infrastructure concentrated in a 42 square kilometre area of a sand dune complex. One characteristic of this industrial land-use is that the mixed-forest matrix in which the oil-field infrastructure is located, has been retained, not removed as would be the case for agricultural development on more fertile sites. The diverse mixedwood habitat is therefore available for wildlife, albeit in a fragmented state, alongside the oilfield installations.

The Wildlife Habitat Unit affected by gravel extraction is the Drainage Course WHU (balsam poplar - willow variant) located on the point-bars along the North Saskatchewan River Valley. The narrow band of riparian woodland has been removed along sections of the North Saskatchewan River, although the dominant species of this WHU (balsam poplar), is quickly regenerating on the spoil heaps left from former gravel extraction operations. This uneven terrain has resulted in many small ponds which will likely become valuable wildlife habitat with continued regeneration of forest cover around these features.

Extraction of sand is limited to small workings in eolian sand dunes supporting Upland Coniferous WHUs. Regeneration of these sites to native vegetation (jack pine - hairy wild rye-grass) has likely been slowed by off-road vehicle use.

6 WILDLIFE SPECIES HABITAT REQUIREMENTS IN STRATHCONA COUNTY

Wildlife resource assessment techniques have recently begun to rely upon habitat evaluations as opposed to, or in addition to, direct population measurement (Eccles and Stelfox 1985). Working definitions of the term "habitat" can be vague due to the range of scales at which it can be defined. For example, definitions can range from how species are associated with broad landscape-scaled vegetation types to detailed descriptions of immediate physical environments used by certain species. A common thread, however, amongst the differing definitions and terms is that habitat relates the presence of a species to attributes of the physical and biological environment (Morrison et al. 1992). The distribution and abundance of food also influences habitat use. If food is distributed in patches, a species may be restricted only to a portion of its potential habitat. Optimal foraging theory (Stephens and Krebs 1986) attempts to explain how the distribution, abundance, and quality of forage influence distributions, habitat use, and movements of avifauna. Therefore, it is crucial to understand that wildlife management and conservation is synonymous with habitat management and conservation. The following sections describe the general habitat requirements and relationships of the major wildlife guilds and species groups anticipated to use appropriate habitats within Strathcona County.

6.1 Waterbirds

Waterfowl and other groups of avifauna that are dependent upon wetland and marsh-based habitats have been grouped together for purposes of this discussion. The species groups included in this guild are waterfowl (including all *Anatidae*), loons (*Gaviidae*), cranes (*Gruidae*), and shorebirds (*Charadriiformes*). It is recognized that other species may also be somewhat dependent upon wetland and water-dominated habitats, however their sensitivity and/or significance is based primarily on other intrinsic biological and ecological characteristics. Examples of such species groups include gulls and terns (*Laridae*) and some grebes (*Podocipidae*), which are mostly colonial nesters, and some warblers (*Emberizidae*), which are better classified among other small, terrestrial nesting songbirds.

Migratory waterfowl have been recognized as important consumptive, non-consumptive, and non-use resources throughout North America (Blatt *et al.* 1992, Van Kooten 1993). They are a diverse group of avifauna that have widely divergent requirements for survival and recruitment. Over an annual cycle, waterfowl utilize a diverse and widely distributed series of wetlands. While not all wetlands can support all of the broad annual requirements of waterfowl, many seasonal habitats are provided by groups of closely associated wetlands such as are found throughout Strathcona County. The major components of the annual cycle of waterfowl include molt, autumnal migration, winter courtship activity and initial pair bond formation, spring migration, arrival on the breeding grounds, nesting, egg laying, and brood rearing. The temporal separation of these events reflects the evolution of mechanisms that control annual cycles so that activities with high energy requirements are discretely partitioned (King 1974).

The diversity of wetland habitats utilized by waterfowl during reproduction, molt, and migration are provided in and around the area of Strathcona County through dynamic wetland ecosystems, the natural fluctuations of which coincide with waterfowl utilization. Waterbodies in southeast and east-central Alberta are noted for their provision of staging habitats for migratory fowl and also for their provision of significant breeding habitats for waterfowl during the spring and summer months. The wetlands of southern and central Alberta constitute a major component of the “prairie pothole” region, which is a great expanse of prairie extending from south-central Canada through north-central United States.

This pock-marked country was created by the advancing and retreating of glaciers during the recent ice age and moraines, such as the Cooking Lake Moraine, scattered throughout the area contain both permanent wetlands and numerous shallow depressions that are filled with water during run-off. These prairie potholes have been described as “the backbone of duck production in North America”. The importance of the area is further emphasized by the fact that the prairie pothole region makes up only 10% of the total waterfowl breeding area in North America, yet it produces at least 50% of the waterfowl population in an average year (Smith et al. 1964).

Twenty-six duck species breed in the prairie provinces with the grassland and parkland regions providing what Hochbaum (1983) referred to as the most significant breeding complex on the continent. Strathcona County lies at the northern periphery of this significant waterfowl habitat complex. Kemper (1976) described waterfowl habitats in the Cooking Lake area as follows:

> *The highest possible habitat quality ratings were applied to parts of the Cooking Lake moraine; nowhere else in the province, except for the remote Peace-Athabasca delta and the Hay-Zama Lakes area, is such a large block of habitat found. Nowhere else in Alberta is such a large area of high quality waterfowl habitat found in close proximity to a major urban center....*

Populations of ducks in North America generally are considered to have declined since the late 1950s, with the sharpest declines being witnessed for prairie-nesting species such as mallard (*Anas platyrhynchos*) and northern pintail (*A. acuta*). The loss or deterioration of breeding habitats on parkland landscapes due to agricultural activities has been implicated as the main cause of these declines. Among the prairie provinces, Alberta is recognized in the Canada Land Inventory (CLI) as having the highest density of breeding waterfowl in all classes of waterfowl habitat. Patterson (1978) reported that lands with high capability for waterfowl production, or CLI Class 1 and 2 lands, produce up to 85 ducks / sq. km. in Alberta compared to 80 in Manitoba and 69 in southern Saskatchewan. CLI Class 3 habitats, or those with slight limitations for breeding waterfowl, also have similar variations in breeding densities with Alberta producing up to 62 ducks / sq. km., Manitoba producing 36 ducks / sq. km. and Saskatchewan producing 35 ducks / sq. km.

Based on general geographic distributions provided by Godfrey (1986), Salt and Salt (1976), and Semenchuk (1992) as well as on site-specific studies such as Saxena et al. (1994, 1996a, 1996b), Strong et al. (1985), and Kemper (1976), a total of 19 species of waterfowl can be expected to breed in the Strathcona County study area, including ducks, geese, and swans. Mallard, green-winged teal (*Anas crecca*), and Canada goose (*Branta canadensis*) are ubiquitous in the County, while other species such as white-winged scoter (*Melanitta fusca*) rarely occur in the study area.

The strategies of North American waterfowl during their annual cycle are largely influenced by the instability of wetland ecosystems at high latitudes. Freezing and the concurrent lack of food necessitate seasonal migrations to warmer climates and return trips to northerly breeding grounds. Waterfowl migrate in the spring by a series of short flights that move the birds northward along large bodies of water. The large, irregularly shaped lakes in Strathcona County, such as Cooking, Hastings, Wanisan, Antler, Twin Island, and Bennett lakes, are a few of the many stop-over, or staging, sites along both autumnal and vernal migratory pathways. The migration process in waterfowl has likely been studied in more detail and is better understood than any other non-breeding waterfowl activity and the attention is well warranted. During vernal migrations towards breeding grounds, waterfowl are involved in numerous critical life stages including pair bond formation and nutrient reserve collection. The process of collection of body reserves begins along the migration route and reaches its pinnacle during the demands of egg laying and incubation on the breeding grounds.

Detailed reviews and accounts of breeding, molting, and staging ecology of North American waterfowl can be found in other sources such as Owen and Black (1990) and Blatt et al. (1992), among others and will, therefore, not be reiterated in the context of this report. However, a basic understanding of molting habitat and requirements of molting waterfowl is necessary for management purposes because many waterfowl undergo their post-breeding molt in wetlands of Strathcona County. The waterfowl which breed within the County undergo postbreeding molt on adjacent waterbodies and these molting sites may be used year after year by the same waterfowl. Some researchers have attributed this traditional use on homing characteristics of waterfowl to nesting areas and subsequent use of nearby areas for molting (Dubowy 1985). However, the same author also reports that many waterfowl migrate hundreds of miles to traditional molting sites, suggesting that such wetlands possess unique attributes that appeal to molting waterfowl.

As is the case for nesting and brood-rearing, aquatic vegetation also provides shelter and forage for molting waterfowl. Flooded areas with robust emergent vegetation such as cattail (*Typha latifolia)*, bulrush, or tall sedges are the most desirable molting habitats within wetlands of Strathcona County. On wetlands that are largely seasonal or ephemeral, these habitats became more scarce as water levels continued to drop during the late summer and autumn seasons and waterfowl use of the those wetlands also drop off at this time. Diving ducks are able to utilize available habitats later in the season than are dabbling ducks due to their reliance on open water for security. During the molt period dabbling ducks prefer secrecy found in open water interspersed with extensive emergent vegetation.

The physical characteristics of wetlands and wetland complexes in Strathcona County also provide spatial requirements which adequately accomodate the needs of breeding waterfowl. The series of small ponds and ephemeral wetlands as well as heavily vegetated inlets provide the spacing necessary to limit territorial aggression and, thus, maximize breeding pair densities. Wetlands most attractive to dabbling ducks contain approximately a 50:50 ratio of open water to emergent vegetation. Patches of emergent vegetation, such as are common on numeous relatively large lakes within the study area, are more attractive than large blocks of thin vegetation or large blocks of extremely dense vegetation. However, because many dabbling ducks inhabiting the County's wetland complexes nest in upland habitats surrounding the wetlands, recruitment of waterfowl in the area is closely tied to both terrestrial and wetland communities.

Waterfowl managers have long recognized the relationship among habitat structure, water depth, and water use by waterfowl. While dabbling ducks usually nest further away from water than do diving ducks, both tribes require a high interspersion of cover and open water (Kaminski et al. 1981, Nietfeld et al. 1984). The extensive development of littoral zones characterizes many wetlands in the County, most of which can be described more accurately as palustrine rather than lacustrine habitat. Palustrine environments are those that are seasonally inundated with shallow water and are generally highly productive (Graves and Dittberner 1986). The frequency and magnitude of water-level fluctuations in these wetlands affect habitat quality by either flooding or exposing breeding areas. Both physical (climatic, topographic, hydrologic) and biotic (production rates, root binding, herbivory, peat accumulation) processes combine in varying proportions and interact to produce observed wetland landscape processes. The resultant patterns of vegetative zonation provide heterogenous aquatic vegetation structure which is preferred by most waterfowl to provide cover as well as food. Dense stands of tall emergent vegetation are avoided by most species of waterfowl as are areas of extensive open water. Shallow water sparsely vegetated with emergents and exposed shorelines form the bulk of nesting habitat within the study area. Communities dominated by tall hydrophytes may provide escape cover for waterfowl, however nesting and brood-rearing habitat is more closely associated with diverse littoral and littoral - pelagic ecotonal zones.

Quality nesting cover is considered to be the most essential requirement for breeding waterfowl. Food requirements, while also very critical, have not been quantified in priority Wildlife Habitat Units but, rather, were assumed to be met in areas which provided good nesting cover. Quality escape cover, usually found in association with nesting cover, is important to ensure brood survival and survival of adults during the post-breed molt. In accordance with parameters previously identified by other authors (Bellrose 1976), permanent or semipermanent open water with emergent vegetation were recorded as providing the best reproductive habitat for waterfowl and, thus, were given high priority in the ranking of WHUs.

Critical waterfowl breeding areas within various portions of Strathcona County have been previously delineated by Griffiths (1992) and others, but the County has yet to be quantifiably and consistently inventoried for waterfowl breeding habitat and habitat use (A. Richard, J. Martin, personal communication). As a result, the wetlands identified in this project as priority Wildlife Habitat Units are currently the most updated inventory of biophysically-based critical habitat units for waterfowl in the County. Such WHUs can be actively incorporated into land use and development plans. Recognition of these areas is important because human distrubance can have several impacts on the reproductive success of birds (Korschgen and Dahlgren 1992) through:

1. flushing of hens leads to exposure of eggs to heat or cold and may kill the embryos;

2. predation of eggs may increase when hens are flushed from nests;

3. predation of eggs and hens may increase at nests when humans create trails or leave markers by which predators find nests;

4. broods may be scattered, separating them from their parents and increasing vulnerability to predation;

5. broods and adults may be killed or injured directly by both terrestrial and over-water vehicles and equipment;

6. pair bonds may be disrupted; and

7. clutch sizes may be reduced.

Once such areas have been 'flagged', the potential of disturbance during critical periods can be avoided and the aforementioned negative impacts of anthropogenic activities can be minimized.

While ducks constitute the major component of waterfowl fauna in Strathcona County, perhaps the single most precariously sensitive waterfowl species in Alberta is the trumpeter swan *(Cygnus buccinator)*. The trumpeter swan is the largest and rarest swan in the world. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) had listed the species as vulnerable in 1978 and it retained that status until being completely de-listed in 1996. The provincial status of the species has yet to be updated, as Alberta Fish and Wildlife Division (1991) has designated the trumpeter swan as an Endangered Animal under the umbrella of the Alberta Wildlife Act.

The historic range of the trumpeter swan included nesting areas from Ontario to British Columbia and north as far as southern portions of the Yukon and Northwest Territories with wintering sites along the Mississippi River valley and the Atlantic, Pacific, and Gulf coasts (Shandruk 1987). Since then, the species has witnessed a tremendous range constriction and had been significantly reduced in number, prompting concern over the potential extinction of trumpeter swans in the early 1900s. A series of conservation attempts, including the creation of Yellowstone National Park in 1919, culminated in 1983 with the implementation of the North American Trumpeter Swan Management Plan to establish management and population objectives and address concerns for trumpeter swans in North America (Shandruk 1989; AFWD 1990b).

Aerial surveys have been conducted by the Canadian Wildlife Service and Alberta Fish and Wildlife Division to gain knowledge of nesting pair and population distribution of trumpeter swans in Alberta, most of which are located in the Peace River Parkland Natural Subregion and the Foothills Natural Region in the province's northwest. In 1972, the Canadian population was estimated at 1,000 birds and, by 1994, had increased to over 2,100 birds. Of this population, Beyersbergen and Shandruk (1993) estimated the Interior Canada sub-population to be 1,437 birds, of which the largest flock is one numbering 419, located near Grande Prairie. In 1983, a transplant program was begun in an attempt to expand the breeding range of trumpeter swans in Canada and, between 1983 and 1987, numerous birds were captured from the Grande Prairie flock and re-introduced in Elk Island National Park, immediately east of the County of Strathcona. This re-introduction effort has met some success, as trumpeter swans have since been recorded as returning to Elk Island National Park from their wintering grounds and have also been recorded on other lakes in the area such as Beaverhill Lake (Shandruk and Winkler 1989, Winkler 1991).

Their requirements for shallow wetlands with good aquatic vegetation growth and little human disturbance result in a limited choice of nesting areas for trumpeter swans but also result in a good chance of re-population success on wetlands in the area of Strathcona County. Shandruk (1989) described four basic habitats that trumpeter swans utilize:

1. Long, narrow, deep lakes that are used for summering and staging;
2. Perched basins and associated terraces;
3. Outflow streams in valley bottoms with connections to beaver impoundments or perched basins; and
4. Oxbow wetlands associated with major river channels.

Nesting activity begins in late April on the nesting lakes of northern and western Alberta. Criteria for potential nesting habitat for the trumpeter swan include: shallow, productive waters; emergent vegetation such as cattail (*Typha latifolia*) on the perimeter; muskrat (*Ondatra zibethicus*) and beaver activity; a high biomass of submergent aquatic vegetation; and little to no human development on the perimeter of the waterbody or in its immediate vicinity. Typically, these nest structures are consistent with those described by Banko (1960) as being partially or completely surrounded by water.

The highly territorial nature of the trumpeter swan generally limits nesting densities to one breeding pair per wetland. However, G. Beyersbergen (personal communication) reports that multiple nesting does occur in situations where nesting wetlands are sufficiently large and spatially arranged so as to provide visual blocks to separate the pairs. As a result of this territoriality, trumpeter swans exhibit considerable site tenacity during the spring mating and nesting seasons.

Trumpeter swans arrive from their wintering grounds approximately 2 to 3 weeks before nesting lakes become ice-free. During that time, they will congregate in open waters of local rivers and sloughs and will feed in fields if food is limited (Shandruk 1989). Breeding pairs usually exhibit strong fidelity to nesting wetlands and often return to the same nest sites every year. Non-breeders tend to congregate on lakes not utilized for nesting. These areas are critical due to their potential to eventually support nesting activity in view of limited nesting sites elsewhere in the region. Hobson *et al.* (1990) report that trumpeter swan populations are generally stable in Alberta while other sources (Beyersbergen and Shandruk 1993, for example) indicate that the Alberta population is increasing. Once nesting wetlands in northwestern and west-central Alberta have reached carrying capacity, the maintenance of other quality habitats, such as those found in Elk Island National Park and other areas around Strathcona County, are anticipated to be significant in allowing for the continued expansion of the population.

Shorebirds comprise another diverse group of species, including plovers, sandpipers, yellowlegs, snipes, godwits, curlews, and phalaropes. There are 42 species of shorebirds that occur regularly in Canada (Godfrey 1986) and 27 of them are long-distance migrants, wintering in Central and South America. Based on geographic distributions reported by Salt and Salt (1976) and Semenchuk (1992) and on species lists generated by Alberta Recreation and Parks (no date), 13 species of shorebirds are anticipated to breed in the area of Strathcona County and numerous additional species likely occur as seasonal migrants. Among the County's resident shorebirds are very common and widespread species such as lesser yellowlegs (*Tringa flavipes*) and American coot (*Fulica americana*) and more rare species such as the Virginia rail (*Rallus limicola*).

Two decades of research in North America (Morrison et al. 1991, 1995) has identified many of the key areas used by shorebirds throughout their migration ranges and has demonstrated that some species of shorebirds concentrate, with major proportions of the population occuring at only a few sites during all life stages (nesting, migration, and wintering). These birds depend on a chain of critically important wetlands to complete their annual migrations.

Of 51 Western Hemipshere Shorebird Reserve Network (WHSRN) sites identified in Canada by Morrison et al. (1995), 22 are located in the prairie region and seven of these are in the prairie and parkland of Alberta. These staging sites are fundamentally different from those in other parts of Canada. Most of them are situated on shallow saline or alkaline wetlands where water levels and conditions can vary annually. Changing patterns of prairie shorebird communities reflect the unpredicatability of wetland resources. Colwell (1991), for example, reported annual variations in shorebird communities and changes in spring shorebird assemblages which were shown to be attributed to water levels. Because habitat availability depends heavily on water levels and shoreline development, shorebirds in Alberta often use different wetlands from year to year, thus justifying the management of such areas as wetland complexes rather than as individual wetlands.

While most shorebirds migrate to remote arctic and subarctic areas to breed and winter as far south as Tierra del Fuego (Morrison and Ross 1989), some species do breed and winter primarily in the temperate regions of North America. Upland sandpiper (*Bartramia longicauda*), for example, is a species which is "red-listed" in Alberta and requires native prairie grassland for nesting (AFWD 1991). Semenchuk (1992) reports that over 70 percent of recorded breeding in Alberta occurs in the Grassland Natural Region, however it has been recorded fairly regularly at Beaverhill Lake, approximately 15 km east of the County and its potential distribution within the County itself is unknown at this time. While the species is fairly common in its remaining habitat, overall numbers of upland sandpipers are low as it has also suffered from a loss of native grassland habitats.

6.2 Songbirds

Traditional habitat management has focussed on the perpetuation of harvestable populations of game species. This historical emphasis on waterfowl as gamebirds, for example, has resulted in a relative lack of attention being placed on non-game birds. Non-game birds are a heterogenous group, distinguished more by a process of elimination than by a precise statement of definition; basically, they include all of those species that are not hunted for food or sport (Kroodsma 1979). For purposes of indentifying critical non-game avifauna habitats in Strathcona County, non-game birds are defined here as the neotropical migrant landbirds, or those that breed in the nearctic and migrate south to the neotropics of the southern hemisphere. These species are of particular concern and have experienced drastic population declines due, in large part, to a documented deforestation problem on their tropical wintering habitats (for reviews concerning the impacts of tropical deforestation on neotropical songbirds, see Diamond 1991, Robbins et al. 1992, Thiollay 1992, Petit et al. 1993). While tropical deforestation of winter habitats has been implicated as a major cause of declining songbird populations, a concomitant fragmentation of breeding habitat in temperate regions of North America has also contributed cumulatively to the declining population trends.

Researchers have long hypothesized that a correlation existed between certain habitat features and components of an area's breeding avifauna (MacArthur and MacArthur 1961). This concept has been accepted and built upon by modern conservation biologists, who now widely recognize that the distribution and abundance patterns of avifauna species reflect the composition and structure of vegetation or habitat communities (Hunter 1990). Declining trends of songbird populations have largely been described for agriculturally dominated landscapes in the eastern United States, where habitat fragmentation has been proposed as a primary contributor to species loss (Faaborg and Clawson 1991). Fundamental differences between fragmentation patterns in eastern North America and those currently shaping western landscapes have rendered comparisons between the two processes difficult. Nonetheless, the habitat characteristics related to fragmentation are relevant to western songbirds and to neotropical migrants indigenous to central Alberta.

Aspen mixedwood forests have already been described as widespread throughout Strathcona County and these habitats have one of the most diverse communities of breeding birds in North America (Robbins et al. 1986). Forest-dwelling birds in Alberta exhibit a diversity of ecological profiles, as exemplified by Smith (1993). Physiographic variation within the area encompassing and surrounding Strathcona County - provided by the interspersion of open cultivation, aspen parkland, aspen mixedwood forests, and coniferous forests - results in its avian inhabitants displaying considerable variation in migratory patterns (permanent residents, short distance migrants, and long distance migrants); foraging guilds (granivores, insectivores, and carnivores); and nest site selection (cavity nesters, ground nesters, and brood parasites). Complexity, both of the forest strata and of the forest mosaic, is the key to diversity of avian community structure in these mixedwood forests. Vertical and horizontal heterogeneity (Hunter 1990) provide differentiated and stratified niches and a relatively large accumulation of biomass which, in turn, supports a diverse food web (Saxena 1994). Within forested communities of Strathcona County, several vegetation parameters can be used to determine the importance and the capability of these habitats to support passerine species. These parameters have been identified by Nietfeld and Stelfox (1993) and measured in aspen mixedwood forests of northeastern Alberta (Table 5):

Table 5: VEGETATION PARAMETERS ASSOCIATED WITH BIRD HABITATS IN FORESTED COMMUNITIES

Habitat Structure	Measurable Parameters
Tree	• species • dbh • height • basal area • canopy cover and density
Shrub	• species • height • density • vertical cover • horizontal cover
Herbaceous	• percent of cover graminoids • forbs • non-vasculars • litter • bare ground • overall height
Deadfall	• frequency • size • rot class • foraging activity

In the Dry Mixedwood and the Central Mixedwood subregions of the Boreal Forest Natural Region in east-central Alberta, Schieck and Nietfeld (1995) conducted a study of bird species richness and abundance in relation to stand age and structure in aspen mixedwood habitats. They found that old aspen mixedwood stands (over 120 years) supported more bird species than did young stands (20-30 years), which, in turn, supported more bird species than mature stands (aged 50-65 years). Variation in bird abundance in such variously-aged aspen mixedwood stands is attributable to a combination of the density of live trees present, the height of the canopy trees, and the heterogeneity of the canopy in each age class.

Size, extent, and structure of habitat patches are critical factors which determine use of appropriate habitats by various passerine species in Strathcona County. Fragmentation of large tracts of forest inherently produces ecological edges (Leopold 1933), or ecotones, which have been shown to adversely affect forest interior species such as the ovenbird (*Seiurus aurocapillus*). It is axiomatic that many game species are more abundant near edges. Harris (1988) contends that wildlife managers have traditionally been taught that "edge" was good for wildlife and, in many cases, wildlife management was considered synonymous with creating edge habitat. While certain species thrive in edge habitats, increased nest predation and parasitism have also been documented at forest edges (Brittingham and Temple 1983, Yahner and Scott 1988, Hannon 1993) and have negatively impacted forest interior species.

Parasitism by the brown-headed cowbird (*Molothrus ater*) has been recently characterized by Robinson et al. (1993) as one of the major threats to populations of neotropical migrants on temperate breeding grounds. The brown-headed cowbird is a generalist brood parasite and Friedmann and Kiff (1985) describe 240 separate host species in whose nests cowbirds will lay their eggs. Cowbird parasitism drastically reduces host nest productivity for the following reasons (Roskaft et al. 1990, Sealy 1992):

1. female cowbirds often remove at least one host egg from the parasitized nest;

2. cowbird eggs are unusually thick and, when laid, often break those of the host;

3. cowbird eggs have a shorter incubation period than most host eggs;

4. cowbirds usually parasitize hosts smaller than themselves, giving cowbird nestlings a competitive advantage over host nestlings.

Graham (1989) describes the brown-headed cowbird as having undergone one of the greatest range expansions of any North American bird species in the past 200 years. Large scale landscape changes during the same period has allowed for such an expansion, as cowbirds are frequently associated with agriculture, human settlements, and internal and external edges; all characteristic of the human-dominated ecosystems of Strathcona County. Most ecologists today (Robinson et al. 1993, for example) argue that the most efficient method of reducing cowbird impacts on neotropical migrants is through landscape-level management aimed at maintaining large areas of contiguous forested habitat. The minimum area thought to be required to retain local populations of forest songbirds varies considerably in the literature, ranging from as small as 3,000 ha (Robbins et al. 1989) to areas as large as 50,000 ha (Biological Advisory Team 1990).

A quantitative loss of habitat is the most noticeable impact of forest fragmentation both in Strathcona County and in other adjacent forested regions (Saxena et al. 1996a, 1996b). However, qualitative changes in the remaining forest fragments are anticipated to be of equal or greater concern for many neotropical migrants breeding in the area of Strathcona County since most of these species utilize small territories. Higher rates of brood parasitism by brown-headed cowbirds, as discussed above, has already been documented as a major qualitative impact of fragmentation. Other documented qualitative mechanisms responsible for changes in forest songbird populations as a result of fragmentation include increased rates of interspecific competition (Ambuel and Temple 1983), reductions in pairing success (Villard et al. 1992), and reductions in nesting success (Hoover 1992).

Arguedes (1992) and Faaborg et al. (1993) suggest that neotropical migrants might be the vertebrate group least sensitive to isolation of fragments due to their long distance travel capabilities. Such contentions, however, do not preclude the need to adequately conserve as large areas as possible of contiguous aspen mixedwood for songbirds. Villard et al. (1992) provide some evidence that forest bird populations function as metapopulations within landscapes. Therefore, effective conservation of neotropical songbirds may require the preservation of suitable but intermittently unoccupied habitat (Freemark et al. 1993).

6.3 Raptors

The generic name applied to this group of predatory birds is intended in this report to include both *Falconiformes* and *Strigiformes* Orders. Based on geographic distributions identified by Salt and Salt (1976) and Semenchuk (1992), 13 species of hawks, falcons, and owls are anticipated to nest in appropriate habitats within Strathcona County to some extent. A few of these species, such as red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) are habitat generalists and are common throughout most of the province. Other species are habitat specialists that are dependent upon unique structural features of forested habitats; examples include the northern saw-whet owl (*Aegolius acadicus*) which is a secondary cavity nester and is dependent upon abandoned woodpecker cavities. Among the raptors that are resident in the study area, one species - the short-eared owl (*Asio flammeus*) - is federally listed by COSEWIC; it is designated as “vulnerable” (COSEWIC 1996). Cooper’s hawk (*Accipiter cooperii*) was also designated as “vulnerable” in 1983, but its status was re-examined and the species was delisted in 1996.

The Dry Mixedwood and Central Parkland Subregions of Alberta are the northern most limit of the Cooper’s hawk breeding range (Godfrey 1986). Kirk (1996) reported that, from 1987-1991, breeding observations of Cooper’s hawk in Alberta accounted for 55 occurences in the Parkland, 41 in the Boreal Forest, 20 in the Rocky Mountain, 24 in the Grassland, and 1 occurrence in the Canadian Shield Natural Regions. This indicates a distinct preference for nesting habitat in the Parkland Natural Region.

The Cooper’s hawk was on the North American Blue List from 1972-1981 and again in 1986 when populations were shown to be low in number throughout most of its range. In Alberta, it was blue-listed in an attempt to reflect this population decline. Penak (1983) attributed the decrease in Canadian populations of Cooper’s hawk to a number of factors. Most significant was the fragmentation of suitable mature woodlands (Snyder and Snyder 1975), intensive shooting at hawk migration points in the early 1900s (Henny and Wight 1972, Evans 1982), and more recently the widespread application of toxic pollutants, such as DDT, in the form of pesticides (Adkisson 1990). Cumulatively, these factors have all taken their toll on Cooper’s hawk populations within the last century. In 1996, the national status of the Cooper’s hawk was reassigned to ‘not at risk’ by COSEWIC. A recent synopsis of the Cooper’s hawk by Kirk (1996) reported, “most of the main data sources suggest that Cooper’s hawk populations are stable or increasing in Canada." Kirk (1996) and Evans (1982) attribute the recovery of the hawk's populations to the 1972 banning of DDT use in North America. Other researchers (Braun et. al. 1977) suggest that reduced shooting pressure may have contributed to the recovery which coincides with the implementation of the North American Migratory Bird Act, which prohibits the shooting of raptors for sporting purposes.

Throughout most of its range, the Cooper's hawk remains a habitat specialist. At the landscape level, its preferences for both nesting and foraging structural features include, pure and mixed deciduous woodlands, aspen groves, bushy or moderately timbered coulees and river bottoms. In general, most researchers agree that the Cooper's hawk has been primarily associated with extensive, closed, dense woods as opposed to forest edges (Godfrey 1986, Semenchuk 1992, Penak 1983). By contrast, it should be mentioned that there appears to be evidence indicating a diversification in the habitat preferences for nesting Cooper's hawks (Beebe and Webster 1964, Snyder and Snyder 1975, Jones 1979, Smith 1996). Furthermore, most evidence regarding the impact of both human disturbance and habitat fragmentation on the Cooper's hawk also appears to be conflicting. In addition, habitat requirements for the Cooper's hawk tend to reflect the availability of prey species (Hamerstrom 1972, Jones 1979, Rosenfield and Bielefeldt 1993). For the most part, researchers have shown that small birds comprise the majority of diet for the Cooper's hawk (Craighead and Craighead 1956, Storer 1966, Snyder and Wiley 1976, Jones 1979, Rosenfield and Bielefeldt 1993).

In contrast to most data indicating Cooper's hawk preference for dense woodland and avoidance of edge habitats, vast research also exists showing the selection of nesting sites in the vicinity of human habitation, including both rural and urban developments (Snyder and Snyder 1974, Lee 1981, Kirk 1996). Kirk (1996) reports that breeding densities appear to be similar in both rural and urban settings. As a result of this evidence, many researchers suggest that the accipiter exhibits a high tolerance to disturbance and fragmentation of habitats and some researchers have even presented the theory that forest fragmentation may enhance Cooper's hawk populations (Rosenfield 1988). Bosakowski *et. al.* (1993) contradict the available evidence by suggesting that Cooper's hawks breeding in the vicinity of human development does not indicate that hawk populations are viable in urban areas, but that the birds involved are young, inexperienced breeders, breeding in suboptimal habitats. They also found that the accipiters tend to be secretive and attempt to avoid human contact.

The ambivalence of data pertaining to Cooper's hawk preferred habitat types and sensitivity to disturbance creates a unique management situation for land resource managers. Over a diverse range of nesting habitats, it has been shown that the accipiter has evolved extreme levels of tolerance and adaptability to various conditions. In the absence of any concrete confirmation of this site-specific data, it becomes imperative that management decisions should focus on protecting a wide range of habitat types to assure the protection of essential or significant communities. Despite the recent delisting of the Cooper's hawk from the COSEWIC 'vulnerable' list, the identification of the factors attributed to the recovery of the hawk are unknown. Based on bird atlas data, Semenchuk (1992) indicates Cooper's hawks nesting densities are concentrated in the Strathcona County region. Therefore, protection of a range of forest communities in this area will serve to benefit Cooper's hawk populations.

The great horned owl is recognized as the official provincial bird of Alberta and is common throughout the Parkland and Boreal Forest Natural Regions within Strathcona County. This habitat generalist utilizes a diverse group of habitat types within the province, thereby, making the Strathcona area no less valuable as a nesting and foraging habitat than other areas. Because this owl maintains a wide range of habitat preferences, classifying habitat requirements often becomes very difficult. Godfrey (1986) and Semenchuk (1992) generalized the habitat as both deciduous and coniferous woodlands from extensive heavy forests to isolated groves, woods of city parks, and wooded valleys. The wide range in great horned owl habitat preferences may be the key to understanding the abundant and widespread occurrence of this bird throughout the province. Currently, the provincial status of the great horned owl (green-listed) reflecting the overall abundance of the bird (AFWD 1991).

While identifying high quality great horned owl habitat presents a dilemma for many habitat managers, the importance of recognizing the most valuable habitat (i.e., good nesting and foraging potential) for this species is intensified because of their non-migratory habits. The great horned owl is a year-round resident of Alberta that depends upon a foraging habitat not only in the summer months but also during the winter months where the same habitat will also provide a source of cover. In effect, land-use plans must incorporate the owl into management decisions because of its year-round presence. The most important factor dictating the abundance of the great horned owl in any habitat is the density of its prey species (Semenchuk 1992). The Canadian Wildlife Service (1977) reported that in 1966 near Rochester, Alberta, when snowshoe hares (*Lepus americana*), a major prey species, increased from 40 per square kilometer to 800 per km^2, great horned owls increased from 1 to 16 breeding pairs over an area of 150 km^2. In Strathcona County, great horned owls prey upon a wide variety of species, ranging from geese and skunks to shrews and songbirds. Their adaptation to handling a diversity of prey is an additional factor contributing to their broad distribution throughout North America.

In the future, population trends of great horned owls will be determined by the extent of forest and land-use activities that infringe upon its predominantly arboreal habitats. In essence, this raptor will continue to be a conspicuous part of our natural history in response to cooperative land management decisions that includes the great horned owl in conventional land use planning.

6.4 Small Mammals

In natural habitats, vegetative complexity and habitat size are major determinants of the abundance of small mammal species and of the structure of mammalian communities. Recent studies conducted in the mixedwood forests of northeastern Alberta also echo the view that mammal species richness and abundance in mixedwood forests reflect the structural complexity of the forest (Roy *et al.* 1995). Roy *et al.* (op cit) observed that structurally complex old stands (greater than 120 years old) supported more species than did structurally simple mature stands (aged 50-65 years) or young stands (aged 20-30 years) that were intermediate in structural complexity.

The suite of small terrestrial mammals in Strathcona County is a relatively sedentary group of species, most of which have small home ranges. For such species, the maintenance of cover and dispersal corridors remain as critical to the propagation of the regional population as is food and breeding habitat. Among the small terrestrial mammals in the study area are included numerous species of microtine rodents, sciurids, and both indigenous species of lagomorphs.

Three species of ground squirrels, Richardson's, Franklin's, and thirteen-lined (*Spermophillus richardsonii, S. franklinii, and S. tridecemlineatus*, relatively), are on the northern periphery of their range in the vicinity of Strathcona County. Other species such as deer mouse (*Peromyscus maniculatus*) and red-backed vole (*Clethrionomys gapperi*) are perhaps the most common and abundant mammals in the province and both are found throughout the County. Mice, voles, and shrews are a major food source for animals higher on the food chain, including avian, mammalian, and reptilian predators.

Red squirrel (*Tamiasciurus hudsonicus*) and snowshoe hare (*Lepus americanus*) are a few of the more visible species common to appropriate habitats within the County. Red squirrels are widely distributed in Alberta, occurring primarily in association with coniferous forest communities. They subsist primarily on conifer seeds and buds; therefore, mature white spruce or mixed white and black spruce stands are considered to provide optimum habitat but the species does extend into the Parkland Natural Region, although at much lower densities. A capability classification developed through extensive sampling of representative forest types in the province (Todd 1978) illustrates the relative value of these habitats to red squirrels (Table 6):

Table 6: HABITAT CAPABILITY CLASSES FOR RED SQUIRRELS IN ALBERTA (from Todd 1978)

Capability Class	Description
1	Mature white spruce or mixed white and black spruce. Tightly interspersed black spruce stands or small wooded muskegs may comprise up to 35% of the area. Probable resident squirrel density, assuming mature stands and moderate or greater tree densities, 178+ adults / 100 ha
2	White or mixed spruce dominant, with jack or lodgepole pine comprising 1/4 to 1/2 of the total basal area. Probable density 115-175 adults / 100 ha
3	Mature stands dominated by jack pine or lodgepole pine, or deciduous stands with white spruce comprising 1/4 to 1/2 of the basal area. Probable density of 85-112 adults / 100 ha
4	Deciduous-dominated mixed stands with pine comprising 1/4 to 1/2 the basal area; deciduous stands with heavy hazelnut understory; black spurce bog. Probable density 48-82 adults / 100 ha
5	Other deciduous stands. Probable density 12-45 adults / 100 ha
6	Open muskeg; muskeg woods with tamarack. Probable density <12 adults / 100 ha
7	Cultivated fields; naked talus slopes or rock outcrops. Probable density nil.

Despite the fact that trees in open or scattered stands may produce more cones than trees in dense stands, habitat value for red squirrels is generally decreased if cone-bearing trees are widely spaced. In addition, although stands of white or mixed spruce are considered to provide optimal habitat, an interspersion of sub-optimal types (such as aspen or jack pine stands) can serve to provide food sources during years of white spruce cone shortage and can also provide buffer habitat for juvenille dispersal (Kemp and Keith 1970, Rusch and Reeder 1978).

Snowshoe hares are also widely distributed throughout the province, except in the high elevation mountainous areas and in the extreme southeast (Smith 1993). Hares utilize appropriate habitats in Strathcona County for food, hiding, reproductive cover, and thermal cover. A variety of conifer forests, mixedwood forests, aspen forests, spruce bogs, and alder, willow, buffalo berry, and silverberry thickets have been reported by numerous authors as receiving high use by hares. However, of critical value to snowshoe hares is the availability of a dense shrub layer. As a result, heavy browsing and removal of the shrub layer (by a combination of browsing wild ungulates and grazing domestic ungulates) can severely limit habitat suitability for hares in some regions, as has been reported from studies of competetive exclusion of sympatric herbivores at Elk Island National Park (Cairns 1976). Unrestricted grazing of forested habitats within the County has resulted in the distinct lack of a shrub layer for most small mammal guilds.

Snowshoe hares are a relatively sedentary species occupying well-defined but overlapping home ranges. The species undergoes cyclic fluctuations, reaching peak densities every 8 to 11 years. These cycles are important spatial and temporal determinants of habitat use and have a profound effect on predator populations, particularly the Canada lynx.

6.5 Semi-Aquatic Mammals

While active management of forest and oil and gas resources is also occuring minimally in portions of Strathcona County, the dominant land uses in the area are agricultural and residential deevlopment activities. Therefore, the elimination of wetlands through drainage or filling and associated wetland and riparian influences are of primary concern to wildlife habitat issues in this region. Mammals that inhabit wetlands in Strathcona County exhibit specific traits that make them highly vulnerable to isolation and habitat fragmentation. Virtually every species of North American mammal weighing more than 0.5 kg that inhabits wetlands is commercially valuable as a furbearing animal (Harris 1988). As a result, the wetland-associated furbearing animals, such as mink (*Mustela vison*), muskrat, and beaver warrant particular attention.

Generally, wetlands in the vicinity of Strathcona County provide good habitat for beaver. The Beaver Hills complex in and around Elk Island National Park is an area of exceptional beaver habitat. Beaver populations reported from the parkland and mixedwood forests of central Alberta are among the highest densities recorded in North America (Skinner 1984, Novak 1987) (Table 7).

Table 7: ABUNDANCE OF BEAVER FAMILIES IN VARIOUS AREAS OF NORTH AMERICA (summarized from Novak 1987)

Location	Abundance (# families / km2)	Source
central Alberta	3.9	Novak unpubl. data
northern Alberta	0.4 - 0.9	Fuller and Keith 1980
Northwest Territories (Mackenzie Delta)	0.15 - 0.38	Aleksiuk 1970
Northwest Territories (southern Mackenzie River)	0.35 (stream) 0.24 (lake)	Dennington and Johnson 1974
Ontario (Bruce Peninsula)	0.22	Morris 1976

Some of the larger lakes in the County are limited for beaver by shoreline regularity and condition, exposure, and excessive depth. However, large portions of the study area have been described as being rich in both wetland diversity and areal extent while aspen and balsam poplar, two preferred browse species for beaver, are also among the most abundant trees throughout most of the County.

The distribution of beaver in central and east-central Alberta is influenced by numerous factors including topography, slope, vegetation quality and quantity, and, of course, water availability. In areas where general topographic requirements are met, though, food availability is the most important biotic constraint to beaver distribution. Although herbaceous upland vegetation may sometimes receive extensive use as food by beavers in spring and summer, deciduous trees and shrubs constitute the main source of food. Aspen and willow are generally the preferred forage throughout east-central Alberta, although both balsam poplar and birch (Betula papyrifera) are also used extensively where they are locally abundant.

Specific habitat requirements for beavers in Alberta have been summarized by Todd (1977) as follows:

1. Beaver require water of sufficient depth and extent to accomodate bank dens or lodges and permit free movement from the dwelling to the food cache during the winter. While this requirements obviously varies with latitude, minimum water depths would be 0.9 to 1.5 m throughout most beaver range in Alberta. The water supply must be permanent and the water level should

preferably be stable.

2. Beaver require bank material of sufficiently fine texture, and hence stability, to support excavation (burrowing) or dam and lodge construction. Soils heavy with clay are best suited for construction; coarse sands and gravels are unsuitable.

3. Beaver require a suitable source of food species and construction materials, both within 200 m of the shoreline.

The beaver's water depth requirements can be met either through the utilization of lakes and streams with suitable existing profiles or by damming watercourses. The latter alternative provides beavers with control of water levels and a desirable level of environmental stability. Ponding also increases the area of suitable habitat by creating hydric sites that support willow and alder for beaver use and makes onshore woody species more accessible. Therefore, lakes with narrow dammable outlets are preferred habitats while low gradient water courses and tributaries also provide relatively broad floodplains with extensive floodable areas.
As with beaver, water is the primary requistite for muskrat habitat as well. However, muskrats reach their highest densities in standing water bodies, as opposed to beaver which can reach high densities in either lotic or lentic habitats. Growth of emergent aquatic vegetation such as bulrushes (Scirpus spp.), cattail (Typha latifolia), and sedges (Carex spp.) is the primary characteristic of muskrat-inhabitated lakes and wetlands throughout the County. These emergent wetland vegetation species are utilized by muskrat as both building material for lodges and as forage resources. Ideal depth ranges for muskrat habitats have been identified as 0.9 - 1.8 m in order to facilitate growth and anchoring of emergent vegetation as well as over-wintering capability of muskrats.

Of the semi-aquatic mammals found within Strathcona County, those that are carnivorous (either carnivores in the strict sense or omnivorous members of the order Carnivora) have larger home ranges than herbivores of the same size and, because they inhabit the water and the water's edge, their home ranges tend to be long and narrow, aggravating the probability of fatal encounters with humans or with human activity. Mink are the only carnivorous semi-aquatic mammal present in appropriate habitats within the County and they are one of the most widespread carnivores in North America.

Populations of mink are reported by Alberta Fish and Wildlife Division (AFWD 1991) to be generally healthy and stable, occurring throughout appropriate range wherever water margins with good prey availability are present. In Strathcona County, mink are found in association with stream and river banks, lake shores, and freshwater marshes. They are a highly adaptable species, and can change their daily habits according to environmental conditions, particularly prey availability. Mink have been shown to be tolerant of human activity and will inhabit sub-optimum habitats as long as an adequate food source is available. However, many man-induced changes to aquatic edge landscapes inherently reduce the ability of these areas to provide forage for mink. Reduced vegetative cover and diminished shoreline complexity due to the removal of snags, rocks, and vegetation, and the development of beaches are all examples of developments which have commonly taken place in the County and which may, concurrently, cause rapid declines in mink activity at a particular site.

The availability of suitable den sites may be a primary limiting factor for mink throughout their range. Mink typically select den sites that are close to preferred foraging areas or concentrations of prey items and they use several dens within a single home range for concealment, shelter, and litter rearing. Inter-den movements are most often made in, or along, linear habitat features such as lake shores, river banks, or stream margins (Birks and Linn 1982), thus necessitating the need to conserve such ecosystems intact. A full complement of structural features are also required within these ecosystems, as Racey and Euler (1983) and other authors have shown that deadfall, stumps, windthrown tree roots, and other such "natural cavities" are most often selected for denning activity.

Furthermore, the maintenance of intact ecosystems and landscapes for conservation of mink is favourable because it is the most efficient method of ensuring that an adequate prey base exists for them. While the mink's foraging niche is typically associated with aquatic habitats, there is considerable variation in its diet, depending on season, prey availability, and habitat type (Smith and McDaniel 1982, Allen 1986). The literature on mink biology makes reference to prey items as varied as fish, reptiles, amphibians, birds, and mammals. In Strathcona County, potential prey items may include slow-moving fish, frogs and toads, waterfowl, small microtine mammals, and other furbearers such as muskrat and snowshoe hare. Obviously, any attempt to conserve or otherwise manage mink on the basis of providing potential forage opportunities will only be successful if it addresses the maintenance or improvement of habitat diversity to sustain or increase the abundance or diversity of prey.

6.6 Ungulates

Three ungulate species are indigenous to the aspen mixedwood forest habitats of central Alberta - mule deer (Odocoileus hemionus), white-tailed deer (O. virginianus), and moose - all three of these species are found in varying densities in Strathcona County as well. Elk Island National Park, located on the eastern boundary of the County, is a major source of ungulate diversity in the region, particularly of both deer species. Elk (Cervus elaphus) also occur in the area but are a re-introduced species restricted primarily to the enclosed Elk Island National Park. Mammalian faunal diversity in the Park is higher than would be expected from island biogeography theory due to its uniquely fenced and enclosed nature (Table 8).

Table 8: POPULATIONS OF SELECTED UNGULATE SPECIES IN ELK ISLAND NATIONAL PARK (summarized from Blyth et al. 1992; Saxena et al. 1994)		
Species	Population	Density
moose	292	.028 / ha
deer (both species)	154	n/a
elk	1038	.06 / ha

As a matter of fact, white-tailed and mule deer are the only ungulate species that regularly emmigrate and immigrate across the fenced boundaries of the Park. Others, such as elk, moose, and bison (Bison bison) are effectively contained within the Park and interactions with free-roaming populations outside the Park are limited, except in the case of deer. Historical and current ungulate population levels and management initiatives within Elk Island National Park have previously been reported by numerous authors (Blyth and Hudson 1987, Blyth et al. 1992, and Saxena et al. 1994, for example).

The geographic ranges of mule deer and white-tailed deer are sympatric in many regions of Alberta, however the two species have different habitat preferences. While white-tailed deer generally prefer habitats containing interspersed woody vegetation, mule deer frequent semi-arid, open forests and shrublands associated with steep, rough, or broken terrain. It follows, then, that in moving north through the province, white-tailed deer occur in increasing abundance while mule deer are the more abundant species in southern Alberta. Within the County, Infotech Services (1989) reported deer densities to be directly correlated to the amount of tree cover remaining in upland areas and further reported mule deer distribution to be fairly restricted in the County while white-tailed deer were found to be ubiquitous wherever appropriate habitat (forage / browse and cover) is present. The distribution of ungulates reported from the Lakes Management Plan area around Cooking Lake in the southern portion of the County (Zelt and Glasgow 1975) also showed similar results, as white-tailed deer were by far the more abundant species, with mule deer occupying patchy habitats, most of which were located further south of the County in the vicinity of Ministik Lake.

The Alberta provincial government has divided the province into nine Deer Management Areas (DMAs), each representing a group of Wildlife Management Units with similar deer population characteristics (AFWD 1989, 1995). The boundaries of these DMAs correlate closely to provincial habitat regions (Pedocan 1984) and, thus, to the Natural Regions boundaries as well.

While boundaries of DMAs do not perfectly match those of the Natural Regions, crude equivalencies can be drawn between DMA #4 and the Parkland Natural Region. Based on these delineations, AFWD (1989, 1995) estimated the following population trends for deer in DMA #4 (Table 9):

Table 9: STATUS OF DEER POPULATIONS IN THE PARKLAND NATURAL REGION (DMA #4)

Species	Population	% Of Provincial Population	Productivity	Habitat Status
Mule deer	5700	9	moderate	decreasing
White-tailed deer	28800	35	high	decreasing

Agricultural lands, such as annual cultivated cropland and improved and unimproved livestock grazing in mixed farming operations, dominate the landscape of the County area. In combination with small, but increasing, amounts of timber harvesting in the area, these land uses have created a patchwork mosaic of deciduous, mixedwood, and coniferous forest, and clearings associated with agricultural and timber harvesting land use regimes. Such habitats favor the more highly adaptable white-tailed deer over its sympatric associate, the mule deer in much of the study area. However, the major drainage in the study area - the North Saskatchewan River - and its tributaries have important mule deer habitat associated with them. These localized landform features are used extensively by yarding deer in the winter, as riparian areas provide local relief from severe winter conditions. Deer populations at northern latitudes appear to be regulated primarily by low temperatures and duration of snow cover rather than by range condition (Wishart 1986), thus emphasizing the importance of maintaining winter refugia such as are found in many of the remnant Wildlife Habitat Units identified in the County through this study.

Moose are a typical boreal forest species whose distribution is closely related to the range of northern trees and plants. In North America, moose inhabit all forested areas south of the tree line and occur in varying densities throughout their range. Compared to other areas of Alberta, moose densities in the vicinity of Strathcona County are low, as they are reaching the southern limit of their circumpolar range in this region. While a substantial moose population is present in Elk Island National Park, that population has been allowed to grow under circumstances which protected it from human hunting, natural predation, and competition from other ungulates. Telfer (1984) has identified an average moose density in Alberta’s boreal and coniferous / deciduous transition ranges of 0.001 to 0.003 moose per hectare, a figure considerably more sparse than the historical mean density of 0.28 moose per hectare reported by Blyth et al. (1992)

for Elk Island National Park. It is likely that, within Strathcona County, moose populations are limited to large areas of undisturbed forest located adjacent to a colonizing source such as the Park.

Throughout most of its range in North America, moose are associated with sub-climax plant communities. Geist (1971) described moose habitats as: (a) transient communities of deciduous trees and shrubs that are unstable, short-lived, and grow on burns, and (b) permanent communities of climax deciduous tree and shrub associations along watercourses and alluvial deltas. Krefting (1974) reviewed moose habitat selection in North America and concluded that the most significant habitats in mixedwood forests are produced in early seral stages of plant succession. Berg and Philips (1974) described moose habitat selection in relatively flat areas supporting broad expanses of marsh, willow, aspen, and coniferous forests. These authors found that willow and associated willow habitats supported the majority of observed moose use.

Snow condition is a major determinant of moose winter habitat selection in most moose ranges as snow depth, hardness, and crusting conditions influence the availability of browse. Kelsall and Prescott (1971) also reported snow depths of 70 to 90 cm as restricting moose movements. As a result, most researchers agree that the availability of winter forage species is one of the major limiting factors of moose populations throughout their range. Winter moose food habit studies have been reported extensively in the literature. A review of the major findings of these studies shows that willows (Salix spp.) are the primary food source for moose in western North America. Coniferous trees adjacent to these shrub stands serve to enhance the value of these riparian habitats by providing cover. Climax communities in the study area, dominated by willow and dwarf birch (Betula glandulosa) in upland areas and decadent willow / aspen / muskeg complexes in lowland areas, also provide some winter habitat for moose.

The habitats considered most valuable to moose are those in which regrowth of palatable browse species following disturbance is interspersed with mature or unaltered stands. Le Resche et al. (1974) reported moose densities to peak 20 to 25 years following burning, after which time the growth of shrubs and invasion of less palatable species is inevitable. Basically, as forest succession advances, the quality of moose habitat decreases.

6.7 Herpetiles

Amphibians are often abundant and functionally critical elements in most terrestrial and many freshwater ecosystems and, therefore, constitute a significant component of the world's biological diversity. However, Bishop and Pettit (1992) and numerous other researchers recognize that there is currently a dearth of knowledge about the health and stability of most populations of amphibians and reptiles worldwide. Despite this paucity, most authors also acknowledge recent global declines in amphibian populations (Barinaga 1990, Blaustein and Wake 1990). As a group, herptiles are also acknowledged as one of the most endangered groups of organisms in the prairie and parkland of southern Canada (WWFC 1988, Quinn 1991). Causes for declines, both globally and in North America, that have been proposed by D. Seburn (1993) include acid precipitation, airborne pesticides, and ultraviolet light. Clearly, habitat degradation should be added to this list, as losses caused by agricultural activity are major causative factors of declining biodiversity.

The herpetofaunal assemblage of Alberta is generally not regarded as being extensive, with the greatest concentration of species occuring in the arid southeastern corner of the province. A total of eight species of reptile and 10 species of amphibian are known to occur in Alberta but ranges described by Russell and Bauer (1993) indicate that only eight species - tiger salamander (Ambystoma tigrinum), western toad (Bufo cognatus), Canadian toad (Bufo hemiophrys), striped chorus frog (Pseudacris triseriata), wood frog (Rana sylvatica), northern leopard frog (Rana pipiens), plains garter snake (Thamnophis radix), and red-sided garter snake (T. sirtalis) - potentially occur in the study area.

Most of the herpetofaunal species present in the study area occur in abundance throughout much of Alberta and their population trends are relatively stable (such as Canadian toad, striped chorus frog, and wood frog). Other species, such as western toad, northern leopard frog, and plains garter snake, occur on the peripheries of their Alberta ranges in the vicinity of Strathcona County. The only herpetofaunal species in the County requiring specific conservation attention from a provincial perspective is the northern leopard frog, which has witnessed a considerable decline since the mid-1960s in the U.S. portions of its range and since the late-1970s in Alberta. The northern leopard frog was once the most widespread frog species in North America and was abundant throughout eastern, central and southern Alberta. Roberts (1981) noted the total disappearance of the northern leopard frog from much of its range in 1979 - from sites where the species had been not only present, but abundant, a year earlier. As of 1990, only 32 locations of northern leopard frog were known from Alberta and only 17 of these populations showed evidence of breeding (AFWD 1990a).

It is generally accepted that central Alberta populations of northern leopard frog have been extirpated (Roberts 1992) and that all extant populations of the species now occur at or south of the Red Deer River and in the extreme northeastern corner of the province. Surveys conducted in central Alberta by Alberta Fish and Wildlife Services (Hofman 1991a) confirmed a few scattered occurences of the species but did not confirm any breeding activity. Transplants and re-introductions have also been suggested as conservation measures for northern leopard frogs (AFWD 1990a, C. Seburn 1993) however recognition of key habitat areas is first necessary in order for such measures to be successful