understanding of the baseline composition of species, including the number of species at risk, species distribution among habitats, amount of habitat loss and indirect alteration, and the sensitivity of species to disturbances. The selected indicators examine the likelihood of each ecosite to maintain vascular plant species at risk, bird species at risk, butterflies at risk, and fish species at risk.

S2. Species Richness and Habitat Rating Areas (ha) within Taxonomic Groups

This indicator examines native species within taxonomic groups based on collected field data. The habitat of each species or species group needs to be understood to examine risks. Species loss is particularly important for those species occurring in uncommon ecosystems, species with low populations exhibiting wide habitat ranges, species sensitive to disturbance and species that are rare, threatened, or endangered. Indicator groups are based on available data and include vascular and nonvascular plants and breeding birds. These indicators are assessed to determine which ecosites are most likely to maintain high species richness.

S3. Habitat Associations for Taxa of Interest

The following taxonomic groups are of particular interest to regulators and/or other stakeholders: ungulates, carnivores, furbearers, waterfowl and amphibians. The first four of these groups include species that are hunted, trapped, or enjoyed by nature enthusiasts, and their persistence helps indicate a healthy ecosystem. Amphibians as a group are considered to be in worldwide decline; concern for this taxonomic group was expressed during stakeholder engagement for the Project.

S4. Distribution of Non-native Species

Exotic and opportunistic plant species (weeds) may become increasingly established in disturbed and adjacent undisturbed areas, and these species may be dispersed to these sites along corridors that connect to existing populations, or may otherwise be spread by wind, water, animals, or humans and their equipment. The introduction and establishment of weeds can impede the re-establishment of native species and can affect native species diversity through competitive effects. Risk of biodiversity loss from exotic species invasion depends on the competitive ability of native species, the density and area of infestation, the types of species invading, and the habitats affected. The exotic species indicator examines the relationship between non-native plant species and habitats.

5.3.4.4 Methods

Species Data

Vegetation plot data and bird point count data were obtained from baseline studies in 2008 and 2009. Data were checked for classification and taxonomic accuracy prior to completion of analyses. Species nomenclature followed information provided by the SKCDC. Field data were entered into a MS Access Database to facilitate diversity calculations.

Wildlife Species at Risk lists and habitat associations were obtained from literature sources and from the wildlife baseline report. Fish and aquatic data were obtained from the Fisheries and Aquatic Resources assessment.

Spatial Datasets and Mapping

To describe the biodiversity Base Case, the following spatial information was obtained:

- Saskatchewan Government Hydrology Layer (1:50,000);
- Saskatchewan Forest Vegetation Inventory (SFVI) in the RSA;
- Forest Harvest and Road network provided by Saskatchewan Ministry of Environment;
- Disturbance data provided by Shore; and

Orthophotography and Digital Elevation Model data obtained from GeoSask.

These datasets represent the baseline condition of natural vegetation areas. Anthropogenic disturbances in the RSA and LSA were updated using Project information, 2007 aerial photography, and data provided by Shore Gold. Sites regenerating from forest harvest, disease, insects, and fire were summarized from the SFVI.

Indicator Measurements

Landscape-level Indicators

Landscape Classes were identified using slope, aspect and elevation data overlain onto an orthophoto for the RSA. Presence of wetlands and forest cover from the SFVI were also used to help delineate uplands and lowlands. Riparian areas included areas surrounding permanent or ephemeral lakes, ponds, creeks, and rivers, and were mapped based on slope surrounding creek areas, and included the creek bottom and the lower slopes of the adjacent gully systems. In areas with relatively flat terrain where slope could not be used to identify riparian classes, a 50 m buffer around creeks and lakes was applied.

Natural patches were defined as natural habitat surrounded by anthropogenic disturbances. Patches were summarized into 6 size classes: 0 to 1 ha, 1 to 5 ha, 5 to 25 ha, 25 to 100 ha, 100 to 400 ha, and greater than 400 ha. Patch area, number, and mean patch size were examined. For this assessment, disturbances included roads, trails, pipeline and utility corridors, industrial sites, exploration lands and recently harvested areas.

The area of disturbances within each Landscape Class was represented by the density of linear disturbances. The length of all linear disturbances (roads, rights-of-way and trails) was calculated on a per-area basis. Creek crossings included all intersections of linear disturbances with creek or river features. The number of creek crossings was divided by the length of creeks to determine density.

Habitat-level Indicators

Habitat indicators were assessed at the ecosite level of classification following McLaughlan et. al. (2010) for the Boreal Plain reference area (Table 5.3.4-2). In addition to ecosites described in the guide, additional habitat classes were defined for the study areas that did not fit into these ecosites, including: open water, dry shrubland, cutbank, and deciduous swamp classes. A description of dominant species present in each ecosite is provided in Appendix 5.3.4-A. Each polygon in the SFVI was reclassified into ecosites, based on moisture, tree species, shrub and grass coverage, tree density and wetland classification. Clear-cuts, burns, and other existing disturbances were classified based on other fields of information stored in the SFVI dataset.

Ecosites were divided into mature and regeneration classes based on stand age. Forests up to 30 years of age were classed as regeneration, while those older than 30 years were classified as mature. This classification was used to examine habitat structure and species associations with habitat.

Age classes and old-growth forests were calculated based on the SFVI forest inventory origin data. Age was calculated as analysis year (2011) minus stand origin class year. Forests were placed into 20-year classes ranging from less than 20 to greater than 120 years. Old-growth forest was defined as all forests >120 years of age.

Habitat structure measurements included mean tree height, tree cover and cover of grass, herbs, shrubs, moss, lichens and downed wood in each ecosite class. Anthropogenic edge to area ratio (AEAR) was calculated using the length of adjacent disturbances divided by the area of each ecosite. In this analysis, edges included both linear and area disturbances. Analytical software IAN™ was used, whereby the RSA and LSA were converted to raster, and then the number of pixels of each disturbance type adjacent to pixels of each other habitat type was summed to give the shared edge in metres.

Table 5.3.4-2: Ecosites in the LSA and RSA

Ecosite Code	Ecosite
BP01	June grass - mountain goldenrod grassland
BP02	Jack pine/lichen
BP03	Jack pine/feathermoss
BP04	Jack pine - trembling aspen/feathermoss
BP05	Trembling aspen/prickly rose/grass
BP06	Trembling aspen/beaked hazel/sarsaparilla
BP07	Trembling aspen - white birch/sarsaparilla
BP08	Trembling aspen - white birch/mountain maple
BP09	White spruce - trembling aspen/feathermoss
BP10	Trembling aspen - white spruce/feathermoss
BP11	White birch - white spruce - balsam fir
BP12	Jack pine - spruce/feathermoss
BP13	White spruce - balsam fir/feathermoss
BP14	Black spruce/Labrador tea/feathermoss
BP15	Balsam poplar - white spruce/feathermoss
BP16	Balsam poplar - trembling aspen/prickly rose
BP17	Manitoba maple - balsam poplar/ostrich fern
BP18	Black spruce - tamarack treed swamp
BP19	Black spruce treed bog
BP20	Labrador tea shrubby bog
BP21	Graminoid bog
BP22	Open bog
BP23	Tamarack treed fen
BP24	Leatherleaf shrubby poor fen
BP25	Willow shrubby rich fen
BP26	Graminoid fen
BP27	Open fen
BP28	Seaside arrow-grass marsh
Other Natural Classes Mapped and Described for this Project	
BP01a	Dry shrubland
BP18a	Deciduous - mixedwood swamp
Cutbank	Sparsely vegetated riparian slopes
Open Water	Lakes, Flooded Areas, River

Species Indicators

Species at risk included those listed as a tracked rare species by the SKCDC, SARA or COSEWIC. Each taxonomic group was assessed separately including vascular plants, birds, butterflies, and fish. Mammals and amphibians were not examined since each taxonomic group includes only one species at risk. Data from published sources (Moss 1983; Smith 1993; Semenchuk 1992; Russell and Bauer 1993) and from the SKCDC were used to assemble a list of species at risk likely to occur within the FalC forest. Habitat information for each species was based on recorded observations in previous studies and on vegetation keys, floras, wildlife distribution maps and other taxonomic sources (Godfrey 1986; Johnson et al. 1995; Kershaw et al. 2001; Moss 1983; National Geographic Society 1983; Pattie and Fisher 1999; Russell and Bauer 1993; Semenchuk 1992; Smith 1993). Based on this information, the potential occurrence of species within ecosites was determined. These were summed and ecosites were ranked into high, medium and low species at risk classes.

Species richness was also assessed for three taxonomic groups with available baseline data, including: breeding birds, vascular plants, and nonvascular plants. Three species richness metrics were examined:

- total richness (total number of plant and bird species among all sample sites);
- mean richness (average number of plant and bird species per plot sampled); and

unique or rare richness (number of plant and bird species found only in a single ecosite plus observed incidences of species at risk).

Each metric was calculated among habitat classes and divided into high, moderate and low richness ranges. The results were combined into an overall species richness ranking. The habitat areas of each ranked class were calculated for the LSA and RSA.

Non-native plant species listed by the SKCDC were examined within the vegetation data, based on the proportion of plots that had non-native species. Ecosites were ranked into low, medium and high risk classes (i.e., risk for non-native establishment). The area of each ranked risk class was determined for the LSA and RSA.

Taxonomic groups of concern to regulators and other stakeholders included ungulates, carnivores, furbearers, waterfowl, and amphibians. Species and their ecosite associations were assessed based on published literature sources and information provided in the Wildlife Baseline (Section 5.3.3). Each species was assessed as being likely present or likely not present in each ecosite and ecosites were ranked from low to high.

5.3.4.5 Baseline Conditions

Landscape Diversity

Indicator L1 – Area and Distribution of Landscape Classes

The Project LSA covers 12,218 ha or just over 9% of the RSA (FaIC forest) which is 132,769 ha. The distribution of Landscape Classes in the LSA is 62% in uplands, 25% in lowlands and 14% riparian areas (Table 5.3.4-3, Figure 5.3.4-1). In the RSA, uplands make up 39% of the area, lowlands 53%, and riparian 9% (Figure 5.3.4-2). The proximity of the LSA to the Saskatchewan River, and the presence of several major creek gullies resulted in a relatively high proportion of riparian lands in the LSA.

Table 5.3.4-3: Baseline Landscape Class Area

Landscape Class	LSA		RSA	
	Area (ha)	**% of LSA**	**Area (ha)**	**% of RSA**
Uplands	7,581	62.0	51,684	38.9
Lowlands	2,991	24.5	69,854	52.6
Riparian	1,646	13.5	11,232	8.5
Total	**12,218**	**100.0**	**132,769**	**100.0**

Indicator L2 – Disturbance Area by Landscape Classes

The FaIC forest has been affected by salvage logging following fires in the area, as well as roads (primarily logging roads), other linear disturbances (e.g., transmission lines) and other industrial and exploration disturbances (Table 5.3.4-4). In the LSA, there are currently 3,651 ha (30%) of disturbed lands (Table 5.3.4-4, Figure 5.3.4-3). Of this disturbance, 28% is from recent harvest, and 1% each from linear disturbances and other clearings. Most of the harvested lands occur in the upland landscape class. The RSA has a lower proportion of disturbance than the LSA, at 23%. Recent harvest accounts for 11%, 1% is linear disturbances, and <1% is other clearings (Table 5.3.4-4, Figure 5.3.4-4).

In the LSA, lowlands are 41% disturbed, compared to 31% of uplands and 5% of the riparian areas. In the RSA, a similar proportion of disturbance occurs within uplands (29%), followed by 20% of lowlands and 6% of riparian areas.

Table 5.3.4-4: Baseline Disturbance within Landscape Classes

Landscape Class	Disturbance Category	LSA			RSA		
		Disturbed Area (ha)	% of Landscape Class	% of LSA	Disturbed Area (ha)	% of Landscape Class	% of RSA
Uplands	Linear Disturbances	69.6	0.9	0.6	604.0	1.2	0.5
	Agricultural Lands	0.0	0.0	0.0	143.7	0.3	0.1
	Recent Forest harvest	2,208.0	29.1	18.1	14,290.7	27.7	10.8
	Industrial Clearings	33.9	0.4	0.3	55.2	0.1	0.0
	Reclaimed Clearings	2.2	0.0	0.0	5.6	0.0	0.0
	Total	2,313.0	30.5	18.9	15,099.0	29.2	11.4
Lowlands	Linear Disturbances	57.3	1.9	0.5	763.1	1.1	0.6
	Agricultural Lands	0.0	0.0	0.0	166.4	0.2	0.1
	Recent Forest harvest	1077.4	36.0	8.8	13,224.4	18.9	10.0
	Industrial Clearings	68.5	2.3	0.6	99.8	0.1	0.1
	Reclaimed Clearings	15.3	0.5	0.1	46.5	0.1	0.0
	Total	1,219.0	40.7	10.0	14,300.0	20.5	10.8
Riparian	Linear Disturbances	4.1	0.2	0.0	38.3	0.3	0.0
	Agricultural Lands	0.0	0.0	0.0	19.9	0.2	0.0
	Recent Forest harvest	81	4.9	0.7	630.6	5.6	0.5
	Industrial Clearings	3.3	0.2	0.0	9.6	0.1	0.0
	Reclaimed Clearings	0.7	0.0	0.0	0.8	0.0	0.0
	Total	89.1	5.4	0.7	699.2	6.2	0.5
Total	Linear Disturbances	131.0	1.1	1.1	1,405.0	1.1	1.1
	Agricultural Lands	0.0	0.0	0.0	330.0	0.2	0.2
	Recent Forest harvest	3,366.0	27.6	27.6	28,145.7	21.2	21.2
	Industrial Clearings	105.7	0.9	0.9	165.0	0.1	0.1
	Reclaimed Clearings	18.2	0.1	0.1	52.9	0.0	0.0
	Grand Total	3,621.0	29.6	29.6	30,099.0	22.7	22.7

Indicator L3 – Density of Linear Disturbances

Almost all baseline linear disturbances in the RSA are logging and access roads, while industrial exploration roads occur more commonly in the LSA. There is also a provincial highway in the RSA and several trails used by hunters and trappers. The LSA has 194.8 km of access, and a linear disturbance density of 1.59 km/km^2 (Table 5.3.4-5). The RSA has 1,931.8 km of access and a density of 1.45 km/km^2. The pattern of access among landscape classes is similar to that observed in the total disturbance indicator. In the LSA, the highest densities occur in the lowlands, followed by uplands, with little density of disturbance in riparian areas.

Table 5.3.4-5: Baseline Density of Linear Disturbance

	LSA				RSA			
	Uplands	**Lowlands**	**Riparian**	**Total**	**Uplands**	**Lowlands**	**Riparian**	**Total**
Length of Linear Disturbances (km)	103.8	84.4	6.6	194.8	783.5	1,098.20	50.1	1931.8
Landscape Area (km^2)	75.8	29.9	16.5	122.2	516.8	698.5	112.3	1327.7
Linear Disturbance Density (km/km^2)	1.37	2.82	0.40	1.59	1.52	1.57	0.45	1.45

Indicator L4 – Creek Crossings

The total number of creek crossings in the LSA is 23 (Figure 5.3.4-5), whereas there are 146 crossings in the RSA (Table 5.3.4-6). When the number of crossings is divided into the total length of creeks, the LSA and RSA have 0.27 and 0.25 crossings per km, respectively. On average, creeks flow 4 km between each crossing.

Table 5.3.4-6: Creek Crossing Density

	Water Crossings	**Creek Length (km)**	**Crossing Density (crossings/km)**
LSA	23	85.5	0.27
RSA	146	583.0	0.25

Indicator L5 – Natural Patch Number and Size Distribution

Patches, as defined here, include only the natural habitat areas surrounded by anthropogenic features, including access corridors, small clearings, agricultural areas and recently harvested areas. The total natural patch area in the LSA, 8,691 ha, is therefore less than the total LSA which also includes the area of these disturbances. In the LSA, most patches are small to medium (0 to 25 ha), with 71% of patches <1 ha (Table 5.3.4-7) and an additional 19% in the 1 to 5 ha class. Only 17 patches were greater than 25 ha, including three patches in the 100 to 400 ha class and three in the >400 ha class. The total area of these patches shows the opposite distribution to the number of patches. Almost 80% of the

LSA occurs within the largest patches (>400 ha), and the smallest patches (<1 ha) in the LSA make up <1% of the LSA. The spatial distribution of patches in the LSA is shown in Figure 5.3.4-6. The pattern of patch number and area is similar in the RSA, with a slightly greater percentage of larger patches by number and by area. The mean patch size in the RSA is 41.2 ha, compared to 18.5 ha in the LSA.

Table 5.3.4-7: Baseline Natural Patch Numbers and Areas

Patch Size Class (ha)	LSA				RSA			
	Patch Count	**% of Patches**	**Patch Area (ha)**	**% of Patch Area**	**Patch Count**	**% of Patches**	**Patch Area (ha)**	**% of Patch Area**
0 to 1 ha	334	71.2	69	0.8	1,676	67.4	329	0.3
1 to 5 ha	90	19.2	213	2.5	484	19.5	1,108	1.1
5 to 25 ha	28	6.0	317	3.7	182	7.3	2,100	2.1
25 to 100 ha	11	2.3	535	6.2	73	2.9	3,543	3.5
100 to 400 ha	3	0.6	721	8.3	43	1.7	8,814	8.6
>400 ha	3	0.6	6,836	78.7	29	1.2	86,472	84.5
Total	**469**	100.0	**8,691**	100.0	**2487**	100.0	**102,364**	100.0
Mean Patch Size (ha)	**18.5**				**41.2**			

Indicator L6 – Forest Harvest and Natural Disturbance Areas

This indicator examines the past history of natural disturbed areas and compares these to the area affected by anthropogenic disturbance. The RSA has been influenced by 34,182 ha (25.7% of the RSA) of burns in the last 30 years (Table 5.3.4-8). A fire cycle may be determined by dividing the percent burned by the number of years, assuming burns do not overlap. Therefore in the RSA the annual burn rate is 0.86%, or a fire cycle of approximately 116 years. The fire cycle is within the average range experienced in the boreal forest of Saskatchewan (Weir and Johnson 1995). The LSA has had a greater proportion of area burned (51.5%) than the RSA.

The amount of forest harvest is largely influenced by past burns. Of the 28,146 ha (21% of the RSA) harvested in the last 30 years, 68%[7] was salvage logging in burnt areas. In the LSA there were a total of 3,366 ha harvested of which 86% was salvage logging. Only 3.6% of the RSA was clear-cut in unburned areas and an additional 3.2% had partial cutting. In the LSA, forest harvest in non-burned areas totalled 1.4% for clear-cuts and 2.5% for partial cuts.

[7] Salvage logging area divided by the combined harvest area = 68% (RSA) and 86% (LSA)

Other natural disturbances in the RSA include disease; largely dwarf mistletoe and insect damage, which cover 12.3% of the RSA and 15.7% of the LSA. Dwarf mistletoe infestations vary from light to severe in the FalC and management of stands infected with dwarf mistletoe is a priority within the draft Land Use Plan (SMOE 2005).

The total area of natural disturbances, including burns, insect, and disease, and forestry operations covers 71.1% of the LSA and 45.5% of the RSA. In comparison, all other anthropogenic disturbances affect 2.1% of the LSA and 1.5% of the RSA.

Table 5.3.4-8: Landscape Disturbance Regime

Disturbance Class	Subclass	Area in the LSA	% of LSA	Area in the RSA	% of RSA
Natural Disturbances	Complete Burn	2,142	17.5	9,705	7.3
	Partial Burn	1,251	10.2	5,347	4.0
	Complete Natural Disturbance	11	0.1	271	0.2
	Partial Natural Disturbance	1,906	15.6	16,042	12.1
Forestry	Clear Cut	172	1.4	4,825	3.6
	Partial Cut	301	2.5	4,191	3.2
	Salvage Cut	2,188	17.9	16,747	12.6
	Partial Salvage Cut	705	5.8	2,383	1.8
	Silvicultural Treatment	0	0.0	917	0.7
Other Anthropogenic	Agriculture	0	0.0	330	0.2
	Reclaimed Area	18	0.1	53	0.0
	Other Cleared Area	106	0.9	162	0.1
	Linear Disturbances	131	1.1	1,408	1.1
Total Burn (includes salvage)		6,286	51.5	34,182	25.7
Total Other Natural		1,917	15.7	16,313	12.3
Total Natural Disturbances		8,203	67.1	50,495	38.0
Total Harvest (includes salvage)		3,366	27.6	28,146	21.2
Total Forestry		3,366	27.6	29,063	21.9
Total Other Anthropogenic		255	2.1	1,953	1.5
Total Anthropogenic		3,621	29.6	31,016	23.4
Total Disturbance		8,931	73.1	62,380	47.0

The two study areas were primarily affected by past fire history with logging taking a secondary role. These disturbances have likely influenced the current biodiversity, providing high quality habitat for species preferring shrubby open regenerating habitats and reducing high quality habitat for species requiring mature forest cover.

Habitat Diversity

Indicator H1 Habitat Cover Classes

The LSA is dominated (i.e. has greater than 5% of the total area covered) by five ecosites: BP03 (Jack pine/feathermoss), BP04 (Jack pine - trembling aspen/feathermoss), BP05 (Trembling aspen/prickly rose/grass), BP06 (Trembling aspen/beaked hazel/sarsaparilla), and BP16 (Balsam poplar - trembling aspen/prickly rose) (Table 5.3.4-9, Figure 5.3.4-7). These five classes collectively make up 75% of the LSA. The remaining 25% is divided among the other 25 ecosites, three water classes, cutbanks and disturbed areas. Disturbances (as defined here to exclude forestry activities and natural disturbances) occur in 1.5% of the LSA.

In the RSA the dominant ecosites were BP03 (Jack pine/feathermoss), BP04 (Jack pine - trembling aspen/feathermoss), BP05 (Trembling aspen/prickly rose/grass), BP06 (Trembling aspen/beaked hazel/sarsaparilla), BP18 (Black spruce - tamarack treed swamp), and BP25 (Willow shrubby rich fen) (Figure 5.3.4-8). The relative difference between the LSA and RSA is reflective of the differences in landscape proportions in the two areas, with greater coverage of wetland classes in the RSA than in the LSA. The regional distribution was used to define uncommon ecosites as these are the habitats in shortest supply that may support unique or important wildlife or plant species. Uncommon ecosites included BP01a (Dry shrubland), BP11 (White birch - white spruce - balsam fir), BP13 (White spruce - balsam fir/feathermoss), BP15 (Balsam poplar - white spruce/feathermoss), BP18a (Deciduous - mixedwood swamp), BP19 (Black spruce treed bog), BP24 (Leatherleaf shrubby poor fen), BP26 (Graminoid fen), BP28 (Seaside arrow-grass marsh), Cutbank, Flooded, Lake, and River.

Indicator H2 – Forest Age and Old Growth Forest

The LSA is composed of 11,536 ha of forests. Among forests, the age classes ranged from <20 years to >120 years (Figure 5.3.4-9). Most forest was found in the 20 to 39 year age class, followed by the 40 to 59 year class and the 80 to 99 year class. Forest stands 120 years of age or older (old-growth forests) covered 0.2% of the LSA. In comparison, the RSA had a similar proportion of total forests, but the age class distribution is more even, with most forests in the 80 to 99 year, 60 to 79 year, and <20 year classes. Forest stands 120 years of age or older (old-growth forests) covered 4.3% of the RSA (Table 5.3.4-10, Figure 5.3.4-10).

Table 5.3.4-9: Baseline Ecosites within Landscape Classes

Ecosite Code	Ecosite	LSA					RSA				
		Area (ha)	Percent of LSA	Percent Upland	Percent Lowland	Percent Riparian	Area (ha)	Percent of RSA	Percent Upland	Percent Lowland	Percent Riparian
BP01	June grass - mountain goldenrod grassland	141	1.2	43	48	9	1,680	1.3	42	55	3
BP01a	Dry shrubland	184	1.5	48	12	40	704	0.5	45	28	27
BP02	Jack pine/lichen	340	2.8	57	42	1	1,528	1.2	56	41	3
BP03	Jack pine/feathermoss	5,061	41.4	69	29	2	32,799	24.7	44	54	2
BP04	Jack pine - trembling aspen/feathermoss	1,392	11.4	74	19	7	14,996	11.3	41	57	2
BP05	Trembling aspen/prickly rose/grass	1,163	9.5	55	34	11	18,109	13.6	44	51	5
BP06	Trembling aspen/beaked hazel/sarsaparilla	780	6.4	81	8	11	11,394	8.6	45	47	8
BP07	Trembling aspen - white birch/sarsaparilla	557	4.6	68	8	24	3,661	2.8	72	13	15
BP09	White spruce - trembling aspen/feathermoss	185	1.5	28	2	69	4,440	3.3	36	34	30
BP10	Trembling aspen - white spruce/feathermoss	22	0.2	68	0	32	1,795	1.4	49	39	12
BP11	White birch - white spruce - balsam fir	79	0.6	65	10	25	249	0.2	59	19	22
BP12	Jack pine - spruce/feathermoss	48	0.4	52	9	39	3,615	2.7	37	59	4
BP13	White spruce - balsam fir/feathermoss	0	0.0	0	0	0	6	0.0	0	100	0
BP14	Black spruce/Labrador tea/feathermoss	135	1.1	66	5	29	5,639	4.2	24	69	7
BP15	Balsam poplar - white spruce/feathermoss	10	0.1	64	11	25	380	0.3	32	56	12
BP16	Balsam poplar - trembling aspen/prickly rose	779	6.4	60	27	13	6,479	4.9	45	40	15
BP18	Black spruce - tamarack treed swamp	215	1.8	70	11	20	11,080	8.3	25	66	9
BP18a	Deciduous - mixedwood swamp	104	0.9	43	46	11	752	0.6	16	72	12
BP19	Black spruce treed bog	1	0.0	0	0	100	121	0.1	15	76	8
BP23	Tamarack treed fen	3	0.0	76	21	3	1,574	1.2	17	68	15
BP24	Leatherleaf shrubby poor fen	0	0.0	0	0	0	57	0.0	34	48	18
BP25	Willow shrubby rich fen	384	3.1	16	16	68	7,448	5.6	10	72	18
BP26	Graminoid fen	0	0.0	0	0	0	11	0.0	4	96	0
BP28	Seaside arrow-grass marsh	2	0.0	28	0	72	1,275	1.0	15	26	59
	Cutbank	0	0.0	0	0	0	12	0.0	1	0	99
	Flooded	3	0.0	31	0	69	18	0.0	17	0	83
	Lake	0	0.0	0	0	0	225	0.2	4	4	91
	River	372	3.0	0	0	100	767	0.6	0	0	100
	Disturbances	255	2.1	41	55	3	1,953	1.5	41	55	4
	Total	**12,218**	**100.0**	**62**	**24**	**13**	**132,769**	**100.0**	**39**	**53**	**8**

Table 5.3.4-10: Baseline Age Classes and Old-growth Forests

Age Class	LSA		RSA	
	Area (ha)	% of LSA	Area (ha)	% of RSA
<20 year	931	7.6	24,675	18.6
20-39 year	5,603	45.9	13,139	9.9
40-59 year	2,079	17.0	15,324	11.5
60-79 year	561	4.6	23,362	17.6
80-99 year	2,060	16.9	33,624	25.3
100-119 year	279	2.3	7,367	5.5
>120 year	24	0.2	5,714	4.3
Forest Land	**11,536**	**94.4**	**123,205**	**92.8**
Non-forested Lands	681	5.6	9,564	7.2
Total	**12,218**	**100.0**	**132,769**	**100.0**

Indicator H3 – Anthropogenic Edge to Area Ratio

Anthropogenic edge occurred adjacent to 102.5 km (6.1 km/km^2) of natural ecosites at baseline in the LSA (Table 5.3.4-11). Habitat classes with the greatest edge to area ratio included BP01, BP03, and BP19, each with a ratio >1.0 km/km^2. Among all ecosites, the ratio was 0.9 km/km^2 in the LSA. No dominant pattern in edge was apparent. The RSA had less overall edge to area ratio than the LSA, with a value of 0.8 km/km^2.

Indicator H4 - Habitat Structure

Habitat structure among ecosites is shown in Table 5.3.4-12. Mature forests have somewhat greater tree cover, and much greater tree height than regenerating forests. Graminoid cover, shrub cover, and downed wood cover are greater in regenerating forests, herb and lichen cover is similar, and moss cover is greater in mature forests. Forested wetlands are similar to mature forests, with the exception of lower mean tree height.

Table 5.3.4-11: Baseline Anthropogenic Edge to Area Ratio

Ecosite Code	LSA			RSA		
	Edge (km)	**Area (km^2)**	**Edge to Area Ratio**	**Edge (km)**	**Area (km^2)**	**Edge to Area Ratio**
BP01	3.1	1.4	2.2	39.6	16.8	2.4
BP01a	1.2	1.8	0.6	7.0	7.0	1.0
BP02	2.4	3.4	0.7	11.3	15.3	0.7
BP03	60.9	50.6	1.2	368.3	328.0	1.1
BP04	12.1	13.9	0.9	170.0	150.0	1.1
BP05	8.2	11.6	0.7	148.2	181.1	0.8
BP06	3.9	7.8	0.5	60.7	113.9	0.5
BP07	4.3	5.6	0.8	16.6	36.6	0.5
BP09	0.1	1.8	0.1	11.3	44.4	0.3
BP10	<0.1	0.2	<0.1	9.3	18.0	0.5
BP11	0.5	0.8	0.7	0.9	2.5	0.4
BP12	0.1	0.5	0.2	19.3	36.2	0.5
BP13	-	-	-	<0.1	0.1	0.7
BP14	0.5	1.4	0.3	16.0	56.4	0.3
BP15	<0.1	0.1	0.4	1.8	3.8	0.5
BP16	3.0	7.8	0.4	39.4	64.8	0.6
BP18	0.1	2.2	0.1	29.2	110.8	0.3
BP18a	0.8	1.0	0.8	4.2	7.5	0.6
BP19	<0.1	<0.1	1.1	0.2	1.2	0.1
BP23	0.0	<0.1	0.0	3.7	15.7	0.2
BP24	-	-	-	0.3	0.6	0.6
BP25	1.1	3.8	0.3	26.7	74.5	0.4
BP26	-	-	-	0.1	0.1	0.6
BP28	0.0	<0.1	0.0	2.4	12.7	0.2
Total Ecosites	*102.5*	*115.9*	*0.9*	*986.6*	*1297.9*	*0.8*
Cutbank	-	-	-	0.0	0.1	0.0
Lake	-	-	-	<0.1	2.2	<0.1
Flooded	0.0	<0.1	0.0	<0.1	0.2	0.2
River	0.0	3.7	0.0	0.0	7.7	0.0
Total Other Classes	*0.0*	*3.8*	*0.0*	*0.1*	*10.2*	*<0.1*
Total Natural Classes	**102.5**	**119.6**	**0.9**	**986.7**	**1308.2**	**0.8**

Table 5.3.4-12: Mean Habitat Structure within Ecosites

Ecosite	Maturity Class	Sample Size (Cover)	Sample Size (Height)	Tree Cover (%)	Height (m)	Herb Cover (%)	Graminoid Cover (%)	Lichen Cover (%)	Moss Cover (%)	Shrub Cover (%)	Wood Cover (%)
BP01	N/A	1	0	0	-	42	53	43	7	35	1
BP01a	N/A	1	0	0	-	19	22	6	0	43	0
BP02	Mature	6	0	32	-	20	14	64	21	45	4
BP02	Regen	29	8	39	6.9	7	13	14	1	35	8
BP03	Mature	7	3	37	18.3	21	5	5	61	56	2
BP03	Regen	15	3	33	10.0	7	27	2	8	38	4
BP04	Mature	1	1	80	20.0	175	162	25	85	263	0
BP04	Regen	8	2	31	10.0	13	10	3	5	64	4
BP05	Mature	1	0	88	-	120	14	10	7	56	0
BP05	Regen	11	3	58	8.3	16	11	1	1	63	4
BP06	Mature	13	3	58	18.3	20	3	1	1	87	4
BP06	Regen	11	5	67	9.0	14	12	0	1	92	8
BP07	Mature	2	2	60	12.5	21	36	5	4	145	11
BP07	Regen	0	0	-	-	-	-	-	-	-	-
BP09	Mature	7	3	55	20.0	33	6	2	26	80	8
BP09	Regen	3	1	20	10.0	16	10	3	18	62	11
BP10	Mature	1	0	80	-	43	2	2	15	72	10
BP10	Regen	4	4	50	12.5	28	2	2	1	66	5
BP11	Mature	2	2	30	15.0	23	3	0	1	105	26
BP11	Regen	0	0	-	-	-	-	-	-	-	-
BP12	Mature	3	0	33		52	4	2	29	82	4
BP12	Regen	0	0	-	-	-	-	-	-	-	-
BP13	Mature	4	1	60	15.0	17	15	4	24	47	5
BP13	Regen	0	0	-	-	-	-	-	-	-	-
BP14	Mature	4	0	45	-	35	9	1	42	77	2
BP14	Regen	3	1	13	5.0	22	13	4	4	86	7
BP15	Mature	3	2	60	20.0	57	12	0	16	120	2
BP15	Regen	2	1	30	5.0	43	24	1	0	55	1
BP16	Mature	1	0	60	-	89	18	2	2	111	10
BP16	Regen	7	2	49	10.0	32	17	0	0	74	5
BP17	Mature	1	0	60	-	39	5	0	0	131	1
BP17	Regen	0	0	-	-	-	-	-	-	-	-
BP18	N/A	9	5	59	13.0	15	19	2	30	72	7
BP18a	N/A	2	0		-	67	52	1	1	79	6
BP19	N/A	2	0	40	-	8	36	4	27	90	8
BP23	N/A	2	0	41	-	66	53	0	44	12	0
BP24	N/A	1	0	0	-	5	32	1	1	24	1
BP25	N/A	7	0	0	-	17	41	1	9	73	3
BP26	N/A	1	0	0	-	7	121	0	0	4	10
BP28	N/A	0	0	-	-	-	-	-	-	-	-
BP28a	N/A	2	0	0	-	79	58	0	0	63	0
Mature Forests		56	17	51	13	33	11	9	23	82	5
Regen Forests		93	30	42	9	14	15	5	3	55	6
Forested Wetlands		15	5	46	8	28	30	2	28	67	6
Shrublands		9	0	0	-	16	38	2	7	64	2
Open Meadows		3	0	0	-	69	96	14	2	55	4

Species Diversity

Indicator S1 - Species at Risk in Taxonomic Groups

Species at risk in Saskatchewan occurring within the boreal forest are listed in Appendix 5.3.4-B. Literature sources have been used to determine habitat preferences and the ecosites or landscape areas where each species is likely to occur (see Appendix 5.3.4-B). These potential occurrences were summed in each ecosite or landscape and ranked following the criteria in Table 5.3.4-13. Habitat ranks for each ecosite are shown in Table 5.3.4-14.

Table 5.3.4-13 Species at Risk Ranking Criteria

Taxonomic Group	Ranking	At Risk Species per Ecosite
Birds	Low	0-3
	Medium	4-6
	High	>6
Butterflies	Low	0-1
	Medium	2-4
	High	>4
Plants	Low	0-13
	Medium	14-27
	High	28 or more
Fish	Low	0-1
	Medium	2-4
	High	5 or more

Note: The rankings applied are relative within a group, so a high ranking for one group cannot be compared to a high rank for any other group. Also fish at risk habitats were based on data obtained for this Project for species occurring in small creeks or in the Saskatchewan River.

Table 5.3.4-14 Species at Risk Rankings by Ecosite and Landscape Classes

Ecosite Codes	Birds at Risk	Butterflies at Risk	Plants at Risk	Fish at Risk
Agriculture	Low	High	Low	Not Ranked
Baseline Disturbance	Not Ranked	Not Ranked	Not Ranked	Not Ranked
Baseline Reclaimed	Low	High	Low	Not Ranked
BP01	Medium	High	High	Not Ranked
BP01a	Medium	Medium	Medium	Not Ranked
BP02	Low	Low	Medium	Not Ranked
BP03	Low	Low	Medium	Not Ranked
BP04	Medium	Low	Medium	Not Ranked
BP05	Medium	Low	Medium	Not Ranked
BP06	Medium	Low	Medium	Not Ranked
BP07	Medium	Low	Medium	Not Ranked
BP09	High	Low	Medium	Not Ranked
BP10	High	Low	Medium	Not Ranked
BP11	High	Low	Low	Not Ranked
BP12	Medium	Low	Medium	Not Ranked
BP13	Medium	Low	Medium	Not Ranked
BP14	Medium	Low	Medium	Not Ranked
BP15	High	Low	Medium	Not Ranked
BP16	Medium	Low	Medium	Not Ranked
BP18	High	Low	High	Not Ranked
BP18a	Medium	Low	High	Not Ranked
BP19	Medium	Low	Medium	Not Ranked
BP23	High	Low	High	Not Ranked
BP24	Medium	Low	Medium	Not Ranked
BP25	Low	Low	High	Not Ranked
BP26	Low	High	High	Not Ranked
BP28	Low	Medium	High	Not Ranked
Regenerating forests	Low	Low	Low	Not Ranked
Clearing	Low	High	Low	Not Ranked
Cutbank	Medium	High	High	Not Ranked
Impact Footprint	Not Ranked	Not Ranked	Not Ranked	Not Ranked
Lake	High	Low	Low	Low
Pond	Low	Medium	High	Not Ranked
Powerline	Not Ranked	Not Ranked	Not Ranked	Not Ranked
Riparian (Non-disturbed)*	High	Medium	High	Not Ranked
Rivers (excluding Saskatchewan River)	Medium	Low	Low	Medium
Saskatchewan River	Medium	Low	Low	High

Habitats ranked high for birds at risk include mature mixedwood forests (BP09, BP10, BP11, and BP15), treed fens (BP23), and all areas within the riparian landscape and lakes. Habitats ranked high for butterflies include grassland (BP01), graminoid fens (BP26), open cutbanks, clearings, agricultural areas, and reclaimed disturbances. Habitats ranked high for plants at risk include grasslands (BP01), fen, swamp, marsh, riparian areas, and flooded areas. The only fish at risk habitat ranked high was the Saskatchewan River. These rankings were applied to the areas of each ecosite in the LSA and RSA to provide the baseline distribution of habitats for species at risk (Table 5.3.4-15, Figure 5.3.4-11).

Table 5.3.4-15: Baseline Distribution of Habitats for Species at Risk

Species Group	Ranking	LSA Baseline (ha)	LSA %	RSA Baseline (ha)	RSA %
Birds	High	1,760	14.4	27,397	20.6
	Medium	2,271	18.6	43,422	32.7
	Low	7,950	65.1	60,393	45.5
	Not Ranked	237	1.9	1,556	1.2
Butterflies	High	161	1.3	2,088	1.6
	Medium	1,597	13.1	12,020	9.1
	Low	10,223	83.7	117,105	88.2
	Not Ranked	237	1.9	1,556	1.2
Plants	High	850	7.0	23,832	18.0
	Medium	10,658	87.2	105,724	79.6
	Low	454	3.7	1,259	0.9
	Not Ranked	255	2.1	1,953	1.5
Fish	High	371	3.0	766	0.6
	Medium	1	0.0	1	0.0
	Low	0	0.0	225	0.2
	Not Ranked	11,846	97.0	131,777	99.3
Total		12,218	100.0	132,769	100.0

Indicator S2 – Species Richness

Vascular and Nonvascular Plants

The goal of this analysis was to examine vascular and non-vascular plant species observations in relation to ecosite. This information was used to rank each ecosite, on a scale from high to low, for the purposes of mapping relative vegetation species diversity in the study area.

Data from terrestrial plots obtained for this Project were used within this analysis. The assessment of vegetation diversity focussed on all vascular and non-vascular plant species, including rare species. Introduced species were also recorded. A total of 279 plots in 25 ecosite were surveyed. Of this data a total of 177 plots had detailed vegetation species and cover information and were used to examine species dominance. All plots included at least a list of species encountered and were used in the assessment of species richness. The number of plots per ecosite ranged from 1 to 44 (Table 5.3.4-16).

Table 5.3.4-16: Vegetation Survey Plots in the LSA and RSA

Ecosite Code	Ecosite Name	All Plots	Detailed Plots
BP01	June grass - mountain goldenrod grassland	4	1
BP01a	Dry shrubland	2	1
BP02	Jack pine – lichen	44	35
BP03	Jack pine – feathermoss	26	22
BP04	Jack pine - trembling aspen – feathermoss	24	9
BP05	Trembling aspen - prickly rose – grass	18	12
BP06	Trembling aspen - beaked hazel – sarsaparilla	26	24
BP07	Trembling aspen - white birch – sarsaparilla	5	2
BP09	White spruce - trembling aspen – feathermoss	16	10
BP10	Trembling aspen - white spruce - feathermoss	5	5
BP11	White birch - white spruce - balsam fir	2	2
BP12	Jack pine - spruce – feathermoss	8	3
BP13	White spruce - balsam fir – feathermoss	6	4
BP14	Black spruce - Labrador tea – feathermoss	12	7
BP15	Balsam poplar - white spruce – feathermoss	11	5
BP16	Balsam poplar - trembling aspen - prickly rose	14	8
BP17	Manitoba maple - balsam poplar - ostrich fern	2	1
BP18	Black spruce - tamarack - treed swamp	16	9
BP18a	Deciduous -mixedwood swamp	9	2
BP19	Black spruce - treed bog	2	2
BP23	Tamarack - treed fen	4	2
BP24	Leatherleaf - shrubby poor fen	1	1
BP25	Willow - shrubby rich fen	12	7
BP26	Graminoid fen	1	1
BP28a	Riparian Meadow	9	2
Total		**279**	**177**

A cross tabulation summary of vascular and non-vascular species by habitat type is shown in Appendix 5.3.4-C (Table 1). Also presented is the relative commonness of the species occurrence in each habitat, in three classes: infrequent, uncommon and common.

Total Vegetation Species Richness

Total richness is the complete number of species among all sample locations for each ecosite (Table 5.3.4-17). Total richness provides an estimate of alpha richness (i.e., richness within a class) but is highly influenced by sample size, since additional species are observed as more plots are surveyed, up until the entire possible range of species is observed in each ecosite. This is shown in Figure 5.3.4-12. Since the number of species is strongly affected by sample size, this measure is considered to be biased and is not used in the overall ranking of species richness.

Table 5.3.4-17: Total Vegetation Species Richness by Ecosite

Ecosite Code	Number of Sample Sites	Total Vascular Species	Total Non-Vascular Species	Total Species Observed
BP01	4	46	21	67
BP01a	2	50	3	53
BP02	44	139	43	182
BP03	26	132	38	170
BP04	24	145	54	199
BP05	18	154	34	188
BP06	26	99	30	129
BP07	5	68	26	94
BP09	16	139	36	175
BP10	5	70	11	81
BP11	2	36	2	38
BP12	8	108	11	119
BP13	6	118	7	125
BP14	12	127	15	142
BP15	11	169	11	180
BP16	14	142	14	156
BP17	2	60	0	60
BP18	16	110	45	155
BP18a	9	218	5	223
BP19	2	24	8	32
BP23	4	48	5	53

Ecosite Code	Number of Sample Sites	Total Vascular Species	Total Non-Vascular Species	Total Species Observed
BP24	1	19	3	22
BP25	12	134	27	161
BP26	1	16	1	17
BP28a	9	201	1	202

Mean Vegetation Species Richness

Mean richness per sample site (Table 5.3.4-18) is an unbiased estimate of species richness, as long as the number of sample sites is high enough to provide a confident mean. Typically, high confidence is achieved when the number of sample sites per habitat type is greater than five.

Ranking species richness provides the relative level of species richness among ecosites. Rank values cannot be compared to rank values from other study areas since they are based on different sets of data. Mean vegetation species richness was ranked using the following criteria based on the percentile ranks >67% (High), <67% and >33% (Medium) and <33% (Low) among ecosites.

For vascular species:

- High ≥15.00 species/plot
- Medium 11.00 to 14.99 species/plot

Low 0 to 10.99 species/plot

For non-vascular species:

- High ≥2.20 species/plot
- Medium 1.10 to 2.20 species/plot

Low <1.10 species/plot

Table 5.3.4-18: Mean Vegetation Species Richness by Habitat Class

Ecosite Code	Mean Vascular Species	Ranking	Mean Non-Vascular Species	Ranking
BP01	11.50	Medium	5.25	High
BP01a	25.00	High	1.50	Medium
BP02	3.16	Low	0.98	Low
BP03	5.08	Low	1.46	Medium
BP04	6.04	Low	2.25	High
BP05	8.56	Low	1.89	Medium
BP06	3.81	Low	1.15	Medium
BP07	13.6	Medium	5.20	High
BP09	8.69	Low	2.25	High
BP10	14.00	Medium	2.20	High
BP11	18.00	High	1.00	Low
BP12	13.50	Medium	1.38	Medium
BP13	19.67	High	1.17	Medium
BP14	10.58	Low	1.25	Medium
BP15	15.36	High	1.00	Low
BP16	10.14	Low	1.00	Low
BP17	30.00	High	0	Low
BP18	6.88	Low	2.81	High
BP18a	24.22	High	0.56	Low
BP19	12.00	Medium	4.00	High
BP23	12.00	Medium	1.25	Medium
BP24	19.00	High	3.00	High
BP25	11.17	Medium	2.25	High
BP26	16.00	High	1.00	Low
BP28a	22.33	High	0.11	Low

Unique and Rare Vegetation Species Richness

Unique species are those that occur only within a single ecosite (Appendix 5.3.4-C: Table 2). They are considered important species since they may be more vulnerable if habitat of a single type is affected by development. A total of 177 species (134 vascular and 43 nonvascular) were unique to a single habitat (after removing non-native and nonidentified species from the total). Ecosite BP28 (seaside arrow-grass marsh) had the highest number of unique species.

Rare species include those listed by the SKCDC, from ranking levels S1 (most rare) to S4 (least rare). A total of 59 rare vascular plant species and 70 rare non-vascular plant species were recorded (See Appendix 5.3.4-C: Table 2). The total unique and rare species among habitats were used to rank the importance of habitats to maintain species richness (Table 5.3.4-19). The ranking was based on the count of all unique and sensitive species by class. Note that where the same species were both unique and rare within the same ecosite, they were counted only once. Note also that species found in both lists were only counted once. Species of each group were totalled and ranked, using the following criteria:

- High ≥7 species
- Medium 3 to 6 species

Low 0 to 2 species

Table 5.3.4-19: Unique and Rare Plant Species Richness by Habitat

	Vascular					Nonvascular				
Ecosite Code	**Unique Species**	**Rare Species**	**Unique and Rare**	**Total[1]**	**Ranking**	**Unique Species**	**Rare Species**	**Unique and Rare**	**Total[1]**	**Ranking**
BP01	2	1	0	3	Medium	3	6	-1	8	High
BP01a	2	1	0	3	Medium	0	0	0	0	Low
BP02	8	6	0	14	High	4	7	-1	10	High
BP03	1	4	0	5	Medium	2	7	-1	8	High
BP04	3	5	-1	7	High	4	15	-3	16	High
BP05	6	4	0	10	High	1	7	0	8	High
BP06	1	2	0	3	Medium	8	4	-4	8	High
BP07	0	0	0	0	Low	2	7	-1	8	High
BP09	5	6	-2	9	High	2	8	-1	9	High
BP10	1	1	0	2	Low	0	1	0	1	Low
BP11	0	0	0	0	Low	0	0	0	0	Low
BP12	4	1	0	5	Medium	0	0	0	0	Low
BP13	3	2	-1	4	Medium	0	0	0	0	Low
BP14	3	1	0	4	Medium	0	0	0	0	Low
BP15	8	1	0	9	High	0	0	0	0	Low
BP16	2	1	0	3	Medium	0	1	0	1	Low
BP17	2	1	0	3	Medium	0	0	0	0	Low
BP18	2	8	-1	9	High	7	6	-2	11	High
BP18a	26	8	-6	28	High	0	0	0	0	Low
BP19	0	0	0	0	Low	0	0	0	0	Low
BP23	4	2	-1	5	Medium	0	0	0	0	Low
BP24	2	0	0	2	Low	0	0	0	0	Low
BP25	9	1	0	10	High	9	1	-2	8	High
BP26	0	0	0	0	Low	1	0	0	1	Low
BP28a	40	3	-2	41	High	0	0	0	0	Low

Note: 1: Total = Unique + Rare + (Unique and Rare) columns.

Vegetation Community Similarity

Communities sharing a large number of species with other communities are less unique, and less important in terms of maintaining a unique set of species when compared to other communities. Conversely, communities with fewer shared species are more important for maintaining species richness, because they maintain more species not found in other classes. Community similarity was assessed and compared by use of the Sorensen similarity index, which compares each community (ecosite) to each other community in a pair-wise manner. The index value is computed as:

$$2C / (A + B),$$

where: A = Number of species in the first habitat
B = Number of species in the second habitat
C = Shared species

Vegetation index values were computed using plant observations for each ecosite, for each of vascular (Table 5.3.4-20) and nonvascular (Table 5.3.4-21) species. Similarities ranged from 0.00 to 0.88 among habitats, and habitats with species similarity of 0.50 or higher were considered to have a high number of shared species. The habitats were then ranked using the following criteria:

- High 0-2 habitats with high number of shared species;
- Medium 3-6 habitats with high number of shared species; and

Low 7-16 habitats with a high number of shared species.

Table 5.3.4-20: Vascular Plant Similarity Matrix by Ecosite Class

Ecosite	BP 01	BP 01a	BP 02	BP 03	BP 04	BP 05	BP 06	BP 07	BP 09	BP 10	BP 11	BP 12	BP 13	BP 14	BP 15	BP 16	BP 17	BP 18	BP 18a	BP 19	BP 23	BP 24	BP 25	BP 26	BP 28a	# > 0.5
BP01	1.00	0.47	0.43	0.41	0.37	0.30	0.27	0.27	0.28	0.29	0.18	0.38	0.27	0.34	0.21	0.22	0.31	0.18	0.17	0.07	0.05	0.03	0.18	0.04	0.21	0
BP01a	0.47	1.00	0.45	0.40	0.42	0.35	0.25	0.24	0.27	0.21	0.15	0.34	0.24	0.31	0.19	0.21	0.20	0.15	0.13	0.03	0.05	0.03	0.11	0.03	0.21	0
BP02	0.43	0.45	1.00	0.69	0.73	0.60	0.54	0.46	0.52	0.44	0.28	0.57	0.47	0.52	0.48	0.48	0.34	0.38	0.38	0.08	0.07	0.04	0.37	0.10	0.40	7
BP03	0.41	0.40	0.69	1.00	0.71	0.62	0.61	0.51	0.67	0.53	0.33	0.66	0.59	0.63	0.58	0.56	0.41	0.48	0.42	0.16	0.19	0.07	0.45	0.10	0.39	12
BP04	0.37	0.42	0.73	0.71	1.00	0.66	0.59	0.50	0.61	0.54	0.34	0.65	0.56	0.60	0.55	0.56	0.37	0.46	0.42	0.12	0.13	0.04	0.41	0.08	0.43	11
BP05	0.30	0.35	0.60	0.62	0.66	1.00	0.64	0.53	0.65	0.49	0.37	0.61	0.59	0.62	0.61	0.61	0.40	0.50	0.51	0.10	0.15	0.05	0.52	0.09	0.47	13
BP06	0.27	0.25	0.54	0.61	0.59	0.64	1.00	0.64	0.67	0.61	0.54	0.66	0.70	0.61	0.65	0.71	0.52	0.59	0.46	0.11	0.18	0.07	0.51	0.17	0.39	16
BP07	0.27	0.24	0.46	0.51	0.50	0.53	0.64	1.00	0.57	0.60	0.60	0.57	0.56	0.53	0.51	0.52	0.38	0.53	0.38	0.17	0.13	0.07	0.42	0.15	0.32	12
BP09	0.28	0.27	0.52	0.67	0.61	0.65	0.67	0.57	1.00	0.58	0.42	0.68	0.67	0.65	0.72	0.71	0.43	0.58	0.53	0.12	0.20	0.08	0.53	0.13	0.43	15
BP10	0.29	0.21	0.44	0.53	0.54	0.49	0.61	0.60	0.58	1.00	0.53	0.60	0.59	0.58	0.51	0.56	0.50	0.55	0.35	0.17	0.15	0.08	0.49	0.11	0.30	12
BP11	0.18	0.15	0.28	0.33	0.34	0.37	0.54	0.60	0.42	0.53	1.00	0.44	0.49	0.39	0.36	0.42	0.39	0.39	0.25	0.11	0.08	0.11	0.31	0.20	0.24	3
BP12	0.38	0.34	0.57	0.66	0.65	0.61	0.66	0.57	0.68	0.60	0.44	1.00	0.65	0.64	0.59	0.60	0.47	0.51	0.41	0.17	0.18	0.05	0.48	0.10	0.38	13
BP13	0.27	0.24	0.47	0.59	0.56	0.59	0.70	0.56	0.67	0.59	0.49	0.65	1.00	0.61	0.69	0.69	0.42	0.63	0.46	0.17	0.24	0.10	0.48	0.13	0.40	12
BP14	0.34	0.31	0.52	0.63	0.60	0.62	0.61	0.53	0.65	0.58	0.39	0.64	0.61	1.00	0.62	0.62	0.46	0.62	0.50	0.23	0.28	0.13	0.53	0.11	0.42	14
BP15	0.21	0.19	0.48	0.58	0.55	0.61	0.65	0.51	0.72	0.51	0.36	0.59	0.69	0.62	1.00	0.76	0.40	0.58	0.57	0.16	0.22	0.10	0.56	0.11	0.46	14
BP16	0.22	0.21	0.48	0.56	0.56	0.61	0.71	0.52	0.71	0.56	0.42	0.60	0.69	0.62	0.76	1.00	0.50	0.62	0.57	0.15	0.19	0.11	0.57	0.14	0.45	14
BP17	0.31	0.20	0.34	0.41	0.37	0.40	0.52	0.38	0.43	0.50	0.39	0.47	0.42	0.46	0.40	0.50	1.00	0.38	0.33	0.08	0.12	0.11	0.40	0.14	0.34	1
BP18	0.18	0.15	0.38	0.48	0.46	0.50	0.59	0.53	0.58	0.55	0.39	0.51	0.63	0.62	0.58	0.62	0.38	1.00	0.50	0.29	0.41	0.17	0.52	0.14	0.32	10
BP18a	0.17	0.13	0.38	0.42	0.42	0.51	0.46	0.38	0.53	0.35	0.25	0.41	0.46	0.50	0.57	0.57	0.33	0.50	1.00	0.13	0.25	0.12	0.54	0.12	0.54	6
BP19	0.07	0.03	0.08	0.16	0.12	0.10	0.11	0.17	0.12	0.17	0.11	0.17	0.17	0.23	0.16	0.15	0.08	0.29	0.13	1.00	0.44	0.11	0.15	0.00	0.04	0
BP23	0.05	0.05	0.07	0.19	0.13	0.15	0.18	0.13	0.20	0.15	0.08	0.18	0.24	0.28	0.22	0.19	0.12	0.41	0.25	0.44	1.00	0.26	0.26	0.10	0.09	0
BP24	0.03	0.03	0.04	0.07	0.04	0.05	0.07	0.07	0.08	0.08	0.11	0.05	0.10	0.13	0.10	0.11	0.11	0.17	0.12	0.11	0.26	1.00	0.10	0.19	0.06	0
BP25	0.18	0.11	0.37	0.45	0.41	0.52	0.51	0.42	0.53	0.49	0.31	0.48	0.48	0.53	0.56	0.57	0.40	0.52	0.54	0.15	0.26	0.10	1.00	0.14	0.38	8

Ecosite	BP 01	BP 01a	BP 02	BP 03	BP 04	BP 05	BP 06	BP 07	BP 09	BP 10	BP 11	BP 12	BP 13	BP 14	BP 15	BP 16	BP 17	BP 18	BP 18a	BP 19	BP 23	BP 24	BP 25	BP 26	BP 28a	# > 0.5
BP26	0.04	0.03	0.10	0.10	0.08	0.09	0.17	0.15	0.13	0.11	0.20	0.10	0.13	0.11	0.11	0.14	0.14	0.14	0.12	0.00	0.10	0.19	0.14	1.00	0.09	0
BP28a	0.21	0.21	0.40	0.39	0.43	0.47	0.39	0.32	0.43	0.30	0.24	0.38	0.40	0.42	0.46	0.45	0.34	0.32	0.54	0.04	0.09	0.06	0.38	0.09	1.00	1

Table 5.3.4-21: Non-Vascular Plant Similarity Matrix by Ecosite Class

Ecosite	BP 01	BP 01a	BP 02	BP 03	BP 04	BP 05	BP 06	BP 07	BP 09	BP 10	BP 11	BP 12	BP 13	BP 14	BP 15	BP 16	BP 17	BP 18	BP 18a	BP 19	BP 23	BP 24	BP 25	BP 26	BP 28a	# > 0.5
BP01	1.00	0.00	0.49	0.33	0.36	0.39	0.23	0.20	0.38	0.40	0.00	0.32	0.18	0.37	0.23	0.21	0.00	0.26	0.18	0.27	0.10	0.10	0.10	0.00	0.00	0
BP01a	0.00	1.00	0.06	0.07	0.04	0.07	0.08	0.00	0.07	0.25	0.00	0.00	0.00	0.20	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
BP02	0.49	0.06	1.00	0.68	0.53	0.57	0.37	0.42	0.49	0.29	0.00	0.33	0.21	0.41	0.33	0.26	0.00	0.46	0.15	0.21	0.11	0.05	0.17	0.00	0.00	3
BP03	0.33	0.07	0.68	1.00	0.64	0.59	0.40	0.58	0.57	0.32	0.00	0.38	0.24	0.41	0.37	0.34	0.00	0.52	0.18	0.24	0.12	0.06	0.19	0.00	0.00	6
BP04	0.36	0.04	0.53	0.64	1.00	0.58	0.47	0.54	0.62	0.26	0.00	0.26	0.15	0.32	0.25	0.34	0.00	0.51	0.12	0.15	0.08	0.04	0.34	0.00	0.00	6
BP05	0.39	0.07	0.57	0.59	0.58	1.00	0.42	0.60	0.52	0.34	0.00	0.40	0.25	0.49	0.33	0.31	0.00	0.44	0.19	0.25	0.13	0.07	0.24	0.00	0.00	5
BP06	0.23	0.08	0.37	0.40	0.47	0.42	1.00	0.43	0.44	0.31	0.00	0.25	0.21	0.29	0.30	0.39	0.00	0.27	0.21	0.21	0.07	0.07	0.38	0.00	0.00	0
BP07	0.20	0.00	0.42	0.58	0.54	0.60	0.43	1.00	0.50	0.14	0.00	0.35	0.23	0.32	0.20	0.36	0.00	0.42	0.15	0.15	0.16	0.00	0.36	0.00	0.00	3
BP09	0.38	0.07	0.49	0.57	0.62	0.52	0.44	0.50	1.00	0.38	0.00	0.32	0.24	0.36	0.37	0.24	0.00	0.43	0.18	0.24	0.12	0.06	0.15	0.00	0.00	3
BP10	0.40	0.25	0.29	0.32	0.26	0.34	0.31	0.14	0.38	1.00	0.00	0.57	0.55	0.63	0.67	0.22	0.00	0.24	0.36	0.73	0.40	0.22	0.00	0.00	0.00	5
BP11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
BP12	0.32	0.00	0.33	0.38	0.26	0.40	0.25	0.35	0.32	0.57	0.00	1.00	0.73	0.88	0.67	0.44	0.00	0.29	0.36	0.73	0.40	0.22	0.00	0.00	0.00	5
BP13	0.18	0.00	0.21	0.24	0.15	0.25	0.21	0.23	0.24	0.55	0.00	0.73	1.00	0.62	0.67	0.40	0.00	0.21	0.50	0.75	0.57	0.33	0.00	0.00	0.00	6
BP14	0.37	0.20	0.41	0.41	0.32	0.49	0.29	0.32	0.36	0.63	0.00	0.88	0.62	1.00	0.71	0.40	0.00	0.32	0.31	0.62	0.33	0.18	0.00	0.00	0.00	5
BP15	0.23	0.22	0.33	0.37	0.25	0.33	0.30	0.20	0.37	0.67	0.00	0.67	0.67	0.71	1.00	0.42	0.00	0.28	0.50	0.67	0.36	0.40	0.07	0.00	0.00	5
BP16	0.21	0.00	0.26	0.34	0.34	0.31	0.39	0.36	0.24	0.22	0.00	0.44	0.40	0.40	0.42	1.00	0.00	0.39	0.40	0.27	0.14	0.31	0.29	0.00	0.00	0
BP17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
BP18	0.26	0.00	0.46	0.52	0.51	0.44	0.27	0.42	0.43	0.24	0.00	0.29	0.21	0.32	0.28	0.39	0.00	1.00	0.15	0.21	0.16	0.11	0.24	0.00	0.00	2
BP18a	0.18	0.00	0.15	0.18	0.12	0.19	0.21	0.15	0.18	0.36	0.00	0.36	0.50	0.31	0.50	0.40	0.00	0.15	1.00	0.25	0.29	0.33	0.07	0.00	0.00	0
BP19	0.27	0.00	0.21	0.24	0.15	0.25	0.21	0.15	0.24	0.73	0.00	0.73	0.75	0.62	0.67	0.27	0.00	0.21	0.25	1.00	0.57	0.33	0.00	0.00	0.00	6
BP23	0.10	0.00	0.11	0.12	0.08	0.13	0.07	0.16	0.12	0.40	0.00	0.40	0.57	0.33	0.36	0.14	0.00	0.16	0.29	0.57	1.00	0.00	0.00	0.00	0.00	2
BP24	0.10	0.00	0.05	0.06	0.04	0.07	0.07	0.00	0.06	0.22	0.00	0.22	0.33	0.18	0.40	0.31	0.00	0.11	0.33	0.33	0.00	1.00	0.08	0.00	0.00	0

Ecosite	BP 01	BP 01a	BP 02	BP 03	BP 04	BP 05	BP 06	BP 07	BP 09	BP 10	BP 11	BP 12	BP 13	BP 14	BP 15	BP 16	BP 17	BP 18	BP 18a	BP 19	BP 23	BP 24	BP 25	BP 26	BP 28a	# > 0.5
BP25	0.10	0.00	0.17	0.19	0.34	0.24	0.38	0.36	0.15	0.00	0.00	0.00	0.00	0.00	0.07	0.29	0.00	0.24	0.07	0.00	0.00	0.08	1.00	0.00	0.00	0
BP26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0
BP28a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0

Overall Ranking of Vegetation Species Richness

Overall vegetation richness was ranked from low to high based on a combination of the three rankings for mean species richness (MR), unique/sensitive species richness (UR), and community similarity (CS) (Table 5.3.4-22). The ranking was determined by first converting each component rank to a numerical score: low = 1; medium = 2; and high = 3. The total of these values was calculated and re-ranked into an overall score based on the following criteria:

- High: total score >7
- Medium: total score = 5 to 7

Low: total score = 3 to 4

These results were summarized by habitat type (Table 5.3.4-23) and mapped in the LSA (Figures 5.3.4-13 and 5.3.4-14).

Table 5.3.4-22: Vascular Plant Richness Summary Ranking

Ecosite Code	Vascular					Nonvascular				
	MR[1]	UR[2]	CS[3]	Score	Overall Richness Rank	MR	UR	CS	Score	Overall Richness Rank
BP01	2	2	3	7	Medium	3	3	3	9	High
BP01a	3	2	3	8	High	2	1	3	6	Medium
BP02	1	3	1	5	Medium	1	3	2	6	Medium
BP03	1	2	1	4	Low	2	3	2	7	Medium
BP04	1	3	1	5	Medium	3	3	2	8	High
BP05	1	3	1	5	Medium	2	3	2	7	Medium
BP06	1	2	1	4	Low	2	3	3	8	High
BP07	2	1	1	4	Low	3	3	2	8	High
BP09	1	3	1	5	Medium	3	3	2	8	High
BP10	2	1	1	4	Low	3	1	2	6	Medium
BP11	3	1	2	6	Medium	1	1	3	5	Medium
BP12	2	2	1	5	Medium	2	1	2	5	Medium
BP13	3	2	1	6	Medium	2	1	1	4	Low
BP14	1	2	1	4	Low	2	1	2	5	Medium
BP15	3	3	1	7	Medium	1	1	2	4	Low
BP16	1	2	1	4	Low	1	1	3	5	Medium
BP17	3	2	2	7	Medium	1	1	3	5	Medium
BP18	1	3	1	5	Medium	3	3	3	9	High
BP18a	3	3	1	7	Medium	1	1	3	5	Medium
BP19	2	1	3	6	Medium	3	1	2	6	Medium
BP23	2	2	3	7	Medium	2	1	3	6	Medium
BP24	3	1	3	7	Medium	3	1	3	7	Medium
BP25	2	3	1	6	Medium	3	3	3	9	High
BP26	3	1	3	7	Medium	1	1	3	5	Medium
BP28a	3	3	3	9	High	1	1	3	5	Medium

Note: [1] Mean species richness;
[2] Unique/sensitive species richness;
[3] Community similarity.

Table 5.3.4-23: Plant Species Richness Habitat Area Summary

Species Group	Ranking	LSA Baseline (ha)	LSA %	RSA Baseline (ha)	RSA %
Vascular Plants	High	819	6.7	11,889	9.0
	Medium	1,816	14.9	36,967	27.8
	Low	9,345	76.5	82,025	61.8
	Not Ranked	238	1.9	1,888	1.4
Nonvascular Plants	High	1,514	12.4	34,834	26.2
	Medium	8,164	66.8	69,497	52.3
	Low	2,302	18.8	26,550	20.0
	Not Ranked	238	1.9	1,888	1.4
Grand Total		**12,218**	**100.0**	**132,769**	**100.0**

Breeding Birds

Bird species were assessed within habitat classes. Habitat classes were defined based on overstorey tree species, site moisture and stand age (mature vs. regenerating). Bird species observations were used to rank each habitat type, on a scale from high to low, for the purposes of mapping relative bird diversity in the LSA. Data from terrestrial point count locations obtained for this Project were used in the analysis.

The assessment of breeding birds focussed on breeding pairs within each habitat. To be considered for analysis, species needed to be positively identified by song or visually. Only species recorded within 50 m of the plot centre were analyzed to ensure the observations were representative of the habitat condition at each plot.

A total of 117 point count plots were conducted. The number of plots per habitat ranged from 3 to 12 (Table 5.3.4-24). One sample point could not be placed into a habitat type (i.e., unclassified) and was not analysed.

A cross tabulation summary of bird species by habitat type is shown in Table 3 in Appendix 5.3.4-C. Also shown is the relative commonness of the species occurrence in each habitat, in three classes: infrequent, uncommon, and common.

Table 5.3.4-24: Breeding Bird Survey Points

Habitat Classes	Total Plots by Habitat
Dry Pine	8
Dry Pine (Regenerating)	10
Dry Shrubland/Grassland	3
Mesic Pine	6
Mesic Pine (Regenerating)	10
Pine-Aspen	6
Dry Aspen	5
Mesic Aspen	12
Mesic Aspen (Regenerating)	3
Aspen-White Spruce	5
Moist Aspen	5
Balsam Poplar	4
Balsam Poplar-White Spruce	3
White Spruce	4
Shrubland	3
White Spruce-Black Spruce	4
Treed Poor Fen	3
Treed Rich Fen	5
Shrubby Fen	3
Deciduous Swamp	3
Shrubby Swamp	7
Marsh	4
Unclassified	1
Total	**117**

Total Bird Species Richness

Total richness is the complete number of species among all sample locations for each habitat type (Table 5.3.4-25). It provides an estimate of alpha richness (i.e., richness within a class) but is highly influenced by sample size, since additional species are observed as more plots are surveyed, up until the entire possible range of species is observed in each ecosite. This measure is considered to be strongly biased and was not used in the overall ranking of species richness.

Table 5.3.4-25: Total Breeding Bird Species Richness by Habitat Classes

Habitat Classes	Number of Sample Sites	Total Species Observed
Dry Pine	8	13
Dry Pine (Regenerating)	10	12
Dry Shrubland/Grassland	3	6
Mesic Pine	6	9
Mesic Pine (Regenerating)	10	10
Pine-Aspen	6	13
Dry Aspen	5	9
Mesic Aspen	12	13
Mesic Aspen (Regenerating)	3	8
Aspen-White Spruce	5	13
Moist Aspen	5	13
Balsam Poplar	4	13
Balsam Poplar-White Spruce	3	7
White Spruce	4	7
Shrubland	3	9
White Spruce-Black Spruce	4	9
Treed Poor Fen	3	3
Treed Rich Fen	5	8
Shrubby Fen	3	7
Deciduous Swamp	3	7
Shrubby Swamp	7	13
Marsh	4	14

Mean Bird Species Richness

Mean richness per sample site is an unbiased estimate of species richness, as long as the number of sample sites is high enough to provide a confident mean (Table 5.3.4-26). Typically, high confidence is achieved when the total number of sample sites per habitat type is greater than five, although three plots for birds are considered adequate.

Ranking species richness provides the relative level of species richness among habitat classes. Rank values cannot be compared to rank values from other study areas since they are based on different sets of data. Mean bird species richness was ranked using the following criteria:

- High more than 2.3 species/plot;
- Medium 1.6 to 2.3 species/plot; and

Low less than 1.6 species/plot.

Table 5.3.4-26: Mean Breeding Bird Species Richness by Habitat Class

Habitat Classes	Mean Species per Sample Site	Ranking
Dry Pine	1.63	Medium
Dry Pine (Regenerating)	1.20	Low
Dry Shrubland/Grassland	2.00	Medium
Mesic Pine	1.50	Low
Mesic Pine (Regenerating)	1.00	Low
Pine-Aspen	2.17	Medium
Dry Aspen	1.80	Medium
Mesic Aspen	1.08	Low
Mesic Aspen (Regenerating)	2.67	High
Aspen-White Spruce	2.60	High
Moist Aspen	2.60	High
Balsam Poplar	3.25	High
Balsam Poplar-White Spruce	2.33	High
White Spruce	1.75	Medium
Shrubland	3.00	High
White Spruce-Black Spruce	2.25	Medium
Treed Poor Fen	1.00	Low
Treed Rich Fen	1.60	Medium
Shrubby Fen	2.33	High

Habitat Classes	Mean Species per Sample Site	Ranking
Deciduous Swamp	2.33	High
Shrubby Swamp	1.86	Medium
Marsh	3.50	High

Unique and Sensitive Bird Species Richness

Unique bird species are those occurring only within a single habitat type. These bird species are considered important species, since they may be more vulnerable if habitat of a single type is affected by development. A total of 28 species in this study were unique to a single habitat. Habitat class marsh, had the highest number of unique species. Unique species by habitat type included the following:

- Dry Pine Cedar waxwing;
- Fresh Pine Brown creeper;
- Fresh Pine Regenerating Barn swallow, northern flicker, and turkey vulture;
- Pine-Aspen Black-and-white warbler;
- Mesic Aspen Red-tailed hawk;
- Mesic Aspen Regenerating Cooper's hawk;
- Aspen-White Spruce Gray jay;
- Balsam Poplar Eastern phoebe, gray catbird, ring-billed gull, and rose-breasted grosbeak;
- Balsam Poplar-White Spruce Red-breasted nuthatch and white-breasted nuthatch;
- White Spruce Evening grosbeak;
- Dry Shrubland/Grassland Mountain bluebird;
- Treed Rich Fen Tennessee warbler and winter wren;
- Shrubby Swamp Marsh wren, red-necked grebe, ruddy duck, and sora; and

Marsh Belted kingfisher, Brewer's blackbird, common merganser, olive-sided flycatcher, and red-winged blackbird.

Sensitive species include those listed by the SKCDC as rare species, from ranking levels S1 (most rare) to S4 (least rare). Two sensitive bird species, among two habitat classes, were recorded in this study:

- one turkey vulture in regenerating mesic pine; and two Cooper's hawks in regenerating mesic aspen .

The total unique and sensitive bird species among habitats were used to rank the importance of habitats to maintain species richness (Table 5.3.4-27). The ranking was based on the count of all unique and sensitive species by class. Species found in both lists were only counted once. They were totalled and ranked, using the following criteria:

- High 4-5 species;
- Medium 2-3 species; and

Low 0-1 species.

Table 5.3.4-27: Unique and Sensitive Breeding Bird Species Richness by Habitat Class

Habitat Classes	Total Unique and Sensitive Species	Ranking
Dry Pine	1	Low
Dry Pine (Regenerating)	0	Low
Dry Shrubland/Grassland	1	Low
Mesic Pine	1	Low
Mesic Pine (Regenerating)	3	Medium
Pine-Aspen	1	Low
Dry Aspen	0	Low
Mesic Aspen	0	Low
Mesic Aspen (Regenerating)	0	Low
Aspen-White Spruce	0	Low
Moist Aspen	0	Low
Balsam Poplar	4	High
Balsam Poplar-White Spruce	2	Medium
White Spruce	1	Low
Shrubland	0	Low
White Spruce-Black Spruce	0	Low
Treed Poor Fen	0	Low
Treed Rich Fen	2	Medium
Shrubby Fen	0	Low
Deciduous Swamp	0	Low
Shrubby Swamp	4	High
Marsh	5	High

Bird Community Similarity

Communities sharing a large number of species with other communities are considered to be less unique, and are less important in terms of maintaining species richness within a defined area. Conversely, communities with fewer shared species are more important for maintaining species richness. Community similarity was assessed and compared by use of the Sorensen similarity index, which compares each bird community (habitat type) to each other community in a pairwise manner. The index value is computed as:

$$2C / (A + B),$$

where:
A = Number of species in the first habitat
B = Number of species in the second habitat
C = Shared species

Community index values were computed using all bird observations for each habitat type. The index values comparing habitats are shown in Table 5.3.4-28. Similarities ranged from 0.00 to 0.69 among habitats, and habitats with species similarity of 0.50 or higher had a high number of shared species. The habitats were then ranked using the following criteria:

- High 0-2 habitats with high number of shared species;
- Medium 3-4 habitats with high number of shared species; and

Low 5 or more habitats with a high number of shared species.

Table 5.3.4-28: Community Similarity Matrix by Habitat Type

Ecosite	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	# > 0.5
A. Dry Pine	1.00	0.64	0.21	0.55	0.35	0.54	0.36	0.54	0.38	0.69	0.38	0.31	0.30	0.40	0.64	0.27	0.25	0.29	0.50	0.30	0.31	0.22	6
B. Dry Pine (Regen)	0.64	1.00	0.33	0.57	0.36	0.56	0.48	0.48	0.20	0.64	0.48	0.32	0.32	0.32	0.48	0.38	0.40	0.40	0.32	0.42	0.24	0.23	4
C. Dry Shrubland/ Grassland	0.21	0.33	1.00	0.27	0.50	0.42	0.53	0.21	0.14	0.21	0.42	0.32	0.31	0.31	0.27	0.40	0.22	0.14	0.31	0.31	0.32	0.30	1
D. Mesic Pine	0.55	0.57	0.27	1.00	0.42	0.55	0.33	0.45	0.35	0.64	0.45	0.27	0.38	0.50	0.67	0.22	0.50	0.47	0.38	0.38	0.27	0.17	5
E. Mesic Pine (Regen)	0.35	0.36	0.50	0.42	1.00	0.43	0.42	0.35	0.22	0.35	0.43	0.35	0.35	0.35	0.32	0.32	0.15	0.22	0.35	0.47	0.35	0.33	0
F. Pine-Aspen	0.54	0.56	0.42	0.55	0.43	1.00	0.55	0.62	0.38	0.54	0.69	0.31	0.50	0.30	0.45	0.36	0.25	0.29	0.30	0.30	0.38	0.30	7
G. Dry Aspen	0.36	0.48	0.53	0.33	0.42	0.55	1.00	0.36	0.35	0.27	0.45	0.45	0.25	0.38	0.33	0.33	0.17	0.24	0.25	0.38	0.45	0.52	3
H. Mesic Aspen	0.54	0.48	0.21	0.45	0.35	0.62	0.36	1.00	0.38	0.54	0.62	0.38	0.50	0.40	0.45	0.36	0.13	0.19	0.40	0.30	0.31	0.30	4
I. Mesic Aspen (Regen)	0.38	0.20	0.14	0.35	0.22	0.38	0.35	0.38	1.00	0.29	0.38	0.19	0.27	0.27	0.35	0.24	0.00	0.13	0.13	0.13	0.19	0.27	0
J. Aspen-White Spruce	0.69	0.64	0.21	0.64	0.35	0.54	0.27	0.54	0.29	1.00	0.54	0.31	0.40	0.50	0.64	0.45	0.38	0.38	0.50	0.50	0.31	0.22	7
K. Moist Aspen	0.38	0.48	0.42	0.45	0.43	0.69	0.45	0.62	0.38	0.54	1.00	0.46	0.50	0.40	0.45	0.64	0.13	0.19	0.40	0.40	0.38	0.37	4
L. Balsam Poplar	0.31	0.32	0.32	0.27	0.35	0.31	0.45	0.38	0.19	0.31	0.46	1.00	0.20	0.40	0.36	0.55	0.00	0.10	0.30	0.30	0.38	0.44	1
M. Poplar-White Spruce	0.30	0.32	0.31	0.38	0.35	0.50	0.25	0.50	0.27	0.40	0.50	0.20	1.00	0.14	0.25	0.25	0.20	0.13	0.14	0.14	0.10	0.19	0
N. White Spruce	0.40	0.32	0.31	0.50	0.35	0.30	0.38	0.40	0.27	0.50	0.40	0.40	0.14	1.00	0.63	0.50	0.20	0.27	0.57	0.57	0.50	0.38	3
O. Shrubland	0.27	0.38	0.40	0.22	0.32	0.36	0.33	0.36	0.24	0.45	0.64	0.55	0.25	0.50	0.33	1.00	0.00	0.12	0.38	0.50	0.45	0.52	3
P. White-Black Spruce	0.64	0.48	0.27	0.67	0.32	0.45	0.33	0.45	0.35	0.64	0.45	0.36	0.25	0.63	1.00	0.33	0.50	0.47	0.50	0.50	0.36	0.26	4
Q. Treed Poor Fen	0.25	0.40	0.22	0.50	0.15	0.25	0.17	0.13	0.00	0.38	0.13	0.00	0.20	0.20	0.50	0.00	1.00	0.55	0.20	0.40	0.00	0.00	1
R. Treed Rich Fen	0.29	0.40	0.14	0.47	0.22	0.29	0.24	0.19	0.13	0.38	0.19	0.10	0.13	0.27	0.47	0.12	0.55	1.00	0.40	0.40	0.10	0.09	1
S. Shrubby Fen	0.50	0.32	0.31	0.38	0.35	0.30	0.25	0.40	0.13	0.50	0.40	0.30	0.14	0.57	0.50	0.38	0.20	0.40	1.00	0.57	0.40	0.29	2
T. Deciduous Swamp	0.30	0.42	0.31	0.38	0.47	0.30	0.38	0.30	0.13	0.50	0.40	0.30	0.14	0.57	0.50	0.50	0.40	0.40	0.57	1.00	0.40	0.29	2
U. Shrubby Swamp	0.31	0.24	0.32	0.27	0.35	0.38	0.45	0.31	0.19	0.31	0.38	0.38	0.10	0.50	0.36	0.45	0.00	0.10	0.40	0.40	1.00	0.44	0
V. Marsh	0.22	0.23	0.30	0.17	0.33	0.30	0.52	0.30	0.27	0.22	0.37	0.44	0.19	0.38	0.26	0.52	0.00	0.09	0.29	0.29	0.44	1.00	2

Overall Ranking of Breeding Bird Species Richness

Overall breeding bird richness was ranked from low to high based on a combination of the three rankings for mean species richness, unique/sensitive species richness, and community similarity (Table 5.3.4-29). The ranking was determined by first converting each component rank to a numerical score: low = 1; medium = 2; and high = 3. The total of these values was determined and re-ranked into an overall score based on the following criteria:

- High: total score = 8-9
- Medium: total score = 5-7

Low: total score = 3-4

Results are summarized by habitat type (Table 5.3.4-30) and mapped in the LSA (Figure 5.3.4-15).

Table 5.3.4-29: Breeding Bird Richness Summary Ranking

Habitat Classes	Mean Species Richness	Unique and Sensitive Richness	Community Similarity	Score	Overall Breeding Bird Richness
Dry Pine	2	1	1	4	Low
Dry Pine (Regenerating)	1	1	2	4	Low
Dry Shrubland/Grassland	2	1	3	6	Medium
Mesic Pine	1	1	1	3	Low
Mesic Pine (Regenerating)	1	2	3	6	Medium
Pine-Aspen	2	1	1	4	Low
Dry Aspen	2	1	2	5	Medium
Mesic Aspen	1	1	2	4	Low
Mesic Aspen (Regenerating)	3	1	3	7	Medium
Aspen-White Spruce	3	1	1	5	Medium
Moist Aspen	3	1	2	6	Medium
Balsam Poplar	3	3	3	9	High
Balsam Poplar-White Spruce	3	2	3	8	High
White Spruce	2	1	2	5	Medium
Shrubland	3	1	2	6	Medium
White Spruce-Black Spruce	2	1	2	5	Medium

Habitat Classes	Mean Species Richness	Unique and Sensitive Richness	Community Similarity	Score	Overall Breeding Bird Richness
Treed Poor Fen	1	1	3	5	Medium
Treed Rich Fen	2	2	3	7	Medium
Shrubby Fen	3	1	3	7	Medium
Deciduous Swamp	3	1	3	7	Medium
Shrubby Swamp	2	3	3	8	High
Marsh	3	3	3	9	High

Table 5.3.4-30: Breeding Bird Habitat Rankings in the LSA and RSA

Species Group	Ranking	LSA Baseline (ha)	LSA %	RSA Baseline (ha)	RSA %
Breeding Birds	High	597	4.9	10,392	7.8
	Medium	5,335	43.7	57,027	43.0
	Low	5,677	46.5	62,790	47.3
	Not Ranked	609	5.0	2,560	1.9
Grand Total		12,218	100.0	132,769	100.0

Indicator S3 – Wildlife

Wildlife species groups were ranked by summing the expected habitat associations for each species within habitat classes (Table 5.3.4-31). These expectations were determined from literature sources and from the information presented in the wildlife baseline (Section 5.3.3). Broad classes were used to better match the level of information available, and were then associated with the appropriate ecosites for analysis (Table 5.3.4-32).

Rankings for mammals were assessed by summing the number of expected ecosites where a species is likely to be present for at least part of its lifecycle. Rankings for waterfowl and amphibians were directly applied to ecosites (Table 5.3.4-32). These were applied to habitat data in the LSA and RSA to show the area of each rank in the baseline case (Table 6.3.4-33). A summary of high rated wildlife habitat classes is shown in Figure 5.3.4-16.

Table 5.3.4-31: Species Richness Rankings for Wildlife Groups

Taxonomic Groups	Furbearers												Ungulates						Carnivores						
Habitat	Muskrat	Fox	Marten	Fisher	Ermine	Weasel	Mink	Otter	Red Squirrel	Beaver	Total	Rank	Moose	Elk	White Tail	Mule Deer	Total	Rank	Black Bear	Wolf	Cougar	Coyote	Lynx	Tot al	Rank
Pine		x[1]	x	x	x	x			x		6	High					0	Low	x	x				2	Med
Pine Regen		x									1	Low	X	x			2	Med	x	x		X		3	Med
Shrubland		x				x					2	Med	x	x			2	Med	x	x		X		3	Med
Grassland		x				x					2	Med		x			1	Low	x	x		X		3	Med
Mixedwood		x			x	x			x		4	High	x	x	x	x	4	High	x	x	x		x	4	High
Mixedwood Regen		x									1	Low	x	x	x	x	4	High	x	x		X		3	Med
Deciduous		x				x					2	Med	x		x	x	3	High	x	x	x			3	Med
Deciduous Regen		x									1	Low	x	x	x	x	4	High	x	x		X		3	Med
Coniferous		x	x	x	x	x			x		6	High	x	x			2	Med	x	x	x		x	4	High
Coniferous Regen		x									1	Low	x	x			2	Med	x	x		X		3	Med
Treed Fen/Swamp			x	x	x	x			x		5	High	x				1	Low	x					1	Low
Shrubby Fen/Swamp											0	Low	x				1	Low						0	Low
Graminoid Fen/Swamp											0	Low					0	Low				X		1	Low
Marsh	x									x	2	Med	x				1	Low						0	Low
Lake	x						x	x		x	4	High					0	Low						0	Low
River							x	x		x	3	High					0	Low						0	Low
Flooded	x									x	2	Med	x				1	Low						0	Low
Disturbed											0	Low		x	x	x	3	High				X		1	Low
Riparian							x	x		x	3	High	x		x	x	3	High		x	x	X		3	Med

Note: 1. Preferred habitat for species

Table 5.3.4-32: Final Rankings by Habitat Class for Taxonomic Groups of Interest

Ecosite	Structure	Amphibian	Furbearer	Ungulate	Carnivore	Waterfowl
BP01 / Cutbanks	All	NR[2]	Medium	Low	High	NR
BP01a	All	NR	Medium	Medium	High	NR
BP02	Mature	NR	High	Low	Medium	NR
BP02	Regen	NR	Low	Medium	High	NR
BP03	Mature	NR	High	Low	Medium	NR
BP03	Regen	NR	Low	Medium	High	NR
BP04	Mature	NR	High	High	High	NR
BP04	Regen	NR	Low	High	High	NR
BP05	Mature	NR	Medium	High	High	NR
BP05	Regen	NR	Low	High	High	NR
BP06	Mature	NR	Medium	High	High	NR
BP06	Regen	NR	Low	High	High	NR
BP07	Mature	NR	Medium	High	High	NR
BP07	Regen	NR	Low	High	High	NR
BP09	Mature	NR	High	High	High	NR
BP09	Regen	NR	Low	High	High	NR
BP10	Mature	NR	High	High	High	NR
BP10	Regen	NR	Low	High	High	NR
BP11	Mature	NR	High	High	High	NR
BP11	Regen	NR	Low	High	High	NR
BP12	Mature	NR	High	Medium	High	NR
BP12	Regen	NR	Low	Medium	High	NR
BP13	Mature	NR	High	Medium	High	NR
BP13	Regen	NR	Low	Medium	High	NR
BP14	Mature	NR	High	Medium	High	NR
BP14	Regen	NR	Low	Medium	High	NR
BP15	Mature	NR	High	High	High	NR
BP15	Regen	NR	Low	High	High	NR
BP16	Mature	NR	Medium	High	High	NR
BP16	Regen	NR	Low	High	High	NR
BP18a	All	Low	Low	Low	Low	Low
BP18	All	Low	High	Low	Low	NR
BP19	All	Low	High	Low	Low	NR
BP23	All	Low	High	Low	Low	NR
BP24	All	Low	High	Low	Low	NR
BP25	All	Low	Low	Low	Low	Low
BP26	All	Low	Low	Low	Low	Low
BP28	All	High	Medium	Low	Low	High
Clearings / Agriculture	All	NR	Low	High	Low	NR
Industrial Disturbance	All	NR	NR	NR	NR	NR
Lake	All	Medium	High	Low	Low	High
Flooded	All	High	Medium	Low	Low	High
Riparian[1]	n/a	Low	High	High	High	Medium
Creeks and Rivers[2]	All	Medium	High	Low	Low	Medium
Saskatchewan River	All	Low	Low	Low	Low	Medium

1. Non-disturbed riparian areas
2. Excluding the Saskatchewan River
3. NR = Not Ranked

Table 5.3.4-33: Habitat Ranking Areas for Wildlife Species

Species Group	Ranking	LSA Baseline (ha)	LSA %	RSA Baseline (ha)	RSA %
Amphibians	High	6	0.0	1,293	1.0
	Medium	1	0.0	226	0.2
	Low	1,909	15.6	28,465	21.4
	Not Ranked	10,302	84.3	102,785	77.4
Furbearers	High	4,560	37.3	64,973	48.9
	Medium	1,670	13.7	27,804	20.9
	Low	5,751	47.1	38,487	29.0
	Not Ranked	237	1.9	1,504	1.1
Ungulates	High	5,862	48.0	67,660	51.0
	Medium	3,269	26.8	20,940	15.8
	Low	2,850	23.3	42,665	32.1
	Not Ranked	237	1.9	1,504	1.1
Carnivores	High	9,253	75.7	89,828	67.7
	Medium	2,291	18.7	22,093	16.6
	Low	437	3.6	19,344	14.6
	Not Ranked	237	1.9	1,504	1.1
Waterfowl	High	6	0.0	1,517	1.1
	Medium	1,493	12.2	10,086	7.6
	Low	235	1.9	6,805	5.1
	Not Ranked	10,485	85.8	114,361	86.1
Grand Total		12,218	100.0	132,769	100.0

Indicator S4 – Non-native Plant Species

Non-native plant species records in the vegetation database for this Project were obtained. Observed non-native species frequencies among habitat classes are shown in Appendix 5.3.4-C (Table 4). Habitat classes with more than eight non-native species were ranked high, and those with greater than 160% observation frequency were ranked at high risk for species invasion (Table 5.3.4-34). These two metrics were combined into the overall ranking. In addition, all disturbed and reclaimed sites were ranked high. In this case, a high ranking indicates the ecosite is at high risk for species invasion. Total areas of high, medium and low ranked areas at risk for non-native species invasion are shown in Table 5.3.4-35.

Table 5.3.4-34: Ranking of Non-Native Species Risk by Ecosite

Ecosite	N	Total Weed Species	Total Richness Ranking	Total Observation of species	Ratio (Observation /plots)	Observation Ratio Ranking	Overall Ranking
BP01	4	3	Medium	4	100.0	Medium	Medium
BP01a	2	2	Low	2	100.0	Medium	Low
BP02	44	10	High	13	29.5	Low	Medium
BP03	26	5	Medium	7	26.9	Low	Low
BP04	24	4	Medium	10	41.7	Low	Low
BP05	18	9	High	27	150.0	Medium	High
BP06	26	2	Low	8	30.8	Low	Low
BP07	5	1	Low	1	20.0	Low	Low
BP09	16	4	Medium	14	87.5	Medium	Medium
BP10	5	1	Low	4	80.0	Medium	Low
BP11	2	1	Low	1	50.0	Medium	Low
BP12	8	6	Medium	8	100.0	Medium	Medium
BP13	6	4	Medium	6	100.0	Medium	Medium
BP14	12	6	Medium	10	83.3	Medium	Medium
BP15	11	7	Medium	14	127.3	Medium	Medium
BP16	14	3	Medium	10	71.4	Medium	Medium
BP17	2	4	Medium	4	200.0	High	High
BP18	16	2	Low	2	12.5	Low	Low
BP18a	9	11	High	23	255.6	High	High
BP19	2	0	Low	0	0	Low	Low
BP23	4	0	Low	0	0	Low	Low
BP24	1	0	Low	0	0	Low	Low
BP25	12	5	Medium	11	91.7	Medium	Medium
BP26	1	0	Low	0	0	Low	Low
BP28a	9	25	High	44	488.9	High	High

Table 5.3.4-35: Risk of Non-native Species Invasion Ranking Areas

Species Group	Ranking	LSA Baseline (ha)	LSA %	RSA Baseline (ha)	RSA %
Non-native Species	High	1,525	12.5	22,102	16.6
	Medium	2,022	16.5	31,215	23.5
	Low	8,671	71.0	79,452	59.8
Grand Total		12,218	100.0	132,769	100.0

5.3.4.6 Summary

For this assessment, biodiversity was defined as the natural state of variability among living organisms and within the ecological systems they occupy. This can include variability in terms of composition, structure and distribution of biotic and abiotic resources at a landscape, habitat and species level. In this assessment, one or more measurable indicators were selected for each valued component. The baseline condition of each indicator was assessed based on mapping of current ecological and disturbance conditions in both the RSA and LSA and on vegetation, wildlife and aquatic data collected in field investigations.

Four valued components were examined to assess landscape diversity, including landscape composition, landscape intactness, landscape spatial structure and landscape disturbance regimes. Landscape composition was examined with the indicator: area and distribution of landscape classes. In the LSA, 62% of lands are uplands, 25% are lowlands and 14% are riparian areas, while the RSA is composed of 39% uplands, 53% lowlands and 9% riparian areas. Thirty percent of the LSA, and 23% of the RSA was disturbed at baseline; forest harvest was the most important disturbance. The LSA has a linear disturbance density of 1.59 km/km^2 compared to 1.45 km/km^2 in the RSA. The total number of creek crossings (i.e. intersections) was 23 in the LSA and 146 in the RSA. The mean patch size in the RSA is 41.2 ha, compared to 18.5 ha in the LSA. In the LSA and RSA, most patches were small although most area was found in large patches.

There were three valued components for habitat diversity including habitat composition, forest structure and habitat intactness. Habitat composition was examined by the area of ecosites in the RSA and LSA. Of particular importance were those classes uncommon in the RSA, as those classes could be more easily impacted even with a small area affected. The LSA has 13 ecosites identified as being uncommon including shrubland, grassland, and several wetland and open water classes. Forest structure was examined with age and structure classes, including old-growth forests (>120 yr). Old-growth forests cover 0.2% of the LSA and 4.3% of the RSA. Anthropogenic edge to area ratio was higher in the LSA (0.9 km/km^2) than in the RSA (0.8 km/km^2).

Four valued components were examined for species diversity including species at risk, species richness, regulatory/culturally important species and native species diversity. Species at risk were examined among taxonomic groups including birds, butterflies, plants, and fish. Each species was assigned to ecosites based on published habitat associations, and these data were used to rate habitats for potential to maintain species at risk within each taxonomic group. Habitats ranked high for birds at risk covered 14.4 % of the LSA and 20.6% of the RSA. High ranked habitat supporting butterflies at risk covered 1.3% of the LSA and 1.6% of the RSA. High ranked habitat for plants at risk covered 14.6% of the LSA and 20.7% of the RSA, and high ranked habitat for fish covered 3.0% of the LSA and 0.6% of the RSA.

Species richness was assessed for three taxonomic groups: vascular plant species; nonvascular plant species; and bird species. For vascular plant species, 6.7% of the LSA and 9.0% of the RSA is composed of high ranked richness habitats. High ranked habitats supporting nonvascular plants occur on 12.4% of the LSA and 26.2% of the RSA. High ranked habitats for birds occur in 4.9% of the LSA and 7.8% of the RSA.

Regulatory and culturally important species were also examined within taxonomic groups and the habitats (ecosites) were rated based on published species associations for the following groups: ungulates, carnivores, furbearers, waterfowl and amphibians. Ungulates were ranked high in 48.0% of the LSA and 51.0% of the RSA. Carnivore habitat rated high in 75.7% of the LSA and 67.7% of the RSA. High ranked furbearer habitats covered 37.3% of the LSA and 48.9% of the RSA. High ranked waterfowl habitat covered <1% of the LSA and 1.1% of the RSA. High ranked amphibian habitat occurs in <1% of the LSA and 1% of the RSA.

The distribution of non-native species among ecosite was used to determine which habitats were most at risk from colonization by non-native species. Classes at the greatest risk covered 6.9% of the LSA and 5.3% of the RSA.