Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
c1	*Pleurozium schreberi*	Big red stem	Moss	N
c1	*Pohlia spp.*		Moss	N
c1	*Polytrichum commune*	Common hair-cap	Moss	N
c1	*Polytrichum juniperinum*	Juniper hair cap	Moss	N
c1	*Polytrichum spp.*		Moss	N
c1	*Polytrichum strictum*	Slender hair-cap	Moss	N
c1	*Populus balsamifera*	Balsam poplar	Tree	N
c1	*Populus tremuloides*	Trembling aspen	Shrub	N
c1	*Potentilla tridentata*	Three-toothed cinquefoil	Forb	N
c1	*Ptilium crista-castrensis*	Knight's plume	Moss	N
c1	*Ranunculus lapponicus*	Lapland buttercup	Forb	N
c1	*Rhizomnium pseudopunctatum*	Felt round moss	Moss	N
c1	*Ribes triste*	Wild red currant	Shrub	N
c1	*Rosa acicularis*	Prickly rose	Shrub	N
c1	*Rubus arcticus spp. acaulis*	Dwarf raspberry	Forb	N
c1	*Rubus chamaemorus*	Cloudberry, bakeapple	Forb	N
c1	*Rubus pubescens*	Dewberry, Running raspberry	Forb	N
c1	*Salix arbusculoides*	Little tree willow	Shrub	N
c1	*Salix bebbiana*	Beaked willow	Shrub	N
c1	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
c1	*Salix myrtillifolia var. pseudomyrsinites*	Tall blueberry willow	Shrub	N
c1	*Salix pedicellaris*	Bog willow	Shrub	N
c1	*Salix planifolia*	Flat leaved willow	Shrub	N
c1	*Salix pyrifolia*	Balsam willow	Shrub	N
c1	*Salix scouleriana*	Scouler's willow	Shrub	N
c1	*Salix Species*	Willow	Shrub	N
c1	*Shepherdia canadensis*	Canadian Buffalo-berry	Shrub	N
c1	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
c1	*Solidago canadensis*	Canada goldenrod	Forb	N
c1	*Solidago multiradiata*	Northern goldenrod	Forb	N
c1	*Solidago spathulata*	Spike-like goldenrod	Forb	N
c1	*Sphagnum angustifolium*	Yellow-green peat moss	Moss	N
c1	*Sphagnum spp.*	Peat moss	Moss	N
c1	***Splachnum luteum***	**Yellow collar moss**	**Moss**	**Y**
c1	***Splachnum rubrum***	**Red collar moss**	**Moss**	**Y**
c1	*Tetraplodon angustatus*	Narrow-leaved splachnum	Moss	N
c1	*Tomenthypnum nitens*	Golden fuzzy fen moss	Moss	N
c1	*Trientalis borealis*	Star flower	Forb	N
c1	*Usnea spp.*	Lichen	Lichen	N
c1	*Vaccinium caespitosum*	Dwarf bilberry	Shrub	N
c1	*Vaccinium myrtilloides*	Blueberry	Shrub	N
c1	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
c1	*Viburnum edule*	Low-bush cranberry	Shrub	N
c1	*Vicia americana*	Wild vetch	Forb	N
c1	*Viola renifolia*	Kidney-leaved violet	Forb	N
c1	*Viola spp.*	Violet	Forb	N
d1	*Achillea millifolium*	Yarrow	Forb	N
d1	*Actaea rubra*	Baneberry	Forb	N
d1	*Alnus crispa*	Green alder	Shrub	N
d1	*Amelanchier alnifolia*	Saskatoon	Shrub	N
d1	*Aralia nudicaulis*	Wild sarsaparilla	Forb	N
d1	*Aster ciliolatus*	Lindley's aster	Forb	N
d1	*Betula neoalaskana*	Alaska birch	Shrub	N
d1	*Betula occidentalis*	Black birch	Shrub	N
d1	*Betula papyrifera*	Paper birch	Shrub	N
d1	*Betula pumila*	Dwarf birch	Shrub	N
d1	*Brachythecium campestre*	Cedar moss	Moss	N
d1	*Bromus ciliatus*	Fringed brome	Grass	N
d1	*Bromus inermis*	Awnless brome	Grass	N
d1	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
d1	*Cladina spp.*	Lichen	Lichen	N
d1	*Coptis trifolia*	Goldthread	Forb	N
d1	*Cornus canadensis*	Bunchberry	Forb	N
d1	*Delphinium glaucum*	Tall larkspur	Forb	N
d1	*Dicranum undulatum*	Wavy dicranum	Moss	N
d1	*Dryopteris carthusiana*	Narrow spinulose shield fern	Moss	N
d1	*Elymus innovatus*	Hairy wild rye	Grass	N
d1	*Elymus trachycaulum ssp. subsecundum*	Slender wheatgrass	Grass	N
d1	*Epilobium angustifolium*	Fireweed	Forb	N
d1	*Equisetum arvense*	Common horsetail	Forb	N
d1	*Equisetum palustre*	Marsh horsetail	Forb	N
d1	*Equisetum pratense*	Meadow horsetail	Forb	N
d1	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
d1	***Euphrasia hudsoniana***	**Hudson Bay eyebright**	**Forb**	**Y**
d1	*Fragaria vesca*	Woodland strawberry	Forb	N
d1	*Fragaria virginiana*	Wild strawberry	Forb	N
d1	*Galium boreale*	Northern bedstraw	Forb	N
d1	*Habenaria orbiculata*	Round-leaved orchid	Forb	N
d1	*Halenia deflexa*	Spurred gentian	Forb	N
d1	*Hylocomium splendens*	Stair-step moss	Moss	N
d1	*Lathyrus ochroleucus*	Creamy peavine	Forb	N
d1	*Ledum groenlandicum*	Labrador tea	Shrub	N
d1	*Linnaea borealis*	Twin-flower	Shrub	N
d1	*Lonicera caerulea*	Fly honeysuckle	Shrub	N
d1	*Lonicera dioica*	Twining honeysuckle	Shrub	N
d1	*Lonicera involucrata*	Bracted honeysuckle	Shrub	N
d1	*Lycopodium annotinum*	Stiff club-moss	Forb	N
d1	*Lycopodium clavatum*	Common club-moss	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
d1	Lycopodium complanatum	Ground cedar	Forb	N
d1	Lycopodium obscurum	Ground pine	Forb	N
d1	Maianthemum canadense	Wild lily-of-the-valley	Forb	N
d1	Mertensia paniculata	Tall mertensia	Forb	N
d1	Mitella nuda	Bishop's-cap, Mitrewort	Forb	N
d1	Orthelia secunda	One-sided wintergreen	Forb	N
d1	Parnassia palustris	Grey starburst	Forb	N
d1	Pedicularis labradorica	Labrador lousewort	Forb	N
d1	Peltigera aphthosa	Freckle pelt	Lichen	N
d1	Petasites palmatus	Palmate-leaved coltsfoot	Forb	N
d1	Petasites sagittatus	Arrow-leaved coltsfoot	Forb	N
d1	Picea glauca	White spruce	Shrub	N
d1	Picea mariana	Black spruce	Shrub	N
d1	Pinus banksiana	Jack pine	Tree	N
d1	Plagiomnium cuspidatum	Woodsy mnium	Moss	N
d1	Pleurozium schreberi	Big red stem	Moss	N
d1	Poa pratensis	Kentucky bluegrass	Grass	N
d1	Populus balsamifera	Balsam poplar	Shrub	N
d1	Populus tremuloides	Trembling aspen	Shrub	N
d1	Ptilium crista-castrensis	Knight's plume	Moss	N
d1	Pylaisiella polyantha	Stocking moss	Moss	N
d1	Pyrola asarifolia	Pink wintergreen	Forb	N
d1	Ribes glandulosum	Skunk cabbage	Shrub	N
d1	Ribes lacustre	Bristly black currant	Shrub	N
d1	Ribes oxyacanthoides	Wild gooseberry	Shrub	N
d1	Ribes triste	Wild red currant	Shrub	N
d1	Rosa acicularis	Prickly rose	Shrub	N
d1	Rosa woodsii	Common wild rose	Shrub	N
d1	Rubus idaeus	Wild red raspberry	Forb	N
d1	Rubus pubescens	Dewberry, Running raspberry	Forb	N
d1	Salix bebbiana	Beaked willow	Shrub	N
d1	Salix lucida	Shining willow	Shrub	N
d1	Salix scouleriana	Scouler's willow	Shrub	N
d1	Shepherdia canadensis	Canadian Buffalo-berry	Shrub	N
d1	Smilacina racemosa	False Solomon's Seal	Forb	N
d1	Smilacina stellata	Star-flowered Solomon's-seal	Forb	N
d1	Smilacina trifolia	Three-leaved Solomon's-seal	Forb	N
d1	Symphoricarpos albus	Snowberry	Shrub	N
d1	Symphoricarpos occidentalis	Buckbrush	Shrub	N
d1	Thalictrum venulosum	Veiny meadow rue	Forb	N
d1	Trientalis borealis	Star flower	Forb	N
d1	Usnea spp.		Lichen	N
d1	Vaccinium myrtilloides	Blueberry	Shrub	N
d1	Vaccinium vitis-idaea	Bog cranberry	Shrub	N
d1	Viburnum edule	Low-bush cranberry	Shrub	N
d1	Vicia americana	Wild vetch	Forb	N
d1	Viola renifolia	Kidney-leaved violet	Forb	N
d2	Achillea millifolium	Yarrow	Forb	N
d2	Actaea rubra	Baneberry	Forb	N
d2	Alnus crispa	Green alder	Shrub	N
d2	Alnus tenuifolia	River alder	Shrub	N
d2	Aralia nudicaulis	Wild sarsaparilla	Forb	N
d2	Arctostaphylos uva-ursi	Bearberry	Shrub	N
d2	Aster ciliolatus	Lindley's Aster	Forb	N
d2	Astragalus americanus	American milk-vetch	Forb	N
d2	Betula neoalaskana	Alaska birch	Shrub	N
d2	Betula pumila	Dwarf birch	Shrub	N
d2	Bryoria spp.		Lichen	N
d2	Calamagrostis canadensis	Bluejoint, Marsh reed grass	Forb	N
d2	Campanula rotundifolia	Bluebell	Forb	N
d2	Cladina mitis	Yellow reindeer lichen	Lichen	N
d2	Cladina rangiferina	Reindeer lichen	Lichen	N
d2	Cladina spp.		Lichen	N
d2	Corallorhiza trifida	Pale coral-root	Forb	N
d2	Cornus canadensis	Bunchberry	Forb	N
d2	Delphinium glaucum	Tall larkspur	Forb	N
d2	Dicranum undulatum	Wavy dicranum	Moss	N
d2	Elymus innovatus	Hairy wild rye	Grass	N
d2	Epilobium angustifolium	Fireweed	Forb	N
d2	Equisetum arvense	Common horsetail	Forb	N
d2	Equisetum pratense	Meadow horsetail	Forb	N
d2	Equisetum sylvaticum	Woodland horsetail	Forb	N
d2	Eurhynchium pulchellum	Common beaked moss	Moss	N
d2	Evernia spp.		Lichen	N
d2	Fragaria vesca	Woodland strawberry	Forb	N
d2	Fragaria virginiana	Wild strawberry	Forb	N
d2	Galium boreale	Northern bedstraw	Forb	N
d2	Geocaulon lividum	Northern bastard toadflax	Forb	N
d2	Goodyera repens	Rattlesnake plantain	Forb	N
d2	Habenaria orbiculata	Round-leaved orchid	Forb	N
d2	Hylocomium splendens	Stair-step moss	Moss	N
d2	Hypogymnia physodes	Monk's hood lichen	Lichen	N
d2	Lathyrus ochroleucus	Creamy peavine	Forb	N
d2	Ledum groenlandicum	Labrador tea	Shrub	N
d2	Linnaea borealis	Twin-flower	Shrub	N
d2	Lycopodium annotinum	Stiff club-moss	Forb	N
d2	Lycopodium clavatum	Common club-moss	Forb	N
d2	Lycopodium complanatum	Ground cedar	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
d2	*Lycopodium obscurum*	Ground pine	Forb	N
d2	*Maianthemum canadense*	Wild lily-of-the-valley	Forb	N
d2	*Mertensia paniculata*	Tall mertensia	Forb	N
d2	*Mitella nuda*	Bishop's-cap, Mitrewort	Forb	N
d2	*Orthelia secunda*	One-sided wintergreen	Forb	N
d2	*Parmelia spp.*		Lichen	N
d2	*Pedicularis labradorica*	Labrador lousewort	Forb	N
d2	*Peltigera aphthosa*	Freckle pelt	Lichen	N
d2	*Peltigera neopolydactyla*	Frog pelt	Lichen	N
d2	*Peltigera spp.*		Lichen	N
d2	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
d2	*Picea glauca*	White spruce	Shrub	N
d2	*Picea mariana*	Black spruce	Shrub	N
d2	*Pinus banksiana*	Jack pine	Shrub	N
d2	*Pleurozium schreberi*	Big red stem	Moss	N
d2	*Populus balsamifera*	Balsam poplar	Shrub	N
d2	*Populus tremuloides*	Trembling aspen	Shrub	N
d2	***Pseudobryum cinclidioides***	**River Thyme Moss**	**Moss**	**Y**
d2	*Ptilium crista-castrensis*	Knight's plume	Moss	N
d2	*Pylaisiella polyantha*	Stocking moss	Moss	N
d2	*Pyrola asarifolia*	Pink wintergreen	Forb	N
d2	*Ribes oxyacanthoides*	Wild gooseberry	Shrub	N
d2	*Ribes triste*	Wild red currant	Shrub	N
d2	*Rosa acicularis*	Prickly rose	Shrub	N
d2	*Rubus idaeus*	Wild red raspberry	Shrub	N
d2	*Rubus pubescens*	Dewberry, Running raspberry	Forb	N
d2	*Salix bebbiana*	Beaked willow	Shrub	N
d2	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
d2	*Salix planifolia*	Flat leaved willow	Shrub	N
d2	*Salix pyrifolia*	Balsam willow	Shrub	N
d2	*Salix scouleriana*	Scouler's willow	Shrub	N
d2	*Shepherdia canadensis*	Canadian Buffalo-berry	Shrub	N
d2	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
d2	*Solidago multiradiata*	Northern goldenrod	Forb	N
d2	*Trientalis borealis*	Star Flower	Forb	N
d2	*Usnea spp.*		Lichen	N
d2	*Vaccinium myrtilloides*	Blueberry	Forb	N
d2	*Vaccinium spp.*		Shrub	N
d2	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
d2	*Viburnum edule*	Low-bush cranberry	Shrub	N
d2	*Vicia americana*	Wild vetch	Forb	N
d2	*Viola renifolia*	Kidney-leaved violet	Forb	N
d3	*Actaea rubra*	Baneberry	Forb	N
d3	*Aralia nudicaulis*	Wild sarsaparilla	Forb	N
d3	*Aster ciliolatus*	Lindley's sster	Forb	N
d3	*Betula neoalaskana*	Alaska birch	Shrub	N
d3	*Betula papyrifera*	Paper birch	Shrub	N
d3	*Cornus canadensis*	Bunchberry	Forb	N
d3	*Dryopteris assimilis*	Broad spinulose shield fern	Forb	N
d3	*Elymus innovatus*	Hairy wild rye	Grass	N
d3	*Epilobium angustifolium*	Fireweed	Forb	N
d3	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
d3	*Fragaria virginiana*	Wild strawberry	Forb	N
d3	*Galium boreale*	Northern bedstraw	Forb	N
d3	*Geranium bicknellii*	Bicknell's geranium	Forb	N
d3	*Goodyera repens*	Rattlesnake plantain	Forb	N
d3	*Habenaria orbiculata*	Round-leaved orchid	Forb	N
d3	*Hylocomium splendens*	Stair-step moss	Moss	N
d3	*Lathyrus ochroleucus*	Creamy peavine	Forb	N
d3	*Linnaea borealis*	Twin-flower	Shrub	N
d3	*Lycopodium annotinum*	Stiff club-moss	Forb	N
d3	*Maianthemum canadense*	Wild lily-of-the-valley	Forb	N
d3	*Mertensia paniculata*	Tall mertensia	Forb	N
d3	*Mitella nuda*	Bishop's-cap, Mitrewort	Forb	N
d3	*Moneses uniflora*	One-flowered wintergreen	Forb	N
d3	*Orthelia secunda*	One-sided wintergreen	Forb	N
d3	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
d3	*Picea glauca*	White spruce	Shrub	N
d3	*Picea mariana*	Black spruce	Shrub	N
d3	*Pleurozium schreberi*	Big red stem	Moss	N
d3	*Populus balsamifera*	Balsam poplar	Shrub	N
d3	*Populus tremuloides*	Trembling aspen	Shrub	N
d3	*Ptilium crista-castrensis*	Knight's plume	Moss	N
d3	*Pyrola asarifolia*	Pink wintergreen	Forb	N
d3	*Pyrola chlorantha*	Greenish-flowered wintergreen	Forb	N
d3	*Ribes lacustre*	Bristly black currant	Shrub	N
d3	*Rosa acicularis*	Prickly rose	Shrub	N
d3	*Rubus pubescens*	Dewberry, Running raspberry	Forb	N
d3	*Salix scouleriana*	Scouler's willow	Shrub	N
d3	*Trientalis borealis*	Star Flower	Forb	N
d3	*Vaccinium myrtilloides*	Blueberry	Shrub	N
d3	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
d3	*Viburnum edule*	Low-bush cranberry	Shrub	N
d3	*Viola canadensis*	Western Canada violet	Forb	N
d3	*Viola renifolia*	Kidney-leaved violet	Forb	N
e1	*Alnus tenuifolia*	River alder	Shrub	N
e1	*Aster puniceus*	Purple-stemmed aster	Forb	N
e1	*Aulacomnium palustre*	Tufted moss	Moss	N

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Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
e1	*Betula neoalaskana*	Alaska birch	Shrub	N
e1	*Betula papyrifera*	Paper birch	Shrub	N
e1	*Brachythecium campestre*	Cedar moss	Moss	N
e1	*Brachythecium spp.*		Moss	N
e1	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
e1	*Caltha palustris*	Marsh marigold	Forb	N
e1	*Carex spp.*		Grass	N
e1	*Climacium dendroides*	Common tree moss	Moss	N
e1	*Cornus canadensis*	Bunchberry	Forb	N
e1	*Dicranum spp.*		Moss	N
e1	*Epilobium angustifolium*	Fireweed	Forb	N
e1	*Epilobium ciliatum*	Northern willowherb	Forb	N
e1	*Epilobium palustre*	Marsh willowherb	Forb	N
e1	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
e1	*Galium trifidum*	Small bedstraw	Forb	N
e1	*Galium triflorum*	Sweet-scented bedstraw	Forb	N
e1	*Goodyera repens*	Rattlesnake plantain	Forb	N
e1	*Hylocomium splendens*	Stair-step moss	Moss	N
e1	*Ledum groenlandicum*	Labrador tea	Shrub	N
e1	*Linnaea borealis*	Twin-flower	Shrub	N
e1	*Lycopodium annotinum*	Stiff Club-moss	Forb	N
e1	*Maianthemum canadense*	Wild lily-of-the-valley	Forb	N
e1	*Mentha arvensis*	Wild mint	Forb	N
e1	*Peltigera aphthosa*	Freckle pelt	Lichen	N
e1	*Peltigera spp.*		Lichen	N
e1	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
e1	*Picea glauca*	White spruce	Shrub	N
e1	*Picea mariana*	Black spruce	Tree	N
e1	*Plagiomnium ellipticum*	Marsh magnificent moss	Moss	N
e1	*Pleurozium schreberi*	Big red stem	Moss	N
e1	*Populus balsamifera*	Balsam poplar	Tree	N
e1	*Populus tremuloides*	Trembling aspen	Tree	N
e1	*Potentilla palustris*	Marsh cinquefoil	Forb	N
e1	*Ptilium crista-castrensis*	Knight's plume	Moss	N
e1	*Ribes oxyacanthoides*	Wild gooseberry	Shrub	N
e1	*Ribes spp.*		Shrub	N
e1	*Ribes triste*	Wild red currant	Shrub	N
e1	*Rubus idaeus*	Wild red raspberry	Shrub	N
e1	*Rubus pubescens*	Dewberry, Running raspberry	Forb	N
e1	*Salix bebbiana*	Beaked willow	Shrub	N
e1	*Salix planifolia*	Flat leaved willow	Shrub	N
e1	*Salix pyrifolia*	Balsam willow	Shrub	N
e1	*Salix scouleriana*	Scouler's willow	Shrub	N
e1	*Sanionia uncinata*	Sickle moss	Moss	N
e1	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
e1	*Sphagnum sp.*	Peat moss	Moss	N
e1	*Sphagnum squarrosum*	Spreading-leaved peat moss	Moss	N
e1	*Stellaria longipes*	Long-stalked chickweed	Forb	N
e1	*Trientalis borealis*	Star flower	Forb	N
e1	*Usnea spp.*		Lichen	N
e1	*Vaccinium myrtilloides*	Blueberry	Shrub	N
e1	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
e1	*Viola palustris*	Marsh violet	Forb	N
e1	*Viola renifolia*	Kidney-leaved violet	Forb	N
g1	*Antennaria parvifolia*	Small-leaved everlasting	Forb	N
g1	*Arctostaphylos uva-ursi*	Bearberry	Shrub	N
g1	*Aulacomnium palustre*	Tufted moss	Moss	N
g1	*Betula glandulosa*	Bog birch	Shrub	N
g1	*Betula neoalaskana*	Alaska birch	Shrub	N
g1	*Betula pumila*	Dwarf birch	Shrub	N
g1	*Bryoria spp.*		Lichen	N
g1	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
g1	*Campanula rotundifolia*	Bluebell	Forb	N
g1	*Carex aquatilis*	Water sedge	Grass	N
g1	*Carex spp.*		Grass	N
g1	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
g1	*Cladina mitis*	Yellow reindeer lichen	Lichen	N
g1	*Cladina rangiferina*	Reindeer lichen	Lichen	N
g1	*Cladina spp.*		Lichen	N
g1	*Cladina stellaris*	Cauliflower heads	Lichen	N
g1	*Coptis trifolia*	Goldthread	Forb	N
g1	*Cornus canadensis*	Bunchberry	Forb	N
g1	*Dicranum polysetum*	Electric eels	Moss	N
g1	*Dicranum scoparium*	Broom moss	Moss	N
g1	*Dicranum spp.*		Moss	N
g1	*Dicranum undulatum*	Wavy dicranum	Moss	N
g1	*Elymus innovatus*	Hairy wild rye	Grass	N
g1	*Empetrum nigrum*	Crowberry	Shrub	N
g1	*Epilobium angustifolium*	Fireweed	Forb	N
g1	*Equisetum arvense*	Common horsetail	Forb	N
g1	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
g1	*Eriophorum viridi-carinatum*	Thinleaf cottonsedge	Grass	N
g1	*Geocaulon lividum*	Northern bastard toadflax	Forb	N
g1	*Hylocomium splendens*	Stair-step moss	Moss	N
g1	*Hypogymnia physodes*	Monk's hood lichen	Lichen	N
g1	*Kalmia polifolia*	Bog Laurel	Shrub	N
g1	*Ledum groenlandicum*	Labrador tea	Shrub	N
g1	*Limprichtia revolvens*	Brown moss	Moss	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
g1	Linnaea borealis	Twin-flower	Shrub	N
g1	Lycopodium annotinum	Stiff club-moss	Forb	N
g1	Lycopodium complanatum	Ground cedar	Forb	N
g1	Oxycoccus microcarpus	Small bog cranberry	Shrub	N
g1	Oxycoccus quadripetalus	Bog cranberry	Shrub	N
g1	Pedicularis labradorica	Labrador lousewort	Forb	N
g1	Peltigera aphthosa	Freckle pelt	Lichen	N
g1	Peltigera canina	dog lichen	Lichen	N
g1	Peltigera spp.		Lichen	N
g1	Petasites palmatus	Palmate-leaved coltsfoot	Forb	N
g1	Picea mariana	Black spruce	Shrub	N
g1	Pinus banksiana	Jack pine	Shrub	N
g1	Pleurozium schreberi	Big red stem	Moss	N
g1	Pohlia spp.		Moss	N
g1	Polytrichum spp.		Moss	N
g1	Populus tremuloides	Trembling aspen	Shrub	N
g1	Potentilla tridentata	Three-toothed cinquefoil	Forb	N
g1	Ptilium crista-castrensis	Knight's plume	Moss	N
g1	Ranunculus lapponicus	Lapland buttercup	Forb	N
g1	Ribes americanum	Wild Black currant	Shrub	N
g1	Rosa acicularis	Prickly rose	Shrub	N
g1	Rubus chamaemorus	Cloudberry, Bakeapple	Forb	N
g1	Salix bebbiana	Beaked willow	Shrub	N
g1	Salix candida	Hoary willow	Shrub	N
g1	Salix planifolia	Flat leaved willow	Shrub	N
g1	Salix pyrifolia	Balsam willow	Shrub	N
g1	Salix scouleriana	Scouler's willow	Shrub	N
g1	Smilacina trifolia	Three-leaved Solomon's-seal	Forb	N
g1	Sphagnum angustifolium	Yellow-green peat moss	Moss	N
g1	Sphagnum fuscum	Common brown sphagnum	Moss	N
g1	Sphagnum spp.	Peat moss	Moss	N
g1	Usnea spp.		Lichen	N
g1	Vaccinium caespitosum	Dwarf bilberry	Shrub	N
g1	Vaccinium myrtilloides	Blueberry	Shrub	N
g1	Vaccinium spp.		Shrub	N
g1	Vaccinium vitis-idaea	Bog cranberry	Shrub	N
g1	Viburnum edule	Low-bush cranberry	Shrub	N
g1	Viola adunca	Early Blue violet	Forb	N
h1	Achillea millifolium	Yarrow	Forb	N
h1	Andromeda polifolia	Bog rosemary	Shrub	N
h1	Aster ciliolatus	Lindley's aster	Forb	N
h1	Aulacomnium palustre	Tufted moss	Moss	N
h1	Betula glandulosa	Bog birch	Shrub	N
h1	Betula occidentalis	Black birch	Shrub	N
h1	Betula papyrifera	Paper birch	Tree	N
h1	Betula pumila	Dwarf birch	Shrub	N
h1	Botrychium virginianum	Grape fern	Forb	N
h1	Bryoria spp.		Lichen	N
h1	Calamagrostis canadensis	Bluejoint, Marsh reed grass	Forb	N
h1	Calliergon giganteum	Giant water moss	Moss	N
h1	Calliergon stramineum	Straw-colored water moss	Moss	N
h1	Caltha palustris	Marsh marigold	Forb	N
h1	Campanula rotundifolia	Bluebell	Forb	N
h1	Carex aquatilis	Water sedge	Grass	N
h1	Carex brunnescens	Brownish sedge	Grass	N
h1	Carex capillaris	Hair-like sedge	Grass	N
h1	Carex chordorrhiza	Creeping sedge	Grass	N
h1	Carex curta	Short sedge	Grass	N
h1	Carex deflexa	Bent Sedge	Grass	N
h1	Carex diandra	Two stamened sedge	Grass	N
h1	Carex disperma	Two seeded sedge	Grass	N
h1	Carex gynocrates	Northern bog sedge	Grass	N
h1	Carex leptalea	Bristel stalked sedge	Grass	N
h1	Carex limosa	Mud sedge	Grass	N
h1	Carex paupercula	Bog sedge	Grass	N
h1	Carex praticola	Meadow sedge	Grass	N
h1	Carex spp.		Grass	N
h1	Carex tenuiflora	Thin flowered sedge	Grass	N
h1	Carex vaginata	Sheathed sedge	Grass	N
h1	Chamaedaphne calyculata	Leather-leaf	Shrub	N
h1	Cladina mitis	Yellow reindeer lichen	Forb	N
h1	Cladina rangiferina	Reindeer lichen	Lichen	N
h1	Cladina spp.		Lichen	N
h1	Cladina stellaris	Cauliflower heads	Lichen	N
h1	Cladonia spp.		Lichen	N
h1	Climacium dendroides	Common tree moss	Moss	N
h1	Coptis trifolia	Goldthread	Forb	N
h1	Cornus canadensis	Bunchberry	Forb	N
h1	Corydalis sempervirens	Pink corydalis	Forb	N
h1	Dicranum spp.		Moss	N
h1	Dicranum undulatum	Wavy dicranum	Moss	N
h1	Drosera anglica	Sundew	Forb	N
h1	Drosera rotundifolia	Sundew	Forb	N
h1	Elymus innovatus	Hairy wild rye	Grass	N
h1	Epilobium angustifolium	Fireweed	Forb	N
h1	Epilobium palustre	Marsh willowherb	Forb	N
h1	Equisetum arvense	Common horsetail	Forb	N
h1	Equisetum pratense	Meadow horsetail	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
h1	*Equisetum scirpoides*	Dwarf scouring rush	Forb	N
h1	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
h1	*Eriophorum vaginatum*	Sheathed cotton grass	Grass	N
h1	***Euphrasia hudsoniana***	**Hudson Bay eyebright**	**Forb**	**Y**
h1	*Evernia spp.*		Lichen	N
h1	*Fragaria virginiana*	Wild strawberry	Forb	N
h1	*Galium boreale*	Northern bedstraw	Forb	N
h1	*Galium triflorum*	Sweet-scented bedstraw	Forb	N
h1	*Geocaulon lividum*	Northern bastard toadflax	Forb	N
h1	*Habenaria hyperborea*	Northern green orchid	Forb	N
h1	*Hylocomium splendens*	Stair-step moss	Moss	N
h1	*Hypnum pratense*	Meadow pigtail moss	Moss	N
h1	*Hypogymnia physodes*	Monk's hood lichen	Lichen	N
h1	*Hypogymnium spp.*		Lichen	N
h1	*Icmadophila ericetorum*	Spraypaint	Lichen	N
h1	*Jamesoniella autumnalis*	Jameson's liverwort	Moss	N
h1	*Kalmia polifolia*	Bog laurel	Shrub	N
h1	*Larix laricina*	Tamarack	Shrub	N
h1	*Ledum groenlandicum*	Labrador tea	Shrub	N
h1	*Lepidozia reptans*	Little Hands liverwort	Moss	N
h1	*Limprichtia revolvens*	Brown moss	Moss	N
h1	*Linnaea borealis*	Twin-flower	Shrub	N
h1	*Lonicera caerulea*	Fly honeysuckle	Shrub	N
h1	*Lonicera caerulea var. villosa*	Fly honeysuckle	Shrub	N
h1	*Lophozia ventricosa*	Leafy liverwort	Moss	N
h1	*Lycopodium annotinum*	Stiff club-moss	Forb	N
h1	*Lycopodium clavatum*	Common club-moss	Forb	N
h1	*Lycopodium obscurum*	Ground pine	Forb	N
h1	*Marchantia spp.*		Moss	N
h1	*Mertensia paniculata*	Tall mertensia	Forb	N
h1	*Mitella nuda*	Bishop's-cap, Mitrewort	Forb	N
h1	*Orthelia secunda*	One-sided wintergreen	Forb	N
h1	*Oryzopsis pungens*	Northern ricegrass	Grass	N
h1	*Oxycoccus microcarpus*	Small bog cranberry	Shrub	N
h1	*Parmelia sulcata*	Waxpaper lichen	Lichen	N
h1	*Parnassia palustris*	Grey starburst	Forb	N
h1	*Pedicularis labradorica*	Labrador lousewort	Forb	N
h1	*Pedicularis parviflora*	Swamp Lousewort	Forb	N
h1	*Peltigera aphthosa*	Freckle pelt	Lichen	N
h1	*Peltigera spp.*		Lichen	N
h1	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
h1	*Petasites sagittatus*	Arrow-leaved coltsfoot	Forb	N
h1	*Picea mariana*	Black spruce	Shrub	N
h1	*Pinus banksiana*	Jack pine	Shrub	N
h1	*Plagiomnium cuspidatum*	Woodsy mnium	Moss	N
h1	*Pleurozium schreberi*	Big red stem	Moss	N
h1	*Poa pratensis*	Kentucky bluegrass	Grass	N
h1	*Pohlia cruda*	Glaucous thread moss	Moss	N
h1	*Pohlia nutans*	Copper wire moss	Moss	N
h1	*Pohlia wahlenbergii*	Pale-leaved thread moss	Moss	N
h1	*Polytrichum juniperinum*	Juniper hair cap	Moss	N
h1	*Polytrichum spp.*		Moss	N
h1	*Polytrichum strictum*	Slender hair-cap	Moss	N
h1	*Populus tremuloides*	Trembling Aspen	Shrub	N
h1	*Potentilla palustris*	Marsh cinquefoil	Forb	N
h1	*Potentilla tridentata*	Three-toothed cinquefoil	Forb	N
h1	*Ptilium crista-castrensis*	Knight's plume	Moss	N
h1	*Pyrola asarifolia*	Pink wintergreen	Forb	N
h1	*Pyrola chlorantha*	Greenish-flowered wintergreen	Forb	N
h1	*Ranunculus lapponicus*	Lapland buttercup	Forb	N
h1	*Rhizomnium gracile*	Slender round moss	Moss	N
h1	*Rosa acicularis*	Prickly rose	Shrub	N
h1	*Rubus arcticus spp. acaulis*	Dwarf raspberry	Forb	N
h1	*Rubus chamaemorus*	Cloudberry, Bakeapple	Forb	N
h1	*Salix athabascensis*	Athabasca willow	Shrub	N
h1	*Salix bebbiana*	Beaked willow	Shrub	N
h1	*Salix brachycarpa*	Short-capsuled willow	Shrub	N
h1	*Salix candida*	Hoary willow	Shrub	N
h1	*Salix maccalliana*	Velvet fruited willow	Shrub	N
h1	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
h1	*Salix myrtillifolia var. pseudomyrsinites*	Tall blueberry willow	Shrub	N
h1	*Salix pedicellaris*	Bog willow	Shrub	N
h1	*Salix planifolia*	Flat leaved willow	Shrub	N
h1	*Salix pyrifolia*	Balsam willow	Shrub	N
h1	*Salix serissima*	Autumn willow	Shrub	N
h1	*Salix Spp.*	Willow	Shrub	N
h1	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
h1	*Solidago multiradiata*	Northern goldenrod	Forb	N
h1	*Solidago spp.*		Forb	N
h1	*Sphagnum angustifolium*	Yellow-green peat moss	Moss	N
h1	*Sphagnum fuscum*	Common brown sphagnum	Moss	N
h1	*Sphagnum magellanicum*	Midway peat moss	Moss	N
h1	*Sphagnum spp.*	Peat moss	Moss	N
h1	*Spiranthes romanzoffiana*	Ladies'-tresses	Forb	N
h1	***Splachnum luteum***	**Yellow collar moss**	**Moss**	**Y**
h1	***Splachnum rubrum***	**Red collar moss**	**Moss**	**Y**
h1	*Stellaria longifolia*	Long-leaved chickweed	Forb	N
h1	*Stellaria longipes*	Long-stalked chickweed	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
h1	*Tomenthypnum nitens*	Golden fuzzy fen moss	Moss	N
h1	*Urtica dioica ssp. gracilis*	Common nettle	Forb	N
h1	*Usnea spp.*		Lichen	N
h1	*Vaccinium caespitosum*	Dwarf bilberry	Shrub	N
h1	*Vaccinium myrtilloides*	Blueberry	Shrub	N
h1	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
h1	*Vicia americana*	Wild vetch	Forb	N
h1	*Viola renifolia*	Kidney-leaved violet	Forb	N
h2	*Andromeda polifolia*	Bog rosemary	Shrub	N
h2	*Arctostaphylos uva-ursi*	Bearberry	Shrub	N
h2	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
h2	*Cladina mitis*	Yellow reindeer lichen	Lichen	N
h2	*Cladina rangiferina*	Reindeer lichen	Lichen	N
h2	*Dicranum undulatum*	Wavy dicranum	Moss	N
h2	*Eriophorum vaginatum*	Sheathed cotton grass	Grass	N
h2	*Eriophorum viridi-carinatum*	Thinleaf cottonsedge	Grass	N
h2	*Kalmia polifolia*	Bog laurel	Shrub	N
h2	*Larix laricina*	Tamarack	Shrub	N
h2	*Ledum groenlandicum*	Labrador tea	Shrub	N
h2	*Oxycoccus microcarpus*	Small Bog cranberry	Shrub	N
h2	*Picea mariana*	Black spruce	Shrub	N
h2	*Pleurozium schreberi*	Big red stem	Moss	N
h2	*Polytrichum strictum*	Slender hair-cap	Moss	N
h2	*Rubus chamaemorus*	Cloudberry, Bakeapple	Forb	N
h2	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
h2	*Sphagnum fuscum*	Common brown sphagnum	Moss	N
h2	***Splachnum luteum***	**Yellow collar moss**	**Moss**	**Y**
h2	***Splachnum rubrum***	**Red collar moss**	**Moss**	**Y**
h2	*Usnea spp.*		Lichen	N
h2	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
i1	*Achillea millifolium*	Yarrow	Forb	N
i1	*Andromeda polifolia*	Bog rosemary	Shrub	N
i1	*Aulacomnium palustre*	Tufted moss	Moss	N
i1	*Betula glandulosa*	Bog birch	Shrub	N
i1	*Betula pumila*	Dwarf birch	Shrub	N
i1	*Bryum caespiticium*	Dry calcareous bryum	Moss	N
i1	*Bryum pseudotriquetrum*	Tall clustered thread moss	Moss	N
i1	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
i1	*Calliergon giganteum*	Giant water moss	Moss	N
i1	*Caltha palustris*	Marsh marigold	Forb	N
i1	*Cardamine pratensis L. ssp palustris*	Cuckoo Flower	Forb	N
i1	*Carex aquatilis*	Water sedge	Grass	N
i1	*Carex chordorrhiza*	Creeping sedge	Grass	N
i1	*Carex curta*	Short sedge	Grass	N
i1	*Carex diandra*	Two stamened sedge	Grass	N
i1	*Carex disperma*	Two seeded sedge	Grass	N
i1	*Carex leptalea*	Bristel stalked sedge	Grass	N
i1	*Carex limosa*	Mud sedge	Grass	N
i1	*Carex media*	Norway sedge	Grass	N
i1	*Carex paupercula*	Bog sedge	Grass	N
i1	*Carex rostrata*	Beaked sedge	Grass	N
i1	*Carex tenuiflora*	Thin flowered sedge	Grass	N
i1	*Carex vaginata*	Sheathed sedge	Grass	N
i1	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
i1	*Cladina mitis*	Yellow reindeer lichen	Lichen	N
i1	*Cladina rangiferina*	Reindeer lichen	Lichen	N
i1	*Cladina spp.*		Lichen	N
i1	*Cornus canadensis*	Bunchberry	Forb	N
i1	*Drepanocladus aduncus*	Common hook Moss	Moss	N
i1	*Drosera rotundifolia*	Sundew	Forb	N
i1	*Epilobium angustifolium*	Fireweed	Forb	N
i1	*Epilobium leptophyllum*	Narrow leaved willowherb	Forb	N
i1	*Epilobium palustre*	Marsh willowherb	Forb	N
i1	*Equisetum arvense*	Common horsetail	Forb	N
i1	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
i1	*Eriophorum vaginatum*	Sheathed cotton grass	Grass	N
i1	***Euphrasia hudsoniana***	**Hudson Bay eyebright**	**Forb**	**Y**
i1	*Galium labridoricum*	Labrador bedstraw	Forb	N
i1	*Galium trifidum*	Small bedstraw	Forb	N
i1	*Geocaulon lividum*	Northern bastard toadflax	Forb	N
i1	*Habenaria hyperborea*	Northern green orchid	Forb	N
i1	*Hylocomium splendens*	Stair-step moss	Moss	N
i1	*Hypogymnia physodes*	Monk's hood lichen	Lichen	N
i1	*Jamesoniella autumnalis*	Jameson's liverwort	Moss	N
i1	*Kalmia polifolia*	Bog laurel	Shrub	N
i1	*Larix laricina*	Tamarack	Shrub	N
i1	*Ledum groenlandicum*	Labrador tea	Shrub	N
i1	*Limprichtia revolvens*	Brown moss	Moss	N
i1	*Lonicera caerulea*	Fly honeysuckle	Shrub	N
i1	*Lonicera caerulea var. villosa*	Fly honeysuckle	Shrub	N
i1	*Mitella nuda*	Bishop's-cap, Mitrewort	Forb	N
i1	*Moss spp.*		Moss	N
i1	*Orthelia secunda*	One-sided wintergreen	Forb	N
i1	*Oxycoccus microcarpus*	Small bog cranberry	Shrub	N
i1	*Oxycoccus quadripetalus*	Bog cranberry	Shrub	N
i1	*Parmelia sulcata*	Waxpaper lichen	Lichen	N
i1	*Parnassia palustris*	Grey starburst	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
i1	*Pedicularis labradorica*	Labrador lousewort	Forb	N
i1	*Peltigera spp.*		Lichen	N
i1	*Petasites frigidus var x vitifolius*	Vine-leaved coltsfoot	Forb	N
i1	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
i1	*Picea mariana*	Black spruce	Shrub	N
i1	*Plagiomnium ellipticum*	Marsh magnificent moss	Moss	N
i1	*Pleurozium schreberi*	Big red stem	Moss	N
i1	*Polytrichum strictum*	Slender hair-cap	Moss	N
i1	*Potentilla palustris*	Marsh cinquefoil	Forb	N
i1	*Ptilium crista-castrensis*	Knight's plume	Moss	N
i1	*Pyrola asarifolia*	Pink wintergreen	Forb	N
i1	*Ranunculus lapponicus*	Lapland buttercup	Forb	N
i1	*Ribes triste*	Wild red currant	Shrub	N
i1	*Rosa acicularis*	Prickly rose	Shrub	N
i1	*Rubus arcticus spp. acaulis*	Dwarf raspberry	Forb	N
i1	*Rubus chamaemorus*	Cloudberry, Bakeapple	Forb	N
i1	*Rubus idaeus*	Wild red raspberry	Shrub	N
i1	*Rumex spp..*		Forb	N
i1	*Salix athabascensis*	Athabasca willow	Shrub	N
i1	*Salix candida*	Hoary willow	Shrub	N
i1	*Salix glauca*	Grey-leaved willow	Shrub	N
i1	*Salix maccalliana*	Velvet fruited willow	Shrub	N
i1	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
i1	*Salix myrtillifolia var. pseudomyrsinites*	Tall blueberry willow	Shrub	N
i1	*Salix pedicellaris*	Bog willow	Shrub	N
i1	*Salix planifolia*	Flat leaved willow	Shrub	N
i1	*Salix pyrifolia*	Balsam willow	Shrub	N
i1	*Salix serissima*	Autumn willow	Shrub	N
i1	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
i1	*Sphagnum angustifolium*	Yellow-green peat moss	Moss	N
i1	*Sphagnum fuscum*	Common brown sphagnum	Moss	N
i1	*Sphagnum spp.*	Peat moss	Moss	N
i1	*Stellaria longifolia*	Long-leaved chickweed	Forb	N
i1	*Stellaria longipes*	Long-stalked chickweed	Forb	N
i1	*Usnea spp.*		Lichen	N
i1	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
i2	*Andromeda polifolia*	Bog rosemary	Shrub	N
i2	*Betula glandulosa*	Bog birch	Shrub	N
i2	*Carex aquatilis*	Water sedge	Grass	N
i2	*Carex chordorrhiza*	Creeping sedge	Grass	N
i2	*Carex limosa*	Mud sedge	Grass	N
i2	*Carex rostrata*	Beaked sedge	Grass	N
i2	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
i2	*Drosera rotundifolia*	Sundew	Forb	N
i2	*Eriophorum vaginatum*	Sheathed cotton grass	Grass	N
i2	*Larix laricina*	Tamarack	Shrub	N
i2	*Ledum groenlandicum*	Labrador Tea	Shrub	N
i2	*Oxycoccus microcarpus*	Small bog cranberry	Shrub	N
i2	*Oxycoccus quadripetalus*	Bog cranberry	Shrub	N
i2	*Picea mariana*	Black spruce	Shrub	N
i2	*Salix pedicellaris*	Bog willow	Shrub	N
i2	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
i2	*Sphagnum spp.*	Peat moss	Moss	N
i2	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
j1	*Achillea millifolium*	Yarrow	Forb	N
j1	*Alnus crispa*	Green alder	Shrub	N
j1	*Andromeda polifolia*	Bog rosemary	Shrub	N
j1	*Aulacomnium palustre*	Tufted moss	Moss	N
j1	*Betula glandulosa*	Bog birch	Shrub	N
j1	*Betula neoalaskana*	Alaska birch	Shrub	N
j1	*Betula pumila*	Dwarf birch	Shrub	N
j1	*Bryoria spp.*		Lichen	N
j1	*Bryum pseudotriquetrum*	Tall clustered thread moss	Moss	N
j1	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
j1	*Calamagrostis stricta*	Slimstem reed grass	Grass	N
j1	*Calliergon giganteum*	Giant water moss	Moss	N
j1	*Caltha palustris*	Marsh marigold	Forb	N
j1	*Campylium stellatum*	Yellow star moss	Moss	N
j1	***Cardamine pratensis***	**Meadow bitter cress**	**Forb**	**Y**
j1	***Cardamine pratensis L. ssp palustris***	**Cuckoo Flower**	**Forb**	**Y**
j1	*Carex aenea*	Bronze sedge	Grass	N
j1	*Carex aquatilis*	Water sedge	Grass	N
j1	*Carex brunnescens*	Brownish sedge	Grass	N
j1	*Carex capillaris*	Hair-like sedge	Grass	N
j1	*Carex chordorrhiza*	Creeping sedge	Grass	N
j1	*Carex diandra*	Two stamened sedge	Grass	N
j1	*Carex disperma*	Two seeded sedge	Grass	N
j1	*Carex gynocrates*	Northern bog sedge	Grass	N
j1	*Carex leptalea*	Bristel stalked sedge	Grass	N
j1	*Carex limosa*	Mud sedge	Grass	N
j1	*Carex loliacea*	Rye grass sedge	Grass	N
j1	*Carex paupercula*	Bog sedge	Grass	N
j1	*Carex prairea*	Prairie sedge	Grass	N
j1	*Carex rostrata*	Beaked sedge	Grass	N
j1	*Carex spp.*		Grass	N
j1	*Carex tenuiflora*	Thin flowered sedge	Grass	N
j1	*Carex vaginata*	Sheathed sedge	Grass	N
j1	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
j1	Cicuta bulbifera	Bublet water hemlock	Forb	N
j1	Cicuta virosa	Northern water hemlock	Forb	N
j1	Cladina mitis	Yellow reindeer lichen	Lichen	N
j1	Cladina rangiferina	Reindeer lichen	Lichen	N
j1	Coptis trifolia	Goldthread	Forb	N
j1	Dicranum spp.		Moss	N
j1	Dicranum undulatum	Wavy dicranum	Moss	N
j1	Drepanocladus aduncus	Common hook moss	Moss	N
j1	Drosera rotundifolia	Sundew	Forb	N
j1	Eleocharis quinqueflora	Fewflower spikerush	Grass	N
j1	Elymus innovatus	Hairy wild rye	Grass	N
j1	Empetrum nigrum	Crowberry	Shrub	N
j1	Epilobium angustifolium	Fireweed	Forb	N
j1	Epilobium leptophyllum	Narrow leaved willowherb	Forb	N
j1	Epilobium palustre	Marsh willowherb	Forb	N
j1	Epilobium spp.		Forb	N
j1	Equisetum arvense	Common horsetail	Forb	N
j1	Equisetum fluviatile	Swamp horsetail	Forb	N
j1	Equisetum hyemale	Scouring rush	Forb	N
j1	Equisetum scirpoides	Dwarf scouring rush	Forb	N
j1	Equisetum sylvaticum	Woodland horsetail	Forb	N
j1	Eriophorum chamissonis	Russet cotton grass	Grass	N
j1	Eriophorum vaginatum	Sheathed cotton grass	Grass	N
j1	Evernia spp.		Lichen	N
j1	Fragaria virginiana	Wild strawberry	Forb	N
j1	Galium boreale	Northern bedstraw	Forb	N
j1	Galium labridoricum	Labrador bedstraw	Forb	N
j1	Galium trifidum	Small bedstraw	Forb	N
j1	Galium triflorum	Sweet-scented bedstraw	Forb	N
j1	Habenaria hyperborea	Northern green orchid	Forb	N
j1	Hamatocaulis vernicosus	Stick hook moss	Moss	N
j1	Helodium blandowii	Blandow's feather moss	Moss	N
j1	Hylocomium splendens	Stair-step moss	Moss	N
j1	Hypnum lindbergii	Clay pigtail moss	Moss	N
j1	Hypogymnia physodes	Monk's hood lichen	Lichen	N
j1	Kalmia polifolia	Bog laurel	Shrub	N
j1	Larix laricina	Tamarack	Shrub	N
j1	Ledum groenlandicum	Labrador tea	Shrub	N
j1	Limprichtia revolvens	Brown moss	Moss	N
j1	Linnaea borealis	Twin-flower	Shrub	N
j1	Lonicera caerulea	Fly honeysuckle	Shrub	N
j1	Lysimachia thyrsiflora	Tufted Loosestrife	Forb	N
j1	Maianthemum canadense	Wild lily-of-the-valley	Forb	N
j1	Meesia uliginosa	Meesia moss	Moss	N
j1	Melampyrum lineare	Cow-wheat	Forb	N
j1	Menyanthes trifoliata	Buck-bean	Forb	N
j1	Mertensia paniculata	Tall mertensia	Forb	N
j1	Mitella nuda	Bishop's-cap, Mitrewort	Forb	N
j1	Moehringia lateriflora	Blunt-leaved Sandwort	Forb	N
j1	Myurella julacea	Small mouse-tail moss	Moss	N
j1	Orthelia secunda	One-sided wintergreen	Forb	N
j1	Oxycoccus microcarpus	Small bog cranberry	Shrub	N
j1	Oxycoccus quadripetalus	Bog cranberry	Shrub	N
j1	Parmelia spp.		Lichen	N
j1	Parnassia palustris	Grey starburst	Forb	N
j1	Pedicularis labradorica	Labrador lousewort	Forb	N
j1	Pedicularis parviflora	Swamp lousewort	Forb	N
j1	Peltigera aphthosa	Freckle pelt	Lichen	N
j1	Peltigera neopolydactyla	Frog pelt	Lichen	N
j1	Peltigera spp.		Lichen	N
j1	Petasites palmatus	Palmate-leaved coltsfoot	Forb	N
j1	Petasites sagittatus	Arrow-leaved coltsfoot	Forb	N
j1	Picea mariana	Black spruce	Forb	N
j1	Plagiomnium cuspidatum	Woodsy mnium	Moss	N
j1	Plagiomnium ellipticum	Marsh magnificent moss	Moss	N
j1	Pleurozium schreberi	Big red stem	Moss	N
j1	Pohlia nutans	Copper wire moss	Moss	N
j1	Polytrichum spp.		Moss	N
j1	Polytrichum strictum	Slender hair-cap	Moss	N
j1	Potentilla palustris	Marsh cinquefoil	Forb	N
j1	Ptilium crista-castrensis	Knight's plume	Moss	N
j1	Pyrola asarifolia	Pink wintergreen	Forb	N
j1	Pyrola minor	Lesser wintergreen	Forb	N
j1	Ranunculus lapponicus	Lapland buttercup	Forb	N
j1	Rhamnus alnifolia	alder-leaved Buckthorn	Shrub	N
j1	Ribes hudsonianum	Wild black currant	Shrub	N
j1	Ribes lacustre	Bristly black currant	Shrub	N
j1	Ribes oxyacanthoides	Wild gooseberry	Shrub	N
j1	Ribes triste	Wild red currant	Shrub	N
j1	Rosa acicularis	Prickly rose	Shrub	N
j1	Rubus arcticus spp. acaulis	Dwarf raspberry	Forb	N
j1	Rubus chamaemorus	Cloudberry, Bakeapple	Forb	N
j1	Rumex crispus	Curled dock	Forb	N
j1	Salix athabascensis	Athabasca willow	Shrub	N
j1	Salix bebbiana	Beaked willow	Shrub	N
j1	Salix candida	Hoary willow	Shrub	N
j1	Salix glauca	Grey-leaved willow	Shrub	N
j1	Salix lucida ssp. lassiandra	Western shining willow	Shrub	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
j1	*Salix maccalliana*	Velvet fruited willow	Shrub	N
j1	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
j1	*Salix myrtillifolia var. pseudomyrsinites*	Tall blueberry willow	Shrub	N
j1	*Salix pedicellaris*	Bog willow	Shrub	N
j1	*Salix planifolia*	Flat leaved willow	Grass	N
j1	*Smilacina stellata*	Star-flowered Solomon's-seal	Forb	N
j1	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
j1	*Sphagnum angustifolium*	Yellow-green peat moss	Moss	N
j1	*Sphagnum fuscum*	Common brown sphagnum	Moss	N
j1	*Sphagnum spp.*	Peat moss	Moss	N
j1	*Spiranthes romanzoffiana*	Ladies'-tresses	Forb	N
j1	*Stellaria crassifolia*	Fleshy stitchwort	Forb	N
j1	*Stellaria longifolia*	Long-leaved chickweed	Forb	N
j1	*Stellaria longipes*	Long-stalked chickweed	Forb	N
j1	*Tomenthypnum nitens*	Golden fuzzy fen moss	Moss	N
j1	*Triglochin maritima*	Seaside arrowgrass	Forb	N
j1	*Usnea spp.*		Lichen	N
j1	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
j1	*Viola renifolia*	Kidney-leaved violet	Forb	N
j1	*Warnstorfia fluitans*	Warnstorfia moss	Moss	N
j2	*Achillea millifolium*	Yarrow	Forb	N
j2	*Agrostis scabra*	Hair grass	Grass	N
j2	*Andromeda polifolia*	Bog rosemary	Shrub	N
j2	*Arctostaphylos uva-ursi*	Bearberry	Shrub	N
j2	*Aulacomnium palustre*	Tufted moss	Moss	N
j2	*Betula glandulosa*	Bog birch	Shrub	N
j2	*Betula pumila*	Dwarf birch	Shrub	N
j2	*Brachythecium turgidum*	Thick ragged moss	Moss	N
j2	*Bryum caespiticium*	Dry calcareous bryum	Moss	N
j2	*Bryum pseudotriquetrum*	Tall clustered thread moss	Moss	N
j2	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
j2	*Calliergon giganteum*	Giant water moss	Moss	N
j2	*Caltha palustris*	Marsh marigold	Forb	N
j2	***Cardamine pratensis L. ssp palustris***	**Cuckoo Flower**	**Forb**	**Y**
j2	*Carex aquatilis*	Water sedge	Grass	N
j2	*Carex aurea*	Golden sedge	Grass	N
j2	*Carex chordorrhiza*	Creeping sedge	Grass	N
j2	*Carex diandra*	Two stamened sedge	Grass	N
j2	*Carex disperma*	Two seeded sedge	Grass	N
j2	*Carex gynocrates*	Northern bog sedge	Grass	N
j2	***Carex heleonastes***	**Hudson Bay sedge**	**Grass**	**Y**
j2	*Carex lasiocarpa*	Wolly fruit sedge	Grass	N
j2	*Carex leptalea*	Bristel stalked sedge	Grass	N
j2	*Carex limosa*	Mud sedge	Grass	N
j2	*Carex paupercula*	Bog sedge	Grass	N
j2	*Carex rostrata*	Beaked sedge	Grass	N
j2	*Carex tenuiflora*	Thin flowered sedge	Grass	N
j2	*Carex utriculata*	Beaked sedge	Grass	N
j2	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
j2	***Chrysosplenium tetrandrum***	**Green Saxifrage**	**Forb**	**Y**
j2	*Cicuta bulbifera*	Bublet water hemlock	Forb	N
j2	*Cicuta virosa*	Northern water hemlock	Forb	N
j2	*Cladina rangiferina*	Reindeer lichen	Lichen	N
j2	*Corallorhiza trifida*	Pale coral-root	Forb	N
j2	*Drosera anglica*	Sundew	Forb	N
j2	*Drosera rotundifolia*	Sundew	Forb	N
j2	*Epilobium angustifolium*	Fireweed	Forb	N
j2	*Epilobium leptophyllum*	Narrow leaved willowherb	Forb	N
j2	*Epilobium palustre*	Marsh willowherb	Forb	N
j2	*Equisetum fluviatile*	Swamp horsetail	Forb	N
j2	*Equisetum scirpoides*	Dwarf scouring rush	Forb	N
j2	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
j2	*Eriophorum chamissonis*	Russet cotton grass	Grass	N
j2	*Eriophorum gracile*	Slender cotton grass	Grass	N
j2	*Eriophorum viridi-carinatum*	Thinleaf cottonsedge	Grass	N
j2	*Evernia spp.*		Lichen	N
j2	*Galium boreale*	Northern bedstraw	Forb	N
j2	*Galium labridoricum*	Labrador bedstraw	Forb	N
j2	*Habenaria hyperborea*	Northern green orchid	Forb	N
j2	*Helodium blandowii*	Blandow's feather Moss	Moss	N
j2	*Hypnum pratense*	Meadow pigtail moss	Moss	N
j2	***Juncus stygius***	**Stygian Rush**	**Grass**	**Y**
j2	*Larix laricina*	Tamarack	Shrub	N
j2	*Lathyrus ochroleucus*	Creamy peavine	Forb	N
j2	*Ledum groenlandicum*	Labrador tea	Shrub	N
j2	*Leptobryum pyriforme*	Long-necked bryum	Moss	N
j2	*Limprichtia revolvens*	Brown moss	Moss	N
j2	*Lonicera caerulea*	Fly honeysuckle	Shrub	N
j2	*Lysimachia thyrsiflora*	Tufted Loosestrife	Forb	N
j2	*Menyanthes trifoliata*	Buck-bean	Forb	N
j2	*Mitella nuda*	Bishop's-cap, Mitrewort	Forb	N
j2	*Orthelia secunda*	One-sided wintergreen	Forb	N
j2	*Oxycoccus microcarpus*	Small bog cranberry	Shrub	N
j2	*Oxycoccus quadripetalus*	Bog cranberry	Shrub	N
j2	*Parnassia palustris*	Grey starburst	Forb	N
j2	*Pedicularis labradorica*	Labrador lousewort	Forb	N
j2	*Pedicularis parviflora*	Swamp lousewort	Forb	N
j2	*Peltigera aphthosa*	Freckle pelt	Lichen	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
j2	*Petasites palmatus*	Palmate-leaved coltsfoot	Forb	N
j2	*Picea mariana*	Black spruce	Shrub	N
j2	*Pinus banksiana*	Jack pine	Shrub	N
j2	*Plagiomnium drummondii*	Drummond's leafy moss	Moss	N
j2	*Plagiomnium ellipticum*	Marsh magnificent moss	Moss	N
j2	*Populus tremuloides*	Trembling aspen	Shrub	N
j2	*Potentilla palustris*	Marsh cinquefoil	Forb	N
j2	*Potentilla tridentata*	Three-toothed cinquefoil	Forb	N
j2	*Pyrola asarifolia*	Pink wintergreen	Forb	N
j2	*Ranunculus lapponicus*	Lapland buttercup	Forb	N
j2	*Rosa acicularis*	Prickly rose	Shrub	N
j2	*Rubus arcticus spp. acaulis*	Dwarf raspberry	Forb	N
j2	*Rumex spp.*		Forb	N
j2	*Salix athabascensis*	Athabasca willow	Shrub	N
j2	*Salix candida*	Hoary willow	Shrub	N
j2	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
j2	*Salix myrtillifolia var. pseudomyrsinites*	Tall blueberry willow	Shrub	N
j2	*Salix pedicellaris*	Bog willow	Shrub	N
j2	*Salix planifolia*	Flat leaved willow	Shrub	N
j2	*Salix pyrifolia*	Balsam willow	Shrub	N
j2	*Salix serissima*	Autumn willow	Shrub	N
j2	*Sanionia uncinata*	Sickle moss	Moss	N
j2	***Sarracenia purpurea***	**Pitcher Plant**	**Forb**	**Y**
j2	*Scheuchzeria palustris*	Rannoch rush	Grass	N
j2	*Scorpidium scorpioides*	Scoroidium moss	Moss	N
j2	*Sium suave*	Water parsnip	Forb	N
j2	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
j2	*Sphagnum sp.*	Peat moss	Moss	N
j2	*Spiranthes romanzoffiana*	Ladies'-tresses	Forb	N
j2	*Stellaria borealis*	Boreal starwort	Forb	N
j2	*Stellaria longifolia*	Long-leaved chickweed	Forb	N
j2	*Tomenthypnum nitens*	Golden fuzzy fen moss	Moss	N
j2	*Triglochin maritima*	Seaside arrowgrass	Forb	N
j2	*Usnea spp.*		Lichen	N
j2	*Utricularia intermedia*	Flat-leaved bladderwort	Forb	N
j2	*Utricularia minor*	Small bladderwort	Forb	N
j2	*Vaccinium myrtilloides*	Blueberry	Shrub	N
j2	*Vaccinium vitis-idaea*	Bog cranberry	Shrub	N
j2	*Warnstorfia exannulata*	Brown moss	Moss	N
j3	*Andromeda polifolia*	Bog rosemary	Shrub	N
j3	*Betula glandulosa*	Bog birch	Shrub	N
j3	*Betula pumila*	Dwarf birch	Shrub	N
j3	*Calamagrostis canadensis*	Bluejoint, Marsh reed grass	Grass	N
j3	*Calamagrostis stricta*	Slimstem reedgrass	Grass	N
j3	*Calla palustris*	Water arum, Wild calla	Forb	N
j3	*Carex aquatilis*	Water sedge	Grass	N
j3	*Carex curta*	Short sedge	Grass	N
j3	*Carex diandra*	Two stamened sedge	Grass	N
j3	*Carex lasiocarpa*	Wolly fruit sedge	Grass	N
j3	*Carex limosa*	Mud sedge	Grass	N
j3	***Carex rostrata***	**Beaked sedge**	**Grass**	**Y**
j3	*Chamaedaphne calyculata*	Leather-leaf	Shrub	N
j3	*Cicuta bulbifera*	Bublet water hemlock	Forb	N
j3	*Cicuta virosa*	Northern water hemlock	Forb	N
j3	*Epilobium leptophyllum*	Narrow leaved willowherb	Forb	N
j3	*Eriophorum chamissonis*	Russet cotton grass	Grass	N
j3	*Eriophorum gracile*	Slender cotton grass	Grass	N
j3	*Eriophorum polystachion*	Tall cotton grass	Grass	N
j3	*Eriophorum vaginatum*	Sheathed cotton grass	Grass	N
j3	*Galium labridoricum*	Labrador bedstraw	Forb	N
j3	*Kalmia polifolia*	Bog laurel	Shrub	N
j3	*Larix laricina*	Tamarack	Shrub	N
j3	*Ledum groenlandicum*	Labrador tea	Shrub	N
j3	*Limprichtia revolvens*	Brown moss	Moss	N
j3	*Lycopus uniflorus*	Northern bugleweed	Forb	N
j3	*Lysimachia thyrsiflora*	Tufted loosestrife	Forb	N
j3	*Menyanthes trifoliata*	Buck-bean	Forb	N
j3	*Nuphar variegatum*	Yellow pond-lily	Forb	N
j3	*Oxycoccus microcarpus*	Small bog cranberry	Shrub	N
j3	*Oxycoccus quadripetalus*	Bog cranberry	Shrub	N
j3	*Picea mariana*	Black spruce	Shrub	N
j3	*Polygonum amphibium*	Water Smartweed	Forb	N
j3	***Potamogeton natans***	**Floating-leaved pondweed**	**Forb**	**Y**
j3	***Potamogeton praelongus***	**White-stem pondweed**	**Forb**	**Y**
j3	*Potamogeton zosteriformis*	Flat-stem pondweed	Forb	N
j3	*Potentilla palustris*	Marsh cinquefoil	Forb	N
j3	*Rumex spp.*		Forb	N
j3	*Scutellaria galericulata*	Skullcap	Forb	N
j3	*Smilacina trifolia*	Three-leaved Solomon's-seal	Forb	N
j3	***Sparganium spp***		**Forb**	**Y (?)**
j3	*Sphagnum spp.*	Peat moss	Moss	N
j3	*Triglochin maritima*	Seaside arrowgrass	Forb	N
j3	*Typha latifolia*	Common cattail	Forb	N
j3	*Utricularia intermedia*	Flat-leaved bladderwort	Forb	N
j3	*Utricularia vulgaris*	Common bladderwort	Forb	N
BU	*Achillea millifolium*	Yarrow	Forb	N
BU	*Aster ciliolatus*	Lindley's aster	Forb	N
BU	*Campanula rotundifolia*	Bluebell	Forb	N

Appendix E Species List for Each Ecosite in the Area of the LSA in the Central Mixedwood and Lower Boreal Highland Subregions

Ecosite Phase	Scientific Name	Common Name	Life Form	Rare (Yes/No)
BU	*Cornus canadensis*	Bunchberry	Forb	N
BU	*Corydalis aurea*	Golden corydalis	Forb	N
BU	*Dracocephalum parviflorum*	American dragonhead	Forb	N
BU	*Elymus innovatus*	Hairy wild rye	Grass	N
BU	*Epilobium angustifolium*	Fireweed	Forb	N
BU	*Epilobium ciliatum*	Northern willowherb	Forb	N
BU	*Equisetum arvense*	Common horsetail	Forb	N
BU	*Equisetum scirpoides*	Dwarf scouring rush	Forb	N
BU	*Equisetum sylvaticum*	Woodland horsetail	Forb	N
BU	*Erigeron acris*	Northern daisy fleabane	Forb	N
BU	*Geranium bicknellii*	Bicknell's geranium	Forb	N
BU	*Lathyrus ochroleucus*	Creamy peavine	Forb	N
BU	*Ledum groenlandicum*	Labrador tea	Shrub	N
BU	*Linnaea borealis*	Twin-flower	Shrub	N
BU	*Lonicera caerulea*	Fly honeysuckle	Shrub	N
BU	*Marchantia polymorpha*	Green-tongue liverwort	Forb	N
BU	*Pedicularis labradorica*	Labrador lousewort	Forb	N
BU	*Petasites palmatus*	Palmate-leaved Coltsfoot	Forb	N
BU	*Phacelia franklinii*	Scorpion weed	Forb	N
BU	*Populus balsamifera*	Balsam poplar	Shrub	N
BU	*Rosa acicularis*	Prickly rose	Shrub	N
BU	*Salix myrtillifolia*	Myrtle leaved willow	Shrub	N
BU	*Solidago multiradiata*	Northern goldenrod	Forb	N
BU	*Stellaria longipes*	Long-stalked chickweed	Forb	N
BU	*Vaccinium myrtilloides*	Blueberry	Shrub	N
BU	*Vicia americana*	Wild vetch	Forb	N

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11A1   HABITAT EVALUATION PROCEDURES

The following Habitat Evaluation Procedure (HEP) models are designed to provide an assessment of the potential for the local and regional study areas (LSA and RSA) to support the selected indicators. The models assess the potential impacts to habitat from the Project. This assessment was based on the following procedures:

- Delineate habitat types within the LSA and RSA;

- Determine habitat characteristics within the LSA and RSA;

- Develop HEP models based on habitat requirements of indicators; and

- Calculate for each indicator, the amount of habitat available (measured in habitat units) within the LSA and RSA (depending on species).

The models presented in this report were adapted and modified from the models provided in DCEL (2005), except woodland caribou, muskrat, barred owl, northern goshawk, and boreal owl. This report provides information specific to the model mechanics since the background information is available from numerous sources including DCEL (2005). Since the species listed above were not included in DCEL (2005), a detailed model is presented in this report.

11A1.1   Habitat Suitability Indices

With HEP, the value of a habitat type for a given species is the product of the quality of the area multiplied by the size of the area:

Habitat Value = Habitat Quality X Habitat Quantity

Habitat quality in the above formula is expressed in the form of a habitat suitability index (an HSI) that measures how suitable the habitat type is for a particular species when compared to optimal habitat. This index varies from 0–1 (0 represents unsuitable habitat and 1 represents optimal habitat). The quantity part of the formula is any measure of area (i.e., acres, hectares, square miles, or sections), which is appropriately sized for the particular study. The product of these two variables, called "habitat value" is expressed as a Habitat Unit (HU). The measure of habitat unit becomes:

$$HU = \sum(HSI_i \times A_i)$$

where:

HSI_i = the Habitat Suitability Index for ecosite phase (habitat type) polygon i and A_i = the area (ha) of that particular habitat polygon and summed across the study area.

Habitat suitability refers to the ability of a land unit to provide essential life requisites (i.e., food and/or cover) for a given wildlife species based on measurable variables such as vegetation (e.g., tree canopy cover or tree height) or terrain characteristics. Habitat Suitability Index modeling assumes that measurable parameters can be used to predict the ability of the land unit to support a particular wildlife species. In addition to the relative value of an area based on ecological components, habitat suitability can also be expressed as a function of both habitat availability and habitat effectiveness based on proximity to anthropogenic disturbances.

11A1.1.1 Habitat Availability

Environmental, spatial and temporal parameters with predictive value for species preference or avoidance are selected for inclusion in an HSI model. Selection of these parameters is based on a combination of literature review, expert opinion and traditional ecological knowledge. The amount of habitat available is simply the sum of all these products. HU calculations are based on habitat types and disturbance features on the project area landscape (identified as a biophysical map).

11A1.1.2 Habitat Effectiveness

Habitat effectiveness refers to the ability of a habitat to support a given species relative to local disturbance factors (i.e., the willingness of a species to utilize a particular habitat). For example, a particular area may not be suitable at a given time of year because of human disturbance (Jalkotzy et al. 1997). Wildlife responses to human developments and disturbances can be incorporated into the modeling process by weighting components according to their known effects, or suspected effects based on professional judgment, on species behavior based on empirical research. For certain species, habitat in close proximity to intensive land-use activities (known as a Region of Influence, ROI) has lower habitat effectiveness than comparable land units in remote areas. The extent of the ROI depends on the sensitivity of a given species, the terrain and vegetation characteristics surrounding the activity and the intensity and duration of the particular activity. ROI are therefore variable among species based on empirical evidence, when available. Within the modeling process, a disturbance coefficient is applied to the HSI values within the ROI reflecting the reduction in overall suitability of the habitat. For several species, an ROI is not applicable because the literature does not indicate avoidance behavior. Typically, ungulates and carnivores display avoidance of human activities based on a learned response.

11A1.2 Model Validation

Wildlife surveys were conducted in the LSA and surrounding oil sands area in general, which provided data on habitat use by wildlife. We compared model predictions of habitat suitability with these data on species habitat use where applicable if adequate data were available. For wide ranging species such as lynx, moose and caribou data from winter tracking and scat data were used. A selectivity index was used, where empirical animal locations were compared to random locations. This index is scaled from -1 to +1, where a negative value indicates avoidance or not preferred; a positive value indicates preference; a value of 0 indicates random habitat selection.

11A1.3 Canadian Toad Habitat Suitability Model

11A1.3.1 Introduction

The Canadian toad has highly specific habitat requirements that include various types of wetlands for breeding, upland deciduous dominated habitats for foraging, and sandy sites most often dominated by jack pine, for hibernation. The highest-quality habitat occurs where these features are all within 1,000 m. The following assumptions and limitations are specific to this model:

- The model evaluates year round habitat requirements;

- Ponds, lake margins, streams and beaver impoundments are suitable breeding habitat;

- During summer, toads use a variety of habitats near water, most frequently in aspen-dominated stands;

- Hibernation sites are limiting compared to upland habitats used in post breeding periods;

- Hibernation sites are limited to sandy soils within 1,000 m of breeding habitats; and,

- Model is adapted for habitat requirements in northeastern Alberta.

11A1.3.2 Model Mechanics

Habitat is optimal for Canadian toads when the following three parameters occur together:

- The availability of suitable breeding wetlands;

- Suitable upland aspen areas near these wetlands; and,

- Suitable soil types for hibernation near breeding wetlands and aspen foraging areas.

Breeding and foraging habitat include the water source itself and terrestrial habitats within 1,000 m from the water source. Upland ecosite phases with aspen dominance are preferred. Since each component is required for life requisites of the Canadian toad, each component has been assessed separately. Each essential habitat component was then buffered by 1,000 m and high suitable habitat within the buffered area was considered high quality habitat for the Canadian toad. Habitat outside this buffered area was reduced to unsuitable habitat. The following formulae were used to calculate Habitat Suitability Indices for Canadian toad:

$$\text{HSI}_{\text{Foraging habitat}} = \text{SI}_{\text{Aspen dominance}};$$

$$\text{HSI}_{\text{Hibernating habitat}} = \text{SI}_{\text{Soil Substrate}}; \text{ and,}$$

$$\text{HSI}_{\text{Breeding}} = \text{SI}_{\text{water}} = 1.0$$

11A1.3.2.1   Spatial Variables

The juxtaposition of the three habitat variables is required to be considered high suitable habitat for the Canadian toad. The three habitats required (i.e., breeding wetland, aspen foraging habitat, hibernating habitat) must be within 1,000 m of each other. All suitable habitats outside this buffer are rated as unsuitable.

11A1.3.3 Model Validation

No toads were detected during the 2006 survey. Therefore, a model validation could not be completed.

A model validation for the Nexen Long Lake South was conducted. Data on habitat use by toads from a spring Canadian toad survey and monitoring were used to validate this model. A total of 46 Canadian toads were detected at 22 sites in the Nexen LSA. Canadian toad locations were overlaid atop habitat suitability maps and toad locations were queried to the corresponding habitat values. Eighty-two percent (n = 18) of the toads occurred in high-quality habitat, none occurred in medium quality habitat, 18% occurred in low-quality habitat and none occurred in unsuitable habitat However, the toad locations in low quality habitat were in very close proximity to high-quality habitat. Most of these locations were triangulated from two separate points and therefore the positions are an approximation. This may explain why some toad locations did not occur in high-quality habitat. Overall, this model is a reliable predictor of Canadian toad habitat at the scale of the LSA.

11A1.4 Northern Goshawk Habitat Suitability Model

11A1.4.1 Introduction

Northern goshawks (goshawk) occupy many different ecoregions of North America (Hawk Mountain Wildlife Sanctuary 2007). For this HSI model, habitats used by goshawks throughout their range were identified from the literature, with specific emphasis on the western and northern Canadian portions of their distribution. Where possible, background data was cited for studies from regions of similar habitat characteristics to the project area. The HSI model used here was adapted from Schaffer et al. (1999), which was developed for use in the boreal forest of Alberta and in the Foothills Model Forest in west-central, Alberta. Additional model parameters and model structure were also incorporated from a model developed by Mahon et al. (2003 - draft) for northern British Columbia.

11A1.4.2 Review of Important Habitat Components

11A1.4.2.1   General

The goshawk has a circumpolar Holarctic distribution, inhabiting boreal and temperate forests in North America, Europe, northwestern Africa, continental Asia and Japan (Hawk Mountain Wildlife Sanctuary 2007). The North American distribution of the goshawk occurs in Canada, the northern United States (including much of Alaska), the mountainous western United States and northwestern Mexico. In Canada, goshawks are distributed from coast to coast, extending northward to the southern Mackenzie District of NWT, southern Nunavut and Yukon Territory. In Alberta and Saskatchewan, generally do not occur in unsuitable (i.e., unforested) habitats of the south-eastern grasslands of the province (Royal Alberta Museum, 2006).

SARA/COSEWIC lists the Canadian population of the goshawk as 'Not at Risk', although Alberta Sustainable Resource Development defines the species as 'Sensitive' due to their requirement for relatively large tracts of mature or old-growth forest for successful nesting and foraging (ASRD 2006; COSEWIC 2007). The greatest threat posed to goshawks is from human activity and encroachment and the species is particularly sensitive to deforestation, which causes reduction and fragmentation of their habitats (Mahon et al 2003 – draft). Contaminant bioaccumulation of environmental pollution in these top predators is also of concern, as this can lead to physiological stress and in some cases be fatal (Senthilkumar et a.l 2002; Kenntner et al 2003).

11A1.4.3 Model Construction and Suitability Ratings

11A1.4.3.1   Model Variables

The model includes many variables. They include nesting site habitat variables: canopy tree closure (N_1) – nesting, canopy tree height (N_2), stand structural stage (N_3), percent deciduous in canopy (N_4), minimum contiguous suitable nesting habitat (N_5), minimum nest period foraging area (N_6), human disturbance to nesting (N_7) and foraging habitat variables; stand structural stage, percent canopy closure – foraging, prey abundance and minimum foraging area.

11A1.4.4 Model Mechanics

This model is a two part model that is designed to have nest and forage run separately. First, the Forage model is run to define foraging quality. Following this, Nest model is run to delineate areas with suitable forest structure for nest sites. Finally, if the area around a suitable nest site

has sufficient forage quality in the surrounding buffer zone, the area is then defined categorically Overall as high, moderate or low quality goshawk habitat.

The following information details limitations and formulae for the goshawk habitat model:

1. run (**HSI $_{Forage}$**) to define foraging habitat quality across region;

2. run (**HSI $_{Nest}$**) to define sites with suitable forest structure to support nesting (sites with **HSI $_{Nest}$** > 0.67 considered to be selected as nesting sites);

3. run (**HSI $_{Overall}$**) = to define areas with suitable nest characteristics that are surrounded by a sufficiently large regions of high quality forage habitat.

HSI $_{Forage}$ = (SI Structural Stage) x (SI Canopy Tree Closure) x (SI $_{maximum}$ Snowshoe hare)

The Forage value of an area is directly influenced by potential prey abundance (maximum snowshoe hare SI value), forest structural values that influence prey availability to goshawks (structural stage, canopy closure, forest gaps) and amount of foraging habitat within the territory home range (minimum HR forage area).

The Forage sub-model follows a non-compensatory design, where low suitability in one variable can not be compensated for by a higher rating for another variable.

HSI $_{Nest}$ = (SI Canopy Tree Closure) x (SI Stand Height) x (SI Structural Stage) x (Percent Deciduous) x (Human Disturbance Coefficients) x (Minimum Nest Habitat - Buffer) x (Minimum Nesting Forage Area - Buffer)

The Nest sub-model defines the minimum requirements for a suitable nest site. Effects of human disturbances are built in. The nest cover value of the habitat is a combination of forest structural characteristics, available forage and low human disturbance. Basic nest cover requirements are considered more important than foraging quality and the model is structured keeping this in mind. Sites with **HSI $_{Nest}$** > 0.67 are considered to be selected as nesting sites. High quality areas are also assessed as to whether they meet the minimum size requirements. Finally, sites that meet the minimum nest habitat standards are further assessed as to whether enough foraging habitat is available.

HSI $_{Overall}$ = (SI Minimum Home Range Forage Area% Quality - Buffer), applied around suitable nest sites.

Overall habitat suitability is the combination of forage availability and nest cover. Both food and cover availability must be > 0 to produce a positive final SI value. The Overall model follows a non-compensatory, limiting factor approach where low suitability in one nesting variable can not be compensated by a higher rating for another variable.

11A1.4.5 Model Validation

No data were available with which to test and validate this model. No goshawks were observed, so the fit of the model cannot be evaluated.

11A1.5 Great Gray Owl Habitat Suitability Model

11A1.5.1 Introduction

The great gray owl has complex habitat requirements. Nesting sites are located near suitable foraging habitats consisting of habitats preferred by their primary prey species, the meadow vole. Meadow voles prefer moist habitats with high graminoid cover and low shrub cover. Nesting habitat consists of mature and old growth deciduous dominated forests with high canopy cover. In addition, habitat suitability is reduced near human disturbances (Table I-1).

Table 11A1.5-1   Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient for the Great Gray Owl

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
High-level Disturbances			
Primary and Secondary Roads	Provincial highways with high speed and high daily volumes of traffic	100	0.50
Primary and Secondary industrial sites (200 x 100 m)	Permanent facility, daily construction sites with heavy equipment activity	100	0.50
Moderate Disturbances			
Resource access roads, small facility developments (35 x 35 m) and major utility corridors (50 m)	No regular road maintenance; irregular traffic use (not daily)	N/A	N/A
Lower-level Disturbances			
Trails, abandoned roads, existing seismic and utility corridors (pipeline/electrical, 15–25 m)	Various widths up to 25 m wide; sporadic traffic use (mostly seasonal)	N/A	N/A

11A1.5.2 Model Mechanics

Foraging and nesting habitat must be in close proximity to be considered optimal habitat for the great gray owl. Since foraging habitat is rated higher, highly suitable foraging habitat (≥ 0.67 SI) was buffered by 500 m and highly suitable nesting habitat within this buffer maintained its suitability. Highly suitable nesting habitat outside the 500 m buffer was reduced to an SI < 0.67. Highly suitable foraging habitat that is not within 500 m of suitable nesting habitat is not likely to be used during the nesting season and its suitability should be reduced in a similar manner as above. However, it was determined that all highly suitable foraging habitat within the LSA is within 500 m of highly suitable nesting habitat and therefore, no buffer was required.

The following equations, with the spatial variables described above, were developed to calculate habitat suitability indices for the great gray owl:

$$HSI_{overall} = ((HSI_{food}) + (HSI_{cover}))^{0.5} \times \text{Disturbance Coefficient}$$

$$HSI_{Food} = \{[(0.5 \times SI_{Graminoid\ Density}) + (0.5 \times SI_{Moisture\ regime})] \times SI_{Shrub\ Density}\}$$

$$HSI_{Cover} = \{[(0.5 \times SI_{Tree\ Density}) + (0.5 \times SI_{Structural\ Stage})] \times SI_{Deciduous\ Dominance}\}$$

Food value is directly influenced by percent graminoid density and moisture regime and modified (multiplied) by shrub density. Cover value is directly influenced by tree density and structural

stage and modified by deciduous dominance. The overall value is the geometric mean of weighted food plus cover values.

11A1.5.3 Model Validation

Only one great gray owl was observed, therefore model validation could not be conducted.

11A1.6 Barred Owl Habitat Suitability Model

11A1.6.1 Introduction

This model is based on Olsen et al. (1999) which was developed for west-central Alberta. It has been updated with recent literature and adapted specifically for this ecoregion of Alberta.

11A1.6.2 Review of Important Habitat Components

11A1.6.2.1   General

Barred owls are widely distributed throughout North America, ranging from the Atlantic coast to the Pacific northwest (Taylor and Forsman 1976). Barred owls primarily inhabit mature and old mixedwood and coniferous forests (Godfrey 1986, Boxall and Stepney 1982, Dunbar et al. 1991, Van Ael 1996, Mazur et al. 1997, Mazur et al. 1998, Mazur and James 2000). In Saskatchewan, barred owls avoided young (< 50 years) forests in both the breeding and non-breeding seasons, on both an individual location and home range scale (Mazur et al. 1998).

The persistence of barred owls is dependent upon mature and old growth forests. These stands provide the requisite reproductive habitat, namely large diameter dead trees for nesting.

11A1.6.3 Model Construction and Suitability Ratings

11A1.6.3.1   Model Variables

The model includes seven variables: tree canopy height, deciduous trees > 35cm dbh, tree canopy closure (%), spruce and fir composition (%), distance from human disturbance (see Table I-2), distance to open habitat > 5ha and tree canopy height.

Table 11A1.6-1   Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient (DC) for the Barred Owl

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
Roads, cutlines, pipelines, industrial sites, active well sites and camps	Human disturbance is defined as roads and trails with motor vehicle access, railways, pipelines industrial sites, active well sites and settlement areas.	0-50	0.5

11A1.6.4 Model Mechanics

The barred owl model has two separate equations: nesting and foraging. Both equations are non-compensatory, meaning that one variable cannot compensate for a low ranking of another. However, in the case where SI values are decimals and each are ranked high (i.e., ≥ 0.67 and < 1.0), the multiplication of these values will result in a lower SI value overall. In instances where this occurs, the geometric mean was calculated. The geometric mean takes the form of:

$$\left(\sum_{i=1}^{n} a_i\right)^{1/n} = \sqrt[n]{a_1 \times a_2 \times ... a_n}$$

Both components are considered equally important and given the overlap in habitat variables and their attributes:

$$HSI_{Nesting} = S_1 \times S_2 \times S_3 \times S_4 \times S_5 \times S_6$$

$$HSI_{Foraging} = S_3 \times S_7$$

$$HSI_{Overall} = 0.5*HSI_{Nesting} + 0.5*HSI_{Foraging}$$

11A1.6.5 Model Validation

Only four barred owls were found within the LSA during the owl survey. Due to this low sample size, a model validation could not be completed.

11A1.7 Boreal Owl Habitat Suitability Model

11A1.7.1 Introduction

This model is based on the model developed by Heinrich et al. (1999) for owls in the Foothills model forest of west-central Alberta and later used in northeastern Alberta by Golder Associates Ltd. for the MEG Energy Christina Lake Regional Project (Golder 2005).

11A1.7.2 Review of important habitat components

11A1.7.2.1 General

The boreal owl lives and breeds in dense boreal/taiga conifer forests and mountainous regions of North America and Eurasia (Lewis 2005, Internet site). In Canada the boreal owl is classified as 'not at risk' federally by SARA/COSEWIC. In Alberta, the boreal owl is not designated as a species at risk or of concern

Boreal owls live year-round in Alberta. Although some boreal owls do not migrate, most individuals migrate to wintering areas in the northern states (ASRD 2007, Internet site). In Alberta, they breed in all but the alpine and prairie zones where conifer forests do not occur. Nesting habitats are similar to winter foraging and roosting habitats, therefore habitat requirements vary little throughout the year. Boreal owls use old woodpecker nests and empty tree cavities for nests (ASRD 2007, Internet site). The boreal owl is a small nocturnal owl that preys on small rodents, especially voles, lemmings, shrews and mice. They occasionally take small birds, squirrels, bats, frogs, moths and beetles (König et al. 1999).

Limited information is available on boreal owl habitat use in Alberta. Preferred habitat in Alberta is mainly old-growth forests (either deciduous or conifer) with an abundance of natural tree cavities and cavities made by pileated woodpeckers and northern flickers which are used for nesting and roosting (Johnsgard 1988, Hayward et al 1993, Heinrich et al 1999). Foraging habitat is characterized as open forest and forest gaps/meadows where their primary prey, small mammals, are abundant and accessible. During early spring, boreal owls feed in open spaces and clearcuts where snowmelt occurs earlier and then move to feed in forested areas once the undergrowth in the open areas becomes too thick for effective hunting (Palmer 1986). Boreal owls are

considered to be sensitive to disturbance due to their dependence on nest cavities in large-diameter trees, usually found in mature and old-growth forest types (Mossop 1997, Heinrich et al 1999).

11A1.7.3 Model Construction and Suitability Ratings

11A1.7.3.1   Model variables

The model includes six variables: nesting, cover and roosting, density of large conifer and deciduous trees and snags (dbh> 35 cm), tree canopy closure class, conifer canopy height, conifer percentage composition – weighted spruce, fir and pine in tree canopy,

11A1.7.4 Model mechanics

11A1.7.4.1   Overall Habitat Suitability Index Equation

The equation assumes that all components are equally important and non-compensatory. The overall HSI equation is:

$$HSI = S_1 \times S_2 \times S_3 \times S_4$$

11A1.7.5 Model Validation

Only one Boreal owl was detected in the LSA during the owl survey. Due to this low sample size, a model validation could not be completed.

11A1.8 Mixedwood Forest Bird Community Model

An HSI model was not prepared for the mixedwood forest bird community and instead, an area analysis was conducted to determine the availability of mixedwood forest habitat within the LSA. For this analysis, ecosite phases b1, b3, d2, e2, and f2 for the BM and ecosite phases b1 and d2 for the LBH were considered mixedwood forest habitat highly suitable for the mixedwood forest bird community. All other habitats were considered unsuitable (i.e., not mixedwood forest). Mixedwood forests may be utilized by both coniferous and deciduous forest species. Bird species observed during surveys conducted in the LSA included the brown creeper, magnolia warbler, bay-breasted warbler, blue-headed vireo, red-breasted nuthatch, and winter wren.

11A1.9 Old Growth Forest Bird Community Model

An HSI model was not prepared for the old growth forest bird community, but instead, an area analysis was conducted to determine the availability of old growth forest habitat within the LSA and RSA. Tree age is only one of the many defining characteristics of old growth forests. For this analysis, forests highly suitable for the old growth forest bird community were based on known relationships between stand age and successional stage (Schneider 2002). The age-based definitions of old growth are different for each forest type because different tree species mature at different rates. However, these definitions are generalizations, as stand development varies substantially depending on local variations in soil and microclimate (Schneider 2002).

Deciduous and mixedwood forests (i.e., b1, b2, b3, d1, d2, e1, e2, f1, and f2 ecosite phases for the Boreal Mixedwood Natural Subregion, BM), and b1, b2, d1, d2, and e1 ecosite phases for the Lower Boreal Highlands Natural Subregion, LBH) greater than 100 years old are considered old growth. Coniferous forests (i.e., a1, b4, c1, d3, e3, f3, g1, h1, i1, j1 and k1 ecosite phases for the

BM, and a1, b3, c1, d3, f1, g1, h1, i1 and j1 ecosite phases for the LBH) greater than 120 years old are considered old growth. All stands that did not meet the above stand age and successional stage criteria were considered unsuitable (i.e., not old growth forests).

Bird surveys were conducted in the LSA and bird species typical of old growth forests were detected in point counts conducted in this habitat type. Such species included the brown creeper, red-breasted nuthatch, golden-crowned kinglet, winter wren, and western tanager.

11A1.10 Snowshoe Hare Habitat Suitability Model

11A1.10.1   Introduction

Although the snowshoe hare is not an indicator species, this model is used as the food variable for fisher and lynx. The habitat model assumes that food and dense shrub habitats are interrelated requirements for the snowshoe hare. The following assumptions are specific to this model's predictive capability:

- Water requirements are met by existing surface water and snow;
- Habitat interspersion is met by the existing mosaic of habitats; and,
- Dense shrub cover with preferred browse is a prime requisite of habitat.

The model assumes that habitat suitability increases linearly with increasing shrub cover. Habitats with at least 90% shrub cover are considered optimal. Habitats with a tree canopy closure of 51-80% are optimal for hare; canopy closures > 80% would shade out important understory cover. For the food component of the model, habitats with cover of preferred browse species (alder, saskatoon, paper birch, swamp birch, hazelnut, larch, jack pine, rose, raspberry, willow, and buffaloberry) ≥ 60% are considered optimal.

11A1.10.2   Model Mechanics

The following formulae were used to calculate Habitat Suitability Indices for snowshoe hare:

$$HSI_{Overall} = (0.5 \times HSI_{Food}) + (0.5 \times HSI_{Cover})$$

where:

$HSI_{Food} = (SI_{Shrub\ Density} \times SI_{Preferred\ Browse\ Density})^{0.5}$ and,

$HSI_{Cover} = (0.8 \times SI_{Shrub\ Density}) + (0.2 \times SI_{Tree\ Density})$.

HSI $_{Cover}$: Cover value is directly influenced by shrub density (SI $_{Shrub\ density}$) and tree density (SI $_{Tree\ Density}$) and each variable has been weighted accordingly to relative importance.

HSI $_{Food}$: Food value is directly influenced by shrub density (SI $_{Shrub\ Density}$), as modified (multiplied) by the availability of preferred browse species (SI $_{Preferred\ Browse\ Density}$).

HSI $_{Overall}$: Overall habitat suitability is the combined value of the weighted food and cover habitat suitability values (weighted equally).

11A1.11 Beaver Habitat Suitability Model

11A1.11.1   Introduction

Beaver inhabit low-gradient rivers and streams and a wide variety of lentic habitats such a lakes and ponds. They depend year round on woody shoreline vegetation comprised in this area mainly of aspen and willow. The model recognizes food (woody rather than herbaceous vegetation) and cover as separate variables, with food being considered of greater significance. Although both food classes can be used on a year-round basis, woody vegetation can limit the abundance and distribution of beaver, particularly in northern regions where woody food caches are the primary food source during winter.

To quantify beaver habitat, a shoreline width of 100 m (based on foraging and cover requirements) is applied to all linear shorelines (riverine and lentic) evaluated in the study. The important habitat factors that influence the availability of both food and cover are discussed in the following sections.

11A1.11.2   Model Mechanics

Assumptions: All wetland habitat (lakes, rivers, creeks) is considered high quality habitat. Large rivers with high gradients and wide channel widths have been rated as moderate. Foraging habitat within 60 m of shoreline is considered optimal (SI = 1.0), whereas foraging from 61−100 m considered less suitable and the SI is reduced by 50%. Habitat beyond 100 m is considered unsuitable.

Since all riverine habitats in the Wildlife LSA are categorized as either highly suitable or moderately suitable, submodels for lentic and riverine models were not incorporated.

The following formula was used to calculate Habitat Suitability Indices for beaver:

$$HSI_{Overall} = \{[(0.4 \times SI_{Deciduous\ Tree\ Density} \times SI_{Deciduous\ Tree\ Size})^{0.5} + 0.6 \times SI_{Deciduous\ Shrub\ Density}] \times SI_{proximity\ to\ waterbody}\}^{0.5}$$

The food/cover value for beaver is directly influenced by deciduous tree density ($SI_{Deciduous\ Tree\ Density}$) as modified by the tree size ($SI_{Deciduous\ Tree\ Size}$) and deciduous shrub density ($SI_{Deciduous\ Shrub\ Density}$), for terrestrial habitats within 100 m of waterbodies, where the HSI = 1.0 for all aquatic habitat.

11A1.11.3   Model Validation

A beaver lodge survey was not conducted for the Project, therefore model validation could not be conducted. However, model validation for the Nexen Long Lake South EIA was performed. Data on active beaver lodge surveys from 2006 (most recent) were used to validate the beaver model. Active beaver lodge locations were overlaid atop mapped HSI values and lodge locations were queried to the corresponding habitat values. Seventy-five percent (n = 6) of the active beaver lodges corresponded with high-quality habitat, 25% (n = 2) corresponded with moderate quality habitat, none beaver lodges occurred in low-quality habitat. As with the Canadian toad model validation, all of the active lodges in the LSA occurred within very close proximity to high-quality habitat. These lodges lie within the mapped streams and rivers in the LSA. In the context of the ecology of this species, ecosite phases are mapped at a relatively coarse scale. The beaver HSI model is considered to be a good predictor of beaver habitat.

11A1.12 Muskrat Habitat Suitability Model

11A1.12.1 Introduction

This model is based on Allen and Hoffman (1984) and Golder (2000). It has been updated with recent literature and adapted specifically for this ecoregion of Alberta.

11A1.12.2 Review of Important Habitat Components

11A1.12.2.1 General

Muskrats are found throughout North America, from Alaska to Northern Mexico (Boutin and Birkenholz 1987). Muskrats are essentially a large aquatic vole adapted to an aquatic environment (Banfield 1974, Boutin and Birkenholz 1987). Muskrats are found throughout Alberta wherever suitable habitats exist and are classified as Secure (ASRD 2007, Internet site).

The muskrat is an amphibious rodent that spends the majority of their time in water (Banfield 1974, Boutin and Birkenholz 1987). While somewhat flexible in their habitat requirements, muskrats need a permanent water source and a protected site for rearing their young (Boutin and Birkenholz 1987). This protected site can be in the form of a floating lodge constructed of vegetation or bank dens (Boutin and Birkenholz 1987).

Muskrat densities are dependent upon the amount of interspersion between water and emergent vegetation (Weller 1978, Boutin and Birkenholz 1987). Muskrat densities fluctuate with changing water levels and ideal muskrat habitat occurs where there is an equal ratio of open water to emergent vegetation.

11A1.12.3 Model Construction and Suitability Ratings

11A1.12.3.1 Model Variables

The model includes four variables: emergent herbaceous vegetation, percent of year with surface water present, percent of herbaceous canopy cover within 10 m of water's edge and percent stream gradient.

11A1.12.4 Model Mechanics

Using the AWI data, graminoid marsh (MONG) and shallow open water (WONN) found within 100 m of open water are considered to be high quality muskrat habitat for both food and cover.

Herbaceous Wetland:

$$HSI_{Food} = MONG \text{ and } WONN$$

$$HSI_{Cover} = MONG \text{ and } WONN \text{ within 100 m of open water}$$

Riverine:

$$HSI_{Food} = \text{Percent of Herbaceous Canopy Cover within 10 m of Water's Edge}$$

$$HSI_{Cover} = \text{Low Gradient Streams and Rivers}$$

11A1.12.5   Model Validation

No muskrat surveys were conducted; therefore model validation could not be completed.

11A1.13 Red-Backed Vole Habitat Suitability Model

11A1.13.1   Introduction

Although the red-backed vole is not an indicator species, this model is used as the food variable for fisher. A year-round model has been developed that accounts for both food and cover. The following assumptions are specific to the model:

- Water requirements are met by surface water, snow and vegetation; and,

- Dense shrub and ground cover and woody downfall are assumed to be the primary requisites.

11A1.13.2   Model Mechanics

The following information details the limitations and formula for the red-backed vole habitat model.

$$\text{HSI }_{Overall} = [(0.3 \text{ x SI }_{Vascular\ plant\ \&\ litter\ cover} \text{ x SI }_{CWD})]^{0.5} + (0.4 \text{ x SI\% }_{shrub\ Canopy\ Closure}) +$$

$$[(0.3 \text{ x SI\% }_{Tree\ Canopy\ Closure} \text{ x SI }_{Structural\ Stage})]^{0.5}$$

HSI $_{Overall}$**:** The food and cover value of an area for red-backed voles is directly related to the density of vegetation and litter in the ground strata, modified by the density of CWD. This is related to and affected by vegetation density in the shrub and tree strata, with the latter modified by stand structural stage as a surrogate of stand maturity. The overall HSI values are calculated for a habitat type by adding the weighted SI values for each of these three variables.

11A1.14 Fisher Habitat Suitability Model

11A1.14.1   Introduction

As the availability of prey and cover determine the fisher's use of habitat, food and cover have been addressed separately in the model. The diet is typically comprised of small mammals that inhabit all seral stages of forested habitats. Although non-forested cover types and clearcut areas may support small mammals, they must be in close proximity to forest and contain sufficient amounts of vegetation and debris to provide adequate security and foraging cover if they are to be used by fishers. The following assumptions and limitations are specific to this model:

- Water requirements are met by surface water and snow;

- Snow depths are assumed not to be limiting; and,

- Dense forest stands in the latter seral stages represent the highest quality winter habitat for fisher.

11A1.14.2   Model Mechanics

The following information details the limitations and formulae for the fisher habitat model:

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$$HSI_{Overall} = (HSI_{Cover} \times HSI_{Food})^{0.5} \times \text{Disturbance Coefficient}$$

Overall habitat suitability is the geometric mean of combined food and cover, which are considered equally important. Both food and cover have to be > 0 to produce a positive SI value.

$$HSI_{Cover} = \text{Maximum SI percent shrub cover}, [(\text{SI Tree Canopy Closure}) \times (\text{SI Stand Age}) \times (\text{SI Conifer Canopy Closure})]^{0.33}$$

The cover value of the habitat is a combination of maximum shrub cover or the geometric mean of the combination of SI tree canopy closure x SI stand age x SI conifer closure. If one of the components in the geometric mean is zero, then the relationship is defined by shrub cover.

$$HSI_{Food} = (SI_{maximum} \text{ Snowshoe hare or Red-backed vole})$$

The food value of an area is directly influenced by prey abundance, maximum of either red-backed vole or snowshoe hare.

11A1.14.3   Model Validation

Model validation could not be performed due to the lack of empirical data. Fisher were only detected in areas outside of the LSA, where habitat mapping was not available.

11A1.15 Lynx Habitat Suitability Model

11A1.15.1   Introduction

Preferences for certain habitat types and prey availability are the primary factors of lynx abundance. Food and cover are therefore key variables in the habitat model; however, food is given a higher weighting (0.8) than cover (0.2). The following assumptions are noted:

- Spatial requirements are not incorporated in the model; and,

- Avoidance of roads and trails by resource development activities is assumed to result in a loss of habitat effectiveness.

Loss of habitat effectiveness related to increased access and human activity in the LSA are built into the model. HSI values of habitats within 250 m of what are considered high human activity disturbance types (Table I-3) are reduced by 25%, while HSI values of habitats within 100 m of a moderate disturbance are reduced by 10%. HSI values for low-level disturbances are not modeled for loss of habitat effectiveness.

Lynx occur primarily in forested areas with dense shrub understories. It is assumed that crown densities of 51– 70% represent optimal cover conditions for lynx; however, because higher crown density may not support sufficient shrub understory, cover quality degrades beyond 70%. Lynx are closely related to the distribution and abundance of snowshoe hares that are found primarily in areas with an extensive shrub understory. It is assumed that shrub density of 51– 70% represent optimal habitat conditions for lynx with slight degradation beyond that. Snowshoe hare availability, measured as the HSI value of any given area for snowshoe hare, is used in the lynx habitat evaluation model to calculate the contribution of food to overall habitat suitability.

Table 11A1.15-1 Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient for Lynx

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
High-level Disturbances			
Primary and Secondary Roads	Provincial highways with high speed and high daily volumes of traffic	250	0.75
Primary and Secondary industrial sites (200 x 100 m)	Permanent facility, daily construction sties with heavy equipment activity	250	0.75
Moderate Disturbances			
Resource access roads, small facility developments (35x35 m) and major utility corridors (50 m)	3No regular road maintenance; irregular traffic use (not daily)	100	0.90
Lower-level Disturbances			
Trails, abandoned roads, existing corridors (pipeline/electrical)	Various widths up to 25 m wide; sporadic traffic use (mostly seasonal)	N/A	N/A

11A1.15.2   Model Mechanics

The following formulae and definitions were used in the lynx habitat model.

$$HSI_{Overall} = [(0.8 \times HSI_{Food}) + (0.2 \times HSI_{Cover})] \times \text{Disturbance Coefficient}$$

The overall habitat suitability is the combined value of the weighted food and cover suitability values. Food is considered to be a more important determinant of habitat suitability than is cover and is weighted accordingly.

$$HSI_{Food} = (SI_{\text{Snowshoe hare HSI}})$$

The food value of an area is directly determined by snowshoe hare abundance ($SI_{\text{Snowshoe hare HSI}}$).

$$HSI_{Cover} = (0.5 \times SI_{\text{Tree Density}}) + (0.5 \times SI_{\text{Shrub density}})$$

The cover value of an area is determined by the density of tree cover ($SI_{\text{Tree Density}}$) and by shrub density ($SI_{\text{Shrub Density}}$). Both are weighted equal in importance.

11A1.15.3   Model Validation

Data on habitat use of lynx from winter track surveys were used to validate this model. A selectivity index was used, where empirical lynx locations were compared to random locations. This index is scaled from -1 to +1, where a negative value indicates avoidance or not preferred; a positive value indicates preference; a value of 0 indicates random habitat selection. When compared to random locations, lynx had no preference for unsuitable and low quality habitats, preference for moderate quality habitats, and no preference for high quality habitats (selection value was -0.1; close to zero; Figure I-1). However, these tracking data were collected in 25 meter intervals, and sample size was not optimal for this validation (n = 19). Most of the track locations in moderate quality habitats were in close proximity to high quality habitats. This model is considered a moderate predictor of lynx habitat.

Figure 11A1.15-2 Habitat selection for lynx in the LSA using snow tracking data compared to random locations
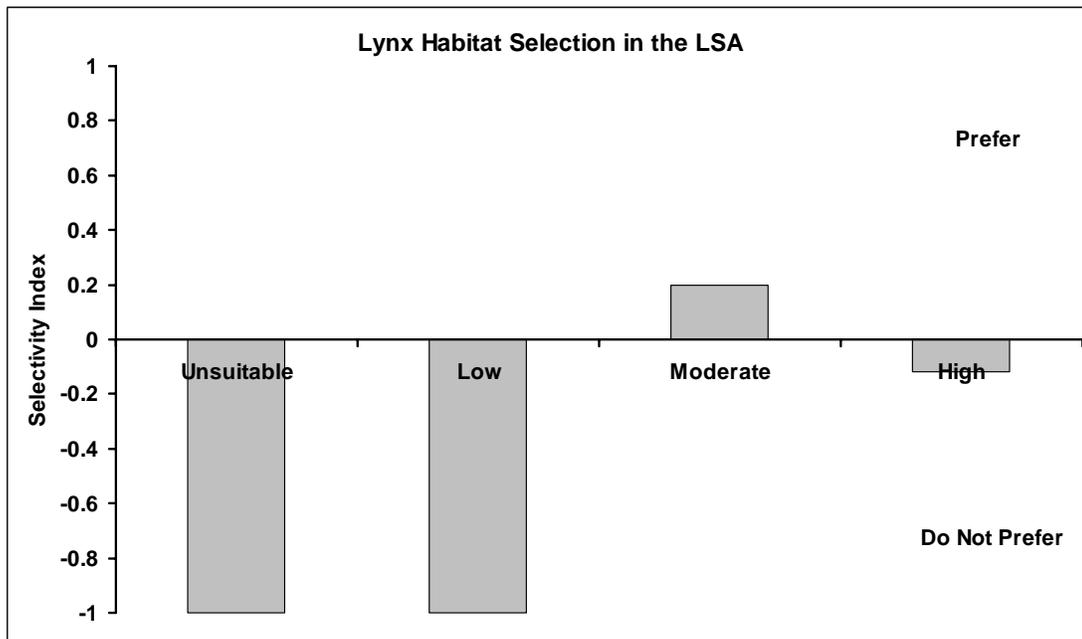
11A1.16   Black Bear Habitat Suitability Model

11A1.16.1   Introduction

While black bears use the full spectrum of forest types and seral stages within conifer, mixedwood and deciduous habitats, the availability of late summer and fall berry crops significantly influences their survival and reproductive success (Jonkel and Cowan 1971, Kellyhouse 1980). Consequently, a model based on summer/fall food and cover habitat requirements has been developed for this project. The following assumptions and limitations are specific to this model:

- water requirements are met by surface water and snow;

- requirements for habitat interspersion are met by the existing landscape;

- requirements for denning are met within the existing landscape; and,

- berry-producing habitats represent the highest quality habitat for black bear.

Shrub abundance, based on percent canopy closure in the low shrub stratum, has been incorporated as a variable in the model. Shrub canopy closure of 71-80% is considered optimal. A tree canopy cover that exceeds 80% will reduce the potential development of herbaceous understory; therefore, a tree canopy of 71–80% is considered optimal. Trees are used by black bears as escape cover, and therefore, stand maturity has been incorporated as a variable to modify percent tree canopy closure. Habitat suitability increases directly with increasing stand maturity. The percent canopy cover of berry producing species in both the shrub and ground strata has been used as the measurable variable. Those species considered important berry

producers include: buffaloberry, blueberry, saskatoon, low-bush cranberry, rose, currant, raspberry, bearberry, and bunchberry.

Human developments and associated activities cause black bears to avoid otherwise suitable habitat. This model assumes that habitat suitability is reduced by the presence of human disturbance according to different disturbance types. Individual ROI have been assigned to each disturbance type based on a general understanding of black bear responses (Table I-4).

Table 11A1.16-1 Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient for Black Bears

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
High-level Disturbances			
Primary and Secondary Roads	Provincial highways with high speed and high daily volumes of traffic	500	0.50
Primary and Secondary industrial sites (200 x 100 m)	Permanent facility, daily construction sites with heavy equipment activity	500	0.50
Moderate Disturbances			
Resource access roads, small facility developments (35x35 m) and major utility corridors (50 m)	No regular road maintenance; irregular traffic use (not daily)	100	0.50
Lower-level Disturbances			
Trails, abandoned roads, existing corridors (pipeline/electrical)	Various widths up to 25 m wide; sporadic traffic use (mostly seasonal)	N/A	N/A

11A1.16.2   Model Mechanics

The black bear model is a combination of food and habitat requirements, modified by habitat effectiveness based on a ROI and associated disturbance coefficient. The following formulae and definitions were used in the black bear habitat model.

$$HSI_{Overall} = [(0.7 \times HSI_{Food}) + (0.3 \times HSI_{Cover})] \times \text{Disturbance Coefficient}$$

The overall HSI value is calculated by adding the weighted HSI value for food to the weighted HSI value for cover; food is weighted more heavily than cover.

$$HSI_{Food} = SI\%_{Cover\ Berry\ Producers}$$

The food value of an area is directly influenced by the availability of berry producing shrubs (both shrub and herbaceous strata).

$$HSI_{Cover} = (0.6 \times SI_{Shrub\ Density}) + [(0.4 \times SI_{Tree\ Density}) \times (SI_{Tree\ Maturity})]^{0.5}$$

The summer/fall cover value of an area is directly influenced by percent shrub canopy closure ($SI_{Shrub\ Density}$) and percent tree canopy closure ($SI_{Tree\ Density}$), the latter modified (multiplied) by tree maturity ($SI_{Tree\ Maturity}$). The cover value is calculated by adding the weighted SI value for $SI_{Shrub\ Density}$ to the weighted and modified value for $SI_{Tree\ Density}$.

11A1.16.3   Model Validation

Surveys for black bears have not been considered for oil sands EIAs since the methods required (e.g., telemetry or DNA sampling) are intensive and invasive. Such studies have been conducted elsewhere in North America, including boreal forests and the habitat suitability model makes use of this existing information.

11A1.17   Moose Habitat Suitability Model

11A1.17.1   Introduction

Winter is the most difficult time for moose to access food and habitats used during this season are often limited in availability. With these considerations, the model has been developed to only evaluate moose winter habitat. The following assumptions and limitations are specific to this model:

- Water requirements are met by surface water and snow;

- Habitat interspersion is not a limiting factor within the study area;

- Snow depth is not a limiting factor within the study area; and,

- High, moderate and low suitability habitat are present in the study area.

Based on the literature, moose generally select habitats based on forage productivity, rather than cover, except during winter and extreme weather conditions. Therefore, food rather than cover is considered to be the life requirement of greatest importance and has been weighted accordingly. The important habitat factors that influence the availability of food and/or cover are also built into the model.

Browse is a key factor in determining the suitability of a given habitat as winter moose range. It is assumed that canopy closure greater than 50% represents optimal foraging conditions. It is assumed that a tree canopy cover of 50–70% represents optimal cover conditions. The suitability of tree canopy cover declines slightly between 70–100%. Forests with a conifer component of greater than 60% of total canopy cover are optimal. The canopy cover of mature stands offers the best protection from snow accumulations and thermal extremes. Consequently, canopy height, as measured by mean stand height, has been incorporated into the model as a second variable to modify cover potential.

The model includes five variables: preferred browse density (in shrub stratum), tree density, coniferous dominance, canopy height and disturbance impacts (Table I-5)

11A1.17.2   Model Mechanics

The following formulae and definitions are used in the moose habitat model.

$$HSI_{Overall} = \text{spatial analysis of } [(0.7 \times HSI_{Food}) + (0.3 \times HSI_{Cover})] \times \text{Disturbance Coefficient}$$

The overall value of an area is subjected to spatial analysis and weighted with an emphasis on food compared to cover and modified by a disturbance coefficient from high and moderate disturbance features.

$$HSI_{Food} = (SI_{Pref. Browse Density})$$

The food value of an area for moose is directly influenced by preferred browse abundance, as measured by preferred shrub canopy cover ($SI_{Pref. Browse Density}$).

$$HSI_{Cover} = [SI_{Tree Density} \times [(0.5 \times SI_{Coniferous Dominance})]^{0.5} + (0.5 \times SI_{Canopy Height})]$$

The cover value of an area is directly influenced by tree density ($SI_{Tree Density}$) modified by conifer dominance and canopy height

Table 11A1.17-1 Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient for Moose

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
High-level Disturbances			
Primary and Secondary Roads	Provincial highways with high speed and high daily volumes	500	0.40
Primary and Secondary industrial sites; active construction sites	Permanent facility, daily construction sites with heavy equipment activity	500	0.40
Moderate Disturbances			
Resource and winter roads	3 season access, no regular road maintenance	100	0.40
Lower-level Disturbances			
Trails, abandoned roads, existing corridors (pipeline/electrical)	Various widths up to 50 m wide	N/A	N/A

Reduced Habitat Effectiveness: In order to account for loss of habitat effectiveness in proximity to human infrastructure and disturbance activities, HSI values of habitats within each ROI were reduced by multiplying the disturbance coefficient. For moose, the ROI from high-level disturbances was 500 m with coefficient of 0.40 (reduced 60%). The ROI from moderate level disturbances was 100 m with a coefficient of 0.40. Low-level disturbance features were not buffered by reduced habitat effectiveness.

11A1.17.3   Model Validation

Data on habitat use of moose from the scat detection survey were used to validate this model in the LSA. A selectivity index was used, where empirical moose scat locations (n = 468) were compared to random locations. This index is scaled from -1 to +1, where a negative value indicates avoidance or not preferred; a positive value indicates preference; a value of 0 indicates random habitat selection. When compared to random locations, moose had avoided or no preference for unsuitable and low quality habitats (negative value), and random selection for moderate and high quality habitats (selection values very close to zero; Figure I-2). It is unclear whey there was not a pattern of preference for either of the upper quality habitats. This model is considered a low to moderate predictor of moose habitat.

Figure 11A1.17-1   Habitat selection for moose in the LSA using scat detection survey data compared to random locations

Moose Habitat Selection in the LSA
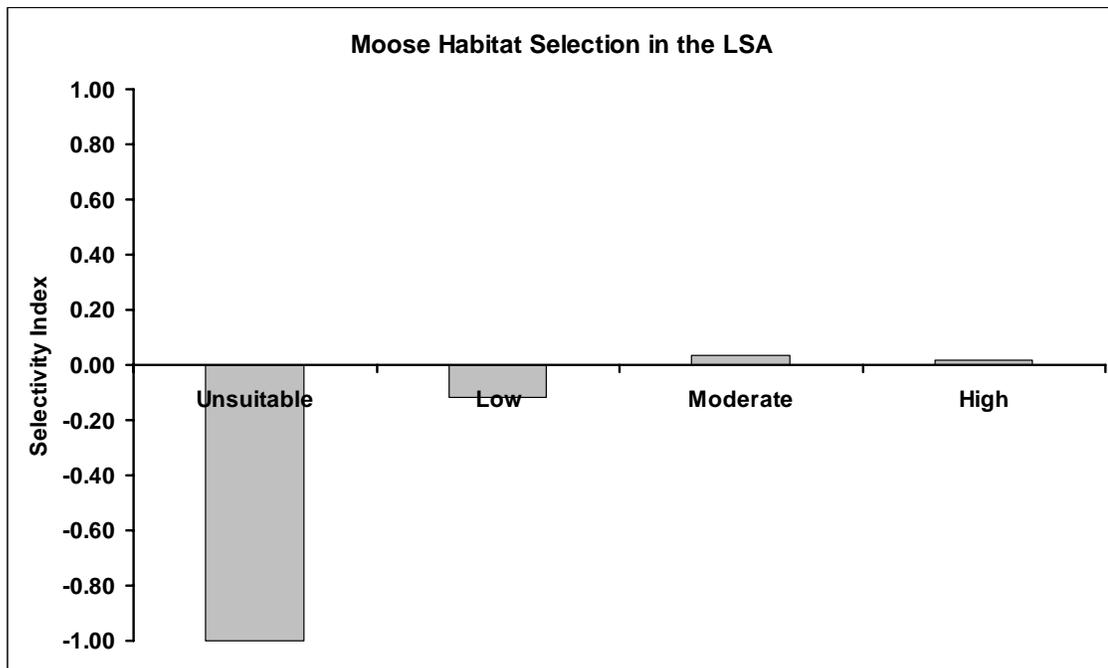
11A1.18 Woodland Caribou Resource Selection Function

11A1.18.1   Introduction

Woodland caribou are designated as a 'Threatened' species in Canada (COSEWIC 2007). In Alberta woodland caribou are considered to be "At Risk" as a threatened species under Alberta's Wildlife Act (ASRD 2006). These designations reflect declining woodland caribou populations and distributions in Alberta.

An ability to predict preferential habitat sites for caribou, especially in areas where previous occupancy is not known, is needed to support an ongoing mandate to recover woodland caribou in Alberta. The resource selection function (RSF – Manly et al. 2002) and the resource selection probability function (RSPF – Lele and Keim, 2006) are functions that compute the probability (or relative probability if RSF is used) that a particular resource, as characterized by a combination of environmental variables, will be used by an individual animal. Resource selection models (RSF and RSPF) were estimated for woodland caribou in the RSA using readily available GIS data and winter caribou scat-locations.

Unlike expert-opinion and literature-based HSI models, resource selection models use empirical data to derive the probability of habitat use at a site.

11A1.18.1.1 Data Description

Study Area

The study area is defined by the Caribou RSA for the Project and is 360,767.5 ha (3,608 km2). It contains approximately 85% the Egg Pony caribou herd range and a small portion of the Wiau caribou herd range in northeast Alberta.

Scat Location Data

Caribou scat samples were collected between January and March of 2006 and 2007, using specially trained scat detection dogs. Detection dogs were able to locate scat samples from considerable distances, even in several feet of snow.

Between January 16 - March 15, 2006, and January 19 - March 19, 2007, 3-4 dog teams, worked with aboriginal orienteers from the local community, including two tribal elders. The entire study area was divided into 8 km x 8 km contiguous cells, with a 5 km x 5 km area nested within each cell. This nested design served to maximize the area covered (number of individuals sampled per species) without sacrificing recapture rates per individual.

In 2006, 658 caribou scat samples along with a GPS location for each sample was collected in the study area. In 2007, 606 caribou scat samples along with a GPS location for each sample was collected in the study area.

GIS Data

To predict the site selection of wintering caribou, a number of covariates were considered including:

- The variation in elevation (meters above sea level) surrounding a site;

- The nearest distance to a road, highway, or railroad (relatively high use anthropogenic disturbances);

- A categorical covariate for wetlands, and

- A categorical covariate for sites having an open forest canopy (less than 6% canopy cover).

All covariates are identifiable and can be easily derived in a GIS, using widely available data sources. A digital elevation model (DEM) at 70 meter-pixel-resolution was used to derive the continuous topographic covariate for elevation. Anthropogenic disturbances were derived from existing data sources including Alberta Vegetation Index (AVI), seismic lines, satellite imagery, and LiDAR data. Readily available vegetation inventory (AVI) from the Province of Alberta was used to code covariates for wetlands and forest canopy cover.

11A1.18.1.2 Data Analysis and Statistical Models

A use / available study design (Manly et al. 2002, Keating and Cherry 2004, Lele and Keim 2006) was employed in the analysis of data and in the development of statistical models. In this analysis, used sites are defined by the caribou scat locations. Available sites are represented by 60,000 locations that were randomly selected from within the study area. The available sites represent what types of habitats might be potentially available to caribou. Statistical analysis was conducted in the statistical software program R Statistical Computing Version 2.2.4©. In the

following sections, the statistical models used, the final model selected, and an evaluation of the model fit within the study area is presented.

Statistical Models

Two statistical models, both applicable to the use / available study design (Manly et al. 2002, Keating and Cherry 2004, Lele and Keim 2006), were employed in analysis of the caribou data. The first model, the exponential form of the RSF is the most common modeling approach for estimating the relative probability of resource selection by animals, including caribou (Johnson et al. 2004, 2005, 2006). The second, the Logistic RSPF, was recently identified as an alternative approach for estimating the probability of resource selection by animals and has also been used to estimate caribou site selection (Keim and Lele 2007, in preparation).

In Table I-6, the Bayesian information criterion (BIC) value (Burnham and Anderson 2002) for the fitted exponential RSF and the fitted Logistic RSPF models are provided.

Table 11A1.18-1   Log-likelihood values for best fit multiple covariate models. A model with a larger log-likelihood value is considered to provide a better fit.

Model	Log-likelihood value
Exponential RSF	-433.79
Logistic RSPF	-341.64

The Logistic RSPF provides a better descriptor of the data, under assumptions of the BIC.

Final Baseline Model

The Logistic RSPF is estimated as the final model for evaluation in a GIS to the extent of the study area. The best fit Logistic RSPF model takes the form:

$$\pi(\underline{x}; \beta) = \frac{\exp(\underline{x}\beta)}{1 + \exp(\underline{x}\beta)}$$

The parameter estimates (β) and the standard errors for the final model are provided in Table I-7. All covariates are significantly different from zero.

Table 11A1.18-2   The estimated coefficients (β) and the standard errors (SE) for the model covariates used in the Logistic RSPF.

Covariate	B	SE
Intercept	-2.38	0.03
Standard Deviation of Elevation	-1.69	0.01
Distance to Anthropogenic disturbance (meters / 100)	0.03	0.00
Wetlands	1.50	0.02
Canopy Cover	3.18	0.02

Based on the final model, caribou preferred sites:

1. with lower variation in elevation (meters above sea level) measured within a 140m radius;

2. That are more distant from high-use anthropogenic disturbances;

3. That are within wetland complexes; and

4. Those having relatively open forest canopies.

The quantitative findings in the final model are generally consistent with the ecological conditions that woodland caribou are known to use in this study area (Dzus 2001).

11A1.18.2   Baseline Model Validation

A measure of the residual sum of squares (RSS - Lele and Keim 2007) and a selection index (Manly et al. 2002) was used to determine the fit of the final model within the study area at baseline conditions. In this approach the final model was applied in a GIS to the extent of the study area.

To calculate the RSS, the final model needed to be categorized into a grouping of ordinal bins where the highest ranked bin contained the most preferred sites and visa versa. The model was converted into an index in a GIS by dividing each pixel value by the maximum model value attained within the study area. This conversion allowed the model to be scaled between 0 and 1.0, where a value of 1.0 represents the most preferred sites. The model was then classified into 20 equally distributed bins, in increments of 0.05. For each bin, the area (number of pixels) and the number of scat locations predicted by the model in the study area was calculated. Using these data the proportion of scat locations and the predicted-value (expected) proportion of scat locations was calculated for each bin using the following calculations.

[1] Used Proportion = # of scat locations / ∑ scat locations in all bins

[2] Predicted-value = the bin mid-point value * (Area / ∑ Area in all bins)

To derive the predicted value the mid-point value of the model interval at each bin was used as per Johnson et al. (2005) and Boyce and McDonald (1999). The RSS was calculated using the Log transformation of the predicted-value and the used proportion using the following function.

$$J = \sum_{i=1}^{K} \{(y_i - x_i) - (\bar{y} - \bar{x})\}^2$$

Where; K is the total number of bins, y_i is the logarithmic transformation of the proportion of predicted use, x_i is the logarithmic transformation of the proportion of observed use.

The RSS for the final Logistic RSPF model is 0.14. A plot of the residuals is provided in Figure I-3. If the model has a good fit, one would expect:

1. A RSS value approximate to zero, and

2. A linear relationship between the used proportion and the predicted value on the Log scale, to have a slope of 1.0 (with an intercept defined by the relationship).

The RSS value is relatively close to zero indicating a strong model fit. Similarly the expected linear relationship between the used proportion and the predicted value on the Log scale is noticeable in Figure I-3, indicating a strong model fit.

Figure 11A1.18-1   Plot of model fit for the Logistic RSPF model on the Log scale. A red line indicates the expected model fit. The bin number is denoted above each point, where a larger bin number represents a grouping of more preferred sites
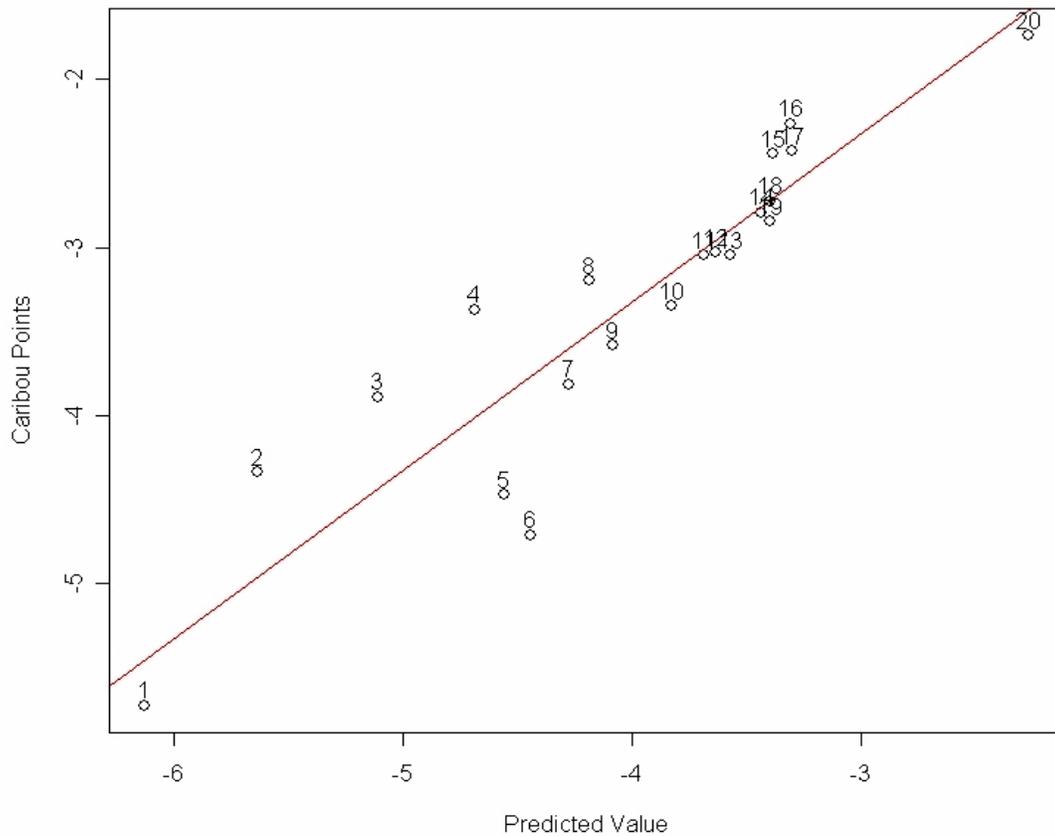
A version of the selection index (Manly et al. 2002) was used to assess the relationship between resource selection and each model bin. To calculate this index, the proportion of scat locations that occurred within each individual model bin (say, bin 20) was divided by the proportion of area predicted by that same model bin within the extent of the study area (I.e. the used proportion of locations over the available proportion of sites). The selection index value was then transformed using the Log function to scale the selection index values as positive and negative numbers. A Log ratio larger than 0 indicates the resource is selected preferentially and a Log ratio less than 0 indicate the resource is not selected. If there is no selection, a Log ratio equal to 0 will result. A selection index plot is provided for the final Logistic RSPF model in Figure I-4.

Figure 11A1.18-2   Selection index plot on the log scale for each of 20 bins from the final Logistic RSPF winter caribou model. A Log selection index greater than 0 indicates preferential selection and a Log selection index less than 0 indicates no preference relative to availability.

Selection Index: Caribou RSPF Model
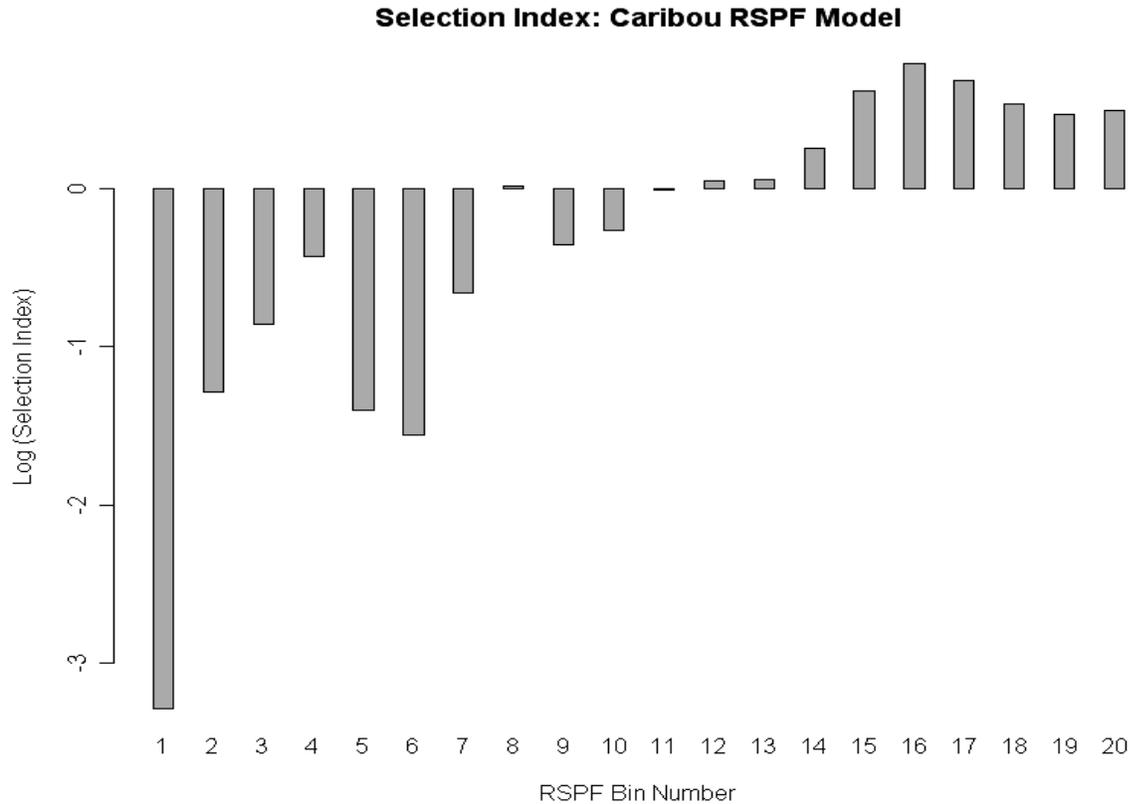
In the selection index plot, it is noticeable that caribou did not prefer sites within model bins 1 to 7 (relative to availability), have relatively low levels of selection for model bins 8 to 13, and strongly preferred sites within model bins 14 to 20. As such, these respective bin groupings were subjectively used to define low, moderate, and high quality habitat classes in the environmental assessment.

11A1.18.2.1 Estimating Project Impacts

For predicting the effects of Project related impacts on winter caribou habitat, the estimated baseline caribou habitat was used in combination with ROI and disturbance coefficients. The ROI's and disturbance coefficients that were applied to this model at are provided in Table I-8. The disturbance coefficients and ROI used were obtained from exiting studies and research on woodland caribou in Alberta (Bradshaw et al. 1997, Dyer et al. 2001, Weclaw 2001).

Table 11A1.18-3   Disturbance Types, Description of Activity, Region of Influence (ROI) and Disturbance Coefficient for Woodland Caribou

Disturbance Feature	Description of Disturbance	ROI (m)	Dist. Coef.
High-level Disturbances			
Primary and Secondary Roads	Provincial highways with high speed and high daily volumes	500	0.75
		250	0.50
Primary and Secondary industrial sites; active construction sites	Permanent facility, daily construction sites with heavy equipment activity	250	0.75
		50	0.50
Moderate Disturbances			
Resource and winter roads	3 season access, no regular road maintenance	100	0.75
Lower-level Disturbances			
Trails, abandoned roads, existing corridors (pipeline/electrical)	Various widths up to 50 m wide	N/A	N/A

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11B1   Introduction

The following definitions are used within the tables:

ASRD 2006

- At risk: Any species known to be "At Risk" after formal detailed status assessment and designation as "Endangered" or "Threatened" in Alberta.

- May be at risk: Any species that "May Be At Risk" of extinction or extirpation, and is therefore a candidate for detailed risk assessment.

- Sensitive: Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.

- Secure: A species that is not "At Risk," "May Be At Risk" or "Sensitive".

- Undetermined: Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status. Exotic/Alien; Any species that has been introduced as result of human activities.

COSEWIC 2007

- Endangered: A species facing imminent extirpation or extinction.

- Threatened: A species likely to become endangered if limiting factors are not reversed.

- Special concern: A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

- Not at risk: A species that has been evaluated and found to be not at risk.

SARA 2007

- Schedule 1: A species has been assessed by COSEWIC and the listing provided from COSEWIC has been accepted by the Minister of Environment. The species is now protected legally under SARA and a recovery planning is mandatory.

- Schedule 2: A species is not on the official SARA list, however, the status of the species must be assessed within a given timeframe. These species are listed as endangered or threatened by COSEWIC.

- Schedule 3: A species is not on the official SARA list, however, the status of the species must be assessed within a given timeframe. These species are listed as species of special concern by COSEWIC.

Occurrence

r – year round resident species, breeds in the region

ss – summer seasonal species, breeds in the region

ss/r – most individuals are present during the breeding season but there are winter records in the province

r/ss – most individuals are resident but some may make short distance migrations

sw – winter seasonal species, generally does not breed in the region

Table 11B-1 Wildlife Species Potentially Occurring in the Region Including Their Provincial and Federal Status

Common Name	Scientific Name	ASRD 2006	COSEWIC 2006	SARA 2006	Occurrence
Amphibians and Reptiles					
Boreal chorus frog	Pseudacris maculata	Secure			r
Wood frog	Rana sylvatica	Secure			r
Canadian toad	Bufo hemiophrys	May be at risk	Not at risk		r
Western toad	Bufo boreas	Sensitive	Special concern	Schedule 1	r
Red-sided garter snake	Thamnophis sirtalis	Sensitive			r
Birds					
Common loon	Gavia immer	Secure	Not at risk		ss
Pied-billed grebe	Podilymbus podiceps	Sensitive			ss
Horned grebe	Podiceps auritus	Sensitive			ss
Red-necked grebe	Podiceps grisegena	Secure	Not at risk		ss
Western grebe	Aechmophorus occidentalis	Sensitive			ss
Eared grebe	Podiceps nigricollis	Secure			ss
American white pelican	Pelecanus erythrorhynchos	Sensitive	Not at risk		ss
Double-crested cormorant	Phalacrocorax auritus	Secure	Not at risk		ss
American bittern	Botaurus lentiginosus	Sensitive			ss
Great blue heron	Ardea herodias	Sensitive			ss
Canada goose	Branta canadensis	Secure			ss
Green-winged teal	Anas crecca	Sensitive			ss
Mallard	Anas platyrhynchos	Secure			ss
Northern pintail	Anas acuta	Sensitive			ss
Blue-winged teal	Anas discors	Secure			ss
Northern shoveler	Anas clypeata	Secure			ss
Gadwall	Anas strepera	Secure			ss
American wigeon	Anas americana	Secure			ss
Canvasback	Aythya valisineria	Secure			ss
Redhead	Aythya americana	Secure			ss
Ring-necked duck	Aythya collaris	Secure			ss
Lesser scaup	Aythya affinis	Sensitive			ss
White-winged scoter	Melanitta fusca	Sensitive			ss
Common goldeneye	Bucephala clangula	Secure			ss
Bufflehead	Bucephala albeola	Secure			ss
Hooded merganser	Lophodytes cucullatus	Secure			ss
Common merganser	Mergus merganser	Secure			ss
Red-breasted merganser	Mergus serrator	Secure			ss
Ruddy duck	Oxyura jamaicensis	Secure			ss
Osprey	Pandion haliaetus	Sensitive			ss
Bald eagle	Haliaeetus leucocephalus	Sensitive	Not at risk		ss
Northern harrier	Circus cyaneus	Sensitive	Not at risk		ss
Sharp-shinned hawk	Accipiter striatus	Secure	Not at risk		ss
Cooper's hawk	Accipiter cooperii	Secure	Not at risk		ss
Northern goshawk	Accipiter gentilis	Sensitive	Not at risk		r
Broad-winged hawk	Buteo platypterus	Sensitive			ss
Red-tailed hawk	Buteo jamaicensis	Secure	Not at risk		ss
American kestrel	Falco sparverius	Secure			ss
Merlin	Falco columbarius	Secure	Not at risk		ss

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Common Name	Scientific Name	ASRD 2006	COSEWIC 2006	SARA 2006	Occurrence
Peregrine falcon	*Falco peregrinus*	At risk	Special concern	Schedule 3	ss
Spruce grouse	*Falcipennis canadensis*	Secure			r
Willow ptarmigan	*Lagopus lagopus*	Secure			sw
Ruffed grouse	*Bonasa umbellus*	Secure			r
Sharp-tailed grouse	*Tympanuchus phasianellus*	Sensitive			r
Sora	*Porzana carolina*	Sensitive			ss
Yellow rail	*Coturnicops noveboracensis*	Undetermined	Special concern	Schedule 1	ss
American coot	*Fulica americana*	Secure	Not at risk		ss
Sandhill crane	*Grus canadensis*	Sensitive			ss
Semipalmated plover	*Charadrius semipalmatus*	Secure			ss
Killdeer	*Charadrius vociferus*	Secure			ss
American avocet	*Recurvirostra Americana*	Secure			ss
Greater yellowlegs	*Tringa melanoleuca*	Secure			ss
Lesser yellowlegs	*Tringa flavipes*	Secure			ss
Solitary sandpiper	*Tringa solitaria*	Secure			ss
Spotted sandpiper	*Actitis macularia*	Secure			ss
Least sandpiper	*Calidris minutilla*	Secure			r/ss
Short-billed dowitcher	*Limnodromus griseus*	Undetermined			ss
Common snipe	*Gallinago gallinago*	Secure			ss
Wilson's phalarope	*Phalaropus tricolor*	Secure			ss
Red-necked phalarope	*Phallaropus lobatus*	Secure			ss
Franklin's gull	*Larus pipixcan*	Secure			ss
Bonaparte's gull	*Larus philadelphia*	Secure			ss
Ring-billed gull	*Larus delawarensis*	Secure			ss
Herring gull	*Larus argentatus*	Secure			ss
California gull	*Larus californicus*	Secure			ss
Common tern	*Sterna hirundo*	Secure	Not at risk		ss
Rock dove	*Columba livia*	Exotic/Alien			r
Mourning dove	*Zenaida macroura*	Secure			ss
Black tern	*Chlidonias niger*	Sensitive	Not at risk		ss
Great horned owl	*Bubo virginianus*	Secure			r
Northern hawk-owl	*Surnia ulula*	Sensitive	Not at risk		r
Northern pygmy owl	*Glaucidium gnoma*	Sensitive			r
Barred owl	*Strix varia*	Sensitive			r
Great gray owl	*Strix nebulosa*	Sensitive	Not at risk		r
Long-eared owl	*Asio otus*	Secure			ss
Short-eared owl	*Asio flammeus*	May be at risk	Special concern	Schedule 3	ss
Boreal owl	*Aegolius funereus*	Secure	Not at risk		r
Northern saw-whet owl	*Aegolius acadicus*	Secure			r/ss
Common nighthawk	*Chordeiles minor*	Sensitive	Threatened		ss
Ruby-throated hummingbird	*Archilochus colubris*	Secure			ss
Belted kingfisher	*Ceryle alcyon*	Secure			ss
Yellow-bellied sapsucker	*Sphyrapicus varius*	Secure			ss
Downy woodpecker	*Picoides pubescens*	Secure			r
Hairy woodpecker	*Picoides villosus*	Secure			r
Three-toed woodpecker	*Picoides tridactylus*	Secure			r

Common Name	Scientific Name	ASRD 2006	COSEWIC 2006	SARA 2006	Occurrence
Black-backed woodpecker	*Picoides arcticus*	Sensitive			r
Northern flicker	*Colaptes auratus*	Secure			ss/r
Pileated woodpecker	*Dryocopus pileatus*	Sensitive			ss/r
Olive-sided flycatcher	*Contopus cooperi*	Secure			ss
Western wood-pewee	*Contopus sordidulus*	Secure			ss
Yellow-bellied flycatcher	*Empidonax flaviventris*	Undetermined			ss
Alder flycatcher	*Empidonax alnorum*	Secure			ss
Least flycatcher	*Empidonax minimus*	Sensitive			ss
Eastern pheobe	*Sayornis phoebe*	Sensitive			ss
Say's phoebe	*Sayornis saya*	Secure			ss
Eastern kingbird	*Tyrannus tyrannus*	Secure			ss
Tree swallow	*Tachycineta bicolor*	Secure			ss
Bank swallow	*Riparia riparia*	Secure			ss
Cliff swallow	*Petrochelidon pyrrhonota*	Secure			ss
Barn swallow	*Hirundo rustica*	Sensitive			ss
Gray jay	*Perisoreus canadensis*	Secure			r
Blue jay	*Cyanocitta cristata*	Secure			r
Black-billed magpie	*Pica hudsonia*	Secure			r
American crow	*Corvus brachyrhynchos*	Secure			ss
Common raven	*Corvus corax*	Secure			r
Black-capped chickadee	*Poecile atricapilla*	Secure			r
Boreal chickadee	*Poecile hudsonica*	Secure			r
Red-breasted nuthatch	*Sitta canadensis*	Secure			r
White-breasted nuthatch	*Sitta carolinensis*	Secure			r
Brown creeper	*Certhia americana*	Sensitive			r
House wren	*Troglodytes aedon*	Secure			ss
Winter wren	*Troglodytes troglodytes*	Secure			ss
Marsh wren	*Cistothorus palustris*	Secure			ss
Golden-crowned kinglet	*Regulus satrapa*	Secure			ss
Ruby-crowned kinglet	*Regulus calendula*	Secure			ss
Mountain bluebird	*Sialia currucoides*	Secure			ss
Veery	*Catharus fuscescens*	Secure			ss
Swainson's thrush	*Catharus ustulatus*	Secure			ss
Hermit thrush	*Catharus guttatus*	Secure			ss
American robin	*Turdus migratorius*	Secure			ss
Bohemian waxwing	*Bombycilla garrulus*	Secure			ss
Cedar waxwing	*Bombycilla cedrorum*	Secure			ss
Northern shrike	*Lanius excubitor*	Secure			ss/r
European starling	*Sturnus vulgaris*	Exotic/alien			ss
Blue-headed vireo	*Vireo solitarius*	Secure			ss
Warbling vireo	*Vireo gilvus*	Secure			ss
Philadelphia vireo	*Vireo philadelphicus*	Secure			ss
Red-eyed vireo	*Vireo olivaceus*	Secure			ss
Tennessee warbler	*Vermivora peregrina*	Secure			ss
Orange-crowned warbler	*Vermivora celata*	Secure			ss
Yellow warbler	*Dendroica petechia*	Secure			ss
Magnolia warbler	*Dendroica magnolia*	Secure			ss
Cape May warbler	*Dendroica tigrina*	Sensitive			ss
Yellow-rumped warbler	*Dendroica coronata*	Secure			Ss
Black-throated green warbler	*Dendroica virens*	Sensitive			Ss

Common Name	Scientific Name	ASRD 2006	COSEWIC 2006	SARA 2006	Occurrence
Palm warbler	*Dendroica palmarum*	Secure			Ss
Bay-breasted warbler	*Dendroica castanea*	Sensitive			ss
Blackpoll warbler	*Dendroica striata*	Secure			ss
Black-and-white warbler	*Mniotilta varia*	Secure			ss
American redstart	*Setophaga ruticilla*	Secure			ss
Ovenbird	*Seiurus aurocapillus*	Secure			ss
Northern waterthrush	*Seiurus noveboracensis*	Secure			ss
Connecticut warbler	*Oporornis agilis*	Secure			ss
Mourning warbler	*Oporornis philadelphia*	Secure			ss
Common yellowthroat	*Geothlypis trichas*	Sensitive			ss
Wilson's warbler	*Wilsonia pusilla*	Secure			ss
Canada warbler	*Wilsonia canadensis*	Sensitive			ss
Western tanager	*Piranga ludoviciana*	Sensitive			ss
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Secure			ss
Chipping sparrow	*Spizella passerina*	Secure			ss
Clay-colored sparrow	*Spizella pallida*	Secure			ss
Vesper sparrow	*Pooecetes gramineus*	Secure			ss
Savannah sparrow	*Passerculus sandwichensis*	Secure			ss
Le Conte's sparrow	*Ammodramus leconteii*	Secure			ss
Sharp-tailed sparrow	*Ammodramus nelsoni*	Secure	Not at risk		ss
Fox sparrow	*Paserella iliaca*	Secure			ss
Song sparrow	*Melospiza melodia*	Secure			ss
Lincoln's sparrow	*Melospiza lincolnii*	Secure			ss
Swamp sparrow	*Melospiza georgiana*	Secure			ss
White-throated sparrow	*Zonotrichia albicollis*	Secure			ss
White-crowned sparrow	*Zonotrichia leucophrys*	Secure			ss
Dark-eyed junco	*Junco hyemalis*	Secure			ss
Snow bunting	*Plectrophenax nivalis*	Secure			sw
Red-winged blackbird	*Agelaius phoeniceus*	Secure			ss
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Secure			ss
Rusty blackbird	*Euphagus carolinus*	Sensitive	Special concern		ss
Brewer's blackbird	*Euphagus cyanocephalus*	Secure			ss
Common grackle	*Quiscalus quiscula*	Secure			ss
Brown-headed cowbird	*Molothrus ater*	Secure			ss
Northern oriole	*Icterus galbula*	Sensitive			ss
Pine grosbeak	*Pinicola enucleator*	Secure			r
Purple finch	*Carpodacus purpureus*	Secure			ss/r
Red crossbill	*Loxia curvirostra*	Secure			r
White-winged crossbill	*Loxia leucoptera*	Secure			r
Common redpoll	*Carduelis flammea*	Secure			sw
Hoary redpoll	*Carduelis hornemanni*	Secure			sw
Pine siskin	*Carduelis pinus*	Secure			ss
American goldfinch	*Carduelis tristis*	Secure			ss
Evening grosbeak	*Coccothraustes vespertinus*	Secure			r
House sparrow	*Passer domesticus*	Exotic/alien			R
Mammals					
Masked shrew	*Sorex cinereus*	Secure			r
Dusky shrew	*Sorex monticolus*	Secure			r

Common Name	Scientific Name	ASRD 2006	COSEWIC 2006	SARA 2006	Occurrence
Water shrew	*Sorex palustris*	Secure			r
Arctic shrew	*Sorex arcticus*	Secure			r
Pygmy shrew	*Sorex hoyi*	Secure			r
Little brown myotis	*Myotis lucifugus*	Secure			r
Northern long-eared bat	*Myotis septentrionalis*	May be at risk			r
Big brown bat	*Eptesicus fuscus*	Secure			r
Hoary bat	*Lasiurus cinereus*	Sensitive			r
Silver-haired bat	*Lasionycteris noctivagans*	Sensitive			r
Red bat	*Lasiurus borealis*	Sensitive			r
Snowshoe hare	*Lepus americanus*	Secure			r
Least chipmunk	*Tamias minimus*	Secure			r
Woodchuck	*Marmota monax*	Secure			r
Red squirrel	*Tamiasciurus hudsonicus*	Secure			r
Northern flying squirrel	*Glaucomys sabrinus*	Secure			r
American beaver	*Castor canadensis*	Secure			r
Deer mouse	*Peromyscus maniculatus*	Secure			r
Southern red-backed vole	*Clethrionomys gapperi*	Secure			r
Heather vole	*Phenacomys intermedius*	Secure			r
Meadow vole	*Microtus pennsylvanicus*	Secure			r
Taiga vole	*Microtus xanthognathus*	Undetermined			r
Muskrat	*Ondatra zibethicus*	Secure			r
Northern bog lemming	*Synaptomys borealis*	Secure			r
House mouse	*Mus musculus*	Exotic/alien			r
Meadow jumping mouse	*Zapus hudsonius*	Secure			r
Porcupine	*Erethizon dorsatum*	Secure			r
Coyote	*Canis latrans*	Secure			r
Gray wolf	*Canis lupus*	Secure	Not at risk		r
Red fox	*Vulpes vulpes*	Secure			r
Black bear	*Ursus americanus*	Secure	Not at risk		r
Raccoon	*Procyon lotor*	Secure			r
Marten	*Martes americana*	Secure			r
Fisher	*Martes pennanti*	Sensitive			r
Short-tailed weasel	*Mustela erminea*	Secure			r
Least weasel	*Mustela nivalis*	Secure			r
Mink	*Mustela vison*	Secure			r
Wolverine	*Gulo gulo*	May be at risk	Special concern	No schedule	r
Northern river otter	*Lutra canadensis*	Secure			r
Striped skunk	*Mephitis mephitis*	Secure			r
Canada lynx	*Lynx canadensis*	Sensitive	Not at risk		r
Mule deer	*Odocoileus hemionus*	Secure			r
White-tailed deer	*Odocoileus viginianus*	Secure			r
Moose	*Alces alces*	Secure			r
Woodland caribou	*Rangifer tarandus caribou*	At risk	Threatened	Schedule 1	r

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11B2 Literature Cited

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Table 11C-1   Density of Songbird Species in Each Ecosite Phase within the North American LSA (Number of Territories/40 ha)

Species	a1	b1	b2	c1	d1	d2	d3	e1	f1	g1	h1	h2	i1	i2	j1	j2	j3	Average Bird Density
Alder flycatcher												5.66				7.28		0.51
American redstart					1.76													0.25
Bay-breasted warbler						3.64												0.25
Black-and-white warbler					1.76													0.25
Black-capped chickadee					1.76													0.25
Boreal chickadee										9.10	3.92			10.19	7.28			2.54
Brown creeper		3.40	12.74		1.76	3.64	50.96						10.19					2.04
Clay-colored sparrow																	4.25	0.25
Cedar waxwing		3.40								3.64								0.76
Chipping sparrow		6.79		3.40		7.28				10.92	11.76	28.31	20.38	10.19	18.20	14.56	8.49	9.17
Common raven					1.76													0.25
Common snipe																14.56		0.51
Connecticut warbler					8.79													1.27
Common yellowthroat																7.28		0.25
Dark-eyed junco	25.48				5.27	7.28				10.92	27.44	28.31	15.29	20.38	32.76	21.84	8.49	12.99
Golden-crowned kinglet	12.74		25.48		3.51	3.64												1.53
Gray jay	12.74	13.59		10.19		10.92	25.48	16.99	16.99	1.82	5.88			5.10	10.19	3.64	7.28	5.61
Greater yellowlegs													10.19	40.76	3.64	29.12	8.49	3.31

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Species	a1	b1	b2	c1	d1	d2	d3	e1	f1	g1	h1	h2	i1	i2	j1	j2	j3	Average Bird Density
Hermit thrush					3.51	3.64				1.82	3.92					14.56		2.04
Lapland longspur																	4.25	0.25
Le Conte's sparrow																7.28		0.25
Least flycatcher	12.74									1.82	1.96				3.64			1.02
Lincoln's sparrow										1.82		5.66	15.29	10.19	32.76	14.56		4.33
Magnolia warbler		3.40											5.10					0.51
Northern flicker				3.40														0.25
Orange-crowned warbler				3.40					3.64		3.92	11.32	5.10		3.64	14.56	8.49	3.31
Olive-sided flycatcher														10.19				0.25
Ovenbird		10.19	12.74	6.79	21.08	21.84												6.11
Palm warbler									1.82		3.92	11.32	10.19	3.57	10.92	14.56		3.82
Philadelphia vireo				6.79	8.79				16.99									2.04
Pine siskin		3.40		16.99														1.52
Red-breasted nuthatch						7.28												0.51
Ruby-crowned kinglet	12.74	3.40		10.19					12.74		7.84	5.66	5.10		14.56	21.84		6.37
Red-eyed vireo				1.76														0.25
Savannah sparrow																	8.49	0.51
Solitary sandpiper									1.82		1.96							0.51
Song sparrow														20.38		14.56		1.02
Solitary vireo		3.40	12.74		3.51		25.48											1.27
Sharp-tailed																	4.25	0.25

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Species	a1	b1	b2	c1	d1	d2	d3	e1	f1	g1	h1	h2	i1	i2	j1	j2	j3	Average Bird Density
sparrow																		
Swamp sparrow											1.96				10.92	14.56	4.25	1.78
Swainson's thrush			12.74	3.40	5.27				1.82		1.96							1.78
Tennessee warbler		6.79			10.54	7.28		16.99					5.10		10.92	7.28		4.08
Three-toed woodpecker									1.82									0.25
Vesper sparrow													5.10					0.25
Western tanager						3.64					1.96							0.51
Winter wren				3.40		3.64		16.99	1.82				5.10					1.27
White-throated sparrow					5.27							11.32						1.27
Yellow-bellied sapsucker					8.79		25.48											1.53
Yellow-rumped warbler	25.48	6.79		20.38	10.54	29.12	25.48		18.20		9.80	11.32	5.10		10.92	14.56		12.23

APPENDIX 12A
CALCULATION OF SPECIES BIODIVERSITY POTENTIAL

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12A CALCULATION OF SPECIES BIODIVERSITY POTENTIAL

12A.1 Introduction

Using biological resources in a sustainable manner is a principal goal of the Canadian Biodiversity Strategy (Environment Canada, 1995). For this assessment, ecosite phases in the LSA were ranked for their species biodiversity potential. This ranking was calculated using data describing potential species richness and the proportion of species that were unique to each ecosite phase (uniqueness, in this case, meaning species that occurred in three or fewer ecosite phases).

Knowing the diversity for each ecosite phase helps to assess potential impacts of the development on overall diversity. This appendix outlines the methods used and provides species lists for each ecosite phase.

12A.2 Study Area

The assessment of Project impacts on species and community level terrestrial biodiversity was confined to the LSA. A detailed description of the study area is provided in the biodiversity section of this EIA (Volume 4, Section 12).

12A.3 Methods

12A.3.1 Calculation of the Ranking for Biodiversity Potential

12A.3.1.1 Potential Species Richness Index

A potential species richness index was calculated to reflect the number of species that were observed or expected in each ecosite phase relative to other ecosite phases. The index was determined by calculating the number of species observed or recorded as a proportion of the number in the ecosite phase with the most species. Potential plant species richness was determined by combining lists of prominent species associated with each ecosite phase in Beckingham and Archibald (1996) and species recorded during field surveys for the vegetation assessment (Volume 4, Section 10). Wildlife species data were obtained from field surveys for the Wildlife assessment (Volume 4, Section 11). An example calculation is given below.

Example

1. Total number of plant species observed or expected in the LSA: 337

2. Number of species observed or expected in ecosite phase h1: 181

3. Potential species richness index for ecosite phase h1: 181 / 337 = 0.54

12A.3.1.2 Rarity Index

A rarity index was calculated to indicate the relative potential of each ecosite phase for containing rare species. For wildlife species, this index was determined by calculating the number of species-at-risk in each ecosite as a proportion of the number in the ecosite phase with the most species-at-risk. An example is given below:

1. Highest number of species-at-risk recorded in any ecosite phase: 31 (j3)

2. Number of species-at-risk recorded in ecosite phase h1: 8

3. Wildlife rarity index for ecosite phase h1: 8 / 31 = 0.26

For vegetation species, the rarity index was determined by summing the Alberta Natural Heritage Information Centre (ANHIC) rarity rankings for each species. The ANHIC rankings reflect the provincial and global rarity of species on a scale of 1 (extremely rare) to 5 (common). Species ranked S1 are considered extremely rare in Alberta and those ranked G1 are globally rare. Those ranked S5 and G5 are common provincially and globally. For each ecosite phase, the minimum possible value (the value if all species are ranked S1) was divided by the sum of all S rankings and by the sum of all G rankings. The resulting values were then summed and the total was compared with the total for other ecosite phases to derive the rarity index. An example is shown below:

1. Sum of S rankings for species in ecosite phase g1: 426

2. Sum of G rankings for species in ecosite phase g1: 445

3. Minimum possible value for sum or S or G rankings: 90

4. 90 / 426 = 0.2113

5. 90 / 445 = 0.2022

6. 0.2113 + 0.2022 = 0.4135

7. Highest value: 0.4384 (calculated for ecosite phase j3)

8. Vegetation rarity index for ecosite phase g1: 0.4135 / 0.4384 = 0.94

12A.3.1.3 Unique Species Indices

Number of unique species (relative to other ecosite phases)

To calculate the number of unique species in each ecosite phase relative to that in other ecosite phases, the total for each phase was calculated as a proportion of that in the phase with the most unique species. An example follows.

1. Highest number of unique wildlife species recorded in any ecosite phase: 9 (d1)

2. Number of unique wildlife species recorded in ecosite phase h1: 4

3. Wildlife rarity index for ecosite phase h1: 4 / 9 = 0.44

Relative proportion of species in each ecosite phase that are unique species

An index was also calculated that showed the proportion of species in each ecosite phase that were unique relative to the same value for all other ecosite phases. The approach was similar to that for determining other indices. For each ecosite phase, the number of unique species was divided by total species richness. The resulting value was calculated as a proportion of the value for the ecosite which had the highest proportion of unique species. An example follows.

1. Total wildlife species richness for ecosite phase h1: 23

2. Number of unique species in ecosite phase h1: 4

3. Proportion of wildlife species in ecosite phase h1 that are unique: 4 / 23 = 0.17

4. Ecosite phase with the highest proportion of unique wildlife species: f1 = 0.33

5. Index of the proportion of unique species for ecosite phase h1: 0.17 / 0.33 = 0.52

12A.3.1.4 Overall Species Biodiversity Index

Indices for plant and wildlife species were summed for each ecosite phase to derive an overall index of diversity potential.

1. Sum of indices for plant species for ecosite phase h1:

$$= 1.00 + 0.96 + 1.00 + 0.89 = 3.85$$

2. Sum of indices for wildlife species for ecosite phase h1:

$$= 0.77 + 0.26 + 0.44 + 0.52 = 1.99$$

3. Overall index for ecosite phase h1: 3.85 + 1.99 = **5.84**

12A.3.1.5 Rankings of Ecosite Phases for Species Biodiversity Potential

Ecosite phases were ranked on the basis of the overall index. Ranking boundaries were as follows:

- High species biodiversity potential: 5.4 to 8.0

- Moderate species biodiversity potential: 2.8 to 5.3

- Low species biodiversity potential: less than 2.7

- Nil: anthropogenic disturbances

- Unknown: ecosite phases and other habitat types for which data are unavailable or incomplete

A ranking of Nil was given to areas that were affected by anthropogenic disturbance. The final rankings for the biodiversity potential of each ecosite phase are given in Table 12A-1. Values were calculated only for ecosite phases in the Lower Boreal Highlands subregion because species data were not collected in the Central Mixedwood subregion as this subregion occupied only a very small proportion of the LSA.

12A.4   Literature Cited

Beckingham, J.D. and J.H. Archibald. 1996. Field Guide to Ecosites of Northern Alberta. Special Report 5. Canadian Forest Service, Northwest Region, Northern Forestry Centre. UBC Press. Vancouver, BC.

Environment Canada. 1995. Canadian Biodiversity Strategy. Canada's Response to the Convention on Biological Diversity. Report of the Biodiversity Working Group. Canadian Museum of Nature.

Table 12A-1   Plant Species Richness, Rare Species, and Unique Species Indices at Baseline in the Local Study Area

Ecosite Phase	No. of Species	Richness Index	No. of Potential Rare Plants	Rare Plant Potential Index	No. of Unique Species	Unique Species Index	Proportion of Unique Species	Proportion Unique Species Index	Total Index (Max = 4)
a1	33	0.20	0.4129	0.94	4	0.07	0.12	0.22	**1.43**
b1	88	0.52	0.4141	0.94	7	0.13	0.08	0.14	**1.74**
b2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
b3	31	0.18	0.4080	0.93	3	0.06	0.10	0.18	**1.35**
c1	131	0.78	0.4206	0.96	29	0.54	0.22	0.40	**2.67**
d1	93	0.55	0.4123	0.94	26	0.48	0.28	0.51	**2.48**
d2	87	0.51	0.4087	0.93	10	0.19	0.11	0.21	**1.84**
d3	48	0.28	0.4110	0.94	9	0.17	0.19	0.34	**1.73**
e1	65	0.38	0.4140	0.94	14	0.26	0.22	0.39	**1.98**
f1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
g1	106	0.63	0.4135	0.94	19	0.35	0.18	0.33	**2.25**
h1	169	1.00	0.4226	0.96	48	0.89	0.28	0.52	**3.37**
h2	24	0.14	0.4154	0.95	2	0.04	0.08	0.15	**1.28**
i1	113	0.67	0.4189	0.96	19	0.35	0.17	0.31	**2.28**
i2	33	0.20	0.4096	0.93	4	0.07	0.12	0.22	**1.42**
j1	155	0.92	0.4265	0.97	54	1.00	0.35	0.63	**3.52**
j2	113	0.67	0.4358	0.99	42	0.78	0.37	0.68	**3.12**
j3	51	0.30	0.4384	1.00	28	0.52	0.55	1.00	**2.82**
Max	**169**		**0.4384**		**54**		**0.55**		

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Table 12A-2   Wildlife Species Richness, Rare Species, and Unique Species Indices at Baseline in the Local Study Area

Ecosite Phase	No. of Species	Richness Index	No. of Potential Rare Plants	Rare Plant Potential Index	No. of Unique Species	Unique Species Index	Proportion of Unique Species	Proportion Unique Species Index	Total Index (Max = 4)
a1	6	0.20	16	0.52	0	0.00	0.00	0.00	0.72
b1	23	0.77	11	0.35	3	0.33	0.13	0.39	1.85
b2	10	0.33	20	0.65	0	0.00	0.00	0.00	0.98
b3	0	0.00	18	0.58	0	0.00	0.00	0.00	0.58
c1	18	0.60	15	0.48	3	0.33	0.17	0.50	1.92
d1	30	1.00	27	0.87	9	1.00	0.30	0.90	3.77
d2	19	0.63	31	1.00	1	0.11	0.05	0.16	1.90
d3	16	0.53	23	0.74	1	0.11	0.06	0.19	1.57
e1	0	0.00	22	0.71	0	0.00	0.00	0.00	0.71
f1	3	0.10	24	0.77	1	0.11	0.33	1.00	1.99
g1	26	0.87	22	0.71	3	0.33	0.12	0.35	2.26
h1	23	0.77	8	0.26	4	0.44	0.17	0.52	1.99
h2	16	0.53	7	0.23	2	0.22	0.13	0.38	1.36
i1	20	0.67	8	0.26	3	0.33	0.15	0.45	1.71
i2	20	0.67	8	0.26	3	0.33	0.15	0.45	1.71
j1	17	0.57	11	0.35	1	0.11	0.06	0.18	1.21
j2	28	0.93	15	0.48	5	0.56	0.18	0.54	2.51
j3	13	0.43	31	1.00	3	0.33	0.23	0.69	2.46
Max	30		**31**		9		0.33		

Table 12A-3   Final Rankings for Biodiversity Potential for Ecosite Phases in the LSA

Ecosite Phase	Total Index (Plant spp.)	Total Index (Wildlife spp.)	Overall Total	Final Ranking
a1	1.43	0.72	2.15	LOW
b1	1.74	1.85	3.59	INT
b2	N/A	0.98	N/A	N/A
b3	1.35	0.58	1.93	LOW
c1	2.67	1.92	4.59	INT
d1	2.48	3.77	6.25	HIGH
d2	1.84	1.90	3.74	INT
d3	1.73	1.57	3.30	INT
e1	1.98	0.71	2.69	LOW
f1	N/A	1.99	N/A	N/A
g1	2.25	2.26	4.50	INT
h1	3.37	1.99	5.36	HIGH
h2	1.28	1.36	2.63	LOW
i1	2.28	1.71	3.99	INT
i2	1.42	1.71	3.13	INT
j1	3.52	1.21	4.73	INT
j2	3.12	2.51	5.63	HIGH
j3	2.82	2.46	5.28	INT