APPENDIX 1
Procedures for Selecting Amphibian and Reptile Species of Interest

Minnesota's reptiles and amphibians do not fall neatly into any of the EQB categories, but they are an integral part of the state's fauna and thus considered for the GEIS in regards to biodiversity. All resident herpetofauna were considered for analysis, although complete analysis was only performed on species that have a marked preference for forested habitats.

No reptile and amphibian species that occur in Minnesota are listed federally, however 15 are state listed species.

Endangered:

five-lined skink (*Eumeces fasciatus*)

Threatened:

wood turtle (*Clemmys insculpta*)
Blanding's turtle (*Emydoidea blandingi*)

Special Concern

Blanchard's cricket frog (*Acris crepitans*)
snapping turtle (*Chelydra sepentina*)
racer (*Coluber constrictor*)
timber rattlesnake (*Crotalus horridus*)
rat snake (*Elaphe obsoleta*)
fox snake (*Elaphe vulpina*)
western hognose snake (*Heterodon nasicus*)
eastern hognose snake (*Heterodon platyrhinos*)
milk snake (*Lampropeltis triangulum*)
bull snake (*Pitouphis melanoleucus*)
massassauga (*Sistrurus catenatus*)
lined snake (*Tropidoclonion lineatum*)
bullfrog (*Rana catesbeiana*)
pickerel frog (*Rana palustris*)

Of the 55 species of reptiles and amphibians that may be encountered in the state, only 47 have established breeding populations. The following species are not considered resident species, and thus are not covered in this report. They are listed as possible border entrants by the Minnesota Department of Natural Resources:

slender glass lizard (*Ophisaurus attenuatus*)
spotted salamander (*Ambystoma maculatum*)
Tremblay's salamander (*Ambystoma tremblayi*)
four-toed salamander (*Hemidactylium scutatum*)
Woodhouse's toad (*Bufo woodhousei*)
plains spadefoot (*Scaphiopus bombifrons*)

After initial contacts and literature review, five groups of resident species were excluded from further review.

1. Prarie/grassland species that only occur in forested habitats occassionally. Forest practices would not effect these species to a significant degree:

   six-lined racerunner (*Cnemidophorus sexlineatus*)
   prairie skink (*Eumeces septentrionalis*)
   western hognose snake (*Heterodon nasicus*)
   bull snake (*Pituophis melanoleucus*)
   plains garter snake (*Thamnophis radix*)
   great plains toad (*Bufo cognatus*)
   Canadian toad (*Bufo hemiophrys*)
   cricket frog (*Acris crepitans*)

2. Species that prefer more open areas, forest edge habitats primarily. Although these species may be occasionally found in forested habitats, they are not forest dependent. Forest practices may increase populations in regions of the state were openings are limited and decrease populations in regions where forested habitat is limiting:

   racer (*Coluber constrictor*)
   smooth green snake (*Opheodrys vernalis*)
   brown snake (*Storeria dekayi*)
   redbelly snake (*Storeria occipitomaculata*)
   prarie ringneck snake (*Diadophis punctatus arnyi*)
   fox snake (*Elaphe vulpina*)
   Cope's gray treefrog (*Hyla chrysoscelis*)
   green frog (*Rana clamitans*)

3. Species that are widely distributed in forested and nonforested habitats. All species are found throughout Minnesota. Forest practices should not have a significant impact on these species:

   snapping turtle (*Chelydra serpentina*)
   painted turtle (*Chrysemmys picta*)
   common garter snake (*Thamnophis sirtalis*)
   tiger salamander (*Ambystoma tigrinum*)
   American toad (*Bufo americanus*)
   chorus frog (*Pseudacris triseriata*)
   leopard frog (*Rana pipiens*)

4. Species that are limited primarily by appropriate aquatic habitat, which occur in both forested and nonforested areas. Although these primarily aquatic species may be impacted by timber harvest, we

assume they would be neglible compared to other potential impacts not associated with forestry in Minnesota:

Blanding's turtle (*Emydoidea blandingi*)
map turtle (*Graptemys geographica*)
ouachita map turtle (*Graptemys ouachitensis*)
false map turtle (*Graptemys pseudogeographica*)
smooth softshell (*Apalone muticus*)
spiny softshell (*Apalone spiniferus*)
northern water snake (*Nerodia sipedon*)
mudpuppy (*Necturus maculosus*)
bullfrog (*Rana catesbeiana*)
mink frog (*Rana septentrionalis*)

5. Species that are extremely rare in Minnesota. The species is either a state special concern species only documented from a few specimens (rat snake, massasauga, and lined snake) or is only known from a few localities (five-lined skink) and is a state endangered species. The documentation that there is a suitable breeding population of rat snakes, massasauga or lined snakes is questionable. It would be unreasonable to predict impacts on species that may or may not reproduce within the state. Rat snakes are the only forest dependent species in this group. They are aboreal and prefer moist deciduous forests and could be heavily impacted by forest cutting. All areas were these species exist should be protected from any disturbance without further research on population levels and habitat preferences in Minnesota. Five-lined skink habitat should be protected from any disturbance in areas where populations are known to occur. Documentation of five-lined skink habitats is available through the MNDNR Natural Heritage Program. These extremely rare species are:

five-lined skink (*Eumeces fasciatus*)
rat snake (*Elaphe obsoleta*)
massasauga (*Sisturus catenatus*)
lined snake (*Tropidoclonion lineatum*)

Of the 49 species found within the state, 12 were considered for further analysis. The wood turtle is listed as state threatened and the pickerel frog, timber rattlesnake and the eastern hognose are state listed special concern species:

wood turtle (*Clemmys insculpta*)
northern ringneck snake (*Diadophis punctatus edwardsi*)
milk snake (*Lampropeltis triangulum*)
blue-spotted salamander (*Ambystoma laterale*)
eastern newt (*Notophthalmus viridescens*)

redback salamander (*Plethodon cinereus*)
spring peeper (*Hyla crucifer*)
gray treefrog (*Hyla versicolor*)
pickerel frog (*Rana palustris*)
wood frog (*Rana sylvatica*)

The following species are found in more open habitats, including forest edges, however, the species prefers edges of older forests:

timber rattlesnake (*Crotalus horridus*)
eastern hognose snake (*Heterodon platyrhinos*)

APPENDIX 2
Detailed Species Descriptions—Small- and Medium-sized Mammals

In this section are detailed species accounts for the 22 mammal species included in impact analyses, along with citations from the published literature and other information on geographical range, habitat distribution and relevant aspects of natural history, and known impacts of timber harvest. Condensed versions of these accounts are presented in the body of this paper.

SNOWSHOE HARE (*Lepus americanus*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal Status:	Federal - none
	State - regulated game species

Geographical distribution: Snowshoe hares occur throughout boreal North America (Bittner and Rongstad 1982; Hazard 1982). This species occurs in most of the forested regions of Minnesota (Hazard 1982; Heaney and Birney 1975; Pietz and Tester 1983) this range encompasses ecoregions 1, 2, 3, and 4 in their entirety, the northern portion of ecoregion 5, and a small part of ecoregion 9.

Habitat distribution, natural history, and impacts of timber harvesting: This species exhibits marked fluctuations in abundance with a periodicity of 7 to 10 years (Boutin et al. 1985; Cary and Keith 1979; Fox 1978; Green and Evans 1940a,b,c; Keith and Windberg 1978; Meslow and Keith 1968; Windberg and Keith 1976); during high points in the hare *cycle* these animals can be found in a variety of habitat types (Bittner and Rongstad 1982; Keith 1966; Pietz and Testor 1983; Windberg and Keith 1976; Wolfe et al. 1982). Their abundance typically is greatest in lowland conifer forests, and these habitats serve as important refugia during low points in the cycle (Brand and Keith 1979; Buehler and Keith 1982; Dolbeer and Clark 1975; Fuller and Heisey 1986; Keith 1966; Ward and Krebs 1985; Wolff 1980). Hares are most abundant in forests containing dense shrub layers, including very often the presence of conifer understory that provides cover (Bookhout 1965; Krenz 1988; Litvaitis et al. 1985; Pietz and Tester 1983; Sullivan and Moses 1986; Wolfe et al. 1982; Wolff 1980). Except on the edges of clearcuts (especially with adjacent conifer cover [Conroy et al. 1979]), snowshoe hares typically are absent or occur only at very low abundance during the first few years after clearcutting, but they may use clearcut areas extensively following re-growth of overhead cover. In balance, the available information suggests that hare numbers are reduced on clearcut areas for the first decade, compared with numbers in uncut forest (Thompson et al. 1989; Wolfe et al. 1982). Studies in mixed deciduous-coniferous forests in Ontario have shown that peak density of hares occurs in 20-year-old stands (Thompson et al. 1989; see also Monthey 1986). As discussed below, snowshoe hares are important prey for bobcats and lynx, as well as a variety of other mammalian predators and a number of raptors (Arthur et al. 1989; Berg 1979; Berg and

Chesness 1978; Brand and Keith 1979; DeVos 1951; Hamilton and Cook 1955; Kuehn 1989; Nellis and Keith 1968; Nellis et al. 1972; Raine 1987; Rollings 1945; Ward and Krebs 1985).

EASTERN CHIPMUNK (*Tamias striatus*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	None

Geographical distribution: The eastern chipmunks occurs throughout almost the entire eastern one-half of the U.S. and southern Canada (Hazard 1982). Its range includes almost all of Minnesota, with the likely exception of the extreme southwest (Hazard 1982).

Natural history and habitat distribution: Eastern chipmunks, which are active during the day, consume a variety of foods, and hibernate (Hazard 1982), occur in a broad variety of coniferous and deciduous forest types (Forbes 1966; Geier and Best 1980; Iverson et al. 1967; Kirkland and Griffin 1974; Krefting and Ahlgren 1974; Morris 1979; Timm 1975) and a variety of stand ages (Healy and Brooks 1988; Krull 1970a). They also inhabit brushland areas (Hazard 1982).

Impacts of timber harvest: Results of previous studies do not provide a consistent view of the effects of timber removal on this species. Krull (1970a) and Lovejoy (1975) concluded that clearcutting has no appreciable effect on the abundance of this species in northern hardwood forests. Kirkland et al. (1985) observed increased abundance of eastern chipmunks in clearcut oak forests. However, others (Kirkland 1977, 1990) reported decreased abundance in clearcuts, and Probst and Rakstad (1987) did not capture eastern chipmunks on clearcut aspen forests in Minnesota and upper Michigan. Use of clearcuts by this species reflects primarily activity at the uncut forest-clearcut interface, as they seem to avoid the interior of large clearcuts (Kirkland et al. 1985).

LEAST CHIPMUNK (*Tamias minimus*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal Status:	none

Geographical distribution: The least chipmunk occurs in North America from the Great Lakes region, northwest across Canada to the Yukon, and in montane regions of western U.S. (Hazard 1982). It occupies the northeastern approximately one-third of Minnesota, including ecoregions 1, 2, and 3, and the northern approximately one-half of ecoregion 4.

Natural history and habitat distribution: The habits of least chipmunks are broadly similar to those of the eastern chipmunk (Hazard 1982). Like the eastern chipmunk, it is found in a variety of habitats but is especially abundant in disturbed habitats: around resorts and cabins, on and around poorly vegetated rocky outcrops, and in clearcuts and burned areas (Forbes 1966; Hazard 1982; Martell 1984; Timm 1975). Unlike the eastern chipmunk, it is uncommon under dense shrub cover or in mature, closed forest (Hazard 1982).

Impacts of timber harvest: Most available evidence indicates that least chipmunks respond positively to clearcutting and other forms of disturbance. Verme and Ozoga (1981) reported a 4-fold increase in abundance of this species following strip clearcutting in an upper Michigan conifer swamp. In black spruce forests in Ontario, Martell and Radvanyi (1977) captured least chipmunks only on clearcuts. Forbes (1966) reported this species to be especially abundant in a large slash pile on a clearcut; least chipmunks appear to inhabit the interiors of large clearcuts.

FOX SQUIRREL (*Sciurus niger*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Hardwood-dependent species
Legal status:	Federal - none State - regulated game species

Geographical distribution: The fox squirrel occurs over most of the eastern United States (Hamilton and Whitaker 1979); its native range extends as far west as western Kansas, Oklahoma, and Nebraska and eastern Colorado (Armstrong 1972; Flyger and Gates 1982a). The fox squirrel reaches the northern limit of its distribution in Minnesota. In the state, its primary range is the southern approximately two-thirds of the state (Hazard 1982; MNDNR hunter harvest statistics), including the southern one-half of ecoregion 4, virtually all of ecoregion 5 (probably present only at very low densities in the extreme northern part of the ecoregion), all of ecoregion 6, most of ecoregion 7, ecoregion 8, and a portion of ecoregion 9.

Natural history: The primary food of fox squirrels is mast, especially hickory nuts, acorns, and walnuts (Allen 1943; Flyger and Gates 1982a; Havera and Smith 1979; Havera and Nixon 1980; Nixon et al. 1968; Short 1976; Smith and Follmer 1972) but their diets also include a variety of other nuts, berries, fungi, and a substantial proportion of animal matter (Nixon et al. 1968). Fox squirrels scatter hoard nuts singly (Smith and Follmer 1972; Stapanian and Smith 1978), and may play a role in the invasion of prairie habitats by nut-bearing trees (Stapanian and Smith 1986). Cached nuts are used extensively during winter (Cahalane 1942). Fox squirrels use both dens in tree cavities and leaf nests, but are less reliant on cavities than gray squirrels (Bakken 1952; Flyger and Gates 1982a). Fox squirrels are active throughout the year.

Habitat distribution: Before European settlement, fox squirrels in the midwestern U.S. inhabited prairie *edges*—oak savannas, parklands, and oak islands—in the transition between western prairies and eastern deciduous forests (Allen 1943; Hazard 1982). They also occurred in wooded bottomlands and riparian forests extending into the prairie regions. The distribution of fox squirrels has increased since the latter part of the 19th century with the fragmentation of relatively continuous eastern deciduous forest into scattered woodlots (Allen 1943; Flyger and Gates 1982a; Hazard 1982) and with creation of wooded fencerows and shelterbelt plantings (Flyger and Gates 1982a; Hazard 1982).

In Wisconsin, primary habitat is oak-hickory woodlots; oak forest, lowland hardwoods, and mixed upland hardwoods represent secondary habitat (Flyger and Gates 1982a). Allen (1943) regarded oak-hickory woodlands as optimal habitat for fox squirrels in Michigan; he also considered oak river bottom as important habitat. Lowland forests of soft maple and elm are poor-quality habitat for fox squirrels (Allen 1943), except perhaps on a seasonal basis (Flyger and Gates 1982a). Fox squirrels are not as closely associated with continuous forests as gray squirrels (Baumgartner 1943; Flyger and Gates 1982a). Fox squirrels often occupy habitats containing only a few trees (e.g., fencerows, isolated groups of trees in pastures). As the proportion of forest coverage in an area increases, gray squirrels increase in abundance and fox squirrels decline; for example, Besnady (1957) indicated that fox squirrels are not present in an area if it is 70 percent or more forested. Terrill (1941; cited in Flyger and Gates 1982a) showed that fox squirrels declined and gray squirrels increased on a plot in Missouri that was allowed to succeed into forest and where minimal grazing was allowed. In contrast, in another portion of the same county where grazing was more intense and where small, isolated woodlots more common, population trends for the two squirrel species were reversed. However, despite some characteristic differences between fox and gray squirrels in habitat selection, the two species co-occur in many forest stands in Minnesota (Hazard 1982).

GRAY SQUIRREL (*Sciurus carolinensis*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Hardwood-dependent species
Legal status:	Federal - none State - regulated game species

Geographical distribution: The gray squirrel is distributed in most of the eastern half of the United States, but the range of this species does not extend as far west into prairie regions as the fox squirrel (Flyger and Gates 1982a; Hamilton and Whitaker 1979; Hazard 1982). The gray squirrel approaches the northwestern periphery of its range in Minnesota. It is absent from or extremely uncommon in the northern tier of counties in Minnesota, and apparently is present at only low densities in several counties along the western border of the state (Minnesota DNR, hunter harvest distribution statistics). Its range in the state includes most of ecoregion 4 except the northeast approximately one-third (it is present in the northeastern part of ecoregion 4 but only at very low densities), ecoregions 5 and 6 in their entirety, all of ecoregion 7 but the extreme west, nearly all of ecoregion 8, and much of ecoregion 9.

Natural history: Food habits of gray squirrels are broadly similar to those of fox squirrels (Flyger and Gates 1982a; Nixon et al. 1968), and both species rely heavily on mast during the winter (Flyger and Gates 1982a). Gray squirrels also scatter hoard nuts (Flyger and Gates 1982a) and are active throughout the year. Gray squirrels are more strongly dependent on tree cavities than fox squirrels (Flyger and Gates 1982a); thus, presence of an adequate number of den trees may be an important component of top-quality habitat for gray squirrels (Barkalow and Soots 1965; Burger 1969).

Habitat distribution: Although gray squirrels occupy a variety of habitats, primary habitat is mature hardwood forest (Flyger and Gates 1982a). In Illinois, gray squirrels are found in forests containing sugar maple, white oak, elms, and black oak, all of which are climax or near-climax species in forests of the region (Nixon et al. 1978). In contrast, Illinois forests from which gray squirrels are absent are characterized by early-successional tree species (Nixon et al. 1978). Fischer and Holler (1991) studied gray squirrels in hardwood, even-aged pine, and mixed pine-hardwood stands in Alabama. Abundance was similar in the hardwood and mixed pine-hardwood stands, both of which supported more squirrels than the even-aged pine stands. However, most squirrel activity in mixed pine-hardwood and even-aged pine stands was associated with narrow bands of hardwoods along streams ("hardwood stringers"); Fischer and Holler (1991) suggested that the lack of difference in squirrel abundance between hardwood and mixed pine-hardwood stands may reflect the presence of hardwood stringers in the latter stand type. Their results emphasize the close association between gray squirrels and abundant hardwoods. Presence of an adequate number and reasonable diversity of mast-producing trees is a critical habitat component for gray squirrels (Nixon et al. 1968, 1978).

Based on their studies of gray squirrels in Illinois, Nixon et al. (1978) reported that at least 20 percent of the land area of counties in central and northern parts of the state must be in forest cover for gray squirrels to be abundant. They found that squirrel harvests consisting of at least 50% gray squirrels occurred only in counties at least 30 percent forested; indeed, they reported a significant positive relationship between the common log of the proportion of gray squirrels in the harvest and the amount of hardwood cover in each county. As reported by Brown and Batzli (1984; discussed further below), the amount of forested area in Illinois counties is highly correlated with the area of individual timber stands in the county. Thus, forests occupied by gray squirrels tend to be extensive, ungrazed, and to contain predominately sawtimber trees (Nixon et al. 1978). Forests occupied by gray squirrels commonly have a well-developed tree canopy that facilitates travel among trees (Nixon et al. 1978).

Several authors have identified the presence of an abundant shrub layer as an important feature of good-quality habitat for gray squirrels (Madson 1964; Nixon et al. 1978), whereas fox squirrels typically are more successful in forests with sparse shrub cover. However, Brown and Batzli (1984) questioned the direct importance of low shrubs for gray squirrels. The results of their analyses and their re-examination of the data of Nixon et al. (1978) lead them to suggest that small, widely scattered woodlots are more likely to have the understory removed by grazing, whereas extensive tracts of forested land seldom are grazed and tend to have a well-developed understory. Thus, understory cover may be correlated with forest size (Brown and Batzli 1984), rather than representing a critical habitat component for gray squirrels.

Nixon et al. (1978) found that the average density of tree cavities in forests occupied by gray squirrels was twice as high as in forests where gray squirrels are absent. The mean density of cavities in forests occupied by gray squirrels was never less than 6/ha, whereas some forests from which gray squirrels were absent had no tree cavities (Nixon et al. 1978; see also Packard 1956). The long period of time typically required for cavity formation in many species of trees (Sanderson 1975) is a major factor in the association of gray squirrels with mature forests.

Impacts of timber harvest: Both gray and fox squirrels are strongly adversely affected by clearcutting (Kirkland 1990; Nixon et al. 1980a), undoubtedly reflecting dual impacts on availability of nest cavities and of food. These effects often are protracted, and it may be several decades before squirrels reinvade clearcut forests (Nixon et al. 1980a). However, selective cutting of moderate intensity may produce little lasting impact on either species (Nixon et al. 1980b).

RED SQUIRREL (*Tamiasciurus hudsonicus*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Conifer-dependent species
Legal status:	none

Geographical distribution: The red squirrel occurs in a broad belt across North America from Labrador to Alaska, bounded in the north by the distributional limit of trees. In the east red squirrels range as far south as Georgia in the Appalachians, and in the west in the Rocky Mountains as far south as Arizona and New Mexico (Flyger and Gates 1982b; Hazard 1982; Jones and Birney 1988). In Minnesota, red squirrels occur as far south as the Iowa border, but are most common in the northern half of the state (Hazard 1982). The only area in Minnesota where red squirrel populations are not present coincides approximately with ecoregion 8.

Natural history: Red squirrels opportunistically consume a variety of foods when available, including seeds and winter terminal buds from conifers, sap, buds, seeds, fruits, and flowers from hardwood trees, mushrooms (including many types poisonous to humans), berries, bark, young birds, young mammals, and insects (Flyger and Gates 1982b; Hazard 1982; Jackson 1961; Reichard 1976). Conifer seeds are an important part of the red squirrel diet in the boreal forest, and in some areas dependence on spruce seed is so strong that cone crop failures may initiate population declines in red squirrels (Flyger and Gatesb 1982; Kemp and Keith 1970; Layne 1954; C. C. Smith 1968; M. C. Smith 1968). White spruce seed is preferred to black spruce seed, and that preference influences the distribution of red squirrels in Alaska. Red squirrels are present almost everywhere white spruce occurs, but are virtually absent from large tracts of pure black spruce forest (Brink and Dean 1966).

Red squirrels are usually conspicuous when present in a forest because they advertise ownership of their territory with several types of vocalizations (C. C. Smith 1968, 1978; Flyger and Gates 1982b; Hazard 1982; Jackson 1961). Defended territories may be of two types. One type is the vicinity of a winter food cache and is defended only during winter. The other type is year-round prime territory which contains mature cone-bearing conifers. In mixed forests, prime territories are mostly held by adult squirrels, where the survivorship rate is high and residency time is long. In hardwood stands, winter territories are maintained by a population of almost entirely juvenile squirrels, where residency time is short and survivorship rates are low (Kemp and Keith 1970; Rusch and Reeder 1978).

Home ranges may be as large as 10 ha in deciduous forests, but in good quality coniferous habitat home-range size is much smaller, averaging 1.3 and 1.5 ha for females and males, respectively (Flyger and Gates 1982b; Jones and Birney 1988).

Cavities in trees are preferred denning sites, but where unavailable red squirrels build leaf nests. The red squirrel is active year-round, but during periods of extreme cold may stay in an arboreal den for several days at a time or, more commonly, retreat to subnivean denning sites (Pruitt 1960; Zirul and Fuller 1970).

Habitat distrbution: The red squirrel occurs in a variety of habitat types including pure hardwood stands, although coniferous forests are the preferred type (Flyger and Gates 1982b; Hazard 1982; Jones and Birney 1988; Kemp and Keith 1970; Layne 1954; Rusch and Reeder 1978). Red squirrels are most abundant in uncut, mature forests (Thompson, et al. 1989). In mixed forest landscapes, adults maintain territories year-round in conifer stands, and over-wintering juveniles may temporarily defend territories in hardwood stands (Kemp and Keith 1970; Rusch and Reeder 1978).

Impacts of timber harvest: Few studies have quantified red squirrel population responses to timber harvesting. In New York, Krull (1970a) censused for 10 years, starting from one to nine years following logging operations, and compared red squirrel populations in forests which he described as clearcut (tree stem basal area was about 70 square feet per acre), and uncut forests (basal area was about 140 square feet per acre). Red squirrels were about one third less abundant in logged areas.

During a study from 1980 to 1985 red squirrels in Ontario were always significantly less abundant in regenerating stands less than 5 years old, and were always most abundant in uncut stands (Thompson et al. 1989).

Negative effects on red squirrel populations from clearcutting result from removal of mature cone-bearing conifers and cavity trees. Hardwood-dominated regenerating forest stands which are too o young to have cone-bearing conifers are likely to be functioning as dispersal sinks for juvenile red squirrels (Van Horne 1983). Although many squirrels may be present the habitat quality is poor and survivorship rates are usually quite low (Kemp and Keith 1970; Rusch and Reeder 1978).

NORTHERN FLYING SQUIRREL (*Glaucomys sabrinus*)
SOUTHERN FLYING SQUIRREL (*Glaucomys volans*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors Hardwood-dependent species (southern flying squirrel)
Legal status:	none

Geographical distribution: The northern flying squirrel occurs in Alaska, much of Canada, the northern portion of the United States, and in montane forests of the eastern and western U.S. (Hazard 1982). This species is at the southern limit of its range in Minnesota, occurring primarily in the northeastern half of the state (Hazard 1982); this distribution coincides closely with ecoregions 1, 2, 3, and 4 but includes small portions of ecoregions 5, 6, and 9 as well.

The geographical range of the southern flying squirrel includes primarily the eastern United States and southeastern Canada (Hazard 1982). It is at the northwestern limit of its range in Minnesota, where it occupies only the southeastern approximately one-fourth of the state. Its range in Minnesota includes virtually all of ecoregion 6, the eastern approximately one-half of ecoregion 5, and the southeastern portion of ecoregion 4; in the latter ecoregion, its range overlaps with that of the northern flying squirrel (Hazard 1982). The northern limit of the range of the southern flying squirrel in Wisconsin and Minnesota coincides with the -11°C isotherm of average January temperature; across the entire northern boundary of the species, the average number of frost-free days is quite constant (about 140; Muul 1968).

Natural history: Flying squirrels are common in much of their range butut are inconspicuous because they are virtually strictly nocturnal; both species are active throughout the year. These squirrels are well known for their gliding locomotion. The northern flying squirrel uses both tree cavities and leaf nests as nesting tes (Cowan 1936), and probably is less dependent on tree cavities than the southern flying squirrel (Weigl 1978). The northern flying squirrel consumes a variety of foods, but a large portion of the diet often consists of lichens and fungi (Gunther et al. 1983; Weigl 1978; Maser et al. 1978a,b, 1985; Wells-Gosling and Heaney 1984); some of the fungi consumed by this species are hypogeous, mycorrhizal associates of higher plants, and consumption by flying squirrels and other rodents may play an important role in the distribution and dissemination of these fungi in forest ecosystems (Fogel and Trappe 1978; Maser et al. 1978a,b). The southern flying squirrel feeds less extensively on fungi but uses seeds and nuts heavily, and depends on these food items during the winter (Weigl 1978). Although both species include animal matter in the diet, the southern flying squirrel tends more towards omnivory/carnivory than the northern flying squirrel (Dolan and Carter 1977).

Habitat distribution: The northern flying squirrel occurs in a variety of woodland habitats. According to Wells-Gosling and Heaney (1984), it occupies spruce-fir and mixed hemlocks and adjacent mature hardwoods in the Appalachian Mountains, and beech-maple-hemlock, spruce-fir, and jackpine forests as well as white cedar swamps in the Great Lakes region. The species may occur in hardwood forests but typically conifers are present (Weigl 1978). In regions where the ranges of the two species overlap, the link between the northern flying squirrel and coniferous forests may be related to the need to consume needles or staminate cones of conifers, the oils of which may defendnd against a nematode parasite (*Strongyloides* sp.) transmitted from the southern flying squirrel (Weigl 1968, 1978; Payne et al. 1989).

The southern flying squirrel is associated primarily with deciduous forests (Dolan and Carter 1977; Hazard 1982; Sollberger 1940; Sonenshine and Levy 1981; Wei 1978); in the northern part of its range, it occupies some mixed hardwood-conifer stands, especially where hardwoods predominate (Dolan and Carter 1977). In mature hardwoods of Minnesota, it inhabits stands of basswood, sugar maple, elm, and oak, as well as associations of oak-aspen (Muul 1968). Weigl (1978) suggested that the northern part of its range approximates the northern limits of most mast-producing species (especially oaks and hickories), although Muul (1968) presented conflicting arguments. In Virginia, optimal habitats for southern flying squirrels were oak or oak-associated forest types, but pine and oak-pine dominated stands were not used extensively (Sonenshine and Levy 1981). Positive associations between southern flying squirrels and shrub density were described qualitatively by Jordan (1948) and subsequently have been quantified (Bendel and Gates 1987; Sonenshine and Levy 1981). It has been well documented that abundant snag trees with den cavities are an important habitat component for southern flying squirrels (Bendel and Gates 1987; Dolan and Carter 1977; Gilmore 1985; Sollberger 1940; Weigl 1978). It is believed that each individual squirrel requires several cavities, with some used as primary or maternity nests, some as secondary or escape nests, and some as feeding stations (Bendel and Gates 1987). Several authors (Muul 1968; Sonenshine et al. 1979) reported an association between habitat distribution of southern flying squirrels and presence of standing water, although Madden (1974) observed squirrels at least 200 m from the nearest water.

The impact of forest succession on flying squirrels has not been widely studied, although the prevailing view is that both species are largely associated with intermediate-age or mature forests. Healy and Brooks (1988) reported that southern flying squirrels were absent from seedling-stage (8- to 9-year age) northern hardwood stands in West Virginia, but were as common in saplings (12- to 14-year age) as in sawtimber (61- to 76-year age) and mature (>100-year-old) stages; however, their sampling protocols were not specifically designed to capture arboreal or volant rodents and capture rates for flying squirrels were extremely low. Carey (1989) found that northern flying squirrels in Washington and Oregon were most abundant in old-growth (>200-year-old) forests and usually low in abundance in young (40- to 70-year-old) stands.

Impact of timber harvesting: The impact of clearcutting on both species of flying squirrels has been studied in a variety of forest types throughout North America. The evidence clearly indicates a strong negative impact of clearcutting on these species (Kirkland 1990). In coniferous forests of western North America, northern flying squirrels are absent or occur only in extremely low abundances following clearcutting (Gashwiler 1970; Gunther et al. 1983; Hooven and Black 1976; Tevis 1956). Kirkland (1977) reported a similar pattern for southern flying squirrels in hardwood forests in the Appalachians (see also Kirkland 1990). In a study in a mixed oak stand in Pennsylvania, Kirkland et al. (1985) livetrapped small mammals on a grid that straddled a forest-clearcut interface. They captured southern flying squirrels only on the forested half of the grid. Bendel and Gates (1987) found that radiotagged southern flying squirrels in Maryland tended to avoid clearcut areas, although one female used the same glide path to cross a corner of a clearcut on several occasions. Although information is limited, flying squirrels seem to have extremely large home ranges and may require large tracts of timber to maintain stable populations (Bendel and Gates 1987; Gilmore 1985; Jordan 1948; Madden 1974; Rosenberg and Raphael 1986; Sawyer and Rose 1985; Sonenshine et al. 1979).

BEAVER (*Castor canadensis*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	Federal - none
	State - regulated furbearer

Geographical distibution: Beaver occur in almost all of North America north of Mexico, except in the Basin and Range province, northwest Texas, and north of the tree line (Hazard 1982; Hill 1982; Jones and Birney 1988). In Minnesota beaver occur throughout the state (Hazard 1982; Jones and Birney 1988).

Natural history and habitat distribution: Beaver diet shifts seasonally from succulent vegetation during summer to bark during the balance of the year, with usual woody plant species utilized in order of preference including aspen, willow, and alder, although many other plant species are consumed (Aldous 1938; Basey et al. 1990; Erickson 1939; Hall 1960; Hill 1982; Hazard 1982; Jones and Birney 1988). The supply of woody plant stems for bark is stored underwater in a cache, usually in a pond whose water level is maintained by a dam constructed by the beaver. The pond and associated wetland provide good quality habitat for many wildlife species (Grasse 1951; Hall 1960; Renouf 1972; Rutherford 1955) and forest management to improve beaver habitat has been recommended (Erickson 1939; Grasse 1951; Neff 1957; Patric and Webb 1953; Slough and Sadler 1977). The effect of flooding from beaver activities on road maintenance costs, flooded agricultural land, or loss of timber supply has caused beaver at times to be considered a nuisance species (Smith and Knudson 1955; Hill 1982).

Outbreaks of the disease tularemia have occasionally reduced population densities of Minnesota beaver (Stenlund 1953). Vacant habitat is usually recolonized eventually by dispersing juvenile beavers (Beer 1955). Population density of beaver has reached relatively high levels in some areas in Minnesota recently (Fuller and Markl 1987; R. J. Naiman, pers. comm.; W. E. Berg, pers. comm.).

Suitable habitat for beaver colonies includes streams ranging from intermittentlowages through mid-sized rivers, and ponds or lakes, if woody plants are adjacent. The best quality habitat contains early- to mid-successional aspen forest (Basey et al. 1988, 1990; Erickson 1939; Hall 1960; Hill 1982; Patric and Webb 1953).

Impacts of timber harvest: Conversion of mature forest to regenerating aspen-dominated stands through logging, fire, or other disturbance is very likely to favor increases in beaver populations (Hill 1982, Patric and Webb 1953; Slough and Sadleir 1977). Although there may be a few years following clearcutting of poor habitat conditions for beaver until aspen stems become large enough to utilize, "doghair aspen" stands are better beaver habitat than older stands of aspen or other covertypes (Basey et al. 1988, 1990).

WOODLAND DEER MOUSE (*Peromyscus maniculatus gracilis*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors
Legal status:	None

Geographical distribution: The various subspecies of *Peromyscus maniculatus* occur through much of North America (Hazard 1982; Jones and Birney 1988). The woodland deer mouse occurs in the northern Great Lakes region, parts of southern and southeastern Canada, and portions of New England (Hazard 1982; Jones and Birney 1988). Its distribution in Minnesota includes virtually all of ecoregions 1, 2, 3, and 4, and small portions of ecoregions 5 and 9. Another subspecies, the prairie deer mouse (*Peromyscus maniculatus bairdii*) also occurs in Minnesota, but it inhabits primarily open grassland areas in the southern and western parts of the state (Hazard 1982; Jones and Birney 1988).

Natural history and habitat distribution: This mouse is a widespread, ecologically general omnivore-granivore (Hazard 1982; Jones and Birney 1988; Martell and MaCaulay 1981). It is a dominant or co-dominant (with the red-backed vole) species in a wide variety of forest habitats (Buech et al. 1977; Christian 1982a,b, 1990; Jones and Birney 1988; Kirkland et al. 1985; Lederle 1982; Nagorsen and Peterson 1981; Niemi et al. 1984; Richens 1974; Timm 1975; Trcka 1981). In portions of its range that overlap with the range of the white-footed mouse, the deer mouse often is found in coniferous or mixed coniferous-deciduous forests, and the white-footed mouse often is associated with more-strictly deciduous forests. However, in parts of Minnesota, the two species coexist in the same forest stand (pers. observ.; Hazard 1982; Hermeling 1992; Lederle 1982). Although the deer mouse is found in lowland conifer forests, it generally is more abundant in drier, upland forests (Halvorson 1981; Lovejoy 1975; Miller and Getz 1977; Vickery et al. 1989). Within a given forest stand, the deer mouse often is more abundant in dry than in moist microhabitats (Halvorson, 1981; Kirkland and Griffin 1974). Reported relationships between abundance of the deer mouse and within-stand variation in vegetation are inconsistent (Miller and Getz 1977; Vickery 1981; Vickery et al. 1989).

Impacts of timber harvesting: Deer mouse numbers frequently increase, often dramatically, following forest fires (Ahlgren 1966; Buech et al. 1977; Clough 1987; Gashwiler 1970; Hooven 1969; Krefting and Ahlgren 1974; Martell 1984) or clearcutting or clearcutting and slash burning (Gunther et al. 1983; Halvorson 1982; Hooven and Black 1976; Kirkland 1974, 1990; Martell 1983a,b; Martell and Radvanyi 1977; Probst and Rakstad 1987; Ramirez and Hornocker 1981; Sims and Buckner 1973; Verme and Ozoga 1981; Sullivan 1979a,b; Tevis 1956; Walters 1991). Responses to clearcutting often are more pronounced in coniferous than deciduous forest (Kirkland 1990). There is considerable variation among studies in the duration of elevated numbers on clearcut or cut and burned areas. In some studies, densities have remained higher on cut areas 5 years or more after timber harvest or burning (Clough 1987; Ramirez and Hornocker 1981); in black spruce forests in Ontario, Martell (1983b) found that deer mice remained the dominant species on clearcuts at least 13 years after harvest. On the other hand, Monthey and Soutiere (1985) found deer mice more abundant in uncut softwoods than in clearcut stands; Scrivner and Smith

(1984) found that deer mice in spruce-fir forests in Idaho increased with forest succession, being significantly more abundant in 80+ year-old stands than in 1-to 10-year-old stands. Although Probst and Rakstad (1987) found high numbers of deer mice on clearcut aspen forests in the northern Great Lakes region, abundance was greatest in mature forest. Furthermore, several studies (Martell 1983a; Sullivan 1979a,b) have shown that the elevated numbers of deer mice on clearcut forests often reflect unstable populations of mobile, juvenile males that have dispersed onto clearcuts from adjacent, uncut forest.

Some of the variation in results of the above studies may reflect geographical or subspecific effects; these are poorly understood. The view most consistent with studies on deer mice in the Great Lakes region is that, with the exception of the rather brief pulse in numbers following cutting or cutting and burning, abundance generally is greater in more mature forests; this is the view we have adopted in our analysis of impacts of timber harvest on this species.

WHITE-FOOTED MOUSE (*Peromyscus leucopus*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors
Legal Status:	None

Geographical distribution: The white-footed mouse ranges from Mexico through the eastern approximately two-thirds of the U.S. to southern Canada (Hazard 1982; Jones and Birney 1988). It is present over much of Minnesota except for the northeast, being absent from ecoregions 2, all but small parts of 1 and 3, and the northeastern approximately 40 percent of ecoregion 4.

Natural history and habitat distribution. The white-footed mouse is an insectivore-omnivore (Hazard 1982; M'Closkey 1975). Like the woodland deer mouse, it occurs in a number of forested habitat types (Birney and Nordquist 1988; Geier and Best 1980; Hazard 1982; Iverson et al. 1967; Kirkland 1984; Kirkland et al. 1985; Lederle 1982; Miller and Getz 1977; Trcka 1981). The white-footed mouse is more often associated with deciduous covertypes than is the woodland deer mouse (Hazard 1982; M'Closkey 1975). Habitat distribution of this mouse is related to such factors as presence of debris cover (Miller and Getz 1977), abundant overstory trees (Morris 1979; Yahner 1982), and shrub or foliage density (M'Closkey and Lajoie 1975; Yahner 1982).

Impact of timber harvesting: Reports on the impact of clearcutting on this species indicate varied patterns. One systematic study on aspen stands of different ages in Minnesota and the upper peninsula of Michigan indicates that white-footed mice are extremely uncommon in clearcut and sapling-stage aspen stands relative to mature stands (Probst and Rakstad 1987); however, other studies in western Minnesota have shown that at least in some years these mice may be very abundant in early regenerating aspen stands, although their abundance on recent clearcuts was not addressed in that study (G. Nordquist, pers. communication). Kirkland (1990), summarizing results of many studies on impacts of clearcutting on small mammals, concluded that mice of the genus *Peromyscus* tend to decrease following clearcutting of deciduous forests; a number of the studies on white-footed mice included in his summary reflect that pattern. There is evidence that spatial distribution and abundance of this species may be affected by forest fragmentation resulting from clearcutting (Yahner 1986), even though these rodents may respond positively to the creation of small gaps in the forest canopy (Buckner and Shure 1985).

SOUTHERN RED-BACKED VOLE (*Clethrionomys gapperi*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors
Legal status:	None

Geographical range: This species is found throughout Canada, in the Great Lakes region, and the Rocky and Appalachian Mountains (Hazard 1982; Jones and Birney 1988). It occurs throughout most of Minnesota except the southwest and the extreme southeast, being generally absent from the southeastern approximately one-half of ecoregion 6, the southwestern approximately one-half of ecoregion 7, and ecoregion 8.

Natural history and habitat distribution: The red-backed vole is an extremely abundant and widespread rodent in Minnesota. It occupies a great variety of habitats throughout the state, and is a dominant or codominant member of small-mammal communities in nearly every forested cover type in the region (Christian 1982a,b, 1990; Iverson et al. 1967; Kirkland 1984; Lederle 1982; Nagorsen and Peterson 1981; Niemi et al. 1984; Powell and Brooks 1981; Richens 1974; Timm 1975; Trcka 1981; Yahner 1982). Although this vole has been widely studied, the relationships between its abundance and forest type or successional stage are not fully understood. Some of the variation in abundance of red-backed voles is explained by their affiliation with sites having abundant woody debris on the ground and for sites with moist substrates (Gunderson 1959; Lovejoy 1975; Miller and Getz 1973, 1977; Yahner 1983); these are features not commonly reflected in broad classifications of forest type. Within-habitat distribution of red-backed voles in northern Minnesota may be associated with presence of a conifer understory (pers. observation). Some habitats where red-backed voles are consistently abundant are a variety of lowland conifer forest types and some, particularly moist, upland coniferous forests. Dry northern hardwoods forests and oak-hickory forests often support only low densities of these voles.

Red-backed voles are herbivores-omnivores (Martell 1981; Schloyer 1977; Vickery 1979), and they may play an important role in forest ecology through their substantial consumption of hypogeous mycorrhizal fungi (Maser et al. 1978a,b; Ovaska and Herman 1986; Whittaker 1962; Williams and Finney 1964). In addition, this is an extremely important small mammal in forests of northern Minnesota because it is a staple prey item for a variety of raptors (for example, boreal owls [E. Reese, unpubl. data]) and for several mammalian predators (including the pine marten).

Impact of timber harvesting: Population increases of red-backed voles have been reported following clearcutting of some forest stands (Gunther et al. 1983; Kirkland 1977, 1978; Kirkland et al. 1985; Lovejoy 1975; Monthey and Soutiere 1985; Verme and Ozoga 1981); these often are dry sites where preharvest numbers of red-backed voles are low. In contrast, clearcutting of moist sites often results in no change or a decline in numbers compared to those in adjacent, uncut forest. Studies in aspen stands in northern Minnesota and in the upper peninsula of Michigan have shown numbers of red-backed voles to be lower in recent clearcuts than in sapling and mature stages (Probst and Rakstad 1987); results of a number r of other studies indicate that abundance of red-backed voles declines following clearcutting (Martell 1983a,b; Martell and Radvanyi 1977; Ramirez and Hornocker 1981; Scrivner and Smith 1984; Walters 1991).

Scrivner and Smith (1984) found that red-backed voles were most abundant in mature forest, and suggested that populations of these voles did not reach prelogging levels until about 40 years aer harvesting of spruce-fir forest in Idaho. Several studies have shown that red-backed voles may remain on clearcuts for the first two or so years after cutting, after which their numbers decline to rarity (Martell 1983a,b; Martell and Radvanyi 1977). Walters (1991) suggested that edge habitat in forests adjacent to clearcuts may be unfavorable for red-backed voles. Natural forest fires, prescribed burns, or postharvest burning of slash nearly always result in greatly reduced numbers of red-backed voles, at least until ground- and shrub-layer vegetation recovers (Ahlgren 1966; Gunther et al. 1983; Halvorson 1981, 1982; Krefting and Ahlgren 1974; Martell 1984; Sims and Buckner 1973; Walters 1991; but see Tester 1965).

MEADOW VOLES (*Microtus pennsylvanicus*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors
Legal status:	None

Geographical distribution: The meadow vole ranges from Alaska throughout most of Canada and south to New Mexico, the central Great Plains, and Georgia (Hazard 1982; Jones and Birney 1988). It occurs throughout Minnesota (Hazard 1982).

Natural history and habitat distribution: This species, a specialized herbivore (Batzli 1985), most often is associated with moist grass or grass-sedge habitats, and it occurs in forested regions in circumstances in which this ground cover develops (Hazard 1982; Hodgson 1972; Iverson et al. 1967; Probst and Rakstad 1987). Some mature forest cover types provide suitable habitat for meadow voles, but more often this species is associated with permanently nonforested sites or with the grassy cover that develops in some stands following timber harvest. Suitable conditions for meadow voles in these sites commonly persist for only a few years following disturbance; numbers of this specs in these habitats typically are lower than those in more continous, grassland habitats (Christian 1982b; pers. obs.; Timm 1975). The meadow vole also is a common prey item for many raptors and carnivores, but this species cannot be viewed as a substitute for red-backed voles in early-successional habitats, primarily because some predators (such as the pine marten during winter) typically do not hunt in many of the habitat types in which meadow voles are abundant.

Impact of timber harvesting: Because of its association with early successional stages and with grassy cover often seen on early postharvest stands, the meadow vole undoubtedly responds positively to timber harvesting.

WOODLAND JUMPING MOUSE (*Napaeozapus insignis*)
MEADOW JUMPING MICE (*Zapus hudsonius*)

EQB Grouping:	Forest furbearers (carnivores and rodents) Prey base for forest raptors
Legal status:	None

Geographical distribution: The woodland jumping mouse occurs throughout much of eastern North America, west as far as Manitoba (Hazard 1982; Jones and Birney 1988). It occurs in the northeastern approximately one-third of Minnesota, a range corresponding with ecoregions 1, 2, and 3, and most of ecoregion 4. The meadow jumping mouse occurs in much of the boreal zone of the U.S. and Canada, and its range includes the entire state of Minnesota (Hazard 1982; Jones and Birney 1988).

Natural history and habitat distribution: Both species of jumping mice are hibernators (Hazard 1982) and both consume varied diets that include substantial amounts of hypogeous fungi (Ovaska and Herman 1986; Vickery 1979; Whitaker 1962; Williams and Finney 1964). Both species tend to occur in moist areas with dense vegetative cover (Brower and Cade 1966; Lovejoy 1975; Miller and Getz 1977; Morris 1979; Vicke 1981). The meadow jumping mouse is widespread in a variety of habitats that includes a number of forest types, especially early successional stages (Hazard 1982; Iverson et al. 1967; Parker 1989; Probst and Rakstad 1987; Timm 1975); the woodland jumping mouse commonly inhabits forested areas, often coniferous forests with heavy ground cover (Jones and Birney 1988; Kirkland and

Griffin 1974; Miller and Getz 1977; Vickery 1981); this species is more strongly associated with mature forests than the meadow jumping mouse (Hazard 1982).

Impact of timber harvesting: Information on responses of jumping mice to timber harvest is limited. As would be expected from their association with early-successional stages, meadow jumping mice often respond positively to timber harvest (Kirkland 1990; Probst and Rakstad 1987). Patterns for woodland jumping mice are more varied. In one 9-year study, woodland jumping mice were more abundant on the cut area during 4 years but more abundant on the uncut area in the other years (Krull 1970b). Kirkland (1977) reported a significant increase in abundance on deciduous clearcuts but the complete absence of this species from recently clearcut coniferous forest. Lovejoy (1975) found that numbers of woodland jumping mice on clearcuts were low in the first 1 to 2 years after logging, but increased subsequently.

PORCUPINE (*Erethizon dorsatum*)

EQB Grouping: Forest furbearers (carnivores and rodents)
Legal status: None

Geographical distributution: The porcupine is widely distributed throughout northern and western North America (Hazard 1982). It occurs in forested regions in the northeastern approximately one-half of Minnesota, a distribution corresponding closely to ecoregions 1, 2, 3, and 4 but also including parts of ecoregions 5 and 9.

Habitat distribution, natural history, and impact of timber harvest: Porcupines occur in various forest types. They seem to be most abundant in oak and oak-hickory, maple-basswood, and white pine stands. This pattern in abundance reflects partly the winter food selectivity of porcupines. During much of the winter they feed primarily on the inner bark of sugar maple and white pine and foliage of white pine and white cedar (Schmidt 1990; Tenneson and Oring 1985). Winter foraging by porcupines seems to be concentrated primarily in late second-growth or mature stands, with little or no use made of early regenerating stands (Schmidt 1990; Tenneson and Oring 1985). During summer porcupines consume a variety of leaves and herbaceous vegetation, gathered either in trees or on the ground (Shapiro 1949; Woods 1973). In our analysis of porcupine abundance as it is affected by timber harvesting, we emphasized the importance of the more-critical winter habitats. Although porcupines may forage along the edges of clearcuts during summer, the overall abundance of this species typically is extremely low in clearcuts (pers. obs.; W. E. Berg, pers. comm.).

The importance of porcupines as food for predators in Minnesota generally is unappreciated. They are among the top five prey items for several major predators in the state (wolf, coyote, bobcat [W. E. Berg, pers. comm.]).

RED FOXES (*Vulpes vulpes*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	Regulated furbearer

Geographical distribution: The distribution of the red fox includes virtually all of boreal and temperate North America; this species occurs throughout Minnesota but is generally less abundant in densely forested portions in the northeast than elsewhere (Hazard 1982; Jones and Birney 1988; MNDNR harvest statistics).

Habitat distribution, impact of timber harvest: Red foxes generally are more abundant in semiopen country, agricultural areas, and early-successional forest stages. There is no reason to suspect that this species would be affected negatively by an increase in timber harvest; instead, it is likely red foxes would increase in abundance, as they apparently have in response to clearing of land for agricultural purposes (Jones and Birney 1988).

GRAY FOX (*Urocyon cinereoargenteus*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	Regulated furbearer

Geographical distribution: The range of the gray fox includes southern Ontario and Quebec and portions of the U. S. including the eastern one-half of the country, the southern Rockies, the southwest, and the Pacific coastal states (Hazard 1982; Jones and Birney 1988). There are distributional records of gray foxes from much of Minnesota, but this species is extremely uncommon in the northeast and is reasonably abundant only in the southeastern and central part of the state (Boggess and Loegering 1985). The common range for the species includes all of ecoregion 6, the eastern approximately two-thirds of ecoregion 5, the central part of ecoregion 4, and the eastern approximately one-half of ecoregion 7.

Habitat distribution: In contrast to the red fox, gray foxes are less often associated with open areas and occur more often in brushy areas or mature forests (Hazard 1982; Jones and Birney 1988; Trapp and Hallberg 1975). Particularly in the transition zone (ecoregion 4), gray foxes often are associated with riparian timber along major rivers (W. E. Berg, pers. commun.). Although specific informamation is limited on responses of gray foxes to timber harvest, it is unlikely that they make extensive use of recent or early clearcuts, or—because of their frequent association with brushy wooded areas—that selective cutting of hardwood stands has major impact on them. There are indications from studies in northwestern U.S. that gray foxes are one of relatively few species of mammals that sw negative responses to forest fragmentation (Rosenburg and Raphael 1986).

PINE MARTEN (*Martes americana*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
	Conifer dependent species
	Species that require old or mature forests
Legal status:	Federal - undertermined.
	State - special concern (Nordquist and Birney, 1988).

Geographic range: Marten are resident in northeastern Minnnesota, and presently are found in much of ecoregion 1, all of ecoregions 2 and 3, and the northeast portion of ecoregions 4 (MNDNR harvest statistics). Minnesota's marten population represents part of the southernmost range of marten in central North America (Hazard 1982; Jones and Birney 1988).

The marten (*Martes americana*) is found only in North America and formerly was distributed in a broad belt across the continent in mixed coniferous-deciduous and boreal coniferous forests as far north as the tree line. Its range reached south into New England, the Alleghenies, the southern Great Lakes region, the Rocky Mountains as far south as New Mexico, the Sierra Nevadas, and the Cascades (Clark et al. 1987; Hagmeier 1956; Strickland et al. 1982a). The size of marten range, especially southeastern parts, has undergone large fluctuations in size since European settlement. Due to human impacts marten populations were extirpated or severely reduced in southern Ontario, southern Quebec, most of New England and portions of the Great Lakes region. Viable marten populations remain in northern parts of Maine, Vermont, New York, and Minnesota, and have been reintroduced in Wisconsin and Michigan (Clark et al. 1987; Davis 1983; Jones and Birney 1988).

The original range of marten in Minnesota before European settlement roughly corresponded to the coniferous fost zone on F. J. Marshner's map of natural vegetation of Minnesota (Berg and Kuehn 1991; Heinselman 1974). Marten were present as far south as Crow Wing and Polk counties (Hagmeier 1956), and at least as far south as Pine county in central Minnesota at the turn of the century (J. W. Harth, pers. comm.). Minnesota's marten habitat was severely reduced in quality when the virgin pine forests were logged (Dana et al. 1960), and was further degraded by a series of large fires in the early part of the century (Pyne 1982). After the logging boom peaked and began to decline around 1900 (Dana et al. 1960), many unemployed loggers began trapping (Berg and Kuehn 1991). The concurrent loss of habitat and increased trapping pressure reduced the Minnesota marten population to the point that marten were considered to be possibly extirpated (Hagmeier 1956). The last marten to be trapped in Minnesota in the first half of the twentieth century was captured in the Northwest Angle in 1920 by Adolph Hodap, and trapping for marten in Minnesota was finally prohibited in 1929 (Stenlund 1955). During the decades that marten were protected from trapping, second-growth forests in much of the northeastern part of the state matured and succeeded to shade-tolerant conifers, creating widespread habitat conditions more favorable to marten (Berg and Kuehn 1991; Mech and Rogers 1977). Documented sightings (Mech and Rogers 1977) and MNDNR confiscation records (Berg and Kuehn 1991) indicated a steady increase in Minnesota's marten population, and in 1985 the state opened a carefully controlled trapping season on marten. In spring, 1990, the population of yearling and older marten was estimated to number 9,100 individuals and occupied about 34,000 square km (Berg and Kuehn 1991).

Natural history: Numerous studies of marten food habits (Bissonette et al. 1988; Buskirk and McDonald 1984; Douglas et al. 1983; Cowan and Mackay 1950; de Vos 1951; Hargis 1982; Hargis and McCullough 1984; Hawley and Newby 1957; Koehler et al. 1975; Koehler and Hornocker 1977; Lensink et al. 1955; Marshall 1946; More 1978; Murie 1961; Quick 1955; Raine 1987; Simon 1976; Spencer and Barrett 1983; Spencer and Zielinski 1983; Thompson and Colgan 1987, 1990; Weckwerth and Hawley 1962; Zielinski et al. 1983) indicate that marten are opportunistic generalist predators which consume small mammals, snowshoe hares, red squirrels, birds, carrion, fruit, and insects. Unlike bobcat and lynx, marten population cycles are not synchronous with cycles of the snowshoe hare population (Cowan 1950), but instead may decline when *Clethrionomys gapperi* (red-backed voles) population densities are low (Hawley and Newby 1957; Thompson and Colgan 1987, 1990).

Marten, like some other mustelids, have evolved a long and thin body form (Clark et al. 1987; Strickland et al. 1982) which permits them to pursue prey in small spaces. The advantage of greater access to prey is somewhat offset by the metabolic costs of that body form (Brown and Lasiewski 1972). The relationship between body surface area and body volume of the marten is less favorable for heat retention than in other mammals of similar mass, and the resting metabolic rate of the marten is about 12 percent higher than for non-mustelids of the same body size (Worthen and Kilgore 1981). Marten do not hibernate or migrate, and are active through periods of extreme cold (Herman 1974). To maintain energy balance in extremely cold weather, marten rest in subnivean spaces (under the snowpack) where the temperature is much higher than above the snow (Pruitt 1960). Marten most commonly gain access to subnivean spaces by way of natural openings in the snow cover at snags or deadfalls (Buskirk et al. 1989; Simon 1976; Steventon and Major 1982). The dependence on subnivean resting sites during periods of extreme cold may explain why marten sometimes have been considered an inhabitant of old-growth forests, where snags and deadfalls are usually abundant.

Marten, like many other carnivores, have relatively low reproductive output. Females do not reproduce in the first year, but about 80 percent of 18-month-old female marten show evidence of sexual maturity (Berg and Kuehn 1991; Strickland et al. 1982) and the number of corpora lutea averages only 3.1 ± 0.8 per pregnant female (Berg and Kuehn 1991). The very slow recovery of Minnesota's marten population over 6 or 7 decades may be related to their low reproductive rate.

Habitat distribution: Studies on habitat selection in a number of geographical regions have shown that marten are linked to conifer-dominated mature forests (Barrett and Spencer 1982; Bissonette et al. 1988; Buskirk et al. 1989; de Vos and Guenther 1952; Hargis 1982; Hargis and McCullough 1984; Koehler et al. 1975; Koehler and Hornocker 1977; Marshall 1951; Mech and Rogers 1977; More 1978; Raphael 1986; Robinson 1953; Simon 1976; Snyder and Bissonette 1987; Spencer and Zielinski 1983; Steventon and Major 1982; Taylor and Abrey 1982; Thompson et al. 1989; Zielinski et al. 1983; Wynne and Sherburne 1984). Areas without closed forest canopies (>30 % closure) are either avoided or travelled through swiftly by marten, especially females (de Vos 1951; Hargis and McCullough 1984; Herman and Fuller 1974; Koehler et al. 1975; Robinson 1953; Snyder and Bissonette 1987; Spencer and Barrett 1983). Hardwood stands are used less than expected based on availability (Taylor and Abrey 1982; Wynne and Sherburne 1984). Recent and regenerating clearcuts are used very little by female marten during winter for at least 15 years (Soutiere 1979; Steventon and Major 1982) or 23 years (Snyder and Bissonette 1987) after the cutting. A study on marten habitat selection 150 km east of Thunder Bay, Ontario, showed that regenerating clearcuts up to 30 years old were still used much less than nearby uncut areas (Thompson et al. 1989).

Impacts of timber harvest: The impact of clearcutting on marten populations and habitat use has been investigated in several locations in North America. In Maine, clearcut areas within individual marten ranges were used in summer only when berries were present, and the rest of the year marten used the remaining uncut areas extensively (Steventon and Major 1982). In the same study, marten used 3- to 18-year-old regenerating stands less than expected in relation to availability, and selected uncut softwood stands or selectively cut mixed wood stands. In another Maine study, Soutiere (1979) found that marten rarely used 0- to 15-year-old stands of regenerating clearcut softwoods, and instead selected the residual uncut stands in their home-range for very heavy use. Marten population density was 3 times greater in large blocks of uncut forests than in forests where half of the area had been clearcut and another fourth had been selectively cut during an interval of 15 years (Soutiere 1979).

In Ontario, Thompson et al. (1989) found that clearcuts have long-term effects on marten density and use of habitat. From 1980 to 1985 during winter uncut stands were used from 3 to 40 times more frequently than regenerating clearcuts. Although not extensive, marten use of regenerating clearcuts was greatest at about 10 years after cutting. Use by marten declined to low levels at about 30 years after cutting. The slight peak in use of 10-year-old regenerating clearcuts may be related to re-establishment of canopy closure. The very slight use by marten of 30-year-old regenerating clearcuts may be related to the virtual absence of snags and deadfall, or low availability of preferred prey species.

In a study of habitat selection by marten in Newfoundland, Snyder and Bissonette (1987) found that clearcuts were seldom used, although they represented 41 percent of the study area. Marten activity was mostly restricted to uncut areas and residual stands within clearcuts. Marten density was 0.108 per square km. A virtually uncut adjacent study area had 418 marten per square km (Bissonette et al. 1988).

The decline of marten in areas with extensive clearcuts may be related to several factors. Clearcutting may change the prey base in an area, with declines in the preferred prey species *Clethrionomys gapperi* and *Lepus americanus*, and increases in the low-preference prey species *Peromyscus maniculatus*. Clearcutting removes all canopy cover for a period of time, a condition of which female marten are very intolerant. Burning slash is a treatment used to improve regeneration of conifers in clearcut areas. The removal of coarse woody debris makes access to subnivean resting spaces very difficult for marten.

Marten must be included on the list of species for which spatial aspects of forest harvest need to be considered. Buskirk and McDonald (1989) analyzed variability in marten home-range size as reported from several studies (Archibald and Jessup 1984; Bateman 1986; Bissonette et al. 1988; M. K. Brown, N.Y. Dep. Environ. Conserv., unpubl. data; Burnett 1981; Buskirk 1983; Major 1979; Mech and Rogers 1977; Raine 1981; Simon 1980; Spencer 1981; Steventon 1979) and found that Minnesota martens require larger home ranges than most other places where the species has been studied in North America. In a study near Ely, Minnesota, on home-range and activity patterns during winter of telemetry-collared marten, Mech and Rogers (1977) found that home-range size varied from 4.3 to 19.9 square km.

For marten management in Newfoundland, Bissonette et al. (1988) recommended that uncut residual stands shouould be at least 15 ha in size, and that no clearcut be more than 500 m wide. They also recommended that spatial intercrconnection of uncut stands should be maintained by either close proximity of stands, or with connecting corridors of closed-canopy uncut forest stringers. In their opinion, ideal conditions for marten habitat in Newfoundland would be to maintain a matrix of old growth rest containing widely-spaced small clearcuts.

Koehler et al. (1975) recommended for management of marten in the west that "openings must be kept small, old growth forests on mesic sites should be kept intact, and forest diversity must be maintained."

Berg and Kuehn (1991) recommend that Minnesota's marten population should be managed by keeping 25 percent of marten range in Minnesota as old growth forest type, with at least 50 percent conifers. They also recommended maintaining overhead cover, and that uprooted blowdowns be left for subnivean rest sites.

FISHER (*Martes pennanti*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	Federal - none
	State - Regulated furbearer

Geographic range: The fisher is resident in northeastern Minnesota, and at present is found in all of the areas within map ecoregions 1, 2, and 3, almost all of ecoregions 4, and small portions of ecoregions 5 and 9 (MNDNR, unpublished trap return data). Fisher occur only in North America, and their range extends from the Atlantic to the Pacific coasts in Canada, but not as far north as the tree line or Alaska. Their range extends south into the U.S. in several New England states, the northern Lake states, the northern Rocky Mountains, and the Sierra Nevadas (Hagmeier 1956; Hazard 1982; Jones and Birney 1988; Powell 1981; Strickland et al. 1982b) and the Minnesota fisher population represents the southernmost part of fisher range in central North America.

The range of fisher throughout North America, especially in southeastern portions, has undergone large fluctuations in size since European settlement (Coulter 1960; de Vos 1956; Dodds and Martell 1971; Hagmeier 1956; Powell 1977). In several states fisher populations were severely reduced or extirpated, and wildlife managers have made efforts to increase fisher population levels by reintroductions, trapping prohibition or restrictions, and habitat management (Brander and Books 1973; Dodds and Martell 1971; Hamilton and Cook 1955; Powell 1977, 1979; Weckwerth and Wright 1968).

In Minnesota fisher populations declined almost to extirpation due to unregulated overtrapping of this easily trapped species, and loss of habitat from extensive logging and forest fires (Berg and Kuehn 1991), and in 1929 trapping was prohibited. When second-growth forests began to mature in northeastern Minnesota the protected fisher populations slowly recovered (Balser 1960; Berg and Kuehn, 1991) and began a range expansion which is still underway (Balser and Langley 1966; MNDNR harvest statistics). In 1977, after nearly fifty years of protection from trapping, the state's fisher population had recovered enough that the MNDNR decided to allow trapping under closely monitored conditions.

Natural history: Numerous studies on fisher diet habits (Arthur et al. 1989; Brander and Books 1973; Brown and Will 1979; de Vos 1951; Hamilton and Cook 1955; Kelly 1977; Kuehn 1989; Raine 1987) have revealed that fishers are opportunistic generalist predators which usually prey on small- and medium-sized mammals and birds. Fisher also will eat fruit when available. Kuehn (1989) examined the contents of 1,649 fisher stomachs from carcasses collected from trappers and fur buyers in Minnesota between 1977 and 1985. He found that snowshoe hare and whitetail deer carrion were important components of fisher diets, and that a large variety of other prey items were also consumed. He also found that fishers switched to small mammals (deer mice, voles, lemmings, shrhrews, and moles) when snowshoe hare populations decline.

Maternal dens are often located high in hollow trees (Strickland et al. 1982b). Temporary dens are located under logs, brush piles, or tree roots, in hollow trees or ground burrows, or under snow (de Vos 1952; Hamilton and Cook 1955; Powell 1977).

Habitat distribution: Fisher can be found in most forest types and stand ages where their prey species occur, including mixed, deciduous, and coniferous stands in both uplands and lowlands, and stand ages ranging from early successional to mature forests (Allen 1983; Arthur et al. 1989; Hamilton and Cook 1955: Kelly 1977; Powell 1981; Strickland et al. 1982b; Thomasma 1988; Thomasma et al. 1991). All authors agree that during winter fisher avoid open places which lack overhead cover, and will usually run directly across open areas to minimize the time in open spaces. Conifer plantations, although providing fairly good canopy closure, are not used in proportion to their occurrence within fisher territories (Thomasma et al. 1991). During winter in Maine, deciduous stands are used by fisher less than expected by availability (Arthur et al. 1989).

Impacts of timber harvest: The historic decline of fisher in eastern North America has been at least partially attributable to extensive forest harvesting, and the recovery of fisher populations in many regions has been aided by improving habitat quality as second growth forests have matured (Balser 1960; Balser and Longley 1966; Berg and Kuehn 1991; Brander and Books 1973; Dodds and Martell 1971; Coulter 1960; Hagmeier 1956; Hamilton and Cook 1955; Powell 1977, 1981; Strickland et al. 1982b). A recent study in Ontario (Smith and Williams 1989) indicates that in areas where greater than 10 percent of the forest has been clearcut fisher populations decline markedly. Fisher are absent from clearcut areas, particularly in winter, until some forest regrowth has taken place (de Vos 1951; Powell 1981; Strickland et al. 1982b).

LYNX (*Lynx canadensis*)
BOBCAT (*Lynx rufus*)

EQB Grouping:	Forest furbearers (carnivores and rodents)
Legal status:	Bobcat - Regulated furbearer Lynx - Fully protected in Minnesota in recent years; previously regulated furbearer; candidate species for Federal listing

Geographical distribution: Lynx occur throughout the boreal regions of North America (Hazard 1982; Jones and Birney 1988); in Minnesota, they are found primarily in the northern tier of counties, including ecoregions 1, 2, and 3 virtually in their entirety and the northeastern approximately one-half of ecoregions 4 (Hazard 1982; MNDNR harvest statistics). Although some authors have suggested that lynx do not breed in the state, but represent only wanderers from the north, this view is not universally held. Bobcats occur throughout much of the U.S. and southern Canada (Hazard 1982; Jones and Birney 1988). Primary range of the bobcat in Minnesota is the forested region south and west of the major range of the lynx; this distribution corresponds with much of ecoregion 1, a portion of ecoregion 2, the southwestern one-half of ecoregion 3, nearly all of ecoregion 4, and northern portions of ecoregion 9.

Habitat distribution, natural history, and impact of timber harvest: Lynx are specialized to live in areas with deep snow. Although they take a variety of prey, they depend extensively on snowshoe hares, a staple of their winter diet (Brand and Keith 1979; Fox 1978; Keith and Windberg 1978; Nellis and Keith 1968; Nellis et al. 1972). Bobcats, although more general in their prey selection than the lynx, also make extensive use of snowshoe hares (Berg 1979; W. E. Berg, pers. commun.; Marston 1942; Hamilton and Hunter 1939; Rollings 1945; Westfall 1956). Lynx occupy a variety of habitats. In mixedwood habitats in Ontario, lynx tracks were most common on sites that had been logged 20 to 30 years ago and were absent in uncut areas and in stands less than 5 years old (Thompson et al. 1989). Bobcats use an array of habitats during spring, summer, and autumn, but the habitats used most extensively during winter are lowland conifers (W. E. Berg, pers. commun.; Berg 1979; Erickson 1955; Rollings 1945; Petraborg and Gulvalson 1962). Bobcats avoid flooded or semiflooded areas (Rollings 1945). During winters when snowshoe hare abundance is low, critical habitats for both the lynx and bobcat are lowland conifer forests that also represent refugial habitat for hares (Buehler and Keith 1982). In our analyses of impacts of timber harvest on these two species, we focused on the importance of lowland conifers because of the bottleneck that winter (in general) and low points in the snowshoe hare cycle (in particular) represent for these species.

Lynx numbers in Minnesota are generally low (for example, MNDNR harvest statistics indicate a total known harvest of 57 animals during 1980-85) and vary substantially from year to year. Bobcat numbers in the state have been relatively stable since about the mid-1950s. However, the population prior to that time was considerably greater; for example, before World War II the state annually bountied more bobcats than are present in the state now (W. E. Berg, pers. commun.). Extensive logging of lowland white cedar and other lowland conifers is thought to have been a factor in this decline. Both bobcats and lynx are relatively vulnerable to trapping (W. E. Berg, pers. commun.; Brand and Keith 1979), and increased access

resulting from development of forest roads must be taken into account in assessing impact of timber harvest on these species.

APPENDIX 3
Large Mammals

WHITE-TAILED DEER (*Odocoileus virginianus*)

EQB Grouping:	Forest Ungulate
Legal Status:	Big-game Animal

The white-tailed deer is one of the most abundant large mammals in Minnesota and the major big-game species (Jones and Birney 1988; Hazard 1982). The estimated harvest of deer in the state was 178,425 in 1990 (Dave Schad pers. comm.). Recreational uses, both consumptive and nonconsumptive, bring an estimated $400 million per year into Minnesota (MNDNR 1990).

The rutting season of the white-tail usually begins in October and most does are bred by November (Erickson et al. 1961.). After a gestation period of approximately 205 days fawns are born in late May or early June (Erickson et al. 1961). Generally, does giving birth for the first time usually have one fawn, while twins are the rule among older deer and triplets and quadruplets are not infrequent (Fashingbauer et al. 1965). Winter severity and condition of does coming out of winter play important roles in the probability of birthing, the number of fawns dropped and the condition of fawns at birth (Erickson et al. 1961). Fawns are usually dropped in areas which provide adequate concealment such as grassy swales or patches of heavy fern (Erickson et al. 1961; Fashingbauer et al. 1965).

Food habits of the white-tail consist of browsing on woody shrubs and trees in the winter, and foraging on grasses, forbs, fruits, and foliage of small shrubs and trees in the summer (Jones and Birney 1988). Preferred browse species are white cedar, mountain maple, red maple, red-osier dogwood, staghorn sumac, oak, alternate-leaved dogwood, juneberry, hard maple, black ash and mountain ash (Fashingbauer et al. 1965). Oaks provide an important food source both in terms of their browse and acorns when available (Fashingbauer et al. 1965; Dorn 1971). During the summer deer eat a variety of herbaceous and cultivated plants such as lamb's quarters, jewel weed, grasses, aquatic plants, cultivated grains, asters and goldenrods (Fashingbauer et al. 1965). They will also seek out cultivated fields, orchards, and potato and rutabaga patches when available (Fashingbauer et al. 1965). Dorn (1971) has found that residual corn plays an important role as a winter food source for deer in the southeast and agricultural regions of the state when natural foods are not available.

Winter cover which protects white-tails from the severity of winter weather, is critical throughout the state (MNDNR 1990). Often times many deer will occupy a "yarding" area during winters of deep snow to escape from the cold winds and avoid fatigue from traveling in the wind and snow (Fashingbauer et al. 1965). While wooded riparian zones and woodlots provide suitable winter and escape cover in the farm regions (McAnnich and Simons pers. comm.), deer seek out conifer cover in severe winters in the northern forest regions of the state because of the thermoregulatory values and protection from snow that they provide (MNDNR 1990).

A nematode brainworm (*Parelaphostrongylus tenuis*) which parasitizes deer with little adverse effect on them, can seriously effect moose, caribou and elk. In northwestern Minnesota both moose and deer can co-exist at relatively high densities (Berg pers. comm.). However, in the northeast, there seems to be a deer-density threshold which at or below will allow for sustained moose populations (Berg pers. comm.). As deer densities increase above this threshold, moose populations may decline substantially (Berg pers. comm.). Therefore, management to promote deer in this area should be discouraged if sustained populations of moose are desired (Berg pers. comm.).

White-tailed deer are preyed upon by large carnivores (gray wolves and black bears) and are hunted by humans (Jones and Birney 1988). Generally predation has not caused declines in deer populations in Minnesota. However, wolves have been implicated, along with degradation of habitat and a series of severe winters, in a deer decline in Minnesota (Mech and Karns 1977).

Because the Minnesota Department of Natural Resources controls the harvest of deer, hunting does not present a significant problem for whitetails. However, there is some concern that increased access associated with increased timber harvesting may contribute to overharvesting, in the form of higher success rates, in the future.

Geographic range within Minnesota: Occurs statewide.

Ecological distribution: The ecological distribution of white-tailed deer in the forested regions of Minnesota is mainly a function of the availability of summer forage, winter cover in close proximity to winter browse, and permanent upland openings (Byelich et al. 1972; Gullion 1984; McCaffery et al. 1981; MNDNR 1985; Buech et al. 1990).

Shade-intolerant types, such as aspen and birch, and their associated shrub and herb layer provide the necessary food supply for deer (MNDNR 1985). Mixed types such as aspen/balsam poplar and balsam fir/aspen/birch provide excellent summer forage because of their high plant species diversity (Mooty 1979). Shade-intolerant types less than 25 years of age are the best producers of deer and deer food (Mooty 1971). Principal summer forage species which are associated with these types include: leaves of young aspen, birch, willow, juneberry, hazel, cherry, bush-honeysuckle, rose, large-leaved aster and strawberry (Mooty 1979; Rogers et al. 1981). Depending on desired deer densities, 25-65% of upland area should be in these intolerant types (Gullion 1984; MNDNR 1980; Byelich et al. 1972; McCaffery et al. 1981).

Good quality winter cover ranges are critical to deer survival in northern Minnesota (MNDNR 1985) and are generally less available than summer and spring-fall ranges. Deer which inhabit areas at the northern edge of their range are limited by problems of overwinter mortality and nutrition-related reproductive failures related to quality and quantity of available food in winter (Rogers et al. 1981; Berg pers. comm.). Studies have shown that deer will not seek out thermal cover, even at very low ambient temperatures, when adequate food is available (Moen 1966 and Schmitz 1990). Moen (1968) suggests that food is the most important factor in deer survival but when food is not available thermal cover becomes important in maintaining thermal balance. Extensive research shows the enhanced energy conservation capabilities for deer through thermoregulation provided by dense stands of conifers (Moen 1968, 1973, 1982; Moen and Evans; Stevens and Moen 1970; Ozoga 1968). Conifer stands with canopy closures >70% improve the thermal balance of deer during severe winters (DelGuidice unpublished). Conifer cover also influences energy balance because it provides snow depths and densities which are lower than those found in other types (Moen and Evans 1971, Moen 1973). Conifer stands provide snowpacks that are less dense than in more open types by reducing wind, and diurnal exposure to solar radiation and snowmelt and by facilitating greater nocturnal downward solar radiation flux from the canopy (Moen and Evans 1971). At snow depths > 12 inches deer will not paw through snow to underlying herbaceous vegetation and at depths > 20 inches deer movements are restricted (Rogers et al. 1981; Kelsall and Prescott 1971). Dense conifer stands can intercept up to 36% of the total winter snowfall (U.S. Army 1956). Winter yarding types, in order of preference are: white cedar, balsam fir, jack pine, white spruce and red pine (MNDNR 1985). Tamarack and black spruce stands also provide quality winter cover (Berg pers. comm.). It is also important that these conifer types be diverse in physical appearance (have some openings and crooked rows), and not be in plantation management (Berg pers. comm.).

High quality winter cover should also be in close proximity to young, regenerating, intolerant types, which provide dormant woody browse (Rogers et al. 1981; Byelich et al. 1972; Perala 1977; Mooty 1979; MNDNR 1985; Krefting and Phillips 1970; Berg pers. comm.). This woody browse dominates white-tail diets until spring (Rogers et al. 1981). 10-20% of management area should consist of the above conifer types (MNDNR 1980; Buech et al. 1990).

Permanent or maintained upland openings are an important component of white-tailed deer habitat in many forested areas (Rogers et al. 1981; McCaffery and Creed 1969; MNDNR 1985; Gullion 1984; McCaffery et al. 1981; Tubbs 1977;). In northern areas, as snow begins to melt, deer move to upland areas and begin to complement their browse diet with small plants which remain green over the winter including: bunchberry, wintergreen and strawberry (Rogers et al. 1981; McCaffery and Creed 1969). As spring progresses new green grass, emerging forbs, emerging leaves of shrubs and trees consist of 90% of their diet (Rogers et al. 1981). Providing these upland openings adjacent to, or near wintering complexes will support adequate spring forage for deer coming out of winter (MNDNR 1985). Optimal upland openings consist of 0.5 to 10 acres in size, less than 10% stocked with trees, less than or equal to 30% shrubs and upland brush (McCaffery and Creed 1969; MNDNR 1985; Gullion 1984; McCaffery et al. 1981; Tubbs 1977;). Depending on desired deer densities, management areas should consist of 3-5% of area in these upland openings (MNDNR 1985; Gullion 1984; McCaffery et al. 1981; McCaffery and Creed 1969).

The aspen/birch type which forms the transition between heavily wooded areas and upland fields in the southeast, was used extensively by deer (Dorn 1971). Bedding in the southeast occurred primarily in wooded uplands and seemed to be chosen because of its proximity to food resources located in the upland fields and aspen/birch type (Dorn 1971). Forestry practices which favor harvesting of mature timber and regeneration of oak may alleviate pressures on crops by providing natural foods (Dorn 1971).

In the agricultural regions of the state deer are less dependent on winter cover provided by conifer types and will seek out riparian zones and woodlots under severe conditions (McAnnich and Simons pers. comm.). Wooded riparian zones may provide deer with needed escape cover during the hunting season in the agricultural portion of the state (Simons pers. comm.). Because conifer cover is limited and rarely used by deer in the northwest, deer tend to suffer higher mortality in this area during severe winters (Berg pers. comm.).

BLACK BEAR *(Ursus americanus)*

EQB Grouping:	Forest Furbearer
Legal Status:	Big-game Animal

Black bears were once abundant in much of the state of Minnesota, including some isolated woodlots in the prairie region, and were generally thought of as a "nuisance" species (MNDNR 1990). Because of agricultural, industrial and urban encroachment, the current black bear range in the State has been reduced to the northern 1/3 of Minnesota (30,000 square miles) (MNDNR 1990). At the same time the black bear in Minnesota has been increasingly recognized as a desired big game animal, and Minnesota currently ranks 6th in numbers of bear harvested by sport hunters (MNDNR 1990).

Bears are hibernators, and will spend from October or November until March or April in deep sleep in a den beneath roots of a tree, in a rock cavity and under boulders (Jones and Birney 1988). A thick layer of fat sustains them (Jones and Birney 1988). During the entire period, they do not urinate or defecate (Jones and Birney 1988). Breeding normally occurs during the summer, but embryos do not implant until autumn and cubs are born in the den in late January or early February (Hazard 1982; Jones and Birney 1988). One to five small young are born in late winter to the dormant female (Jones and Birney 1988). Cubs accompany their mother when she leaves the winter den in late winter or early spring (Jones and Birney 1988).

Black bears generally are restricted to wooded habitats, both hardwood and coniferous, including swampy areas (Jones and Birney 1988). These animals are solitary and primarily diurnal and crepuscular (Jones and Birney 1988). They are omnivores, and probably have a greater diversity in feeding behavior than any other Minnesota mammal (Fashingbauer et al. 1965) Their diet consists of ants, berries, fruits, nuts, honey, carrion, fish, birds and eggs, small mammals, and invertebrates (Jones and Birney 1988).

Black bears have long been thought of as a nuisance species (MNDNR 1990). Shortages of the above mentioned natural foods, especially nuts and berries are quite common in Minnesota, and when not available, bears are attracted to human-related sources of food, such as garbage, crops and livestock (MNDNR 1990). In recent years an estimated 100-350 bears have been killed annually for nuisance related reasons (MNDNR 1990).

Bears have few natural enemies except humans, although large carnivores occasionally take cubs or even adults in exposed dens (Jones and Birney 1988). After a bear reaches 2 years of age, other than disease and natural mortality, the only significant source of mortality is human-induced mortality, with the majority coming from hunting (Garshelis pers. comm.; Rogers 1987). Special measures may be needed to aid survival of females through at least 1 reproductive cycle (6.3 years of age) if the population should decline (Rogers 1987). Although the Minnesota DNR controls hunting of black bears in the state, increases in timber harvesting and the consequential increases in access, may lead to greater vulnerability stemming from increases in hunting success and animal/vehicle collisions (Rogers 1987; Garshelis pers. comm.). Because of the reasons mentioned above, it may become more important to gate or close logging roads immediately following management activity (Rogers 1987; Rogers and Allen 1987).

Species distribution within Minnesota: See map (MNDNR 1990).

Ecological distribution: The black bear's ability to inhabit a broad diversity of physiographic and vegetative associations seems to be related to its ability to hibernate during winter periods when food is scarce (Hamilton and Marchington 1980) and adaptable social behavior (Rogers and Allen 1987). Habitat loss, gunshot, and nutritional deficiencies limit black bear populations over much of the black bear range (Rogers 1987). Black bear habitat is characterized by forest cover interspersed with small clearings and early stages of forest succession (Hugie 1979; Herrero 1979). The southern and western limits of the black bear range in Minnesota are probably determined by the encroachment of agriculture and its associated reduction in forest cover and increased human activity (Garshelis pers. comm.).

Differences in growth and reproduction of black bears have been linked to food availability and differences in food supply (Rogers 1976; Noyce and Coy 1990). Black bears are opportunistic omnivores whose diet is dominated by green vegetation, ants, fruits and nuts (Noyce and Coy 1990), and other easily digested vegetative foods which are high in nutrients and low in cellulose (Rogers 1976; Herrero 1979; Rogers 1987). However, most of their summer weight is gained on berries and nuts eaten after mid-July (Garshelis et al. 1987), and these foods appear to have a strong influence on reproduction (Rogers 1976). The majority of bears in northeastern Minnesota enter dens 1 to 3 months earlier than bears where oak forests are more prominent, and as a result black bear growth and maturation are slower (Rogers and Allen 1987). Green vegetation, although important in spring and when preferred food is scarce are not consumed year-round because of their high cellulose content which bears cannot digest (Rogers 1976; Herrero 1979; Rogers 1987).

Herbs and shrubs that produce fruits consumed by black bears in northcentral Minnesota include; juneberry, wild sarsaparilla, spikenard, alternate-leaf dogwood, roundleaf dogwood, red-osier dogwood, beaked hazel, plum, pincherry, chokecherry, swamp buckthorn, prickly gooseberry, currant, blackberry, red raspberry, red-berried elder, blueberry, arrowwood and highbush cranberry (Noyce and Coy 1990).

Abundance of fruiting plants for all species was greatest on well-drained soils, moderate on poorly-drained soils and lowest on poorly-drained organic soils (Noyce and Coy 1990). Most important forest types, in terms of total fruit biomass, were 10- to 20-year-old red pine and 9-to 16-year-old regenerating aspen (Noyce and Coy 1990). However, fruit biomass estimates such as these, may not directly reflect the relative importance of cover types as sources of food because different fruits have different nutritional values and are likely preferred to different degrees by bears (Garshelis et al. 1988).

Management to maintain or increase important fruit, nut, and acorn species may be more critically important to bears (in northeastern Minnesota) than similar management in regions where food shortages are less frequent and severe (Rogers 1987; Rogers and Allen 1987). In northeastern Minnesota, because of food shortages, bears must fatten in summer on soft mast (Rogers and Lindquist 1991). This is further substantiated by the fact that berry production is much higher in the central part of the State because of the more fertile soils found there (Garshelis pers. comm.). Harvesting methods such as selective and seed tree, allow for preservation of these important food species (Rogers and Allen 1987). Thinning of pine stands (Rogers and Allen 1987) and mixed upland stands (Arimond 1979) also helps productivity of fruiting species. Site preparation should be of low intensity because heavy application of herbicides reduce desirable food plants (Rogers and Allen 1987).

Ants and other insects provide a critical part of bear's diet from mid-June through mid-July before most berries become available (Garshelis pers. comm.). Downed, woody debris associated with aspen stands appears to promote high numbers of ants (Garshelis pers. comm.). Although research on the relationship of ants and downed timber is limited, there may be some timber management practices which are more amenable to providing habitat needs of ants (Garshelis pers. comm.).

Forested areas are important for black bears because bears are reluctant to move far from forest cover especially with cubs, and they are easily heat stressed (Rogers 1987). Large clearcuts can be improved by leaving islands and peninsulas of standing trees for escape and shade (Rogers 1987; Rogers and Allen 1987). Optimal clearcuts should be well dispersed and no larger than 8 ha. and stands adjacent to clearcuts should not be harvested until adequate cover is established in the cut area (Rogers and Allen 1987). Clearcuts with the furthest distance from escape cover being greater than 250 m. have very restricted use by bears (Rogers and Allen 1987).

MOOSE (*Alces alces*)

EQB Grouping:	Forest Ungulate
Legal Status:	Big-game Animal

The moose is the largest, and perhaps the most magnificent mammal in Minnesota (Fashingbauer et al. 1965), and has become a highly regarded game species in the last 20 years (MNDNR 1990). In 1985 there was an estimated $850,000 of direct and indirect income derived from moose hunting in the state (MNDNR 1990). Since a biennial moose hunt was started in 1971, more than 6,500 moose have been harvested (MNDNR 1990). Little is known about the non-consumptive use of moose in the state.

Moose are generally browsers of plant twigs and leaves throughout much of the year (Peek 1974). However, in most areas they will also make considerable use of wetlands and aquatic vegetation especially in summer (Fashingbauer et al. 1965; Belovsky and Jordan 1981; Peek et al. 1976). Because of there large body size, moose must consume large amounts of plant material (Fashingbauer et al. 1965; Jones and Birney 1988;).

Cover for moose consists of vegetation which provides security as well as, protection from heat, cold, wind and deep snow (Timmerman and McNichol 1987). Moose are adapted to withstand extremely cold temperatures, but are intolerant of heat in all seasons (Renecker and Hudson 1986).

The southern limits of the moose range in the northeast seems to be related to deer densities and the incidence of a nematode brainworm

Parelaphostrongylus tenuis which parasitizes both deer and moose with no affect on the former, and usually a fatal affect on the latter (Berg pers. comm.; Jones and Birney 1988; Hazard 1982). In the northeast, there seems to be a certain threshold of deer density, which when exceeded, causes declines in moose densities (Berg pers. comm.). This moose/deer relationship does not seem to be as prevalent in the northwest, where moose and deer co-exist at fluctuating densities (Berg pers. comm.).

The MNDNR controls the hunting of moose in Minnesota, and therefore hunting does not appear to negatively limit populations. However, accelerated timber harvesting in conjunction with increased access may lead to overharvesting due to higher success rates. Studies in Ontario have shown a significant decline in local moose populations in the first year following logging, because of increased vulnerability to hunters in areas of large clear-cuts (Eason et al. 1981; Timmerman and Gollat 1982; Eason 1985).

Geographic range within Minnesota: Before European settlement, moose were found north and east of a line extending from Pine County to the state's northwest corner (MNDNR 1990). Following settlement, moose numbers declined and the moose range receded to a small portion of northern Minnesota (MNDNR 1990). Since the 1930s, moose numbers in the state have gradually increased and 2 autonomous populations have formed, one in the northeast boreal forest zone and the other in the northwest transition zone (MNDNR 1990). In the late 1800s and early 1900s intensive logging, and in the 1920s and 1930s forest fires had converted much of the area to ideal moose habitat (MNDNR 1990). Since this time a reduction in logging and the control of forest fires, has allowed these areas to revert back to later successional stages, and thus a degradation of habitat for moose has occurred (MNDNR 1990).

Northeast Population: This population occurs on the Canadian Shield region of Minnesota, and includes approximately 4,800 square miles (MNDNR 1990). Moose densities in this area are slightly above 1 moose per square mile (MNDNR 1990). This population is most closely associated with the boreal forests of the area, where early successional stages of young shrubby growth, upland brush, young aspen and young birch, and young fir and spruce trees provide optimum habitat (MNDNR 1990; Jones and Birney 1988; Timmerman and McNichol 1987).

Northwest Population: This population occurs primarily in Kittison, Marshall, Pennington, and western Roseau counties and includes approximately 6,800 square miles, although 90% of this area is intensively farmed and not considered moose habitat (MNDNR 1990). This population is most closely associated with the aspen parklands and aspen/willow brushlands typically found in the transition zone (MNDNR 1990; Berg and Phillips 1974; Berg pers. comm.).

Ecological distribution: Northeast population: The ecological distribution of the northeast moose population is mainly a function of the availability and quality of green season and dormant season foods and cover (Allen et al. 1987).

Green Season Food: During the summer, leaves from deciduous trees and shrubs makeup a significant portion of the mooses' diet (Timmerman and McNichol 1987). Upland habitats (aspen and white birch types), which offer a very diverse shrub and herb layer, are used most frequently by moose in summer (Peek et al. 1976). It is important that there be a wide diversity of plant species, because consumption of a diversity of plants is more digestible and provides a high range of nutritive requirements (Miquelle and Jordan 1979). The most common terrestrial browse species eaten by moose during the summer are: trembling aspen, white birch, yellow birch, willow, balsam poplar, mountain ash, mountain maple, red maple, bush-honeysuckle, high-bush cranberry, red-osier dogwoood, beaked hazel, pin cherry, juneberry and green alder (Timmerman and McNichol 1987; Allen et al. 1987). At the same time moose will also seek out aquatic plants because of their high mineral composition (Timmerman and McNichol 1987). Important aquatic macrophytes include: yellow pond lily, pond lily, pond weeds, macroscopic algae, bladderwort and water milfoil (Timmerman and McNichol 1987).

Dormant Season Food: Moose will spend the winter (dormant) season in areas of high woody browse (Timmerman and McNichol 1987). Preferred dormant season browse species are: aspen, cherries, mountain ash, willow, red-osier dogwood, red oak, high-bush cranberry, red maple, beaked hazel and white birch (Allen et al. 1987; Timmerman and McNichol 1987). It is important that browse of this type be in reach of moose (less than 13 ft.) (Allen et al. 1987). Interspersion of these food sources with suitable winter cover will reduce energy use, minimize metabolic demands and maximize winter survival (Timmerman and McNichol 1987). Optimal habitat interspersion is found where dormant season browse is within 100 meters of winter cover (Allen et al. 1987).

Cover for moose can be broken into classes: (1) growing season cover and (2) dormant season cover (Timmerman and McNichol 1987).

Growing Season Cover: Growing season cover is important in eleviating heat stress and the effects of precipitation and sun (Timmerman and McNichol 1987). It also is needed for protection from predators and man. Optimal growing season cover consists of the following cover types in order of preferrence: lowland conifers, lowland hardwoods and upland conifers and hardwoods (Allen et al. 1987). These types should consist of the following criteria in a 1,500 acre unit; there are >= 8 individual stands of which are mature and have closed canopies, the stands should be >= 5 acres (Allen et al. 1987).

Dormant Season Cover: Dormant season cover provides protection from the harsh elements (cold, wind and snow) of winter (Timmerman and McNichol 1987), and is a critical mid-winter component of moose habitat in regions subject to severe winter periods (Allen et al. 1987). Snow depths in open upland stands can have 70% greater snow depths than closed canopy forests in Alberta (Rolley and Keith 1980). Dormant season cover is provided for by tall, dense stands of conifers and/or deciduous types (Peek et al. 1976). Upland spruce/fir types were used most often during severe winter periods, while deciduous stands were used more during less severe periods in northeastern Minnesota (Peek et al. 1976). Other coniferous types providing winter cover include; jack pine, white cedar, white pine and hemlock (Timmerman and McNichol 1987). The significance of conifer cover in providing dormant season cover is not well understood and abundant forage may be more important to maintain good conditions (Crete 1988).

Optimal moose habitat contains a wide variety of stand types and age classes which provide both disturbed areas for food (browse) and mature coniferous cover (Timmerman and McNichol 1987). This vegetative pattern will minimize travel time and allow for optimal foraging, bedding and ruminating activities (OMNR 1984). Highest moose habitat potential in Minnesota was found in township size blocks with 40 to 50% of the area in early succession (<20 years old), 5 to 15% of the area dominated by mature coniferous spruce/fir cover, and 35 to 55% of the area dominated by water and aspen/white birch stands >20 years old (Peek et al. 1976).

Northwest population: Less is known about the ecological distribution and habitat use of moose in the northwest portions of the state. Moose in the northwest are associated with the agricultural/prairie zone and the transition zone between agricultural/prairie and boreal forest (MNDNR 1990). The critical cover types for moose in this area are aspen and willow brushlands (MNDNR 1990; Berg and Phillips 1974), with willow types comprising the bulk of habitat use and moose diet (Fashingbauer et al. 1965; Berg and Phillips 1974). Habitat types used in winter consisted of tall and mature mixed willow, aspen/willow, aspen, and hardwoods (Berg and Phillips 1974). Habitat types used in late spring and summer consisted of more open willow and mixed willow, and wetalnd areas (Berg and Phillips 1974). Agricultural lands adjacent to brushlands are also frequented by moose (MNDNR 1990). Natural succession has limited quality habitat for moose in the area, and increased logging to set back succession should benefit this population (MNDNR 1990; Berg pers. comm.). Although there is little information on the importance of winter cover for moose in the northwest and no indication that the little existing conifer cover is a limiting factor, moose have been known to migrate long distances to woodlots in the winter (Berg pers. comm.).

GRAY WOLF (Canis lupus lycaon)

EQB Grouping:	Forest Furbearer
Legal Status:	State and Federally Threatened

Minnesota is home to the largest population of gray wolves (Eastern Timber Wolf) in the lower 48 states (MNDNR 1990). It is one of 32 subspecies of the gray wolf (Bailey et al. 1978). Originally, the gray wolf occurred throughout most of the eastern United States and southeastern Canada (Bailey et al. 1978). As a direct result of human settlement over the past few hundred years, the range of this subspecies has been reduced to about 3% of its original total (MNDNR 1990). Prior to its protection in the 1970s gray wolves were limited mainly to the far north and northeastern part of the state, and numbers were considerably lower (MNDNR 1990). At present the wolf range in Minnesota is charcaterized by short growing seasons, rocky outcrops, muskeg, infertile soil and low human densities (Bailey et al. 1978). Berg (pers. comm.), Fuller et al. (1990) and MNDNR (1990), however, suggest that since its protection the wolf is expanding its range south and westward and increased in numbers to an estimated 1,542 to 1,734 in 1988-89 (Fuller et al. 1990).

The gray wolf in Minnesota has had a contraversial management history (MNDNR 1990). Factors associated with the reduction of the Eastern Timber Wolf population in the U.S. include: intensified human settlement, conflicts with domestic livestock, human perceptions towards wolves and perceived competition for deer and moose (Goldman 1944).

In 1967, the Minnesota subspecies of the gray wolf was listed by the Department of Interior as endangered in the U.S. (Bailey et al. 1978; MNDNR 1990). The Superior National Forest prohibited the taking of wolves in 1970, and in 1974 the subspecies was legally protected on all lands by the Endangered Species Act of 1973 (Bailey et al. 1978; MNDNR 1990). In 1978 the USFWS, through advisement of the Eastern Timber Wolf Recovery Team, reclassified the subspecies in Minnesota as threatened, and in 1985 an appeal was upheld to outlaw the public harvest of wolves in Minnesota (Bailey et al. 1978; MNDNR 1990).

Wolves normally live in packs of 2 to 8 and have a dominance heirarchy within the pack (Bailey et al. 1978). They generally mate towards the end of February and young are born in late May or early June (Hazard 1982). Young will stay with the pack until they disperse in their second or third year (Hazard 1982).

The wolf in Minnesota is a wide ranging animal and reasonably adaptive, and therefore, it is unrealistic to try to describe habitat for them (Bailey et al. 1978). Minnesota wolf populations seem most affected by availability of prey and human-caused mortality (MNDNR 1988; Fuller 1989;).

Wolves in Minnesota prey largely on white-tailed deer (MNDNR 1990). Where deer densities are low, as in the case of the northeast, wolves prey mostly on moose (MNDNR 1990). Other prey species include beavers in the spring and summer and snowshoe hares which may be important during cyclic peaks, and domestic pets and livestock (Bailey et al. 1978; MNDNR 1990). Use of domestic livestock as prey seems to be primarily a function of winter weather conditions (Bailey et al. 1978). The milder the winter, the greater amount of wolf depredation on livestock the following summer, which may indicate that livestock are secondary prey and their use is generally when deer fawns (primary prey) are less vulnerable due to better prenatal conditions (Mech et al. 1988a). Many negative human attitudes are based on the belief that wolves limit game populations and cause severe losses to livestock ranchers. Although Mech and Karns (1977) have reported the wolfs' implication in a deer decline in Minnesota, generally wolves are not instrumental in causing deer declines (Bailey et al. 1978). Individual losses to livestock ranchers may be significant, but Fritts (1982) found depradation on domestic livestock to be relatively low.

In Minnesota, Wisconsin and Michigan most wolf mortality is human-related (MNDNR 1990). Even while protected, wolves are intentionally shot by hunters, landowners and farmers, trapped or snared incidentally and are hit by vehicles (MNDNR 1990). Wolves are also taken through the U.S. Department of Agriculture, Section of Animal Damage Control, under permit from the U.S. Fish and Wildlife Service where depredation is a problem (MNDNR 1990).

During the 1980s several studies have suggessted a relationship between the increasing road density (an indicator of human activity) and wolf distribution (Fuller 1989; Mech et al. 1988b; Thiel 1985). Mech (1989) found that wolves may exist in areas of high road densities if there are large roadless reervoirs nearby. Roads themselves in most cases do not deter wolves, and often are used as travel corridors. Rather, the roads provide accessibility to people who kill wolves (MNDNR 1988).

Geographic distribution within Minnesota: Occurs in most of the forested portions of the state, but primary populations continue to occur in the northeast. See map (MNDNR 1990).

Ecological distribution: The ecological distribution of the gray wolf in Minnesota is a function of availability of prey and presence of human-caused mortality (Fuller 1989; MNDNR 1990).

The availability of prey in Minnesota is a function of habitat available for white-tailed deer, moose, beaver and snowshoe hares. These prey species are associated with early successional forest types and are for the most part benefited by frequent disturbance such as timber harvesting. (See species documents)

At the same time, increases in timber harvesting result in increased accessibility. Concerns exist as to whether wolves will tolerate increases in access and human activity associated with accelerated timber harvesting, although wolves have been expanding into areas where road densities are already extremely high (Berg pers. comm.). Berg (pers. comm.) has suggested that increases in timber harvesting, and its positive effect on deer populations may outweigh the negative effect of increased access and human activity in terms of wolf productivity.

Until human attitudes towards wolves have changed, Thiel (1985) suggests that road densities still are a valuable tool in determining whether an area can sustain a viable wolf population. The MNDNR uses a road density of 1 mile of road per mile^2 of land over sufficiently large areas (100 miles^2) and pertains to permanent roads requiring routine maintenance that are accessible year-round by 2 wheel-drive vehicles (MNDNR 1988). The regulation of road access, especially during hunting season, likely can control much of the human-caused mortality (Bailey et al. 1978; Thiel 1985; Fuller 1989).

AMERICAN ELK (*Cervus elaphus*)

EQB Grouping: Forest Ungulate

Elk were once common in Minnesota especially in the prairie and prairie-hardwood forest transition but last occurred as natives in the early 1900s (Hazard 1982).

A small herd was established in 1914-15 by introduction in semiconfinement in Itasca State Park (Hazard 1982; Fashingbauer et al. 1965). In 1935, 27 elk from this herd were released in northwestern Beltrami County (Hazard 1982; Fashingbauer et al. 1965). Approxiamtely, 20-30 remnants from this herd remain (Berg pers. comm.)

Elk are associated with early successional types including young forests and active and abandoned farm fields (Berg pers. comm.). They are not dependent on conifer cover and will frequent young-aged aspen stands in winter (Berg pers. comm.).

Elk demonstrate little specialization in food preferences (Fashingbauer et al. 1965). Their diets include grasses, sedges, forbs, and deciduous and coniferous woody plants (Hazard 1982). A variety of herbaceous plants are preferred by elk and favorite woody browse species include aspen and willow (Fashingbauer et al. 1965). Heavy use of aspen, particularily in winter, can cause extensive damage and inhibit its regeneration (Fashingbauer et al. 1965). Elk also feed heavily on domestic forage including grasses, alfalfa either fresh or hayed and small grains (Hazard 1982; Fashingbauer et al. 1965).

Because of the change in land-use, to agriculture in the prairie and prairie-hardwood forest transition since extirpation in the early 1900s, elk currently living in the state have had serious conflicts with farmers. Baled hay is a favorite food resource for elk in winter and they will consume large quantities when available causing negative attitudes from farmers in this area (Fashingbauer et al. 1965).

CARIBOU (*Rangifer tarandus*)

EQB Grouping: Forest Ungulate

Caribou were once common in the deep woods of north central and northeast Minnesota and ranged as far south as Carlton, Mille Lacs and Kittison counties (Hazard 1982). The last recorded sighting in Minnesota was in 1935 (Hazard 1982).

Caribou were associated with the boreal coniferous forests of Minnesota and were most abundant from Lake Superior to Lake of the Woods (Fashingbauer et al. 1965). The last remnant of the caribou herd was in the poorly drained basin of Glacial Lake Aggasiz in the Red Lake area (Fashingbauer et al. 1965). This habitat was characterized by wilderness bog and muskeg with scattered islands of black spruce (Fashingbauer et al. 1965).

The food habits of caribou are primarily that of a grazer, although it browses on deciduous hardwoods during all seasons (Fashingbauer et al. 1965). Lichens appear to be the most preferred foods, although other woody browse are also consumed at various times (Fashingbauer et al. 1965). Ground lichens are an important food and grow best on dry open sites in the coniferous forest, but are susceptible to damage from trampling and overgrazing and are very slow to recover (Fashingbauer et al. 1965). Tree lichens are also important and generally are more available because they are not covered by snow (Fashingbauer et al. 1965). These lichens grow best in moist coniferous forests with heavy crown densities (Fashingbauer et al. 1965). Important tree and shrub browse are mountain maple, mountain ash, willow, red-osier dogwood and high-bush cranberry (Fashingbauer et al. 1965).

Predation has been traditionally overemphasized as a limiting factor in big-game populations. Unless heavy, crusted snow can sustain wolves and not caribou, they will usually outrun their pursuer (Fashingbauer et al. 1965). The caribou is very intolerant of man, and its habits make it extremely vulnerable to hunting with gun (Fashingbauer et al. 1965).

Caribou are very susceptible to the brainworm *Parelaphostrongylus tenuis*. This parasite parasitizes deer with little effect but can also be picked up by caribou where it will likely cause death. Because of the expanding deer population in Minnesota and the occurrence of *P. tenuis*, caribou reintroduction into the state has been criticized. This species does not occur in Minnesota today and was not analyzed.

APPENDIX 4
Detailed Species Descriptions—Forest Birds

Double-crested Cormorant (*Phalacrocorax auritus*)
Double-crested Cormorants are distributed primarily along the Gulf, Atlantic and Pacific coasts of the United States and Canada, as well as portions of the Mississippi valley and the Great Lakes (Peterson 1980, Terres 1987).

In Minnesota the species is a regular migrant and summer resident. Double-crested Cormorants begin returning to Minnesota in late March and continue to arrive through late May (Janssen 1987). Double-crested Cormorants have nested in all regions of the state, although nesting is generally limited in the northeastern and north central regions. Emigration out of Minnesota to wintering areas in the southern United States begin in mid-September, reaching a peak during the third week of October, and may continue into early December (Janssen 1987).

Roberts (1932) reported the species was declining in the early 1900s, yet the species was relatively common until the 1950s. At this time the species was drastically reduced presumably affected by organochlorine chemicals that affected a variety of fish-eating birds during the 1950s and 1960s. Recently, however, colonies have been increasing in number and the species is expanding its range (Janssen 1987).

Breeding colonies are usually associated with bodies of water. Nests are often established in the tops of tall trees along lakes, rivers, and swamps and often on islands. The species often nests in association with Great Blue Herons. Occasionally colonies, such as those in Lake of the Woods, have been built on bare, rocky islands (Roberts 1932, Vermeer 1970), and (Ehrlich et al. 1988). Because of these nesting requirements, the species was classified as associated with mature forests in riparian areas.

Nests are constructed of sticks and other drift materials (Roberts 1932). Two to seven eggs may be laid, although 3 to 4 are the average (Ehrlich et al. 1988). Early nesters use the same nests year after year while younger individuals breeding for the first time are often on the fringes of the colony (McNeil and Leger 1987).

The diet of Double-crested Cormorants is comprised almost entirely of fish (Ehrlich et al. 1988). As a result, the species has not been welcomed by fishermen. Permits have been issued in the past for the killing of cormorants during migration and occasionally at their colonies. In a Wisconsin study, however, cormorant prey base was found to be small forage fish such as sculpin and stickleback, rather than commercially important species (Craven and Lev 1987). Abatement devices have met with limited success; cormorants adjusted to all of the devices within four weeks of their deployment (Craven and Lev 1987).

Double-crested Cormorants were included on the Audubon Blue List from 1972–81. They were a species of special concern in 1982 and of local concern in 1986. Declines in cormorant numbers during the 1950s and early 1960s were probably due to persecution and contamination by chlorinated hydrocarbons. In the 1960s and 1970s, chemicals alone were likely responsible for the continued decline and lack of productivity. The species currently is increasing over a wide geographic area, from 1973–81 cormorant populations experienced an average annual growth rate of 44 percent (Price and Weseloh 1986, Tate 1986).

The primary factor of timber harvesting for the Double-crested Cormorant is the availability of large trees in riparian habitat areas. Artificial platforms have proven to provide a successful substitute for natural nesting substrates (Meier 1981). A secondary issue is the continued availability of suitable fish populations and the protection of fisheries in forested-associated landscapes.

The Double-crested Cormorant was projected to increase in ecoregions 1, 2, and 9 under the base harvest scenario on timberlands, but only increase in ecoregions 1 and 9 in all forest lands. Under the medium harvest scenario, increases were projected for ecoregions 1, 2, and 9 on timberlands and in ecoregions 1 and 9 in all forest lands. In the high harvest scenario, increases were still projected in ecoregions 1, 2, and 9 on timberlands, but only in ecoregions 1 and 9 in all forest lands. From the perspective of available nest trees, the species should not be affected by timber harvesting. However, a variety of additional factors such as food supply will likely determine the future status of this species in Minnesota.

Great Blue Heron (*Ardea herodias*)
Great Blue Herons are regular summer residents in Minnesota. They begin returning from their wintering grounds in the southern U.S. and northern South America in early March and continue arriving into May (Ehrlich et al. 1988, Janssen 1987). Great Blue Herons are common throughout the state, becoming fewer in number in heavily wooded areas, especially the northern regions (Janssen 1987). Overall, they are distributed across North America from southern Canada to Mexico (Peterson 1980).

Great Blue Herons are common in areas of the state where suitable habitat for colonies exist (Janssen 1987). These herons are largely a forest bird and can be found in deciduous or coniferous forests, often on islands, although they have also been reported to nest in tamarack swamps some distance from open water (Roberts 1932). Colony sites are found in mature trees 10 to 25 meters high, and a minimum of 0.4 ha in area (Ehrlich et al. 1988, Mathisen and Richards 1978). The trees can be live or dead, but must have sturdy, exposed limbs on which nests can be constructed. The site must also be free from human disturbance (Markham and Brechtel 1979, Miller 1943). No colony sites are known for the southwestern part of the state (Janssen 1987).

Colony size may vary over the years (Janssen 1987) and Great Blue Herons also may nest in mixed species colonies, usually occupying the higher nests in the colony (Ehrlich et al. 1988).

In addition to adequate nesting substrate, colony sites must also be in proximity to adequate foraging areas (Dennis 1971a, Short and Cooper 1985). These foraging areas must have adequate shallow water areas that does not deepen too rapidly (Dennis 1971a,b). Great Blue Herons' diet is comprised mostly of fish, but nestlings, small mammals, and human food scraps are also taken (Ehrlich et al. 1988). Herons will fish singly, or in groups of 2 to 5, often in association with Great Egrets and Little Blue Herons (Dennis 1971b). As is the case with most herons, foraging success improves with age; adult Great Blues are twice as efficient as the young or immature birds (Ehrlich et al. 1988).

Great Blue Herons begin leaving Minnesota as early as late July and migration may continue through December; some may remain in the southeastern part of the state into February (Janssen 1987) where open water remains.

Great Blue Herons are dependent not only upon mature trees in riparian areas for colony sites, but also upon the juxtaposition of these colony sites with quality foraging areas. Furthermore, these sites must be insulated from human disturbance. A quarter mile radius buffer around the colony should be kept free of human disturbance (Hoover and Wills 1984). Forest management practices which result in the loss of current colony sites will obviously have negative effects on Great Blue Heron populations. Hoover and Wills (1984) suggest managing for 150 acres of disturbance-free nesting habitat with suitable feeding areas nearby. An area of this size would presumably support a minimum population of about 20 herons.

Less obvious, but also important, are losses which may occur to future colony sites. The nesting activity by herons eventually results in the death and decay of their nest trees. Because these dead trees are not permanent landscape features (especially in riparian areas), the loss of potential future colony sites must be considered for appropriate management of Great Blue Heron populations. Nest tree losses may be successfully offset by the addition of artificial nesting platforms (Meier 1981)

For the GEIS process, riparian forest habitat was only considered in the projections for available habitat. The FIA plots did not provide suitable information to complete a more detailed analysis of the appropriate mosaic of suitable colony sites and suitable feeding areas. Given these limitations, the Great Blue Heron was projected to have an increase of available riparian habitat in ecoregions 1, 2, and 9 using timberlands, but only increases in ecoregion 1 and 9 when all forest lands were considered in all harvest scenarios. As with all the riparian associated bird species, riparian habitats were selectively cut in the second runs and, hence, forest type classes did not change, except for aging into more mature forest types. Great Blue Herons can likely tolerate some selective cutting as long as the activity does not include their colony site and is restricted to the nonbreeding season. The MNDNR has guidelines in place for proper management of these colony sites.

Great Egret (*Casmerodius alba*)

Great Egrets are distributed along the Gulf and Atlantic coasts, and along the Mississippi valley. In the western United States they range from Oregon and Idaho south to Arizona (Peterson 1980, Terres 1987). Great Egrets are common summer residents in southern and portions of central Minnesota, and have recently been expanding their range into the northern portions of the state (Janssen 1987). Roberts (1932) reported the species as an occasional straggler from the south.

Great Egrets begin to arrive in Minnesota in late March, and spring migration continues into late May (Janssen 1987). Great Egrets begin leaving Minnesota in late July for their wintering grounds in the southern United States and Central America. Their fall migration may continue into October with a few stragglers sometimes remaining into November (Janssen 1987).

They are found feeding along wetlands, lakes, rivers, and irrigation ditches. They usually nest in colonies, occasionally colonies consist of hundreds of individuals (Ehrlich et al. 1988). These nests are often constructed in medium-sized trees 7 to 15 meters above the ground, but also may be in cattails only 1 meter above the water (Terres 1987). Diet of the Great Egret includes fish, insects, small birds, reptiles, and amphibians; nestlings are usually fed fish, crayfish, and frogs (Ehrlich et al. 1988).

As with Great Blue Herons, loss of current and potential nest colony habitat could have negative effects on Great Egret populations.

The only change projected for the Great Egret was an increase in the southern portion of ecoregion 4 under the base and medium harvest scenarios on timberland. When all forest lands were included no increases, however, were noted. This was due to the increase in total acreage included and the greater change necessary to achieve a significant (+ or - 25 percent) value.

Green-backed Heron (*Butoroides striatus*)

The Green-backed Heron, formerly known as the Little Green Heron or Green Heron, is a regular migrant in Minnesota. In the southern and central regions of the state, it is a common migrant, but becomes more uncommon in the northwestern, north central, and northeastern regions. It is quite rare in the extreme northern parts of the state (Roberts 1932, Janssen 1987). In North America, the Green-backed Heron breeds from southwestern Washington to coastal Maine and New Brunswick, south to Panama and the West Indies (Terres 1987).

Green-backed Herons arrive in Minnesota from early April until early May (Roberts 1932, Janssen 1987), with both sexes arriving about the same time (Terres 1987). Summer birds begin leaving Minnesota in August and migration may extend into late October (Roberts 1932, Janssen 1987). The species over-winters from coastal California through Texas and Florida, and as far south as Columbia and northern Venezuela (Terres 1987). Climate may dictate where this species overwinters since it is present where the average length of frost free periods are 240 days or more (Root 1988).

Nests are often constructed in trees or shrubs, usually willow or tamarack, three to five meters above the ground. These nests may be located along the forested edges of marshes, lakes, rivers, or ponds (Roberts 1932, Ehrlich et al. 1988). Nests built where trees and shrubs are absent may be located on tussocks of emergent vegetation or even muskrat houses. Because of its close association with riparian habitat zones and its association with nesting in trees of these zones, the species was classified as a riparian species.

Nests are usually solitary, but loose colonies of up to ten to fifteen nests are not uncommon (Roberts 1932, Ehrlich et al. 1988). The species can vary in its social structure including individual to group nesting activities. Usually the degree of group nesting also reflects the extent to which it will feed and co-defend food resources in groups (Kaiser and Reid 1987). Three to six eggs are laid which hatch after 17 days of incubation (Roberts 1932). In parts of its range, Green-backed Herons will occasionally raise two broods (Ehrlich et al. 1988).

Diet of these herons includes crawfish, fish, aquatic and terrestrial invertebrates, earthworms, small snakes, and even mice (Roberts 1932, Terres 1987). During the late summer, the diet switches primarily to fish. Prey is usually captured through patient stalking, but bottom sediments may also be stirred up with their feet to uncover prey (Ehrlich et al. 1988). Foraging areas often provide dense vegetation for concealment (Root 1988).

Forest management may cause declines in Green-backed Heron populations if significant reductions in mature riparian forest, occur. Losses of suitable nesting sites in forested areas may be mitigated by the retention of buffer strips around wetlands, lakes, and streams.

Under the base harvest scenario in timberlands, the species was projected to increase in ecoregions 1 and 6, but decrease in ecoregion 3. When all forest land was considered, the increasing trend in ecoregion 6 changed to a decreasing trend. Similarly, under the medium harvest scenario on timberlands, the species was again projected to increase in ecoregions 1 and 6, but decrease in ecoregion 3. In all forest land, an increasing trend in ecoregion 1 was still noted, but a decreasing trend emerged again in ecoregion 6. Under the high harvest scenario, the results were the same as in the medium scenario except no decrease was noted in ecoregion 3 on timberlands. The major reason for the conflicting results of this species in the various ecoregions is due to relatively small acreages of available habitat for this species in ecoregion 6 and its relatively low overall relative abundance. In this case small changes in available habitat can quickly result in significant (+ or - 25 percent) changes in the species relative abundance. In addition, the species is very marginal in ecoregions 1 and 3 where the species distribution is primarily confined to the southern portions of both those ecoregions. In general, timber harvesting under any of the three scenarios are unlikely to have much of an effect on this species.

Black-crowned Night-Heron (*Nycticorax nycticorax*)
Black-crowned Night-Herons are regular summer residents in southern (primarily southeastern), west central, and northwestern Minnesota. Distribution in these areas, however, highly localized, with the species being common in some areas and absent in many others (Janssen 1987). Typically they are birds of the more open areas of the state and are rather sparsely distributed in the wooded portions of the state (Roberts 1932).

Black-crowned Night-Herons begin arriving in Minnesota in late March from their wintering grounds in Central and South America and the Caribbean. They remain until September when they begin their fall migration (Janssen 1987, Ehrlich et al. 1988). Upon arrival, territories are established near marshes, lakes, and ponds; occasionally territories may be located in grasslands. In forested regions of the state, nests are constructed in large hardwood trees, often box elder, willow, or silver maple. They are usually placed about two-thirds the height of the tree, with 1 to 5 nests per tree (Roberts 1932, Hoffman and Prince 1975, Ehrlich et al. 1988). In the prairie regions, dense beds of quill reeds and rushes are also utilized, in which floating nests of bundles of reeds are built just above the water. The nests are closely spaced, with only a few meters separating them. Trees away from water may occasionally be used (e.g., up to 3 km) (Roberts 1932). Nests are perennial and both sexes take part in nest defense (Ehrlich et al. 1988).

As their name implies, Black-crowned Night-Herons forage during crepuscular (dawn and dusk) periods and at night. In searching for food, they employ a variety of methods, including standing, stalking, hawking, hovering, diving, and swimming (Kushlan 1978). Their diet reflects this generalist approach and includes fish, insects, amphibians, small mammals, eggs, and young birds (especially terns and other herons) (Ehrlich et al.

1988). They rely primarily on fish, but also utilize many other potential prey, such as nestling Red-winged Blackbirds (*Agelaius phoeniceus*) (Wolford and Boag 1971).

Because of their diet, Black-crowned Night-Herons have recently been shown to have high levels of organochlorines. High residues of DDE and dieldrin were found in egg samples from Pope and Grant Counties (Ohlendorf et al. 1979). The species was included on the Audubon Blue List from 1972–81. It was listed as a species of special concern in 1982 and of local concern in 1986. Populations are presently stable or increasing in most areas (Tate 1986).

Because of the dependence of the species on relatively large trees for nesting and its preference for nesting near water, the species was classified as associated with mature forests and a riparian-associated species. Timber harvesting would most likely affect current colonial nesting sites or potential future nesting sites. MNDNR guidelines currently protect colony sites for Black-crowned Night Herons. Prediction of future colony sites is difficult; however, suitable mature riparian forest adjacent to aquatic areas with uncontaminated food should be provided.

Few effects on Black-crowned Night-Herons were observed under the three harvest scenarios. The species was projected to increase in ecoregion 1 under all three harvest scenarios and using both timberlands and all forest lands. This is likely relatively trivial because the species is very marginal in this area of the state, where it is only known to occur in Agassiz National Wildlife Refuge in Marshall County (Janssen 1987). Many other factors besides available habitat are likely limiting the species distribution in this portion of the state.

Yellow-crowned Night-Heron (*Nycticorax violaceus*)
Yellow-crowned Night-Herons are regular but rare summer residents and migrants. The species was first recorded breeding in Minnesota in 1955 at Houston County. Since that time their range has expanded northward and westward (Janssen 1987). Overall, the species is distributed from Minnesota and Wisconsin south to Texas, along the Gulf coast, and along the Atlantic coast as far north as Massachusetts (Graber et al. 1978).

Yellow-crowned Night-Herons begin arriving in Minnesota from early April and continue into late May (Janssen 1987). These herons breed along marshes, swamps, or lakes, often in lowland forests, including second growth as well as mature stands. Large, mature trees may be required for roosting (Ehrlich et al. 1988). Nests are constructed singly or in small colonies, in either mixed species or single species heronries. Clumped trees, shrubs and even the ground is sometimes used as nesting substrate (Graber et al. 1978, Ehrlich et al. 1988).

Unlike the Black-crowned Night-Heron, Yellow-crowned Night-Herons often forage during the day, as well as at night. Yellow-crowns also have a heavier bill than other herons, allowing them to take sturdier prey, such as crayfish and turtles. Throughout most of their range they primarily feed in marine environments, specializing on crustaceans. Other items in their diet include fish, leeches, insects, snakes, frogs, mammals, and birds (Kushlan 1978, Ehrlich et al. 1988).

Yellow-crowned Night-Herons begin leaving the state in August for their wintering grounds in Central and South America, and the Caribbean. This migration may continue into late September (Graber et al. 1978, Ehrlich et al. 1988).

As with other herons, loss of mature nesting trees along riparian areas will likely have negative impacts upon this species. Protecting nesting sites in areas of possible range expansion, as well as those presently populated, should be incorporated into management plans. These herons, however, may be able to utilize second growth in riparian areas, possibly reducing impacts of timber harvesting.

No changes were projected for this species under all three harvest scenarios. It is a very rare breeding species in the state and it is unclear what the limiting factors are for this species in Minnesota.

Wood Duck (*Aix sponsa*)
The Wood Duck is the fourth most numerous nesting waterfowl species in Minnesota (Janssen 1987) and is a regular fall and spring migrant in the state (Johnsgard 1975).

The Wood Duck breeds widely throughout most of the eastern United States and across southern Canada from Nova Scotia to east central Alberta. The species also is found breeding widely in the northwestern United States and south throughout much of California (McGilvrey 1968, DeGraaf et al. 1991, National Geographic Society 1983). The wintering range includes much of the southern portions of the species' breeding range including the southeastern United States, Texas, California, parts of Mexico, and Central America. In Minnesota it is most commonly found along the major riverine systems (e.g., Mississippi, Minnesota, and St. Croix) of the southern and central regions, but can be found breeding in a variety of riparian habitats wherever suitable nest sites are found in either natural tree cavities or in artificial nest boxes.

The species is a cavity nesting species (Scott et al. 1977) which readily accepts nest-boxes for use, particularly those which afford protection from predators (Bellrose et al. 1964). Nesting habitats used by the species include floodplain hardwood forests, bottomland sloughs (Ehrlich et al. 1988), and slow moving streams and lakes (Janssen 1987). Habitats with well-developed canopy vegetation and water areas with depths less than 18 inches are preferred by the Wood Duck for foraging and rearing broods (Johnsgard 1975). In areas of high population densities, the species may commonly practice dump-nesting (Morse and Wight 1969, Jones and Leopold 1967). The species was classified as cavity-dependent and a species of mature, riparian forests.

Coulter (1955) found a diet comprised largely of plant food (90.8 percent) and insects (9.2 percent) in 39 stomachs of Wood Ducks examined. It is reported by Bellrose (1976) that ducklings feed almost entirely on insects until 6 weeks of age, before shifting to a diet consisting largely of vegetable matter. Fruits and masts are other important foodstuffs in the Wood Duck diet (Johnsgard 1975).

Wood Ducks exhibit extreme nest-site tenacity (Bellrose 1976) and as a result may be affected by the removal of potential cavity trees either through logging or recreational purposes. Because of this, the construction and placement of nest boxes is considered an integral component of Wood Duck management (McGilvrey et al. 1968). The species will likely be sensitive to habitat alterations (i.e., logging, drainage) within suitable nesting habitat. Reductions in riparian forests with suitable nest cavities can directly affect population levels in this species.

As with all of the riparian-associated bird species, the Wood Duck primarily was predicted to have increased available habitat. Under the base harvest scenario, the species was projected to increase in ecoregions 1, 2, 3, and 9 on timberlands and in all forest lands. Under the medium and high harvest scenarios the species was projected to increase in ecoregions 1, 2, 3, and 9 on both timberlands and all forest lands, but decrease in ecoregion 3 in all forest lands. The overall reasons for these changes are primarily due to the changes in available riparian, mature forest habitats. As discussed for the riparian species, riparian habitats were allowed to be selectively cut in the mitigated harvesting scenarios which resulted in no change in the forest classification for these stands. In addition, during the course of the 50-year projection period, these stands aged which resulted in an increase of riparian forests, especially in ecoregions 1, 2, 3, and 9.

American Black Duck (*Anas rubripes*)
The American Black Duck is regular breeding species throughout northeastern Minnesota and an uncommon winter visitor in southeastern parts of the state, particularly at Silver Lake and Black Dog Lake (Janssen 1987). Peak spring migration typically occurs in mid-April, and the bulk of fall migration takes place throughout October (Janssen 1987). Minnesota is on the southwestern edge of the black duck's breeding range, which extends north to the shores of Hudson's Bay and east to the Atlantic Coast from

North Carolina to the southern edge of the tundra. Wintering birds may migrate to the southern Great Lakes States, or as far south as northern Georgia, Alabama, Louisiana and northeastern Texas (National Geographic Society 1983). Bellrose (1979) estimated American Black Duck density in closed boreal forest of the east at 0.8 birds per square mile in 1977. Density in Great Lakes forests at this time was estimated to be 0.5 birds per square mile, with 10.5 percent of the total population breeding in Great Lakes forests.

Breeding habitat of the American Black Duck includes a wide variety of riparian forest types, wetlands, and water types free of human disturbance. Fall and winter habitat preferences are similarly broad, including most types of unfrozen water. Larger bodies of water are preferred, however (Spencer 1986). In Minnesota, this species requires wetland habitat which contains adequate emergent vegetation and aquatic invertebrates.

Black Ducks are considered "dabblers," feeding primarily in shallow fresh and brackish water on invertebrates, small amphibians, seeds and other plant material (Roberts 1932, Spencer 1986). Nestlings and breeding females rely more heavily on aquatic invertebrates than many other dabbling duck species to provide needed protein. Upland feeding sites are used occasionally (Spencer 1986).

Nests are built on the ground, and are typically depressions lined with dry plant material and down. They are usually well hidden near small beaver ponds in grassy areas, wooded wetlands, or the riparian zone of boreal forest (Ehrlich et al. 1988, Cadman et al. 1987). Most nests are within 75 m of water (Spencer 1986). Abandoned nests of raptors and large corvids are occasionally used (Roberts 1932). Nesting in Minnesota occurs from mid-June through late July (Roberts 1932). Eight to ten eggs are usually laid and incubated by the female for 23 to 33 days prior to hatching. The precocial young are ready to fledge 58 to 60 days after hatching (Spencer 1986). Nest predation by American Crow, Herring Gull, Great Black-backed Gull and Red fox have been reported in Ontario (Atlantic Waterfowl Council 1968).

Population declines throughout the U.S. have been linked not only to habitat changes but also to lead poisoning, pesticide use for controlling spruce budworm, acid rain, overhunting (a disproportionately large harvest of young female black ducks may be accelerating population declines), and competition and hybridization with Mallards (Spencer 1986). Habitat alteration may be causing population decreases indirectly by facilitating the range expansion of Mallards which prefer less forested habitats (Bellrose 1979, Cadman et al. 1987). Concern over black duck population declines began as early as the middle of this century (Spencer 1986). One nationwide survey indicates a 2 percent per year decline for the period 1955 to 1983, with present populations estimated at 40 percent of those at the beginning of the period

(Grandy 1983). These population declines have led to listing the species on the Audubon Blue List (1980-1981), and identifying it as a Species of Special Concern (1982, 1986) (Ehrlich et al. 1988). In Minnesota, the species has increased by about 2 percent in the past 25 years (Janssen 1990). However, the sampling efficiency for this species is quite low and it was only observed on 4 routes.

Because this species was classified as a bird of riparian forests and these areas were not clearcut in the second model runs, an increase in suitable habitat available was projected. Increases were projected in every ecoregion the species occurs in (1, 2, 3, and 4) and statewide under each harvest level. Projected increases were identical for all forest and timberlands.

Common Goldeneye (*Bucephala clangula*)
Common Goldeneyes or "whistlers" regularly nest in northeastern and north central Minnesota, with greatest abundance found in Itasca and Beltrami counties (Janssen 1987). This species is relatively common in winter in the open water areas of Lake Superior, the Mississippi River, and other Minnesota rivers. Goldeneyes are also a common spring and fall migrant, particularly in late March to early May and from November to early December. Breeding range of this species includes most of Canada and Alaska as well as the western Great Lakes. Wintering range also includes the North American Coast and the Mississippi River (National Geographic Society 1983).

Goldeneyes are diving ducks which primarily feed on aquatic invertebrates such as insects and mollusks. Some aquatic vegetation, small fish, and small amphibians are eaten as well (Roberts 1932, Ehrlich et al. 1988). They are secondary cavity nesters, lining an abandoned woodpecker cavity found near the water with wood chips and down (Ehrlich et al. 1988). Seven to ten eggs are laid and incubated exclusively by the female for 28 to 32 days. In Wisconsin, nesting typically occurs from mid-June to early July (Robbins 1991). The young are precocial, remaining in the nest cavity for only 24 to 42 hours. The young are ready to fledge 56 to 60 days after hatching (Ehrlich et al. 1988). Common goldeneyes will use nest boxes when available, and will parasitize other Goldeneye nests when cavities are scarce (Ehrlich et al. 1988).

Preferred breeding habitat includes mature boreal forest with large trees and suitable nest cavities, adjacent to small to large open water areas that contain abundant submerged aquatic vegetation as well as wooded wetlands (Brewer et al. 1991, Ehrlich et al. 1988). DeGraaf et al. (1991) suggest a minimum tree dbh of 20 inches for suitable nesting cavities. Competition for nests sites with Wood Ducks usually favors the Common Goldeneye (Brewer et al. 1991).

Development of lake shore property in the breeding range has likely had negative impacts on this species in Minnesota. Forestry practices which result in further reductions in mature, riparian forest will likely result in additional stress on populations. Aquatic systems that are clear and contain prey that are uncontaminated by bioaccumulative chemicals are also important to this species' viability in Minnesota and throughout its range.

Because Common Goldeneyes are riparian forest birds and riparian areas were protected from harvest, an increase in suitable habitat available for this species was projected under all harvest scenarios. Increases, regardless if timberland or all forest land were considered, were projected for all ecoregions (1, 2, 3, and 4) where the species occurs. A statewide increase was also projected for all harvest levels. A decrease in available habitat, however was projected to occur on all forest land in ecoregion 3 under the medium and high harvest levels. The increase and decrease projected for this species in ecoregion 3 was due to the rather low densities of the species in this area.

Bufflehead (*Bucephala albeola*)
The Bufflehead is a common spring and fall migrant in Minnesota, but it is considered a rare summer resident (Janssen 1987). Nesting has been documented in Marshall and Carver counties, and it has likely bred in other northern and western counties. Nesting is difficult to document as the species typically nests in low densities in remote areas (Cadman et al. 1988). Individuals have over-wintered on Lake Superior and in the southeastern corner of the state. Northern Minnesota is on the southern edge of this species' eastern range. A southern extension into the Rocky mountains of Idaho and Wyoming makes up most of the U.S. breeding range in the lower 48 states. The breeding range also is extensive throughout most of Canada and interior of Alaska, except for the extreme north.

Winter range includes all of the coastal regions of North America as well as interior regions in the southern U.S., Mexico, and along the Central Flyway (National Geographic Society 1983). Spring migration peaks in mid-April, whereas the fall migration peak occurs in early November (Janssen 1987).

Buffleheads are ducks of fresh and brackish water which dive for their invertebrate foods. They will, however, also eat small fish, seeds and other plant material (Roberts 1932, Ehrlich et al. 1988). This species is a secondary cavity nester, with a special preference for abandoned Northern Flicker nests (Roberts 1932). Where tree cavities are unavailable, some nesting in burrows also occurs (Ehrlich et al. 1988). Because of its nesting requirements the species is classified as associated with mature forests for appropriate large cavity trees and riparian habitats for appropriate feeding areas for adults and young.

Eight to ten eggs are usually laid and incubated exclusively by the female for 29 to 31 days. The precocial young are ready to fledge 50 to 55 days after hatching (Ehrlich et al. 1988).

As with many secondary cavity nesting bird species, reductions in mature riparian forest with high structural complexity are likely to result in population declines of Buffleheads. For this species in particular, maintaining mature riparian forests which contain adequate numbers of snags for woodpecker nesting will be important in maintaining this species as a breeder in Minnesota.

Because Buffleheads are riparian forest birds and riparian areas were protected from harvest, an increase in suitable habitat available for this species was projected under all harvest scenarios. An increase in ecoregion 1 and statewide were projected for all harvest levels on timberland and on all forest land.

Hooded Merganser (*Lophodytes cucullatus*)

The Hooded Merganser is a common summer resident throughout all of Minnesota except in the southwestern portion of the state. The species is a spring migrant into Minnesota from March through mid-May, and a fall migrant from September through mid-December, occasionally overwintering in the southeastern corner of Minnesota (Janssen 1987).

In Minnesota the Hooded Merganser is most abundantly found in relatively secluded lacustrine and lotic aquatic habitats in the heavily forested regions. Hence, the species tends to be found along many of the major river systems throughout the state and less habitated lakes of central and northern Minnesota.

In North America, the breeding and wintering distribution of the Hooded Merganser roughly coincides with that of the Wood Duck (*Aix sponsa*) (Morse et al. 1969). The species generally overwinters along the Atlantic Coast States, throughout the Gulf of Mexico region, and into central Mexico (Bellrose 1976).

Morse et al. (1969) found that Hooded Mergansers selected nest sites close to water on the basis of suitable nesting cavities including nest boxes (Johnsgard 1975). Kitchen and Hunt (1969) and Scott et al. (1977) stated that clear water and availability of sustainable foods also contributed to the nesting distribution of the species. The Hooded Merganser, unlike the Wood Duck, appears more sensitive to human disturbances (Scott et al. 1977).

The Hooded Merganser lays up to 13 eggs, and nests with up to 36 eggs ("dump" nests) have been observed. The species frequently lays eggs in Wood Duck nests and vice versa (Bellrose 1976).

Foods for the Hooded Merganser include fish, crustaceans, and insects. Of 138 stomachs examined, fish made up 43.9 percent, crustaceans 32.6 percent, and insects 13.4 percent, of Hooded Merganser stomach contents (Cottam 1939, Palmer 1976).

In Minnesota, reductions in suitable nest-cavity trees in riparian habitats, human disturbance, and water quality appear to be factors most associated with limiting populations. Suitable, well-managed nest box programs can compensate for a lack of natural cavities in habitats that are otherwise satisfactory.

The species was classified as dependent on mature, riparian forests and a cavity-dependent species.

As with many of the riparian-associated species this species showed only increasing projections in available habitat. Under all three harvest scenarios, the species was projected to increase in all ecoregions and statewide for timberlands. When all forest lands were considered, the species was projected to again increase in all ecoregions, but no statewide increase was noted. The reason for the projected increases were due to the selective cutting that occurred in all riparian habitats with the mitigated timber harvesting runs. In these areas, riparian habitats were selectively cut and allowed to mature, but no change occurred in the forest type classification for the stand. Presumably this species can tolerate selective cutting in riparian forest areas as long as the timing of the cuts do not coincide with the nesting season and suitable nesting trees are found in the area.

Common Merganser (*Mergus merganser*)
The Common Merganser is a regular summer resident in northeastern Minnesota, and is considered a common spring and fall migrant throughout many parts of Minnesota from mid-February to mid-May and from mid-September through mid-December. The Common Merganser occasionally overwinters in Minnesota along the Mississippi River (Janssen 1987). The Common Merganser is found breeding across a wide geographic area throughout the northern portion of North America and overwintering in the continental United States. The species is most commonly found along lakes, rivers, and coastal areas.

Throughout its summer range, the bird is generally confined to forested regions (Johnsgard 1975) and, like other fish-feeding waterfowl species, is most successful foraging in relatively clear waters (Bellrose 1976). The Common Merganser is a cavity nesting species when such nest sites are available, but the species is known to nest in boulders and thick vegetation (Scott et al. 1977). The species also readily nests in nest boxes (Bellrose 1976).

The species was classified as dependent on cavities and, because of its size, most suitable natural cavities must be in relatively large, mature trees.

The Common Merganser has been looked upon as a nuisance in trout- and salmon-rearing waters. Of 724 Common Mergansers examined, White (1957) found salmon remains in 45 to 96 percent (yearly variation) of the stomachs examined. More pertinent, however, is data collected by (Timken and Anderson 1969). They found only 13 percent of Common Merganser stomachs collected in Minnesota, Nebraska, and South Dakota contained game fish. They concluded that the species was not a serious predator of game fish.

As with other cavity-dependent waterfowl species in Minnesota, the Common Merganser is susceptible to removal of suitable nesting habitat (cavity trees near water) and human disturbances near nesting grounds.

As with most riparian-associated bird species, the Common Merganser was projected to increase in all ecoregions where it occurs (1, 2, 3, and 4) and statewide under all three harvest scenarios on either timberlands or all forest lands. An exception occurred in ecoregion 3 where the species was not projected to increase in all forest lands under the medium and high harvest scenarios. It is unclear to what extent this species can tolerate selective cutting in riparian areas. Presumably, with the availability of suitable large trees with cavities, nest sites would not be a limiting factor under any of the three harvest scenarios.

Turkey Vulture (*Cathartes aura*)
The Turkey Vulture is regularly found in Minnesota during spring migration, its summer breeding season, and subsequent fall migration (Roberts 1932). Janssen (1987) describes the breeding range in Minnesota as the north central, northeastern, and the southeastern regions of the state. The species has can be found throughout North America to about 50° N. latitude (Palmer 1988).
The Turkey Vulture is observed in a wide variety of habitats in Minnesota including open country, woodlands, farmlands, and heavily forested areas (Kingsley and Nicholls 1991). The species primarily forages in open country, along streams and water bodies, and along roads, while nesting primarily occurs in woodlands that are relatively isolated from human disturbance (Palmer 1988, Brewer et al. 1991). According to Godfrey (in (Brewer et al. 1991), the species seldom uses extensive contiguous forest habitat for either nesting or foraging. Because of the widely varying habitats used, the species was not classified into any of the EQB/FSD groupings.

The species appears to be an opportunistic forager which uses its keen sense of sight and smell to find food. The species is a scavenger that exists in finding carrion. It uses road kills and a variety of vertebrates that have died accidentally (Roberts 1932).

Johnson (1982) suggested that the population of Turkey Vultures is stable, and even increasing, based on migration counts from Hawk Ridge in Duluth, MN. Ehrlich et al. (1988) states that eggshell thinning due to chemical contamination from organochlorine compounds may still be a problem for this species. This is likely associated with its diet of carrion. Carrion may have higher chemical contamination loads than other food sources. This species was placed on the Audubon Blue List in 1972 and 1980 and was a species of special concern in 1981–82.

It has been speculated that the Turkey Vulture is less common today than it was in the past (Roberts 1932, Palmer 1988). The species was probably more abundant when large mammals (e.g., bison) and other large herbivores were more common in the 1800s. However, as road networks increased and road kills became more common the species seems to have again expanded its range northward. Other reasons for recent increases that have been suggested include a warming climate, increased deer populations and more carcasses available, and increased habitat changes in more southern portions of its range (Palmer 1988, Brewer et al. 1991).

Nest sites for the Turkey Vulture range from broken tree tops, shallow caves, to ground scrapes (Scott et al. 1977). The nesting biology of the species is largely unknown in Minnesota, but there is some evidence of increased use of abandoned buildings, possibly due to the decrease in availability of rotting logs and stumps as nest sites (Brewer et al. 1991).

During a study in Fillmore County of southeastern Minnesota, Tenney (1986) suggested that the number of nest sites available to breeding Turkey Vultures may be sensitive to fragmentation effects due to timber harvesting during the nesting phase.

No projected decreases were predicted for this species in any ecoregion or under any of the three harvest scenarios. The species was, however, projected to increase in ecoregion 6 under all three harvest scenarios and on both timberland and all forest land. The increase in open foraging habitat in recently cut areas is likely the reason for the projected increase for this species in ecoregion 6. However, the availability of suitable food sources and protected nest sites are likely more limiting factors for this species.

Osprey (*Pandion haliaetus*)
The Osprey is a cosmopolitan species, found in temperate and tropical environments on nearly every continent, always associated with water. Little is known about migration and wintering grounds (Poole 1989). Osprey can be found throughout the North American Continent along major bodies of

water during the breeding season, and elsewhere during migration (Westall 1986, Palmer 1988). They occur north to the timberline and forested tundra river valleys (Prevost 1983). Migratory populations generally winter in Central and South America to Argentina and Chile (Prevost 1983). The U.S. population is concentrated along the Atlantic Coast, with a secondary concentration in the western Great Lakes states (Poole 1989).

They are regular summer residents and migrants in Minnesota and are listed as a state species of special concern. Osprey were included on the Blue List in 1972, but were delisted in 1981. Osprey formerly nested throughout the forested regions of the state (Roberts 1932), but currently are restricted to northeast and north central Minnesota. A 1984 survey of the Chippewa and Superior national forests found 199 active nests. Of these, only 100 successfully produced young (Coffin and Pfannmuller 1988). The seasonal high for migrating Osprey during fall observation at Hawk Ridge Nature Reserve in Duluth was 247 in 1984 (Janssen 1987).

Osprey rely almost exclusively on a diet of live fish, taking species in relation to their availability and food value (Greene et al. 1983, Palmer 1988). Occasionally other animal prey will supplement this diet (Westall 1986). Prey are captured by diving from 30 to 100 feet above the water surface following the detection of a fish close to the surface. Velocities of 30 to 70 kph are achieved during dives (Palmer 1988). Reported hunting success rates average about 75 percent (Lambert 1943, Uoeka and Koplin 1973, Westall 1986). This success rate is related to water chemistry, primary productivity, and weather among other factors (Uoeka and Koplin 1973, Grubb 1977, Westall 1986).

Elaborate courtship displays help maintain pair bonds which may last for the life of the birds (Westall 1986, Poole 1989). Nest site fidelity also may have an important role in pair maintenance (Fernandez and Fernandez 1977). Nests are usually built in open sites on tree tops over or near water and if destroyed, are rebuilt very close to the original site. Nest destruction from wind damage may occasionally be significant (Palmer 1988). Many unusual nesting substrates have been used, including artificial platforms, utility poles and towers, and channel markers and bouys (Westall 1986, Poole 1989). Nest sites over water are particularly attractive due to their relative safety from predators such as raccoons (Poole 1989). Island nest sites likewise provide some protection from predators, and colonies of Osprey nesting on the ground on small islands were reported in the past. These colonies may have been as large as 200 to 300 nests with as little as 50 to 100 m separating individual nests (Westall 1986, Poole 1989). Nest material is predominantly small (1 to 3 cm) diameter sticks, but may include a wide variety of natural and man-made materials such as plastic bags, discarded clothing, parts of fish nets, and aluminum cans (Westall 1986, Poole 1989).

Clutch size is usually 3 to 4 eggs which are incubated for 30 to 35 days, primarily by the female (Poole 1989). Young Osprey fledge 40 to 45 days after hatching, but the family remains together and parents feed their young for an additional 10 to 20 days (Poole 1989). Dissolution of the family typically begins shortly before fall migration, and young do not return to the breeding grounds until they are two years old (Westall 1986).

The Osprey was one of many raptor species severely impacted by bioaccumulation of organochlorine pesticides. Its position at the top of aquatic food chains makes it particularly vulnerable to persistent toxic chemicals (Palmer 1988). Since the elimination of DDT use in the U.S., Osprey populations have rebounded significantly. Populations in the northeastern U.S. have shown 200 percent increases from lows in the 1970s (Spitzer 1989), and reproductive success has increased as levels of DDE residues in eggs has declined (Spitzer et al. 1978).

Recovery of Osprey populations has also been aided by improved management of nest sites, reintroduction projects, and the species' ability to adapt to human disturbance (Spitzer 1989, Poole 1989). Flook and Forbes (1983) suggest also that stabilization of water levels in wildlife management areas may lead to increases in prey abundance and availability which could lead to increases in Opsrey numbers. Current population estimates put the U.S. breeding population at about 8000 active nests (Poole 1989). Studies on productivity in national forests in the Great Lakes area, however, indicate that reproductive success in these areas is lower than that which is required to maintain populations on the Atlantic Coast (Coffin and Pfannmuller 1988). Breeding Bird Survey data also suggest a decline in more western populations (Robbins et al. 1986). In contrast to eastern regions, human disturbance at nest sites may negatively influence reproductive success in western populations (Swenson 1979, Levenson and Koplin 1984). Osprey have historically been an indicator of environmental change. Use of organochlorine pesticides, reduced fish populations, and loss of forested lands have all negatively impacted Osprey populations.

Current threats include predation by Great Horned Owls and raccoons, especially in human-dominated landscapes where raccoon populations are increasing. Conflicts between aquaculture interests and Osprey are likely to increase with the growth of this industry. Shooting of Osprey by fish farmers is thought by Poole (1989) to be underrated. Loss of nesting sites due to intensive forestry may also be a threat to Osprey populations. This may be mitigated, however, by better nest site management which includes protection of riparian nesting habitats, augmented by erection of artificial nest platforms. Because nest sites may be used continuously for many years, preservation of currently active sites is of primary importance in managing Osprey populations. A 500 m minimum-activity zone around active nests from April to September and a no-cut zone of 100 m is recommended (Palmer 1988).

Because Ospreys are riparian forest birds and riparian areas were protected from clearcutting, an increase in suitable habitat available for this species was projected under all harvest scenarios. Increases on all forest land included all ecoregions where the species occurs and a statewide increase under all harvest levels. Results were the same when timberland was considered. Additional protection of present and potential nest sites will be required to mitigate impacts for this species. In addition, it is essential that proximate logging activity in areas of nesting be completed when the ospreys are not nesting.

Bald Eagle (*Haliaeetus leucocephalus*)
The Bald Eagle is a regular summer resident in Minnesota and a winter visitor in areas with open water. Most Bald Eagles can be found in the northeast and north central parts of the state (Janssen 1987). Spring migration begins as soon as open water becomes available in late February and early March and adults stay until frozen water curtails hunting for the season (Dunstan et al. 1975). Bald Eagles formerly nested on most large lakes and rivers throughout the forested regions of the state (Roberts 1932). The species has recently begun to return to the east central region and some western counties.

Bald Eagles are found only in North America, but are widely distributed throughout the continent. Seasonally occupied breeding range includes a broad band from interior Alaska through the middle of interior western Canada to the southern portions of eastern Canada. Individuals can be found throughout the year from southern coastal Alaska through the Aleutian Islands and western coastal Canada. The species occupies much of the northwestern U.S. from Washington to northern California, west to Montana and Wyoming, and portions of Colorado. In the southeast, the species occurs in Arizona, New Mexico, Baja, and Northern Mexico. Its range also includes the Gulf coast, northern Atlantic coast, western Great Lakes States (including Minnesota, Iowa, Illinois, Ohio, Wisconsin, and Michigan), and the St. Lawrence Seaway. Bald Eagles can be found migrating throughout most of the rest of the continent south of the arctic and north of northern Mexico (Palmer 1988).

There is a slight geographic size relationship from smaller individuals in Florida to larger individuals in Alaska (Amadon 1983). One estimate in 1983 put the U.S population in the lower 48 states at 22,000, with another 48,000 in Canada and Alaska. This estimate may be one-third to one-half of the population of 25 years ago (Gerrard 1983).

Bald Eagles nest throughout North America in diverse types of mature forest habitats, generally close to water where large conifer trees are available for nest construction, and an adequate supply of fish can be found (Palmer 1988). In Minnesota, white and red pine are preferred nesting trees. Trees 15 to 37 m tall, with dead tops which are near water and edges of openings in mature forests are preferred in the Chippewa National Forest (Dunstan et al. 1975, Mathisen 1983). Other large perch trees located nearby are also required. Ground nests may be built on hillsides, cliffs, ridges, or small islands when trees are unavailable (Sherrod et al. 1976, Palmer 1988). Based on this information the species was included in the mature forest, riparian, and forest raptor EQB groups.

Reproductive maturity generally begins at year 5, but some individuals will begin breeding at year 4 when adult birds are not present. Pair bonds are believed to last for life. Nests are very large, with branches and other materials being added every year. Lining material for the nest may include finer materials such as forbs, grasses and moss. Nests may reach 3.5 to 7 m in height, 3 to 4 m in diameter at the top, and may exceed 2 tons in weight after many years of construction (Palmer 1988). During the first year, nests are more typically 0.5 to 1 m in height, and 1.3 to 2 m in diameter (Dunstan et al. 1975). One to three eggs are laid and incubated for 34 to 36 days before hatching. In captivity, females incubate through most of the day, and either sex may incubate through the night. Data from wild individuals in Minnesota indicate that females do most of the incubating. Young begin to fly at 10 to 11 weeks of age and usually leave the nest by the 13th week after hatching. Families may remain together for an additional 5 to 14 weeks (Dunstan et al. 1975, Ehrlich et al. 1988, Palmer 1988).

The diet of the Bald Eagle is predominantly fish, but includes waterfowl and other birds, mammals (especially rabbits), reptiles, invertebrates, garbage, and carrion, all of which may be pirated, scavenged or hunted (Roberts 1932, Dunstan and Harper 1975, Sherrod et al. 1976, LeFrank and Cline 1983, Palmer 1988).

A 1990 survey found 437 active territories in Minnesota which successfully fledged 467 young (Miller and Pfannmuller 1991). This represents a 12 percent increase in active territories since 1989, and a 280 percent increase over the 1973 population of 115 active territories. The majority (52 percent) of territories were found in the Chippewa and Superior national forests. Eagle populations in the Chippewa National Forest have remained stable or increased since the 1970s (Coffin and Pfannmuller 1988), following the time that DDT had likely caused major declines in many parts of the country. The 1991 Chippewa National Forest monitoring program reported 160 active or occupied nests, 160 young were successfully fledged (Chippewa National Forest 1991).

Bald Eagles are listed as federally endangered in all of the lower 48 states, except in the western Great Lakes states (e.g., Minnesota, Wisconsin and Michigan), and the Pacific Northwest. They are listed as federally threatened in these states. In Minnesota they are listed as state threatened as well. As primarily fish eaters and scavengers, Bald Eagles are vulnerable to a variety of environmental stresses. The use of the pesticide DDT was perhaps the largest factor in the decline of eagle populations in recent history. Habitat changes and shooting were other major contributors (Roberts 1932, Grier et al. 1983). Reproductive success has improved since 1981, primarily due to the elimination of DDT use in the U.S., active habitat and nest management, and reintroduction efforts, particularly in the northeast.

Several threats to eagle populations remain. Shooting and accidental capture in leg-hold traps account for nearly 40 percent of the injuries to Bald Eagles admitted to the Raptor Center at the University of Minnesota, and nearly 35 percent of eagles tested had blood lead levels higher than background levels (Martell and Redig 1991). Lead contamination can come from ingestion of lead shot gun pellets from contaminated prey, or directly from shooting of eagles (Grier et al. 1983). Human disturbance, particularly during the courtship and early nesting period, may cause Bald Eagles to desert nests (Dunstan et al. 1975). Studies in Michigan also suggest that in some areas removal of forage fish from inland lakes for sport fish management can lower reproductive success for eagles nesting near these areas (Bowerman 1991).

In Minnesota, the greatest threats to Bald Eagle populations are likely to be the loss of suitable nesting habitat and human disturbance during the nesting period. Distribution of these birds generally depends on the availability of suitable habitat in areas with low human disturbance. A no-activity zone of 100 m during the period from courtship to four weeks after hatching should be enforced when human activity should be reduced or eliminated throughout the year. Clearcutting, land clearing and major construction should be prohibited within 200m of the nest. Thinning, and other human activity should be prohibited during the nesting and rearing period and reduced at other times. Within 0.25 to 0.5 miles, clearcutting and other major landscape alterations should be allowed only when the nest is unoccupied (Mathisen et al. 1977, Grier et al. 1983, MNDNR 1992).

Mathisen (1983) suggests also that habitat management for Bald Eagles in Minnesota should focus on providing large white and red pine canopy emergents with dead, open tops. These nesting areas should be within 80 m of open water and near a forest edge. Planting white pine in areas of low human disturbance can provide replacement nest trees in areas where this tree species is not regenerating naturally. As a top carnivore with a moderately specialized diet, the Bald Eagle also may be threatened by changes in prey populations. Maintenance of an adequate and uncontaminated supply of fish is an important management consideration.

Because Bald Eagles are riparian forest birds and riparian areas were protected from harvest in the model, an increase in suitable habitat available for this species was projected under all harvest scenarios. Increases on all forest land included all ecoregions and a statewide increase under all harvest levels. When timberland was considered, increases were projected in all ecoregions and harvest levels except in ecoregion 5 under the base harvest level. Statewide increases were also projected for all harvest levels on timberland. Additional protection of present and potential nest sites will be required to mitigate impacts for this species. In addition, it is essential that proximate logging activity in areas of nesting be completed when the eagles are not nesting.

Sharp-shinned Hawk (*Accipiter striatus*)
The Sharp-shinned Hawk is a regular nesting species (Johnson 1982) in Minnesota, with a breeding range including the forested northeast, north central, and central regions of the state (Janssen 1987). The species is a common spring and fall migrant throughout the state (Janssen 1987), and overwinters within Minnesota, throughout the upper midwest (Rosenfield et al. 1991), and south to Central and South America (Evans 1982).

The overall distribution of the species is rather broad and includes most of the forested zone of northern North America and throughout the western forests throughout the Rocky Mountains (National Geographic Society 1983).

Because of the species' secretive nature and the dense forest habitats it occupies, little is known about the breeding biology of the Sharp-shinned Hawk (Platt 1976). Reynolds and Wight (1978) considered Sharp-shinned Hawks the most difficult accipiter to locate. Indeed, most current population estimates are likely inaccurately based on migration counts (Rosenfield et al. 1991). It is generally assumed that the population of Sharp-shinned Hawks and other accipiters decreased until the late 1970s, probably a consequence of use of organochlorine compounds (Evans 1982).

The Sharp-shinned Hawk is broadly classified as breeding in the moderately-aged to mature coniferous and mixed conifer deciduous forests of Minnesota (Evans 1982) and primarily in the northern regions (Kingsley and Nicholls 1991). Platt (1976) found that the species often nests in the thick foliage of coniferous trees. The species was consistently found in the Red Lake Peatlands in dense black spruce forests (Niemi and Hanowski 1992). Similarly, (Palmer 1988) and (Brewer et al. 1991) report the species from dense conifer stands, sometimes near a forest opening or path. Moreover, (Palmer 1988) reports that of 200 nests found in the Montreal, Canada area, the majority were in black spruce, some in balsam fir, and the remainder in other conifers. Based on these data, this forest raptor was classified as associated with mature, coniferous forests. In this case, mature does not necessarily imply tall trees because the black spruce trees within peatlands are often old (> 100 years), but not necessarily tall (4 to 10 m).

Food for the Sharp-shinned Hawk includes small to medium-sized birds, small mammals, insects and amphibians (Evans 1982, Palmer 1988). Jones (1979) considered the Sharp-shinned Hawk to be almost exclusively a small bird predator. Storer (1966) found a 97:3 ratio of birds to mammals in the diet of Sharp-shinned Hawks.

There are no systematic inventories or analyses of the population trends of this species in Minnesota. Roberts (1932) commented that the species was far less abundant in the 1920s and 1930s than it was formerly. He attributed declines of this species to their being shot as varmints because of their occasional taking of poultry. Brewer et al. (1991) state that it is unclear whether the species was more abundant in the late 1800s. However, they felt that the species was more widespread and abundant now than it had been in the early part of century. Factors that contribute to uncertainty in the species' early status include the increased ability of observers today over those in the past, the uncertain effects of DDT and other organochlorine compounds on the reproduction of the species in the 1950s and 1960s, and the reduction in illegal shooting of the species.

Intensive forest management is likely to result in a decrease in Sharp-shinned Hawk populations in Minnesota if there is a net loss of conifer forest. This conversion would reduce the amount of suitable nesting habitat for this species.

No increases were projected for the species under any of the three harvest scenarios for any ecoregion. Also no changes were projected under the base harvest scenario. The species was projected to decrease in ecoregion 3 under the medium harvest scenario on all forest lands. Under the high harvest scenario, the species was projected to decrease in ecoregions 2, 3, and 4 and statewide on timberlands, and in ecoregions 3 and 4 and statewide in all forest lands. The overall reduction in the availability of mature coniferous forest habitat in ecoregions 3 and 4 is the primary reason for the projected changes in this species population.

Cooper's Hawk (*Accipiter cooperii*)

The Cooper's Hawk is a regular migrant and summer resident in Minnesota, primarily occurring in the central, southeast, and east central regions (Janssen 1987). The Cooper's Hawk is migratory in the northern portion of Minnesota, and frequently overwinters in southern sections of the state and throughout the midwestern United States. In Minnesota, Johnson (1982) lists the Cooper's Hawk as a "regular" nesting species, especially in the central and southeastern portions of the state.

In presettlement times, this species was considered one of the most common nesting hawks in the Central United States (Roberts 1932, Bent 1937). The Cooper's Hawk population declined from the mid 1900s until the early 1970s, when numbers increased (Rosenfield and Anderson 1983). The use of organochlorine compounds and illegal shooting are invariably listed as likely reasons for the decrease in Cooper's Hawk populations (Jones 1979). In northern North America, the banning of organochlorines and protection of raptors under the Migratory Bird Treaty Act of 1972 are primarily responsible for recent increases in the species population.

Like the other accipiters, the Cooper's Hawk is secretive, and most estimates of the status of Cooper's Hawks are based on numbers extrapolated during fall migrations (Rosenfield et al. 1991).

In Ohio, nesting and roosting habitats for the Cooper's Hawk are generically described as "pine plantations" (Mutter et al. 1984). In Wisconsin, "natural stands of deciduous, coniferous and mixed pine-hardwood forests, and pine plantations" (Rosenfield and Anderson 1983) are selected by the species. Kingsley and Nicholls (1991) suggest that the species is primarily found in mature deciduous or coniferous forests in the midwestern United States.

The Cooper's Hawk appears to be more adaptive in its selection of breeding habitat and relatively tolerant of human disturbance (Murphy et al. 1988). Hence Rosenfield et al. (1991) suggested that breeding habitat may not be a limiting factor in Wisconsin, whereas prey availability is more important. Density estimates for the species in Wisconsin range from one pair/square mile to one pair/five square miles (Rosenfield pers. comm.).

Storer (1966) stated that 7 bird species make up 36 percent of the Cooper's Hawk diet. Meng (1959) reported that 698 of 853 prey items captured by Cooper's Hawks in New York and Pennsylvania were bird species. Of the 698 avian prey items, the Starling (*Sturnis vulgaris*), Northern Flicker (*Colaptes auratus*), Eastern Meadowlark (*Sturnella magna*), American Robin (*Turdus migratorius*) and Common Grackle (*Quiscalus quiscula*) constitute 87 percent of the Cooper's Hawk diet.

In Minnesota, information is lacking on the nesting biology and habitats used by the species in the state. Forestry practices may impact Cooper's Hawk populations directly if there is a reduction in older mature forests for breeding habitat. However, the species appears to be somewhat flexible in its habitat use and indirect effects may be of more concern such as reductions in its prey base.

The Cooper's Hawk showed a mixed response to timber harvesting in Minnesota. Under the base harvest scenario, the species was projected to decrease in ecoregions 1 and 4, but increase in ecoregions 7 and 9 on timberland. For all forest lands, projected decreases were limited to ecoregion 4, but increases were projected for ecoregions 5, 7, and 9. Under the medium harvest scenario, the results were the same on timberlands, but when all forest lands were included projected decreases were observed in ecoregions 1 and 4 and increases were noted in ecoregions 7 and 9. Under the high harvest scenario, the species was projected to decrease in ecoregions 1 and 4 and statewide on timberlands, yet increase in ecoregions 7 and 9. For all forest lands, the results were the same as in the medium harvest scenario. As mentioned above, the habitat specificity of this species is unclear since it might tolerate a wide variety of forest conditions. The reductions noted above are primarily due to decreases in mature hardwood forests in which the species is most associated with during the nesting season.

Northern Goshawk (*Accipiter gentilis*)
The Northern Goshawk has a holarctic distribution across North America and northern Europe and Asia (Palmer 1988). In Minnesota, the species is primarily found in the northern forested regions of the state, and generally it is a relatively rare and secretive species (Roberts 1932, Janssen 1987).

Throughout its range, estimates of the population and status for the Northern Goshawk are difficult to make and often extrapolated from migration counts and banding returns (Rosenfield et al. 1991). The species is considered a regular nesting bird in northern Minnesota (Johnson 1982). Because of its secretive nature, information on the species is noticeably lacking.

The Goshawk relies on a prey base which utilizes both mammalian and avian species. Eng and Gullion (1962) estimated that over 50 percent of Ruffed Grouse (*Bonasa umbellus*) overwintering mortalities were the result of Goshawk predation. However, Meng (1959) determined food habits at 14 Goshawk nests in New York and Pennsylvania. Of 72 mammalian prey items identified, 58 percent were Red Squirrel (*Tamiasciurus hudsonicus*), and of 113 avian prey items examined, 83 percent were Common Crow (*Corvus brachyrhynchos*). Palmer (1988) summarizes the diet as mainly game birds, hares, rabbits, and squirrels. It has been known to consume birds as large as mallards and as small as wood warblers. The diversity of diet and lack of exposure in many forested habitats, particularly the selection of mammalian prey items, may explain why Goshawk populations in the upper Midwest were presumably not affected as much as other raptors by organochlorine contamination of food sources (Jones 1979).

Nesting habitats for the Goshawk are described as mature tracts of coniferous or mixed forests (Bent 1937, Shuster 1980, Johnson 1982, Kingsley and Nicholls 1991). Although the species has been noted to use a variety of forested and semi-open habitats (Palmer 1988), in Minnesota its range is primarily associated with the heavily forested regions of the state. More detailed information from Michigan (Brewer et al. 1991) suggests that the species uses both deciduous, coniferous, and mixed deciduous-coniferous forests. Since the species tends to nest in older deciduous trees (Palmer 1988), mixed forests may indeed be favored. Brewer et al. (1991) further explain that the species inhabits large stands of boreal and northern hardwoods which are relatively free of an understory, the latter being important for hunting below the canopy. Based on these data, this forest raptor was defined as dependent on mature forests, but not associated primarily with coniferous forests.

Goshawks mate for life and utilize the same nesting areas each year (Jones 1979). The use of traditional nesting sites by Goshawks in Minnesota is supported by Gullion (1981) and Palmer (1988).

The use of traditional nesting sites in mature tracts of forests suggests that habitat may be an important component for the Northern Goshawks in Minnesota. In Michigan, Brewer et al. (1991) states that the most significant threat to the species is habitat alteration through timber harvesting. They suggest that timber harvesting will primarily affect the availability of suitable nest sites, enhance the distribution of competitors (primarily Red-tailed Hawk and Great Horned Owl), and affect the abundance of prey. They further suggest clearcutting has led to the abandonment of formerly occupied sites in Michigan. In Minnesota, little information exists on the potential effects of forest practices on Northern Goshawk distribution and abundance.

No ecoregional increases were projected for this species under any of the three harvest scenarios. Under the base harvest, the species was projected to decrease in ecoregion 4 on both timberlands and all forest lands. In the medium harvest scenario, the species was projected to have decreased available habitat in ecoregions 1 and 4 and statewide on timberlands, but to only decrease in ecoregion 4 on all forest lands. Under the high harvest scenario, the species was projected to decrease in ecoregions 1, 2, 3, and 4 and statewide on timberlands and decrease in ecoregions 1, 3, and 4 and statewide on all forest lands. The overall reduction in the availability of mature forest habitat, especially in the medium and high harvest scenario are the reasons for both the projected decreases in ecoregions and statewide for this species. Any potential effects of fragmentation, as suggested for Michigan (Brewer et al. 1991), could not be accounted for in this analysis.

Red-shouldered Hawk (*Buteo lineatus*)
The Red-shouldered Hawk has two major populations in North America. The largest concentration of hawks is found in forested areas of eastern North America and a smaller, disjunct population occurs along the coast of southwestern Oregon and California (Coffin and Pfannmuller 1988). The

eastern population appears to be expanding northward as a result of the maturing of northern hardwoods, aspen, and mixed forest associated with streams and other wet areas (Postupalsky 1980). In Minnesota, the Red-shouldered Hawk breeds from Wabasha and Olmsted counties north and west to Mahnomen, Becker, and Hubbard counties (Coffin and Pfannmuller 1988). The species is a short to long distance migrant that winters throughout the southern portion of its breeding range into Mexico (National Geographic Society 1983). In Minnesota, spring migration of the Red-shouldered Hawk extends from mid-March through early May, while fall migration occurs during early September through early November (Janssen 1987).

The Red-shouldered Hawk is associated with mature, open deciduous, and mixed riparian forest habitats, with a preference for bottomlands and wooded margins near marshes (Woodrey 1986, Bushman and Therres 1988, DeGraaf et al. 1991). The forest is usually interspersed with small wetlands created by meandering, flowing water (Bednarz and Dinsmore 1981).

The species nests in the canopy of a deciduous tree, usually 12 to 48 in dbh (Titus and Mosher 1987), often found near water (Bushman and Therres 1988). Nests are almost always restricted to closed forests with low conifer composition, fewer but larger trees, a well-developed understory, a reduced subcanopy, and low ground cover (Portnoy and Dodge 1979, Morris et al. 1982, Armstrong and Euler 1983). However, it was shown in Iowa that upland forest may compensate for limited floodplain forest at some nest sites (Bednarz and Dinsmore 1981). Clutch size ranges from 2 to 4 eggs, usually 3 (Harrison 1975). The species feeds on small vertebrates and invertebrates including reptiles, amphibians, rodents, birds, and crayfish frequently obtained from marshes and wetlands (Ehrlich et al. 1988).

Large (250 to 625 acres) contiguous forest tracts are necessary to sustain breeding in this species (Bednarz and Dinsmore 1982, Coffin and Pfannmuller 1988). Finch (1991) recently summarized a report by Robbins et al. (1989) and suggests that the species is seldom present in tracts of less than 100 acres, and tracts greater than 7500 acres may be necessary for this species. In habitats such as fragmented, open forests, the more aggressive Red-tailed Hawk (*Buteo jamaicensis*) will generally outcompete the Red-shouldered Hawk (Campbell 1975, Bednarz 19, Bednarz and Dinsmore 1982). However, small clearings are often utilized as hunting areas by the Red-shouldered Hawk and may be dispersed throughout the forest (Bednarz and Dinsmore 1982). Bednarz and Dinsmore (1982) recommended maintaining mature forest at 148 to 400 trees per acre with few understory trees.

Although the Red-shouldered Hawk was one of many raptors adversely affected by organochlorine compounds, nesting habitat loss and alteration is often cited as a primary cause of the Red-shouldered Hawk's decline across eastern and central North America (Henny et al. 1973, Bednarz and Dinsmore 1982, Armstrong and Euler 1983). The species was listed on Audubon's Society Blue List from 1972 to 1986 because of declining numbers throughout its range (Tate 1986). Migration data collected from 1934 to 1986 at Hawk Mountain, Pennsylvania suggest a long-term, nonsignificant decline in the species (Bednarz et al. 1990). The Red-shouldered Hawk is currently listed as a species of special concern in Minnesota, with a statewide breeding population estimated at less than 200 pairs in 1988 (Coffin and Pfannmuller 1988). Management practices that disturb riverine systems, such as timber harvesting, dam construction, and channelization (Choate 1972) may be detrimental to this species (Bednarz and Dinsmore 1981, Kimmel and Fredrickson 1981, Bushman and Therres 1988). Selective cutting, a practice which reduces average crown diameter and lowers tree density through the removal of the largest most mature trees, may permit territory appropriation by the more aggressive Red-tailed Hawk (Bryant 1986). Bryant (1986) suggested leaving a completely uncut buffer zone around traditional Red-shouldered Hawk nest sites to discourage Red-tailed Hawks.

Suitable habitat availability was projected to decrease for the Red-shouldered Hawk in ecoregions 4, 5, 6 and statewide under all three harvest levels. Decreases were the same regardless of whether all forest or just timberlands were considered. Loss of contiguous, mature, deciduous forests throughout this species' range was most likely the cause of the projected decline.

Broad-winged Hawk (*Buteo playtypterus*)
The Broad-winged Hawk regularly nests in forested regions of the north and northeast, but generally is absent from the west and southwest parts of Minnesota (Janssen 1987). This species is the most abundant migrating raptor seen in the fall at Hawk Ridge, Duluth. The daily record was set on September 15, 1978, when 31,831 individuals were recorded. The seasonal record was set in 1970 at 62,470 individuals. Spring migration is far less spectacular, but small groups can be seen with peaks occurring in Minnesota in late April (Janssen 1987).

The breeding season range includes south central and southeastern Canada and the eastern U.S. from Minnesota to eastern Oklahoma and Texas to northern Florida. Small wintering populations are found in coastal regions of southern Florida and southern California (National Geographic Society 1983). Many individuals migrate through northern Central America and winter from Guatemala to Peru and southern Brazil (Brewer et al. 1991).

In Minnesota the species occurs throughout the forested regions, but especially in the mixed deciduous-coniferous forested areas and those associated with woodland ponds, creeks, sloughs, and wetlands (Roberts 1932, Keran 1978). It likely reaches its highest abundance in the central and north central regions of the state where these combinations are most prevalent.

The Broad-winged Hawk typically waits on a low perch on the edge of a small opening or roadside and catches small vertebrates (including Ruffed Grouse, snowshoe hare, voles, snakes and amphibians) or large invertebrate prey (including beetles, ants, grasshoppers, and caterpillars) (Errington and Breckenridge 1938, Rusch and Doerr 1972, Ehrlich et al. 1988, Brewer et al. 1991). Platform nests are built by both parents in a lower crotch of a deciduous tree (mean DBH from 21 to 49 cm [Rosenfield 1984]), usually 30 to 50 feet above ground. A wide variety of tree species have been reported to be used, usually one of the most dominant species found in the forest (Palmer 1988).

Nest materials include sticks and dead leaves for the outer nest, and bark, lichen, and green leaves for a lining (Roberts 1932, Keran 1978, Ehrlich et al. 1988). Two to three eggs are usually laid and incubated (mostly by the female) (Matray 1974) for 28 to 32 days. The young are cared for by both parents and fledge about 35 days after hatching (Matray 1974, Ehrlich et al. 1988). Nests with eggs have been reported from early May to late June in both Minnesota and Wisconsin (Roberts 1932, Robbins 1991).

Preferred nesting habitat includes many types of deciduous and mixed forests where openings occur (Titus and Mosher 1987, Kingsley and Nicholls 1991). Highly fragmented forests are not normally used (Brewer et al. 1991). Keran (1978) quantified nest site selection in north central Minnesota and Wisconsin. Results indicated a preference for oak, aspen, and birch older than 35 years within 125 m of an upland opening, and within 150 m of a wetland. In Hubbard and Becker, 11 nests were found all within 290 m of an opening, and within 325 m of a wetland (Johnson 1982).

Intensive forest management may result in a decline to Broad-winged Hawk populations if reductions of mature, contiguous forests occur in the breeding range. Small openings and wetlands are important habitat components for this species as well, and should be provided for in management planning to ensure viable Broad-winged Hawk populations. Historically, shooting of migrating raptors was likely detrimental to this species during both spring and fall migration periods in Minnesota (Roberts 1932).

Regional declines have been noted in the more developed regions of the northeastern U.S.; increasing trends have been seen in less developed areas (Titus et al. 1989). Migration data from Minnesota suggests a stable population with considerable annual variation (Johnson 1982). Roadside count data from the Breeding Bird Survey has indicated no trend for this species during the past 23 years (Janssen 1990). However, Sauer and

Droege (1992) reported a slight increase of 0.8 percent based on its occurrence on 821 routes in the U.S. from 1966 to 1988.

Projections for the Broad-winged Hawk indicated that the species may increase under the base harvest scenario in ecoregion 9 on either the timberlands or all forest lands. It was also projected to increase in ecoregion 5 when all forest lands were considered. Under the medium harvest scenario, the species was projected to decrease in ecoregion 4 when timberlands or when all forest lands were considered. In contrast, projected increases for the species were possible again in ecoregion 9 on either timberlands or all forest lands.

Under the high harvest scenario, the species was projected to increase in ecoregion 9 but only in all forest lands. However, the species was projected to decrease in ecoregions 1, 2, 3, 4, and statewide when timberlands were included. The pattern was the same for all forest lands, except no decrease was projected for ecoregion 2. As has been shown for species associated with mature forests, this species follows a similar pattern. Under the base harvest scenario, few changes are projected, but as more mature forests are harvested in the medium and, especially, in the high harvest scenario decreases in available habitat are projected.

Red-tailed Hawk (*Buteo jamaicensis*)
The Red-tailed Hawk is one of the most numerous breeding raptors in Minnesota (Johnson 1982), possibly exceeded in numbers only by the American Kestrel and Broad-winged Hawk. The Red-tailed Hawk is a common summer resident in fragmented forest areas and woodlots surrounding agricultural areas throughout the state (Green 1991, Kingsley and Nicholls 1991). However, the species is a rare breeder in contiguous boreal forests of the northeast and north central Minnesota (Janssen 1987).

The Red-tailed Hawk has a very wide breeding distribution across a substantial portion of North America. It is found breeding in areas from west central Alaska, across Canada to Nova Scotia and south throughout the U.S. to Central America. The wintering grounds include areas from southern Canada throughout the remainder of the breeding range (DeGraaf et al. 1991). In Minnesota, the species is most commonly found in woodlands associated with agricultural settings and, hence, is more abundant in the nonforested regions. However, it is commonly found in forested areas, where relatively large openings (e.g., >40 acres) have been created by forest fires or logging activities.

The Red-tailed Hawk undergoes a large movement from northern reaches of the state during its fall migration, but commonly overwinters in the southeastern and south-central portions of Minnesota (Janssen 1987). Orians and Kuhlman (1956) reported the recovery of two hatch-year Red-tailed

Hawks in Florida and Texas, following summer banding in Wisconsin. Fall migration movements from as far south as Panama have been noted (Ehrlich et al. 1988).

The Red-tailed Hawk is primarily found nesting in woodlots associated with open prairies and agricultural lands (Roberts 1932, Palmer 1988). In the forested zones of Minnesota, the species nests in a variety of woodland types, including both deciduous and coniferous forests and will forage in adjacent open habitats such as those created following logging or forest fire (Niemi and Pfannmuller 1979). In the eastern United States, the species has become highly adaptable in its selection of breeding habitat (Brewer et al. 1991).

The species regularly nests in solitary trees along forest edges, or in clumps of trees near openings and edges (Palmer 1988). The Red-tailed Hawk will invariably nest in the highest crotches of the tallest trees. Red-tailed Hawks and Great-horned Owls (*Bubo virginianus*) are often found in similar nesting habitats (Peterson 1979, Dunstan and Harrell 1973, Bednarz and Dinsmore 1982). Competition between these species for nest sites can be intense (Palmer 1988).

The Red-tailed Hawk is considered an opportunistic hunter (Fitch et al. 1946), preying on everything from insects to wounded pheasants (Errington and Breckenridge 1938). Orians and Kuhlman (1956) examined prey contents from 87 Red-tailed Hawk nests in Wisconsin and found the remains of 46 Ring-necked Pheasants (*Phasianus colchicus*), 26 Cottontails (*Sylvilagus floridanus*), 20 chickens, 9 American Crows (*Corvus brachyrhynchos*), and many small rodents. Palmer (1988) suggests that the species is primarily a carnivore on mammal species with birds comprising much of the remainder.

Because of its dietary and breeding adaptability, the Red-tailed Hawk will likely continue to be a common breeding resident of the state. The species appears to have a high tolerance for fragmentation of habitat, primarily because of its use of large open areas for hunting and the need for relatively few trees for nesting habitat. The species, however, needs to have suitably large trees in these areas to properly support its nest.

No projected decreases were noted for this species for any of the three harvest scenarios. The species was projected to increase in ecoregions 3, 7, and 9 under both the base and medium harvest scenarios and on timberlands and all forest lands. Under the high harvest scenario, the species was projected to increase in ecoregions 3 and 7 on both timberlands and all forest lands. Because of the preference of this species to forage in relatively large, open areas created by logging activities, it was projected to increase in several ecoregions of the state. The analysis, however, did not consider the juxtaposition of suitable nesting areas with larger trees adjacent to appropriate foraging areas.

American Kestrel (*Falco sparverius*)
This species is the smallest member of the Falconidae in North America and is considered the most common breeding raptor in Minnesota (Johnson 1982). The species regularly breeds throughout the state but is least numerous in heavily forested regions of northeastern Minnesota (Janssen 1987). The American Kestrel is a common spring and fall migrant in Minnesota. The species, particularly males, are known as common winter residents in southern Minnesota, but banding returns from as far south as Panama have been recorded (Ehrlich et al. 1988).

The American Kestrel has a wide breeding distribution from east central Alaska across the treeline in Canada to Nova Scotia and south throughout the continental United States to Panama. The winter distribution is similar, but most of Canada, the northern portions of the U.S., especially Minnesota, the Dakotas, and Montana are excluded (DeGraaf et al. 1991).

The American Kestrel prefers open and partly open country with scattered trees, cultivated lands, some urban areas, and recently logged areas (Niemi and Hanowski 1984, Smith et al. 1972, Kingsley and Nicholls 1991). Hence, in Minnesota the species is most abundant in open farmland and agricultural areas but is commonly found in recently burned areas and areas that have been recently logged (Niemi 1978, Niemi and Hanowski 1984). American Kestrels prefer natural cavities or old woodpecker holes (Scott et al. 1977). Active management for the species includes the incorporation of nest boxes. In their 5 year study in central Wisconsin, Hamerstrom et al. (1973) found that a series of nest boxes produced a total of 204 young, while naturally occurring cavities produced only 5 young. Johnson (1982) suggests that suitable nesting cavities may be a limiting factor for the American Kestrel population in Minnesota.

Food items of American Kestrel appear to be dependent on the timing of nesting and nest location. Craig and Trost (1979) found a wide variation in prey composition at nest sites in two consecutive years, with mammalian contents ranging from 15.7 to 44.9 percent, and avian items ranging from 53.4 to 67.8 percent. Although the species is believed to consume a large number of small mammals, its reliance on insects is well documented (Bent 1938). The American Kestrel also commonly caches prey items (Tordoff 1955).

Because of its association with open tracts of land, especially in agricultural areas, the species was not classified as a forest raptor, but was classified as dependent on cavities. The American Kestrel is relatively common in recently clearcut areas, as long as some trees with suitable nest sites are available. The presence of perch trees and adequate nesting trees with cavities greatly enhances the species population.

The American Kestrel was projected to increase in ecoregions 1, 2, 3, 4, 5, 6, and 7 and statewide under the base harvest scenario using either timberlands or all forest lands. Under the medium harvest scenario, the species also was projected to increase in all ecoregions and projected to increase statewide using timberlands. When all forest lands were considered, the species was projected to increase in the same six ecoregions identified under the base harvest scenario and statewide. Under the high harvest scenario, the species was projected to increase in all ecoregions and statewide using either timberlands or all forest lands.

These projections are based on the assumption that perch trees and suitable trees with nest cavities are available either within logged areas or adjacent to these areas. Forest management activities must include these components or these projections will not be reliable. In completely clearcut areas, these birds are rare because of the lack of suitable trees.

Merlin (*Falco columbaris*)
The Merlin is one of many raptors that was adversely affected by organochlorine compounds used in the 1950s and 1960s. Because of the status of declining populations the species has been listed as a species of local concern on the Audubon Society's Blue List from 1972-81 (Tate 1981). During the past 10 years the species has been steadily increasing in numbers and has recently begun to use forested urban habitats.

The species is holarctic and breeds across the boreal zones of North America, Northern Europe, and Northern Asia (Hickey 1942). The species is a short to long distance migrant, primarily over-wintering in the southern United States, Mexico, and Central America (Bent 1938). During the last 10 years it has been increasingly found over-wintering in Minnesota (Janssen 1987). The species is a relatively rare bird of the forested zones in Minnesota, formerly most common in the extreme northern portions of the state (Green and Niemi 1979).

The Merlin generally arrives in early March along with many of the first passerine migrants and leaves the state during the fall migration period from mid-August to early November.

The Merlin nests in the canopy of large trees, often in association with older nests of other birds (Cadman et al. 1987). It feeds on small vertebrates, primarily small birds (DeGraaf et al. 1991).

The species uses a variety of mature forested habitats for nesting primarily dominated by coniferous tree species. Intermixed with these mature forest habitats must be areas suitable for foraging such as lakeshores and recently logged areas. Its recent use of urban habitats suggests that habitat is less important than food supply.

In general, habitat does not seem to be a major determinant or limitation for this species in the state. Concentrations of organochlorine compounds in food supplies is likely still a cause for some concern in this species. Because of the historical distribution of this species in Minnesota's forests, it was classified as a forest raptor that requires mature, coniferous forests for nesting.

No changes were projected for this species under the base harvest scenario. Under the medium harvest scenario, the species was projected to decrease in ecoregions 3 and 4 on timberlands, but only in ecoregion 4 when all forest lands were included. In the high harvest scenario, the species was also projected to decrease, but here in ecoregions 1, 2, 3, and 4 and statewide on timberlands. When all forest lands were included, the projected decreases were limited to ecoregions 3 and 4, but a statewide decrease was projected. As with many other species associated with mature coniferous forests, the reduction in older age classes of conifers in the northern regions of the state resulted in decreased available habitat for this species. However, in contrast to other species in mature coniferous forests, this species may not be as affected because of its potential ability to use other habitat types including urban settings.

Mourning Dove (*Zenaida macroura*)

The Mourning Dove is the most abundant dove in North America (Ehrlich et al. 1988). Its range extends from southeastern Alaska and southern Canada south to Panama (Peterson 1980). It breeds throughout Minnesota, except in the boreal forest regions. Mourning Doves are most abundant in the southern and western regions of the state where they frequent woodlots, fencerows, and windbreaks. Pairs of Mourning Doves perched side by side on roadside utility wires are a familiar sight and large flocks are common in the late summer and fall. This species is a short distance migrant. Most individuals leave the northern parts of the state by mid-November, but a few stragglers remain into late December (Janssen 1987). The Mourning Dove is a permanent resident in the southern half of Minnesota, and throughout much of its range in the eastern and southern United States (Peterson 1980).

This species places its flimsy nest in the fork of a horizontal tree branch usually 10 to 25 feet high (Harrison 1975). It lays two or three eggs, and may raise up to six broods of young in a breeding season (Ehrlich et al. 1988). As many as four broods may be produced even in the northern portions of the breeding range (Harrison 1975). The young are fed on crop milk for the first three days. Seeds are added to the diet and by 6 to 8 days they are being fed entirely on seeds. More than 99 percent of the adult birds' diet consists of seeds and waste grains (Ehrlich et al. 1988).

Mourning Doves are commonly found in agricultural areas, suburbs, towns and cities, as well as in open woodlands, orchards, and grasslands with scattered trees (Harrison 1975, Ehrlich et al. 1988). This species is not dependent on contiguous forest and usually avoids dense forest (Harrison 1975, Galli et al. 1976, Brewer et al. 1991, Green 1991). Robbins et al. (1989) found a significant negative correlation between the occurrence of Mourning Doves and percent forested area within 2 km. Whitcomb et al. (1977) found Mourning Doves in disturbed forest tracts where the canopy had been opened by logging, but not in unlogged tracts. Breeding Bird Atlas Habitat Survey data for Michigan showed that 58 percent of Mourning Dove observations were in residence-roadside-fencerow habitat (Brewer et al. 1991).

Data collected in the USFWS Breeding Bird Survey indicate significant increases in the eastern and central regions, and for the continent as a whole. The greatest increases were recorded in Canada, the northeast and the northern plains states, suggesting that the breeding range may be expanding northward (Robbins et al. 1986). In Minnesota, however, a decline in numbers has been noted in recent years (Janssen 1987).

Increased levels of timber harvesting will likely be beneficial to this species, especially in areas near agricultural, fragmented landscapes. Increase in suitable habitat was projected on timberlands and all forest lands in ecoregions 1, 4, 5, 6, 7 and statewide for all harvest levels and in ecoregion 9 under the high harvest scenario.

Black-billed Cuckoo (*Coccyzus erythropthalmus*)
The Black-billed Cuckoo is a summer resident throughout the forested regions of Minnesota, becoming relatively common in the northern portions in association with outbreaks of tent caterpillars (Roberts 1932, Janssen 1987). The overall breeding distribution of the species is primarily woodlands, especially along streams and waterways from southeastern Alberta, across the southern borders of Canada to Newfoundland, south to northern Alabama and Georgia, and west to northern Texas (National Geographic Society 1983). The species overwinters in South America (Bent 1940). The species arrives in Minnesota in early May, and spring migration lasts through early June, with the bulk of migration during the latter part of May. The species leaves the state generally in August, with fall migration occurring through early October (Janssen 1987).

The Black-billed Cuckoo occurs in a wide variety of forested habitats, especially those associated with water edges including willow and alder; however, it also occurs in brushy pastures, along hedgerows and open woodlands, and along wooded roadside areas (Bent 1940, DeGraaf et al. 1991). The species generally nests in a shrub or low tree in well-concealed vegetation, typically 4 to 6 feet above ground (DeGraaf et al. 1991) and will occasionally lay its eggs in nests of other birds. Clutch size is generally 2 to 4 eggs, with the average being 3. In Minnesota the Black-billed Cuckoo primarily feeds on caterpillars, especially tent caterpillars (Spencer 1943). However, the species will also eat a variety of other insects, spiders, mollusks, and wild fruits or berries.

The Black-billed Cuckoo is most abundant in ecoregions 1 and 4, although the population is highly variable due to its close association with tent caterpillar outbreaks. In general, the species has shown a highly significant decrease in population from the period 1978 to 1988 (Sauer and Droege 1992) in the United States based on 944 Breeding Bird Survey roadside counts. No significant trend has been noted in Minnesota over the period from 1966 to 1989 (Janssen 1990). Factors associated with the decline on a nationwide basis are unknown.

In general, it is unlikely that current timber harvesting will have a negative effect on this species, since it occurs in a wide variety of forested habitats, especially brushy edges. However, control programs for the tent caterpillar would likely be detrimental to this species since it is highly associated with outbreaks of these caterpillars.

The Black-billed Cuckoo was projected to increase in ecoregions 2, 3, 5, and 7 under the base harvest scenario when both timberlands and all forest lands were considered. The results were similar under the medium harvest scenario, except when all timberlands were considered, the species also was projected to increase in ecoregion 9. However, when all forest lands were included, projected increases only occurred in ecoregions 2, 3, 5, and 7 and not in ecoregion 9. Under the high harvest scenario, the species was projected to increase in ecoregions 2, 3, 5, 7, and 9 using both timberlands and all forest lands. Even though the species was projected to increase in a variety of ecoregions, no statewide increase was projected. This was primarily due to the high proportion of the available habitat for this species being in ecoregion 4 where the species was projected to remain relatively stable.

Yellow-billed Cuckoo (*Coccyzus americanus*)
In contrast with the Black-billed Cuckoo, this species is primarily found in the southeastern portion of the state and is uncommon in the northeastern and north central regions. All of the known nesting records for the species are from the southern half of the state; however, breeding evidence has been reported from Clearwater, Wadena, and Pine Counties (Green and Janssen 1975).

The breeding distribution of the species is primarily from northern South Dakota, southern Minnesota, throughout eastern North America from Maine to Florida, and west to southeastern California and eastern Nevada (Bent 1940, DeGraaf et al. 1991). The species overwinters in South America (Rappole et al. 1983). The species arrives in Minnesota in early May and generally leaves the state in August and September (Janssen 1987).

General habitat where the species is found is open woodlands associated with willow and alder thickets, secondary growth woodlands, deserted farmlands overgrown with shrubs and brush, and brushy orchards (Roberts 1932, Preble 1957, Brewer et al. 1991, DeGraaf et al. 1991). The species nests in thick cover of vines, small shrubbery, or low in the trees, generally 1 to 3 meters above ground. Three to four eggs are laid, and it rarely lays its eggs in the nests of other birds. The species is highly insectivorous during the breeding season in Minnesota, in which its diet consists mainly of caterpillars, especially tent caterpillars. However, it has also been known to take a variety of other insects, spiders, fruits, and occasionally frogs and small lizards (DeGraaf et al. 1991). Because the species is primarily found associated with hardwood species, it was classified as a hardwood dependent species.

The species has a relatively small breeding population in Minnesota, primarily found in ecoregions 4, 5, 6, and 7. Because of the association between this species and tent caterpillars, the population is highly variable. However, any control programs for tent caterpillars within the state would likely be detrimental to this species.

The species has been identified as a species of concern because of its relatively large population decline of about 6 percent per year from 1978 to 1988 based on over 1200 breeding bird census roadside counts (Sauer and Droege 1992). In Minnesota, the species population has remained relatively stable over the past 23 years (Janssen 1990).

Because of the species' primary association with sapling age class forests and edge type habitats, the species was primarily projected to increase in the state forests under each of the three timber harvest scenarios. In the base harvest scenario, the species was projected to increase in ecoregions 4, 5, and 7 and statewide on timberlands and on all forest lands. Under the medium and high harvest scenarios, the species was projected to increase in ecoregions 4, 5, 7, and 9 and statewide on timberlands and in ecoregions 4, 5, and 7 and statewide in all forest lands.

Eastern Screech Owl (*Otus asio*)
The Screech Owl is a relatively uncommon species and permanent resident of the southeastern and central forests of Minnesota (Janssen 1987). Its overall breeding distribution is relatively broad from northern North Dakota

to northern New York and southern Ontario through Florida into eastern Mexico (DeGraaf et al. 1991). In Minnesota the species is most common in the floodplain forests along the Mississippi and Minnesota Rivers (Janssen 1987).

The breeding habitat for the Screech Owl consists of oak and riparian woodlands, orchards, shade trees in towns and cities, and small woodlots, especially in areas interspersed with grassy open spaces for hunting (Bent 1938, Kingsley and Nicholls 1991). The species apparently tends to avoid large contiguous forests and areas with too many conifers (Brewer et al. 1991). It is, however, also negatively affected by too much urbanization and by many modern agricultural practices. In these situations if few shade trees are available and inadequate food supplies present, the species will have difficulty finding enough shelter, nest sites, or food (Brewer et al. 1991).

The species nests in natural cavities such as in old woodpecker holes created by the Northern Flicker and Pileated Woodpecker, generally a minimum dbh of 12 inches (Scott et al. 1977, DeGraaf et al. 1991). Cavities are generally 3 to 5 inches in diameter and 5 to 50 feet above the ground. Cavities are often used year after year (DeGraaf et al. 1991). The species primarily forages in woodland areas and open habitats where it feeds on a variety of food sources including small mammals, primarily meadow voles, and also eats insects, amphibians, reptiles, and small birds (van Camp and Henny 1975).

In general the population trend of Screech Owls has been relatively stable, and the species has adapted well to human presence and activities (Clark et al. 1987). Limiting factors for the species will likely continue to be habitat, climate, predation, and human-caused mortalities such as use of rodenticides. The species tends to do best in areas of mature forest habitat with suitable nesting sites adjacent to open areas for hunting. As the forests mature and openings are not available, the Barred Owl and Great-horned Owl tend to benefit, both of which are predators of the Screech Owl. An additional major predator is the raccoon (Smith et al. 1987). In Minnesota the concerns for the Screech Owl coincide with those for the birds found in the southeastern forests. The availability of suitable nesting cavities and available prey in openings are essential requirements for the Screech Owl in Minnesota.

This forest raptor species was classified as dependent on mature, hardwood forests and is a cavity dependent species.

Under the base harvest scenario, this species was projected to decrease in ecoregion 4, but increase in ecoregion 7 when timberland was considered. Results were the same when all forest land was considered, but an additional increase was projected for ecoregion 5. Under the medium and high harvest scenarios, the species was projected to increase in ecoregion 7 and decrease in ecoregion 4 on both timberlands and all forest lands. The differential effects of harvesting of mature, hardwood forests in the southern part of ecoregion 4 and in ecoregion 7 are the reasons for the projected differences.

Great Horned Owl (*Bubo virginianus*)
The Great Horned Owl is presently the most numerous breeding owl in the State (Roberts 1932, Janssen 1987). The species has a wide continental range and occurs throughout North America (Peterson 1980). It is a permanent resident in the state, being most common in southern counties and uncommon in the more heavily forested regions of the northeast (Janssen 1990).

Great Horned Owls occupy a wide variety of forested habitats including open coniferous, deciduous, mixed forests, and large city parks (Harrison 1975). Larger woodlots are preferred breeding habitat in Michigan, but availability of suitable nest sites probably most influences choice of nesting in an area (Craighead and Craighead 1956). Coniferous and deciduous trees that retain their leaves such as oaks are preferred winter roost sites (Craighead and Craighead 1956). The species regularly uses the same roost sites (Fuller 1979). The species was classified as a forest raptor and dependent on mature forests.

The Great Horned Owl nests in trees, caves, or occasionally on the ground (Harrison 1975). Nests in eastern deciduous forests were located primarily in oaks and were either old or recently unused hawk, crow, or squirrel nests (Bosakowski et al. 1989). In Labrador, Great Horned Owls also use osprey nests (Wetmore and Gillespie 1976). It has been called "the tiger of the air" because it often attacks researchers or other observers that approach its nest (Roberts 1932).

The species feeds primarily on small- to medium-sized mammals, and its reproductive success has been linked to population cycles of mammals. In Saskatchewan, Great Horned Owl reproductive success was cyclical and followed closely the number of snowshoe hares (Houston 1987). In peak snowshoe hare years, almost all owls nest and reproductive output averages 2.5 young per successful nest. In contrast, when prey abundance is low, fewer individual owls attempt to nest and reproductive success is much lower (Houston 1987).

The species has declined slightly over the past 20 years on USFWS Breeding Bird Survey routes (Janssen 1990). However, roadside counts are likely poor estimates of population abundance for nocturnal species like the Great Horned Owl. Because this bird hunts from elevated perches along edges and open areas (Fuller 1979), it effectively uses small, scattered woodlots

(Brewer et al. 1991). The species is also likely tolerant of some selective cutting in areas of mature forests.

The Great Horned Owl was projected to increase in ecoregion 7 in all harvest scenarios and on both timberland and all forest land. Increases were also projected for ecoregion 9 for all harvest scenarios and both models except the high scenario for timberlands. An increase was also predicted for ecoregion 5 in the base harvest when all forest land was considered. Increases in the southern portion of the state may be attributed to the overall increase in size of forest area used in the mitigated runs. For instance, the size of the forest area available in the southern ecoregions was increased by 25 percent over the 50-year projection period.

No projected decreases were observed in the base harvest scenario for this species. The species was projected to decline in ecoregions 3 and 4 on timberlands in the medium harvest scenario. Declines were projected for ecoregion 4 under the medium harvest scenario when all forest land was considered. The species was projected to decline in ecoregions 1, 2, 3, and 4 in the high harvest scenario on timberlands, but not in ecoregion 2 when all forest land was considered. Declines in the northern portion of the state are likely due to the decreased availability of mature forests.

Barred Owl (*Strix varia*)
This species has a broad breeding distribution across North America. It occurs throughout the southern boreal forests and Canada to northwestern British Columbia to eastern Washington and Oregon and throughout the forested zone of eastern North America (National Geographic Society 1983). The northern limits of the breeding range include the southern boreal forests of Ontario and Quebec, while the southern limits include southern Florida, southern Texas, and northern Mexico. The wintering distribution coincides with the breeding distribution; however, the northernmost populations are partially migratory (DeGraaf et al. 1991, Godfrey 1966). In Minnesota the species occurs throughout the forested regions of the state and is uncommon in the prairie regions (Janssen 1987).

The species occurs in a wide variety of forested habitats in Minnesota ranging from deciduous to coniferous forests, especially mixed deciduous-coniferous forests and those found bordering lakes, streams, or wetlands (Nicholls and Warner 1972, Bushman and Therres 1988, Kingsley and Nicholls 1991). Important habitat needs include large cavity trees for nesting, in association with suitable open areas, clearings, wetlands, or woodlands. The most suitable areas also have relatively low shrub densities for feeding (Scott et al. 1977, Bushman and Therres 1988). The nest is generally placed in a large cavity of a large tree at least 25 feet above the ground within the forest interior (DeGraaf et al. 1991, Nicholls and Warner 1972, Dunstan and Sample 1972) and, hence, is defined as a cavity dependent species. The species may also use an abandoned hawk, crow, or squirrel nest if cavities are scarce (DeGraaf et al. 1991).

The degree of area sensitivity of this species is unclear. Temple et al. (1979) reported that the home range of the species was 213 to 912 acres. The species has also been known to use isolated woodlots when large, mature trees are available (DeGraaf et al. 1991), but Whitcomb et al. (1981) suggests small woodlots are part of a larger contiguous forest. Moreover, Bushman and Therres (1988) comment that the more aggressive Great-horned Owl may outcompete the Barred Owl in small woodlots. The Barred Owl was included as a forest interior species based on its potential area sensitivity in the eastern United States (e.g., Robbins et al. 1989) and its relatively large home range. The use and reproductive success of the species in Minnesota in forests of different size needs further study. Hence, its sensitivity to fragmentation is largely unknown due to the lack of systematic sampling efforts in the forested portions of Minnesota.

The Barred Owl is classified as associated with mature, hardwood forests because of its need for large trees with suitable cavities and the fauna associated with these types of forests which supply food. In Minnesota, the species is most prominent in hardwood forests, but extensive survey data in different forest types are lacking.

The species is congeneric with the Northern Spotted Owl (*Strix occidentalis*), which has recently received much attention in the northern U.S. because of its use of old growth forests. It is not well-known how similar the life history of the Barred Owl is with the Northern Spotted Owl, but certainly many characteristics are shared.

The species feeds on a wide variety of foods, especially small mammals, birds, frogs, salamanders, lizards, snakes, and even large insects (DeGraaf et al. 1991).

The greatest threat to the populations of Barred Owls in the state with respect to timber harvesting and forest management are (1) forest fragmentation, and (2) the loss of large cavity trees for nesting. The species uses mature woodlands associated with a mosaic of wetland and open habitats. However, relatively large areas of forest tracts are necessary to maintain because the species prefers to nest within the forest interior. Here it is more likely to avoid predation from a variety of species such as the raccoon and Great-horned Owl.

Under the base and medium harvest scenarios, the Barred Owl was projected to decrease in ecoregion 6 on timberlands. In contrast, when all forest lands were considered under the base harvest scenario, the species was projected to increase in ecoregion 2, but no decreases in any ecoregions were noted.

Under the medium harvest scenario, the same increases were noted as for the base harvest scenario, but the species was projected to decrease in ecoregion 6 with all forest lands included.

With the high harvest scenario, the Barred Owl was projected to decrease in ecoregions 1, 2, 3, 4, 5, and 6 and statewide under this scenario for timberlands. When all forest lands were considered, all ecoregions showed the same pattern, except no decrease was noted in ecoregion 2, and there was still a statewide decrease.

The preference of this species for mature, hardwood forests is likely associated with the species' projected decreases in several ecoregions under the high harvest scenario. Its possible sensitivity to size of the forest area would further complicate this potential decrease.

Great Gray Owl (*Strix nebulosa*)
The Great Gray Owl is one of the largest owls that is found in Minnesota's northern forests. In size it appears to be larger than the Great Horned Owl, but in weight is smaller (Speirs 1985). It is a permanent resident in the northern portions of Minnesota (ecoregions 1, 2, 3, and 4) and is a short distance, winter visitant to southerly portions of Minnesota. Nero (pers. comm.) has estimated that there are probably 200 pairs of Great Gray Owls found in Minnesota year around. It characteristically has erratic, irruptive movements throughout most of its winter range (Godfrey 1967) (e.g., 122 individuals were observed in March of 1984 (Janssen 1987).

The species has a holarctic distribution and occurs in suitable habitat from Ontario to Alaska, south in the Rockies to northern California and northern Wyoming, across much of the northern Soviet Union, and northern Europe (Bent 1940, Nero 1980, Clark et al. 1987).

The species was first observed nesting in Minnesota in 1935 in Roseau County and since that time has been observed nesting in many of the forested counties in ecoregions 1, 2, and 4 (Janssen 1987). It is likely a permanent resident, albeit rare nesting bird, throughout the Minnesota counties that have extensive coniferous vegetation such as black spruce and tamarack peatlands, extensive upland coniferous forests, and black ash wetlands. The species generally selects an abandoned crow, raven, or raptor nest for breeding, and often can be found nesting in upland hardwood sites where these abandoned nests are more common (MNDNR Guidelines 1985). It also will readily accept nest platforms (Nero 1980).

The primary breeding habitat of the species is coniferous lowland black spruce and tamarack peatlands, black ash wetlands, and coniferous uplands. Minimum habitat requirements are not well understood, but the availability of suitable nesting sites, many hunting perches (30/ac or more), the availability of abundant prey (e.g., primarily voles and lemmings), and coniferous vegetation appear to be important (Nero et al. 1987). The species has likely always been a relatively rare nesting bird in Minnesota and at least partially dependent on the vagaries of meadow vole and lemming populations (Nero et al. 1987). It is likely, however, much rarer today than in presettlement times due to the reduction in coniferous vegetation of the state and an increase of illegal killing. As with many northern boreal species, it is a relatively tame and unwary owl.

This forest raptor was classified as requiring mature, coniferous forests in Minnesota.

Population trends for the species are impossible to detect because of the lack of a suitable monitoring program for this species. Winter invasions of the species (e.g., in 1991-92) suggest highs in the population cycle; however, the causes and source populations for these invasions is unclear. The increased number of bird watchers and their increased communication levels in identifying and reporting rare birds can partly explain the increased numbers observed during invasion years.

The Great Gray Owl was projected to have decreased available habitat in ecoregions 3 and 4 under the base and medium harvest scenarios on timberlands, but only decrease in ecoregion 3 when all forest land was considered. This species was also projected to increase in ecoregion 1 under the base harvest scenario on all forest lands. Under the high harvest scenario the species was projected to decrease in ecoregions 2, 3, and 4 and statewide on timberlands; however, on all forest lands projected decreases were limited to ecoregions 3 and 4. No statewide decrease was projected with all forest lands included, primarily because of the acreage in the BWCAW. The reduction in certain mature coniferous forest habitat in the northern Minnesota ecoregions projected under each of the harvest scenarios explain the decreases predicted for this species.

Long-eared Owl (*Asio otus*)

This species is a regular breeding species throughout the forested areas of east central, central, north central, and northwestern regions of Minnesota (Janssen 1987). The species also is presumed to breed in southeastern and northeastern Minnesota, the latter based on records from the Duluth area. The species is a highly secretive species and little is known about its specific distribution within the state forests. Although the species is rare in the southern parts of the state during summer, it is a regular winter visitant to these areas, primarily the southeast and east central areas. In the rest of the state it is a winter visitant and possible resident (Janssen 1987).

Long-eared Owls typically arrive in Minnesota in March and April (Janssen 1987) from their wintering grounds in the southern United States and

Mexico. Long-eared Owls begin leaving Minnesota in mid-September, with the migration peaking in late October. Records from banding stations in Duluth indicate regular migrations through the area; however, it is not known whether this is the case for the state in general (Janssen 1987).

Breeding habitat of the species has been described as coniferous and mixed coniferous-deciduous forests, especially near water (Roberts 1932, Brewer et al. 1991). Red and jack pine plantations and windbreaks are important habitats in agricultural landscapes, with the owls usually roosting on the north and west edges of the grove (Voight and Glenn-Lewin 1978). Long-eared Owls commonly nest in tamarack swamps, although they may also be found in deciduous forests, orchards, or woodlots. In general, the specific habitat requirements of this species are not well known. The cryptic postures of this species, its relatively undiagnostic calls, and its nocturnal activity make it a very difficult species to study. Despite many intensive searches in core summering areas in Michigan, Brewer et al. (1991) reported little success. Because of the lack of reliable breeding habitat data, we only classified this species as dependent on mature forests. It tends to have an association toward conifers, but it is unclear the extent to which coniferous vegetation is necessary to the species within forested habitats.

The nest is usually constructed in an abandoned hawk, crow, or squirrel nest, which the female selects (Roberts 1932, Ehrlich et al. 1988). Occasionally nests may be constructed in cavities, on cliffs, or in scrapes on the ground (Roberts 1932, Terres 1987). The nests are sometimes found in loose colonies. As with many raptors, breeding densities of Long-eared Owls presumably reflect the abundance of their prey species (Ehrlich et al. 1988).

Long-eared Owls are more restricted than other owls in their diet; one study found small mammals (chiefly voles, *Microtus* and mice, *Peromyscus*) to comprise over 98 percent of their diet, and are taken in disportionately higher numbers than their populations (Marti 1976, Voight and Glenn-Lewin 1978). When populations of these small mammals become depressed, Long-eared Owls readily switch their diet to other small mammals, as well as amphibians, reptiles, fish, insects, and birds (Marti 1976, Voight and Glenn-Lewin 1978, Craig et al. 1988, Ehrlich et al. 1988). Long-eared Owls exhibit less sexual dimorphism than is seen in other owls, which results in a greater overlap in activity between the sexes (Marti 1976). Males and females share a common core territory around the nest but often forage in different areas away from the nest, increasing hunting efficiency and reducing competition among themselves (Craig et al. 1988). Hunting takes place exclusively at night over open areas. The male hunts for both himself and his mate during incubation, feeding the female at the nest (Ehrlich et al. 1988). As the season progresses, the female begins to hunt farther away from the nest and plays an increasingly important role in feeding the young (Craig et al. 1988).

Direct forest management impacts on Long-eared Owl populations may be caused by reductions in breeding habitat of conifer and mixed boreal forest that may accompany increased timber harvesting. Indirect effects would include factors that contribute to reductions in the species' prey base of small mammals. Populations in the southern parts of the state could be enhanced by the inclusion of dense, evergreen windbreaks and delaying tilling of fall harvested crops until spring to provide cover for their prey (USDA Soil Conservation Service 1983).

In Michigan this species has been designated as a threatened species because it is a scarce and declining species (Brewer et al. 1991). Because of the secretive nature of this species, it presumably occurs in more locations than known, but this is unclear. Brewer et al. (1991) state that this species requires (1) conifer stands or other thick growth (e.g., shrubbery), (2) large open areas for foraging, and (3) high vole populations. Moreover, areas of known nesting and roosting activities should be protected and monitored.

Under the base harvest scenario, the species was projected to increase in ecoregions 5 and 7 on timberlands and increase in ecoregions 5, 7, and 9 on all forest lands. In the medium harvest scenario, the species was projected to increase in ecoregion 7, but decrease in ecoregion 4 on timberlands. When all forest lands were considered, an additional increase was projected for ecoregion 9, but decreases were noted in ecoregions 3 and 4. Under the high harvest scenario, the species was again projected to increase in ecoregion 7, but decrease in ecoregions 1, 2, 3, and 4 and statewide on timberlands. Similarly, on all forest lands, an increase was projected for ecoregion 7, but decreases were limited to ecoregions 3 and 4. A statewide decrease, however, was still projected for the species. Even though the species was projected to increase in some ecoregions, the bulk of habitat available habitat for this species is in ecoregion 4. The changes projected for this ecoregion in mature forests are the reason for the projected overall decrease for this species, especially under the high harvest scenario.

Boreal Owl (*Aegolius funereus*)
The Boreal Owl is holarctic in distribution and associated with the boreal zone of vegetation throughout its range (Bent 1940). In Minnesota, the boreal zone can be considered to extend into the northern quarter of the state and is characterized by conifer lowlands, and conifer/deciduous to deciduous uplands. The Boreal Owl has been suggested as a possible breeder (Roberts 1932), a winter visitant (Green and Janssen 1975), and a rare summer resident (Green and Niemi 1978) in Minnesota.

The Boreal Owl was not identified as a breeding species in the forty-eight contiguous United States until 1978 (Eckert and Savaloja 1979). The migratory, winter movements of the species are well documented (Catling 1972, Eckert 1978, Sonerud 1986). Since the initial nesting in 1978, winter observations of the species in Minnesota have been regular (Eckert 1982, S. Wilson MNDNR pers. comm.), but a positive determination of its residency status in the state is still unclear. It is likely a regular nesting species in the state and has been one for a long period of time. Breeding population levels likely fluctuate widely depending on a variety of factors including weather conditions during the winter and nesting season, especially snow depth during critical survival periods, and population levels during the previous year. Johnsgard (1988) states that the population status of the boreal owl "must remain largely conjectural, owing to the bird's elusive, mostly nocturnal nature and its primary association with relatively inaccessible areas of coniferous forests."

Boreal Owls are secondary cavity nesters, laying 4 to 6 eggs in an abandoned woodpecker nest or natural cavity. Eggs are incubated for 27 to 28 days by the female. Young hatch asynchronously and are ready to fledge 28 to 33 days after hatching.

Beginning in 1987, field investigations were undertaken to ascertain the status of the Boreal Owl in northeastern Minnesota (Lane 1988). Nocturnal, auditory surveys were conducted from late February to mid May to determine the distribution of the owl, and beginning in 1990, active monitoring of the species by use of radio-telemetry was initiated. In eastern Lake and Cook Counties of northeastern Minnesota, Lane (1988) reported 31 of 33 cavities used by Boreal Owls were found in aspen, especially those in older forests with a variety of other deciduous and coniferous trees. In addition, 76 of 86 roost sites occurred in lowland black spruce tracts. The species seemed to prefer meadow voles and red-backed voles.

Because of the species' need for large trees, especially mature aspen for nesting cavities, the Boreal Owl is classified as associated with mature forests.

It is currently unclear what factors are associated with limiting this species' population in the state. Maintaining old mature aspen trees in recently logged areas could possibly mitigate potential habitat losses to this species if nest cavities are a limiting factor. Nest boxes have been used heavily by this species in Finland (see Nero et al. 1987).

The Boreal Owl was projected to remain relatively stable under the base harvest scenario when timberlands and all forest lands were considered. Under the medium harvest scenario, the species was projected to decrease in ecoregion 4 on timberlands and in ecoregions 3 and 4 on all forest lands. Under the high harvest scenario, the Boreal Owl was projected to decrease in ecoregions 1, 2, 3, 4, and statewide for timberland, but decreases were eliminated in ecoregions 1 and 2 when all forest lands were included. Reductions in available habitat for this species primarily reflect the increased harvesting of mature forests in the medium harvest scenario and especially in the high harvest scenario.

Northern Saw-whet Owl (*Aegolius acadicus*)
Janssen (1987) considers the Northern Saw-whet Owl a regular winter visitant and summer resident in Minnesota. The species inhabits forested portions of northern, central, and southeastern Minnesota (Green and Janssen 1975). Because of its nocturnal nature, only 22 nesting records of the species have been recorded in the state through 1982 (Johnson 1982). Migratory periods are difficult to define for this species because of the presence of over-wintering birds in most parts of the state.

Overall habitat use by the species is poorly known for Minnesota (Forbes and Warner 1974) and most neighboring states (Brewer et al. 1991). Swengel and Swengel (1987) report that it was found primarily in large forest tracts, including pine plantations. The species had little overlap with Screech Owls which preferred edges and forests with openings. Moreover, roost sites were primarily in coniferous trees including jack pine, white spruce, Norway spruce, and red pine. Brewer et al. (1991) define habitats as moist deciduous or coniferous forests, woodlots, and swamps.

The Saw-whet Owl is dependent on natural or excavated tree cavities (Scott et al. 1977, Holt and Hillis 1987). Cavities are usually associated with those excavated by the larger woodpecker species such as Northern Flicker and Pileated Woodpecker (Brewer et al. 1991). The species is also known to accept nest boxes when they are available (Cannings 1987). In northeastern Minnesota, Bill Lane (pers. obs.) primarily found the species nesting in mature quaking aspen and white pine. Because of the species' need for mature trees for nest sites, it was classified as dependent on mature forests (Swengel and Swengel 1987, Kingsley and Nicholls 1991).

Palmer (1986) suggested that the Northern Saw-whet and Boreal Owl compete for habitat in Colorado. Competition between the two species in the most northern portions of Minnesota is also possible and the availability of nesting cavities may be a cause of interspecific competition between the two species.

The Northern Saw-whet Owl relies on smaller prey items such as deer mice, meadow voles, and shrews (Bondrup-Nielsen 1977, Cannings 1987) for its diet.

At the present time, there are no management guidelines for the Saw-whet Owl in Minnesota. However, there are suggestions that a management plan for Boreal Owls could serve as a management plan for Saw-whet Owls. This is based on the extrapolation that since nesting habitats are similar for both species, other biological parameters should also be the same.

Forestry practices which result in the loss of mature aspen trees with woodpecker-created nest cavities would be detrimental to the species in areas where nest cavities are limited. Additional impacts may be caused by the loss of dense stands of conifer trees near nest sites which provide diurnal roost sites for breeding adults. Providing nest boxes may help mitigate the lack of suitable nest sites.

No projected increases in available habitat were predicted for this species in Minnesota's forests under any of the three harvest scenarios. Under the medium harvest scenario, the species was projected to decrease in ecoregion 3 on both timberlands and all forest lands. Under the high harvest scenario, the species was projected to have decreased available habitat in ecoregions 2, 3, and 4 and statewide on timberlands and decreased habitat in ecoregions 3 and 4 and statewide on all forest lands. The reduction in mature forests, especially in the high harvest scenario, is the primary reason for the projected decreases for this species.

Whip-poor-will (*Caprimulgus vociferus*)
The Whip-poor-will is locally common in the eastern United States north to New England and southern Canada. It is also found in the mountains of the southwestern United States and Mexico (Peterson 1980). In Minnesota the Whip-poor-will is a summer resident throughout the heavily wooded portions of the state except in the northeast where it is very rare and local. It is most abundant in the southeast, along the Mississippi River, and absent in the prairie regions of the southwest and west central regions (Janssen 1987). This species is a short to long distance migrant, wintering from the Gulf states south to Honduras (Ehrlich et al. 1988). The spring migration period extends from early April through late May with peak numbers arriving in early May. In the fall, the birds leave the state from early August through late September (Janssen 1987).

The Whip-poor-will is found in open coniferous and mixed woodlands in the eastern portion of its range, and in montane forests in the southwest. It is uncommon in mature forests, and prefers even-aged successional habitats, from regeneration to pole-sized stands (DeGraaf 1985 in Bushman and Therres 1988, Conner and Adkisson 1975). The Whip-poor-will does not build a nest. Its eggs are laid on the ground, often near the forest edge, and a depression is gradually formed by the female's body during the incubation period (Harrison 1975). This species forages primarily by sight, capturing insects, especially moths, on the wing (Ehrlich et al. 1988).

Loss of habitat and scarcity of the large moths that this species feeds on have prompted concern for its continued well-being. It was added to the Audubon Blue list in 1980-81 and listed again in 1986, as it was reported to be declining in many areas (Tate 1986). Data collected in the USFWS Breeding Bird Survey, however, do not confirm the apparent decline. The only significant reduction in numbers recorded was in the northern portion of the Upper Coastal Plain, and this was offset by increases in the Great Lakes Transition region and in Kentucky (Robbins et al. 1986). Because the Whip-poor-will is a crepuscular and nocturnal species, it is active primarily during dawn and dusk periods. It is not efficiently detected using the roadside count technique. For example, in Minnesota only six of 52 routes were used to analyze whether a trend occurred in Minnesota's population over the past 25 years (Janssen 1990). No trend was detected, but this could be due to its limited distribution in the state and the low sampling efficiency in Minnesota. The status of this species population remains unclear.

Studies conducted in the eastern United States have identified the Whip-poor-will as an area-sensitive forest interior species (Whitcomb et al. 1979, Robbins 1979). According to (Robbins 1979) the Whip-poor-will has disappeared from the Patuxent River Gorge in central Maryland where it previously nested. Although the habitat within the remaining forest has "not changed appreciably," the area of contiguous forest has been reduced from 13,000 acres to about 100 acres during the past 25 years (Robbins 1979). Robbins et al. (1989) found a weak, but significant correlation between the occurrence of this species and the percentage of forested area within 2 km.

No minimum forest area requirements have been defined for the Whip-poor-will because it has been absent from most fragmented woodlands that were studied (Robbins, pers. comm. in Bushman and Therres 1988). Due to this nocturnal nature and its secretiveness, little is known about the species, especially in Minnesota. Bushman and Therres (1988) suggest that fragmentation is probably detrimental, and that large clearcuts may be beneficial as they mature to the pole stage. Hence, this species uses the open arena created by clearcuts, and larger clearcut areas tend to be favorable.

The reduction in clearcutting and creation of early successional forests in the south, will likely result in a decrease in suitable habitat available for the Whip-poor-will. Decreases were projected in ecoregion 7 under all harvest levels. Increases, associated with an increase in early-successional forests however, was projected in ecoregion 5 under all harvest levels. Increases were projected to occur on timberlands and all forest lands. When only timberland was considered, more increases in the high scenario were projected in ecoregion 9.

Chimney Swift (*Chaetura pelagica*)

The Chimney Swift's breeding range extends east of the Rocky Mountains from east central Saskatchewan to New Brunswick, south to eastern New Mexico and the Gulf Coast (DeGraaf et al. 1991). Throughout Minnesota, the species is an abundant summer resident, but is less common in the state's northwest corner (Janssen 1987). The Chimmney Swift is a long-distance night migrant that winters in Peru, northern Chile and northwest Brazil

(Ehrlich et al. 1988). In Minnesota, the species is a migrant that is seldom seen in the spring, but is occasionally encountered as large roosting flocks in the fall (Janssen 1987). The Chimney Swift arrives in Minnesota during mid-April through late May and leaves during mid-August through mid-October (Janssen 1987).

The Chimney Swift's breeding habitat is largely dependent on the availability of suitable nesting sites (DeGraaf et al. 1991). Formerly found in habitats with mature, hollow trees, the species now primarily occurs near towns and farms (DeGraaf et al. 1991, Brewer et al. 1991) where it uses chimneys, air shafts, silos, and other suitable structures for nest sites (Harrison 1975). The Chimney Swift also builds its nest in caves and tree hollows. Clutch size ranges from three to six eggs, commonly four to five (Harrison 1975). The species primarily feeds on flying insects (DeGraaf et al. 1985) but will sometimes glean caterpillar from tree branches or leaves (DeGraaf et al. 1991).

Breeding Bird Survey data from 1965 to 1979 show the Chimney Swift population increased slightly but significantly in the Eastern region and over the continent as a whole (Robbins et al. 1986). Minnesota Breeding Bird Survey data from 1966 to 1990 show the Chimney Swift population to be stable in the state (Janssen 1990).

The species appears to have converted to using urban and farm environments. Hence, most silvicultural practices will be irrelevant and tolerated by this species. Forestry practices, however, that leave mature, decayed trees may be highly beneficial to this species. It currently is relatively rare in most forest environments, but it formerly was highly associated with landscapes with caves and old, dead trees with suitable nest sites.

Suitable habitat for the Chimney Swift was projected to increase in all ecoregions (except 6) and statewide under all three harvest levels. Increases were projected to occur on both all forest and timberlands and were most likely due to the species' cosmopolitan habitat distribution. Decreases in suitable habitat was predicted for the high harvest level in some decades in ecoregion 2, 3 and 4 for timberland in ecoregions 3 and 4 when all forest lands were considered. Decreases in the north where there are fewer urban areas were likely attributable to the loss of mature forests.

Ruby-throated Hummingbird (*Archilochus colubris*)
The Ruby-throated Hummingbird's breeding range extends east of the Rocky Mountains from central Alberta to New Brunswick, south to the Gulf Coast (DeGraaf et al. 1991). The species is a common, summer resident in the northern part of Minnesota, decreasing in numbers southward until it

becomes rare in the south central and southwest regions of the state (Janssen 1987).

The Ruby-throated Hummingbird is a long-distance migrant that winters through north central Mexico to central Costa Rica (Ehrlich et al.1988). In Minnesota the species is a common spring and fall migrant, with the exception of the southwest region, where it is uncommon (Janssen 1987). The species arrives in the state from late April through early June and leaves during early August through early October (Janssen 1987).

The Ruby-throated Hummingbird breeds near water in dense to open deciduous or mixed forests (Brewer et al. 1991), parks, gardens, and orchards (Ehrlich et al. 1988). In Minnesota, Ruby-throated hummmingbirds have been observed in mature aspen (3 pairs/40 acres) (Kelleher 1967), (2 pairs/40 acres) (Kelleher 1967); mature maple-basswood (2 pairs/40 acres) (Kelleher 1967), (1.5 pairs/40 acres) (Blockstein 1991); and mature elm-ash-cottonwood (2 birds/40 acres) (Ponto and Loeffler 1980). In Michigan, the species was primarily observed in roadside-hedgerow habitat types (Brewer et al. 1991). Scott and Crouch (1987) frequently observed hummingbirds in clearcuts in southwestern Colorado.

The Ruby-throated Hummingbird builds its nest 1 to 15 m above the ground in a deciduous or, occasionally, coniferous tree (Harrison 1975). Clutch size is usually two eggs (Harrison 1975). The species is a nectar specialist (DeGraaf et al. 1985) that requires plants that provide tubular nectar-bearing flowers such as honeysuckle (*Lonicera* spp.), gilia (*Gilia* spp.), and trumpet-creeper (*Campsis* spp.) (Bertin 1982, DeGraaf et al. 1991). Their diet also includes insects and tree sap provided by woodpecker drilling (Ehrlich et al. 1988).

Breeding Bird Survey data from 1965 to 1979 show this species population to be stable throughout its range; an increase in Ohio was the only significant change detected (Robbins et al. 1986). Minnesota Breeding Bird Survey data from 1966 to 1989 show a significant annual increase (1.3 percent) for the Ruby-throated Hummingbird in the state (Janssen 1990). However, the species was Blue-listed from 1978 to 1986 because of widespread reports of declines (Tate 1986).

Suitable habitat availability for the Ruby-throated Hummingbird was projected to increase in ecoregions 7 and 9 under the base and medium harvest intensities on timberland. Under the high level, increases were noted for ecoregions 2 and 7. When all forest land was considered, increases were projected for ecoregions 5, 7 and 9 in the base and medium harvest levels and in ecoregions 5 and 7 under the high harvest regime. Increases for this species were likely due to its association with younger forests.

Red-headed Woodpecker (*Melanerpes erythrocephalus*)
The Red-headed Woodpecker is a regular, summer resident in southern, central, and northwestern regions of Minnesota (Janssen 1987). The species is a common spring migrant in the southern part of the state; however, it decreases in abundance in the more northern reaches of its range in Minnesota. Red-headed Woodpeckers arrive in Minnesota from wintering grounds within the United States from late March through the month of May (Janssen 1987). Fall migration for Red-headed Woodpeckers begins in early August and may continue through late October.

The species is a regular winter visitor in wooded portions of southern and central Minnesota, in some areas becoming common (Janssen 1987). Christmas Bird Counts in Iowa from 1951-1975 indicated an increase in the winter populations of the species apparently due to an increased percentage of birds foregoing migration and staying throughout the winter (Koenig 1977). Forest areas dominated by oak, hickory, and maple are preferred habitat in winter and acorns comprise a large portion of the winter diet (Reller 1972, Hardin and Evans 1977). During this time, food is likely the limiting resource, replacing cavities, and interspecific aggression with Red-bellied Woodpeckers intensifies (Reller 1972).

In the south and central portions of the state, Red-headed Woodpeckers primarily nest in open deciduous woodlands; often in close proximity to clearings (Roberts 1932). In the northern regions where forests become more contiguous and coniferous in composition, the species is primarily found in recently disturbed areas such as those created by forest fires (Niemi 1978) and logging activity (Green and Niemi 1978). If they occur in logged areas, the presence of snags is imperative for suitable nesting or feeding habitat. In the Michigan atlas project, the species showed a clear preference for dry to mesic, open woodlands (Brewer et al. 1991). Mature woodlots with high canopies, high basal areas, and open understories have also been described as typical habitats (Connor and Adkinson 1977). Competition with Starlings (*Sturnus vulgaris*) and Red-bellied Woodpeckers (*Melanerpes carolinus*) for nesting cavities is sometimes minimized by delaying nesting until later in the year (Ingold 1989).

Primary nest trees are usually old snags without bark (Brewer et al. 1991). In addition, nest trees are usually placed in a forest opening and with the actual holes excavated in the bole of the tree rather in dead limbs of living trees often used by the Red-bellied Woodpecker (Reller 1972, Short 1982). Red-headed woodpeckers show strong nest-site fidelity, in part due to the longevity of their nesting cavities (Ingold 1991). Evans and Connor (1979) describe the optimal size of nest trees as those 40 to 60 cm in dbh and 9 to 21 m high. They also suggest that 200 suitable snags per 100 acres are necessary to maintain suitable breeding populations, while wintering snag needs may be considerably higher.

The diet of the Red-headed Woodpeckers is varied, including insects, berries, seeds, nuts, and mice; sap "wells" of Yellow-bellied Sapsuckers (*Sphyrapicus varius*) may also be used (Terres 1987). At times of abundance, additional food may be cached into crevices; however, Blue Jays and Starlings often steal these reserves (Ehrlich et al. 1988, Roberts 1932). Also included opportunistically in their diet are bird eggs, nestlings, and occasionally adult birds (Martin 1960). Connor (1974) documented a male Red-headed Woodpecker enlarging a chickadee cavity and removing and eating 4 of the nestlings during a 2 day period.

Red-headed woodpeckers have been listed on the Audubon Society's Blue List from 1972 to 1986 due to a decline in their population. This decline may be due to the loss of habitat. Management programs focusing on the species could reverse this trend (Tate 1986).

Under the base harvest scenario, the species was projected to have increased available habitat in ecoregions 7 and 9, but decrease in ecoregion 4 on timberlands. On all forest lands, the species was only projected to increase in ecoregions 7 and 9, but no decrease was noted. Under the medium harvest scenario, the species was projected to decrease in ecoregions 7 and 9, but decrease in ecoregions 1, 3, and 4 on timberlands. When all forest lands were considered, the results were the same except no projected decreases were noted in ecoregion 1. In the high harvest scenario, the species was projected to increase in ecoregion 7 on both timberlands and all forest lands, while the species was projected to decrease in ecoregions 1 to 4 on timberlands. In all forest lands, the projected decreases were the same, but no decreases were projected in ecoregion 2. In general, the pattern of increases and decreases among the ecoregions is due to the changes in hardwood forest types and different age classes. Each response must be considered in light of the relative changes within each ecoregion.

Red-bellied Woodpecker (*Melanerpes carolinus*)
The Red-bellied Woodpecker is a regular, permanent resident in Minnesota. They are common in southeastern, south central, and central regions of the state (Janssen 1987). This species presence in the state is relatively recent; the first nest in the state was reported in Goodhue County in 1903, although the species was presumed to be breed in the state several years prior to that time (Roberts 1932). The species has continued to expand its range in Minnesota both northward and westward (Janssen 1987). At the present time, the species has been found in the breeding season as far north as Pine, Aitkin, and Crow Wing Counties, and westward to Todd and Otter Tail Counties. There also are spring and fall records of Red-bellied Woodpeckers as far north as Duluth and along the North Shore of Lake Superior (Janssen 1987). Minnesota forms the northward and westward limit of the species range. Their distribution continues east to the Atlantic coast and south throughout the Gulf Coast and Florida panhandle (Peterson 1980).

Red-bellied Woodpeckers are found nesting in deciduous, coniferous, and mixed forests, forested wetlands, and urban areas (Roberts 1932, Evans and Connor 1979). In the breeding bird atlas project in Michigan, Brewer et al. (1991) found the species to be most abundant in mesic to wet deciduous forests and often associated with riparian habitats. McComb and Rumsey (1983) found them to favor forested sites characterized by trees with high basal area which provided suitable nest sites. Based on these data, the species was classified as a cavity-dependent species and dependent on hardwood forests.

Unlike the Red-headed Woodpecker which usually nests in cavities in the boles of dead trees and in the opening of forests, the Red-bellied Woodpecker tends to select nest sites within the forest and in the dead limbs of a live tree or in a relatively "new" snag that retains its bark and branches (Reller 1972, Hardin and Evans 1977, Ingold 1989). Presumably these differences in habitats and snags used reduces interspecific competition between the two species. Dead branches, however, are retained only over a short time which may explain lower site-tenacity in Red-bellied than in Red-headed Woodpeckers (Ingold 1991). In coniferous-dominated areas, recently-dead trees tend to be used for nest cavities (Kilham 1977). Since their breeding phenologies overlap, Red-bellied Woodpeckers also may compete with Starlings (*Sturnus vulgaris*) for nest cavities (Ingold 1989).

Specific nest trees are suggested to be 36 to 53 cm dbh and 9 to 15 m high (Evans and Connor 1979). In addition, they suggest that the number of available snags should be about 270 per 100 acres to maintain populations of this species.

Red-bellied Woodpecker feed on insects, fruits, and nuts; the latter which it may hoard (Martin 1960, Ehrlich et al. 1988). Occasionally the species feeds on the ground. Areas created by Yellow-bellied Sapsucker (*Sphyrapicus varius*) for sap and insects also may be used to supplement their diet (Ehrlich et al. 1988). During winter the species may exhibit irregular wanderings in response to the availability of food. Flocking, often in association with Yellow-bellied Sapsuckers, is sometimes seen (Ehrlich et al. 1988). Competition with Red-headed Woodpeckers which tends to be avoided during the breeding period, becomes more intense during winter when food resources are more limiting. During this time, oak forests is an important winter habitat, where much of the foraging takes place along the branches (Reller 1972).

Based on the Breeding Bird Survey in Minnesota, the species has been increasing by about 2 percent per year between 1966 to 1989 (Janssen 1990).

Under the base and medium harvest scenario, the species was projected to increase in ecoregion 7 on timberlands and all forest land. Under the high harvest scenario, the species was again projected to increase in ecoregion 7, but projected to decrease in the southern portions of ecoregion 4 on both timberland and all forest lands. The reduction in hardwood forests in ecoregion 4 under the high harvest scenario and the increase in hardwood forests projected within ecoregion 7 are the reasons for these projected changes.

Yellow-bellied Sapsucker (*Sphyrapicus varius*)
The Yellow-bellied Sapsucker is a common breeding species across most of Canada, and in the Rocky Mountains of the western United States. In the eastern United States, its range includes the New England states, New York, and Pennsylvania, and extends south in the Appalachians to eastern Tennessee. In the Midwest, it breeds in northern Michigan, northern Wisconsin (Peterson 1980), and throughout the more heavily forested regions of Minnesota (Janssen 1987). It is most common in the northern regions of the state and rare south of the Minnesota River (Janssen 1987). This species is a short to long distance migrant, wintering in the southern United States, Mexico, and south to Central America and the West Indies (Short 1982c). It generally returns to Minnesota from late March through early May, with peak numbers arriving in mid-April. In the fall, it leaves the northern regions of the state by late September, but many stragglers remain in the south into early winter. There are a number of December and early January records from the Twin Cities and southern portions of the state (Janssen 1987).

The diet of this species consists primarily of sap and insects, especially ants. Sapsuckers drill parallel rows of small holes in live trees, and later return to feed on the sap and the insects attracted to it (Short 1982). The primary nesting habitat of the species is upland deciduous forest, but it can be found in a wide variety of woodland and forest types.

The Yellow-bellied Sapsucker is a cavity nester, and the availability of suitable nest trees is among the primary limiting factors for the species. Several studies have shown that aspen is frequently chosen as nest sites in northern hardwood forests (Runde and Capen 1987, Lawrence 1966, Rushmore 1969). In a study conducted in southeastern Vermont, 26 of 38 Sapsucker nests were located in quaking aspen, and 30 of the nests were in live, deciduous trees with fruiting bodies of heartwood decay fungi (*Phellinus tremulae* and *Fomes fomentarius*) (Runde and Capen 1987). The presence of fruiting bodies of fungi indicates advanced heartrot which softens the heartwood and makes excavation easier for the Sapsucker. The sapwood is unaffected by the fungi and remains intact, providing a sturdy, protective exterior for the nest cavity (Kilham 1971).

Diameters of the nest trees used by Sapsuckers in Vermont were larger than adjacent non-nest trees, indicating that the birds were selecting large trees in proportion to their body size (Runde and Capen 1987). This suggests that if only minimum diameter trees are available, Sapsucker populations could suffer as a result of poor nesting success (Conner 1979, Evans and Conner 1979). These data support the classification of this species as a bird of mature, deciduous forests.

Availability of nest sites are often scarce in young forests and in intensively managed forests of all ages (i.e., if dead trees or live trees with heartwood decay are removed). Clearcutting, timber stand improvement, short harvest rotations, and the removal of snags to reduce fire and safety hazards tend to reduce the number of potential nest sites available for Sapsuckers and other cavity-nesting species (Runde and Capen 1987).

Suitable habitat for the Yellow-bellied Sapsucker was projected to increase in the south and to decrease in the north. Increases were projected in ecoregions 7 and 9 under all harvest levels on timberland and all forest land. An increase was also projected for ecoregion 2 when all forest land was considered. Increases in the south were likely due in part to the overall increase in forest area and lack of clearcutting. Decreases in suitable habitat were projected for ecoregion 4 under the medium and high harvest levels on timberland. Additional decreases were projected for timberland under the high harvest scenario in ecoregions 1, 2, and 3 and statewide. Decreases when all forest land was considered were similar to decreases on timberland, except no declines were noted for ecoregion 2 under the high harvest level. Decreases in the north were likely due to the decrease in forest area and loss of mature forests.

Downy Woodpecker (*Picoides pubescens*)
The Downy Woodpecker is a common permanent resident in Minnesota (Roberts 1932, Janssen 1987). It breeds in forested areas in all parts of the state and can be found throughout the state in winter as well. Some migration occurs in winter when individuals from the north move into southern parts of Minnesota (Janssen 1987). Downy woodpeckers are permanent residents throughout most of the forested regions of the United States and Canada (Roberts 1932, National Geographic Society 1983).

Downy Woodpeckers are primary cavity-nesters, preferring to excavate a nest cavity in a live deciduous tree with decaying wood in the core (e.g., heartwood decay from fungus fruiting bodies) or unhealed broken branches (Runde and Capen 1987). Due to these nesting requirements, Downy Woodpeckers are classified as dependent on mature hardwood forests. They are also cavity dependent species.

Nesting habitat includes deciduous and mixed forests, riparian areas, parks, and orchards (Roberts 1932, Ehrlich et al. 1988). In a mature hardwood forest of New Hampshire, (Holmes 1990) observed 17 nests of the Downy

Woodpecker. Most (>77 percent) were found relatively high (8 to 14 m) in the subcanopy. Hardwood forests are preferred in the eastern part of the range and riparian willow forests are favored in the west and south (Short 1982, Holmes 1990). In Minnesota, the species was found in low abundance in a variety of forest types and ages; however, the species was most abundant in mature, hardwood forests (e.g., (Hanowski and Niemi 1991a,b; Gokee et al. n.d.).

Clutch size is usually 4 to 5 eggs which are incubated for 12 days. Fledging occurs after 20 days (Short 1982). Downy Woodpeckers eat mostly invertebrates (75 to 85 percent), but their diet also includes fruit, seeds, and sap and suet from feeders (Short 1982). Foraging techniques include gleaning, probing and tapping. Excavation in search of prey is uncommon, but is utilized more often in winter (Short 1982). Small branch tips and upper branches of trees, reeds, weeds and tree trunks are all commonly used foraging substrates (Short 1982). Males are more often found on taller snags than females but lower on live trees (Short 1982). Females tend to search trunk bark and larger limbs more frequently than males and eat more homopterans; males tend to eat more ants (Williams 1980).

Minnesota populations appear to be increasing slightly, at an average rate of about 2.5 percent per year (Collins et al. 1992). Throughout North America, populations have also increased in the period from 1965 to 1979 (Robbins et al. 1986). This may partly be due to the increase in winter bird feeders and their relatively high use by Downy Woodpeckers. In the Cornell feeder watch program, Downy Woodpeckers visited 88 percent of feeders during the winter of 1991-92.

The reliance of Downy woodpeckers on dying trees makes them particularly sensitive to population declines related to intensive forest management. If management plans do not provide for older deciduous trees with heart rot fungus, which are suitable for nesting, Downy Woodpecker populations will likely decrease. Regenerating, even-aged stands do not provide suitable nesting habitat (Conner et al. 1975). In addition, because Downy Woodpeckers are primary cavity nesters, a decline in their population will likely have an adverse impact on other bird species which use their cavities for nesting (e.g., secondary cavity-nesters).

Evans and Conner (1979) recommend providing 320 to 400 snags per 100 acres in a size range of 15 to 25 cm dbh, and 3 to 9 m high to maintain good populations of Downy Woodpeckers in northeastern United States. The Habitat Suitability Model for the Downy Woodpecker (Schroeder 1983) also recommends maintaining tree basal areas between 10 and 20 m^2/ha for optimal foraging conditions. Buffer strips of uncut trees along streams and roads may provide some suitable nesting habitat (Conner et al. 1975).

Suitable habitat for the Downy Woodpecker was projected to increase in the southern portion of the state under all harvest levels. When all forest land was considered, increases were projected in ecoregion 7 and 9 under all harvest levels. In addition, suitable habitat in ecoregion 5 was projected to increase under the base and medium harvest scenarios. Results were the same on timberland, except an additional increase was projected in ecoregion 6 under the base harvest level. Projected increase in southern Minnesota was likely due to the increase in forest area and lack of clearcutting in this region.

Hairy Woodpecker (*Picoides villosus*)
The Hairy Woodpecker is a common permanent resident in Minnesota, and can be found throughout the state in any season (Roberts 1932, Janssen 1987). Some migration of individuals from the north occurs in northern and central parts of Minnesota in winter (Roberts 1932, Janssen 1987). Hairy Woodpeckers can be found throughout most of the forested portion of the U.S. and Canada, and into Central America (Roberts 1932, Short 1982).

Hairy Woodpeckers are primary cavity-nesters, preferring deciduous trees, either living or dead, with the presence of some decayed wood in the tree core (Conner et al. 1975, Runde and Capen 1987). Quaking aspen, paper birch, and red maple accounted for >75 percent of all nest trees in a study by (Runde and Capen 1987). Trees selected were larger than adjacent non-nest trees, and often had unhealed, broken branches, and fruiting bodies of wood-rotting fungi (Runde and Capen 1987). In a mature hardwood forest in New Hampshire, Holmes (1990) found 22 nests, most (>77 percent) were in the subcanopy at a height of 8 to 14 meters. Based on these data, the Hairy Woodpeckers was classified as associated with mature forests and dependent on hardwood type tree species.

Nesting habitat includes deciduous and mixed forests, wooded swamps, and other wooded areas (Ehrlich et al. 1988). Hairy Woodpeckers were found in a variety of mature forests (lowland conifer, ash, jack and red pine, oak, maple, and aspen in northern Minnesota in 1991, but in most habitats densities were lower than 1 pair/40 acres (Hanowski and Niemi 1991a, 1991b). Highest densities were found in ash in the Chippewa National Forest (about 1 pair/40 acres) and in upland spruce/birch (about 1.5 pairs/40 acres) in the Superior National Forest.

Four eggs are usually laid, incubated for 11 to 15 days and young fledge after 28 to 30 days (Ehrlich et al. 1988). Invertebrates taken from trunks, branches, and foliage make up the majority of the diet (Short 1982), some sap is taken in the summer, and acorns or other nuts are eaten in winter (Ehrlich et al. 1988). Deep excavations into the tree bark may be drilled, however, flaking, prying and probing techniques are frequently used (Short 1982).

Populations of Hairy Woodpeckers appear to be declining in many areas (Ehrlich et al. 1988). In Minnesota, however, Breeding Bird Survey data from 1966 to 1990 show an average increase of about 3 percent per year (Collins et al. 1992), a significant increase.

Hairy Woodpeckers are able to excavate nests in trees that are relatively sound (Runde and Capen 1987). This ability makes them somewhat less sensitive to decreases in the availability of dead and dying trees. However, their preference for large hardwood nest trees makes them potentially sensitive to intensive forest management. Forest management practices which do not provide for larger diameter trees will likely result in declining Hairy Woodpecker populations (Kilham 1968, Conner et al. 1975, Conner 1979, Runde and Capen 1987, Bushman and Therres 1988). Evans and Conner (1979) recommend managing 160 to 200 snags per 40 ha in a size range of 25 to 35 cm dbh, and 6 to 12 m high to maintain good populations of Hairy Woodpeckers in northeastern U.S. Because Hairy Woodpeckers are primary cavity-nesters, any decline in their population may also have an adverse effect on many other bird species which are secondary cavity-nesters.

The Hairy Woodpecker was projected to increase in ecoregions 7 and 9 under all harvest scenarios and on both timberland and all forest lands. Increases will likely occur in ecoregion 5 in the base harvest scenario when all forests are considered and in all harvest scenarios on timberland. Decreases, however, were projected for ecoregion 6 under all harvest levels and on both timberland and all forest lands. In addition, decreases were projected to occur in ecoregion 3 in the medium and high harvest scenarios on both timberland and all forest lands. Decreases projected for this species are attributable to the decreased availability of mature hardwood forests and the associated availability of large hardwood trees. These trees provide substrates for nesting, shelter, and feeding.

Three-toed Woodpecker (*Picoides ridactylus*); formerly Northern Three-toed Woodpecker, and American Three-toed Woodpecker

The Three-toed Woodpecker is a rare, permanent resident of extreme northern parts of Minnesota (Eckert 1983, Janssen 1987), and is more common as a winter visitor to the northeastern and north central regions of the state. Winter records from as far south as Washington County can be found (Janssen 1987). Three-toed Woodpeckers also can be found nesting along the northern border region from New York to Maine in the eastern U.S., conifer forests of the Rocky Mountains in the western U.S., and most of the forested regions of Canada and Alaska (National Geographic Society 1983). The species is also widely distributed throughout the Palearctic region from northern Scandinavia throughout the taiga of the former Soviet Union (Bock and Bock 1974, Flint et al. 1984).

In general, this species is an extremely rare breeding species in the state. Only one nest of the species has been found, that off the Gunflint Trail in Cook County (Janssen 1987). However, the species is likely a regular nesting species, but presumably in very low numbers and in very remote territory of the state.

Preferred habitat of the Three-toed Woodpecker is generally described as older, dense conifer forests (Roberts 1932, Short 1974, Ehrlich et al. 1988, Robbins 1991, Virkkala et al. 1991). The species also is commonly found in areas of disturbance such as those associated with forest fire, wind, disease, and insect outbreaks (Yunick 1985, Eckert 1983, Virkkala et al. 1991). Niemi and Hanowski (1984, 1992), however, did not observe this species in extensive surveys of the Red Lake Peatland from 1979 to 1981. Breeding habitats tend to be upland forests rather than lowland.

In Colorado, Hoover and Wills (1984) estimate a minimum habitat area requirement of 1000 acres to maintain a minimum viable population of 20 individuals. Hence, some sensitivity to forest area size has been demonstrated; however, no data are available on this issue for Minnesota.

Three-toed Woodpeckers feed primarily on wood-boring beetles by peeling off flakes of loose bark to reveal insects, but will occasionally take fruit and sap (Hogstad 1976, Short 1982). Mature and old growth coniferous trees are predominantly utilized for foraging (Hoover and Wills 1984).

This species is a primary cavity nester, excavating a new nest hole each year, usually in a balsam fir or deciduous snag (Roberts 1932, England 1940, Gibbon 1966). Four eggs are usually laid and incubated for 11 days. Young are ready to fledge after 22 to 26 days (Ehrlich et al. 1988). Where food is abundant, loose breeding colonies may be formed (Ehrlich et al. 1988).

Because this species relies on dead or dying trees as a foraging substrate, intensive forest management may have negative effects on Three-toed Woodpecker populations. Disturbance from logging activity is dissimilar from natural disturbance in that logging activities tend to remove the types of trees that have high populations of insects (Virkkala et al. 1991). Management for Three-toed Woodpeckers appears to require large coniferous forest tracts where natural disturbance regimes are promoted.

Suitable habitat for the Three-toed Woodpecker was projected to decrease statewide and in ecoregion 2 under the high harvest level. This decline was only projected to occur on timberland. Decrease in mature conifer forests was likely the reason for the projected decline.

Black-backed Woodpecker (*Picoides arcticus*)
Black-backed Woodpeckers are permanent residents in the northeastern and north-central conifer forests of Minnesota. Their North American distribution extends across the entire boreal forest of Canada to southeastern Alaska and southward into the Rocky Mountains as far as northern California (National Geographic Society 1983). In Minnesota, irruptions have been known to occur in exceptional fall seasons, with birds recorded as far south as the Twin Cities area (Huber 1974) and (Janssen 1987).

Preferred habitats for this species are mature coniferous forests (Green and Niemi 1978). Specific habitat types include tamarack/spruce bogs, mature white cedar (Roberts 1932, Brewer et al. 1991, Robbins 1991), recently burned conifer stands (Niemi 1977, Brewer et al. 1991), and upland spruce, balsam, and pine (Roberts 1932, Niemi pers. obs.). Niemi and Hanowski (1984, 1992) did not find the species very abundant in the black spruce and tamarack forests of the Red Lake peatland during relatively extensive censuses from 1979 to 1981.

The species has been noted for its irregular irruptions which often last several years and are followed by long periods without irruptions (Yunick 1985). The irruptions seem to be due to various disturbances including fire, disease, and insect infestations such as spruce budworm outbreaks. During these events populations of Black-backed Woodpeckers tend to increase because of the increase in wood-boring beetle larvae (see Yunick 1985 and references therein).

Roberts (1932) speculated that this species had declined in Minnesota from population levels at the turn of the century. These declines were likely related with the loss of suitable, mature conifer forest habitat. Moreover, forest management practices which result in fire suppression and control of insect outbreaks and disease have likely reduced preferred nesting and feeding habitats and populations of these species. No data are available to detect a trend in the population since Roberts book on Minnesota birds was published. The Breeding Bird Survey of roadside counts showed no pattern of trend, but the species was only observed on three of 52 routes (Janssen 1990).

In Wisconsin, Black-backed Woodpeckers were abundant winter visitors in the southeast portion in the mid-1800s (Krumlien and Holister 1951). Loss of conifer forests in southeastern Wisconsin likely is associated with the loss of the species from southern Wisconsin and Minnesota (Robbins 1991).

Nesting occurs in a cavity that the bird excavates each season (Mayfield 1958, Gresser 1974, Ehrlich et al. 1988). Nests are usually in conifer trees (Roberts 1932, Kilham 1966, Cottrille 1974). However, much of the breeding biology of this species is not well known (Ehrlich et al. 1988).

The species was classified as conifer-dependent, a species associated with mature forests, and a cavity-dependent species.

The species gleans bark-dwelling invertebrates by removing flakes of bark from dead or dying conifer trees which reveals wood-boring insect larvae that compose most of their diet along with caterpillars, ants, and other insects (Roberts 1932). Evidence of this type of feeding is quite noticeable as the freshly exposed wood tends to be light in color and easily seen.

Suitable habitat for the Black-backed Woodpecker was projected to increase in ecoregion 1 under the base harvest level on both timberland and all forest land. Increase in this region was likely due to the growth of lowland conifer forests under this harvest level. Decreases, however were projected in ecoregions 3 and 4 under the medium, and high harvest scenarios. Decreases were projected for both all forest and timberland. Under the high harvest scenario, additional decreases were projected for ecoregion 2 and statewide on timberland. Due to the large area of reserved forest in ecoregion 2, no decreases were projected for all forest land in this ecoregion or statewide under the high harvest level. Decreases in suitable habitat were probably due to the decline of mature conifer forests in the northern portion of the state.

Northern Flicker (*Colaptes auratus*)
The Northern Flicker is among the most widely distributed nesting species across North America. It has been found nesting in all of the 49 contiguous United States. Its breeding distribution spans virtually all of the forested zones to the limit of trees across North America (Bent 1939, DeGraaf et al. 1991). Its wintering range broadly overlaps its breeding range; however, it is not found during the winter in the northern portions (e.g., across Alaska, Canada, and most of the northern United States such as Minnesota, Michigan, and Maine). Its winter distribution also expands from the Florida Keys to Cuba, a large portion of the Caribbean, across the southern boundary of the United States including Texas, Baja, and south to Nicaragua (Bent 1939).

The species migrates to Minnesota from early March to early May with a peak in late April, and fall migration begins in late August and lasts to early November. During fall migration, flocks in the hundreds are not unusual (Short 1982, Janssen 1987).

The Northern Flicker is typified by many local geographic races and color morphs. Up until the late 1970s, many of these color morphs were thought to be distinct species. The general breeding habitat of the Northern Flicker includes open woodlands, shrub deserts, riparian forest areas, and city parks (Roberts 1932, DeGraaf et al. 1991). In Minnesota the Northern Flicker is found throughout the state wherever there are scattered trees. The species is commonly found in recently cut areas where it forages in patches of exposed ground. It will also nest in these areas or in adjacent woodlands where suitable trees are available (Back 1979, Niemi and Pfannmuller 1979, Niemi and Hanowski 1984).

The species lays 6 to 9 eggs, and incubation lasts 11 to 12 days. The most typical nest site for the species is a relatively large tree in which a cavity is excavated by both sexes anywhere from 1 to 20 m in height (Scott et al. 1977). A variety of tree species are used including aspen, cottonwood, willows, pine, and oak. Evans and Connor (1979) state that the species territory size is approximately 40 acres and optimum dbh of nest trees is 30 to 44 cm and 6 to 12 m high. They further suggest that snag densities of 50 per 100 acres are needed to maintain populations of this species in an area.

The species primarily forages on the ground. DeGraaf et al. (1991) state that its diet consists of 60 percent animal matter, of which 75 percent of this is comprised of ants. The species also consumes a variety of other ground and tree insects including termites and beetles. With the presence of large swarms of insects, the species will also occasionally fly-catch. In winter, the species also uses a variety of fruits and berries.

The Northern Flicker is a relatively widespread species, and it is unlikely that increased timber harvesting and forest management will have negative effects on the species as long as a suitable number of nest trees are available. Populations are likely to be enhanced in clearcut areas where dead trees and other live trees are left standing. The species is relatively tolerant of other species with the exception of the Red-headed Woodpecker and the Starling. The latter often uses the same nest holes excavated by Flickers; however, in northern forested areas the Starling is a currently a rare bird. The species is also a food source to a variety of predators including hawks, owls, eagles, harriers, and falcons (except the American Kestrel) (DeGraaf et al. 1991).

In general, almost all projections indicated increased available habitat for the Northern Flicker. This is primarily due to the increase in recently cut areas, the primary habitat of this species in forested areas, under each of the three harvest scenarios. This was especially the case in the medium and high scenarios. Under the base harvest scenario, the species was projected to increase in ecoregions 5 and 6 on timberlands and in ecoregions 5, 6, and 7 in all forest lands. The only decrease noted was in ecoregion 2 on timberlands and all forest lands. This was primarily due to the increased aging of the forests in the BWCAW. However, if forest fires occur in the BWCAW, then available habitat in ecoregion 2 would increase (e.g., Niemi 1978).

Under the medium harvest scenario, the species was projected to increase in ecoregion 3, 4, 5, and 6 and statewide on timberlands and in ecoregions 3, 4, 5, 6, and 7 on all forest lands. In the high harvest scenario the species was projected to increase in all ecoregions, except 9, and statewide on both timberlands and all forest lands.

Pileated Woodpecker (*Dryocopus pileatus*)
The Pileated Woodpecker is a permanent resident of North America, whose range extends from southern Canada, east of the Rockies to the Gulf States, and in the mountains of the western United States (National Geographic Society 1983). In Minnesota, the species is common in the heavily forested river valleys and lake areas of the eastern and central regions of the state, however, the woodpecker can be observed as far west as the Minnesota River Valley in Lac Qui Parle County (Janssen 1987).

The Pileated Woodpecker primarily inhabits mature, dense canopied hardwood forests, but is also found in mixed and coniferous forests (Bent 1939, Conner et al. 1975, Bushman and Therres 1988, Renken and Wiggers 1989). The species has been extending its range into parks and wooded suburbs, but it is rare in small woodlots or agricultural areas (Robbins 1980). Based on this information, the species was classified as requiring mature hardwood forests.

The Pileated Woodpecker is an omnivorous lower-canopy forager during the nonbreeding season, and an insectivorous bark excavator year round (DeGraaf et al. 1985). The woodpecker's diet consists principally of dormant carpenter ants (*Camponotus* spp.), but some beetles, termites, and caterpillars also are eaten. About 27 percent of the diet is comprised of various fruits, berries and nuts (Short 1982).

The species nests 5 to 24 meters above the ground in cavities of dead trees that are usually between 100 to 180 years old, 12 to 21 meters in height, and found near permanent water (Conner and Adkisson 1977, Evans and Conner 1979). The Pileated Woodpecker uses a minumum of four cavities per year and clutch size ranges from 3 to 5 eggs (Bent 1939). Thus, the species was classified as a cavity dependent.

Breeding Bird Survey data from 1965 to 1979 show that the continental trend of the Pileated Woodpecker population appears to be stable (Robbins et al. 1986). The species appears to be adjusting to suburban expansion where mature woodlands, with connecting wooded corridors, remain (Christy 1939). The woodpecker's population increased in the western portion of the spruce-hardwood forest (Robbins et al. 1986). This trend was reflected in Minnesota Breeding Bird Survey data collected from 1966 to 1989 (Janssen 1990), where a significantly higher number of routes had increasing numbers of Pileated Woodpeckers.

Habitat area appears to be a limitation for the Pileated Woodpecker. Large forest areas and minimal isolation from contiguous forests were the most important habitat characteristic for determining this species presence in Maryland (Lynch and Whigham 1984). Robbins (1980) estimated the minimum area needed to sustain a viable population at 50 ha, and no woodpeckers were observed in woods less than 20 ha. Whitcomb et al. (1981) reported that the woodpecker disappears from forests smaller than 70 ha and has no tolerance to forest fragmentation. Forest management practices that remove dead or decaying trees or logging debris may be detrimental to the Pileated Woodpecker because of the species need for large nesting trees and foraging substrates (Bushman and Therres 1988, Conner et al. 1975). Long timber rotations of up to 150 years or more are necessary to produce adequate snags, and leaving uncut filter strips along streams may provide suitable nest sites for the Pileated Woodpecker.

The Pileated Woodpecker was classified as a forest interior species based primarily on studies completed in the eastern U.S. In Minnesota, there is no direct evidence to support or refute these data. Green (1991) suggests that the species is primarily associated with contiguous deciduous landscapes, but the species is commonly observed near towns and in some agricultural settings.

Projections of suitable habitat availability for the Pileated Woodpecker indicated an increase in ecoregion 9 under all harvest levels on both all forest and timberlands except in the high harvest scenario for timberland. Decreases, however were noted for ecoregion 6 under all harvest scenarios and on both all forest and timberlands. Additional decreases were noted for ecoregion 3 on timberlands in the medium harvest level and in ecoregion 1 when all forest land was considered. In the high harvest scenario, decreases were projected in ecoregions 1, 2, 3, 4, 5, 6 and statewide on timberland. Results were the same on all forest land except no decreases were noted for ecoregion 2. Decreases were likely due to the loss of mature, contiguous forests throughout the state.

Olive-sided Flycatcher (*Nuttallovnis borealis*)
This species is widely distributed across the boreal zone throughout the forest zone of Canada, extending into the Appalachian Mountains, northern Michigan, and northern Minnesota (National Geographic Society 1983). The western portion of the breeding range extends throughout the Rocky Mountain region to California and northern Arizona and New Mexico. The species overwinters in Central and South America and casually in southern California (Bent 1942, DeGraaf et al. 1991). The species migrates to Minnesota, arriving in early May, and migration may last until mid-June. The species leaves the state beginning in early August to late September (Janssen 1987).

The general breeding habitat of the species consists of a variety of boreal forests including uplands, lowlands, edges, beaver meadows, and recently logged and burned areas (Roberts 1932, Green and Niemi 1978, Niemi and Pfannmuller 1979, Brewer et al. 1991, Peterson and Fichtel 1992). However, the most important aspect needed by this species and noted by all those above, is the presence of standing live or dead trees from which the species forages for insects. Usually the species can be seen at the top of these trees either singing or preparing to forage in its typical flycatching fashion (Roberts 1932). The most commonly used tree species are large pine, spruce, or tamarack. The species was not found abundantly in many of the forested zones of the Chippewa and Superior National Forests (Hanowski and Niemi 1991a, 1991b), nor is very common in the large contiguous, black spruce or tamarack forests of the Red Lake peatland (Niemi and Hanowski 1992). Because of the species varied use of habitats, it was not classified into any of the categories defined by the EQB-FSD.

The species nests on a horizontal conifer branch anywhere from 5 to 18 m in height and generally away from the tree trunk. The species primarily forages by hawking or flycatching for insects from the exposed perches of tall dead standing trees (Green and Niemi 1977, DeGraaf et al. 1991, Peterson and Fichtel 1992).

The species status in North America is emerging as a concern based on its potential decline on Breeding Bird Survey roadside counts (Sauer and Droege 1992). For instance, Peterson and Fichtel (1992) summarize a significant annual decline of 2.6 percent in the eastern United States and approaching a 6.1 percent decrease across the species range in North America. In Minnesota, the species trend has not been shown to be significantly decreasing; however, the trend is negative at approximately 4 percent per year through 1989 (Janssen 1990) and—3 percent through 1990 (Collins et al. 1992). Among the factors mentioned as possibly contributing to the decline are (1) reductions in the availability of snags in suitable habitat, (2) decreased populations of beaver, primarily in the northeastern U.S., (3) suppression of forest fires, (4) loss of habitat to increased urbanization, and (5) habitat changes in migration routes or on the wintering grounds (e.g., see Peterson and Fichtel 1992). Moreover, the species may require relatively large blocks of boreal forest for breeding because Peterson and Fichtel (1992) cite information gathered by LeGrand and Hall, that suggests 50 acres may be necessary to support a single territorial pair.

Under the base harvest scenario, the species was projected to increase in ecoregion 2 on timberland. When all forest land was considered no changes were noted. Under the medium harvest scenario, the species was projected to have increased available habitat in ecoregion 4 on timberland and all forest land. Under the high harvest scenario, increases were projected for ecoregion 4 and statewide for timberland. In all forest lands, a decrease was projected in ecoregion 3, but an increase was projected in ecoregion 4 and statewide. The projected increases were primarily due to the increase in recently cut areas in ecoregion 4. However, these projected increases will not occur unless a suitable number of large, dead or live pines, spruce, or tamarack remain in or adjacent to the cut areas.

Our observations indicate that this species can tolerate disturbance such as logging and forest fire, as long as some large dead and live trees are left standing. The species can greatly benefit by leaving several tall trees and preferably dead trees within these cutover areas. Although quantitative information is lacking, the Olive-sided Flycatcher tends to be found in a variety of habitat types but generally in a landscape matrix with more coniferous or boreal association rather than in a deciduous, dominated landscape. Hence, it is most abundant in Minnesota where these associations are most common such as in ecoregions 1, 2, 3, and 4.

Eastern Wood Pewee (*Contopus virens*)
The Eastern Wood Pewee is a summer resident throughout the wooded portions of Minnesota and is least common in the southwest (Janssen 1987). The species distribution in North America is limited to the eastern United States and southeastern Canada (Peterson 1980). It arrives in Minnesota in late April to late May and departs in early August through late October (Janssen 1987).

The Eastern Wood Pewee is not very specific in its breeding habitat requirements except that it prefers mature forests. Roberts (1932) suggests that the species prefers oak woodlands, but it is commonly found in all types of forests, deciduous and coniferous. Green (1991) suggests that it is most commonly found in contiguous deciduous forests.

The species was found in a variety of forested habitats in the Chippewa National Forest including mature lowland conifer, mature lowland deciduous, and mature upland deciduous (Hanowski and Niemi 1991a). Highest densities in the Chippewa were in mature (sawtimber) ash/elm and mature (sawtimber) paper birch stands (about 3 to 5 pairs/40 acres). The species occurred in pole size and mature pine, maple, and aspen stands in the Superior National Forest in 1991 (Hanowski and Niemi 1991b). Highest densities (about 1 pair/40 acres) were recorded in mature aspen and maple forests (Hanowski and Niemi 1991b). In Michigan, the species is found in open woodlands with incomplete canopies including selectively logged habitats (Hespenheide 1971). It is also found in natural edges along ponds, streams, or fields. Brewer et al. (1991) suggest that the species prefers deciduous forests over mixed or coniferous forests. Based on these data, the species was classified as dependent on mature forests.

The Eastern Wood Pewee places its nest 2 to 6 m above the ground and it usually saddles a small horizontal or sloping branch. The nest is a shallow cup bound together to the branch with spider webs and often covered with lichens (Roberts 1932). Clutch size for the species is generally 3 eggs and ranges from 2 to 4 (Harrison 1975). The incubation period is approximately 12 to 13 days. The Eastern Wood Pewee is a flycatcher and takes aerial invertebrates from a fixed perch. Because of its flycatching habit, the species is usually associated with openings in the forest subcanopy layer which it uses for foraging. Hence, the species is quite accepting of selectively logged forests as long as about 50 percent or more of the mature trees are retained (Niemi and Hanowski 1984; Brewer et al. 1991).

The species has declined significantly by an average of 1.8 percent in the state over the past 25 years based on breeding bird roadside surveys (Janssen 1990). Reasons for this decline are unclear. Declines have also occurred nationwide over the past 25 years (about 1.3 percent) (Sauer and Droege 1992).

Reductions in mature forests would likely negatively affect this species because it generally occurs in larger expanses of mature deciduous or mixed deciduous-coniferous forests. The species would likely tolerate some select cutting and thinning (Brewer et al. 1991). Any practice that would encourage thinning to remove trees less than 10 cm dbh would help create satisfactory habitat (Crawford et al. 1981).

Eastern Wood Pewee available habitat was projected to increase in ecoregions 5, 7 and 9 in the base and medium harvest levels when all timberlands were considered and when all forest land was modeled. Increases were significant in the high harvest level in ecoregions 7 and 9 when all forests were considered but only in ecoregion 7 when timberlands were included. Increases in the southern part of the state were likely due to the overall increase in forest land projected in the second model run and the lack of clearcutting in that part of the state.

Significant decreases were noted in ecoregion 4 in all three harvest levels for all forest land, but decreases on timberland in ecoregion 4 were confined to the medium and high harvest scenarios. Other decreases for all forest land included ecoregions 1, 3, and 4 and statewide in the high harvest scenario. The timberland projections showed additional decreases in ecoregion 2 under the high harvest level as well as a statewide decline in the high harvest intensity. Declines in the northern portion of the state are probably due to the decrease in mature forests.

Yellow-bellied Flycatcher (*Empidonax flaviventris*)
The Yellow-bellied Flycatcher is found in lowland coniferous forests of north central and northeast Minnesota. The species breeding range extends throughout all Provinces of Canada north to Hudson Bay. Minnesota and northern regions of the Great Lakes States are at the southern range of this species (Peterson 1980, DeGraaf 1991). The species is a long-distance

migrant and winters throughout Central America (Rappole et al. 1983). The Yellow-bellied Flycatcher is a late spring migrant in Minnesota. The peak migration begins in early May and continues through early June. Fall migration begins in late July and continues through September (Janssen 1987).

This species has relatively narrow habitat preferences; it is found almost exclusively in mature lowland conifer forests. It occurs in all lowland conifer types including cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), and black spruce (*Picea mariana*). Numbers of Yellow-bellied Flycatchers observed in 1991 were highest in northeast Minnesota (Superior National Forest (about 2 pairs/40 acres) Hanowski and Niemi 1991a). Breeding habitat in northern Michigan was confined to wet conifer forest including sites dominated by spruce, tamarack, and white cedar (Brewer et al. 1991). However, the species also occurs in upland pine, spruce, and fir dominated habitats in Ontario (Brunton and Crins 1975). It is occasionally found in upland coniferous habitats in Minnesota (Niemi 1977), but in lower abundance than in lowland forests. Because of the high association of this species with conifers, it was classified as a conifer dependent species.

The Yellow-bellied Flycatcher nests on the ground. The nest is usually sunk into a layer of moss and is hidden by grass or sedge (Roberts 1932, Harrison 1975). The species is a true flycatcher and feeds primarily on flying invertebrates.

According to breeding bird survey data, the species population has declined slightly in the state over the past 20 years (Janssen 1990). The decline was not significant and the species is only found commonly on nine of 52 routes. Nationwide, the species has increased over the past 25 years (Sauer and Droege 1992).

This species requires large areas of mature lowland conifer habitat and would be adversely affected by timber harvesting of this forest type. It may also require old stands of lowland conifer where a substantial layer of moss has developed for nesting requirements. For example, mature black spruce stands where this species was found in the Red Lake Peatland were >150 years old (Hanowski 1982). The species was also classified as a mature forest bird.

Suitable habitat for the Yellow-bellied Flycatcher was projected to increase under the base harvest level in ecoregions 1, 2 and statewide in timberlands and all forest lands. Increases were likely due to the maturing of lowland conifer that was allowed under the base harvest level. Decreases were projected in ecoregions 2, 3, and 4 on timberlands in the high harvest scenario. No decreases were noted in ecoregion 2 when all forest lands were considered, but otherwise the results were the same as on timberlands.

Declines were likely attributable to the decrease in mature conifer forests (both lowland and upland) in the northern portion of the state.

Acadian Flycatcher (*Empidonax virescens*)
The Acadian Flycatcher's breeding range extends east of the Great Plains from southeastern Minnesota to Massachusetts, south to the Gulf Coast and northern Florida (National Geographic Society 1983). In Minnesota, the species breeding range includes Houston and Fillmore counties in the south, and extends north to Rice, Hennepin, and Chisago counties (Janssen 1987). The state's first confirmed record of the species was a nesting pair discovered in July 1967 in Beaver Creek Valley State Park, Houston County (Janssen 1987). As of 1986, the species appears to be breeding regularly only at this location (Janssen 1987).

The Acadian Flycatcher is a long-distance migrant that winters from eastern Nicaragua south to northeastern South America (Ehrlich et al. 1988). In Minnesota, the species is a rare migrant in the southeastern and east-central regions that appears during late May to early June, and leaves by late August.

The Acadian Flycatcher breeds primarily in mature, deciduous floodplain or swamp forests (Bushman and Therres 1988), but also occurs in unpastured dry forest (Brewer et al. 1991). The species was classified as dependent on mature, hardwood forests because of its close association with these forest types (Bent 1942, Mumford 1964, DeGraaf et al. 1991).

A high, dense canopy (Robbins 1978) and an open understory (Adams and Barrett 1976), characteristics of older, undisturbed forests, are important for foraging and nesting. The species usually nests 1 to 8 meters high in a deciduous shrub or tree, often over a pool in a stream (Bent 1942, Bond 1957, Bushman and Therres 1988). Clutch size ranges from two to four eggs, usually three (Ehrlich et al. 1988). The Acadian Flycatcher is an insectivorous air sallier (DeGraaf et al 1985).

Habitat area may be a limitation for this species. Ambuel and Temple (1983) found that a large, contiguous forest is required for breeding birds. Robbins (1980) estimated a minimum of 80 to 125 acres of forest to sustain a viable breeding population. Kroodsma (1984) found that the species appeared to be negatively affected by the presence of forest edge, and Chasko and Gates (1982) reported the average nest distance from power-line corridors for the Acadian Flycatcher to be 45 meters. Based on these data, the species was classified as a forest interior species. However, because of its limited range in Minnesota, no evidence is available on its area sensitivity in Minnesota.

Forest management practices that lead to increases in understory also may cause this species to decline (Whitcomb et al. 1977); however, some selective logging may be tolerated by the species (Bushman and Therres 1988). The Acadian Flycatcher is also a Brown-headed Cowbird host. Increased forest fragmentation, and a potential increase in cowbirds and predators, may be detrimental to this species (Brittingham and Temple 1983).

Suitable habitat for the Acadian Flycatcher was projected to decline in ecoregion 6 under all harvest scenarios and on both timberlands and all forest lands. Decreases were projected to occur statewide as well as in ecoregion 5 under the high harvest scenario. Decreases under the high scenario were also projected for both timberlands and all forest lands. Decreases in available habitat for this species is attributable to the reduced acreage of contiguous mature forests in the southern portion of the state.

Least Flycatcher (*Empidonax minimus*)
The Least Flycatcher is a summer resident in Minnesota and occurs throughout the wooded portions of the state, except the south central and southwestern regions (Janssen 1987). It arrives in the state in late-April through mid-May after spending the winter in Central America (Mexico to Panama) (Peterson 1980). It begins its fall migration in early August and the last individuals depart in early October. The species' breeding distribution in North America covers the northern and north central portions of the United States, except the northwest, and the southern portions of the eastern and central of Canada (Peterson 1980).

Like the Ovenbird and Red-eyed Vireo, the Least Flycatcher is one of the most abundant birds of mature forests in Minnesota (Roberts 1932). The Least Flycatcher is highly associated with deciduous forests and, hence, the species was classified as a hardwood dependent and mature forest species. In many situations the species is found in deciduous woods with relatively open subcanopies (Breckenridge 1955; Harrison 1975).

In northern Minnesota the species was found in a wide range of habitat types including both upland and lowland deciduous and coniferous forests (Hanowski and Niemi 1991a, 1991b). Highest densities recorded for the species were in mature maple in the Superior National Forest (about 5 to 6 pairs/40 acres) and mature birch in the Chippewa National Forest (Hanowski and Niemi 1991a, 1991b). In northern Michigan, the species occurs in deciduous and mixed forests and occasionally pole size jack pine (Brewer et al. 1991). In some situations, the species seems to form loose colonies (Harrison 1975), sometimes resulting in very dense populations.

The Least Flycatcher places its nest 2 to 6 m up in a tree and 4 eggs are usually laid (Harrison 1975). Incubation requires from 14 to 16 days. This species is an aerial insectivore; it captures flying invertebrates from a fixed perch. Therefore, an open subcanopy in the forest that allows the species to efficiently forage provide ideal conditions (Breckenridge 1957).

Although Least Flycatchers may occupy a wide range of habitats, they may be sensitive to habitat fragmentation (Brewer et al. 1991). Large disturbances in forests in northern Michigan resulted in a shift in territories to the interior portions of the forest. Territories were displaced within 200 m of openings that were ≥40 acres (Dellasala and Rabe 1987). The species is also susceptible to Brown-headed Cowbird parasitism (Briskie et al. 1990), which is often fatal to the host young because the incubation period is longer than that of the cowbird.

The species has shown a significant negative decline of about 3 percent per year in the state over the past 20 years based on breeding bird roadside surveys (Janssen 1990). However, no significant nationwide declines were reported (Sauer and Droege 1992).

The Least Flycatcher was projected to increase in ecoregions 7 and 9 under both the timberland and all forest land models for all harvest regimes. Additional increases were projected for ecoregion 2 for all cutting intensities when all forest land was considered. Increase in ecoregion 7 was likely due to the overall increase of forest land that was projected in the second model runs and the lack of clearcutting prescription for this region. Significant decreases were projected under the high harvest scenario in ecoregions 1, 3, 4 and statewide for all forest lands and in these same ecoregions, statewide, as well as ecoregion 2 when only timberlands were considered. Decreases in the northern portion of the state in the high scenario was likely due to the loss of mature forests.

Eastern Phoebe (*Sayornis phoebe*)

The Eastern Phoebe is a common breeding species east of the Rockies from central and southeastern Canada south to the southern United States (Peterson 1980). In Minnesota, it is most common in the northern regions, and scarce in the south central and southwestern regions south of the Minnesota River (Janssen 1987). The Phoebe is a short distance migrant, wintering primarily in the southern United States, and south into Mexico (Peterson 1980). It arrives in Minnesota from mid-March to early May, with peak numbers appearing in early April. Most individuals leave the state during September, but there are occasional records as late as early November (Janssen 1987).

The Eastern Phoebe may be found in a wide variety of habitats ranging from open woodlands and rocky ravines to farms, suburbs, and towns (Ehrlich et al. 1988). In the Michigan Breeding Bird Atlas Habitat Survey this species showed a preference for residential areas throughout the state, and was less common in the more heavily forested regions (Brewer et al. 1991). Although comparable data are lacking in Minnesota, their habitat requirements in Minnesota are likely the same. In extensive surveys in 1991 and 1992 in the Chippewa and Superior national forests, the species was a relatively rare forest bird (Hanowski and Niemi 1991a, 1991b). Because of the species affinity for structures over water for nesting (bridges), it was classified as a riparian bird.

The Phoebe builds its nest on shelflike projections which accounts for its frequent association with farm buildings, bridges, and suburban gardens (Harrison 1975). It lays 3 to 6 eggs and usually raises two broods per season, but is heavily parasitized by the Brown-headed Cowbird (Ehrlich et al. 1988, Brewer et al. 1991). The diet consists primarily of flying insects which the Phoebe hawks from a perch. Occasionally small fish and frogs are taken, as well as berries and a few seeds (mostly in winter) (Ehrlich et al. 1988).

Since the Phoebe is not dependent upon trees for suitable nesting sites, it is unlikely to be directly affected by forest management practices. Nevertheless, the Eastern Phoebe is apparently declining in many parts of the East and Midwest. It was placed on the Audubon Blue List in 1980, and listed as a species of special concern from 1981–86 (Tate 1986). According to Robbins et al. (1986), the Phoebe population appeared stable until the severe winter of 1976-77, when a period of continuous subfreezing weather destroyed most birds in the northern portion of the winter range. Although the Phoebe has begun a gradual recovery, the long-term trend is still a significant decline in both the Eastern and Central regions and for the continent as a whole (Robbins et al. 1986).

In Minnesota, additional stress could be placed on Eastern Phoebe populations if forest fragmentation results in increased populations and distribution of Brown-headed Cowbirds. Indirect negative effects of timber harvesting could also result if there are reductions in food abundance (i.e., flying insects and/or fruit).

Increases were projected in ecoregion 3 for the medium and high scenarios on timberland. Decreases in suitable habitat, however, were projected for all harvest intensities in ecoregion 2. Results were the same regardless if all forest lands or only timberlands were considered. Because this species is associated with younger riparian communities, decreases in ecoregion 2 were likely due to the maturing of riparian forest buffers along rivers, lakes, and streams. In general this is of little concern because of the species' rarity in this area.

Great Crested Flycatcher (*Myiarchus crinitus*)
The Great Crested Flycatcher's breeding range extends from southeastern Canada, south through the eastern United States and to the Gulf Coast (National Geographic Society 1983). The species is a summer resident throughout the state of Minnesota, except in the extreme northeast and portions of the north central region (Janssen 1987). The Great Crested Flycatcher is a long-distance migrant that winters in central and southern

Florida, central Mexico, south to Columbia and southern Venezuela (Ehrlich et al. 1988). The species arrives in Minnesota during late April through late May, and leaves during early August through late September (Janssen 1987).

The Great Crested Flycatcher breeds primarily in mature, deciduous forest (Ehrlich et al. 1988, Brewer et al. 1991), but is also found in mixed forest, orchards, parks, and swamps (Ehrlich et al. 1988). The species was observed almost exclusively in mature northern hardwoods in the western Great Lakes area. In Minnesota, Breckenridge (1955) found the species occurred in pole size cedar. More recently, Nagel and Madsen (1982) and Hanowski and Niemi (1991a, 1991b) found highest densities of Great Crested Flycatchers occurred in mature elm-ash-cottonwood and mature fir-spruce-birch forest types. Because of the species high association with mature hardwood forests and its need for cavities, primarily in hardwood trees, it was classified as dependent on mature, hardwood forests. Although the species is occasionally found in coniferous forests, it often uses deciduous trees within those forests and its populations are primarily in hardwood regions.

The Great Crested Flycatcher nests 1 to >20 m above the ground in a natural or woodpecker excavated cavity of a deciduous tree (Harrison 1975). Clutch size ranges from four to eight eggs, commonly five (Harrison 1975), and the species is a rare Brown-headed Cowbird host (Brittingham and Temple 1983). The Great Crested Flycatcher is a year-round insectivorous flycatcher, and a frugivorous, lower-canopy gleaner during the nonbreeding period (DeGraaf et al. 1985). Insects from seven different orders have been shown to be main items fed to nestlings, along with some fruit (Taylor and Kershner 1991).

Breeding Bird Survey data from 1965 through 1979 showed the Great Crested Flycatcher increased in the survey's Central region, the Great Lake States, and across the continent (Robbins et al. 1986). Janssen (1990) reported no trend in the population from 1966 to 1989 in Minnesota.

Habitat area does not appear to be a major limitation for this species. The Great Crested Flycatcher has been detected in isolated woods as small as 2 acres (Robbins et al. 1989), however, sufficient cavity trees must be available for the species. Forest management practices which may benefit the Great Crested Flycatcher consist of cavity tree management. Any timber practices which remove all decayed trees may be detrimental. The addition of nest boxes may be effective in enhancing habitat for breeding birds (Taylor and Kershner 1991, Caine and Marion 1991).

Suitable habitat for the Great Crested Flycatcher was projected to increase in the southern portion of the state and to decrease in the north. Increases were projected in ecoregion 7 under all harvest levels and on both all forest and timberlands. Additional increases were projected for ecoregion 9 under the base and medium harvest levels on timberland and in all harvest scenarios when all forest land was considered. Increase in abundance was likely attributable to the lack of clearcutting in the south and the projected increase in forest land in the southern portion of the state. Decreases in the north were probably due to the loss of mature deciduous forests. Decreases were projected for ecoregion 4 under the medium harvest level on timberland and from ecoregions 1, 3, 4 and statewide under the high harvest regime. Impacts were the same on all forest and timberland in the high harvest scenario.

Tree Swallow (*Tachycineta bicolor*)
The Tree Swallow is common throughout its extensive range. It breeds from Alaska south to California in the west, all across Canada, and throughout the eastern United States (Peterson 1980). It is a summer resident throughout Minnesota (Janssen 1987). This species is a short to long distance migrant, wintering from the southern United States south to Honduras, Nicaragua, and Costa Rica (Ehrlich et al. 1988). Tree Swallows are the earliest swallows to return to Minnesota in the spring, arriving as early as late March. The peak of spring migration is in mid- to late-April. In the fall, Tree Swallows form large, communal roosts prior to migration. The bulk of the population leaves the state during August and September (Janssen 1987).

The Tree Swallow is a cavity nesting species. It makes use of old woodpecker holes, fence posts, mailboxes, barn eaves, and nest boxes (Harrison 1975). Its nest is typically lined with feathers. It lays 4-6 eggs and usually raises only one brood (Chapman 1955, Ehrlich et al. 1988). Tree Swallows forage for insects on the wing, often feeding just above the surface of a lake or pond. Occasionally they consume berries when insects are unavailable (Chapman 1955, Ehrlich et al. 1988).

This species is common in any wooded habitat near water, where dead trees or other nest sites are available. Although the Tree Swallow is not dependent on contiguous forest, management practices that include the removal of snags serve to reduce the number of suitable nest sites. Hence, Tree Swallows directly benefit from leaving residual trees in cutover areas throughout Minnesota.

Data collected in the USFWS Breeding Bird Survey suggest that Tree Swallow populations are increasing across the continent. Significant increases were recorded in the Great Lakes States, the Northeastern States, and in Canada. Statewide increases were reported in Minnesota and Michigan (Robbins et al. 1986).

The Tree Swallow's affinity for open, early successional forests is likely the reason for the projected increase in suitable habitat for this species.

Increases were projected for all ecoregions and statewide for all harvest levels on timberlands (except ecoregion 9 under the base harvest level). When all forest land was considered, increases were projected for all ecoregions (except in ecoregion 2 in the base and medium harvest scenarios and in ecoregion 9 in the base) and statewide for all harvest scenarios.

Gray Jay (*Perisoreus canadensis*)

Gray Jays are permanent residents in the northeast and north central parts of Minnesota (Janssen 1987). During occasional winter irruptions, individuals can be found as far south as Lac Qui Parle and Olmstead Counties (Janssen 1987). The overall range of the species corresponds with the distribution of the boreal forest, extending across Canada to Alaska and into the Rocky Mountains as far south as northern New Mexico and Arizona (National Geographic Society 1983).

Primary nesting habitats include dense, closed-canopy lowland conifer stands dominated by mature black spruce, tamarack, and northern white cedar (Roberts 1932, Rutter 1969, Ouellet et al. 1976, Erskine 1977, Green and Niemi 1978, Niemi and Pfannmuller 1979, Niemi and Hanowski 1984, 1992, Robbins 1991, Brewer et al. 1991). The species is also found in upland coniferous forests, especially during the non-breeding season where it can be found foraging in pine and spruce stands (Roberts 1932, Aldrich 1943, Brewer et al. 1991). Green (1991) classified the bird as associated with contiguous coniferous landscapes. Based on these data the species was classified as dependent on mature, coniferous forests.

Both Brewer et al. (1991) and Robbins (1991) report that Gray Jays were relatively common residents in the virgin forests of northern Wisconsin in the 19th century and that the frequency and extent of southward movements into the southern portions of the state have been reduced. For example, Brewer et al. (1991) comment that the Gray Jay has not been seen in the Lower Peninsula of Michigan during the summer since 1915. Reasons for this decrease are not clear, but the overall reduction in mature coniferous forest may be a factor.

Gray Jays are known to many Minnesotans as Canada Jays, Whiskey Jacks, or Camp-robber Jays. They are curious and opportunistic birds that habituate readily to the presence of humans. They are frequent visitors to homes and camping areas in their territories where they pick up bits of food. Gray Jays typically eat invertebrates, fruits, carrion, and occasionally prey upon mice, eggs, and young birds (Roberts 1932, Lawrence 1947, Ouellet 1970). Caching of saliva covered food is common, and may be an adaptation for winter survival during times of lowered food availability (Ehrlich et al. 1988).

The nest is bulky and insulated with grasses, feathers, and hair (Roberts 1932). Only one brood of two to five young is generally produced (Ehrlich et al. 1988).

Based on the USFWS Breeding Bird Survey of roadside counts, the species has shown a significant decrease in the number of routes upon which the species has shown decreased numbers (8 of 11, or 73 percent).

Suitable habitat for the Gray Jay was projected to increase on timberland and in all forest land in ecoregion 1 under the base harvest level. Decreases, however were projected in ecoregion 3 under all harvest levels on both timberland and all forest land. Additional decreases were projected in ecoregion 4 under the medium and high harvest scenarios on both timberland and all forest land and in ecoregion 2 on timberland in the high harvest scenario. Under the high harvest scenario, a statewide decrease was projected for timberlands but not in all forest lands. Decreases were due to the decline of mature lowland conifers in the northern portion of the state.

Blue Jay (*Cyanocitta cristata*)
The Blue Jay breeds throughout the eastern temperate deciduous forest and boreal forest from eastern British Columbia across Canada to Newfoundland, south to Florida and west to Texas (Bent 1946, DeGraaf et al. 1991). In Minnesota, it is found breeding throughout the state in a variety of forested settings. The northernmost populations of the species are likely partially migratory.

The species is a permanent resident throughout Minnesota (Janssen 1987). The majority of migrating individuals will arrive in Minnesota in late April to early June, while fall migration usually begins in late August and lasts through mid-October. The bulk of the fall migration occurs in September, when it is not unusual to find flocks of hundreds of Blue Jays moving together (Janssen 1987).

General breeding habitat for the species consists of deciduous and mixed deciduous forests, farms, gardens, parks, and wooded islands (Bent 1946, DeGraaf et al. 1991). The Blue Jay nests in trees and occasionally shrubs, where the nest is usually hidden in the crotch of a tree from 3 to 10 high and is often placed in a conifer within mixed woodlands (DeGraaf et al. 1991).

The food habits of the species are highly omnivorous. DeGraaf et al. (1988) estimates that 76 percent of the diet consists of vegetable matter and 24 percent animal. The plant material consists of mast, seeds, and fruits, while the animal portion includes insects, mice, and young birds and eggs. The species is commonly found at bird feeders. The Blue Jay is speculated to have been a major dispersal agent for the westward movement of oak trees following glaciation in North America (Johnson and Adkisson 1985).

The species was classified as dependent on hardwood type forests in Minnesota. Although the species can be found in both mixed forests and occasionally in relatively pure coniferous forests, it obtains its highest densities within hardwood type forests (Green and Niemi 1978, Niemi and Pfannmuller 1979, Hanowski and Niemi 1991a, 1991b).

Over the past twenty years in Minnesota, the species has shown about a 2 percent per year increase in its population according the Breeding Bird Survey roadside counts (Janssen 1990).

In general, the Blue Jay is highly tolerant of timber cutting and forest management and will likely increase with further fragmentation of the forest. Any increase of Blue Jays may, however, be detrimental to a variety of bird species associated with forests. The Blue Jay is a predator of young birds and eggs during the breeding season. Unfortunately, there are virtually no data on the specific rates of predation, what species are most likely affected, and what the overall effect these predation rates have on the population biology of those species affected.

The Blue Jay was projected to increase in ecoregions 7 and 9 under the base and medium harvesting scenarios when either timberlands or all forest lands were included. However, the species was projected to decrease in ecoregion 4 under the medium scenario, again using either timberlands or all forest lands, and in ecoregion 4 under the base harvest scenario on timberlands. Under the high harvest scenario, the Blue Jay was projected to increase in ecoregion 7 using both timberlands and all forest lands, but to decrease in ecoregions 1, 2, 3, and 4, and statewide using the timberlands. When all forest lands were considered, projected decreases were limited to ecoregions 1, 3, 4, and statewide. The patterns of increases and decreases within different ecoregions reflects the differential timber harvesting being completed within each ecoregion. Moreover, the species population in Minnesota is highest in ecoregions 1 and 4, where the statewide projected changes primarily reflect this distribution. The Blue Jay primarily nests in intermediate and mature stands of hardwoods; however, it will occur in a variety of forested habitats and is highly tolerant of edge habitats.

Black-billed Magpie (*Pica pica*)

The Black-billed Magpie is found primarily in the northwestern United States, northwest to Alaska, southwest to California, east to Oklahoma, and reaches as far east as northwestern Minnesota and western Ontario (Bent 1946, DeGraaf et al. 1991). In Minnesota the species has become a permanent breeding resident in the northwestern and north central portions of the state (Janssen 1987). The species is a regular winter visitant in northwestern Minnesota and stragglers may be found almost anywhere in the state. Loose migratory periods are common and include returning to the state from mid-February to early April, and fall migration periods occur from early September to mid-November (Janssen 1987).

The species is a marginal species of forested zones and is primarily found in open woodlands, pasture lands, rangelands, and shrubby riparian areas (Linsdale 1937, DeGraaf et al. 1991). It generally avoids dense forested areas. The species builds a bulky nest anywhere from 2 to 25 feet in a tree or shrub. The species is highly omnivorous and will generally feed on insects including grasshoppers, snails, slugs, young birds and eggs, small mammals, and carrion (Martin et al. 1951).

The species has shown a moderately, significant increase in Minnesota based on Breeding Bird Survey roadside counts in Minnesota. Janssen (1990) presented data on a 9 percent annual increase, yet enough data were only available for 9 of 52 routes run in Minnesota.

Because the species marginally uses forested habitat in the state, it is unlikely to be negatively affected by any changes in timber harvesting or forest management. The species is likely to benefit from increased harvesting and any reduction in larger contiguous forests. Furthermore, because the species is a predator of many birds and their young (Andren 1992), any increase would likely negatively affect forest bird species that it overlaps during the breeding season. As with the Blue Jay, quantitative data are lacking to speculate on what the overall effects would be on other species. However, with its current low population in the state, the overall effect of predation by the Black-billed Magpie is likely negligible and localized.

The Black-billed Magpie was not classified into any of the categories of interest in regard to the GEIS process. However, the species was projected to have an increase in ecoregions 1, 4, and 9 and statewide under all three harvest scenarios using timberlands except a decrease was noted in ecoregion 9 on timberlands in the base scenario. The results were the same when all forest lands were considered, except no change was projected for ecoregion 9 under the base harvest scenario. The increase that was projected is due primarily to the young, open stages of forest that the species will occupy within its range in Minnesota. However, because Minnesota is in the eastern extreme of the species range, it is largely unclear whether the population would increase solely as a result of increased habitat availability.

American Crow (*Corvus brachyrhynchos*)

The American Crow is a permanent resident throughout most of Minnesota (Janssen 1987). Significant migratory movements occur throughout the state, however, peaking in March during the spring, and continuing from August through November (Janssen 1987). Crows are most common in the southern half of the state in winter. American Crows can be found throughout most of the southern tier of the Canadian provinces in summer, throughout most of the U.S. on a permanent basis, and into the desert southwest in winter (National Geographic Society 1983).

Crows have an omnivorous diet, feeding on many types of invertebrates, small vertebrates, carrion, bird eggs and nestlings, seeds, fruit, and nuts (Roberts 1932, Ehrlich et al. 1988). Moreover, a fondness for corn often creates conflict between crows and humans. Control measures used have included dynamiting communal roosts, which can eliminate tens of thousands of individuals in a single event (Ehrlich et al. 1988).

American Crows can be found in many types of forested and nonforested habitats (Graber et al. 1987, Ehrlich et al. 1988). In northern Minnesota, they were found in lowland deciduous forest but not in any other forest type (Hanowski and Niemi 1991a). Nests are usually built of branches, twigs, and bark in either a deciduous or coniferous tree, sometimes in a shrub, or even on the ground (Ehrlich et al. 1988). Four to six eggs are usually laid in April or May (Roberts 1932), and incubation takes about 18 days. Fledging occurs 28 to 35 days after hatching. Helpers at the nest are occasionally observed (Ehrlich et al. 1988).

Historical population increases have been attributed to the reduction in numbers of predators of the American Crow and increases in food availability through agriculture (Roberts 1932). From 1966 to 1991, populations have been increasing at a significant rate (route regression, $P < 0.05$) at approximately 1 percent per year (USFWS BBS Data). In Minnesota, the species has been increasing at about 1.9 percent per year since 1966 (Janssen 1990).

Despite historical documentation of the ineffective and oftentimes harmful effects of crow control programs on nontarget species (Roberts 1932 and references therein), Minnesota recently established a crow shooting season. It is premature to assess the effect this policy will have on the population level of American Crows.

The American Crow is a species that appears to be well adapted to changes created by human activity and is highly associated with fragmented landscapes (Green 1991). As such, increased timber harvesting, if it results in reduction of contiguous forests, will likely have a positive effect on crow populations in Minnesota. Management recommendations must focus more on the protection of species which may be negatively impacted by the increased predation of eggs and nestlings by American Crows. Furthermore, control measures targeted at crows need to have educational programs so individuals hunting American Crows can correctly distinguish American Crows from Common Ravens (*Corvus corax*), hawks, owls, and other bird species.

Suitable habitat available for the American Crow was projected to decrease in the northern portion of the state and increase in the south. Under the high harvest level, decreases on timberlands were projected in ecoregions 1, 2, 3, and 4 and statewide. When all forest land was considered, decreases under the high cutting level were projected for ecoregions 1, 3, and 4 as well as statewide. Decreases in the north were likely due to the decrease in mature forests and amount of forest area. On the other hand, increases in southern Minnesota were likely due to the increase in forest area. Suitable habitat was projected to increase in ecoregions 7 and 9 under the base and medium harvest levels on both timberlands and all forest lands. An increase was also noted in ecoregion 5 on timberlands in the base scenario. Under the high scenario, an increase was projected for ecoregion 7 on all forests and timberlands.

Common Raven (*Corvus corax*)
The Common Raven is a permanent resident of northeastern Minnesota (Janssen 1987). Ravens can be found, somewhat less frequently, in west central and north central regions of the state. Some migratory movements occur in fall, but little change is obvious in Common Raven density between seasons. Some individuals can, however, be found in southeastern regions, along the Mississippi River valley, in winter (Janssen 1987).

Historically, ravens were more widespread in both Minnesota (Roberts 1932) and Wisconsin (Robbins 1991), especially in winter. The range of the Common Raven in North America includes most of Canada, Alaska, coasts of Greenland, and west from the Rocky Mountains. In eastern U.S., Common Ravens are typically found only in the western Great Lakes states (i.e., Minnesota, Wisconsin, and Michigan), the Appalachian Mountains, and eastern states along the Canadian border (i.e., New York through Maine).

Ravens are primarily scavengers, relying on carrion, but are very opportunistic. Their diet also includes small mammals, bird eggs and nestlings, insects, garbage, seeds, and fruit (Roberts 1932, Knight and Call 1980).

Nest site fidelity is high, and nests may be used for several years (Knight and Call 1980). They are usually built of branches, twigs, and bark, often in a deciduous tree (Ehrlich et al. 1988) or on a cliff with a protective overhang (Knight and Call 1980). Four to six eggs are typically laid and incubated for 18 to 21 days. Young are ready to leave the nest 38 to 44 days after hatching (Ehrlich et al. 1988). In Northern Wisconsin, nests with eggs have been reported from 16 February to 18 April (Robbins 1991). Nesting in Minnesota likely occurs during the same period.

Social behavior and communication is very complex (Bruggers 1988). Breeding birds may pair for many years, traveling, eating and roosting together, while nonbreeding birds may wander over large distances and roost in perennial communal roosts (Bruggers 1988).

Ravens are found in a wide variety of habitats, from deserts to rugged coastal areas, to boreal forests and tundra (Ehrlich et al. 1988, National Geographic Society 1983). In Minnesota, they are found in the mixed conifer-deciduous forest zone and boreal forests of the north, and are therefore classified as a conifer dependent species in this state. Because large, mature trees are selected for nest placement (Knight and Call 1980), this species is also classified as a species of mature forests. During the breeding season the species is typically found in the contiguous, coniferous forests of Minnesota (Green 1991).

Range reductions in Wisconsin (Robbins 1991) and Minnesota (Roberts 1932) occurred in the late 1800s during the period of major changes in forests of the region. Declines in raven populations have been linked to logging activity and habitat alteration (Knight and Call 1980). The decline in Minnesota was so severe that (Roberts 1932) believed the species to be in danger of extinction. Raven populations increased in both the eastern and western U.S. during the period from 1965–79 (Robbins et al. 1986) and have increased in Minnesota at a rate of a little more than 2 percent/year (significant route regression $P < 0.05$) from 1966 to 1990 (Collins et al. 1992).

Effects of increased timber harvesting on raven populations in Minnesota is difficult to predict, as historical declines are poorly understood. However, if mature conifer and mixed conifer/deciduous habitat are reduced in northern regions, population of Ravens may be susceptible. One clear threat to Common Ravens in the state, however, is incidental shooting due to confusion with American Crows. An indeterminate number of Ravens are likely killed during Minnesota's American Crow shooting season, as they are not easily distinguished by shooters. Restrictions on crow shooting in the northeastern region of the state where both species are commonly found may be required to minimize shooting.

Suitable habitat for the Common Raven was projected to decrease in ecoregion 4 under the medium harvest level on both timberland and all forest land. Under the high harvest scenario, decreases were projected for ecoregions 1, 2, 3, and 4 as well as a statewide decrease on timberlands. Results were similar on all forest lands but increases were limited to ecoregions 3 and 4 and statewide. Decreases were likely due to the decline in mature conifer forests in the northern portion of the state.

Black-capped Chickadee (*Parus atricapillus*)
The Black-capped Chickadee is a common to abundant permanent resident throughout the state (Janssen 1987). Relatively short migrations do occur

when the species moves from north to south every fall and in the reverse order in the spring. It can often be seen with migrating vireos and warblers, especially during fall migration (Janssen 1987). The species has a wide continental distribution, occurring throughout the central United States and north into Canada (Peterson 1980).

The overall natural history of this species has been well described by (Smith 1991). The species occupies a wide range of breeding habitats, occurring in open woodlands, fragmented forests, and in suburban areas (Harrison 1975). In northern Minnesota, highest breeding densities (1.7 pairs/40 acres) were in mature upland spruce and paper birch stands in the Chippewa National Forest in 1991 (Hanowski and Niemi 1991a). The species was less abundant in the Superior National Forest, but highest densities were in mature pine stands (Hanowski and Niemi 1991b). In Michigan, they were found in almost every forest type with little evidence of preference for a particular type (Brewer et al. 1991). Hence, this was classified as a cavity-dependent species.

The Black-capped Chickadee nests in a cavity that is often self-excavated in decaying wood (Roberts 1932, Harrison 1975). Dead, soft-wood or early successional tree species, either well-decayed stubs or limbs, are most often selected for excavation (Odum 1941). In Vermont, all Black-capped Chickadee nests were excavated in well-decayed deciduous snags with broken tops (Runde and Capen 1987). The species typically lays from 6 to 8 eggs and incubation requires from 12 to 14 days (Harrison 1975).

The winter diet of Black-capped Chickadees includes eggs of moths, plant lice, katydids, and spiders. Supplemental winter feeding of this species increases winter survival (Brittingham and Temple 1988). In summer, the species primarily consumes invertebrates (Roberts 1932, Martin et al. 1951).

The species has shown a positive increase in numbers on Breeding Bird Survey routes in Minnesota over the past 20 years (Janssen 1990). This is likely the result of the increased number of feeders which increases winter survival, their relative tolerance for many types of disturbances as long as suitable nest cavities are present, and the wide range of forested habitats that are used by the species. Some concern is warranted on the relative availability of suitable trees for cavity nest sites and for protection during cold winter weather. One study in Connecticut showed that winter survival rates declined after the initiation of clearcutting in the area (Loery and Nichols 1985). Similarly, a number of closely-related species in the genus *Parus* have shown relatively dramatic declines from the 1940s to the 1970s presumably due to the increase in treeless areas due to clearcutting and the decrease in availability of dead trees or snags (Jarvinen et al. 1977).

The Black-capped Chickadee showed significant decreases in suitable habitat in ecoregions 3 and 4 under the medium harvest scenario on timberlands and in ecoregions 1, 2, 3, 4, and statewide under the high harvest scenario when all timberlands were considered. Similar decreases were observed when all forest lands were considered, except no significant decreases were observed in ecoregion 2 under the high harvest scenario. The species also showed increases in suitable habitat in ecoregions 7 and 9 in the base and medium harvest scenarios and increases in ecoregion 7 in the high scenario when all timberlands or all forest lands were considered. The explanation for changes to this species are due to the projected decreases in the maturity of the forests under the medium and high scenarios.

Boreal Chickadee (*Parus hudsonicus*)

The Boreal Chickadee, formerly the Brown-capped Chickadee, is a rare to uncommon permanent resident throughout north central and northeastern Minnesota (Janssen 1987, Green and Niemi 1978), with populations fluctuating widely between years. The species has been reported to breed as far south as northern Aitkin County and as far west as eastern Marshall and Roseau Counties. Infrequent irruptions in late September may result in permanent residents moving southward, while immigrants into northern Minnesota may increase numbers in that region. Movements of residents as far south as Cottonwood, Hennepin, Martin, Stearns, and Wabasha Counties can occur (Roberts 1932, Janssen 1987). These are often in association with mixed flocks of Black-capped Chickadees (*Parus atricapillus*), kinglets, nuthatches and small woodpeckers (Ehrlich et al. 1988). These distributions may persist from early September to early March. Overall the species is distributed from Alaska, across Canada, northern portions of Minnesota, Wisconsin, and Michigan, and to northern New England (Peterson 1980).

Throughout their range, Boreal Chickadees breed in boreal coniferous and mixed coniferous-deciduous woodlands. In Minnesota this is best represented by the black spruce-tamarack community. This habitat is typified by lowland areas dominated by black spruce, tamarack, and white cedar. In these areas, the subcanopy is sparse, the understory poorly developed, and the herbaceous layer well represented, usually by mosses. It can also be found in deciduous uplands, but the presence of balsam fir, white spruce, or pine are necessary. Breeding may also take place in more open, ericaceous-muskeg bog communities (Green and Niemi 1978). In Michigan, breeding Boreal Chickadees were found in sparse jack pines, bordered by spruce, tamarack, and leatherleaf bogs (Walkinshaw and Dyer 1954). Gillespie and Kendeigh (1982) found Boreal Chickadees to be a forest interior species, avoiding forest edge habitats.

Boreal Chickadees construct their nest in cavities, either natural, woodpecker-excavated, or in some cases, excavated on their own. One clutch of 5 to 8 eggs is laid per year. Both parents care for the young, with the male performing the bulk of the feeding immediately after hatching. Their diet includes seeds, insects, and spiders and their eggs, which they glean from the bark and foliage of the vegetation (Ehrlich et al. 1988). In general, they are more generalized in feeding than the Black-capped Chickadee and also forage higher in the vegetation (Rabenold 1978).

The Boreal Chickadee was classified as a species associated with mature, coniferous forests, and a cavity-dependent species. Little is known about the trends of this species in Minnesota. The species only occurred on four of the Breeding Bird Survey roadside count routes run by the USFWS.

Boreal Chickadee populations can be expected to decline if forestry practices result in reductions of conifer or mixed boreal forest. Indirect declines in Boreal Chickadee populations may potentially be caused by reductions in populations of primary cavity nesting species which provide suitable nest cavities for this species.

The Boreal Chickadee was projected to decrease in ecoregion 3 on all forest lands, but increase in ecoregion 5 under the base harvest scenario using timberlands and all forest lands.

Under the medium harvest scenario, the species was projected to decrease in ecoregion 3, but increase in ecoregion 5 using timberland and all forest lands.

Under the high harvest scenario, the species was still projected to increase in ecoregion 5, but decreases were projected for ecoregions 1, 2, 3, and 4 and statewide using timberlands. Results were the same when all forest lands were considered for increasing projections in ecoregion 5, but projected decreases were limited to ecoregions 3 and 4. The statewide trend of a projected decreased population on timberlands was due to the relatively high proportion of the available habitat for this species being within ecoregions 1 and 4. The species is very marginal in ecoregion 5, where it is only found in the extreme northern part of that ecoregion.

Tufted Titmouse (*Parus bicolor*)
The Tufted Titmouse is a permanent resident in Minnesota, but only occurs in the very extreme southeastern corner of the State (Janssen 1987). The species expanded its range northward in Minnesota from 1940 to 1970 to Hennepin County. However, since the mid-1970s its range has gradually retreated southward (Janssen 1987). Southern Minnesota is at the northern limit of the species range in North America. It occurs throughout the eastern and central United States primarily to the south and east of Minnesota (Peterson 1980).

Mature, deciduous woodlands are required for both breeding and wintering habitat for this species (Harrison 1975). This bird is also attracted to shady suburban yards and often frequents feeders (Brewer et al. 1991). Unlike Black-capped Chickadees that migrate, adult Tufted Titmice generally remain within a restricted area throughout the year. Banded birds remained within 20 miles of the banding site (Elder 1985) and winter flocks usually forage within a 15 to 20 acre area (Condee 1970).

The Tufted Titmouse builds its nest in a natural cavity or old woodpecker hole, but also will use nest boxes. It rarely excavates its own nest hole (Forbush 1929). Cavities used range in height from 1 to 30 m, and a typical clutch size is 5 to 6 eggs (Harrison 1975). Incubation requires 12 to 13 days. Caterpillars form more than 50 percent of the animal diet for this species, and wasps make up a large proportion as well (Martin et al. 1951).

Based on these data, the species was classified as a bird of mature forests, a hardwood dependent species, and a cavity nesting species in Minnesota.

The population status of the species has remained unchanged over the past 20 years (Janssen 1990). However, the species has only been recorded on three of 52 routes in Minnesota during the past 25 years.

No changes were projected for this species in ecoregions or statewide under any of the three harvest scenarios.

Red-breasted Nuthatch (*Sitta canadensis*)
Red-breasted Nuthatches are residents from Alaska across Canada, south into California and Arizona, and, in the east, south into the Appalachian Mountains (Terres 1987). In Minnesota, Red-breasted Nuthatches are regular permanent residents across the northeastern and north central portions of the state, nesting as far south as Hennepin, Ramsey and, Stearns counties (Janssen 1987). In the regions of the state south of the coniferous forests, the species is a winter resident in much reduced numbers (Roberts 1932).

Red-breasted Nuthatches primarily occur during the breeding season in mature coniferous forests, including both upland and lowland types (Roberts 1932, Martin 1960, Erskine 1977, Green and Niemi 1978, Capen 1979, Niemi and Pfannmuller 1979, Brewer et al. 1991). The species also is known to use mature deciduous forest habitats, but usually its use within these habitats is associated with the presence of conifers (Brewer et al. 1991). Because of the high association of this species with conifers, this cavity-dependent species was classified as dependent on conifers and mature forest types. The species occurs in midseral to mature stands, but prefer more mature stands of conifer succession for foraging (Langelier and Garton 1986). The species also prefers unbroken canopies, avoiding canopy openings (Langelier and Garton 1986).

Red-breasted Nuthatches nest in existing cavities, or more rarely excavate their own. Use of natural cavities may be restricted by competition for these cavities with red squirrels (*Tamiasciurus hudsonicus*) (Hardin and Evans 1977). Self-excavated nests are usually found in trees having portions softened by decay and are seldom excavated through a layer of hard sapwood. Hence, aspen and paper birch are often preferred (Harestad and Keisker 1989). Evans and Connor (1979) suggest that tree at least 30 cm dbh is optimal. Dead snags with their tops broken off and only a few branches remaining are also favored nesting sites (Raphael 1984). When excavating a cavity, the female chooses the site and does most of the excavation (Hardin and Evans 1977). Nests are constructed largely of grasses. Four to seven eggs are laid, which hatch after a period of twelve days (Roberts 1932).

Food items include insects and their eggs and pine seeds (Martin 1960, Ehrlich et al. 1988). The young are fed nearly 100 percent animal matter (Roberts 1932). Pine, spruce, and fir seeds as well as insects when available, are the primary winter foods (Hardin and Evans 1977). The species also frequently visit feeders in winter where it forages on seeds and suet. Red-breasted Nuthatches forage equally on live trees and snags, utilizing a wide variety of tree species. Most foraging is concentrated on branches and in the foliage (Raphael 1984). Because of their dependence on seeds, populations of Red-breasted nuthatches are subject to irregular irruptions (Roberts 1932). Fall migrations usually begin in August, but during years of irruptions, southward movements may begin as early as July. These irruptions are most likely tied to cone crop failure in more northern areas (Bock and Lepthien 1972).

In Minnesota, no detectable trend in the population has been noted on the Breeding Bird Survey roadside counts from 1966 to 1989 (Janssen 1990).

Red-breasted Nuthatches benefit from forests managed for high tree species diversity, especially conifers. This may be achieved by planting mixtures of trees in clearcuts, retaining conifers, and employing both even and uneven aged forest management techniques (Airola and Barrett 1985). Forest management practices such as select cuts may be tolerated by the species as long as a suitable number of mature trees remain and the general characteristics of a closed canopy are maintained.

Under the base harvest scenario, the species was projected to increase in ecoregions 2 and 5 on timberlands, but only in ecoregion 5 when all forest lands were included. In the medium harvest scenario, the increases were confined to ecoregion 5. Under the high harvest scenario, the species was again projected to increase in ecoregion 5 on both timberlands and all forest lands. However, the species was projected to have decreased available habitat in ecoregions 1, 2, 3, and 4 and statewide on timberlands and decreased habitat in ecoregions 1, 3, and 4 but no statewide change on all forest lands. In general, ecoregion 5 contains relatively little suitable habitat for this species. The projected decreases are primarily due to the reductions in mature coniferous forest habitat projected under the high harvest scenario.

White-breasted Nuthatch (*Sitta carolinensis*)
White-breasted Nuthatches are widely distributed in the eastern United States from the Mississippi River to the Atlantic coast, and along the west coast from southern Canada to Mexico (Peterson 1980, Terres 1987). The species is a permanent resident of the state and is common in all regions, except the northeast (Roberts 1932, Janssen 1987).

White-breasted Nuthatches are distributed primarily in mature hardwood forest communities, generally with closed canopies and open understories (Roberts 1932, Crawford et al. 1981, Brewer et al. 1991). Many of these habitats are characterized by tall (30 m) supercanopies with sparse shrub and ground cover (Green and Niemi 1978). Adams and Barrett (1976) found higher densities of White-breasted Nuthatches in a mature, undisturbed forest than in a selectively cut forest with the characteristics of an earlier seral stage. Results from data gathered in the Chippewa and Superior National Forests showed a preference for mature, deciduous forests (primarily paper birch and aspen), with relatively closed canopies (Hanowski and Niemi 1991a, 1991b). This species requires a minimum area of about 5 acres and is found in greater abundance in forests of 25 or more acres in size (Galli et al. 1976). Based on these habitat requirements, the species was classified as dependent on mature, hardwood forests.

White-breasted Nuthatches are primary cavity-nesting birds; however, they are relatively weak excavators. One study found them to excavate only 15 percent of their holes for nesting (Raphael and White 1984). Rotted out knot-holes are often exploited for cavity construction. They prefer to nest in paper birch and aspen trees that are infected with fruiting bodies of heartwood rot fungi (Harestad and Keisker 1989). Natural cavities and previously excavated cavities were found to be used to different degrees (Kilham 1968, Raphael and White 1984). Small twigs, grass, bark strips, and hair may be used to line the nest (Roberts 1932). Dirt is often smeared around the cavity entrance and deposited on the cavity floor, presumably for sanitary reasons (Duyck et al. 1991). Insects, hair, and other materials are held in the bill and swept back and forth around the outside of the cavity opening to remove the scent of squirrels and reduce their chance of finding the cavity (Kilham 1968).

Five to eight eggs are laid and are incubated for twelve days (Ehrlich et al. 1988). The White-breasted Nuthatch's diet includes caterpillars, spiders, insects, insect eggs, and nuts and acorns in winter (Ehrlich et al. 1988).

Territories are maintained year-round by mated pairs of nuthatches (Woodrey 1990). Preferred winter habitats include forests with open crowns (in contrast to their breeding habitats with closed canopies). These forests tend to have sparse understories and many logs on the ground (McComb and Rumsey 1983). Winter territories are defended from conspecifics, but other species are allowed access to the area; occasionally they join mixed flocks with Brown Creepers (*Certhia americana*), Downy Woodpeckers (*Picoides pubescens*) and chickadees (Grubb 1982). Female White-breasted Nuthatches are socially subordinate to males and may display different foraging niches (Grubb 1982).

Populations of the White-breasted Nuthatch have been increasing significantly by about 1.5 percent per year in the state over the last 23 years based on the breeding bird survey roadside counts (Janssen 1990).

Forest management practices which will likely benefit White-breasted Nuthatches should focus on providing mature forests, little understory, and birch or aspen, the latter especially with fungal heart rot present. Selective cutting and light cuts of large diameter trees may achieve these objectives (Crawford et al. 1981).

The species was projected to increase in ecoregions 7 and 9 on all timberlands and in ecoregions 5, 7, and 9 on all forest lands in the base harvest scenario. Under the medium harvest scenario, the species was projected to increase in ecoregions 7 and 9 on both timberlands and all forest lands, but decrease in ecoregion 4 on both timberlands and all forest lands. Under the high harvest scenario, the species was still projected to increase in ecoregion 7 on timberlands and all forest lands, but decrease in ecoregions 1, 2, 3, and 4 and statewide on timberlands. When all forest lands were considered in the high harvest scenario, the species was still projected to decrease in ecoregions 1, 3, and 4 and statewide. The projected increases in the southern ecoregions is primarily due to the increase projected for mature hardwood forests in the affected ecoregions. The projected decreases in the northern ecoregions are primarily due to the reduction in available habitat of mature hardwood forests.

Brown Creeper (*Certhia americana*) formerly (*C. familiaris*)
The Brown Creeper is a regular summer resident in the state, primarily found in the north central and northeastern regions. It is occasionally a common winter visitor to the southern half of Minnesota (Janssen 1987), and can sometimes be found in winter throughout the state (Roberts 1932). Birds not remaining on the breeding grounds winter throughout the forested region of the U.S., and as far south as Nicaragua (Ehrlich et al. 1988). Distribution of this species is circumboreal, where it is found throughout the forests of Eurasia as well as North America.

Brown Creepers have a distinctive foraging search pattern. A bird will land on the trunk of a large tree, near the base, and spiral its way up, gleaning invertebrates from the bark. It then flies to the base of the next tree to repeat the process. It uses its long, stiff tail for support, and its slender, decurved bill to pluck invertebrates from crevices in the bark. Populations of Brown Creepers have been found to be positively correlated with abundance of spiders crawling on tree trunks (Mariani and Manuwal 1990). Other invertebrates, especially beetles also are important food items (Otvos and Stark 1985).

Nests are built from twigs, bark, and invertebrate silk (Davis 1976) behind loose pieces of bark where cracks and holes permit the birds to enter the small spaces between the bark and trunk. Cracks are typically 5 to 28 cm long and 1 to 3 cm wide (Davis 1976). Clutches usually contain 5 to 6 eggs which are incubated for 15 days. Young fledge 15 to 16 days after hatching (Davis 1976, Ehrlich et al. 1988).

Robbins (1991) identifies the habitat requirements for Brown Creepers in Wisconsin as maple-hemlock-pine forests in the north and silver maple-elm forests in the south. Michigan habitat has been described by Davis (1976) as white cedar swamps and oak-red maple-american elm uplands within 60 m of water, especially where canopy openings permit light penetration. Monitoring data for the Chippewa and Superior National Forests (Hanowski and Niemi 1991a, 1991b) suggest that Brown Creepers prefer mature lowland deciduous stands and mature mixed swamp conifer forests. Other mature forest habitats are utilized where suitable large trees are available for nesting (Apfelbaum and Haney 1977). This species was classified as a mature forest bird.

Breeding Bird Survey Data (Robbins and Bystrak 1986) have indicated an increase in populations from 1965 to 1979 in the Great Lakes States. For instance, in Minnesota the Brown Creeper has been increasing at a rate of 4.9 percent annually since 1966; however, these trends were based on only four census routes for which adequate data were available (Janssen 1990).

Sensitivity to Brown-headed Cowbird parasitism has only been documented on one occasion (Davis 1976). If fragmentation of suitable nesting habitats allows cowbird penetration into areas used by Brown Creepers for nesting, nest parasitism and desertion by parents is likely to increase. Kuitunen and Helle (1988) also found higher rates of nest destruction in areas within 20 m of a forest edge, and lower nest box occupancy in stands <20 acres compared to stands >50 acres in northern and western Europe.

Intensive forest management may adversely impact Brown Creeper populations in other ways. For example, dead and dying trees are essential in providing suitable nest sites. No published guidelines exist however, on types and densities of snags required for maintaining populations of Brown Creepers. Brown Creepers specialize in foraging for bark-dwelling invertebrates. Removal of older trees with higher resident invertebrate populations will likely reduce the prey base, and have a negative effect on Brown Creeper populations.

Suitable habitat for the Brown Creeper was projected to increase in ecoregion 3 under the base harvest level on both all forest land and timberland. Decreases however, were projected to occur in ecoregion 4 under the medium and high harvest scenarios on both timberland and all forest land. A statewide decline was also projected for timberland under the medium harvest level. Under the high harvest level, a decrease was projected for ecoregion 2 and statewide on both all forest and timberland. Decreases in the northern portion of the state were likely due to the loss of mature forests in this area.

House Wren (*Troglodytes aedon*)
The House Wren's breeding range extends from southeastern British Columbia and northern Alberta to New Brunswick; south to Baja California, Mexico, and northwestern Texas; and east to North Carolina (DeGraaf et al. 1991). In Minnesota, the species is a widely distributed, numerous summer resident throughout the state (Janssen 1987). The House Wren is a short-distance migrant that winters from southern California to northern Texas, and coastal Maryland south to Mexico, the Gulf Coast, and Florida (DeGraaf et al. 1991). The species is a common spring and fall migrant throughout Minnesota that arrives during mid-April through mid-May and leaves during mid-August through mid-October (Janssen 1987).

The House Wren breeds in deciduous forests, open woodlands, farmlands, edges of orchards, and suburban gardens (Bent 1948, Ehrlich et al. 1988, DeGraaf et al. 1991). Kroodsma (1973) found the wren associated with low shrub density and increased grassy substrate. In Minnesota, House Wrens have been observed in mature aspen (3 pairs/40 acres) (Kelleher 1967); regenerating aspen (6 pairs/40 acres) (Bergstedt and Niemi 1974); and regenerating jack pine (about 3 pairs/40 acres) (Niemi 1975). The occurrence of the House Wren in recent clearcuts of hardwood or conifer is highly dependent on the availability of suitable nest sites such as those in dead trees left following timber harvesting. For example, the species was commonly found in recently burned areas with many dead trees (Niemi 1977), but was rare or absent in many clearcut areas without such trees (e.g., Niemi 1977, Niemi and Hanowski 1984). Scott and Crouch (1987) also found that in southwestern Colorado, House Wrens preferred clearcuts to mature forest.

The species builds its nest in natural cavities, old woodpecker holes, or nest boxes typically less than 3 m above the ground (Harrison 1975). The species, therefore was classified as a cavity dependent. Clutch size ranges from five to eight eggs, commonly six to seven (Robinson and Rotenberry 1991). The House Wren is an insectivorous lower-canopy gleaner (DeGraaf et al. 1985) whose diet includes caterpillars, millipedes, spiders, grasshoppers, crickets, and snails (Keast 1990, DeGraaf et al. 1991). Prey selection has been shown to depend on abundance, size, and ease of capture (Guinan and Sealy 1987).

Breeding Bird Survey data from 1965 to 1979 show that the House Wren population increased in the Eastern and Central regions despite a winterkill (1976–77) in the East (Robbins et al. 1986). However, Minnesota Breeding Bird Survey data from 1966 to 1989 showed no change in populations during this period (Janssen 1990).

The House Wren has been shown to be widely varying in its habitat preferences and uses a variety of open habitats if appropriate nest boxes are available. Its use of regenerating forests can be greatly enhanced by retention of live or dead trees in recently cut areas.

Due to this species affinity with early successional habitats, it will likely increase in abundance. Increases in suitable habitat were projected for ecoregions 1, 5, 6 ,7 and 9 on timberland under all harvest levels. When all forest land was considered, the species was projected to increase in ecoregions 1, 6 and 7 under all harvest scenarios and in ecoregions 2 and 3 under the high harvest regime. The species was also projected to increase in ecoregion 2 in the medium harvest scenario and in ecoregions 2 and 3 in the high harvest scenario on timberlands.

Winter Wren (*Troglodytes troglodytes*)

The Winter Wren's breeding range extends from coastal southern Alaska to central Quebec and southern Labrador; south to central California, Idaho, northeastern Minnesota and southern Wisconsin; and in the Appalachians to northeastern Georgia (DeGraaf et al. 1991). In Minnesota, the species is a summer resident in the coniferous forest of the northeastern and north central regions of the state (Janssen 1987). Records indicate that nesting may occasionally be attempted in the east central and southeastern regions of Minnesota (Hennepin, Houston, and Goodhue counties) near the Mississippi River (Janssen 1987).

The Winter Wren is a short-distance migrant that winters from southern Alaska along the coast to southern California and central New Mexico; and southern Michigan east to Massachusetts, and south to the Gulf Coast (DeGraaf et al. 1991). The Winter Wren is an uncommon spring and fall migrant in the eastern and central regions of Minnesota, and a rare migrant in the western regions (Janssen 1987). The species arrives in Minnesota during late March through late May (with a peak in late April), and leaves during late August through mid-November (Janssen 1987).

The Winter Wren breeds in coniferous forest with dense understory (Roberts 1932, Barrows 1986), thickets near boreal swamps and bogs (Brewer et al. 1991), banks of marshy ditches, and slash piles (Bent 1948). The abundance of Winter Wrens in mature northern hardwood forests is often related to decaying deadfall and brush piles (e.g., Roberts 1932). In Minnesota, Winter Wrens have been observed in pole-size black spruce and tamarack (Pfannmuller 1979, Warner and Wells 1984), and mature elm-ash-cottonwood forest (Bell and Candee 1981). The species has also been observed in pole size aspen (3 pairs/40 acres), pole size and mature cedar (3 pairs/40 acres), and pole size black spruce and tamarack (3 pairs/40 acres) (Hanowski and Niemi 1991a, 1991b). In Michigan, the wren was absent in narrow, linear forest tracts less than 250 acres (Brewer et al. 1991). The species was not classified into any EQB group.

The Winter Wren nests in cavities amid upturned roots of fallen trees, under stumps, in brush heaps, or rocky crevices (Roberts 1932, DeGraaf et al. 1991). Clutch size ranges from four to seven eggs, commonly five to six (Harrison 1975). The wren is an insectivorous ground gleaner year round (DeGraaf et al 1985) whose diet includes a variety of insects and spiders.

Breeding Bird Survey data from 1965 to 1979 show an overall continental decline for the Winter Wren population despite an increase in the species population in the Western Region (Robbins et al. 1986). The Winter Wren population was increasing in both the Eastern and Western regions through 1976, but its speculated vulnerability to the severe winter weather of 1976–77 and 1977–78 reversed the trend in the Eastern Region and possibly contributed to a 14-year decline (Robbins et al. 1986). Minnesota Breeding Bird Survey data from 1966 to 1989 reflects this continental trend (Janssen 1990). Forest management practices which remove all decayed trees may be detrimental to the Winter Wren due to the species nesting habits. Leaving brush piles in recently cut areas are beneficial and is likely the only reason this species is found in recently cut areas. Forest fragmentation may also increase predation of this species due to its ground nesting habit.

Suitable habitat available for the Winter Wren was projected to decrease in ecoregion 1 under the high harvest scenario on timberlands. Increases, however were noted for ecoregions 1 and 4 under the base harvest scenario on timberlands and on all forest land. Increases were likely due to the wide range of habitat types and age classes that this species is associated with.

Golden-crowned Kinglet (*Regulus satrapa*)
This is one of the smallest forest birds of Minnesota, except for the Ruby-throated Hummingbird, generally weighing between 5 to 6 g (Roberts 1932).

It is one of three warbler-like Minnesota species in the family Muscicapidae in which its primary biogeographic affinities are with species in the Old World. The species is similar to the Firecrest (***Regulus ignacapillus***) which is commonly found in European forests. The Golden-crowned Kinglet has a relatively wide but disjunct breeding distribution. The eastern population breeds from northwestern Manitoba to Newfoundland south to northern New York and northern Minnesota. The western population occurs along the West Coast from Alaska to northern California and inland throughout the Rocky Mountains from New Mexico north to Alberta and the southern Northwest Territories (DeGraaf et al. 1991).

The species is a permanent resident in the state, but since most individuals leave the state during winter, it is formally classified as a short distance migrant. Its winter population and distribution is primarily in the southern part of the state, while its summer distribution is in the conifer, boreal forests of the northern part (Roberts 1932, Janssen 1987, Galati 1991). Minnesota is in the northern limits of its winter distribution. Root (1988) suggests that the species does not overwinter in areas in which the coldest January temperatures exceed 0°F (-18°C) and it is most abundant in the coastal plains of northern Virginia, South Carolina, and Georgia to the Arkansas-Louisiana border and north along the Mississippi River to southern Missouri. The species is also quite common in winter in the western Cascades and along the coastal forests from Washington to northern California.

Spring migrants in Minnesota appear in early March to mid-May, with peak numbers generally in mid-April. Fall migrants begin leaving the state in early September to early December, with peak numbers in mid- to late-October (Janssen 1987).

The primary breeding habitat in the state is coniferous forests including those dominated by white cedar, black spruce, white spruce, tamarack, and, to a lesser extent, pine (white, jack, and red) (Roberts 1932, Green and Niemi 1979, Niemi and Pfannmuller 1979, Niemi and Hanowski 1984, Galati 1991). Niemi (1985) recorded very high densities in upland white cedar habitats of Hovland Woods, along the North Shore of Lake Superior. The species is a very active feeder that gleans and hovers for insects among the evergreen trees, often times at the outer edges of the tree branches (Sabo 1980). It also nests in the same evergreen trees, often at the top of these trees (Roberts 1932, Galati 1991) where it is relatively safe from many mammalian predators.

This species is classified as a conifer-dependent species because of its high degree of association with conifer trees which it uses both for nesting and feeding. It also is associated with mature forests, where it reaches its highest densities (e.g., Niemi 1985). Observations by Niemi and Hanowski in the

Chippewa and Superior national forests in 1991, however, indicate that the species will use mature deciduous forests if large coniferous trees (e.g., balsam fir, white spruce, or white cedar) are present. Unfortunately, habitat classification systems used for forest inventories do not clearly specify the number or ages of the conifer component within deciduous-dominated forests. Hence, the species overall presence in these sites is largely unknown.

The species has likely been affected by reduced densities of coniferous trees in the state. It is a species that is closely associated with many conifer-dwelling neotropical migrant birds such as the Cape May Warbler, Bay-breasted Warbler, Connecticut Warbler, Yellow-rumped Warbler, and Blackburnian Warbler. Management efforts that benefit any of these species will certainly benefit the Golden-crowned Kinglet also.

Breeding bird survey roadside count data indicated that insufficient data were available for this species to detect any trend because of its relatively low populations (Janssen 1990). However, most of these counts are conducted in June when singing activity is less intense and coverage is limited within the species main breeding range in northern coniferous forests.

The Golden-crowned Kinglet was projected to increase in ecoregion 1 when timberland and all forest land was considered under the base harvest scenario. Under the medium harvest scenario, the species was projected to decrease in ecoregion 3 on both timberlands and all forest lands. In the high harvest scenario, the species was projected to decrease in ecoregions 1, 2, 3, and 4 and statewide on timberlands, but only to decrease in ecoregions 3 and 4 and statewide when all forest lands were included. The reasons for the projected decreases are due to the reduction in available mature, coniferous forest habitat and the close association of this species with coniferous forests.

Ruby-crowned Kinglet (*Regulus calendula*)

Ruby-crowned Kinglets nest from Alaska, across the boreal forests in Canada, south to California and Arizona in the west and south into Minnesota, Wisconsin, and Michigan and the Appalachian Mountains in the east (Terres 1987). In Minnesota, the species is primarily found in northeastern, northern, and north central portions of the state (Janssen 1987).

In early to mid March, Ruby-crowned Kinglets begin returning to Minnesota from their wintering grounds stretching from the north central United States south to Guatemala (Janssen 1987, Terres 1987). During spring and fall migration the species is common throughout the state (Janssen 1987). Fall migration begins in late August, the majority of which continues through mid September, although stragglers may continue to pass through the state into early November (Roberts 1932). There are a few records of the species overwintering in Minnesota, however, this is usually quite rare (Janssen 1987).

Ruby-crowned Kinglets are characteristic birds of the boreal forest, breeding in mature white and red pine communities, white cedar, spruce-fir, and black spruce/tamarack bogs (Roberts 1932, Martin 1960, Erskine 1977, Green and Niemi 1978, Niemi and Pfannmuller 1979, Brewer et al. 1991, Niemi and Hanowski 1992). Trimble et al. (1974) and Ohmann et al. (1978) considered them forest interior birds, while Lepthien and Bock (1976) characterized them as edge species, displaying a tolerance or perhaps a preference for open or edge habitats. Gillespie and Kendeigh (1982) found them primarily in forest interior habitats, but also found them to visit forest-edge habitats. In Minnesota, the species sensitivity to edges or to area sensitivity have not been studied. Based on the species high association for mature conifer trees, it was classified as dependent on mature, coniferous forests including both upland and lowland types.

Nests of the species are pensile and placed attached to a conifer branch and generally 5 to 20 meters above the ground (Roberts 1932, DeGraaf et al. 1991). Nests are constructed of twigs, moss, lichen, and down. Seven to nine eggs are laid and incubated for 12 days (Ehrlich et al. 1988).

Ruby-crowned Kinglets primarily glean for insects among the tips of vegetation, but also will hawk for insects from perches. Diet primarily consists of insects, spiders, and occasionally seeds and berries (Roberts 1932, Ehrlich et al. 1988). Ruby-crowned Kinglets are generalists, foraging throughout the selected tree or shrub. However, the species has been noted to have a slight preference for the interior third of the tree (Franzreb 1976, Rabenold 1978).

During the last 25 years the species has shown a significant decline in the forested regions of the state. The species has declined by about 6 percent per year from 1966 to 1989 based on Breeding Bird Survey routes (Janssen 1990).

Changes in the forest that result in fewer coniferous trees will likely reduce the populations of this species in the state because of its high association with coniferous trees. It also forages for insects primarily among coniferous trees such as spruce, cedar, tamarack, and pines.

Most projected changes for this species under the three harvest scenarios were decreases. The only ecoregional increase noted was a projected increase in available habitat in ecoregion 1 on timberlands and all forest lands in the base harvest scenario. Under the medium harvest scenario the species was projected to decrease in ecoregion 3 on both timberlands and all forest lands. Under the high harvest scenario the species was projected to have decreased available habitat in ecoregions 2, 3, and 4 and statewide in timberlands, while in all forest lands the projected decreases were limited to ecoregions 3 and 4. The projected decreases are invariably due to the decreased availability of mature, coniferous forest habitats in areas that showed projected decreases. The reduced level of projected decrease in all forest lands under the high harvest scenario are due to the relatively high availability of habitat in ecoregions 1 and 2.

Blue-gray Gnatcatcher (*Polioptila caerulea*)
The Blue-gray Gnatcatcher is a common breeding species found from southern Utah east to southern Ontario and south to Guatemala (Peterson 1980). It reaches the northern limit of its range in southeastern Minnesota. It is common in summer southeast of the Twin Cities, and especially in Houston County (Eckert 1983). In recent years the Blue-gray Gnatcatcher has been expanding its range northward and westward along the major river valleys in the state (Janssen 1987).

This species is a short to long distance migrant, wintering from the southern United States south to the Bahamas, and west to Guatemala and Honduras (Ehrlich et al. 1988). The spring migration period is from late April to late May. In fall, the birds depart gradually during August and early September (Janssen 1987).

The Blue-gray Gnatcatcher is usually described as a habitat generalist (Ehrlich et al. 1988). In the southern United States, where the species is more common, it is sometimes found in low shrubbery (Robbins 1991). In the east it is found in open woods and brushy edges (Farrand 1983), while in the west it utilizes chaparral (Ehrlich et al. 1988). In Minnesota and Wisconsin, however, the species seems to prefer the tops of the tallest trees in mature deciduous forests. According to (Roberts 1932), "it lives in the treetops, usually in heavy woods, although some of the birds seen here were in small trees and undergrowth."

In eastern Tennessee deciduous forests, areas where Blue-gray Gnatcatchers are most frequently found have open understories and large trees forming a canopy of average biomass (Anderson and Shugart 1974). Graber et al. (1979) describe the primary breeding habitat of the Blue-gray Gnatcatcher in Illinois as riparian woods. Populations of Blue-gray Gnatcatchers in bottomland woods averaged almost three times those in upland forests. Further evidence that bottomland woods is primary Gnatcatcher habitat was shown during a population decline in 1978 when decreases were most evident in upland (less preferred) habitat, and populations in bottomlands remained stable (Graber et al. 1979). Based on these data, the Blue-gray Gnatcatcher was defined as a bird of mature and hardwood forests.

The Blue-gray Gnatcatcher forages and nests in the canopy. This species is mostly or entirely insectivorous (Ehrlich et al. 1988). Its diet consists of locusts, joint-worms, flies, gnats, caddice flies, ants, wood-boring beetles, weevils, and spiders (Roberts 1932). The nest is placed on a horizontal limb, often in an oak, and usually less than 25 feet high (Harrison 1975). Four or five eggs are laid, and probably only one brood is produced per season. This species is commonly parasitized by the Brown-headed Cowbird (Ehrlich et al. 1988).

Data collected in the USFWS Breeding Bird Survey from 1965 to 1979 indicate significant increases in numbers of Gnatcatchers recorded in the eastern Region and across the continent. Occurrences on BBS routes in Massachusetts, New Hampshire, and Vermont reflect a recent northward range expansion into southern New England (Robbins et al. 1986).

Despite these apparent increases, there is some concern for the continued well-being of this species in Minnesota. Several studies provide evidence suggesting that the Blue-gray Gnatcatcher is an area-sensitive species. In southern Wisconsin, (Bond 1957) found that this species had a strong preference for large woods. As the size of the woods increased, the peak in frequency occurred in more xeric stands, suggesting a "delicate balance between the response of the Gnatcatcher to woods size and to vegetational conditions" (Bond 1957). Lynch and Whigham (1984) found a significant negative correlation between abundance of Gnatcatchers and degree of isolation of their study plots in Maryland which suggests a sensitivity to fragmentation. In east central Illinois, Blake and Karr (1984) did not detect this species in woodlots of less than 70 acres. Robbins et al. (1989) found a significant correlation between forest area and abundance of Gnatcatchers on their study plots in the middle-Atlantic states (Maryland, Pennsylvania, West Virginia, and Virginia). They estimate that 40 acres is the minimum area required for breeding, although the maximum probability of occurrence was in areas of over 7,400 acres (Robbins et al. 1989).

Availability of suitable habitat for the Blue-gray Gnatcatcher was projected to increase in ecoregion 7 under all three harvest scenarios when all forest land was considered. Increases were projected in ecoregion 7 on timberland under the base and medium harvest regimes. Suitable habitat was projected, however, to decrease in ecoregion 4 under the medium and high scenarios for both timberlands and all forest lands. Under the high harvest level, a statewide decrease was projected for both timberland and all forest land. Decrease in ecoregion 4 and statewide were likely due to the loss of contiguous, mature, deciduous forests. Increase in the south is probably due to the lack of clearcutting and the projection of a 25 percent increase in forest land.

Eastern Bluebird (*Sialia sialis*)
The Eastern Bluebird breeds from the Atlantic coast westward to the eastern slope of the Rocky Mountains, reaching from the Gulf coast to southern Canada. Breeding populations may reach as far south as Nicaragua (Terres 1987). Eastern Bluebirds are regular summer residents throughout Minnesota, becoming most numerous in the central part of the state from Sherburne County northward to Cass County (Janssen 1987). The species is absent from most of the northern coniferous forests, except in recently burned areas where it will occasionally use shortly after burning (Niemi 1978).

Bluebirds begin returning to Minnesota in early to mid-March from their wintering grounds in Mexico and the central and southern portions of the United States. They remain in Minnesota until early September, with some stragglers lingering into November (Roberts 1932, Janssen 1987). Some bluebirds may spend their winter in the state, but in general they are susceptible to inclement weather. For example, (Roberts 1932) reported that their population was severely reduced by severe weather during the winter of 1894-95.

In forested regions, Eastern Bluebirds are breeders in areas cleared by fire or logging activities. These areas are typified by open canopies with small residual trees or snags and a dominant shrub layer of plants such as raspberry (Crawford et al. 1981). Bluebird use of these openings may be dependent on the presence of trees left standing (Green and Niemi 1978). In other regions of the state, Eastern Bluebirds breed in open areas with scattered trees, often in agricultural settings (Ehrlich et al. 1988, Green and Niemi 1978). They will also occur in fields and other forest openings where suitable nest boxes or nest holes are present. Numbers throughout the state may be increasing with the establishment of nest box programs (Janssen 1987).

Nests are constructed in cavities, either natural or artificial; natural cavities are often previously excavated by woodpeckers. The nest is built of fine grasses, twigs, and occasionally hair or feathers. Four to six eggs are laid and incubation lasts 13 to 15 days (Ehrlich et al. 1988, Roberts 1932). Eastern Bluebirds may rear two broods during one nesting season, and as many as four have been recorded (Tucker 1990). In a study of bluebirds nesting in artificial cavities, over 62 percent of the nests were successful over a five-year period (Rustad 1972).

The bluebirds' diet is made up of grasshoppers, earthworms, seeds, fruits, and berries; young birds are primarily fed insects (Roberts 1932, Ehrlich et al. 1988). Bluebirds hawk insects near the ground, often from a low perch (Ehrlich et al. 1988).

Eastern Bluebirds have been included on the Audubon Blue List in 1972, 1977-82, and 1986, most recently as a species of special concern (Tate 1986). Minnesota populations decreased during the 1970s primarily due to severe weather, but have significantly increased during the 1980s (Sauer and Droege 1990). Bluebirds may benefit if trees are left standing in logged areas, as long as they are suitable for nesting. Nest boxes and fence posts for perching have also enhanced bluebird populations (Janssen 1987).

Because of the Eastern Bluebird's affinity for recently logged habitats, the species was projected to increase statewide under all three harvest scenarios. Under the base harvest scenario, an increase for the species was projected in ecoregions 4, 5, 6, and 7 and statewide on timberlands and in ecoregions 4, 5, 6, and 7 on all forest lands. Under the medium harvest scenario, the species was projected to increase in ecoregions 3, 4, 5, 6, 7, and 9 and statewide on timberlands and in ecoregions 3, 4, 5, 6, and 7 and statewide on all forest lands. Under the high harvest scenario, the species was projected to increase in all ecoregions and statewide on both timberlands and all forest lands. The species was projected to decrease in ecoregion 2 in the base and medium scenarios on all forest lands. The magnitude of the increase for this species is highly dependent upon the availability of suitable nest sites within recently logged habitats. If dead or live trees are available within logged habitats, then Eastern Bluebirds can colonize and successfully nest within these sites. However, if the area is completely clearcut, then the species likely will not be found in the area.

Veery (*Catharus fuscescens*)

The breeding range of the Veery extends across southern Canada, and from the northern tier of states south into the Rocky Mountains and the Appalachians (Peterson 1980). This species is most common in the northern half of Minnesota, and in moist deciduous forests of the central region (Janssen 1987). It is a long distance migrant, wintering from Central America south to northern Columbia and central Brazil (Ehrlich et al. 1988). The spring migration period extends from late April to late May with the bulk of migrants arriving in mid-May. Fall migration is from late July to late September (Janssen 1987).

The Veery nests in a variety of open deciduous and mixed woodlands with dense understories of deciduous shrubs or thickets. According to Ehrlich et al. (1988), the Veery prefers a moist substrate and expands its range of breeding habitat where the Hermit and Swainson's Thrushes are absent. In the Michigan Breeding Bird Atlas Habitat Survey, most Veeries were found in moist forest types, generally northern hardwoods, and often with a conifer component. In the southern Lower Peninsula, Veeries were virtually absent from drier forests (Brewer et al. 1991). In New York, (Webb et al. 1977) found a significant upward trend in numbers of Veeries with increased intensity of logging. They recorded the greatest numbers on plots where 100 percent of the commercial grade timber was harvested (Webb et al. 1977). Robbins et al. (1989) found a significant correlation between the occurrence of Veeries and foliage density 0.3 to 1.0 m tall, as well as a significant correlation with the moisture gradient. They also found significant negative correlations with canopy height and number of tree species (Robbins et al. 1989).

According to Harrison (1975), competition between the Hermit Thrush and the Veery is reduced by their differing habitat preferences. Data from northern Minnesota suggest that there is considerable overlap in the habitat types used by these two species (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b). In general, the Veery is more common in deciduous habitats and the Hermit Thrush shows a preference for coniferous habitats. On the Chippewa National Forest in northeastern Minnesota, highest density of Veeries were recorded in saw-sized balsam fir-aspen-paper birch (10 pairs/40 acres), and the highest density of Hermit Thrushes was recorded in pole-sized balsam fir-aspen-paper birch (7 pairs/40 acres). After mixed forest, highest densities of Veeries were found in mature oak (7 pairs/40 acres), jack pine saplings (6.8 pairs/40 acres), and aspen saplings (6 pairs/40 acres). Probst et al. (1992) also found the Veery to be common in both intermediate and mature stages of aspen regeneration. Because of its affinity with primarily deciduous trees species, it was classified as a hardwood dependent bird.

In contrast, after mixed forest, highest densities of Hermit Thrushes were found in lowland conifer habitats including pole-sized white cedar, and pole-sized and sapling black spruce (Hanowski and Niemi 1991b). On the Superior National Forest there was even greater overlap in the habitat choices of the two species. In general, Veeries were more common in deciduous and upland conifer habitats and Hermit Thrushes preferred lowland conifers (Hanowski and Niemi 1991a).

The Veery nests on or near the ground, often in a brush pile. In New Hampshire, Holmes (1990) found 22 nests, all within 2 m of the ground. Three to five eggs are laid (Harrison 1975), and one brood is raised during the season (Ehrlich et al. 1988). As with other ground nesting birds, forest fragmentation may result in higher levels of predation on Veery nests (Wilcove 1985). The diet of this species consists of insects and spiders as well as some fruit, especially in fall and winter (Ehrlich et al. 1988).

There is some evidence to suggest that the Veery is an area-sensitive species (Blake and Karr 1984, Robbins et al. 1989, Brewer et al. 1991). In a study conducted in east central Illinois, Blake and Karr (1984) did not detect this species in forest islands of less than 70 acres. According to Brewer et al. (1991), the Veery has declined in areas in Michigan where intensive urbanization and agriculture have reduced previously extensive forests to remnant woodlots. Robbins et al. (1989) found a significant correlation between the occurrence of Veeries and the area of the forest tract. They suggest that 50 acres is the minimum area required for breeding, although the maximum probability of occurrence was in tracts of 625 acres (Robbins et al. 1989). This evidence suggests that fragmentation is likely detrimental to the Veery. However, more information is required in Minnesota to determine the species sensitivity to fragmentation in the state.

Data collected in the USFWS Breeding Bird Survey showed decreases in Maryland and New Hampshire as well as in the western states. Increases were recorded in Vermont and New Brunswick (Robbins et al. 1986). A slight decline over the past 25 years was reported for Minnesota (Janssen 1990).

Suitable habitat availability for the Veery was projected to increase in ecoregion 6 under all harvest scenarios. Increases were projected in ecoregions 2, 5 and 9 under the high harvest scenario. A decrease in suitable habitat was projected to occur in ecoregion 1 under the high harvest scenario. Results were the same for all forest and timberlands. Increases were likely due to the species affinity for younger forests.

Swainson's Thrush (*Catharus ustulatus*)
The Swainson's Thrush is a summer resident in the northernmost regions of the state. It occurs throughout northern portions of the northeastern United States, the boreal forests of Canada, and Alaska. Its western range is more extensive. It occurs along the West Coast and south to California and east through the Rocky Mountains (Peterson 1980). The species arrives in Minnesota from mid-April through early June and departs from late July through early November (Janssen 1987). It is a long-distance migrant and winters from Mexico south to Peru (Finch 1991).

The Swainson's Thrush is a classified as both a mature forest and conifer-dependent species because it is primarily found in mature coniferous forests in Minnesota and Canada (Roberts 1932, Erskine 1977, Niemi and Pfannmuller 1979, Green and Niemi 1982). Preferred nesting habitat in Michigan included coniferous or mixed forests of spruce, fir, cedar, or tamarack (Brewer et al. 1991). In the northeast United States, Noon (1981) reported that breeding habitat often contains both deciduous and coniferous trees, but that the species strongly prefers high conifer density in the understory.

Highest densities for this species were recorded in mature lowland conifer stands in the Superior National Forest in 1991 (Hanowski and Niemi 1991b). It also was observed in mature upland pine, aspen, paper birch, and spruce-fir habitat but was most abundant (about 2 pairs/40 acres) in mature white cedar stands. It was the most common thrush species recorded on a 1991 survey of the Boundary Waters Canoe Wilderness area, an unmanaged area in northern Minnesota (Hanowski personal obs). It was uncommon (only one record) in the Chippewa National Forest in 1991 (Hanowski and Niemi 1991a).

The Swainson's Thrush usually nests in a small conifer tree from 2 to 6 m off the ground and close to the trunk (Harrison 1975). It primarily feeds on the ground and consumes both animal and plant matter (Martin et al. 1951).

The number of Breeding Bird surveys routes where this species has been recorded has increased significantly over the past 20 years (Janssen 1990); however, coverage is limited in its preferred habitat. This species has a narrow breeding range in Minnesota, and it is dependent primarily upon conifer species in northernmost regions of the state. Loss or substantial decline in this habitat type would have a detrimental effect on the species status in the state. In addition, this species has been reported to be intolerant of vegetation disturbance associated with cottage development in Ontario (Clark et al. 1983).

Availability of suitable habitat on timberland for the Swainson's Thrush was projected to decline in ecoregion 3 under all harvest scenarios and in ecoregions 2 and 4 and statewide under the high harvest scenario. When all forest land was considered, declines were limited to ecoregion 3 under all harvest levels and to ecoregion 4 under the high harvest regime. Increases in available habitat were found in ecoregions 1 and 2 in the base harvest level on timberland, but only in ecoregion 1 when all forest land was included. Loss of conifer habitat in the northern portion of the State was likely responsible for the predicted declines.

Hermit Thrush (*Catharus guttatus*)
The Hermit Thrush is fairly common throughout its breeding range in Alaska, Canada, New England, and south into the Rocky Mountains and the Appalachians (Peterson 1980). In Minnesota it is a summer resident in the northeastern and north central regions, south to northern Pine and Mille Lacs counties, and west to eastern Marshall and Roseau counties (Janssen 1987). It is a short to long distance migrant, wintering from the southern United States and Mexico south to Guatemala, El Salvador, and the Bahamas (Ehrlich et al. 1988). The spring migration period extends from late March through mid-May with most individuals arriving in mid to late April. In the fall, the bulk of the population leaves Minnesota by mid-October, but stragglers have been recorded into December in the southern portions of the state (Janssen 1987).

The Hermit Thrush is typically found in extensive northern coniferous and mixed forests (Ehrlich et al. 1988). In northern Manitoba, (Gillespie and Kendeigh 1982) found greater numbers of Hermit Thrush territories in "forest" compared to "forest edge" habitats. According to (Harrison 1975), competition between the Hermit Thrush and the Veery is reduced by their differing habitat preferences. Data gathered in northern Minnesota (Hanowski and Niemi 1991a) suggest that there is considerable overlap in the habitat types used by these two species. However, in general, the Hermit Thrush shows a preference for coniferous habitats, and the Veery is more common in deciduous habitats.

On the Chippewa National Forest in northeastern Minnesota, the highest density of Hermit Thrushes was recorded in pole-sized balsam fir/aspen/paper birch (about 6 pairs/40 acres), and the highest density of Veeries was in saw-sized balsam fir/aspen/paper birch (10 pairs/40 acres). After mixed forest, the highest densities of Hermit Thrushes were found in lowland conifer habitats including pole-sized white cedar (about 5 pairs/40 acres), pole-sized black spruce (about 4 pair/40 acres), and sapling black spruce (about 4 pairs/40 acres). In contrast, after mixed forest, the highest densities of Veeries were found in upland conifers (young jack pine) or in deciduous stands (mature oak, young aspen, and mature birch) (Hanowski and Niemi 1991b). On the Superior National Forest there was even greater overlap in the habitat choices of the two species, but, in general, Hermit Thrushes preferred lowland conifers, while Veeries were more common in deciduous and upland conifer habitats (Hanowski and Niemi 1991a).

The Hermit Thrush primarily builds its nest on the ground at the base of a small tree, shrub or fern (Harrison 1975), although nests in shrubs and trees has been reported (e.g., Holmes 1990). In the west, it occasionally nests in trees 1 to 2 m above the ground. Three to four eggs are laid and two, possibly three, broods are raised in the southern portions of its range (Ehrlich et al. 1988). As with other ground nesting birds, forest fragmentation may result in higher levels of predation on Hermit Thrush nests (Wilcove 1985). The Hermit Thrush forages on or near the ground. Its diet consists of insects, spiders, earthworms, and small salamanders. Fruit is an important part of its diet in winter (Ehrlich et al. 1988).

Data collected in the USFWS Breeding Bird Survey showed an increase in the eastern region through 1975, followed by a sharp decline through 1978. The decline was attributed in part to severe weather on the wintering grounds in the southern United States during 1976 and 1977. Highest densities were reported in Maine, Nova Scotia, New Brunswick, Quebec, the Yukon, and portions of the spruce-hardwood forest region including the Arrowhead region of Minnesota (Robbins et al. 1986).

Although there is currently no evidence to suggest that the Hermit Thrush is an area-sensitive species, forest fragmentation within its breeding range is not yet extensive. The extent of coniferous and mixed forests is likely to be a limiting factor for this species in Minnesota. The species occurs in a wide variety of forested habitats, but is most abundant in mature stages (e.g., Probst et al. 1992). Hence, this species was classified in the mature forest bird group.

An increase in suitable habitat for the Hermit Thrush was projected in ecoregion 2 under the base harvest level on timberlands. A decrease was projected in ecoregion 4 under the medium harvest level on timberland. Under the high harvest scenario, the species was projected to decrease in ecoregions 2, 3, and 4 and statewide on timberlands. Results were the same on all forest land, but no change was projected in ecoregion 2. Declines in this species were likely due to the decrease in mature forests (both conifer, deciduous, and mixed) in the northern portion of the state.

Wood Thrush (*Hylochichla mustelina*)
The Wood Thrush's breeding range extends from southeastern South Dakota and northern Michigan east to southeastern Canada, and south to the Gulf Coast and northern Florida (Farrand 1983). The species reaches the northwest limit of its range in Minnesota. It is numerous along the Mississippi River and its tributaries, and locally from maple-basswood forests of central and north central regions of the state, to the hardwood forests in Cook County (Janssen 1987). The Wood Thrush is a long distance migrant that winters from eastern Mexico to northwestern Columbia (Rappole et al 1983). In Minnesota, the species arrives in late April to late May, and leaves during mid-August, with most individuals gone by mid-September (Janssen 1987).

The Wood Thrush breeds primarily in mesic deciduous forest (Roberts 1932). It is also found in mixed forests with a well-developed understory and on occasion, in urban habitats (James et al. 1984, Brewer et al. 1991). In Minnesota, the Wood Thrush is more common in moderately aged (15- to 40-year-old) deciduous forests, but also has been observed in mixed habitats such as fir-spruce-birch forest type (Hanowski and Niemi 1991a, 1991b). This is consistent with the observations of James et al. (1984) throughout the breeding range of the species. Thus, the species was classified as a hardwood and mature forest dependent species.

The species nests 2 to 15 m from the ground and clutch size ranges from three to four eggs, occasionally two (Harrison 1975). The Wood Thrush is an omnivorous ground forager whose diet consists mainly of beetles, spiders, orthoptera, lepidoptera and fruit (Brewer et al. 1991).

Breeding Bird Survey data from 1965 to 1979 showed that Wood Thrush populations had an overall increase in the eastern U.S. where the species is extending its range, and a local increase in portions of the spruce-hardwood forest area (which includes northeastern Minnesota) (Robbins et al. 1986). However, no trends were noticeable in the data analyzed from 1966 to 1989 in Minnesota, which suggests a stable population (Janssen 1990). The Wood Thrush is a common Brown-headed Cowbird host. Increased forest fragmentation and the subsequent increase in cowbirds and predators may be detrimental to this species (Brittingham and Temple 1983).

Suitable habitat for the Wood Thrush was projected to increase in the southern portion of the species' range in ecoregion 7 under all harvest levels in both all forest and timberland. Decreases will likely occur in the north in both all forest land and timberland in ecoregion 4 and statewide under the medium and high levels and in ecoregions 3 and 4 and statewide under the high harvest scenario. Increases in the south are likely due to the increase in forest area and lack of clearcutting. Decreases in the north are probably due to the loss of mature forests from harvesting and a decrease in size of forest area.

American Robin (*Turdus migratorius*)

The American Robin is probably the most familiar bird to residents of Minnesota. It is a common resident throughout the state in summer, and occasionally over-winters along Lake Superior's North Shore and in the Twin Cities area (Janssen 1987). The American Robin is considered by many to be the true harbinger of spring. The first individuals typically arrive in early March, often before the last snowfall of the season. Peak spring migration usually occurs in late March and April. Most fall migrants are seen from late September to October (Janssen 1987). Breeding range of this species includes nearly all of North America south of the treeless zone (Roberts 1932). Wintering birds can be found as far south as Bermuda or Guatemala (Ehrlich et al. 1988).

Earthworms are well known as a major part of the diet of the American Robin, but snails, caterpillars, beetles, grasshoppers, other invertebrates, and a significant amount of fruit during the nonbreeding season are also eaten (Wheelwright 1986, Keast 1990). Winter robin populations along the North Shore of Lake Superior are highly dependent on availability of berries, particularly of mountain ash trees (*Sorbus americana*) (Janssen 1987). Young birds are often fed insects (Ehrlich et al. 1988). In spring, food sources such as feeders may be strongly defended from other robins and other species. When foraging for invertebrates in vegetation, robins typically employ a "sit-and-wait" strategy rather than the "widely foraging" strategy they use when foraging on the ground or for fruit (Paszkowski 1982).

American Robins can be found in a wide variety of habitats including forests, parks, and suburban areas. They thrive in close proximity to man and often occur in greatest densities in urban surroundings (Peterjohn and Rice 1991). In forested areas, they prefer sites that have areas of relatively open shrub and ground cover. In northern Minnesota, the species was found in almost all habitat types including lowland conifer, upland pine and spruce, lowland deciduous, aspen, maple, and birch. Density within each habitat type was about 1 to 2 pairs/40 acres (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b). The species also occurred within each age type (sapling, pole, and saw size).

Nests are usually built in deciduous trees but can be found in conifers, shrubs, on houses, and on the ground (Roberts 1932, Ehrlich et al. 1988). In Maine, (Knupp et al. 1977) found that coniferous trees within 5 m of openings were preferred for nesting, although success was lower in coniferous trees (18 percent) than in deciduous trees (52 percent). Savard and Falls (1981) report a shift in preference from conifers early in the breeding season to deciduous trees later.

The nest is made of sticks, mud, grass, straw, twine, and other such material (Roberts 1932, Ehrlich et al. 1988). Four eggs are usually laid, and incubation takes 12 to 14 days (Roberts 1932, Ehrlich et al. 1988). Young are ready to leave the nest 14 to 16 days after hatching (Ehrlich et al. 1988). Nests may be vigorously defended (Ehrlich et al. 1988). Females may begin second nests after the first young are fledged and males are able to care for first broods alone (Roberts 1932, Ehrlich et al. 1988).

Expansion of irrigated agriculture has resulted in breeding range expansion of the American Robin by making available the mud needed in nest construction (Ehrlich et al. 1988). Negative impacts to American Robin populations in the past have been from DDT use (Beaver 1980, Ehrlich et al. 1988, Robbins 1991), as the pesticide was consumed by the species along with their invertebrate prey. Other sources of mortality include killing for food (Ehrlich et al. 1988) and sport (Robbins 1991). Because Robins are habitat generalists, it is unlikely that changes in timber harvest practices will have an impact on overall population trends. Management for American Robins should include protecting their invertebrate prey from chemical contamination, and providing adequate fruit supplies during spring, winter, and fall.

Roadside count data indicate a significant increasing trend of about 1.3 percent per year since 1966 in Minnesota (Janssen 1990).

Because of the wide range of habitat types and age classes that the American Robin occupies, an increase in suitable habitat was projected for this species. Increases in the base and medium harvest levels were projected for southern ecoregions; 6 and 7 under the base harvest level and 5, 6 and 7 under the medium scenario. Under the high harvest level, increases were projected for all ecoregions except 1 and 9 and statewide. Results were identical for timberlands and all forest lands except no increase was noted in ecoregion 2 on all forest land.

Gray Catbird (*Dumetella carolinensis*)
The Gray Catbird is a common summer resident in almost all of Minnesota except the northeast (Roberts 1932), where it is restricted to brushy openings (Janssen 1987). Migration periods in Minnesota peak in mid-May in the spring, and September in the fall (Janssen 1987). Birds attempting to overwinter in the state have generally been unsuccessful (Janssen 1987). Gray Catbirds range throughout North America east of the Rocky Mountains, and south of the dense boreal forests of the north (National Geographic Society 1983). Individuals winter as far south as Bermuda and Panama (Roberts 1932, Ehrlich et al. 1988).

Gray Catbirds prefer thick shrub carr habitats (Robbins 1991), dense brushy edges (Nickell 1965) and can often be found in shrubby suburban areas (Robbins 1991). In the Chippewa National Forest (Hanowski and Niemi 1991b), Gray Catbirds have been found in semi-open lowland conifer forest and regenerating and young upland deciduous habitats. In suburban environments, high deciduous shrub volume, high total shrub volume and more tall conifer trees were found in areas around nests than other areas (DeGraaf and Stihler 1979).

Nests are made from grass, forbs, twigs, strips of bark, and leaves and usually have four eggs (Nickell 1965). Incubation takes 12 to 15 days and the young generally leave the nest about 11 days after hatching (Nickell 1965). Two broods are usually raised (Nickell 1965). Nest parasitism by Brown-headed Cowbirds on catbirds has been reported to be less than that of other bird species nesting in similar habitat (Scott 1977). Catbirds are able to recognize the eggs of Brown-headed Cowbirds and generally remove them from the nest (Nickell 1965).

While Gray Catbirds eat insects and spiders, the diet of adult catbirds may be more than 50 percent fruit, and young are fed mostly insects (Roberts 1932, Ehrlich et al. 1988). Red squirrels, chipmunks, and raccoons are important predators on catbird nests in Michigan (Nickell 1965). This is likely the case in Minnesota as well.

Gray Catbirds appear to be pre-adapted to the conditions most often created by human activity, at least in terms of habitat modification (Nickell 1965). Their preference for shrub habitats and edges will likely result in increases in population with more intensive timber harvesting, especially if intense shrub growth follows. Current Breeding Bird Survey Data suggest a stable population with nearly four individuals recorded per route (Janssen 1990). A potential negative effect of intensive forest management relates to food supply. If forest ecosystems become more simplified and fruit-bearing trees and shrubs are not maintained, populations of this species may be reduced. If populations of Gray Catbird is to be maintained in Minnesota, healthy numbers of fruit-bearing trees and shrubs must also be maintained.

Suitable habitat available for the Gray Catbird was projected to increase statewide under all harvest levels and on both all forest and timberland. Regional increases were projected for ecoregions 4, 5, 6, and 7 and statewide under all harvest levels on timberland and all forest land. Under the medium and high harvest levels, additional increases were noted for ecoregion 3. An increase was also projected for ecoregions 1, 2, and 9 under the high harvest scenario. The species was projected to decrease in ecoregion 2 in the base and medium scenarios when all forest land was considered. Increases in suitable habitat reflect an increase in amount of early successional forests throughout the species range.

Brown Thrasher (*Toxostoma rufum*)

The Brown Thrasher breeds throughout most of the eastern temperate deciduous forest, generally east of the Rocky Mountains from southern Alberta to the northeastern United States, southern Quebec, to southern Florida, and east to Texas (Bent 1948, DeGraaf et al. 1991). In Minnesota the species is a breeding resident throughout most of the state, but is relatively rare in the dense forested areas of northern Minnesota (Janssen 1987).

The species overwinters in the southern United States east from Texas, throughout the Atlantic Coast, north to Maryland and southern New Jersey, and west to southern Illinois. The species is a winter visitant, primarily in southern Minnesota. The general migration period for the species is from early March to early May, with the bulk from late March to late April. Fall migration usually begins in late August and continues to late November (Janssen 1987).

The general breeding habitat of the species is forest edges, shrubby woodland growth in agricultural areas, second-growth forest, shrubby fence rows, and garden shrubbery (Roberts 1932, Bent 1948, DeGraaf et al. 1991). The species lays 4 to 5 eggs and has an incubation period of 11 to 12 days. Incubation is performed by both sexes. The nest is placed in thickets and shrub vegetation, often in "thorny" types of species. Occasionally, the nest is placed on the ground (Bent 1948).

During the breeding season the species is primarily an insectivore and consumes a variety of insects, spiders, and worms. During late summer and during the nonbreeding season, food also consists of fruits, mast, and waste grains (e.g., corn) (Martin et al. 1951).

The species has shown a significant negative decline over the past twenty years based on a decreasing proportion of routes that the species has been observed in the Breeding Bird Survey (Janssen 1990). The species was not classified into any of the groups identified in the GEIS process.

Issues of forest fragmentation due to increased use of forests, especially in the southern portions of Minnesota, are likely not an issue for this species. However, the presence of fruit-bearing trees for foods, thorny shrubs for appropriate nesting habitats, and potential applications of pesticides within its breeding habitat may have effects on the availability of both vegetable and insect food sources.

The Brown Thrasher was projected to increase in ecoregions 4, 5, 6, 7, and statewide under the base harvest scenario using timberlands. When all forest lands were included, a decrease in ecoregion 2 was noted and no increases were noted on a statewide basis. Under the medium harvest scenario, projected increases were observed in ecoregions 3, 4, 5, 6, 7, and statewide on timberlands and all forest lands. When all forest lands were included, the species was projected to decrease in ecoregion 2. Under the high harvest scenario, the species was projected to increase in all ecoregions and statewide on timberlands and all forest lands. The projected increase in sapling age classes in the forests of these ecoregions and the association of this species with early-successional vegetation is the reason for the patterns observed.

Cedar Waxwing (*Bombycilla cedrorum*)
The Cedar Waxwing nests from southeastern Alaska, across Canada, and south to the central United States. The species overwinters in the southern United States and Central America (Peterson 1980, Terres 1987). Cedar Waxwings are regular summer residents throughout Minnesota, but are most numerous in the northern coniferous forests (Roberts 1932, Janssen 1987). However, they are also regular winter visitants in the state (Roberts 1932). Flocks of 100 to 200 birds may be seen in the fall and winter areas where adequate supplies of mountain ash and crab apples are available (Janssen 1987).

Cedar Waxwings breed in woodlands, along forest edges, and in well-planted suburbs (Ehrlich et al. 1988). They are characteristic birds of the boreal forest and can be found in both uplands and conifer lowlands (Roberts 1932, Martin 1960). Occasionally they may nest in small colonies (Ehrlich et al. 1988). The nest is constructed by the female (although the male assists in collecting nest material) usually 2 to 15 meters in height (Roberts 1932). Twigs, grasses, moss, pine-needles, and bark strips may be used in the nest; in the northern regions *Usnea* moss and pine-needles are commonly used (Roberts 1932, Ehrlich et al. 1988). Three to five eggs are laid and usually hatch within 15 days (Roberts 1932).

The diet of the Cedar Waxwings includes berries, flowers, tree sap, and insects. Cedar Waxwings are excellent flycatchers and can often be seen hawking insects along lakes or streams (Roberts 1932). Fruit, however, is principal in the diet, comprising 70 percent of the yearly average (Ehrlich et al. 1988). Often during feeding, individuals may pass fruit between themselves (Roberts 1932). When foraging, they often range between the tops of the shrubs and the canopy utilizing a wide portion of the forest (Martin 1960).

Cedar Waxwings may experience parasitism by Brown-headed Cowbirds, although they are infrequent hosts. Cowbird eggs are usually ejected, destroyed, or the nest may be deserted in early stages of the breeding season (Ehrlich et al. 1988). It has been suggested that the breeding season of the Cedar Waxwing may be shifting to later in the season to avoid parasitism pressures of the Brown-Headed Cowbird (*Molothrus ater*) (Leck and Cantor 1979). Rothstein (1973) reported hatching failures of 47 percent of eggs near orchards, possibly due to sterility or developmental failure. He suggested this may be due to pesticides or other chemicals.

The species was projected to increase in ecoregion 7 under the base and medium harvest scenario on timberlands and all forest lands. Under the high harvest scenario, the species was projected to increase in ecoregion 7 only in all forest lands, but decrease in ecoregion 1 on timberlands. Critical habitat components for this species are fruit-bearing trees and shrubs. The species tends to be quite flexible in its breeding habitat requirements when it is primarily an insectivore.

Loggerhead Shrike (*Lanius ludovicianus*)
This is one of several officially threatened species in the state. It is a marginal, forest-associated species that primarily occurs in open country and dry upland prairie with shrubs and small trees (Coffin and Pfannmuller 1988). In Minnesota, it primarily occurs in the southeastern portion extending up throughout the Minnesota and Mississippi River Valleys to the central portions of the state (Janssen 1987). In the early 1900s (Roberts 1932) describes the species as commonly found throughout farmland and cut-over areas up to northern Minnesota, but relatively absent in areas dominated by conifers.

In general, the species has a relatively wide distribution across North America, occurring from New York to eastern Oregon and Washington and throughout open country and upland prairie across this region (Bent 1950, DeGraaf et al. 1991). In winter, the species primarily occurs in the southern United States, Mexico, and Central America. Root (1988) suggests its northern limit in winter to be 40° North latitude with highest concentrations found in areas that have less than 30 cm of snow a year.

The Loggerhead Shrike population in the state has decreased substantially over the past 10 to 20 years (Morrison 1981, Janssen 1987). At the present time it is a very rare bird or absent throughout most of its former Minnesota range (Coffin and Pfannmuller 1988). The decline is thought to be primarily due to habitat loss such as removal of nesting shrubs in shelterbelts of intensively farmed areas and, because it is an insect predator, chemical contamination of food sources through pesticide applications. In two recent reviews, Hands et al. (1989) and Bartgis (1992) discounts the role of pesticides as a major problem in eggshell thinning, but their role in reducing food supplies are unclear. They also suggest that among the major problems are farmland abandonment, habitat loss due to development, changes in agricultural practices, and a potential increase in collisions with vehicles. Brooks (1988) further suggests that wintering habitat availability may also be limiting.

The species primarily nests in small shrubs and trees in open habitats (Porter et al. 1975, Kridelbaugh 1983). It often uses shrubs with thorns such as hawthorn and buckthorn for nesting, which it also uses to impale its prey. As noted by Roberts (1932) the species has used cutover areas as long as suitable shrubs and trees were available for nesting along with associated food supplies (e.g., large insects such as grasshoppers, small mammals, and small birds). Agricultural practices have likely had a greater detrimental effect on this species than forestry practices. Even though the Loggerhead Shrike has used cutover areas in the past, it does not appear to use these areas to any degree at the current time. Cutover areas are likely secondary habitat areas that were used when populations in other, more-preferred habitats such as prairies and savannahs were more common. Although additional research and monitoring of this species in Minnesota is clearly warranted, the problems associated with this species are likely unrelated with timber harvesting and forest management.

The projections completed for this species are confined to those habitats that may be suitable to the species in forest landscape setting. The species habitat in agricultural or prairie landscapes was not considered. Using these data, the species was projected to have increased available habitat, primarily recently cut (sapling age classes), in ecoregions 5, 6, and 7 and statewide under all harvest scenarios using both timberlands and all forest lands. During portions of the 50-year projection period, the species was also projected to decrease in ecoregion 7 under both the base and medium harvest scenarios when timberlands and all forest lands were included. It is unclear to what extent these projections would be beneficial to the Loggerhead Shrike. Because of the currently low populations of this species in the state, it is not currently found to any degree using recently logged areas. Moreover, (Hands et al. 1989) and (Bartgis 1992) do not mention the potential role of forest lands and continued survival of Loggerhead Shrikes, presumably because these habitats are highly marginal for the species.

Bell's Vireo (*Vireo bellii*)
The Bell's Vireo is a relatively rare bird in Minnesota and is confined to the extreme southeastern portion of the state, especially along the Mississippi River drainage system (Roberts 1932, Janssen 1987). The species has its

primary breeding distribution throughout the central plains region extending as far north as Minnesota, North Dakota, south into southern Texas, northern Mexico, and west to southern California and southern Nevada. The species winters in Mexico and south throughout much of Central America (Bent 1950, DeGraaf et al. 1991). The species arrives in Minnesota in May and generally leaves the state in July or August. Hence, it is present in Minnesota for approximately 2 to 3 months (Janssen 1987).

Within Minnesota the species is primarily found along the Mississippi River Valley, especially inhabiting streamside willow (*Salix* spp.) habitats and habitats mixed with cottonwood and shrub thickets along streams and rivers (DeGraaf et al. 1991). The species builds its nest generally in a shrub or tree near water and rarely more than 1.5 meters above the ground (DeGraaf et al. 1991). The species is an insectivore, where it gleans its food from leaves and branches; however, the species also will occasionally take berries (Chapin 1925, Bent 1950).

The Bell's Vireo is very rare species in the state and it may have always been relatively rare. Roberts (1932) describes the species as relatively rare and he openly disputes whether it was ever very common in Minnesota, despite some suggestion that it was. In general, the population of the species is decreasing in many portions of its range, especially in California, and also declining in Kansas, Oklahoma, and Texas (Johnsgard 1979). Sauer and Droege (1992) suggest that it has been decreasing by about 2 percent over the past twenty years on the Breeding Bird Survey roadside counts based on over 200 survey routes. Too few data are available in Minnesota to detect any trend.

Two factors are likely responsible for the declining populations of the species: (1) increased populations of the Brown-headed Cowbird and subsequent nest parasitism, and (2) reduction in suitable riparian habitats throughout much of its range (Verner and Voss 1980). It is unclear whether timber harvesting or forest management will have a measurable positive or negative effect on the species in Minnesota. Continued management and protection of riparian habitats in the southeastern portion of the state are essential.

This species was only found in ecoregion 6 of Minnesota and it was projected to increase in that ecoregion under all three harvest scenarios and on timberlands and all forest lands. Hence, a statewide increase was also observed for this species. The projections are highly uncertain for this species because it has a relatively low population in the state and little is known about its breeding biology in Minnesota.

Solitary Vireo (*Vireo solitarius*)

The Solitary Vireo's breeding range in North America extends from British Columbia east to Newfoundland, southeast along the mountains to Georgia and west of the Great Plains south to Guatemala and El Salvador (Farrand 1985). In Minnesota, the species is a summer resident throughout most of the northeastern and north central regions (Janssen 1987). The Solitary Vireo is a long-distance migrant that winters from southern California, Arizona, and South Carolina to Costa Rica and Cuba (Ehrlich et al. 1988). The species arrives in Minnesota during late April to early June, and leaves the state during early August through late October (Janssen 1987).

The Solitary Vireo breeds primarily in coniferous forest (Roberts 1932, Green and Niemi 1978, Niemi and Pfannmuller 1979) but is also found in open mixed northern hardwood forests (Brewer et al. 1991) and western pine-oak woodlands (Farrand 1985). Sabo (1980) found that streams were a key component of the species territories in New Hampshire. In Minnesota, highest densities of Solitary Vireos were observed in mature jack, red, and white pine stands (with an average of about 1 pair/40 acres), but the species was also found in lower abundance in stands of jack pine, and mixed coniferous forests that consist of black spruce, tamarack, and cedar (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b). Hence, the species is classified as a conifer dependent and associated with mature forests.

The species usually nests 1 to 9 m from the ground in either a coniferous (east) or deciduous tree (west) and clutch size ranges from three to five eggs (Harrison 1975). The Solitary Vireo is an insectivorous lower-canopy gleaner during the breeding season, and an omnivorous lower-canopy forager during the nonbreeding season (DeGraaf et al. 1985).

Breeding Bird Survey data from 1965 to 1979 show that the Solitary Vireo population has significantly increased throughout its range (Robbins et al. 1986) and in Minnesota during the past 24 years. Janssen (1991) reports that based on the roadside count, the species increased by 7.6 percent from 1966 to 1989. However, forest fragmentation may be detrimental to this species. Robbins et al. (1989) found that both forest area and local forest cover were predictors of relative abundance of the Solitary Vireo. Solitary Vireos were not found in clearcut or thinned plots in Nova Scotia and their density decreased in strip-cut plots (Freedman et al. 1981). The species is also a Brown-headed Cowbird host. Increased fragmentation, and the subsequent increase in cowbirds and predators, may be detrimental to this species (Brittingham and Temple 1983).

Suitable habitat available for the Solitary Vireo was projected to increase in ecoregion 1 under the base harvest level on both timberland and all forest land. This increase is likely due to the maturing of lowland conifer stands in this ecoregion. Decreases, however were noted for ecoregion 3 in the medium harvest level on all forest land and in ecoregion 4 on timberlands. Under the high harvest regime on timberland, decreases were projected for ecoregions 2, 3, and 4 and statewide. Statewide declines under the high harvest scenario were the same on all forest lands except not in ecoregion 2. Decrease for this species was likely due to the loss of mature coniferous forests in the northern portion of the state.

Yellow-throated Vireo (*Vireo flavifrons*)
The Yellow-throated Vireo is a fairly common breeding species in deciduous forests throughout the eastern United States. Its range extends north to southern Ontario and southern New England, south to the Gulf Coast and Florida, and west to Minnesota, Iowa, Missouri, eastern Oklahoma and eastern Texas (DeGraaf et al. 1991). It is a summer resident throughout most of Minnesota except in the northeast and southwest regions. The spring migration period extends from late April through early June, with peak numbers arriving in early to mid-May. In fall, most individuals leave the state by late August or early September (Janssen 1987). This species is a long distance migrant, wintering from eastern Mexico south to Columbia and northern Venezuela (Ehrlich et al. 1988). A few individuals may be found in winter along the Gulf Coast and in Florida (Peterson 1980).

This species is found in relatively open mature woodlands, tall deciduous floodplain forests, groves of shade trees, and occasionally in mixed deciduous-coniferous forests (Bushman and Therres 1988). In a study conducted in Missouri, the most consistent characteristics of vegetation around 32 song perches were a high canopy (>16 m, never <15), intermediate to nearly complete canopy closure (70 to 90 percent, never <55 percent), and intermediate to nearly closed subcanopy (50 to 90 percent, never <35 percent) (Kahl et al.1985). The Yellow-throated Vireo seldom nests in dense forests, and rarely in conifers. The species was therefore classified as dependent upon mature, deciduous trees.

This vireo both forages and nests in the upper canopy. Its diet consists almost entirely of insects, although berries may also be consumed occasionally, especially in the fall (Ehrlich et al. 1988). Its nest is typically a deep cup, suspended from a forked branch greater than 6 m high (Harrison 1975). It lays three to five eggs (Ehrlich et al. 1988), and probably raises only one brood per season.

Although USFWS Breeding Bird Surveys indicate that regional and continental populations are stable (Robbins et al 1986), marked declines in numbers of Yellow-throated Vireos have been noted by observers in the eastern United States (Whitcomb et al. 1979, Robbins 1979). In Minnesota, its distribution has been apparently increasing in recent years to the north and west (Janssen 1987). United States Fish and Wildlife Service roadside count data, however, indicate no trends in the population since 1966 (Janssen 1990).

Numerous studies provide evidence suggesting that the Yellow-throated Vireo is an area sensitive species. Bond (1957) was the first to report that some species of small songbirds were apparently dependent on large forest tracts. In the course of his study of upland forest habitats in southern Wisconsin, he found that the Yellow-throated Vireo was 50 percent more common in tracts larger than 80 ac (>32 ha) compared to tracts of less than 40 acres. According to Robbins (1979) the Yellow-throated Vireo has disappeared from areas in Maryland where it previously nested. The decrease in numbers is apparently correlated with increased fragmentation of the forests of that region.

The number of Yellow-throated Vireos detected at 500 Breeding Bird Survey stops in central and eastern Maryland declined sharply when contiguous forest adjacent to the stop was less than 250 acres (Robbins 1979). Whitcomb et al. (1979) detected this species only in the largest forest fragments (>175 acres) they censused in central Maryland. In central Illinois, Blake and Karr (1984) detected Yellow-throated Vireos on only two forest islands of less than 295 acres. These were a 16 and 40 acre islands. Lynch and Whigham (1984) found a significant negative correlation between the occurrence of Yellow-Throated Vireos and the degree of isolation of a forest patch. Robbins et al. (1989) found a significant correlation between the occurrence of this species and percent forested area within 2 km.

Contradictory data has been presented on the tolerance of this species to selective cutting and to minimum area requirements of contiguous habitat (Bushman and Therres 1988). Nevertheless, evidence suggests that the extent of mature deciduous forest may be a limiting factor for this species. The species was therefore categorized as a forest interior species.

Loss of mature hardwood forests will likely result in a decrease in suitable habitat for this species. Statewide decreases were projected for all harvest levels on both timberlands and all forest lands. Ecoregion declines on timberlands were projected for ecoregions 4, 5 and 6 under all harvest levels in addition to ecoregion 1 under the high harvest regime. When all forest land was considered, decreases were projected for ecoregions 4 and 6 under all harvest levels and ecoregions 1 and 5 under the medium and high harvest levels. The species was projected to increase in ecoregion 9 under the base and medium harvest scenarios on both timberlands and all forest lands. However, only a small proportion of the species population is found within this ecoregion. Hence the increase projected is of little overall consequence.

Warbling Vireo (*Vireo gilvus*)
The Warbling Vireo is a summer resident throughout Minnesota, except in the northeast and north central portions where it is usually not found in contiguous stands of coniferous vegetation, including spruce bogs (Janssen 1987). The species arrives in Minnesota in late April to early May (Janssen 1987) after spending the winter in Mexico and Guatemala (Peterson 1980). Fall migration begins in late July and continues through early September (Janssen 1987). The species occurs throughout the United States (except the extreme southeast) and Canada (except the northwest) (Peterson 1980).

The Warbling Vireo prefers open deciduous woods and fragmented, forested areas (Harrison 1975). James et al. (1976) found that Warbling Vireos prefer to nest in open habitats ranging from open parkland with isolated trees to small groves in southern Ontario. In Michigan, the most frequently recorded habitat category was residential-roadside-hedgerow. They were also recorded in a variety of forest habitats including mesic, dry, and wet deciduous. Few observations were recorded in mixed forests and no reports indicated an association with coniferous forests in Michigan (Brewer et al. 1991). Therefore, this species was classified as hardwood dependent.

Only one individual was observed in an extensive survey of northern Minnesota in 1991. This individual was found in a mature aspen stand in the Chippewa National Forest (Hanowski and Niemi 1991a). The low number of individuals observed could be attributed to the types of forest areas sampled. For example, this survey focused on censusing in larger areas of contiguous forests. The species generally prefers broken, more fragmented landscapes. Green (1991) classified it as a species of disturbed/fragmented landscapes.

The Warbling Vireo's nest is placed in a tree 6 to 20 m from the ground well out from the trunk (Roberts 1932, Harrison 1975). The average clutch size is 4 eggs and incubation requires 12 days (Harrison 1975). Caterpillars, moths, and butterflies comprise the largest portion of the animal diet of this species (Roberts 1932, Martin et al. 1951). The Warbling Vireo generally forages in the uppermost portion of trees.

The species has not shown any significant change in status in the state during the period 1966 to 1989 based on USFWS Breeding Bird Survey routes (Janssen 1990). Because the Warbling Vireo prefers open-wooded habitats, it is likely that this species was much less common during presettlement times (Brewer et al. 1991). This is likely true in Minnesota also. Roberts (1932) describes the bird as relatively rare in most of the forested zones of Minnesota, but relatively common in the prairie region. As forest areas are fragmented due to agriculture, urbanization, and timber harvesting this species has expanded its range into these areas of Minnesota. However, with reductions in trees in prairie areas and in riparian habitats, the species has likely become less common (Roberts 1932). It may have originally been confined to riparian forests and open wetlands with trees. Because of its association with riparian areas, it was classified as a riparian species.

It would likely not be affected by increases in timber harvesting in the state because it prefers smaller forested areas. An additional negative effect on this species is that it is highly susceptible to Brown-headed Cowbird parasitism (Bent 1950). The habitats used by the Warbling Vireo coincide with agricultural lands in which the Brown-headed Cowbird is also quite common.

Warbling Vireo habitat was projected to increase in ecoregion 9 under all harvest levels and when timberland and all forest land were considered.

Philadelphia Vireo (*Vireo philadelphicus*)
The Philadelphia Vireo is a relatively rare and local breeding species and only occurs in northeast Minnesota (Cook, Lake, and northern St. Louis counties) (Janssen 1987). Roberts (1932) did not list this species as breeding in the state in the early 1900s. The species also has a limited range in North America. It occurs within a narrow band across the extreme northeastern and north central United States and north to the middle portion of Canada (Peterson 1980). The species arrives in the state in early May through early June (Janssen 1987) and overwinters in Mexico and Panama (Peterson 1980). Fall migration begins in mid August and continues into early October (Janssen 1987).

The species' breeding habitat is open woodlands, burned-over areas, and streamside willows and alders (Harrison 1975, Green and Niemi 1982). In Michigan, the species is found in mature deciduous forest comprised primarily of aspen, which may be mixed with sugar maple, red maple, red oak, or birch. Brewer et al. (1991) suggest that the species also prefers edges along little-used roads. In New Hampshire, the species is patchily distributed in mature deciduous forests where white ash and yellow birch are well represented in the canopy (Robinson 1981). Based on this information, the species was not included in any of the EQB groups.

This species was not recorded in an extensive survey of northern Minnesota in 1991. However, some habitats where the species may occur (e.g., streamsides and willow) were not surveyed (Hanowski and Niemi 1991a, 1991b). Moreover, the song of this species is very similar to the highly abundant Red-eyed Vireo and, hence, it tends to be easily overlooked. Rice (1978) suggests that the two species are interspecificly competitive and use the similarity of their songs to defend mutually exclusive territories.

The Philadelphia Vireo places its nest 3 to 15 m above the ground, usually near the upper canopy. Of 14 nests observed by Holmes (1990) in New

Hampshire, 86 percent were in the upper canopy (> 14 m). Four eggs is the normal clutch size for this species, and incubation requires 13 to 14 days (Harrison 1975). The primary food source for this species is caterpillars (Martin et al. 1951). It primarily hovers for prey and is relatively stereotypic in its foraging pattern regardless of tree species and strata (Robinson and Holmes 1984).

Because the species primarily occurs in shrub areas in riparian zones, it may not be affected by increased timber harvesting as long as riparian areas are protected. This species will probably benefit from selective logging provided that the regrowth is the preferred tree species and is allowed to attain moderate height and density (Brewer et al. 1991). The species increased by about 2 percent nationwide in the past 25 years (Sauer and Droege 1992).

No changes were projected for this species in any of the three harvest scenarios.

Red-eyed Vireo (*Vireo olivaceus*)
The Red-eyed Vireo is one of the most abundant breeding birds in the state (Mattson 1979). It is numerous throughout the wooded areas of the state (Janssen 1987) and winters in northern South America (Peterson 1980). It arrives in Minnesota in late April through early June and departs in late July through mid-October. The species distribution encompasses almost all of the United States (except the western and southwestern portions) and Canada (except the extreme northern forested area) (Peterson 1980).

The Red-eyed Vireo is widely distributed across Minnesota primarily in forests (Roberts 1932). The breeding habitat for this species is primarily deciduous, but it will use recently cut areas as soon as a canopy layer develops (Conner and Adkisson 1975). It can occur in a wide range of forest age classes, but is most abundant in mature stands (Conner and Adkisson 1975, Shugart et al. 1978). This species was found in almost every habitat type and age in northern Minnesota forests in 1991. Highest densities in the Superior National Forest were in mature pine and spruce (about 7 pairs/40 acres) (Hanowski and Niemi 1991b). Overall, densities in the Chippewa National Forest were higher than the Superior National Forest, and highest numbers of individuals were recorded in mature pine, oak, maple, paper birch, and aspen forest types (e.g., 8 to 14 pairs/40 acres) (Hanowski and Niemi 1991a). Because of its high use of both mature coniferous and deciduous forests, the species was not classified as a hardwood dependent species, but was considered dependent on mature forests.

(Robbins 1979) found Red-eyed Vireos in woodlots over 50 acres, but estimated the critical forest size to maintain a viable breeding population at 250 acres. This species may not be as vulnerable to forest fragmentation as many other forest interior species. Although it prefers a closed canopy, this species will tolerate a wide variation in canopy cover. It would probably tolerate select cutting (Clark et al. 1983) and small or narrow clearcuts (Crawford et al. 1981). If some residual trees are left in clearcuts, the species was found to reoccupy the stand as early as 12 years after logging (Connor and Adkisson 1975, Probst et al. 1992).

The Red-eyed Vireo places its nest in a shrub or low tree branch from 2 to 3 m above the ground (Roberts 1932, Harrison 1975). Mattson (1979) found nests in northern Minnesota that were located in shrubs from 2 to 3 m above the ground. In general, nests were located in areas where tree cover was more dense than the surrounding area (Mattson 1979). In New Hampshire, Holmes (1990) found 39 nests, they were located equally among the sapling strata (2 to 8 m), subcanopy (8 to 14 m), and canopy (>14 m).

Four eggs is the typical clutch size, and incubation requires 11 to 14 days (Harrison 1975). The primary food of the Red-eyed Vireo are caterpillars, moths, and other invertebrates (Martin et al. 1951). It captures prey by hovering or sometimes by gleaning from leaf surfaces in the subcanopy and lower portions of the canopy (Robinson and Holmes 1984).

The status of the species in the state has remained unchanged during the period 1966 to 1989 based on the USFWS breeding bird roadside surveys (Janssen 1990). Influx of cowbirds into fragmented forest areas in central and southern Minnesota may have a negative impact on this species. Studies in Michigan have found as many as 65 to 75 percent of nests parasitized by Brown-headed Cowbirds (Southern 1958, Kelley 1978). Nationwide, the species has increased by about 1.5 percent over the past 25 years (Sauer and Droege 1992).

Suitable habitat for the Red-eyed Vireo was projected to increase in ecoregions 2, 7 and 9 in all forests under the base and medium harvest levels and in ecoregion 9 under the high harvest regime. Projected increases on timberlands were limited to ecoregions 7 and 9 under the base and medium harvest scenarios and to ecoregion 9 under the high scenario. Increase in ecoregion 7 was likely due to the projected increase in total forest area in the second model runs and the lack of clearcutting in the southern part of the state. Because increases were not projected for timberland in ecoregion 2, increases for all forest land in this ecoregion was likely attributable to the large proportion of acres in forest reserves.

Suitable habitat for the Red-eyed Vireo was projected to decrease on timberlands in ecoregion 6 in all harvest levels and for the medium and high levels when all forest land was considered. Statewide declines were projected under the high harvest level on timberlands as well as regional declines in ecoregions 1, 2, 3, 4, 5 and 6. When all forests were considered, declines in the high scenario were limited to ecoregions 1, 3, 4, 5 and 6.

Declines for this species were likely due to the shift in age of the forest from old to young under the medium and high harvest scenarios.

Blue-winged Warbler (*Vermivora pinus*)
The Blue-winged Warbler is a locally common wood warbler of the eastern United States. The center of abundance was formerly in southern Ohio, Indiana, Illinois, northern Kentucky, northern Missouri, and southern Iowa (Bent 1953). During the past century, however, the Blue-winged Warbler has extended its range northward and eastward, and is now reported breeding from southern New England, west to southern Michigan, southern Wisconsin, and southeastern Minnesota (Peterson 1980). The species first appeared in southeastern Minnesota about 1940 (Gill 1980), and has since extended its range as far north as the Twin Cities. An interesting aspect of the breeding biology of the Blue-winged Warbler is its tendency to hybridize with the closely related Golden-winged Warbler wherever the ranges overlap. There seems to be a close temporal relationship between the establishment of Blue-winged Warbler populations and the local extinction of Golden-winged Warblers over the past 50 years (Gill 1980). The Golden-winged Warbler formerly bred in the southeastern portion of Minnesota, but has disappeared from that area since the arrival of the Blue-winged Warbler (Janssen 1987).

The Blue-winged Warbler is a long-distance migrant wintering from central Mexico south to Honduras and Panama (Ehrlich et al. 1988). It generally arrives on its breeding grounds in Minnesota during the first week in May. The fall migration period extends from late July through September (Janssen 1987).

Confer and Knapp 1981) describe the Blue-winged Warbler as a habitat generalist relative to the Golden-winged Warbler. In a study conducted in Tompkins County, New York, they found Blue-winged Warblers nesting in habitat ranging from abandoned pastures in early successional stages to areas 60 to 70 years into secondary succession with a nearly unbroken tree canopy (Confer and Knapp 1981). Ficken and Ficken (1968) described Blue-winged Warbler habitat as overgrown fields with trees <6 m tall and bordered by taller trees. At Murphy-Hanrehan Park Reserve in northern Scott County, Minnesota, where a substantial breeding population exists, this species nests primarily along the edges of cross-country ski trails within mature second-growth forest. It can also be found nesting on edges between second-growth forest and abandoned pasture or cropland in this Park Reserve.

Because of the breadth of habitats used and its apparent lack of specific needs, this species was not classified into any of the selected categories of birds used in the GEIS.

The Blue-winged Warbler is insectivorous. It forages by gleaning insects from leaves near the tops of shrubs and trees, and by probing buds, leaf clusters, and occasionally flowers (Ficken and Ficken 1968). This species usually nests in loose aggregations or colonies (Confer and Knapp 1981). Its nest is placed on the ground, attached to the upright stems of weeds, and remarkedly well-concealed within the rank growth of forbs and grasses at the woodland edge. Four or five eggs are laid and one brood is raised per season. This species is heavily parasitized by the Brown-headed Cowbird.

Data collected in the USFWS Breeding Bird Survey indicate an increase in numbers of Blue-winged Warblers across the continent (Robbins et al. 1986). Given the wide range of habitats acceptable to Blue-winged Warblers, it seems unlikely that increased timber harvest or forest fragmentation will negatively affect this species.

Suitable habitat for the Blue-winged Warbler was projected to increase in ecoregion 6 and statewide in all harvest levels and on both all forest and timberlands. When all forest lands were considered, additional increases were projected for ecoregion 5 under the base and medium harvest levels. The species occurrence in a wide range of habitats and affinity for early successional communities are likely reasons for this species projected increase.

Golden-winged Warbler (*Vermivora chrysoptera*)
The Golden-winged Warbler is uncommon throughout most of its range in the eastern United States. Although this species has been expanding its range northward and eastward for the last century, it has concurrently disappeared from much of its southern range. In this area it is apparently being displaced by its congener, the Blue-winged Warbler (Gill 1980). It was placed on the Audubon Blue List in 1981 and 1982, and listed as a species of special concern in 1986 (Tate 1986). Data collected in the USFWS Breeding Bird Survey indicate that the Golden-winged Warbler population is stable across the continent. However, there have been significant declines in the Great Lakes subregion and in Wisconsin (Robbins et al. 1986). From 1966 to 1987, the species declined by 4.4 percent per year in Wisconsin, and by 2 percent per year in Michigan and Minnesota (Hands et al. 1989). Overall, there has been a 2.7 percent per year decline in the north central US between 1966 and 1987 (Hands et al. 1989). In Minnesota the Golden-winged Warbler is now absent from the southeastern portion of the state where it formerly bred. It is most common in the central and north central regions and appears to be expanding its range northward (Janssen 1987).

The Golden-winged Warbler is a long distance migrant, wintering in Central America and northern South America from Guatemala to Columbia (Ehrlich et al. 1988). The spring migration period extends from early May to early

June with a peak around May 10th. Fall migration begins in late July and late individuals have been recorded into early October (Janssen 1987).

The ecology and breeding biology of the Golden-winged Warbler is very similar to that of its congener, the Blue-winged Warbler. It is insectivorous, gleaning and probing for insects near the tops of shrubs and trees (Ficken and Ficken 1968). It nests in loose colonies of up to 10 pairs, and its nest is placed on or near the ground where it is supported and concealed by weed stalks. This species hybridizes with the Blue-winged Warbler where the ranges overlap. Gill (1980) has shown there is a close temporal relationship between the establishment of Blue-winged Warbler populations and the local extinction of Golden-winged Warblers over the past 50 years. It may be that the Blue-winged Warbler actually outcompetes the Golden-winged Warbler, or that genetic introgression of the Golden-winged Warbler with the Blue-winged Warbler could account for the disappearance of the Golden-winged Warbler (Gill 1980).

Confer and Knapp (1981) suggest that the Golden-winged Warbler is a habitat specialist requiring early successional fields, while the Blue-winged Warbler is a habitat generalist. In Tompkins County, New York, the Golden-winged Warbler nests only in the shrub stage of successional habitat on large patches of abandoned farmland (Confer and Knapp 1981). In this study, Golden-winged Warbler habitat was typified by a clumped distribution of herbs and shrubs. According to Confer and Knapp (1981), succession on clearcuts in central New York produces dense growths of saplings which are not suitable habitat for these warblers. Only abandoned farmland produces the patchy early successional habitat preferred by the Golden-winged Warbler. In contrast to these findings, our data suggest that the Golden-winged Warbler tolerates a wide variety of habitat types in Minnesota. Highest densities were recorded in sapling jack pines (about 3 pairs/40 acres), and saw-sized balsam fir/aspen/paper birch (about 3 pairs/40 acres). Golden-winged Warblers were also present in pole-sized jack pines, sapling, pole, and saw-sized aspen, saw-sized white pine, and saw-sized elm/ash/maple stands (Hanowski and Niemi 1991b). Kelleher (1967) also reported densities of 3 pairs per 40 acres in saw-sized aspen, and 2.5 pairs per 40 acres in saw-sized oak. Pfannmuller (1979) detected Golden-winged Warblers most frequently in wetlands dominated by alders (about 8 pairs/40 acres), and in young conifer plantations with dense growths of aspen and herbaceous vegetation (about 7 pairs/40 acres). Because of the wide variety of habitats used, the Golden-winged Warbler was not classified into any of the groups specified by the GEIS.

These data suggest that the Golden-winged Warbler utilizes a broad range of habitat types in Minnesota, and may be benefitted by current forest management practices. Increase in suitable habitat was projected to occur in ecoregions 3, 4, and 5 and statewide under all harvest levels on timberlands and all forest land. Increases were projected to occur in ecoregion 1 under the high harvest level on timberlands and forest lands.

Tennessee Warbler (*Vermivora peregrina*)
The Tennessee Warbler is a regular summer resident in the northeastern and north central parts of the state (Janssen 1987). Throughout its Minnesota range, this species is rare and local during the breeding season (Eckert 1983), and is most likely to be found along the Canadian border in Cook, Lake and St. Louis Counties (Janssen 1987). This species breeds throughout the boreal forest region of central and southern Canada, with some breeding range extending south into the upper peninsula of Michigan and the eastern border states from New York to Maine in the east, and northwestern Montana in the west (National Geographic Society 1983).

Winter range is from central Mexico south to northern South America (National Geographic Society 1983). Tennessee Warblers begin arriving in Minnesota as early as late April, and are common to very abundant during peak migration periods in mid-May (Eckert 1983, Janssen 1987). Fall migration peaks occur in late August or early September (Janssen 1987).

Tennessee Warblers feed primarily on invertebrates gleaned from foliage, but also include some fruit in their diet. In winter, nectar and other plant material is eaten as well (Ehrlich et al. 1988, Morse 1989). Caterpillars appear to be important in the summer diet. Clutch size, bird abundance, and territory occupancy may be related to outbreaks of spruce budworm (Morse 1989).

Cup-like nests are built on the ground in bogs, swamps and mixed conifer-deciduous boreal forests (Roberts 1932, Ehrlich et al. 1988, Morse 1989). The nest is often well-hidden at the base of a bush such as Labrador tea (*Ledum groenlandicum*) or on a hummock of *Sphagnum*. Nest material is usually coarse grass with a lining of finer materials (Ehrlich et al. 1988, Brewer et al. 1991). Five or six eggs are usually laid in mid-June (Brewer et al. 1991) and incubated for 11 to 12 days (Ehrlich et al. 1988). It is unknown how long the newly hatched young stay in the nest before fledging (Ehrlich et al. 1988).

Preferred habitat during the breeding season in Michigan has been described by (Brewer et al. 1991) as "... conifer forest bog dominated by somewhat parklike stands of black spruce, usually mixed with scattered tamarack and northern white cedar and sometimes with birch, poplar, and alder. The forest floor is covered with a dense mat of sphagnum moss, grass hummocks, and small northern shrubs such as Labrador tea." In Canada, the Tennessee Warbler is found in spruce dominated communities with a broad-leafed understory component (Erskine 1977). In Minnesota the species is associated with contiguous coniferous forests (Green 1991). Therefore, the species was classified as conifer dependent. No individuals were observed in the Chippewa or Superior National Forests in 1991 (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b) or in the Red Lake Peatland in the early 1980s (Niemi and Hanowski 1992). However, Pfannmuller (Pfannmuller 1979) recorded the species in a mature conifer lowland in northern Minnesota in the late 1970's.

Tennessee Warblers appear to be somewhat more gregarious than other warblers. They have been observed nesting in loose colonies in areas of favored habitat (Ehrlich et al. 1988). They may form flocks of 10 to 200 individuals on their wintering areas when foraging for insects, and they may defend territories when feeding on nectar (Ehrlich et al. 1988, Morse 1989).

Effects of forestry practices on Tennessee Warbler populations are poorly known. It is likely, however, that because this species is both rare and local in abundance and distribution, reductions in suitable coniferous forest habitat in the northeast and north central regions of the state could have negative impacts on the state population of this species. Insect control programs to reduce populations of spruce budworm may also have negative effects (Morse 1989). Numbers of Tennessee Warblers in Minnesota have shown a slight, but not significant increase according to the breeding bird survey (Janssen 1990). Similar trends were found nationwide (Sauer and Droege 1992).

Suitable habitat available for the Tennessee Warbler was projected to decrease in ecoregions 2, 3, and 4 under the high harvest level on timberland. The results were similar on all forest land except a decrease was noted in ecoregion 2. Declines for this species were likely due to the loss of mature conifer habitat in the northern portion of the state.

Nashville Warbler (*Vermivora ruficapilla*)
The Nashville Warbler is a common to abundant breeding bird throughout most of the forested zones of Minnesota, but is relatively rare or absent from the southern portions of Minnesota (Janssen 1987). It has a disjunct breeding distribution with one population in the east centered around the Great Lakes transitional forests and the other in the northwestern U.S., extending from northern California to southern British Columbia (Bent 1953, DeGraaf et al. 1991).

It is a long distance migrant with its primary wintering grounds in Mexico and Guatemala (Finch 1991). It generally arrives in Minnesota during late April to early May with the bulk of long distance migrants arriving in mid-May. It begins its return flight to the tropics from Minnesota in late July and most individuals are gone by early October (Janssen 1987).

It nests on the ground and is highly insectivorous in its habit, primarily gleaning insects from foliage found both in trees, shrubs, and on the ground (Roberts 1932). The Nashville Warbler is found in a variety of forested habitats from black spruce/tamarack bogs and mature deciduous forests to recently cut areas (Lawrence 1948, Green and Niemi 1979, Niemi and Pfannmuller 1979), and (Niemi and Hanowski 1992). Data gathered from a variety of sources indicate that the Nashville Warbler is found in a wide variety of habitat types, but the presence of a well-developed shrub layer and ground vegetation suitable for nesting are important. It is most abundant in conifer-dominated vegetation with suitable shrub cover such as in moderately-aged (15- to 40-year-old) spruce, fir, or pine. In these habitats densities can approach more than 4 pairs per 15 ha throughout northern, northeastern, and central Minnesota. It also is relatively common in many deciduous habitats, but population densities are generally lower, ranging from 1 to 2 pairs per 15 ha.

Because of the wide range of habitats used by this species, it was not classified into any of the EQB-FSD categories. Based on Breeding Bird Survey roadside counts, no trend in the species population is evident in Minnesota over the past 23 years (Janssen 1990). Similarly, no trend was detected by (Sauer and Droege 1992) for this species within its continental range or within the eastern United States.

The Nashville Warbler is a species that has presumably increased over the past 150 years due to the increase of young, second growth forests (Morse 1989). Hence, the species will likely be positively affected by increased timber harvesting if this results in increased edge habitats with shrubs. Because of its ground nesting habit, it may be susceptible to increased predation along edge habitats if thus associated with an increased number of nest predators.

This species was projected to increase in ecoregion 5 under all three harvest scenarios using both timberlands and all forest lands in the analysis. In contrast, the species was projected to decrease in ecoregion 3 under the high harvest scenario and within both timberlands and all forest lands.

Northern Parula (*Parula americana*)
The Northern Parula's distribution in Minnesota is limited to the northeast and north central regions (Janssen 1987). The species is primarily a neotropical migrant (Finch 1991). The species winter distribution is in Mexico to the West Indies and in Nicaragua, but is very rarely found on the north Gulf Coast (Peterson 1980). The species distribution in North America is primarily to the east and south of Minnesota (Peterson 1980). The species arrives in Minnesota in early April through early June and fall migration begins in late August and continues through mid-October (Janssen 1987).

The species prefers mature (Roberts 1932, Collins et al. 1982, Morgan and Freedman 1986) coniferous or mixed forests especially near water for its breeding habitat (Harrison 1975). It is known for its generalized forest habitat requirements, but (Brewer et al. 1991) suggests that it does not use young second-growth areas or other highly disturbed forests (Brewer et al. 1991). Morse (1989) found that the species used small islands and preferred to nest at the edge of these islands. This species was found in a variety of lowland and upland coniferous forest habitats in the Superior and Chippewa national forests in 1991 and 1992. Highest densities in both forests occurred in mature lowland conifer and mature upland spruce forests (about 1 to 3 pairs/40 acres) (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b). Hence, the species was classified as dependent on mature forests and a coniferous-dependent species.

Forest size is also an important habitat factor that determines presence of the Northern Parula in the eastern United States. Robbins (1979, 1980) estimated that 520 acres was required to sustain a viable breeding population in Maryland, and (Blake and Karr 1984) only found this species in forest islands of 160 acres or more in Illinois. Hence, we also classified this species as a forest interior breeding species because of its sensitivity to the sizes of forests where it is found breeding in the eastern United States (Whitcomb et al. 1981).

In Minnesota, the species distribution does not overlap with areas where fragmentation of forested habitat due to agriculture and urban expansion is intense. The species sensitivity to fragmentation in forested settings is not known. Green (1991) describes the species as being associated with contiguous, coniferous habitats.

The species often builds its nest from *Usnea* spp. moss, but nesting habitat is presumably not limited by the presence of the moss (Morse 1989). Five nests found in northern Michigan were on average 3 m above ground in areas with dense clumps of *Usnea* (Pettingill 1974). Average clutch size for the species is 4 to 5 eggs and incubation requires 12 to 14 days (Harrison 1975). The species has been known to hybridize with Yellow-throated Warblers and this hybridization results in a sexually viable species, the Sutton's Warbler (Morse 1989). However, the Yellow-throated Warbler is not found in Minnesota.

The Northern Parula feeds primarily on invertebrates that are gleaned from the tips of tree branches (Morse 1989). The area in which they forage may be influenced by the presence of Black-throated Green and Yellow-rumped Warblers. The species has been described as socially subordinate and highly plastic in where it forages within trees. Morse (1989) suggests that it forages closer to the tree trunk and lower in the canopy when these two species are absent (Morse 1989).

According to the Breeding Bird Survey, the species status in the State has remained relatively constant during the past 25 years (Janssen 1990). The species may tolerate a wide range of canopy closure values and could tolerate small or narrow clearcuts, thinning overmature trees, and select cutting (Crawford et al. 1981). In addition, the preference of this species to use *Usnea* moss which is sensitive to air pollution and acid precipitation may be limiting this species distribution and abundance in the northeastern U.S. Widespread loss of *Usnea* is a suspected cause for declines of this species in the northeast United States (Laughlin and Kibbe 1985). The species has declined significantly across the United States and in the east in the past 10 years by about 2 percent.

Increases in available habitat were predicted for ecoregion 1 under the base harvest level for both timberlands and all forest land models. When only timberlands were considered, declines were projected in ecoregion 4 in the medium harvest scenario and in ecoregions 2, 3, 4 and statewide under the high harvest level. Decreases were limited to ecoregions 3 and 4 and statewide under the high harvest level when all forest lands were considered. Declines for this species were likely due to the loss of mature conifer forests in the northern portion of the state.

Yellow Warbler (*Dendroica petechia*)
The Yellow Warbler is a regular resident throughout Minnesota. It is a common species except in heavily forested areas (Janssen 1987). It is abundant during spring migration, arriving in the state in large numbers with the bulk of other warblers in mid-May, and leaving in the fall during August and September (Roberts 1932, Eckert 1983, Janssen 1987). Yellow Warblers can be found throughout most of North America in the breeding season with the exception of the extreme north, in Texas, and the Gulf Coast (National Geographic Society 1983). In winter, Yellow Warblers can be found from the Bahamas and northern Mexico south to Brazil (Ehrlich et al. 1988).

The Yellow Warbler diet is mostly invertebrates (Roberts 1932, Busby and Sealy 1979) gleaned from foliage, but bark gleaning, hawking, and hover gleaning foraging strategies are used as well. Berries may also occasionally be eaten (Ehrlich et al. 1988).

Brush openings,edges, shrub carr, shrub fields in urban areas, roadsides, and riparian habitats are the preferred habitats for this species in the breeding season (Roberts 1932, Collins et al. 1982, Taylor and Littlefield 1986, Ehrlich et al. 1988, Robbins 1991). Wet habitats with willows and alders from 1.5 to 4 m in height had the highest occupancy rates and density values (16 males/40 acres) based on Breeding Bird Census data (Schroeder 1982). Minimum habitat area was estimated to be at least 0.5 acres (Schroeder 1982).

Nests are carefully woven cups made of forbs, bark, grass, and other plant fibers, usually lined with finer material such as wool, feathers, or hair. Nest material is occasionally stolen from other birds' nests (Ehrlich et al. 1988, Robbins 1991). The nest is usually built in a shrub or tree 1 to 4 meters from the ground (Roberts 1932, Ehrlich et al. 1988). Four to five eggs are usually laid in mid-June (Roberts 1932, Goossen and Sealy 1982), and incubated for 11 to 12 days before hatching; young are ready to leave the nest 9 to 11 days after hatching (Ehrlich et al. 1988).

This species is one of the most common hosts for Brown-headed Cowbirds (Roberts 1932, Ehrlich et al. 1988). Goossen and Sealy (1982) reported a 25 percent nest parasitism rate in Manitoba. Nests containing cowbird eggs are frequently built over with a completely new nest (Clark and Robertson 1981). Nests have been found several levels deep due to repeated cowbird parasitism (Roberts 1932). Nest desertion is an alternative anti-parasite strategy (Clark and Robertson 1981). Yellow Warblers also respond aggressively to the presence of cowbirds early in the nesting period (Folkers and Lowther 1985).

Robbins (1991) identifies conversion of forests and savannah to agriculture as a reason for declines in Yellow Warbler populations in Wisconsin. This species was placed on the Audubon Blue List (Arbib 1971) in 1973. It was delisted in 1982, but was classified as a species of Special Concern by the U.S. Fish and Wildlife Service in 1986. In Minnesota, Breeding Bird Survey results indicate no significant population trend either increasing or decreasing (Janssen 1990). In western parts of this species range, populations have increased in areas where riparian vegetation has been allowed to regrow with reductions in livestock grazing pressure and herbicide use (Taylor and Littlefield 1986).

Because the Yellow Warbler is associated with early successional vegetation, it was projected to increase statewide under the medium and high harvest levels on both timberland and all forest land. Regional increases were projected for ecoregions 5, 6 and 7 under all harvest levels, in ecoregions 3 and 4 under the medium harvest scenario, and in all ecoregions under the high harvest level. These increases were projected for all forest land. Results were similar for timberland, except an increase was projected in ecoregion 4 under the base harvest level and not in ecoregion 7. Increases were projected in all ecoregions but 1, 2 and 7 under the medium harvest level. Results for the high harvest scenario on timberlands were the same as on all forest lands.

Chestnut-sided Warbler (*Dendroica pensylvanica*)
The Chestnut-sided Warbler breeds from central Canada south to central North Dakota and eastern Nebraska. The species occurs eastward to the Atlantic coast reaching as far south as South Carolina and Georgia (Terres

1987). In Minnesota, Chestnut-sided Warblers are common migrants and regular summer residents. They are most common in the northern regions of the state, extending as far southward as Anoka, Stearns, and Douglas Counties (Janssen 1987). This range has receded over the past sixty years; in 1932 Roberts reported the species to breed throughout the state (Roberts 1932).

Chestnut-sided warblers begin returning to Minnesota in early May from their wintering grounds in southern Central America, (Ehrlich et al. 1988), and continue arriving into late May (Roberts 1932). These wintering grounds are geographically restricted and the species is intolerant of disturbed habitats within this range (Finch 1991).

Chestnut-sided Warblers breed primarily in open vegetation recently disturbed by fire or logging activities. These warblers may reach their highest densities, up to 190 pairs per km^2, in clearcuts (Freedman et al. 1981). They may also respond favorably to cottage developments which revert the surrounding vegetation to an earlier successional stage (Clark and Euler 1984). Chestnut-sided Warblers breed in early-successional deciduous and coniferous communities with trees 3 to 30 feet high, usually associated with a dense shrub understory. Highest densities are associated with the earliest stages of forest succession (Green and Niemi 1978).

Data from northern Minnesota, show the species to be most common in early successional forests, primarily deciduous in composition, with a canopy of approximately 15 feet (Niemi 1977, Niemi and Pfannmuller 1979, Niemi and Hanowski 1984, Hanowski and Niemi 1991a,b, Probst et al. 1992). Nests are usually built in saplings or low bushes, only a few feet from the ground and often in the fork of a branch. Three to five eggs are laid and incubated for 10 to 11 days. As with other open cup nesters, Chestnut-sided Warblers are frequently parasitized by Brown-headed Cowbirds (*Molothrus ater*) (Roberts 1932).

Chestnut-sided Warblers are primarily insectivorous, however they will eat berries when insects are scarce (Ehrlich et al. 1988).

In Minnesota, the species has not exhibited a change in population according to the Breeding Bird Survey roadside counts over the past 23 years (Janssen 1990). However, Sauer and Droege (1992) detected a short-term (1978–88) decrease in the population based on 584 roadside counts within the United States and Canada.

Timber harvesting opens forested areas and, therefore, creates suitable habitat for this species. Moreover, short term rotations will likely increase habitats in earlier stages. Hence, increased timber harvesting and forest management would likely be beneficial to this species.

The species was projected to increase in ecoregion 5 in the base harvest scenario on timberland. Under the medium harvest scenario, the species was projected to increase in ecoregions 5 and 9 on timberlands. No change was projected when all forest lands were included in either the base or medium scenarios. Under the high harvest scenario, however, the species was projected to increase in ecoregions 3, 4, 5, and 9 and statewide on timberlands and in ecoregions 2, 3, 4, and 5 and statewide in all forest lands. The Chestnut-sided Warbler uses both sapling and pole-sized age classes of a variety of forests, both deciduous and coniferous. Under the high harvest scenario, the increase in sapling age class vegetation is primarily responsible for the projected increases in available habitat.

Magnolia Warbler (*Dendroica magnolia*)
Magnolia Warblers breed from southern Canada south to Minnesota and Wisconsin in the west and New Jersey and Massachusetts in the east (Terres 1987). In Minnesota, Magnolia Warblers are regular summer residents in the northeastern and north central regions of the state. The species breeds south to Crow Wing and Mille Lacs Lake Counties and west to Roseau County (Roberts 1932, Janssen 1987). Magnolia Warblers begin arriving in Minnesota in early to mid-May. Magnolia Warblers begin leaving the state in mid-August and this migration may continue into early October. During the beginning of this migration, they may be found in tamarack swamps or upland forests (Roberts 1932). By mid-October, all Magnolia Warblers have left for their wintering grounds in the Caribbean, Central America, and the southern United States (Terres 1987, Ehrlich et al. 1988).

In the state, Magnolia Warblers are likely most abundant in northeastern Minnesota where they primarily are found in the intermediate stages of coniferous forest regeneration and in some black spruce bogs or white cedar lowlands (Green and Niemi 1978) and (Niemi and Pfannmuller 1979). They also breed in fir-spruce-hardwood habitats, but in lower densities than those in pure coniferous forests (Martin 1960). Based on the species high association with coniferous tree species, it was classified as dependent on coniferous forests.

The young conifer transition communities with conifer trees from 5 to 10 meters high are the primary breeding habitat for this species (Green and Niemi 1978, Brewer et al. 1991). As these trees become older, their lower branches begin to coalesce and the species, which forages on the outer branches of the conifers, are forced to higher positions on the trees. Hall (1984) documented a decline in population of Magnolia Warblers from 19 males/15 acres in 20 year old spruce to 2 males/15 acres in 60 year old spruce over a 40 year period of succession.

Nests are constructed in small evergreens, usually 1 to 2 meters above the ground, and well hidden (Roberts 1932, Ehrlich et al. 1988). Twigs, grasses, pine needles, and spider webs are used in nest construction, and are lined with hair, grasses, and fine, black rootlets. Four eggs are usually laid, although 3 to 6 are possible, and are incubated for 11 to 13 days (Roberts 1932, Ehrlich et al. 1988).

Magnolia Warblers are primarily insectivorous feeding on spiders, caterpillars, and other insects. A small amount of fruit may also be included in their diet (Roberts 1932, Ehrlich et al. 1988).

Although the species was not commonly found on the Breeding Bird roadside counts, (Janssen 1990) reported an increasing proportion of routes that the species was observed on over the past 23 years. Similarly, (Sauer and Droege 1992) report a slight (2 percent) annual increase in the species over the past 23 years in the eastern United States.

Increased timber harvesting and forest management will affect this species if the proportion of intermediately aged conifer habitat is not allowed to develop. In Minnesota, this species primarily needs spruce and fir trees 3 to 10 meters in height and where these trees are relatively dense.

In general, few significant changes were projected for the species. It was projected to decrease in ecoregion 3 under the base harvest scenario when all forest lands were included. Similarly, the species was projected to decrease in ecoregion 3 in the medium and high harvest scenarios using both timberlands and all forest lands. The overall reduction in coniferous forest vegetation in ecoregion 3 is the reason for the projected decreases in habitat available to this species.

Cape May Warbler (*Dendroica tigrina*)
The Cape May Warbler is an uncommon to locally common bird in the northernmost portions of Minnesota (Roberts 1932, Hanowski and Niemi 1991a,b). The species can be found breeding from northeastern British Columbia in a narrow zone across the southern boreal forest to Newfoundland and Maine (Bent 1953, DeGraaf et al. 1991). In winter, the species is found primarily from southern Florida and throughout the Caribbean islands (Morse 1989). The species migrates to Minnesota from early May to the first part of June and leaves the state during fall migration in early August through early October (Janssen 1987).

In Minnesota the Cape May Warbler is primarily found in upland spruce forests, especially in the northernmost counties including Cook, Lake, and St. Louis of extreme northeastern Minnesota (Green and Niemi 1978, Hanowski and Niemi 1991b). The species has also been recorded to occur as far south as southern St. Louis County and west to Itasca State Park (Green and Janssen 1975). In general, the species is very difficult to identify by song when it is most conspicuous during the breeding season, and, hence, it may be more abundant than presently known.

The species primarily nests in coniferous forests of spruce, cedar, balsam fir, and tamarack (Roberts 1932, Green 1991, Hanowski and Niemi 1991b). It lays 5 to 6 eggs in a nest that is usually placed in the tops of conifer trees, oftentimes 35 to 40 feet (Roberts 1932). In general, little is known about the nesting biology of the species because of its relatively sparse populations in remote areas and because the nest is so difficult to locate (DeGraaf et al. 1991). DeGraaf et al. (1991) also point out that nests are difficult to find because the females tend to land near the base of the tree and move up through the middle rather than flying directly to the nest.

This species is highly insectivorous and gathers insects primarily by gleaning them from the tips of conifer branches near the top of the trees and occasionally by flycatching. The species has been noted as especially common in areas with high infestations of spruce budworm. Usually the species is relatively uncommon, but when associated with outbreaks of spruce budworm Kendeigh (1947) noted 28 pairs per 100 acres and Speirs (1949) noted 19 pairs in 75 acres.

In general, little is known about the overall population trend of Cape May Warblers in the state of Minnesota. Janssen (1990) reported that the species has been found too infrequently on the Breeding Bird roadside counts to detect any trend. The species may have always had a limited state distribution, but relatively high populations have likely occurred in localized areas associated with spruce budworm (Morse 1989).

Two factors will pay a major role in the abundance of Cape May Warblers in the future: (1) the extent of conifers, especially spruce, in northern forests, and (2) the extent to which spruce budworm infestations are controlled through chemical or other applications. Any reduction in conifers or reduced populations of spruce budworm would likely have a negative effect on this species.

The Cape May Warbler was projected to increase in ecoregion 2 under the base harvest scenario on timberlands and increase in ecoregion 1 on all forest lands. Under the medium harvest scenario, the species was projected to decrease in both ecoregions 3 and 4 on timberlands, but only in ecoregion 3 on all forest lands. In the high harvest scenario, the species was projected to decrease in ecoregions 1, 2, 3, and 4 and statewide on timberlands, but only decrease in ecoregions 3 and 4 on all forest lands. The close association of the Cape May Warbler with upland mature coniferous forests, especially spruce, and the associated decrease in this habitat type within ecoregions 3 and 4 are associated with the projected decreases for this species.

Black-throated Blue Warbler (*Dendroica caerulescens*)
The Black-throated Blue Warbler is a rare and local summer resident in Minnesota. Breeding birds can be found consistently only in the mature sugar maple forests of Cook County (Eckert 1983). The overall breeding distribution of the species extends from Nova Scotia and New Brunswick, south along the Atlantic Coast and into the Appalachian mountains to western North Carolina, and west around the Great Lakes to northeastern Minnesota (National Geographic Society 1983). In Minnesota, spring migration usually occurs in early to late May. Fall migration may begin in mid-August, and last through late October (Janssen 1987). This species is one of the least numerous regular nesting warblers in Minnesota (Janssen 1987) and Wisconsin (Robbins 1991).

Preferred breeding habitats in Minnesota, Wisconsin, and Michigan include deciduous habitats usually dominated by sugar maple, but often mixed with other deciduous trees such as oak, paper or yellow birch, and aspen (Green and Niemi 1978, Brewer et al. 1991, Robbins 1991). Coniferous trees such as spruce and pine are often present, but seldom dominating. Critical characteristics appear to large deciduous trees, especially sugar maple and a well-developed understory of deciduous shrubs (Nice 1930, Walkinshaw and Dyer, Freer 1958, Brewer et al. 1991).

Black-throated Blue Warblers have been identified as sensitive to forest area size. For example, Finch (1991) classified this species as area sensitive and suggested minimum area of suitable habitat for breeding at 1000 ha (Finch 1991). These data, however, were compiled from studies in the eastern United States where fragmentation into isolated forest areas in an urbanized and agricultural dominated landscape. The sensitivity of the species to stand size in a forest-dominated landscape is unknown.

Nests are cup-like in shape and generally placed in shrubs or small trees (Ehrlich et al. 1988). In New Hampshire, Holmes (1990) located 66 nests all of which were in shrubs from 0.1 to 0.9 meters from the ground.

These birds are foliage gleaning insectivores which specialize in near-surface chase tactics, and take small to medium sized invertebrates (Black 1975, Robinson and Holmes 1982). Both sexes forage primarily in the shrub layer, with males foraging higher than females (Ehrlich et al. 1988). Winter diets consist of a large proportion of seeds and other plant matter (Ehrlich et al. 1988).

Based on these data, the species was classified as associated with mature, hardwood forests, and an area sensitive species.

The projected available habitat of this species will decline significantly in both ecoregions 2 and 3 as well as statewide under the high harvest scenarios when all timberlands were considered. When all forest lands were considered, significant decreases in available habitat were only found in ecoregion 3 and statewide. These decreases were attributable to the decrease in mature deciduous forests, especially maple-dominated stands. The correspondence between significant decreases in available habitat in ecoregion 3 and statewide primarily reflects the predominant presence of this species in the state in ecoregion 3.

Black-throated Green Warbler (*Dendroica virens*)
The Black-throated Green Warbler is a locally common summer resident in the northeastern and north central parts of the state (Janssen 1987). Historical range included deciduous forests of Hennepin, Wright, and other central counties (Janssen 1987), but loss of forest, as early as the beginning of the century (Roberts 1932) has likely made these areas now unsuitable for nesting. Peak spring migration is early to mid-May, the height of fall migration usually occurs in early September. Wintering grounds are throughout Mexico and into Central America (Roberts 1932) and on Jamaica, Cuba, and the Bahamas (Ehrlich et al. 1988).

The Black-throated Green Warbler occupies a wide range of habitat types including pine forests, spruce, cedar, balsam fir, mixed spruce-fir-deciduous and beech-maple-birch forests (Collins 1983). Robbins (1991) identifies the breeding habitat in Northern Wisconsin as maple-hemlock-pine forest, and conifer forest. He also notes that Black-throated Green Warblers once nested throughout the forested regions of Wisconsin, but due to the virtual elimination of forest habitat in the southern part of the state, these warblers are now found nesting only in a few isolated locations. In other regions, older, forest interior habitats such as mature hardwood forests with a well developed shrub layer are preferred (Morgan and Freedman 1986).

In Minnesota, the Black-throated Green Warbler is associated with mature forests (Collins et al. 1982). Therefore, the species was classified as dependent upon mature forests. Green (1991) lists this species as preferring contiguous coniferous forests in Minnesota. However, the species was found in a variety of forest types in northern Minnesota in 1991 including lowland conifer, upland pine, lowland ash, maple, birch, and aspen. Highest densities occurred in white pine (4.7 paris/40 acres) and balsam fir (6.8 pairs.40 acres) in the Chippewa National Forest (Hanowski and Niemi 1991a). Overall, densities were lower in the Superior National Forest and highest numbers were found in mature maple (Hanowski and Niemi 1991b). The species was not included as being either conifer of hardwood dependent.

The diet of summer residents is invertebrates such as caterpillars, spiders, beetles, and other invertebrates gleaned from foliage. Some hawking and bark gleaning may also be employed (Ehrlich et al. 1988). Black-throated

Green warblers typically feed high in the tree, with males foraging at greater heights than females (Ehrlich et al. 1988).

Numbers of Black-throated Green Warblers observed on breeding bird survey routes in Minnesota have remained consistent over the past 25 years (Janssen 1990). However, the species declined significantly in Wisconsin and Michigan from 1985 to 1989 (Blake et al. 1992). Declines may have been related to a drought that occurred in this region from 1986 to 1988.

The future of this species in Minnesota may rely on the preservation of large tracts of contiguous deciduous and coniferous forests. Compaction of the species range in both Wisconsin and Minnesota due to loss of forests in the early part of this century in the southern portions of both states support this premise. In addition, this species requires larger territories than other warblers and is excluded from small islands (Morse 1989) which indicates that it may be area sensitive as well. Because of the lack of support in the literature, however, it was not included as a forest interior species.

The Black-throated Green Warbler was projected to decrease in ecoregion 4 and statewide under the medium harvest level on timberland, but only in ecoregion 4 on all forest land. The species was projected to decline in ecoregions 2, 3, and 4 and statewide in the high harvest scenario on both timberlands and on all forest lands. Declines are probably attributable to the reduction in availability of mature forests in the northern portion of the state.

Blackburnian Warbler (*Dendroica fusca*)
The Blackburnian Warbler is a summer breeding species in north central regions of Minnesota (Janssen 1987). The species' breeding range in North America is limited to the extreme north central and northeastern United States, south into the northern Appalachians, and southeast Canada (Peterson 1980). It arrives in Minnesota in early May through early June after spending the winter in a region of Central and South America from Costa Rica to Peru (Peterson 1980). Fall migration begins in mid-August with late departing individuals staying until early October (Janssen 1987).

Over most of its breeding range, the Blackburnian Warbler is highly associated with coniferous tree species and especially mature (Collins et al. 1982) coniferous forests (MacArthur 1958, Beals 1960, Morse 1976, Green and Niemi 1978, Collins 1983). Green (1991) classified this species as primarily associated with contiguous coniferous forests. Its habitat requirements in Ontario included mature stands of conifers including white pine, white and black spruce, hemlock, and red pine in that order of importance (De Kiriline Lawrence 1953). In its range in the Appalachians the species will inhabit pine-oak vegetation (Harrison 1975). However, when it is found in deciduous forest areas, the species is primarily associated with mature coniferous trees found within these areas (Morse 1989). The presence of mature, tall conifer trees that represent more than 50 percent of the canopy cover are important vegetation characteristics of its breeding habitat (Titterington et al. 1979, Collins 1983).

In Minnesota the species is found most abundantly in a variety of lowland and upland, mature coniferous forests. Highest densities in the Chippewa National Forest in 1991 and 1992 were recorded in pole size red and jack pine stands (3.1 to 3.4 pairs/40 acres) (Hanowski and Niemi 1991a). The species also occupied several habitat types in the Superior National Forest, but was most abundant in mature white pine and upland spruce (4.0 to 4.3 pairs/40 acres) (Hanowski and Niemi 1991b). Niemi (1977) also found it in relatively high abundance in mature coniferous forests.

The Blackburnian Warbler, like many species that have high-pitched songs, primarily sings from the top of tall conifer trees (Ficken and Ficken 1962). They nest in conifer trees; placing their nest from 5 to 85 feet above the ground (Roberts 1932, Harrison 1975). The nest usually contains 4 to 5 eggs and is well concealed in foliage or *Usnea* moss (Harrison 1975). The species forages in tree tops near the tips of conifer foliage (Morse 1989). The primary food sources are invertebrates and the species densities may be affected by spruce budworm outbreaks (Kendeigh 1947, Morris et al. 1958). However, because Bay-breasted and Cape May Warblers numbers increase during budworm outbreaks, Blackburnian Warblers may be limited due to interspecific competition with these species (Kendeigh 1947).

Numbers of Blackburnian Warblers recorded on Breeding Bird Survey routes in Minnesota have remained essentially the same over the past 25 years (Janssen 1990). However, because of the species high dependency on mature coniferous trees it will be most affected by overall changes in the distribution and abundance of these mature conifers.

The Blackburnian Warbler was projected to decrease under the medium harvest scenario in ecoregions 3 and 4 on timberlands. No decreases were projected when all forest lands were included. Decreases were projected in ecoregions 3 and 4 and statewide under the high scenario for all forest lands. Additional declines were projected to occur in ecoregions 1 and 2 on timberlands in the high harvest scenario. The projected decreases for this species are invariably due to reductions in mature conifer forests under the medium and high harvest scenarios.

Pine Warbler (*Dendroica pinus*)
The Pine Warbler is a resident of north and north central Minnesota where it is most frequently found in large stands of white pine (Janssen 1987). It arrives in the breeding area in early May and begins its fall migration in mid-September. The species winters primarily in the southern United States (Rappole et al. 1983). The Pine Warbler's breeding range in North America

is confined primarily to eastern United States. It is very rare or absent from the Mississippi and Ohio River Valleys and breeds only locally throughout New England (Peterson 1980). Local populations of the species also occur in the Bahamas (Rappole et al. 1983).

The Pine Warbler is highly specific in its habitat requirements, being found almost exclusively in mature pine trees. Roberts (1932) commented that the species "spends it entire existence, with the exception of the time consumed in migration, in pine trees." The species clearly responds to presence of pine and generally ignores deciduous trees in its habitat (Morse 1974). Brush and Stiles (1990) found that Pine Warblers foraged mainly in pines throughout the breeding season and were more abundant in pine dominated habitats in New Jersey. It can be found in deciduous forests with as little as 10 percent conifer cover, but pines are essential (Morse 1974). Schroeder (1982) observed that the species cannot be supported in mature deciduous forests without pines. Highest densities in Virginia were in mature pine stands (Connor et al. 1979). The species requires mature forests (Collins et al. 1982) and many breeding territories are characteristically associated with a few individual pines projecting above the lower canopy (Brewer et al. 1991).

The species is recognized as an indicator species of white pine habitat in both the Superior and Chippewa national forests. Data from the Chippewa National Forest in 1991 indicated that the species occurred in jack, red, and white pine stands, but densities were highest in white pine (about 6 pairs/40 acres) (Hanowski and Niemi 1991a). Highest abundance for the species in the Superior National Forest also occurred in white pine stands (6 pairs/40 acres) (Hanowski and Niemi 1991b). We classified this species as dependent on mature forests and a conifer-dependent species.

The Pine Warbler also may be sensitive to forest fragmentation. The minimum amount of forested area required to sustain a breeding population in Maryland was 160 acres (Robbins 1979). However, because of the lack of extensive evidence on the species sensitivity to forest area size, we did not classify it as a forest interior species.

The Pine Warbler nests in pine trees, on a horizontal branch or among the foliage at the branch tip usually >5 m above the ground (Harrison 1975). The species feeds primarily on insects gleaned from pine foliage. Morse (1989) speculates that their skulls are too broad and their bill too short to forage in pine cones. Male and females generally forage at the same height and use the same substrate for feeding. This is probably due to the simplicity of the habitat and the low volume of insects present in this habitat type (Morse 1974). The species also uses tree trunks and branches, and the extent to which individuals use this substrate is specific to certain subpopulations (Emlen and DeJong 1981).

Based on breeding bird roadside counts, the species has significantly increased by about 7.0 percent per year in numbers over the past 20 years in Minnesota (Janssen 1990). However, these data were only based on 11 of 52 routes covered in Minnesota. Its overall status remains unclear in Minnesota.

It is likely that in presettlement times, the Pine Warbler was much more abundant. Roberts (1932) describes the species as one of the most common warblers throughout the coniferous region of northern Minnesota. This is certainly not true today, where it is relatively uncommon in most localities. Further reductions in pine, especially white pine, will have a negative effect on the breeding population in the state. Maintenance of mature pine trees in future cuts and preservation of some mature pine stands will be required to mitigate impacts for this species.

Suitable habitat for the Pine Warbler was projected to decrease in ecoregions 1 and 3 when timberlands and all forest lands were considered in the medium harvest scenario. Additional decreases were projected for ecoregion 4 for both timberland and all forest land under the high harvest scenario. A statewide decline was also projected in the high harvest level as well as in ecoregion 2 under the high harvest level for timberlands. A statewide decline was also projected when all forest land was considered under the high harvest scenario. Decrease in suitable habitat for this species is probably attributable to the loss of mature pine forests in the northern portion of the state.

Palm Warbler (*Dendroica palmarum*)
The Palm Warbler's range in Minnesota is confined to the north central and northeast portions of the state. The primary breeding range is north of Minnesota (all provinces of Canada except British Columbia) and it is an uncommon breeding species in Wisconsin (Robbins 1991). The Palm Warbler can be classified as both a short and long distance migrant. A portion of the population winters in Caribbean islands (Bahamas, Cuba, Jamaica, and Puerto Rico), while other individuals migrate to the southern United States along the Gulf and Atlantic Coasts. Spring migrants arrive in mid-April to late May and fall migration begins in mid-August and continues through early November (Janssen 1987).

Breeding habitat for this species within its range in Minnesota is highly specific and consists of lowland conifer forests, especially those in large peatlands. Within these peatlands, Palm Warblers prefer muskeg type habitat where trees are relatively sparse, but somewhat uniformly distributed and within areas of low shrubs and Sphagnum (Niemi and Hanowski 1992). Breeding densities in lowland black spruce (*Picea mariana*) stands in the seedling-sapling and pole size age classes in the Chippewa National Forest were around 1 breeding pair/40 acres (Hanowski and Niemi 1991a). In large contiguous lowland conifer areas in the Red Lake peatland, densities of about 7 pairs/40 acres were found (Hanowski 1982). The presence of this species in poorly stocked lowland conifer may indicate that the species could use areas that are in early stages of regeneration. However, their occurrence in stands may be misleading because the age of stands in the seedling-sapling age class in the Chippewa National Forest was found to average >65 years. Based on this information, the species was classified as a conifer dependent species.

The Palm Warbler is one of only two *Dendroica* species that habitually nests on the ground (Mayfield 1960). The nest is generally placed in *Sphagnum* moss under small trees surrounded by sedge, grass, leatherleaf, and Labrador tea (Brewer et al. 1991). Welsh (1971) found nests in Nova Scotia that were all less than a foot from the ground. It could be susceptible to increased nest predation in areas where its preferred habitat becomes more fragmented because of its ground nesting habit.

Summary of breeding bird survey data from 1969 to 1989 indicated that the number of Palm Warblers increased significantly in Minnesota during that time period (Janssen 1990). However, the species was only well represented on three of fifty-two routes, so these data may be unreliable for this species. Because of the narrow range of habitat used in Minnesota, loss of lowland conifer habitat likely would be detrimental to this species in the state. Maintenance of large tracts of contiguous lowland conifer forests within peatlands of northern Minnesota is required for this species.

Palm Warbler suitable habitat was projected to increase in ecoregions 1, 2, and statewide in the base harvest level when timberlands and all forest lands were considered. Additional increases were projected for timberlands in ecoregion 4 under the base harvest scenario. Projected declines were projected only on timberlands in ecoregions 2 and 4 and statewide under the high harvest level. Decrease in the high harvest scenario was likely due to the loss of older lowland conifer habitat in the northern portion of the state.

Bay-breasted Warbler (*Dendroica castanea*)
The Bay-breasted Warbler is one of the species of the state that is highly associated with outbreaks of spruce budworm and generally its highest densities are found in areas where spruce budworm is found (Morse 1989). The breeding distribution of the species follows a narrow strip from extreme northeastern British Columbia in the southern Mackenzie area across the southern boreal forest of Canada to Newfoundland and Maine (Bent 1953, Godfrey 1966, DeGraaf et al. 1991). The winter distribution of the species is limited to southern Central America, primarily Panama, and northern South America, including northern Venezuela and northern Columbia (DeGraaf et al. 1991).

The migration of this species occurs from early May through early June in the spring, while fall migration begins in mid-July and lasts through mid-October. In Minnesota the species primarily occurs in the northern portions of Cook, Lake, and St. Louis counties. The species has been reported from as far south and west as Itasca State Park (Janssen 1987).

The Bay-breasted Warbler occurs in mid-age to mature spruce fir forests in Minnesota and often is associated with spruce budworm outbreaks (Mendall 1937, Morse 1989). The species has a relatively large clutch size of 5 to 6 eggs, and sometimes clutches of up to 8 eggs have been reported during spruce budworm outbreaks (Morse 1989). The nest is placed on a horizontal branch of a conifer from 4 to 40 feet above the ground and placed away from the tree trunk (DeGraaf et al. 1991). The Bay-breasted Warbler was classified as a conifer-dependent species, but not associated with mature forests. The species often uses mature conifer forests, but it can be found in a variety of age-classes of conifer forests. The availability of suitable insect populations in coniferous forests, especially spruce budworm, seem to be of critical importance in Minnesota.

The species is highly insectivorous during the breeding season. Morse (1989) suggests that the species concentrates most of its activities on the larger inner parts of the limbs in contrast to the outer portions of the tree. Sealy (1979) noted that the species also was associated with forest tent caterpillars, in which it took many of the smaller sized caterpillars. Greenberg (1979) described the species as relatively plastic in foraging during the winter.

Little is known about the overall population trend of Bay-breasted Warblers in the United States because of the remote areas where they are primarily found. However, with the decrease in conifer vegetation of spruce and fir and the large scale spruce budworm control programs (Blais 1973 in Morse 1989) the population is likely lower today than it has been in the past. The potential effects of increased timber harvesting and forest management depend on the extent to which conifers decrease in abundance and control programs are initiated to reduce populations of spruce budworm. Both will be detrimental to the species.

The Bay-breasted Warbler was projected to decrease in ecoregion 3 under the medium harvest scenario when either timberlands or all forest lands were considered. On all forest lands the species was projected to increase in ecoregion 1 in the base harvest scenario. Under the high harvest scenario, the species was projected to decrease in ecoregions 1, 2, and 3 and statewide when timberlands alone were considered, but when all forest lands were included decreases were only found in ecoregion 3. This species has a relatively narrow habitat tolerance, primarily occurring in areas of mature, upland coniferous forests, usually spruce or fir, and often in association with spruce budworm populations. Reductions in this habitat type are estimated to directly reduce populations of this species in the state.

Cerulean Warbler (*Dendroica cerulea*)
The Cerulean Warbler is a locally common breeding bird in the mature deciduous forests of eastern North America. Its range extends from Minnesota south to northeastern Texas, east to northern Alabama, and north to southern Ontario. It also breeds east of the Appalachian Mountains in central Virginia, Maryland and eastern Pennsylvania (Peterson 1980). In Minnesota, the species is confined to the southeastern portion of the state primarily along the Mississippi, Minnesota, and St. Croix River Valleys. It has been reported as far north as Mahnomen County and as far west as Brown County (Janssen 1987).

The Cerulean Warbler is a long-distance migrant, wintering from Venezuela and Columbia south to eastern Peru and northern Bolivia (Ehrlich et al. 1988). It generally arrives on its breeding grounds in Minnesota during early May and leaves for the tropics again by late August (Janssen 1987).

The preferred habitat of the Cerulean Warbler is mature, deciduous floodplain forests (Graber et al. 1983, Brewer et al 1991). In Missouri, (Kahl et al. 1985) found Cerulean Warblers on moist, wooded slopes and stream valleys in uplands as well as in bottomland hardwood forests. In this study, vegetation samples at 77 song perches were characteristic of mature forest with a high, dense canopy and well-developed but not dense subcanopy and shrub layers. Moisture gradient was not significantly correlated with abundance of Cerulean Warblers (Kahl et al. 1985). Bond (1957) also recorded Cerulean Warblers on upland sites in southern Wisconsin, and stated that this species should not be considered "a strictly bottomland bird." However, Bond (1957) found the Cerulean Warbler "strikingly more common with increasing mesic conditions." It was present on xeric sample plots only if the forest tract was larger than 40 ac (16 ha) (Bond 1957). In southern Illinois, populations of Cerulean Warblers in upland forests were about half as dense as those in bottomland forests (Graber et al. 1983).

Based on these data, the Cerulean Warbler is classified as dependent on mature, hardwood forest types, primarily those in ecoregions 5, 6, and 7.

The Cerulean Warbler forages and nests in the upper canopy of the tallest trees. The nest is placed on a horizontal limb often as high as 20 m (60 ft) above the ground (Harrison 1975, Roberts 1932). Little is known of its specific diet, but it is presumed to be largely or entirely insectivorous (Ehrlich et al. 1988).

The Cerulean Warbler is fairly common within its preferred habitat and is thought to be expanding its range in the south and northeast (Ehrlich et al.

1988). It is sensitive, however, to fragmentation of its breeding habitat, and the extent of mature deciduous forest may be a major determinant for the Cerulean Warbler in Minnesota. Several studies provide evidence suggesting that the Cerulean Warbler is an area-sensitive species. Bond (1957) found these warblers much more common in medium (40 to 80 ac) and large (>80 ac) forest tracts in southern Wisconsin than in small tracts (<40 ac). In east central Illinois, Blake and Karr (1984) did not detect Cerulean Warblers on study plots of less than 65 ha (160 ac). Research by Robbins et al. (1989) in the middle-Atlantic states suggests that this species is rarely found in forest tracts of less than 138 ha (340 ac) and tracts of greater than 3,000 ha (7,400 ac) may be necessary to insure its continued presence.

Data collected in the USFWS Breeding Bird Survey indicate that although the Cerulean Warbler apparently increased in Wisconsin, overall, it decreased by 3.1 percent per year in the north central U.S. from 1966 to 1987 (Hands et al. 1989). Sauer and Droege (1992) recently reported a decrease of about 4 percent in the eastern United States for data gathered through 1988. No trend data are available for the species in Minnesota because it was too infrequently observed on roadside counts (Janssen 1990, Collins et al. 1992).

Graber et al. (1983) attributed the apparent decline of this species in Illinois to a loss of bottomland forest habitat. Due to its sensitivity to fragmentation, the Cerulean Warbler is classified as a forest interior species. Overall, the best documentation of this area sensitivity and the issues associated with the species are described by (Robbins et al. 1992).

The projected decrease in suitable habitat for the Cerulean Warbler was identical for timberland and all forest land. Declines were projected to occur in ecoregion 6 under all harvest levels, statewide in both the medium and high levels, and in ecoregion 5 under the high harvest scenario. Projected declines in abundance are likely due to the loss of contiguous, mature, deciduous forests in the southern portion of the state.

Black-and-White Warbler (*Mniotilta varia*)
The Black-and-White Warbler's breeding range extends from west-central Mackenzie to southern Quebec and Newfoundland; east of the Rocky Mountains to the Atlantic coast; and south to central Texas and Louisiana (DeGraaf et al. 1991). In Minnesota, the warbler is a regular summer resident primarily in the northeastern and north central regions. The species becomes relatively scarce in central Minnesota and south and west of the Mille Lacs Lake area (Janssen 1987).

The Black-and-White Warbler is a long-distance migrant that winters from southern Texas, coastal South Carolina, Florida, Mexico and Central America to Venezuela, Ecuador, and Columbia (DeGraaf et al. 1991). The warbler is a common spring and fall migrant throughout Minnesota that appears during mid-April through late May, and leaves the state from early August to mid-October (Janssen 1987).

The Black-and-White Warbler breeds in various types of upland deciduous and mixed forests (Stewart and Robbins 1958, Temple et al. 1979), and has been shown to be abundant in pole-stage stands (Conner and Adkisson 1975, Crawford et al. 1981, Bushman and Therres 1988). The warbler prefers woods with a closed canopy, a well-developed understory layer, and low shrub density, but tolerates semi-open stands (Crawford et al. 1981).

In Minnesota, the Black-and-white Warbler has been observed in mature maple-basswood forest (Kelleher 1967), regenerating and mature jack pine (Niemi 1974, Pfannmuller 1979), mature red pine and black spruce-tamarack forest types (3 pairs/15 ha), and regenerating aspen (2 pairs/15 ha) (Hanowski and Niemi 1991a, 1991b). Hence, the species occurs in a wide variety of habitats including both deciduous and coniferous dominated vegetation. Data for the Chippewa and Superior national forests suggest that the species is most abundant in early to midsuccessional forest stages, especially in mixed deciduous-coniferous habitat associations.

Earlier Breeding Bird Survey data from 1965 to 1979 showed a significant increase in the species population in Minnesota (Robbins et al. 1986), but this is no longer true based on data through 1989 (Janssen 1990). The warbler nests on the ground at the base of a tree or stump and clutch size ranges from four to five eggs (Harrison 1975). The species is an insectivorous bark gleaner year round (DeGraaf et al. 1985).

Habitat area may be a limitation for the Black-and-White Warbler. The species was commonly found in forests larger than 4000 ha in western Maryland (Anderson and Robbins 1981) and the minimum forest area needed to sustain a viable breeding population was estimated at 300 ha (Robbins 1979, 1980). The species has been shown to have a low tolerance to forest fragmentation since it is not normally found in forests smaller than 70 ha (Whitcomb et al. 1981). In contrast, the Black-and-White Warbler has been recorded in smaller woodlots that were close to more extensive forests (Galli et al. 1976). Wilcove (1985) considers the warbler to be one of the species most sensitive to forest fragmentation in Maryland. In addition to the warbler's ground nesting habit, the species also is a frequent Brown-headed Cowbird host (Brittingham and Temple 1983). Increased forest fragmentation, and the subsequent increase in cowbirds and predators, may be detrimental to this species (Wilcove 1985). Based on these data, the species was classified as a forest interior species.

The Black-and-White Warbler is a relatively common species in most of the forested zones of Minnesota and does not appear to be detrimentally affected by timber harvesting activity. No detailed information, however, are available. Because of its documented sensitivity to forest area size, its ground nesting habit, and its parasitism by Brown-headed Cowbirds, the status of the species population in the state deserves monitoring. Moreover, Roberts (1932) suggests that the species was formerly more common throughout the state, especially in areas of "heavy timber." He further suggests that timber harvesting in southern Minnesota reduced populations of the species in that part of the state. The possible retraction of the species range from central and southern Minnesota may have been due to factors associated with habitat fragmentation in those regions

A decrease under the high harvest scenario was projected to occur in ecoregion 5 on both all forest and timberlands. An increase was projected for this species in ecoregion 2 on timberlands in the high harvest scenario. Increases and decreases are likely due to the amount of mid-successional forest (pole-sized stands) available in an ecoregion.

American Redstart (*Setophaga ruticilla*)

The American Redstart is a common to abundant summer resident throughout Canada and the eastern United States (except Florida). In the west, it breeds in the Dakotas, Wyoming, Montana and Oregon (Peterson 1980). It is common in the forested regions of Minnesota, but scarce or absent in the prairie regions in the southwestern portion of the state (Janssen 1987). The American Redstart is a long distance migrant, wintering from Mexico and the West Indies, south to Brazil and northern Peru (Ehrlich et al. 1988). The spring migration period extends from late April through late May with most individuals arriving in Minnesota during mid-May. In the fall, most Redstarts leave the state from late August to mid-September (Janssen 1987).

This species breeds in a wide variety of both deciduous and mixed forest types, as well as in alder swamps (Howe 1974) and various early successional habitats. According to Sherry (1979) the Redstart prefers habitats with open areas at middle height within the forest which permit aerial pursuit of insects. Bond (1957) found the highest densities of Redstarts in the middle portion of his vegetational gradient. These stands were characterized by a diffuse canopy with 70 to 80 percent closure, fewer saplings than in the more mesic stands but greater diversity of sapling species, and more sapling-like shrubs. Three of the five bird species which peaked conspicuously in the intermediate stands (including the Redstart) are sapling nesters. Bond (1957) speculated that the more evenly branched and foliaged saplings in these intermediate stands "would probably provide more of the upright crotches generally required as nest sites by these species."

In New York, the Redstart showed an upward trend in total numbers with increased logging intensity. Highest numbers were recorded on plots in which 75 percent of the commercial timber volume was removed. This treatment "opened up the canopy, and encouraged regeneration to grow rapidly" (Webb et al. 1977). Titterington et al. (1979) found a significant positive correlation between Redstart occurrence and hardwood regeneration >2 m tall on logged plots in Maine 7 to 12 years after clearcutting. Data for northeastern Minnesota indicate highest densities of Redstarts in stands of mature paper birch (10 pairs/40 acres) and mature oak (8 pairs/40 acres). Redstarts were also recorded in pole-sized Jack pine (6 pairs/40 acres), mature aspen (4 pairs/40 acres), mature elm-ash-cottonwood (3 pairs/40 acres), and regenerating aspen stands (2 pairs/40 acres) (Hanowski and Niemi 1991b). Probst et al. (1992) also found the American Redstart to be most abundant in the intermediate stages of aspen regeneration in the Chippewa National Forest.

The Redstart places its cuplike nest in the upright fork of a small tree or shrub from 1 to 10 m above the ground. It lays two to five eggs, usually four, and raises a single brood per season (Harrison 1975). Its diet consists primarily of insects gleaned from foliage, and flying insects which it actively pursues in flycatcher fashion (Ehrlich et al. 1988).

Several studies provide evidence that the American Redstart is an area sensitive species. Bond (1957) found this species 50 percent more common in forest tracts larger than 80 acres compared to tracts of less than 40 acres. Even in their preferred habitat, Redstarts were more common in larger tracts. When found in the more mesic or more xeric stands, they occurred almost exclusively in the larger woods (Bond 1957). According to Robbins (1979) the American Redstart has declined by 60 percent or more on several study areas in Maryland. The decrease in numbers is apparently correlated with the extensive fragmentation of the forests of that region (Robbins 1979). In a study conducted in east central Illinois, Blake and Karr (1984) did not detect American Redstarts on forest islands of less than 290 acres. Robbins et al. (1989) found a significant correlation between occurrence of this species and percent forested area within 2 km.

Because of this potential sensitivity to size of forest area, the American Redstart is classified as a forest interior species. However, there is no direct evidence for this in Minnesota. More detailed research is necessary to determine the sensitivity of this species to timber harvesting. However, use of intermediate stages of aspen regeneration should result in positive effects on the population of this species. Its susceptibility to Brown-headed Cowbird parasitism and its possible sensitivity to forest area size should be carefully monitored.

Data collected in the USFWS Breeding Bird Survey indicate increased numbers of Redstarts in the northeastern states and provinces, but significant declines in the southeastern states and from the Great Lakes south to Arkansas and Alabama (Robbins et al. 1986). The species has declined significantly in Minnesota over the past 25 years at a rate of about 3 percent per year (Janssen 1990).

An increase in suitable habitat for the American Redstart was projected for ecoregion 9 on timberland for the base and medium harvest levels. When all forest land was considered, increases were noted for ecoregions 2 and 9 for the base and medium harvest scenarios and ecoregion 9 under the high harvest regime. Decreases were projected for ecoregions 1, 2 and 6 on timberland and in ecoregion 1 when all forest land was considered under the high harvest level.

Prothonotary Warbler (*Protonotaria citrea*)
The Prothonotary Warbler is a rare summer resident in southeast and south central Minnesota. It occurs primarily in bottomland forests along the Mississippi, Rum, Minnesota, and St. Croix rivers. It is a rare spring migrant in the state and gradually leaves breeding areas from late July through late August (Janssen 1987). The species primary breeding range is to the south and east of Minnesota (Peterson 1980). Roberts (1932) suggested that the species gradually moved north to Minnesota by following the Mississippi River valley. The Prothonotary Warbler winters in southeast Mexico and as far south as northern South America (Rappole et al. 1983).

The Prothonotary Warbler is insectivorous and forages on the ground or gleans insects from low vegetation near water (Samson 1979). It requires riparian habitat for breeding; Walkinshaw (1953) found all territories within the immediate vicinity of well-shaded water. It is one of only two warbler species that nests in cavities (Morse 1989). Cavities used for nesting are either natural cavities or old woodpecker cavities (Harrison 1975). Fifty percent of cavities used were those excavated by Downy Woodpeckers (Walkinshaw 1953). This species competes for nest cavities with Tree Swallows and House Wrens (Morse 1989). However, because it arrives later in the breeding season than these two species, suitable nest sites are often occupied. A lack of available nest sites may be a factor that has limited the species abundance. In addition, two introduced species, the Starling and House Sparrow, also use similar nest sites (Morse 1989). This species was classified (EQB group) as a riparian species, cavity nester, forest interior species, and a species that requires mature forests.

This species will accept nest boxes (Walkinshaw 1953, Petit et al. 1987, Petit 1989) and this may be used to mitigate possible declines in numbers. Petit (1989) found densities three times higher in areas where nest boxes were placed.

Populations may also be limited by forest size (Galli et al. 1976). Robbins (1979, 1980) estimated the minimum area required to sustain a viable breeding population at 250 acres. Others (Whitcomb et al. 1981) found

Prothonotary Warblers only in extensive forests; those larger than 200 acres. This species may be affected by forest management practices that remove trees with available cavities (Bushman and Therres 1988). Old growth stands would most likely benefit this species because older trees are more likely to develop cavities (Conner and Adkisson 1977, Evans and Conner 1979).

Timber harvest practices that leave snags or decaying trees in suitable habitats will be beneficial to the species. In addition, Bushman and Therres (1988) suggest leaving buffer strips in riparian habitats of at least 100 m on each side of streams.

No significant increases or decreases were projected for this species.

Ovenbird (*Seiurus aurocapillus*)
The Ovenbird is one of the most common summer residents in the forested portions of the state, particularly in the northern, east central, and southeastern regions (Janssen 1987). The peak of spring migration is in mid-May. The peak of fall migration is from early to late September (Janssen 1987). Ovenbirds winter in Central America, south to northern Venezuela, in second growth forest and scrub habitats (Ehrlich et al. 1988, Morse 1989).

Ovenbirds nest on the ground in upland deciduous woods, building a nest roofed with leaves and branches, resembling the oven for which they are named. Two broods are occasionally raised, three broods may be raised in areas with spruce budworm outbreaks (Ehrlich et al. 1988). Ovenbirds are ground-foraging insectivores, whose diet may include worms, spiders, and snails (Ehrlich et al. 1988). Abundance of Ovenbirds appears to be related to populations of prey and habitat structure (Smith and Shugart 1987, Collins 1991, Zach and Falls 1975, Stenger 1958).

Hardwood forests with closed canopies, a high basal area of medium sized trees, open understories, and intermediate shrub density are preferred (Crawford et al. 1981, Bushman and Therres 1988). Mature and old growth trees may be important as song perches (Hopkins 1984). In suitable mature and old-growth forest interior habitat (Bushman and Therres 1988, Morse 1989), Ovenbirds may be very abundant (Robbins 1991). This species is more often seen than heard. Its loud "TEACHER TEACHER" song is familiar to many, but its relatively drab plumage and secretive behavior make it difficult to observe (Roberts 1932).

In Minnesota, the Ovenbird was found in almost all habitat types and ages in 1991. Overall, densities increased with maturity of forests; young stands had the lowest densities and mature stands the highest densities (Hanowski and Niemi 1991a, 1991b). Jack pine, red pine, white pine, maple, and birch forests had densities greater than 10 pair/40 acres in Chippewa National

Forest. In the Superior National Forest, red pine and birch habitat types had densities greater than 10 pair/40 acres.

The Ovenbird has been reported to be sensitive to forest fragmentation (Bushman and Therres 1988) and is a frequent host to Brown-headed Cowbirds (*Molothrus ater*) brood parasitism (Kerlinger and Doremus 1981, Ehrlich et al. 1988). The species' ground nesting habitat makes it more sensitive to predation which follows fragmentation and other anthropogenic disturbances (Morse 1989). Forest fragmentation and loss of larger woodlands may be threats to Ovenbirds in marginal habitats and fringes of the species range (Brewer et al. 1991). The species was classified as a forest interior bird.

There has been no change in abundance of Ovenbirds in Minnesota in the past 25 years (Janssen 1990). The species did decline significantly in both northern Wisconsin and Michigan from 1985 to 1989 in response to a drought (Blake et al. 1992). Nationwide, the species has declined by about 1 percent over the past 10 years (Sauer and Droege 1992).

Available habitat for the Ovenbird was projected to increase in ecoregion 9 where it has a limited range under all harvest levels when all forests were considered and in the base and medium harvest levels when only timberlands were considered. Decreases were projected to occur in ecoregion 6 in both timberland and all forest land under all cutting regimes. Decreases in ecoregion 4 were projected on timberlands and all forest lands for the medium and high harvest scenarios. Under the high harvest level, it was projected that there will a statewide decline as well as regional declines in ecoregions 1, 3, and 5 under both the timberland and all forest lands. The species' available habitat was also projected to decline on timberlands in ecoregion 2 under the high harvest level.

Northern Waterthrush (*Seiurus noveboracensis*)

The Northern Waterthrush is fairly common in northern bogs and forested swamps, and near wooded streams and lakeshores (Green and Niemi 1980). Its range extends from Alaska, east across Canada, and south into the northern edge of the United States (Peterson 1980). In Minnesota, it is a summer resident primarily in the northeast and north central regions. Surprisingly, it has been reported regularly during the breeding season at Cedar Creek Scientific and Natural Area in Anoka County, well south of its typical range (Janssen 1987). This species is a long distance migrant, wintering from Central America south to eastern Ecuador and northeastern Peru (Ehrlich et al. 1988). The spring migration period extends from mid-April through early June with the bulk of migrants arriving in early to mid-May. Most individuals leave the state in the fall by mid-October (Janssen 1987).

The Northern Waterthrush is classified as a riparian species. Graber et al. (1983) report that, while passing through Illinois during both spring and fall migration, this species shows "a strong and consistent preference for bottomland forest habitat." Gillespie and Kendeigh (1982) recorded a very high density of Northern Waterthrushes (17 pairs/40 acres) in their Herriot Creek "riparian" plot. In a study conducted in Connecticut, typical Northern Waterthrush habitats were in mixed deciduous-coniferous swamps with dense shrub cover, and standing water or slow-moving streams (Craig 1985). Robbins et al. (1989) found significant positive correlations between the occurrence of Northern Waterthrushes and foliage density (0.3 to 1.0 m high), moisture gradient, and percent conifer canopy cover. There was also a significant negative correlation with percent total canopy cover (Robbins et al. 1989).

The nest of this species is usually hidden among the roots of an uprooted tree or under an overhanging bank near water (Ehrlich et al. 1988). Four or five eggs are laid, but the number of broods is unknown (Harrison 1975, Ehrlich et al. 1988). The Northern Waterthrush forages by gleaning from moist soil and litter, consuming aquatic and terrestrial insects, mollusks, small crustaceans, worms and occasional minnows (Craig 1984, DeGraaf et al. 1991).

Data collected in the USFWS Breeding Bird Survey indicate an increase in the Eastern region and the Great Lakes Transitional forest area. A decline in the west was not significant. Highest breeding densities were recorded in the Canadian Rockies, British Columbia, and New Brunswick (Robbins et al. 1986).

There is some evidence to suggest that the Northern Waterthrush is an area sensitive species. In a study of a lakeshore buffer strip and an undisturbed lake shore in Maine, the Northern Waterthrush was absent from the 100 m wide buffer strip. The authors speculated that the absence of this species might be related to sensitivity to disturbance, or to insufficient amount of contiguous habitat (Johnson and Brown 1990). Robbins et al. (1989) found a significant positive correlation between the occurrence of Northern Waterthrushes and the area of the forest tract. They suggest that 500 acres is the minimum area required for breeding, although the maximum probability of occurrence was in tracts greater than 7,500 acres (Robbins et al. 1989). The extent of forested lowlands is likely to be a limiting factor for this species in Minnesota.

The Northern Waterthrush was classified as a forest interior species, although there is no data available specifically for Minnesota. In addition, in places where this species occurs in Minnesota, there is little fragmentation of habitat in the way that fragmentation has occurred in agriculturally or urban-dominated landscapes. The species is highly associated with riparian habitats throughout the forested zones of Minnesota. Protection of riparian zones associated with timber harvesting and riparian development will likely mitigate effects of increased harvesting of forests in Minnesota.

Suitable habitat for the Northern Waterthrush was projected to increase on timberland in ecoregion 2 and statewide under all harvest levels. The projected increase was likely due to the protection of riparian forested areas in the state.

Louisiana Waterthrush (*Seiurus motacilla*)
The Louisiana Waterthrush's breeding range extends from eastern Nebraska, east to New England, and south to eastern Texas, central Georgia, and the Carolinas (Farrand 1985). The species is more abundant in the eastern part of its range than in the western portion (Coffin and Pfannmuller 1988). In Minnesota, the Louisiana Waterthrush breeds locally in southeast Minnesota along the Mississippi, St. Croix, and Minnesota river valleys (Janssen 1987). Described as "common" in these areas in the early 1900s, today the species is listed as one of special concern in Minnesota due to its decline in abundance (Coffin and Pfannmuller 1988). The species is a long distance migrant, wintering in the West Indies, Mexico, Central America, and northern South America (Farrand 1985). The warbler arrives in Minnesota during mid-April to mid-May and leaves during August, with nearly all individuals gone by mid-September (Janssen 1987).

The Louisiana Waterthrush inhabits mature deciduous, mixed floodplain, and swamp forests near swiftly flowing water (Bent 1953, Craig 1985, Bushman and Therres 1988). Craig (1985) found that in areas of Connecticut where both species of waterthrush occur, the Louisiana Waterthrush territories ranged from deciduous lined rocky streams to heavily coniferous swampy streams, but contained significantly greater areas of fast-moving water and more deciduous cover. In West Virginia, the Louisiana Waterthrush is common in all types of deciduous forest, but is strictly limited to streamside situations (Hall 1983). Robbins et al. (1989) identified the following habitat variables as significant predictors of the species relative abundance: tree basal area, forest area, and moisture gradient. Base on this information the species was classified as requiring hardwood and riparian habitat.

The Louisiana Waterthrush builds its nest on the ground along stream banks or amid roots of fallen trees found a few feet from water (Harrison 1975). Clutch size ranges from four to six eggs, usually five (Harrison 1975). The warbler is primarily an insectivore, in which it gleans terrestrial and aquatic insects, mollusks, crustaceans, and occasionally small fish from the shores of freshwater streams (DeGraaf et al. 1985, Ehrlich et al. 1988).

Habitat area may be a limitation for this species. A summary by (Finch 1991) recently indicated that the species was not found in forested tracts of less than 60 acres, while 7,500 acres may be required to guarantee that the species will be present. Whitcomb et al. (1981) found the Louisiana Waterthrush only in forest fragments of 175 acres or more in Maryland, and Robbins (1979) estimated the critical forest size required for this species at 250 acres. However, Robbins et al. (1989) suggested that the species could likely be a resident in smaller forests if tracts containing bottom-land habitat or streams were preserved. With this information, the species was classified as an interior forest bird.

Alteration of wooded streambanks and ravines may be detrimental to the species because of its dependence on such habitats (Bushman and Therres 1988). Forest fragmentation may also have an adverse affect on the Louisiana Waterthrush due to the species ground nesting habit and its affinity for extensive forest with little edge (Robbins 1980, Bushman and Therres 1988). The species is a common Brown-headed Cowbird host (Ehrlich et al. 1988). In areas of fragmentation, the subsequent increase in cowbirds and predators may be detrimental to this species.

Suitable habitat was projected to increase in ecoregion 5 for the Louisiana Waterthrush under all harvest levels and when both timberland and all forest land was considered. This increase was likely due to the protection of riparian areas that were projected in the second model runs. Decreases were projected for ecoregion 7 under all harvest levels on both timberland and all forest land. Decrease in the southern portion of the state was probably due to the loss of mature, contiguous forests in this area.

Connecticut Warbler (*Oporonis agilis*)
The Connecticut Warbler is a regular summer resident (Janssen 1987) in northeastern Minnesota. The species also breeds in northern Wisconsin and Michigan in the United States and in regions of most Canadian provinces. Spring migration in Minnesota peaks in late May, and fall migration occurs from mid-August through late October (Janssen 1987). Few individuals are seen in migration (Kilgore and Breckenridge 1929, Eckert 1983), but in Wisconsin, data from banding records and tower kills, indicates that the species is more abundant during migration than observation records alone suggest (Robbins 1991). Historical range of this species in the state included areas as far south as Isanti County (Kilgore and Breckenridge 1929, Roberts 1932). Winter range is not well known but is believed to be in northern and central South America (Ehrlich et al. 1988).

Connecticut Warblers forage on the ground and in low shrubs (Morse 1989), but few specifics are known about their diet. Invertebrates in moss and leaf litter likely make up the majority of items taken, with some seeds and fruit making up a small percentage of the diet (Ehrlich et al. 1988).

Breeding habitat includes mature black spruce-tamarack bogs (Kilgore and Breckenridge 1929, Roberts 1932, Erskine 1977, Hanowski and Niemi 1991a, 1991b, Niemi and Hanowski 1992), and jack pine barrens with a thick shrub understory (Robbins 1991). Hence, the species is classified as associated with mature, coniferous forests. However, the species is most abundant in mature, lowland coniferous habitats and is uncommon to rare in other types of coniferous vegetation (e.g., Niemi and Pfannmuller 1979, Green and Niemi 1978, Warner and Wells 1984).

Nests are built of leaves in sphagnum moss or grass, or are simple depressions lined with fine grasses and roots (Kilgore and Breckenridge 1930, Roberts 1932, Ehrlich et al. 1988). Clutches usually contain 4 to 5 eggs, but little is known about incubation time or time to fledging (Ehrlich et al. 1988). Ground nesting birds such as the Connecticut Warbler may be sensitive to habitat fragmentation due to increases in nest predation and parasitism that may accompany decreases in forest interior habitat (Wilcove 1985).

Management prescriptions on bird species as poorly known as the Connecticut Warbler are speculative. It is likely, however, that historical range reductions in Minnesota have been due to loss of suitable nesting habitat in more southerly portions of this species range. Maintenance of mature black spruce-tamarack bogs is essential.

Roadside count data for Minnesota has indicated no change in the population of the species since 1966 (Janssen 1990). However, few individuals of this species are observed along these routes. Hence, the sample size is relatively small for detecting a significant trend.

Maturing of lowland conifer habitat in northern Minnesota under the base harvest scenario is likely the reason for the projected increase in suitable habitat for the Connecticut Warbler in ecoregion 1. When timberland was considered, increases were projected for ecoregions 1 and 2. A decrease in suitable habitat was projected in ecoregion 3 under all three harvest levels on both timberland and all forest land. Additional decrease was projected in ecoregion 4 under the high harvest level for all forest land. When timberland was considered, decreases were projected in ecoregions 2, 3, and 4 as well as statewide under the high harvest level. A decrease in mature lowland conifer habitat was likely the cause for the projected decrease.

Mourning Warbler (*Oporornis philadelphia*)
The Mourning Warbler is a common breeding species throughout eastern Canada, and south into the north central and northeastern United States (Peterson 1980). In Minnesota, it is a summer resident primarily in the wooded portions of the state north of the Twin Cities (Janssen 1987). In June of 1983 and 1984, there were records from Brown County in the

Minnesota River Valley (Janssen 1987), and in 1989, a pair was observed feeding fledged young at Murphy-Hanrehan Park in northeastern Scott County (C. Pearson, personal observation). This species is a long distance migrant, wintering from southern Nicaragua south to northern South America (Ehrlich et al. 1988). The spring migration period extends from early May through early June with most individuals arriving during late May. In fall, most birds probably leave the state from late August through early October (Janssen 1987).

The Mourning Warbler is commonly found in brushy clearings or dense undergrowth of open woodlands. It may also be encountered in roadside tangles and swampy thickets along bog and marsh edges (Harrison 1975, Ehrlich et al. 1988). Cox (1960) found Mourning Warblers breeding in a wide range of coniferous and deciduous habitats with partially open canopies, and dense herb and shrub cover. Titterington et al. (1979) recorded the highest densities of Mourning Warblers (about 4 pair/40 acres) in the second seral stage after clearcutting of spruce-fir forests in Maine (3 to 5 years after cutting). This stage was characterized by a dense raspberry stratum and regenerating hardwoods <2 m tall (Titterington et al. 1979).

In Minnesota, the Mourning Warbler is one of the most abundant birds found in early successional forests following logging or forest fire (Niemi 1977, Niemi and Hanowski 1987, Niemi and Probst 1990, Probst et al. 1992). In these habitats densities of Mourning Warblers are often 1 pair/ha or greater. Data collected in the Michigan Breeding Bird Atlas Habitat Survey indicate a preference in this species for wet and mesic habitats (72 percent), and for young or second-growth vegetation (62 percent) (Brewer et al. 1991). The species was not assigned to any EQB group.

The Mourning Warbler forages low in thickets or on the ground for insects and spiders (Cox 1960, Ehrlich et al. 1988). The nest is placed on or near the ground, and well-concealed among dense herbaceous plants or in a tangle of briars (Bent 1953, Cox 1960, Harrison 1975). Three to five eggs are laid (Cox 1960, Harrison 1975), and apparently only one brood is raised per season.

Although the Mourning Warbler will likely benefit from timber harvest in terms of increased habitat and early successional vegetation, its ground nesting habit may make it more susceptible to the increased nest predation that may accompany forest fragmentation. Data collected in the USFWS Breeding Bird Survey showed no significant trend in numbers of Mourning Warblers recorded. Highest counts were in Ontario and the central portion of the Spruce-Hardwood Forest region (Robbins et al. 1986).

Due to the Mourning Warbler's affinity for early successional forests, suitable habitat was projected to increase in ecoregions 4 and 5 under all harvest levels, and statewide under the high scenario. These increases were projected to occur on timberland. When all forest land was considered, increases were projected for ecoregions 4 and 5 under the medium and high scenarios and statewide in the high harvest level.

Common Yellowthroat (*Geothlypis trichas*)
The Common Yellowthroat is probably the best represented and evenly distributed species in the state (Janssen 1987). It also has a wide distribution across North America, occurring throughout the United States and Canada (except the extreme north) (Peterson 1980). The species arrives in Minnesota in late April through late May, and most individuals have left by late October (Janssen 1987).

The Common Yellowthroat occupies a wide range of habitats throughout its range. It prefers cattail marshes, grassy fields, thickets, and shrub areas (Roberts 1932, Harrison 1975). In forested zones, the species is most common in young regenerating stands (Morgan and Freedman 1986), but also occurs in mature stands where pockets of wet shrubs are present. Densities in the Superior National Forest were highest in regenerating jack and red pine (Freedman et al. 1981) stands (2 to 3 pairs/40 acres) (Hanowski and Niemi 1991b). Densities in the Chippewa National Forest were highest in tamarack, black spruce, and mixed swamp conifer stands (14 to 4 pairs/40 acres) (Hanowski and Niemi 1991a). Based on this information, the species was not included in any of the EQB groups.

The Common Yellowthroat places its nest just above the ground in weeds, reeds, cattails, or shrubs (Harrison 1975). Four eggs are generally laid and incubation requires 12 days (Harrison 1975). The species primarily forages in shrubs where it gleans the vegetation for invertebrate prey (Morse 1989).

The annual survival rate for Common Yellowthroats is estimated at 54 percent (Roberts 1971). The species' status in the state based on the Breeding Bird Survey roadside counts has remained unchanged over the past 20 years (Janssen 1990). Nationwide trends suggest that the species has declined by about 2 percent in the last ten years (Sauer and Droege 1992). Because of the species' affinity for shrubs, the status of the species will likely increase in the state if suitable shrub habitat increases, especially those adjacent to or within lowland deciduous and coniferous forests.

Increases in amount of suitable habitat were projected for ecoregions 5, 6 and 7 for timberland and all forest land under the base harvest scenario and for ecoregions 2, 3, 6 and 7 for timberlands. Increases under the medium harvest scenario were projected in ecoregions 3, 5, 6 and 7 in all forest lands and in ecoregions 3, 4, 5, 6, 7, and 9 and statewide for timberlands. Increases were projected to occur in all ecoregions except 9 under the high harvest scenario for all forest land and in all ecoregions and statewide on timberlands. Increases are likely due to the increase in amount of early successional forests.

Hooded Warbler (*Wilsonia citrina*)
The Hooded Warbler's breeding range extends east of the Great Plains from southern Michigan east to southern Rhode Island, and south to the Gulf Coast and northern Florida (Farrand 1985). In Minnesota, the Hooded Warbler has been recorded in the east central, south central, and southeastern regions of the state, with records mainly in the Twin Cities area (Janssen 1987). Singing males had been observed in Clearwater and Scott counties prior to the discovery of the state's first Hooded Warbler nest at Murphy-Hanrehan Park in 1984 (Janssen 1987). The Hooded Warbler is a long-distance migrant that winters from southeast Mexico to Panama (Rappole et al. 1983). Earliest spring migration dates recorded in Minnesota are April 22 and 30. Only three fall migration dates have been recorded in the state: August 25, 1983; September 10, 1969; and October 3, 1982 (Janssen 1987).

The Hooded Warbler occupies mature, moist, deciduous woodland and swamp forests and is particularly attracted to damp areas formed by seeps, streams, or swamps (Bent 1953, Robbins 1978). The species is most abundant in mature stands (Noon et al. 1979, Whitcomb et al. 1981), but is also found in medium-aged stands (Conner and Adkisson 1977, Robbins 1978). A dense shrub layer, suitable for foraging and nesting, and scant ground cover are important (Bent 1953, Powell and Rappole 1986). Robbins et al. (1989) identified the following habitat variables as significant predictors of the species relative abundance: canopy height, percent of forest within 2 km of counting point, and foliage density between 0.3 and 1 m.

The Hooded Warbler nests 0.6 to 0.9 m above the ground in dense undergrowth and clutch size ranges from three to four eggs (Harrison 1975). Females primarily glean insects from the lower canopy and ground and males hawk insects or sally to the ground from an elevated perch (Powell and Rappole 1986).

Habitat area may be a limitation for this species. The Hooded Warbler occurred only in the most extensive forest in Wisconsin (Ambuel and Temple 1983). In the Washington D.C. area, the species became extinct in forest fragments that were less than 1,200 acres (Briggs and Criswell 1975, Robbins 1979). In Illinois, Hooded Warblers were not found in woods smaller than 1,500 acres (Blake and Karr 1984). In western Maryland, the species was detected only in forests larger than 10,000 acres (Anderson and Robbins 1981). In addition to the warblers's shrub nesting habit, the species is also a frequent Brown-headed Cowbird host (Ehrlich et al. 1988). Increased forest fragmentation, and the subsequent increase in cowbirds and predators, may be detrimental to this species (Brittingham and Temple 1983). Hooded Warblers are therefore best classified as a forest interior species.

Rapid deforestation in Central America, the principal wintering ground for the species, may also result in a decline in this and other migrant birds (Powell and Rappole 1986).

Hooded Warbler available habitat was projected to decline in ecoregion 6 under all three harvest levels and in ecoregion 5 under the high harvest scenario regardless of whether all forest or timberland were considered. Statewide decreases in suitable habitat was also projected for all forest land under all three harvest scenarios. When timberland was considered, statewide decreases were projected for the medium and high harvest scenarios. Loss of mature, contiguous, hardwood forests in the southern portion of the state was likely the cause of the species decline.

Wilson's Warbler (*Wilsonia pusilla*)
The primary breeding range of this species lies within the boreal forest zone extending from Alaska across Canada, south into the Rocky Mountains and into northern New England (Peterson 1980). Within this range the Wilson's Warbler is fairly common. In Minnesota it is rare and local in summer in the extreme northeastern counties (Eckert 1983). Breeding was confirmed in northern Lake County in 1980, and the species is believed to breed "sparingly" in the northern portions of Cook and St. Louis counties, and possibly in the northern portions of the north central and west central regions as well (Janssen 1987).

It is a long-distance migrant that winters mainly from Mexico to Panama (Ehrlich et al. 1988). The spring migration period extends from late April to early June with the bulk of migrants moving through the state in late May. Most individuals begin the return flight to the tropics by early August, but late individuals have been recorded into October (Janssen 1987).

Wilson's Warbler is a bird of early successional habitats, and edges associated with water. It breeds in willow and alder thickets, brushy northern bogs, wooded swamp borders, and streamside thickets (Harrison 1975, Ehrlich et al. 1988). In a study conducted in northern Manitoba, Wilson's Warblers were recorded in "forest edge" and "riparian" plots, but were absent from "forest" (interior) plots (Gillespie and Kendeigh 1982). The only density data available for this species in Minnesota were reported by (Warner and Wells 1984) in a study conducted near Waskish in Beltrami County. Four singing males were recorded in a 40 ha "swamp thicket" (1.5/40 acres), but nesting was not confirmed (Warner and Wells 1984). The species was not assigned to any EQB group.

The nest of this species is placed on the ground, often at the base of a sapling or shrub, and is well-concealed in moss or grass hummocks. In favorable habitat, Wilson's Warbler may be found nesting in loose colonies

(Harrison 1975). Its diet consists largely of insects for which it forages in shrubby vegetation close to the ground (Ehrlich et al. 1988).

Data collected in the USFWS Breeding Bird Surveys from 1965 to 1979 indicated an increase for this species in the eastern region centered in Quebec (Robbins et al. 1986).

Because of its limited breeding distribution in the state, timber harvesting will likely have little effect on the species. In Minnesota the species has primarily been found in lowland shrub and streamside shrub habitats; however, if it also occurs in early successional vegetation than it may benefit from increased timber harvesting.

Maturing of forest reserves in ecoregion 2 was likely the cause of a projected decrease in suitable habitat for the Wilson's Warbler under the base and medium harvest levels on all forest land. A statewide decrease was projected under the base and medium harvest levels on all forest land. An increase was projected in ecoregion 2 and statewide under the high scenario on timberlands and all forest lands. Increases were likely due to the increase in early successional forests especially in the high harvest scenario.

Canada Warbler (*Wilsonia canadensis*)
The Canada Warbler spends the winter in South America (Peterson 1980) and is a summer breeding resident primarily in north central and northeastern Minnesota (Janssen 1987). The breeding distribution of the species in North America is primarily northeast and north central United States, the Appalachians, and southern Canada, excluding the western portion (Peterson 1980). It is an uncommon spring migrant in the state, arriving in early May through early June (Janssen 1987). Fall migration begins in mid-August and continues through early October (Janssen 1987).

The Canada Warbler occupies dense wooded areas with a well-developed shrub layer (Harrison 1975). The species prefers mesic deciduous, wet mixed, and mesic mixed forest including northern hardwoods, white pine, balsam fir, hemlock, and cedar. Within these habitats, the species prefers deciduous thickets, usually in association with open water, such as small creeks (Roberts 1932). It occasionally occurs in shrub wetlands of alder adjacent to permanent bodies of water (Brewer et al. 1991). In northern Minnesota, the species was observed primarily in mature stands in the Chippewa National Forest in 1991. Highest density was in upland spruce stands (about 3 pairs/40 acres) (Hanowski and Niemi 1991a). The species occupied a wider range of habitats in the Superior National Forest including lowland conifer, pine forests, deciduous forests, and upland spruce forests. Highest densities in the Superior National Forest were recorded in lowland conifer and mature aspen (about 2 pairs/40 acres) (Hanowski and Niemi 1991b).

Most individuals were observed in mature stands in northern Minnesota in 1991. This suggests that a well-developed shrub layer, often in association with small creeks and streams, under a canopy of mature trees is their preferred breeding habitat (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b).

The Canada Warbler places its nest on or near the ground, in a cavity or bank, in roots, on ledges, or in hummocks (Roberts 1932, Harrison 1975). Four eggs is the typical clutch size for the species (Harrison 1975). Canada Warblers are foliage gleaners, primarily insectivorous, and use both conifer and deciduous substrates (Morse 1989).

The status in Minnesota for this species is unclear because it has not occurred in high enough abundance over the past 23 years on the Breeding Bird Surveys to detect a trend (Janssen 1990). Sauer and Droege (1992), however, noted a short term decrease of about 2 percent per year from 1978 to 1988 based on 340 roadside counts gathered in the eastern United States. In addition, the species seems to require large expanses of forest area and therefore, may be susceptible to forest fragmentation (Finch 1991). It was included as a forest interior species because Finch (1991) reports that it was found in isolated forest areas that were larger than 470 acres. Robbins et al. (1989) reported that the species requires areas of 1,250 acres for breeding. However, there is no evidence of area sensitivity in Minnesota because no studies have been published to date.

No major increases or decreases in suitable habitat availability were projected for this species under any harvest level. This was probably due to the wide range of habitat types and forest ages that the species uses in the state, especially those areas with shrub cover.

Yellow-breasted Chat (*Icteria virens*)
The Yellow-breasted Chat is the largest warbler in North America and is found breeding throughout the lower 48 United States, but is relatively uncommon in the northern tier of states (Bent 1953, DeGraaf et al. 1991). The species is a casual resident in Minnesota, limited to the southeastern and southwestern corners of the state, where populations are highly variable from one year to the next (Green and Janssen 1975, Janssen 1987). The species overwinters in southern Texas, southern Florida, and from Mexico, Central America, and western Panama. The species arrives in Minnesota during spring throughout May and generally leaves the state during the fall, from August to early September (Janssen 1987).

The general breeding habitat of the species consists of riparian habitats with shrubs, thickets, and small trees, forest edges, overgrown pastures, scrub, and early successional forests (Petrides 1938, Bent 1953, Dennis 1958, Thompson and Nolan 1973). The species lays 3 to 5 eggs, generally from

2 to 8 ft in a small bush, thicket, or in a small tree. Incubation is generally 11 to 12 days and is performed by the female. This species is a highly insectivorous bird on the breeding grounds and gleans insects from shrubs and tree foliage. It, however, is also known to consume some fruits and berries (DeGraaf et al. 1991).

As with many of the species that occur in the southern portions of Minnesota, overall timber harvesting and forest management will likely have little effect on the species. The maintenance of riparian vegetation along the Mississippi and Minnesota River valleys and shelter belts in agriculturally-dominant landscapes will be important for the long-term survival of the species in the state. Its co-association with species such as the Bell's Vireo, Loggerhead Shrike, and Blue Grosbeak will also benefit by management for these kinds of habitats.

The species was not classified into any of the EQB-FSD grouping. In addition, because of the species rarity in the state, no data are available on its overall population trends based on the Breeding Bird Survey roadside counts.

The species was projected to have increased available habitat in ecoregion 6 and statewide under all three harvest scenarios and on both timberlands and all forest lands. The species habitat association with younger aged forests is the primary reason for this projected increase. However, there are likely a variety of other factors associated with limitations of nesting of this species in Minnesota. The presence of potentially available habitat alone will be unlikely to increase its population.

Scarlet Tanager (*Piranga olivacea*)
The Scarlet Tanager's breeding range extends from southern Manitoba east to southern New Brunswick, south through the eastern United States, to central Alabama and northern Georgia (Farrand 1985). The species is an uncommon summer resident in Minnesota. It is most numerous in the heavily wooded central, east central, and southeastern regions of the state (Janssen 1987). The Scarlet Tanager is a long-distance migrant that winters from Panama, along the western coast to northwestern Bolivia (Ehrlich et al. 1988). In Minnesota, the species is an uncommon spring and fall migrant in the eastern, central, and northwestern regions of the state that arrives during late April through early June, and leaves from mid-August through late-October (Janssen 1987).

The Scarlet Tanager breeds in mature deciduous forest, but is also found in mixed and coniferous forest (Bent 1958, Brewer et al. 1991), parks, and extensive planting of mature shade trees in suburbs (Farrand 1985). In eastern United States, the Scarlet Tanager has a preference for oak trees (Robbins 1978) and a relatively closed canopy (Anderson et al. 1974). In

Minnesota, Kelleher (1967) reported about 3 pairs/40 acres and Back (1979) reported about 5 pairs/40 acres in mature oak. Scarlet Tanagers were common, 3 pairs/40 acres in mature maple-basswood forest but were also recorded in a variety of habitats ranging from pole size jack pine to mature aspen (Hanowski and Niemi 1991a,b). Because of the many habitats the species has been recorded (e.g., Hanowski and Niemi 1991a,b) we classified the species as dependent on mature forests. In contrast to the eastern United States, where coniferous forests and trees are not as common, the species is relatively commonly found in mixed hardwood-coniferous forests.

The Scarlet Tanager nests 2 to >20 m above the ground and clutch size ranges from two to five eggs, commonly four (Harrison 1975, Holmes 1990). The Scarlet Tanager is a common Brown-headed Cowbird host (Brittingham and Temple 1983), therefore, reproductive success may be higher in forest interior areas. During the breeding season, the species is an insectivorous upper-canopy gleaner (DeGraaf et al. 1985). Berries and fruits are included in the Scarlet Tanager's diet during the nonbreeding season (Farrand 1985).

Breeding Bird Survey data from 1965 through 1979 show that the Scarlet Tanager population increased in the survey's eastern region, despite migration casualties in northern New England during the 1974 spring migration (Robbins et al.1986). The Great Lakes and northeastern states both showed significant increases, but highest densities occurred in the mountainous areas of the northeastern United States (Robbins et al 1986). In Minnesota from 1966 to 1989, the species reportedly increased by about 2.5 percent per year (Janssen 1990).

The minimum area needed to sustain a viable breeding population was estimated by (Robbins 1980) as 25 acres. In Wisconsin, (Ambuel and Temple 1983) reported Scarlet Tanagers in woods of 12 acres or more. The species has been found in woods of 3 to 35 acres in Maryland (Whitcomb et al. 1981, Anderson and Robbins 1981, Blake and Karr 1984) found Scarlet Tanagers present in woods of 40 acres in Illinois.

The Scarlet Tanager does not appear to be as sensitive to forest fragmentation in comparison with other area sensitive species. A fairly broad range of forest management practices may be tolerated. Large clearcuts would temporarily remove the species habitat, but when small trees were left uncut, the tanager was found to occupy clearcut areas as early as 12 years after cutting (Conner and Adkisson 1977). Selective cutting appeared to have no effect on Scarlet Tanager populations in Indiana (Adams and Barrett 1976). The Scarlet Tanager's canopy nesting may make the species less susceptible to predation.

Abundance of suitable habitat available for the Scarlet Tanager was projected to increase in ecoregion 9 under the base and medium harvest levels on both timberland and all forest land. The species was also projected to increase in ecoregion 9 in the high harvest scenario on all forest land. On timberland, decreases were noted for ecoregion 6 under all harvest levels, in ecoregion 4 and statewide under the medium and high levels, and in ecoregions 1, 2, 3, 5, and 6 under the high harvest scenario. Decreases on all forest land were similar, except no statewide decrease occurred under the medium harvest level or in ecoregion 2 under the high harvest scenario. Decreases for this species were likely due to the loss of mature, contiguous forests throughout the state.

Northern Cardinal (*Cardinalis cardinalis*)
The Northern Cardinal is an abundant bird found throughout the eastern temperate deciduous forest, northeast to Maine, south to Florida, west throughout Mexico, Oklahoma, Kansas, Nebraska, and in Minnesota breeds throughout the southern portion of the state (Bent 1968, DeGraaf et al. 1991). In general, the species has been expanding northward throughout its breeding range, and in Minnesota breeding records have been found north to Aitkin, Crow Wing, St. Louis, and Cass counties (Janssen 1987). The species is generally sedentary, hence, its breeding population generally coincides with its wintering grounds, and no distinct migratory periods are evident.

The general breeding and wintering habitat of the species consists of forest edges, brushy forest openings, parks, residential areas, second-growth woods, and open swamp thickets (Bent 1968). Generally this includes any areas with dense shrub understory and dense shrub vegetation (Brewer et al. 1991). Because of the species wide habitat use in forested areas, it was not classified into any of the groups defined by the EQB-FSD document.

The species lays 3 to 4 eggs, and usually the nest is placed from 1.5 to 3 m in a shrub or small tree, usually in an area of dense vegetation. Incubation is 12 to 13 days and is performed by the female. The species eats plant matter including grains, weed seeds, and wild fruits; however, some insects are consumed, especially during the breeding season (Martin et al. 1951).

In general, the Northern Cardinal is not likely to be affected by increased timber harvesting or forest management in Minnesota because of its high tolerance and use of second-growth forests, especially those with a high proportion of shrubs and small trees. The increase of urban areas with associated ornamental shrubbery and second-growth forests in Minnesota may have resulted in the expansion of the Northern Cardinal in Minnesota. This pattern of expansion has also been noted in other parts of the midwest and eastern United States. The species also is a frequent user of feeders in winter. This has likely aided its higher survival rates in many of the northern areas of the United States.

The species was projected to decrease in the southern part of ecoregion 4 in all harvest scenarios in timberlands and all forest lands, but only in the medium and high harvest scenarios. The species was projected to increase in ecoregion 7 on timberland and in ecoregions 5 and 7 on all forest lands under the base harvest scenario. Under both the medium and high harvest scenarios, the species was projected to increase in ecoregion 7 on timberlands and all forest lands. The increase in younger aged forests (sapling stages) in this ecoregion were primarily responsible for the increases projected for this species.

Rose-breasted Grosbeak (*Pheuticus ludovivianus*)
The Rose-breasted Grosbeak is common in southeastern and central Canada, and in northeastern and north central United States (Peterson 1980). It is a summer resident throughout the forested portions of Minnesota, but most numerous in the deciduous forests of the central and southeastern regions (Janssen 1987). This species is a long-distance migrant, wintering from Mexico and the West Indies south to northern South America (Ehrlich et al. 1988). The spring migration period extends from late April through early June, with peak numbers arriving in mid-May. The fall migration peaks in early September, but a few stragglers remain in November, and there are occasional winter records as well (Janssen 1987).

Descriptions of Rose-breasted Grosbeak habitat found in the literature are seemingly contradictory. Bond (1957) found the Rose-breasted Grosbeak to be "a fairly important and abundant member of the (avian) community" in the xeric stands in his study in southern Wisconsin. These stands were characterized by decreasing canopy density, decreasing moisture, decreasing sapling density, and increasing shrub density. It was "insignificant, if present at all, in the more mesic stands" (Bond 1957). In contrast, Kahl et al. (1985) observed this species primarily in central Missouri bottomland hardwoods characterized by open mature forest habitat with numerous pole sized trees and sparse shrub and ground layers. Webb et al. (1977) found that the opening of forest stands by removal of varying amounts of commercial timber increased Rose-breasted Grosbeak populations in New York. According to Weber and Theberge (1977) there was a direct relationship between Grosbeak numbers and canopy closure along roadside transects in Ontario.

Galli et al. (1976) classified the Rose-breasted Grosbeak as "an uncommon species independent of forest size." Blake and Karr (1984), however, did not detect this species in forest tracts of less than 70 acres in east central Illinois. Robbins et al. (1989) found a significant positive correlation between forest area and the occurrence of Rose-breasted Grosbeaks. In light of these seeming contradictions, Kahl et al. (1985) conclude that the Rose-breasted Grosbeak appears to be a habitat generalist, occurring in various wooded habitats in different parts of its breeding range.

In Minnesota, the Rose-breasted Grosbeak occurs in a wide variety of age classes in deciduous forests. Probst et al. (1992) recorded it as most abundant in the midsuccessional stages of aspen regeneration. This also appears to be the case in surveys completed in the Chippewa and Superior National Forests (Hanowski and Niemi 1991a, 1991b). Hence, the Rose-breasted was classified as a hardwood-dependent species because of its affinities towards forest settings dominated by deciduous tree and shrub species (Green 1991).

The nest of the Rose-breasted Grosbeak is often placed in a tree or shrub at the border of an open area such as a field, road, or garden (Stokes and Stokes 1983). Of 25 nests found in New Hampshire (Holmes 1990), most nests were found in the upper canopy (>14 m) while the remaining were found either in the sapling or subcanopy layers. Three to six eggs are laid, usually four (Harrison 1975), and one or two broods are raised per season (Ehrlich et al. 1988). The diet of this species includes insects, seeds, buds, and fruit (Ehrlich et al. 1988).

Data collected in the USFWS Breeding Bird Survey indicate that Rose-breasted Grosbeak populations are stable in the Central and Great Lakes regions and show significant population increases in the Eastern region (Robbins et al. 1986). In Minnesota, the trends were similar to those reported in the Central and Great Lakes region (Janssen 1990).

Given its association with successional and edge habitats, it seems unlikely that the Rose-breasted Grosbeak will be adversely affected by increased timber harvest in Minnesota. Increases in suitable habitat were projected in ecoregions 7 and 9 under all harvest levels on timberland and all forest land. In all forests increases were also noted in ecoregion 2 in the high harvest scenario.

Indigo Bunting *(Passerina yanea)*
The Indigo Bunting is common in the eastern United States from the Gulf Coast to southern Ontario and west to the Dakotas, Nebraska, Kansas, Oklahoma, and eastern Texas (Peterson 1980). Its range is expanding into Colorado, New Mexico, and Arizona as well. The Indigo Bunting is a common summer resident throughout Minnesota, although it is less numerous in the heavily forested regions of the northeast, and also in the prairie regions of the southwest (Janssen 1987). This species is a short to long distance migrant, wintering from southern Florida through eastern Mexico, south to Panama and the West Indies (Ehrlich et al. 1988). It generally

arrives on its breeding grounds in Minnesota during mid-May and begins the return flight to the tropics in early September (Janssen 1987).

The Indigo Bunting is typically found in a wide variety of open and semi-open, early-successional habitats with shrubby vegetation including brushy pastures, aspen clearcuts, overgrown fields (Kahl et al.1985), forest edge (Gates and Gysel 1978, Payne 1982), disturbed forest (Whitcomb et al.1977), early-successional hardwood forests (Holmes 1990), and shrubby swamps (Payne 1982). This species tends to avoid mature forests (Roberts 1932, Payne 1982). Sixty-three percent of the Buntings studied in southern Michigan by (Payne 1982) were located in forest edge or shrubby swamp habitats. In his study of upland habitats in southern Wisconsin, (Bond 1957) found Indigo Buntings about five times more abundant in the most xeric continuum interval than in the most mesic interval. Characteristics of these stands were decreasing canopy density, decreasing moisture, decreasing sapling density, and increasing shrub density (Bond 1957). Robbins et al. (1989) found a significant negative correlation between forest area and abundance of Indigo Buntings. They suggest, however, that this probably reflects the increased distance of sample points from the forest edge in large tracts, rather than an actual preference for small forests (Robbins et al. 1989).

In Minnesota, the species is found in the same habitats described above, especially along edges, in brushy pastures, and in recently logged areas (e.g., Probst et al. 1992). It was not placed in any EQB group.

The Indigo Bunting places its cuplike nest in the crotch of a shrub, small tree, or tangle of blackberries, usually not more than 5 feet above the ground (Harrison 1975). It often raises two broods of 4 to 5 young, but is heavily parasitized by the Brown-headed Cowbird (Ehrlich et al. 1988). The diet of this species consists primarily of weed seeds, but insects such as grasshoppers, caterpillars, plant lice, beetles, flies and mosquitos are also consumed (Roberts 1932, Ehrlich et al. 1988).

Since 1900, the Indigo Bunting has increased in abundance throughout its range as a result of increased habitat created by timber harvest and by abandonment of former croplands. Data collected in the USFWS Breeding Bird Survey showed significant increases in the Great Lakes States and northeastern states since 1965 (Robbins et al. 1986).

Given its preference for early successional habitats, this species is likely to benefit from increased timber harvest. Increases in suitable habitat were projected on timberland in ecoregions 2, 6, 7 and 9 under all harvest levels in ecoregion 3 in the medium harvest scenario, and in ecoregion 4, 5 and statewide under the high harvest regime. When all forests were considered, increases were projected for ecoregions 2, 6 and 7 under all harvest scenarios. In the medium harvest scenario increases were also projected for ecoregions 3 and 5. Under the high harvest scenario, increases were projected in ecoregions 4 and 5 and statewide. Decreases were noted for the species in ecoregion 1 in the high harvest scenario for both timberland and all forest land.

Rufous-sided Towhee (*Pipilo erythrophthalmus*)
The Rufous-sided Towhee is represented by two subspecies in North America. The eastern race breeds throughout the eastern United States from southern Canada south to Florida and Guatemala. This species is migratory only in the northern portions of its range. It is a permanent resident as far north as northern Illinois, Indiana, and Ohio (Peterson 1980). In Minnesota, the Rufous-sided Towhee is a summer resident in the southeastern and east central regions, and in the western portion of the north central region. It is rare or absent from the prairie and boreal forest regions of the state.

The spring migration period extends from mid-April through late May, with peak numbers arriving in late April. In the fall, most individuals leave Minnesota by mid-October and overwinter in the southern states. Stragglers are occasionally recorded into late November and early December (Janssen 1987).

The Rufous-sided Towhee is common throughout its breeding range in brushy grasslands, old fields, forest edges, and open woodlands (Galli et al. 1976, Whitcomb et al. 1977, Lynch and Whigham 1984, Kahl et al. 1985, Robbins et al. 1989). Robbins et al. (1989) found a significant negative correlation between percent canopy cover and Towhee abundance. Likewise, Whitcomb et al. (1977) recorded Towhees in forest tracts in which the canopy had been opened by selective logging. According to Kahl et al. (1985) the most consistent characteristics of vegetation around Towhee song perches were a litter layer of intermediate depth (1.0 to 3.0 cm) and dense coverage (70 to 90 percent). They concluded that the litter layer "possibly fulfills the only critical habitat requirement other than brushy cover." The species was not assigned to any EQB group.

Leaf litter provides a substrate for foods of this species which forages on the ground by scratching with both feet like a Fox Sparrow (Kahl et al. 1985, Ehrlich et al. 1988). The diet consists of terrestrial invertebrates, seeds, acorns, and berries (Ehrlich et al. 1988). The Towhee typically nests on or near the ground in dense woody vegetation, although late nests are sometimes placed one to two m high in a low bush or small tree (Harrison 1975). Towhees lay 3 to 5 eggs and generally raise two broods of young. They are frequently parasitized by the Brown-headed Cowbird (Ehrlich et al. 1988).

Data collected in the USFWS Breeding Bird Survey, however, indicate that while numbers of Rufous-sided Towhees have increased in the west, there has been an offsetting decrease in the east, resulting in a slight but significant decrease for the continent as a whole (Robbins et al. 1986). This may be partly due to its susceptibility to nest predation because of its ground nesting habit, and its potential sensitivity to parasitism by Brown-headed Cowbirds. In Minnesota, the species has increased slightly in the past 25 years (Janssen 1990).

Because the Towhee is adapted to open woodlands and edge habitats it is unlikely to be affected by forest fragmentation or increased timber harvest. Projected increases in suitable habitat will occur in ecoregions 4, 6 and statewide under all harvest levels on timberland and all forest land. Additional ecoregion increases under the base and medium (ecoregion 5) and high (ecoregion 1) scenarios were projected on timberland and all forest land.

Chipping Sparrow (*Spizella passerina*)
The Chipping Sparrow has a relatively wide breeding habitat distribution. It occurs from the southeastern United States, north to Canada and across the tree limit to Alaska. It also occurs throughout the Rocky Mountain region, south to Mexico and California (Bent 1968, DeGraaf et al. 1991). In Minnesota the species is a breeding resident throughout the state and most numerous in the eastern and central regions (Green and Janssen 1975, Janssen 1987).

The wintering grounds of the species primarily include the southern United States, north along the Atlantic coast to Maryland, west to California, and south into a substantial part of Mexico (National Geographic Society 1983). In Minnesota the species arrives between late March to late May on the breeding grounds and generally departs the state during the fall migration from early August to late October, with the bulk in September (Janssen 1987).

During the breeding season the species is primarily found in open woodlands, edges, and generally forested areas bordering on areas with open ground available for foraging (Bent 1968). Hence, the species is quite common in a variety of places, especially where conifers such as ornamental fir trees are abundant (Walkinshaw 1944). In Minnesota, the species is found in a variety of habitats including parks, residential areas, and cemeteries. In the more forested areas, it is commonly found in mixed conifer deciduous woods, coniferous forests, and even in coniferous black spruce bogs (Green and Niemi 1978; Hanowski and Niemi 1991a,b; Niemi and Hanowski 1992). The species was classified as dependent on conifers and mature forests in Minnesota's forest region.

The species lays 3 to 5 eggs and requires 11 to 12 days for incubation (Bent 1968). The nest is generally placed from 3 to 10 feet in a tree or shrub, often in a conifer (Reynolds and Knapton 1984). The species forages on the ground for insects and seeds, hence the combination of large conifer or deciduous trees and open ground provide ideal habitat for the species (DeGraaf et al. 1991).

No trends were evident in the species breeding population based on the Breeding Bird Survey roadside counts over the past 23 years (Janssen 1990).

The species will probably be quite tolerant of an increase in timber harvesting and forest management because of its acceptance of habitats in open woodlands, edges, and a variety of places that are likely to be relatively common in second growth and logged habitats. Since the species is most often found associated with coniferous forest vegetation, reductions in coniferous trees may show decreasing trends for this species if the number of conifers decrease with timber harvesting. However, the species is among the most-tolerant forest species in its use of urban and suburban habitats where mature conifer trees are found.

The Chipping Sparrow was projected to increase in ecoregion 7 on timberland and in both ecoregion 7 and 9 on all forest lands under the base harvest scenario. Under the medium harvest scenario, the species was projected to increase in ecoregions 5 and 7 when timberlands were included, but in ecoregions 5, 7, and 9 on all forest lands. Under the high harvest scenario, the Chipping Sparrow was projected to increase again in ecoregions 5 and 7, but decrease in ecoregions 3 and 4 on timberlands and in ecoregion 3 only on all forest lands. No overall statewide trend was noted under any of the three harvest scenarios. In contrast with other conifer dependent species that have shown decreasing trends, this species uses a wider variety of habitats including urban areas and it occurs throughout a wider range in Minnesota than many other conifer dependent species. These factors are likely associated with the fewer projected decreases for the species across the state forests.

Song Sparrow (*Melospiza melodia*)
The Song Sparrow's breeding range extends from southern Alaska across Canada to Newfoundland, south across the northern United States, along the Pacific Coast, and into Mexico (DeGraaf et al. 1991). In Minnesota, the species is found in all regions and is one of the most numerous breeding species in the state (Janssen 1987). The Song Sparrow is a short-distance migrant that winters along the coast from Alaska and Newfoundland, south throughout the southern half of its breeding range into Mexico (DeGraaf et al. 1991). The species is a common and widespread spring and fall migrant in Minnesota. It arrives during early March through early May and leaves during late August through late November (Janssen 1987). The Song Sparrow has been most often recorded during winter in Minnesota in the Twin Cities area and along the Mississippi River in the east central and southeast regions of the state (Janssen 1987).

The Song Sparrow is one of the most intensively studied songbirds in North America (Nice 1937). It is commonly found in a variety of open and semi-open habitats with scattered shrubs and small trees.

The Song Sparrow inhabits dense vegetation along waterways, seacoasts with marshes of cattails (*Typha* spp.) or bulrushes (*Scirpus L.* spp.) (DeGraaf et al. 1991), forest edges, fencerows, thickets, gardens (Brewer et al. 1991), and bog and bog edges (Ewert 1982, Brewer 1967). In Minnesota, Song Sparrows have been observed in regenerating jack pine (9 pairs/40 acres), (8 pairs/40 acres) (Niemi 1975, Hanowski and Niemi 1991a); pole aspen (10 pairs/40 acres) (Doran and Todd 1976); and pole-size elm-ash-cottonwood (5 pairs/40 acres) (Hanowski and Niemi 1991a, 1991b). The species is typically among the most abundant species in the earliest stages of forest regeneration following logging activity (e.g., see Niemi 1977, Back 1979, Niemi and Hanowski 1983, Probst et al. 1992). The species also was one of the most common species associated with clearcuts in Pennsylvania (Dessecker and Yahner 1987). The species was not assigned to any EQB group.

The Song Sparrow builds its nest in a brush pile, low bush or as high as 4 m in a tree and clutch size ranges from three to five eggs (Harrison 1975). Except for the Yellow Warbler (*Dendroica petechia*), the Song Sparrow is the most frequently reported Brown-headed Cowbird (*Molothrus ater*) host (Harrison 1975). The Song Sparrow is an omnivorous lower-canopy and ground forager during the breeding season, and a granivorous ground gleaner during the nonbreeding season (DeGraaf et al. 1985). Keast (1990) observed an exclusive insectivorous diet during the nesting season in Ontario consisting primarily of spiders, lepidopteran adults, beetles, caterpillars, and odonates.

Breeding bird Survey data from 1965 to 1979 show a significant decline in Song Sparrows in eastern regions, with populations nearly stable in the central and western regions (Robbins et al. 1986). The eastern region decline, which may have been due to severe winters of 1976–77, was sufficient to generate a significant decline for the continent. Minnesota Breeding Bird Survey data from 1966 to 1990 show the Song Sparrow population to be stable in the state (Janssen 1990).

Increases in suitable habitat availability were projected for this species, primarily because of its affinity for young forests. Increases were noted for ecoregions 4, 5, 6, and 7 for all harvest levels on timberland and all forest land. Additional increases were projected in ecoregion 3 and statewide under the medium harvest level and in ecoregions 1 and 9 under the high harvest level on both timberlands and all forest lands. When all forest lands were considered, a decrease in habitat availability was projected for ecoregion 2 under the base and medium harvest levels. This decrease is likely due to the maturing of forests in reserves in this area (e.g., BWCAW).

Lincoln's Sparrow (*Melospiza lincolnii*)
The Lincoln's Sparrow is an uncommon breeding species in Minnesota and is restricted to northern Minnesota. Nest records for this species indicate that it probably breeds sparingly across the northern portions of the state (Janssen 1987). Minnesota is at the extreme southern portion of the species range which extends throughout Canada to Hudson Bay and into Alaska. The species has a western range in the continental United States that extends from the Rocky Mountains to the Pacific Coast. The Lincoln's Sparrow is a short- to long-distance migrant. Some individuals winter in southern portions of the United States, while others over-winter in Central America. Spring migration in Minnesota is from mid-April through late-May and fall migration begins in late July and continues into October (Janssen 1987).

This species occupies a narrow range of habitat in Minnesota in the breeding season. It is found almost exclusively in lowland black spruce stands where tree density is sparse and height is low (<10 m) (Niemi and Hanowski 1992). Typical breeding densities for this species in the Chippewa National Forest in 1991 were less than one breeding pair/40 acres in seedling-sapling and pole-sized lowland black spruce (*Picea mariana*) stands. The species was also observed in low densities in seedling aspen (<1 pair/40 acres) and pine (<1 pair/40 acres) stands in northern Minnesota (Superior and Chippewa national forests) in 1991 (Hanowski and Niemi 1991a,b). The Lincoln's Sparrow also occur in early successional jack pine stands in northern Michigan (Walkinshaw 1983). This habitat type is more similar to habitats that they occupy in northern and western portions of their range (Spindler and Kessel 1980). Based on this information, the species was classified as a conifer dependent species.

The presence of this species in poorly stocked lowland conifer may indicate that the species prefers areas that are in early stages of regeneration. However, this may be misleading because age of stands in seedling-sapling class of black spruce in the Chippewa National Forest where the species was found averaged >65 years. In Minnesota, the species is most abundant in unproductive forest lands (lowland conifer) found in peatland areas of northern Minnesota (Niemi and Hanowski 1992).

The species nests and feeds (primarily on insects) on the ground. Therefore, a critical habitat need is a well-developed ground cover of *Sphagnum* and other mosses to provide nesting cover for this species (Brewer et al. 1991).

The population in Minnesota appears to have remained stable over the past 20 years based on its presence on 12 breeding bird survey routes in northern Minnesota (Janssen 1990).

The Lincoln's Sparrow was projected to decline throughout its range (ecoregions 1, 2, 3, 4) and statewide under all harvest levels for both the timberland and all forest land models. Increases were predicted in ecoregion 3 under the high harvest level when both timberland and all forest lands were considered. Projected changes for this species were likely due to the succession of lowland conifer from seedling-sapling to pole and saw size stands. However, because this species occurs in seedling-sapling and pole size stands that are usually more than 50 years old, the forest model that "grows" trees to saw size in 70 years is probably not a good predictor of actual changes that may occur for this species especially on unproductive lowland conifer sites.

White-throated Sparrow (*Zonotrichia albicollis*)
The White-throated Sparrow is a common breeding species across Canada, and south into the north central and northeastern United States (Peterson 1980). In Minnesota, it is a summer resident from the northeast and north central regions, southward into the northern portions of the central and east central regions. Breeding evidence has been reported from as far south as the Cedar Creek Scientific and Natural Area in Anoka County (Janssen 1987). This species is a short distance migrant, wintering from southeastern Wisconsin and southern Michigan south to northeastern Mexico (Ehrlich et al. 1988). It is a permanent resident in portions of southern Ontario, New York, Vermont, New Hampshire, and Connecticut (Peterson 1980). The White-throated Sparrow is a common to abundant migrant throughout Minnesota, and may be encountered in groups ranging from a few individuals to hundreds.

The spring migration period extends from mid-March into late May with peak numbers arriving in late April and early May. Fall migration begins in mid-August, but stragglers are often encountered as late as mid-December. Individuals are often recorded overwintering at feeding stations, especially in the Twin Cities area and southward (Janssen 1987).

The White-throated Sparrow is commonly found in recently logged areas, brushy thickets, edges of conifer and mixed conifer-deciduous forests, and a variety of forested habitats with shrubby openings. It seldom ventures far from dense cover. Titterington et al. (1979) recorded the highest densities of White-throated Sparrows (36 pairs/15 ha) in the second seral stage after clearcutting of spruce-fir forests in Maine (3 to 5 years after cutting). This stage was characterized by a dense raspberry stratum, and regenerating hardwoods <2 m tall. They found a significant positive correlation between White-throated Sparrows and the raspberry layer. This species was also very common (26 pairs/40 acres) in the third seral stage after clearcutting when regenerating hardwoods >2 m tall were the dominant feature, and in the first seral stage after clearcutting (22 pairs/40 acres) when slash was dominant (Titterington et al. 1979).

Webb et al. (1977) found a significant upward trend in numbers of White-throated Sparrows with increased intensity of logging in New York. They recorded the highest densities on 100 percent clearcuts in the immediate postlogging period. Ten years after logging, populations of this species on the clearcut plots had returned to the levels on the unlogged control plot "clearly showing that their tenure in the second-growth environment was of short duration" (Webb et al. 1977).

Our data show that this species uses a wide range of forest types in northeastern Minnesota. The species is among the most abundant in early-successional vegetation following logging activities (e.g., Niemi 1977, Back 1979, Niemi and Hanowski 1984, Probst et al. 1992). High densities on the Superior National Forest were also recorded in pole-sized white cedar (9 pairs/40 acres), and sapling red pine (8 pairs/40 acres) (Hanowski and Niemi 1991a). On the Chippewa National Forest, high densities were recorded in pole-sized tamarack (8 pairs/40 acres), and saw-sized fir/aspen/paper birch (7 pairs/40 acres) (Hanowski and Niemi 1991b). It was not assigned to any EQB group.

The White-throated Sparrow forages mainly on the ground, scratching in leaf litter or gleaning from weeds and grasses (DeGraaf et al. 1991). The diet consists primarily of weed and grass seeds, wild fruits, and insects, spiders, and snails (Ehrlich et al. 1988, DeGraaf et al. 1991). The nest is usually placed on the ground at the edge of a clearing, and well-concealed in a brush pile, grass hummock, or mat of dead ferns (Harrison 1975). Four eggs are commonly laid, and one or two broods are produced during a breeding season (Ehrlich et al. 1988).

This species may benefit from an increase in second-growth forests resulting from increased timber harvest. However, because of its ground nesting habit, it may be susceptible to increased nest predation associated with habitat fragmentation. Data collected in the USFWS Breeding Bird Survey showed a significant decline in the number of White-throated Sparrows recorded in the Eastern region and for its entire range. This decline, however, was attributed to abnormally cold winters during 1976-77 and 1977-78 on the wintering grounds in the southern United States (Robbins et al. 1986). In Minnesota, the White-throated Sparrow has shown no trend in its population since 1966 (Janssen 1990).

No changes were projected for this species under any of the three harvest scenarios.

Dark-eyed Junco (*Junco hyemalis*)
The Dark-eyed Junco is common throughout Alaska, Canada, and New England. Its breeding range extends into the northern tier of States, and south into the Rocky Mountains and the Appalachians (Peterson 1980). It is

a summer resident in Minnesota primarily in the coniferous forests of the northeast and north central regions (Janssen 1987). This species is a short distance migrant, wintering from the southern portions of Minnesota, south to the Gulf states and northern Mexico (Ehrlich et al. 1988). The bulk of spring migration takes place in late March and early April. In the fall, most individuals withdraw from the northern regions of the state by October (Janssen 1987).

During the breeding season, the Dark-eyed Junco is typically found in boreal or coniferous forests (Roberts 1932, Brewer et al 1991). According to (Brewer et al. 1991) the Junco is "not a bird of the deep forest, but of openings, clearings, or edges." (DeGraaf et al. 1991) describe the special habitat needs of this species as "openings in wooded habitats covered with dense herbaceous vegetation such as grasses or forbs." In a study conducted in Maine, (Titterington et al. 1979) recorded the highest densities of Juncos (11/40 acres) in the first seral stage following clearcutting of spruce-fir forests. This seral stage was characterized by a dense slash stratum and open ground that dominated for the first two years after clearcutting. The occurrence of Juncos was positively correlated with the slash stratum and negatively correlated with the number of raspberry stems. Juncos were absent from clearcut plots in the seral stages dominated by dense shrubby vegetation, but were present again, although in lower densities (1.8/40 acres), in the fifth seral stage (25 years after clearcutting). This stage was characterized by a dense softwood overstory and an open forest floor. The slash stratum consisted of windthrown trees and branches, and could be locally important (Titterington et al.1979). These data suggest that, although this species requires some ground cover (i.e., slash or windthrown trees), it avoids areas with dense shrubby vegetation. Holmes (1990) also reported the species in early-successional sequences of hardwood regeneration.

In Minnesota the Dark-eyed Junco is primarily found nesting in coniferous-dominated vegetation situations (Green and Niemi 1979, Green 1991). It is found in highest abundance in lowland conifer habitats (e.g., Niemi and Hanowski 1992). However, it is also found in a variety of coniferous-dominated habitats (upland and lowland) (Hanowski and Niemi 1991a,b). In contrast to studies in the eastern United States, little evidence exists for the occurrence of this species in recently logged areas. The species is not listed as occurring in this habitat in several published studies in this region (e.g., Niemi 1977, Niemi and Hanowski 1984, Probst et al. 1992). Based on its primary breeding distribution in Minnesota, the species was classified as conifer-dependent because of its high degree of association with conifer-dominated landscapes.

The Dark-eyed Junco typically places its nest in a shallow depression on the ground concealed by overhanging moss or grasses, often in tree roots or under a fallen tree or log (Harrison 1975). Four or five eggs are laid, and one or two broods are raised depending on latitude and elevation (Ehrlich et al. 1988). The Junco forages primarily on the ground (DeGraaf et al. 1991). Its diet consists of insects including weevils, leaf beetles, lace-winged flies, moths, caterpillars and grasshoppers, spiders, and a wide variety of seeds and small fruits (Roberts 1932, Ehrlich et al. 1988, DeGraaf et al. 1991).

Data collected in the USFWS Breeding Bird Survey indicate significant decreases in numbers of Juncos recorded in New Brunswick, New Hampshire and New York, contributing to a significant decline for the eastern region as a whole. Highest densities were from the Canadian Rockies and the Yukon Territory (Robbins et al. 1986).

Suitable habitat for the Dark-eyed Junco was projected to decrease in ecoregion 3 under all harvest scenarios and on both all forest and timberlands. Additional declines on timberlands and all forest lands were projected to occur in ecoregion 4 under the base harvest scenario and in ecoregion 2 under the high harvest regime in timberlands only. Declines were likely attributable to the loss of later successional conifer forests in the northern portion of the state.

Rusty Blackbird (*Euphagus carolinus*)
The Rusty Blackbird has a relatively large breeding distribution primarily confined to the boreal zone of Canada. In Minnesota the species is a rare nesting bird in northern Cook, Lake, and St. Louis counties (Janssen 1987). The species is a common spring migrant in Minnesota and a relatively common fall migrant. The spring migration period is generally from mid-March through mid-May, with most migrants occurring during the month of April. Fall migration is from early September through early December, with most of the migrants being found in the month of October. The species occasionally occurs as a winter visitant in the southern portion of the state (Janssen 1987).

On the breeding grounds the species is almost always found associated with water such as woodland ponds, bogs, flooded lakes, stream edges, or habitat created by beaver dams (Kennard 1920, Bent 1958, Erskine 1977, Brewer et al. 1991). Hence, the species was classified as a riparian associated species. Brewer et al. (1991) noted that the species territories seem to be rather large because nest sites are generally separated by 0.8 km or more.

The species generally constructs its nest in dense undergrowth of evergreens, but deciduous shrub vegetation is also used, usually in association with water. The nest is generally less than 10 feet above ground, and 4 to 5 eggs are typically laid (Godfrey 1966, DeGraaf et al. 1991). The species is highly omnivorous and will forage on insects, seeds, grains, and fruit, depending on availability (Martin et al. 1951). During the summer the diet is more insectivorous, while in the winter more grains and fruits are taken.

In Minnesota no information is available on general population trends of the species because of its rarity. The species has likely always been relatively rare in Minnesota because its primary breeding habitat is farther north throughout Canada. However, because the species is associated with water edges created by beaver dams, it may have been more common in the past. It is unlikely that timber harvesting or forest management had a major effect on the species. Reductions in beaver populations and development of lakeshore property have likely had a greater effect on the species in Minnesota.

The species was projected to increase in ecoregion 2 and statewide under all three harvest scenarios when timberland was included. However, when all forest land was included, no changes were projected to occur. The reason for this change was due to the relatively large proportion of ecoregion 2 that is in the BWCAW.

Common Grackle (*Quiscalus quiscula*)
Common Grackles are distributed from western Canada across southern Canada south to the Gulf coast. They extend westward across the United States to the Rocky Mountains (Terres 1987). In Minnesota, Common Grackles are regular summer residents throughout the entire state. This species is least common in forested regions of central and northeastern Minnesota (Janssen 1987).

Common Grackles begin returning from their wintering grounds in the southeastern United States in late February and continue to arrive into May (Janssen 1987, Terres 1987). Grackles breed in open forests and clearings, especially those associated with human settlements where they often nest in colonies (Roberts 1932, Ehrlich et al. 1988). Windbreaks in rural areas are especially favored because of the shelter provided by conifers that are often planted in these settings (Janssen 1987).

Bulky nests are constructed in mature conifers and shrubs, as well as deciduous trees and emergent vegetation near water (Dolbeer 1980). Nests may also be constructed in cavities in trees or artificial structures (Ehrlich et al. 1988). Mud, grass, twigs, and human debris may be used in nest construction. Four to six eggs are laid which hatch after 14 days of incubation (Roberts 1932, Ehrlich et al. 1988).

Diet of the Common Grackle is highly omnivorous and includes fruits, seeds, insects, spiders, snakes, minnows, and crayfish (Terres 1987). Roberts (1932) commented upon their habit of searching lakeshores and riverbanks for crayfish. The species will also consume the eggs and young of smaller birds in their diet (Ehrlich et al. 1988), as well as young corn plants (Dolbeer 1980).

Flocking begins in late July and fall migration follows in late August, continuing into late November. During late summer and fall, grackles may begin to roost with Red-winged Blackbirds (*Agelaius phoeniceus*) in marshes (Dolbeer 1980). Some individuals remain into winter, where they can be seen singly or in small groups at feeders or livestock feedlots in many regions (Janssen 1987, National Audubon Society 1990). Corn left in fields after harvesting appears to be an important source of food in winter, as are acorns (Dolbeer 1980).

No change in Common Grackle populations were reported over the past 23 years by (Janssen 1990) based on the Breeding Bird Surveys where the species was reported from all 52 routes.

Attempts at controlling this species population have taken place in urban areas and agricultural settings where large aggregations of grackles have proven to be a nuisance (Ehrlich et al. 1988).

This species was not classified into any of the categories of concern identified in the FSD. In general, the species was projected to increase in the state under all three harvest scenarios. Under the base harvest scenario, the species was projected to increase in ecoregions 4, 5, 6, and 7 on timberlands. The species was projected to decrease in ecoregion 2 in both the base and medium scenarios when all forest lands were included—the only decreases noted for the species. Patterns of increase were the same in all forest lands. Under the medium harvest scenario, the species was projected to increase in ecoregions 3 to 7 and statewide on timberlands and in ecoregions 3 to 7, but not statewide on all forest lands.

Under the high harvest scenario, the species was projected to increase in all ecoregions and statewide on both timberlands and all forest lands. The affinities of this species toward edges, riparian areas, and early-successional vegetation are the primary reasons for the projected increases in available habitat for this species.

Brown-headed Cowbird (*Molothrus ater*)
The Brown-headed Cowbird's breeding range extends from northeastern British Columbia to northern Ontario and southern Nova Scotia, south to northern Mexico (Farrand 1985). The species is a summer resident throughout the state of Minnesota, but is most numerous in central and southern Minnesota (Janssen 1987). The Brown-headed Cowbird is a short-distance migrant that winters in central and southern portions of its breeding range (Minnesota and southern Ontario) to southern Mexico (Farrand 1985).

In Minnesota, the species is a common to abundant spring migrant, that arrives during early March through early May, and an uncommon to common fall migrant, that leaves around late June and July (Janssen 1987).

During winter, the species is casual in the southern half of the state, from Hennepin County south in the east, to Big Stone County in the west (Janssen 1987).

The Brown-headed Cowbird inhabits farmlands, early-successional deciduous and coniferous forests, forest edge, grassland, and suburban gardens (Ehrlich et al. 1988, Harrison 1975). Whitmore (1976) designated the cowbird as a habitat generalist. Once found primarily in the plains and prairies west of the Mississippi River, the open habitat created as eastern forests were cut by settlers provided opportunities for the cowbird's eastward expansion (Mayfield 1965). In Minnesota's forested zones, the species is relatively uncommon in the northern sections, especially those distant from agricultural zones and towns.

The highly gregarious Brown-headed Cowbird is the only obligate brood parasite in North America (Roberts 1932). Passerines such as warblers, vireos, and tanagers are the species primary hosts (Brittingham and Temple 1983). The cowbird does not build a nest, but instead lays its eggs in different host nests. Clutch size ranges from one to seven eggs, usually six or more, and the cowbird may have three to four clutches per season (Harrison 1975). During the breeding season, the cowbird is an omnivorous ground forager feeding on spiders, snails, grain, grass and forb seeds (Ehrlich et al. 1988). The species is a granivorous ground gleaner during the nonbreeding period (DeGraaf et al. 1985).

Breeding Bird Survey data from 1965 through 1979 show a significant increase in Brown-headed Cowbirds for the continent, despite a significant decrease in the survey's Eastern region (Robbins et al. 1986). This increase in abundance may be due to an increase in winter food supply and wintering habitat. For instance, in southern states, waste grain in rice (*Oryza sativa*) fields provides an abundant food source during winter months (Brittingham and Temple 1983). As forests continue to be fragmented, and Brown-headed Cowbird population steadily increase, brood parasitism may become a major factor in both maintaining and accelerating the decline of eastern deciduous songbirds (Brittingham and Temple 1983). In Minnesota, however, the species is supposedly declining since 1966 at the rate of about 3.6 percent per year (Janssen 1990).

Brown-headed Cowbird habitat availability was projected to increase under all harvest scenarios. Increases were likely attributable to an increase in early successional habitats. On timberland, increases were projected in ecoregions 6 and 7 under all harvest levels, in ecoregion 5 under the medium scenario, and in ecoregion 4 and statewide under the high scenario. Increases in suitable habitat were similar when all forest land is considered except an increase was also projected in ecoregion 4 under the medium harvest level. Increase in abundance and distribution of this species will likely be detrimental to many forest songbirds, especially those that are sensitive to habitat fragmentation.

Orchard Oriole (*Icterus spurious*)
The Orchard Oriole is primarily a bird of the eastern temperate deciduous forest, where it is found from eastern Montana across North America to the southern New England states, south to Florida, and west to eastern Colorado, Texas, and Mexico (Bent 1958, DeGraaf et al. 1991). In Minnesota the species is primarily a resident of the southwestern half of the state, along the Mississippi River north to the Twin Cities area, and as far north as Red Lake County (Janssen 1987). The species overwinters in an area from Mexico to South America, throughout Central America (DeGraaf et al. 1991). The species migrates to Minnesota throughout the month of May and departs the state in late July to early September (Janssen 1987).

The general breeding habitat of the species in Minnesota consists of a variety of open woodlands with scattered trees (Roberts 1932). It generally avoids dense forests and, hence, is found primarily in agricultural regions, farmlands, or urban settings with shade trees (Dennis 1948). Because of the association of this species with hardwood trees, it was classified as dependent on hardwood forests.

The species lays 3 to 7 eggs, mostly 4 to 5, in a semipendulous nest anywhere from 5 to 20 feet in the fork of a tree or shrub. Incubation is 11 to 14 days and is performed by the female. The species primarily gleans insects, which constitute approximately 90 percent of its diet during the breeding season, but also will occasionally take fruit (Martin et al. 1951).

As with many species that are primarily associated with urban and agricultural settings within Minnesota, this species will likely not be affected by timber harvesting or forest management within the primary forest zones in Minnesota. However, it is sensitive to the loss of trees within these semi-open areas, although canopy closure in forests lands are not favored by this species (Brewer et al. 1991). Nationwide the species has been decreasing according to Breeding Bird Survey roadside counts (Droege and Sauer 1989). Its status in Minnesota is unclear, but reductions in woodlots and scattered trees in the western prairie region have likely contributed to a decline in Minnesota. A variety of factors are likely to have played a role in this decline. These include loss of semi-open forested habitats, the use of pesticides that have reduced insect populations in orchards, and possibly increased parasitism from Brown-headed Cowbirds (Brewer et al. 1991).

No projected decreases were noted for this species in any ecoregion. The species was projected to increase in ecoregion 7 on timberlands and increase in ecoregions 5 and 7 on all forest lands under the base harvest scenario. Under the medium and high harvest scenarios, the species was projected to have an increase in available habitat in ecoregion 7 on both timberlands and all forest lands. The overall projected increase in hardwood forests in ecoregions 5 and 7, especially the 25 percent increase in southern forest ecoregions included in the mitigation runs, explain the projected increases. Because of the preference of this species for semi-open forests and forest areas in fragmented landscapes (Green 1991), the species may not be modeled well with this approach. The FIA data base does not permit an itemization of the openness of the canopy in hardwood forests nor the landscape context of the forest areas.

Northern Oriole (*Icterus galbula*)
The Northern Oriole is an abundant summer resident throughout Minnesota in all but the two northeastern counties (Lake and Cook), where it is rare and local (Janssen 1987). Orioles are common migrants in both spring (migration peaks in mid-May) and fall (August through September) (Janssen 1987). In summer, Northern Orioles can be found throughout the United Sates with the exception of the Gulf Coast region. Their range also includes southern and central Canada (National Geographic Society 1983). Their winter range extends south through southern Mexico and Central America to Columbia (Roberts 1932).

The Northern Oriole's diet consists mainly of caterpillars, beetles, and other invertebrates. Fruit, seeds of forbs, and nectar comprise the remainder of their diet (Roberts 1932, Ehrlich et al. 1988). Foliage gleaning is the primary foraging strategy, but individuals will also hawk insects (Ehrlich et al. 1988). Orioles also are often attracted to feeding stations where orange halves, orange juice, or hummingbird nectar is provided.

Nests are deep, purse-shaped structures, usually suspended at the outer end of a tree branch, 3 to 20 m high in a deciduous tree (Roberts 1932, Ehrlich et al. 1988). American elm, oak, and maple are favored nest trees (Brewer et al. 1991). The nest is tightly woven of forbs, strips of bark, and string on the outside and thickly lined, at the bottom, with soft plant down and hair (Roberts 1932). Three to six eggs are laid in late May or June, and incubated for 12 to 14 days before hatching (Roberts 1932, Ehrlich et al. 1988). Young fledge after an additional 12 to 14 days in the nest (Ehrlich et al. 1988).

Northern Orioles are found in a wide variety of habitats, including open deciduous and mixed forests, riparian areas, forest edges, open areas with only a few trees, parks, and suburban sites with large hardwood trees (Roberts 1932, Ehrlich et al. 1988, Brewer et al. 1991). Its strong preference for hardwood trees justify its classification as a hardwood dependent species.

Northern Oriole populations in the forested regions of Minnesota have been increasing at a median rate of 1.5 percent (route regression analysis, $P < 0.01$) for the period from 1966 to 1990 (Collins et al. 1992).

Concern that Northern Oriole populations might be negatively impacted due to loss of American elms with the spread of Dutch elm disease (Robbins 1991) appear to be unfounded. Orioles have proven to be able to nest quite successfully in other large deciduous tree species (Robbins 1991). The high degree of association of this species with fragmented landscapes (Green 1991), especially with urban environments such as parks, forest edges, and wood lots will likely render the species unaffected by increased timber harvesting. The continued availability of large hardwood trees and diversity of forest areas, however, are essential.

An increase in size of forested area in southern Minnesota was likely the reason for the projected increase in suitable habitat for the Northern Oriole in ecoregion 7 under all harvest levels. Increases were projected for all forest and timberland. On the other hand, decreases were projected in northern ecoregions partially in response to a decrease in size of forest area and loss of mature deciduous habitats. When all forest land was considered, suitable habitat was projected to decrease in ecoregion 4 under all harvest levels. A statewide decrease was projected under the medium and high harvest levels. Additional ecoregion declines under the high harvest level were projected for ecoregion 1. Results for timberlands were similar except a decrease was also projected for ecoregion 2 under the high harvest level.

Purple Finch (*Carpodacus purpureus*)
The Purple Finch has a relatively wide breeding distribution. This includes the Great Lakes region, north throughout the wooded regions of Canada, to the western Rockies, and south to California (Bent 1968). In Minnesota the species is a resident throughout the northeastern and north central regions and breeds as far south as Stearns and Isanti counties (Roberts 1932, Janssen 1987). During the winter the species is found throughout the western Rockies, south to Baja, California and north to southern British Columbia. This species is commonly found during the winter season at feeders. The species migrates to Minnesota from late February to late May and generally departs the state beginning in mid-July, but many individuals will still be found into late November (Janssen 1987).

The general breeding habitat distribution of the species corresponds to conifer and mixed conifer-deciduous forests, conifers in parks, and in similar residential areas (Roberts 1932, Bent 1968, Niemi and Pfannmuller 1979, DeGraaf et al. 1991, Brewer et al. 1991). In the Chippewa and Superior national forests the species was observed in a variety of forest types, including both coniferous-associated and deciduous forests (Hanowski and Niemi 1991a,b). The latter generally included some coniferous trees.

Because of the wide use of the species of different forest types and age classes, the species was not classified into any of the categories identified by the EQB-FSD.

The species is an omnivore and consumes insects and fruits, which it gleans both from trees, shrubs, and on the ground. During the nonbreeding season when insects are not as abundant, the diet primarily consists of seeds and fruits (Martin et al. 1951). The species is also a frequent visitor to feeders in urban areas. The species lays 4 to 6 eggs, and the nest is generally placed from 1 to more than 20 m in a conifer tree, especially spruce (Roberts 1932).

The species has not shown a significant trend in its population in Minnesota based on the Breeding Bird Survey roadside counts gathered over the past 23 years (Janssen 1990).

Throughout its distribution in Minnesota, the Purple Finch seems relatively plastic in its habitat use. However, it does prefer habitats with a conifer component for nesting. Reductions in pole and saw-sized conifers and mixed deciduous-coniferous forests may have a negative effect on the population levels of the species within Minnesota's forests. Because the species nests in late April to late May, it is not censused well by the prevailing methods that focus on counts done in late May to early July. Hence, the species is likely more abundant than most data would indicate.

The only projected increase for this species was in ecoregion 5 in the base harvest scenario and only when all forest lands were included. Projected decreases for this species were predicted in ecoregion 3 under the base harvest scenario and on timberlands and all forest lands. Under the medium harvest scenario, the species was projected to have a decrease in available habitat in ecoregions 3 and 4 and statewide on timberlands but only decreases in ecoregions 3 and 4 on all forest land. In the high harvest scenario, the species was similarly projected to decrease in ecoregions 2, 3, 4, and 6 and statewide on timberlands, but only in ecoregions 3 and 4 and statewide on all forest lands. The overall reduction in pole and saw-sized forest classes and in conifer-associated forest types are the reasons for the projected decreases in available habitat for this species.

Red Crossbill (*Loxia curvirostra*)
The Red Crossbill is a nomadic species that breeds in Minnesota on a rare and irregular basis (Janssen 1987). This species is most commonly seen in fall and winter in small groups of three to ten birds (Janssen 1987). Red Crossbills may, however, be seen in any season. The northeastern and north central parts of the state are the most common places to observe this species. However, during periods of high conifer cone abundance in more southerly parts of the state, the species is more widely distributed. A major irruption of Red Crossbills occurred in March to May of 1988, with observations

recorded even form extreme southwestern counties (Janssen 1987). This invasion of the south central and southwestern regions coincided with a large crop of conifer cones.

The range of the Red Crossbill includes the boreal forest zone of southern Canada and northern U.S. in the east, and boreal forests in mountainous areas in the west from southern Alaska to Central America. They can also be found in the boreal forest zone of northern Europe and Asia.

Red Crossbills nest in conifer-dominated forests and mixed conifer-deciduous forests. They use their unusual bill to pry open the scales of conifer cones to get at the seeds. They also will eat the seeds of deciduous trees, fruit (Ehrlich et al. 1988), and invertebrates (Roberts 1932). Breeding typically takes place in late winter or early spring. Breeding activity in Minnesota has been recorded from July to late August as well (Roberts 1932). Three or four eggs are usually laid in a nest well away from the trunk on a horizontal branch (Roberts 1932, Ehrlich et al. 1988). The nest is built from a wide variety of materials, including twigs, bark, roots, grass, and lichens (Ehrlich et al. 1988).

This species was classified as a conifer dependent species that also requires mature forests for breeding.

An increase in suitable habitat available for the Red Crossbill was projected for ecoregion 1 under the base harvest level when timberland and all forest land was considered. An increase in this region is likely due to the amount of unproductive lowland conifer habitat. Decreases for this species, however were projected in ecoregion 3 under the medium and high harvest levels and on both all forest land and timberland. Under the high harvest level, a decrease in suitable habitat was projected for ecoregion 4 for both timberland and all forest land. A statewide decrease was also projected to occur under the high harvest level on timberlands as well as decreases in ecoregion 2. Loss of mature conifer (both upland and lowland) forests were likely the cause of the decrease in these areas.

White-winged Crossbill (*Loxia leucoptera*)
The White-winged Crossbill is a nomadic species and an uncommon but regular breeder in Minnesota. No nests have been found, however (Janssen 1987). The species is most commonly found during winter in boreal forests of northern Minnesota, but can be observed throughout the state during invasion years (Janssen 1987). During the fall and winter of 1989—90, there was a record irruption of White-winged Crossbills in Minnesota (Janssen 1990), Wisconsin, and Michigan (P. Collins, pers. obs.). Janssen (1990) documented the irruption in Minnesota, recording the species in every county in the state. Nomadic finches, such as White-winged Crossbills, likely irrupt due to a combination of lowered food abundance in more northerly portions

of their range and high production of conifer cones in the areas invaded (Bock and Lepthien 1976). The cone crop in Minnesota during the 1989-90 invasion was very large (Janssen 1990) and was probably an important factor in this unusually large invasion.

The range of this species in North America includes most of the boreal forest zone of Canada and Alaska, to the tree line (Roberts 1932), with more southerly extensions in northern Minnesota, Wisconsin, Michigan, and Maine in the east and into the Rocky mountains in the west. The range appears to be increasing southward in the west (National Geographic Society 1983).

They build a nest on a horizontal branch of a conifer tree, some distance from the trunk (Ehrlich et al. 1988). The nest is usually made of twigs, bark, grass, lichens, and moss (Ehrlich et al. 1988). Four eggs are typically laid in late winter to early spring (Ehrlich et al. 1988). The young (and incubating female) are fed regurgitated seeds (Ehrlich et al. 1988). The bill of this species is adapted for prying open the scales of conifer cones to get at the seeds. Conifer seeds make up the bulk of their diet, but this species also takes the seeds of deciduous trees, grasses, and forbs. Some fruit and insects may also be included in the diet (Ehrlich et al. 1988).

White-winged Crossbills nest in coniferous and mixed conifer-deciduous forests as well as conifer lowlands. This species depends primarily on mature spruce for its diet of conifer cones. It was included as a conifer and mature forest bird in the EQB groupings. During invasions, such as 1989-90, ornamental spruces in residential areas and cemeteries are likely places to readily observe this species. Conifer lowlands of black spruce and tamarack, and upland conifer forests of white spruce are likely more important throughout the state in providing an adequate food supply. Forest management practices should provide for maintaining spruce and tamarack stands in age classes which produce abundant cone crops to ensure this food supply. Major reductions in these tree species could have negative consequences for this species throughout its range if food is not available in southern areas during irruption years.

Results for this species were the same as for the Red Crossbill.

Pine Siskin (*Carduelis pinus*)
The Pine Siskin is a sporadic breeder primarily in northeast and north central Minnesota (Janssen 1987). The species also occurs throughout the United States, southern Canada and northwest into Alaska (Peterson 1980). In winter, it is an erratic resident throughout the State, but is most numerous in the eastern and central regions (Janssen 1987). The species has no exact migration periods; it characteristically moves erratically throughout its range. Nesting by this species generally occurs in years preceded by large influxes (Weaver and West 1943).

The species prefers contiguous coniferous forests or mixed woods for nesting (Erskine 1977, Harrison 1975), although they occasionally nest entirely in deciduous areas (Brewer et al. 1991). Roberts (1932) describes this species as most common in coniferous forests in northern Minnesota, but also found them nesting in coniferous trees in parks, cemeteries, and other urban areas. The species was not recorded in an extensive survey of northern Minnesota forests in 1991 (Hanowski and Niemi 1991a, Hanowski and Niemi 1991b). Because of its high degree of association with coniferous trees for nesting and feeding, the species was classified as a conifer-dependent species.

The nest is placed in a tree or shrub one to eighteen meters above the ground, usually in a conifer tree out on a branch away from the trunk (Harrison 1975). Three to five eggs are the typical clutch size, and incubation requires 13 days. Primary food items taken are pine and alder seeds, weed seeds, and caterpillars (Martin et al. 1951).

Breeding bird survey in the past 20 years has indicated that the species has declined by about 4 percent in the state (Janssen 1990). Replacement of coniferous with deciduous forests throughout the Great Lakes area has likely resulted in a reduction of Pine Siskins in this area (Brewer et al. 1991).

Suitable habitat for the Pine Siskin was projected to increase in ecoregion 9 under all harvest scenarios on both timberlands and all forest lands. Declines were projected for ecoregion 5 under the base harvest level on both timberlands and all forest lands. The species was projected to decline in ecoregions 1, 3, and 5 and statewide in the medium harvest scenario on timberlands. On all forest lands, projected decreases were not found statewide, but were also found in ecoregion 6. Other regional decreases were projected in ecoregion 2 and 4 in the high harvest scenario on timberlands, but not in ecoregion 2 on all forest lands. However, a statewide decrease was projected on all forest lands. Overall, a net decrease of conifers in the state was probably responsible for the projected decrease in suitable habitat available for this species.

American Goldfinch (*Carduelis tristis*)
The American Goldfinch is an abundant resident throughout Minnesota (Janssen 1987). The species is most common in the southern half of the state, with fewer individuals found in heavily forested areas of the north (Janssen 1987). In winter, state populations are variable, but are consistently larger in the south near abundant food supplies (Janssen 1987). Goldfinches are common in both spring and fall migration, with a spring migration peak in mid to late April and a fall peak in October (Janssen 1987).

The American Goldfinch range includes all of the United States and southern Canada. In winter, the species can be found along the northern border region of Mexico (National Geographic Society 1983). Individuals may winter much farther north (including Minnesota), often in flocks with Pine Siskins or Common Redpolls.

Goldfinches are primarily granivores; consuming seeds of deciduous trees, forbs (especially thistle and dandelion), grasses, and berries. Some invertebrates are also eaten. Food is found using a foliage gleaning or a ground gleaning strategy (Nickell 1951, Ehrlich et al. 1988). Wintering birds have been reported to eat large numbers of eggs of insect pests (Forbush 1907 cited in Roberts 1932). Goldfinches can often be attracted to feeding stations by providing thistle seed.

Nests are thick and durable, made of tightly woven forbs, grasses, moss, and spider or caterpillar silk, and lined with plant down (Nickell 1951). Crotches in deciduous shrubs, trees, or woody forbs 1 to 10 meters high are common nesting sites. Four to six eggs are typically laid in the cup-shaped nest during late summer (mid-July to late September (Roberts 1932, Robbins 1991) and incubated for 10 to 12 days before hatching. Young usually fledge in 11 to 17 days after hatching. Goldfinches are a major host species for Brown-headed Cowbird.

Preferred habitat includes open deciduous forests, shrub carr, riparian areas, brushy openings and edges, old fields, and shrub or tree islands in prairie habitat (Roberts 1932, Ehrlich et al. 1988, Brewer et al. 1991, Robbins 1991). Land clearing for agricultural fields may have led to increases in suitable nesting habitat in more heavily forested areas (Nickell 1951). In the forested regions of Minnesota, American Goldfinch populations have increased at a median annual rate of about 1.8 percent (route regression analysis, $P < 0.05$) for the period 1966 to 1990 (Collins et al. 1992).

Suitable habitat for the American Goldfinch was projected to decrease in ecoregion 2 under the base and medium harvest levels. The decrease, projected on all forest and timberland was probably due to the small amount of habitat present for the species in this region of the state. Increases in suitable habitat were projected for ecoregions 4, 5, 6, 7 and statewide under the base and medium harvest scenarios on all forest land and timberland. In addition, on timberlands and all forest lands, increases were projected in ecoregion 3 under the medium harvest level. Under the high harvest scenario, increases were projected for all ecoregions and statewide for both all forest and timberlands. Increase in suitable habitat for the American Goldfinch was the result of an increase in early successional habitats throughout the state.

Evening Grosbeak (*Coccothraustes vesperpinus*)
The Evening Grosbeak has a relatively wide breeding distribution, occurring throughout the southern boreal forest of Canada from Newfoundland across the Canadian provinces to western British Columbia, and with populations

occurring throughout the Rocky Mountain zone into southern Mexico (Bent 1968, DeGraaf et al. 1991). Its breeding distribution in the United States is limited to the northern states including northern Minnesota, Wisconsin, Michigan, and the northeastern New England states. The species has been expanding its breeding range south throughout most of the United States.

In Minnesota, the species is primarily found in the northeastern and northern counties, but can now be found breeding in Crow Wing, Cass, Clearwater, and Beltrami counties (Janssen 1987). The winter distribution of the species has primarily coincided with its breeding distribution, but also is found throughout eastern North America. Over the past 20 years the species population has been expanding in the eastern United States. Undoubtedly, this has been due to the availability of food at residential feeders, especially sunflower seeds. The migration of the species is highly erratic. The bulk of spring migrants are found in Minnesota from mid-April through mid-May. The bulk of fall migrants will usually arrive in October and November (Janssen 1987).

The species is primarily a granivore during most of the season; however, during the summer the diet also includes insects. Throughout the year the species eats a wide variety of seeds, fruits, and bugs (Roberts 1932). It has especially become an efficient consumer of sunflower seeds at residential feeders, and it is particularly fond of the Box Elder (*Acer negundo*) (Brewer et al. 1991).

The breeding habitat of the species is primarily coniferous forest consisting of spruce and fir (Roberts 1932, Bent 1968), but the species is known to use mixed forests in the Upper Peninsula of Michigan (Brewer et al. 1991). Most nesting seems to occur in coniferous trees, but little information is available for Minnesota. Generally, the nest is placed at the ends of the branches anywhere from 15 to more than 60 feet up in the tree. In general, little is known about its breeding cycle (Godfrey 1966). Because of the widely varying use of habitats, the species was not classified into any of the EQB bird groupings.

In winter the species occurs in a wide variety of habitats, usually in relatively large flocks where it uses available coniferous woodlots, but it also can be found in pine-oak habitats, parks, and a variety of woodland vegetation (Brewer et al. 1991).

Over the past 20 years the species population has been increasing, probably due to the availability of food during the winter. In addition, its population has been expanding southward throughout a majority of eastern North America. It is unlikely that timber harvesting or forest management associated with timber harvesting will have an effect on this species. It appears to have always been a relatively erratic, nomadic species. Even though it is dependent on and favors conifer forests, the availability of food made available by urban and suburban populations have likely eliminated a major limiting factor, the availability of food in winter. Brewer et al. (1991) also suggests that the planting of box elder across the Canadian prairies possibility aided the dispersal of the species to the east.

No increases were noted in any of the harvest scenarios. A decrease was projected in ecoregion 3 for both timberlands and all forest lands in the medium harvest scenario. Under the high harvest scenario, a decrease was projected in ecoregions 2, 3, and 4 and statewide on timberlands, but for all forest lands the decreases were confined to ecoregions 3 and 4 and statewide. The primary reason for the changes in the species population in Minnesota is due to the changes in mature forest habitat. The species is primarily found in both pole and saw-sized timber classes. These size classes are less abundant in the high harvest scenario.

APPENDIX 5
Tabular Data on Bird Distribution, Habitat Matrices, and Harvesting Impacts

Table 1. Minnesota forest bird distribution by ecoregion (B=breeding; P=permanent; W=Winter visitant) and legal status by state and national (S=special concern; T=threatened).

	Ecoregion									Status	
Species	1	2	3	4	5	6	7	8	9	State	National
Double-crested Cormorant	B	B	B	B	B	B	B	B	B		
Great Blue Heron	B	B	B	B	B	B	B		B		
Great Egret				B	B	B	B				
Green-backed Heron	B		B	B	B	B	B	B			
Black-crowned Night Heron	B				B	B	B	B			
Yellow-crowned Night Heron	B			B	B	B		B			
Wood Duck	B	B	B	B	B	B	B	B			
American Black Duck	B	B	B	B	W	W					
Common Goldeneye	B	B	P	P	P	W					
Bufflehead	B					W					
Hooded Merganser	B	B	B	B	B	P	B		B		
Common Merganser	B	B	B	B							
Turkey Vulture	B	B	B	B		B					
Osprey	B	B	B	B	B					S	
Bald Eagle	B	B	B	B	B	P				T	T
Sharp-shinned Hawk	B	B	B	B							
Cooper's Hawk	B			B	B	B	B	B	B		
Northern Goshawk	B	B	P	B	B						
Red-Shouldered Hawk				B	B	B	B			S	
Broad-winged Hawk	B	B	B	B	B	B			B		
Red-tailed Hawk	B	B	B	P	P	P	B	B	B		
American Kestrel	B	B	B	B	P	P	P	P	P		
Merlin	B	B	B	B							
Mourning Dove	B			P	P	P	P	P	P		
Black-billed Cuckoo	B	B	B	B	B	B	B	B	B		
Yellow-billed Cuckoo	B			B	B	B	B	B	B		
Eastern Screech-Owl				P	P	P	P	P			
Great Horned Owl	P	P	P	P	P	P	P	P	P		
Barred Owl	P	P	P	P	P	P	P				
Great Gray Owl	P	P	P	P							
Long-eared Owl	B	B	B	P	B	P	P		P		
Boreal Owl	P	P	P	P				P			
Northern Saw-whet Owl	B	B	B	B							
Whip-poor-will	B	B	B	B	B	B	B		B		
Chimney Swift	B	B	B	B	B	B	B	B	B		
Ruby-throated Hummingbird	B	B	B	B	B	B	B	B	B		
Red-headed Woodpecker	B	B	B	P	P	P	P	P	B		
Red-bellied Woodpecker				P	P	P	P	P			
Yellow-bellied Sapsucker	B	B	B	B	B	B	B	B	B		
Downy Woodpecker	P	P	P	P	P	P	P	P	P		
Hairy Woodpecker	P	P	P	P	P	P	P	P	P		
Three-toed Woodpecker		P									
Black-backed Woodpecker	P	P	P	P							
Northern Flicker	B	B	B	B	P	P	P	P	B		
Pileated Woodpecker	P	P	P	P	P	P	P		P		
Olive-sided Flycatcher	B	B	B	B							
Eastern Wood-Pewee	B	B	B	B	B	B	B	B	B		

Table 1. Minnesota forest bird distribution by ecoregion (B=breeding; P=permanent; W=Winter visitant) and legal status by state and national (S=special concern; T=threatened).

	Ecoregion									Status	
Species	1	2	3	4	5	6	7	8	9	State	National
Yellow-bellied Flycatcher	B	B	B	B							
Acadian Flycatcher					B	B					
Least Flycatcher	B	B	B	B	B	B	B	B	B		
Eastern Phoebe	B	B	B	B	B	B	B	B	B		
Great Crested Flycatcher	B		B	B	B	B	B	B	B		
Tree Swallow	B	B	B	B	B	B	B	B	B		
Gray Jay	P	P	P	P							
Blue Jay	P	P	P	P	P	P	P	P	P		
Black-billed Magpie	P			P					P		
American Crow	P	P	P	P	P	P	P	P	P		
Common Raven	P	P	P	P	W						
Black-capped Chickadee	P	P	P	P	P	P	P	P	P		
Boreal Chickadee	P	P	P	P	P	W	W				
Tufted Titmouse					P	P					
Red-breasted Nuthatch	P	P	P	P	P	P					
White-breasted Nuthatch	P	P	P	P	P	P	P	P	P		
Brown Creeper	B	B	B	P	P	P	W				
House Wren	B	B	B	B	B	B	B	B	B		
Winter Wren	B	B	B	B							
Golden-crowned Kinglet	B	B	B	B							
Ruby-crowned Kinglet	B	B	B	B							
Blue-gray Gnatcatcher				B	B	B	B	B			
Eastern Bluebird	B	B	B	B	B	B	B	B	B		
Veery	B	B	B	B	B	B			B		
Swainson's Thrush	B	B	B	B							
Hermit Thrush	B	B	B	B							
Wood Thrush			B	B	B	B	B				
American Robin	B	B	P	P	P	P	P	P	B		
Gray Catbird	B	B	B	B	B	B	B	B	B		
Brown Thrasher	B	B	B	B	B	B	B	B	B		
Cedar Waxwing	B	B	B	B	P	P	P	P	B		
Loggerhead Shrike					B	B	B	B	B	T	
Bell's Vireo						B					
Solitary Vireo	B	B	B	B							
Yellow-throated Vireo	B			B	B	B	B		B		
Warbling Vireo	B			B	B	B	B	B	B		
Philadelphia Vireo	B	B	B								
Red-eyed Vireo	B	B	B	B	B	B	B	B	B		
Blue-winged Warbler					B	B					
Golden-winged Warbler	B		B	B	B						
Tennessee Warbler	B	B	B	B							
Nashville Warbler	B	B	B	B	B						
Northern Parula	B	B	B	B							
Yellow Warbler	B	B	B	B	B	B	B	B	B		
Chestnut-sided Warbler	B	B	B	B	B				B		
Magnolia Warbler	B	B	B	B							
Cape May Warbler	B	B	B	B							

Table 1. Minnesota forest bird distribution by ecoregion (B=breeding; P=permanent; W=Winter visitant) and legal status by state and national (S=special concern; T=threatened).

	Ecoregion									Status	
Species	1	2	3	4	5	6	7	8	9	State	National
Black-throated Blue Warbler		B	B								
Yellow-rumped Warbler	B	B	B	B							
Black-throated Green Warbler	B	B	B	B							
Blackburnian Warbler	B	B	B	B							
Pine Warbler	B	B	B	B							
Palm Warbler	B	B		B							
Bay-breasted Warbler	B	B	B								
Cerulean Warbler					B	B	B				
Black-and-white Warbler	B	B	B	B	B						
American Redstart	B	B	B	B	B	B	B		B		
Prothonotary Warbler					B	B					
Ovenbird	B	B	B	B	B	B	B		B		
Northern Waterthrush	B	B	B	B							
Louisiana Waterthrush				B	B	B	B			S	
Connecticut Warbler	B	B	B	B							
Mourning Warbler	B	B	B	B	B	B	B				
Common Yellowthroat	B	B	B	B	B	B	B	B	B		
Hooded Warbler					B	B					
Wilson's Warbler		B									
Canada Warbler	B	B	B	B							
Yellow-breasted Chat						B					
Scarlet Tanager	B	B	B	B	B	B	B		B		
Northern Cardinal				B	B	B	B	B			
Rose-breasted Grosbeak	B	B	B	B	B	B	B	B			
Indigo Bunting	B	B	B	B	B	B	B	B	B		
Rufous-sided Towhee	B			B	B	B					
Chipping Sparrow	B	B	B	B	B	B	B	B	B		
Song Sparrow	B	B	B	B	P	P	B	B	B		
Lincoln's Sparrow	B	B	B	B							
White-throated Sparrow	B	B	B	B	B						
Dark-eyed Junco	B	B	B	B	W	W					
Rusty Blackbird		B				W					
Common Grackle	B	B	B	B	P	P	P	P	B		
Brown-headed Cowbird	B	B	B	B	P	P	P	P	B		
Orchard Oriole					B	B	B	B	B		
Northern Oriole	B	B	B	B	B	B	B	B	B		
Purple Finch	B	B	B	B	P	B	W				
Red Crossbill	P	P	P	P							
White-winged Crossbill	P	P	P	P							
Pine Siskin	B	B	B	P	P		W		B		
American Goldfinch	B	B	B	B	P	P	P	P	B		
Evening Grosbeak	P	P	P	P	W	W	W				

Table 2. Minnesota forest birds nesting, feeding, and migration guild assignments.

Species	Nest	Food	Migration
Double-crested Cormorant	Canopy	Aquatic	Short-distance
Great Blue Heron	Canopy	Aquatic	Short-distance
Great Egret	Canopy	Aquatic	Short-distance
Green-backed Heron	Canopy	Aquatic	Long-distance
Black-crowned Night Heron	Canopy	Aquatic	Short-distance
Yellow-crowned Night Heron	Canopy	Aquatic	Short-distance
Wood Duck	Cavity	Aquatic	Short-distance
American Black Duck	Ground	Aquatic	Resident
Common Goldeneye	Cavity	Omnivore	Resident
Bufflehead	Cavity	Aquatic	Short-distance
Hooded Merganser	Cavity	Aquatic	Resident
Common Merganser	Cavity	Aquatic	Resident
Turkey Vulture	Ground	Vertebrate	Short-distance
Osprey	Canopy	Aquatic	Short-distance
Bald Eagle	Canopy	Aquatic	Short-distance
Sharp-shinned Hawk	Canopy	Vertebrate	Short-distance
Cooper's Hawk	Canopy	Vertebrate	Short-distance
Northern Goshawk	Canopy	Vertebrate	Resident
Red-Shouldered Hawk	Canopy	Vertebrate	Short-distance
Broad-winged Hawk	Canopy	Vertebrate	Long-distance
Red-tailed Hawk	Canopy	Vertebrate	Short-distance
American Kestrel	Cavity	Vertebrate	Short-distance
Merlin	Canopy	Vertebrate	Long-distance
Mourning Dove	Canopy	Seeds	Short-distance
Black-billed Cuckoo	Shrub	Foliage I & S	Long-distance
Yellow-billed Cuckoo	Shrub	Foliage I & S	Long-distance
Eastern Screech-Owl	Cavity	Vertebrate	Resident
Great Horned Owl	Canopy	Vertebrate	Resident
Barred Owl	Canopy	Vertebrate	Resident
Great Gray Owl	Canopy	Vertebrate	Resident
Long-eared Owl	Canopy	Vertebrate	Resident
Boreal Owl	Cavity	Vertebrate	Resident
Northern Saw-whet Owl	Cavity	Vertebrate	Resident
Whip-poor-will	Ground	Aerial I	Long-distance
Chimney Swift	Cavity	Aerial I	Long-distance
Ruby-throated Hummingbird	Canopy	Nectar	Long-distance
Red-headed Woodpecker	Cavity	Bark I	Resident
Red-bellied Woodpecker	Cavity	Bark I	Resident
Yellow-bellied Sapsucker	Cavity	Nectar or sap	Short-distance
Downy Woodpecker	Cavity	Bark I	Resident
Hairy Woodpecker	Cavity	Bark I	Resident
Three-toed Woodpecker	Cavity	Bark I	Resident
Black-backed Woodpecker	Cavity	Bark I	Resident
Northern Flicker	Cavity	Ground I & F	Short-distance
Pileated Woodpecker	Cavity	Bark I	Resident
Olive-sided Flycatcher	Canopy	Aerial I	Long-distance
Eastern Wood-Pewee	Canopy	Aerial I	Long-distance
Yellow-bellied Flycatcher	Ground	Aerial I	Long-distance
Acadian Flycatcher	Shrub	Aerial I	Long-distance

Table 2. Minnesota forest birds nesting, feeding, and migration guild assignments.

Species	Nest	Food	Migration
Least Flycatcher	Shrub	Aerial I	Long-distance
Eastern Phoebe	Ledge	Aerial I	Short-distance
Great Crested Flycatcher	Cavity	Aerial I	Long-distance
Tree Swallow	Cavity	Aerial I	Short-distance
Gray Jay	Canopy	Omnivore	Resident
Blue Jay	Canopy	Omnivore	Resident
Black-billed Magpie	Shrub	Ground I & F	Resident
American Crow	Canopy	Omnivore	Short-distance
Common Raven	Canopy	Omnivore	Resident
Black-capped Chickadee	Cavity	Foliage I & S	Resident
Boreal Chickadee	Cavity	Foliage I & S	Resident
Tufted Titmouse	Cavity	Foliage I & S	Resident
Red-breasted Nuthatch	Cavity	Bark I	Resident
White-breasted Nuthatch	Cavity	Bark I	Resident
Brown Creeper	Cavity	Bark I	Short-distance
House Wren	Cavity	Foliage I & S	Long-distance
Winter Wren	Ground	Foliage I & S	Short-distance
Golden-crowned Kinglet	Canopy	Foliage I & S	Short-distance
Ruby-crowned Kinglet	Canopy	Foliage I & S	Short-distance
Blue-gray Gnatcatcher	Shrub	Foliage I & S	Long-distance
Eastern Bluebird	Cavity	Aerial I	Short-distance
Veery	Ground	Ground I & F	Long-distance
Swainson's Thrush	Canopy	Ground I & F	Long-distance
Hermit Thrush	Ground	Ground I & F	Short-distance
Wood Thrush	Shrub	Ground I & F	Long-distance
American Robin	Canopy	Ground I & F	Short-distance
Gray Catbird	Shrub	Foliage I & S	Long-distance
Brown Thrasher	Shrub	Ground I & F	Short-distance
Cedar Waxwing	Canopy	Fruit	Resident
Loggerhead Shrike	Shrub	Vertebrate	Resident
Bell's Vireo	Shrub	Foliage I & S	Long-distance
Solitary Vireo	Canopy	Foliage I & S	Long-distance
Yellow-throated Vireo	Canopy	Foliage I & S	Long-distance
Warbling Vireo	Canopy	Foliage I & S	Long-distance
Philadelphia Vireo	Canopy	Foliage I & S	Long-distance
Red-eyed Vireo	Canopy	Foliage I & S	Long-distance
Blue-winged Warbler	Ground	Foliage I & S	Long-distance
Golden-winged Warbler	Ground	Foliage I & S	Long-distance
Tennessee Warbler	Ground	Foliage I & S	Long-distance
Nashville Warbler	Ground	Foliage I & S	Long-distance
Northern Parula	Canopy	Foliage I & S	Long-distance
Yellow Warbler	Shrub	Foliage I & S	Long-distance
Chestnut-sided Warbler	Shrub	Foliage I & S	Long-distance
Magnolia Warbler	Canopy	Foliage I & S	Long-distance
Cape May Warbler	Canopy	Foliage I & S	Long-distance
Black-throated Blue Warbler	Shrub	Foliage I & S	Long-distance
Yellow-rumped Warbler	Canopy	Foliage I & S	Short-distance
Black-throated Green Warbler	Canopy	Foliage I & S	Long-distance
Blackburnian Warbler	Canopy	Foliage I & S	Long-distance

Table 2. Minnesota forest birds nesting, feeding, and migration guild assignments.

Species	Nest	Food	Migration
Pine Warbler	Canopy	Foliage I & S	Short-distance
Palm Warbler	Ground	Foliage I & S	Long-distance
Bay-breasted Warbler	Canopy	Foliage I & S	Long-distance
Cerulean Warbler	Canopy	Foliage I & S	Long-distance
Black-and-white Warbler	Ground	Bark I	Long-distance
American Redstart	Canopy	Aerial I	Long-distance
Prothonotary Warbler	Cavity	Foliage I & S	Long-distance
Ovenbird	Ground	Foliage I & S	Long-distance
Northern Waterthrush	Ground	Foliage I & S	Long-distance
Louisiana Waterthrush	Ground	Foliage I & S	Long-distance
Connecticut Warbler	Ground	Foliage I & S	Long-distance
Mourning Warbler	Ground	Foliage I & S	Long-distance
Common Yellowthroat	Shrub	Foliage I & S	Long-distance
Hooded Warbler	Shrub	Foliage I & S	Long-distance
Wilson's Warbler	Shrub	Foliage I & S	Long-distance
Canada Warbler	Shrub	Foliage I & S	Long-distance
Yellow-breasted Chat	Shrub	Foliage I & S	Long-distance
Scarlet Tanager	Canopy	Foliage I & S	Long-distance
Northern Cardinal	Shrub	Foliage I & S	Resident
Rose-breasted Grosbeak	Shrub	Foliage I & S	Long-distance
Indigo Bunting	Shrub	Foliage I & S	Long-distance
Rufous-sided Towhee	Ground	Ground I & S	Short-distance
Chipping Sparrow	Canopy	Ground I & S	Short-distance
Song Sparrow	Shrub	Ground I & S	Short-distance
Lincoln's Sparrow	Ground	Ground I & S	Long-distance
White-throated Sparrow	Ground	Ground I & S	Short-distance
Dark-eyed Junco	Ground	Ground I & S	Short-distance
Rusty Blackbird	Shrub	Ground I & S	Short-distance
Common Grackle	Shrub	Omnivore	Short-distance
Brown-headed Cowbird	Parasite	Ground I & S	Short-distance
Orchard Oriole	Shrub	Foliage I & S	Long-distance
Northern Oriole	Canopy	Foliage I & S	Long-distance
Purple Finch	Canopy	Seeds	Short-distance
Red Crossbill	Canopy	Seeds	Resident
White-winged Crossbill	Canopy	Seeds	Resident
Pine Siskin	Canopy	Foliage I & S	Resident
American Goldfinch	Shrub	Seeds	Short-distance
Evening Grosbeak	Canopy	Foliage I & S	Resident

Table 3. Minnesota forest bird EQB assignments.

Species	Forest Interior	Conifer Dependent	Hardwood Dependent	Forest Raptor	Mature Forest	Riparian	Cavity Dependent
Double-crested Cormorant					x	x	
Great Blue Heron					x	x	
Great Egret						x	
Green-backed Heron						x	
Black-crowned Night Heron					x	x	
Yellow-crowned Night Heron					x	x	
Wood Duck					x	x	x
American Black Duck						x	
Common Goldeneye					x	x	x
Bufflehead					x	x	x
Hooded Merganser					x	x	x
Common Merganser					x	x	x
Turkey Vulture							
Osprey				x		x	
Bald Eagle				x	x	x	
Sharp-shinned Hawk		x		x	x		
Cooper's Hawk			x	x	x		
Northern Goshawk				x	x		
Red-Shouldered Hawk	x		x	x	x		
Broad-winged Hawk				x	x		
Red-tailed Hawk				x			
American Kestrel							x
Merlin		x		x			
Mourning Dove							
Black-billed Cuckoo			x				
Yellow-billed Cuckoo			x				
Eastern Screech-Owl			x	x	x		x
Great Horned Owl				x	x		
Barred Owl	x		x	x	x		x
Great Gray Owl		x		x	x		
Long-eared Owl				x	x		
Boreal Owl				x	x		x
Northern Saw-whet Owl				x	x		x
Whip-poor-will			x				
Chimney Swift					x		
Ruby-throated Hummingbird							
Red-headed Woodpecker			x				x
Red-bellied Woodpecker			x				x
Yellow-bellied Sapsucker			x		x		x
Downy Woodpecker			x		x		x
Hairy Woodpecker			x		x		x

Table 3. Minnesota forest bird EQB assignments.

Species	Forest Interior	Conifer Dependent	Hardwood Dependent	Forest Raptor	Mature Forest	Riparian	Cavity Dependent
Three-toed Woodpecker		x			x		x
Black-backed Woodpecker		x			x		x
Northern Flicker							x
Pileated Woodpecker	x		x		x		x
Olive-sided Flycatcher							
Eastern Wood-Pewee					x		
Yellow-bellied Flycatcher		x			x		
Acadian Flycatcher	x		x		x		
Least Flycatcher			x		x		
Eastern Phoebe						x	
Great Crested Flycatcher			x		x		x
Tree Swallow							x
Gray Jay		x			x		
Blue Jay			x				
Black-billed Magpie							
American Crow							
Common Raven		x			x		
Black-capped Chickadee					x		x
Boreal Chickadee		x			x		x
Tufted Titmouse			x		x		x
Red-breasted Nuthatch		x			x		x
White-breasted Nuthatch			x		x		x
Brown Creeper					x		
House Wren							x
Winter Wren							
Golden-crowned Kinglet		x			x		
Ruby-crowned Kinglet		x			x		
Blue-gray Gnatcatcher			x		x		
Eastern Bluebird							x
Veery			x				
Swainson's Thrush		x			x		
Hermit Thrush					x		
Wood Thrush			x		x		
American Robin							
Gray Catbird							
Brown Thrasher							
Cedar Waxwing							
Loggerhead Shrike							
Bell's Vireo							
Solitary Vireo		x			x		
Yellow-throated Vireo	x		x		x		

Table 3. Minnesota forest bird EQB assignments.

Species	Forest Interior	Conifer Dependent	Hardwood Dependent	Forest Raptor	Mature Forest	Riparian	Cavity Dependent
Warbling Vireo			x			x	
Philadelphia Vireo			x				
Red-eyed Vireo	x						
Blue-winged Warbler							
Golden-winged Warbler							
Tennessee Warbler		x					
Nashville Warbler							
Northern Parula	x	x			x		
Yellow Warbler							
Chestnut-sided Warbler							
Magnolia Warbler		x					
Cape May Warbler		x			x		
Black-throated Blue Warbler	x		x		x		
Yellow-rumped Warbler		x			x		
Black-throated Green Warbler					x		
Blackburnian Warbler		x			x		
Pine Warbler		x			x		
Palm Warbler		x					
Bay-breasted Warbler		x					
Cerulean Warbler	x		x		x		
Black-and-white Warbler	x						
American Redstart	x						
Prothonotary Warbler			x		x	x	x
Ovenbird	x						
Northern Waterthrush	x					x	
Louisiana Waterthrush	x		x			x	
Connecticut Warbler		x			x		
Mourning Warbler							
Common Yellowthroat							
Hooded Warbler	x		x		x		
Wilson's Warbler							
Canada Warbler	x						
Yellow-breasted Chat							
Scarlet Tanager	x				x		
Northern Cardinal							
Rose-breasted Grosbeak			x				
Indigo Bunting							
Rufous-sided Towhee							
Chipping Sparrow		x			x		
Song Sparrow							
Lincoln's Sparrow		x					

Table 3. Minnesota forest bird EQB assignments.

Species	Forest Interior	Conifer Dependent	Hardwood Dependent	Forest Raptor	Mature Forest	Riparian	Cavity Dependent
White-throated Sparrow							
Dark-eyed Junco		x					
Rusty Blackbird						x	
Common Grackle							
Brown-headed Cowbird							
Orchard Oriole			x				
Northern Oriole			x				
Purple Finch							
Red Crossbill		x			x		
White-winged Crossbill		x			x		
Pine Siskin		x					
American Goldfinch							
Evening Grosbeak							

Table 4. Sources of bird abundance values and habitat associations used in bird/habitat matrix.

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Table 5. Releative abundance of Minnesota forest birds by habitat and age class. Values are mean values for all ecoregions across the state.

Species	Lowland conifer			Upland spruce/fir			Upland Pine			Aspen/ Birch			Northern Hardwoods		
	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw
Double-creasted Cormorant					3	3		3	3		3	3		3	3
Great Blue Heron					2	2		2	2		2	2		2	2
Great Egret											2	2		2	2
Green-backed Heron											1	1		1	1
Black-crowned Night Heron											2	2		2	2
Yellow-crowned Night Heron											1	1		1	1
Wood Duck						3			3		3	3		3	3
American Black Duck												1			1
Common Goldeneye					2	2		2	2		2	2		1	2
Bufflehead											1	1		1	1
Hooded Merganser		2	2		2	2		2	2		2	2		2	2
Common Merganser		2	2		2	2		2	2		2	2		2	2
Turkey Vulture				1	1	1	1	1	1	1	1	1	1	1	1
Osprey						1			1			1			1
Bald Eagle						1			1			1			1
Sharp-shinned Hawk		2	2		1	1		1	1		1	1		1	1
Cooper's Hawk											1	1		1	1
Northern Goshawk					1	1		1	1		1	1		1	1
Red-Shouldered Hawk											1	1		1	1
Broad-winged Hawk					2	2		2	2		2	2		2	2
Red-tailed Hawk										1	1	1	1	1	1
American Kestrel				2			2			2			2		
Merlin		1	1		1	1		1	1		1	1		1	1
Mourning Dove				4	2	2	4			3	2	2	4	2	2
Black-billed Cuckoo										3	2	2	3	2	2
Yellow-billed Cuckoo							1			2	2	2	2	2	2
Eastern Screech-Owl											2	2		2	2
Great Horned Owl					1	1		1	1		2	2		2	2
Barred Owl					1	2		1	2		1	2		1	2
Great Gray Owl		1	1		1	1		1	1		1	1		1	1
Long-eared Owl		1	1		1	1		1	1		1	1		1	1
Boreal Owl		1	1		1	1		1	1		1	1		1	1
Northern Saw-whet Owl		1	1		1	1		1	1		1	1		1	1
Whip-poor-will	2			2			2			2	1	1	2	2	2
Chimney Swift									1			1			1
Ruby-throated Hummingbird	2			2			2			2	2	2	2	2	2
Red-headed Woodpecker											2	2		2	2
Red-bellied Woodpecker											2	2		2	2
Yellow-bellied Sapsucker		1	1		3	3		3	3		3	3		3	3
Downy Woodpecker	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Hairy Woodpecker	2	3	3	2	3	3	2	3	3	3	3	3	2	3	3
Three-toed Woodpecker		1	1		1	1		1	1						

1- 1= <=1 2= 1.1-10 3= 11-50 4= 51-100 5= >100 per 1500 ha

Table 5. Releative abundance-1 of Minnesota forest birds by habitat and age class. Values are mean values for all ecoregions across the state.

	Lowland conifer			Upland spruce/fir			Upland Pine			Aspen/ Birch			Northern Hardwoods		
Species	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw
Black-backed Woodpecker		1	1		1	1		1	1						
Northern Flicker	3			3			3			3	1	1	3	1	1
Pileated Woodpecker					1	1		1	1		1	1		1	1
Olive-sided Flycatcher	3	4	4	3	3	3	3	3	3	3			3		
Eastern Wood-Pewee					4	5		5	5		5	5		5	5
Yellow-bellied Flycatcher		5	5		3	3		2	3						
Acadian Flycatcher											2	2		2	2
Least Flycatcher						5			5		5	5		5	5
Eastern Phoebe	2			2			2			2	2	2	2	2	2
Great Crested Flycatcher											3	3		3	4
Tree Swallow				3			3			3			3		
Gray Jay		3	3		3	3		3	3						
Blue Jay		3	3		4	4		4	4		4	4		4	4
Black-billed Magpie				1			1			1			1		
American Crow					3	3		3	3		3	3		4	4
Common Raven					2	2		2	2		2	2		2	2
Black-capped Chickadee		3	3		5	5		4	4		5	5		5	5
Boreal Chickadee		2	2		2	2		2	2						
Tufted Titmouse											1	1		1	1
Red-breasted Nuthatch		3	3		4	4		4	4		3	3		3	3
White-breasted Nuthatch											3	3		3	3
Brown Creeper		2	2		3	4		3	3		3	3		3	3
House Wren				3			3			3	3	3	3	3	3
Winter Wren	4	5	5	4	4	4	4	4	4	4	4	4	4	4	5
Golden-crowned Kinglet		5	5		5	5		5	5						
Ruby-crowned Kinglet		3	3		3	3		3	3						
Blue-gray Gnatcatcher											1	1		1	1
Eastern Bluebird	2			2			2			2			2		
Veery	5			5			5			5	5	5	5	5	5
Swainson's Thrush		4	4		4	4		4	4						
Hermit Thrush		5	5		5	4		4	5		3	4		3	3
Wood Thrush											2	2		2	2
American Robin	5			5			5			5	4	4	5	4	4
Gray Catbird	3			3			3			3			3		
Brown Thrasher	3			3			3			3			3		
Cedar Waxwing	3	3	3	2	3	3	2	2	2	2	3	2	2	2	2
Loggerhead Shrike				1			1			1			1		
Bell's Vireo										1			1		
Solitary Vireo		3	3		3	3		3	3						
Yellow-throated Vireo											3	3		3	3
Warbling Vireo										2	3	3	2	3	3
Philadelphia Vireo	1			1			1			1	1	1	1	1	1

1- 1= <=1 2= 1.1-10 3= 11-50 4= 51-100 5= >100 per 1500 ha

Table 5. Releative abundance-1 of Minnesota forest birds by habitat and age class. Values are mean values for all ecoregions across the state.

	Lowland conifer			Upland spruce/fir			Upland Pine			Aspen/ Birch			Northern Hardwoods		
Species	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw
Red-eyed Vireo				4	5	5	4	5	5	4	5	5	4	5	5
Blue-winged Warbler				1			1			1	1	1	1	1	1
Golden-winged Warbler	3			3			3			3			3	3	3
Tennessee Warbler	1	2	2	1	2	2				1	2	2			
Nashville Warbler	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Northern Parula		4	4		4	5		4	4		3	3		3	3
Yellow Warbler	3			3			3			3			3		
Chestnut-sided Warbler	5			5	5	5	5			5	5	5	5	5	5
Magnolia Warbler	5	5	5	5	5	5	5	5	5						
Cape May Warbler		4	4		4	4		4	4						
Black-throated Blue Warbler					2	2					2	2		2	2
Yellow-rumped Warbler	3	4	5	3	5	5	3	4	5						
Black-throated Green Warbler			5		5	5		5	5		5	5		5	5
Blackburnian Warbler		5	5		5	5		5	5		4	5		4	4
Pine Warbler					4	5		3	5						
Palm Warbler		3	3												
Bay-breasted Warbler		1	1		1	1		1	1						
Cerulean Warbler											2	2		2	2
Black-and-white Warbler	5			5			5			5	5	5	5	5	5
American Redstart	3			3			3			3	4	5	3	4	5
Prothonotary Warbler											1	1		1	1
Ovenbird				3	5	5	3	5	5	4	5	5	3	5	5
Northern Waterthrush					5	5		5	5	4	5	5	4	5	5
Louisiana Waterthrush											1	1		1	1
Connecticut Warbler		5	5												
Mourning Warbler	5	3	3	5	3	2	5	3	2	5	5	5	5	5	5
Common Yellowthroat	4			3			5			4			4		
Hooded Warbler											1	1		1	1
Wilson's Warbler	1			1			1			1			1		
Canada Warbler	4	4		4			4			4	4	4	4	4	4
Yellow-breasted Chat										1			1		
Scarlet Tanager					4	4		4	4		3	3		3	3
Northern Cardinal											3	3		3	3
Rose-breasted Grosbeak	4			4			4			4	4	4	4	4	4
Indigo Bunting	3			3			3			3	3	3	3	3	3
Rufous-sided Towhee	2			2			2			2			2		
Chipping Sparrow	3	4	4	3	5	5	3	5	5	3	3	3	3	3	3
Song Sparrow	4			4			5			4			4		
Lincoln's Sparrow	3														
White-throated Sparrow	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Dark-eyed Junco	3	3	3	3	3	3	3	3	3						
Rusty Blackbird		1	1		1	1		1	1						

1- 1= <=1 2= 1.1-10 3= 11-50 4= 51-100 5= >100 per 1500 ha

Table 5. Releative abundance-1 of Minnesota forest birds by habitat and age class. Values are mean values for all ecoregions across the state.

	Lowland conifer			Upland spruce/fir			Upland Pine			Aspen/ Birch			Northern Hardwoods		
Species	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw	Sap.	Pole	Saw
Common Grackle	4			4			4			4			4		
Brown-headed Cowbird	4			4			4			4	4	4	4	4	4
Orchard Oriole											1	1		1	1
Northern Oriole											3	3		3	3
Purple Finch		2	3		3	3		3	3		3	3		3	3
Red Crossbill		1	1		1	1		1	1						
White-winged Crossbill		1	1		1	1		1	1						
Pine Siskin					2	2		2	2						
American Goldfinch	3			3			4			3			3		
Evening Grosbeak	1	3	3	1	3	3	1	3	3						

1- 1= <=1 2= 1.1-10 3= 11-50 4= 51-100 5= >100 per 1500 ha

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

--- EQB=Forest interior ---

Impact	Both	Species	Base	Medium	High
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S*
Decrease	*	Barred Owl		6	1,3,4,5,6,*S*
Decrease	*	Pileated Woodpecker	6	1,6	1,3,4,5,6,*S*
Decrease		Acadian Flycatcher	6	6	5,6,*S*
Decrease	*	Yellow-throated Vireo	4,6,*S*	1,4,5,6,*S*	1,4,5,6,*S*
Decrease	*	Red-eyed Vireo		6	1,3,4,5,6,*S*
Decrease	*	Northern Parula			3,4,*S*
Decrease		Black-throated Blue Warbler			3,*S*
Decrease		Cerulean Warbler	6	6,*S*	5,6,*S*
Decrease		Black-and-white Warbler			5
Decrease	*	American Redstart			1
Decrease	*	Ovenbird	6	4,6	1,3,4,5,6,*S*
Decrease	*	Louisiana Waterthrush	7	7	7
Decrease		Hooded Warbler	6,*S*	6,*S*	5,6,*S*
Decrease	*	Scarlet Tanager	6	4,6	1,3,4,5,6,*S*
Increase	*	Barred Owl	2	2	
Increase	*	Pileated Woodpecker	9	9	9
Increase	*	Yellow-throated Vireo	9	9	
Increase	*	Red-eyed Vireo	2,7,9	2,7,9	9
Increase	*	Northern Parula	1		
Increase	*	American Redstart	2,9	2,9	9
Increase	*	Ovenbird	9	9	9
Increase	*	Louisiana Waterthrush	5	5	5
Increase	*	Scarlet Tanager	9	9	9

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Conifer - dependent					
Impact	Both	Species	Base	Medium	High
Decrease		Sharp-shinned Hawk		3	3,4,*S*
Decrease		Merlin		4	3,4,*S*
Decrease	*	Great Gray Owl	3	3	3,4
Decrease	*	Black-backed Woodpecker		3,4	3,4
Decrease	*	Yellow-bellied Flycatcher			3,4
Decrease	*	Gray Jay	3	3	3,4
Decrease		Common Raven		4	3,4,*S*
Decrease	*	Boreal Chickadee	3	3	3,4
Decrease	*	Red-breasted Nuthatch			1,3,4
Decrease	*	Golden-crowned Kinglet		3	3,4,*S*
Decrease	*	Ruby-crowned Kinglet		3	3,4
Decrease	*	Swainson's Thrush	3	3	3,4
Decrease	*	Solitary Vireo		3	3,4,*S*
Decrease		Tennessee Warbler			3,4
Decrease	*	Northern Parula			3,4,*S*
Decrease		Magnolia Warbler	3	3	3
Decrease	*	Cape May Warbler		3	3,4
Decrease		Yellow-rumped Warbler	3	3	3,4
Decrease		Blackburnian Warbler			3,4,*S*
Decrease		Pine Warbler		1,3	1,3,4,*S*
Decrease	*	Bay-breasted Warbler		3	3
Decrease	*	Connecticut Warbler	3	3	3,4
Decrease	*	Chipping Sparrow			3
Decrease	*	Lincoln's Sparrow	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S*
Decrease		Dark-eyed Junco	3,4	3	3
Decrease	*	Red Crossbill		3	3,4
Decrease	*	White-winged Crossbill		3	3,4
Decrease	*	Pine Siskin	5	1,3,4,5	1,3,4,5,*S*
Increase	*	Great Gray Owl	1		
Increase	*	Black-backed Woodpecker	1		
Increase	*	Yellow-bellied Flycatcher	1,2,*S*	2	
Increase	*	Gray Jay	1		
Increase	*	Boreal Chickadee	1,5	5	5
Increase	*	Red-breasted Nuthatch	5	5	5
Increase	*	Golden-crowned Kinglet	1		
Increase	*	Ruby-crowned Kinglet	1		
Increase	*	Swainson's Thrush	1		
Increase	*	Solitary Vireo	1		
Increase	*	Northern Parula	1		
Increase	*	Cape May Warbler	1		
Increase		Palm Warbler	1,2,*S*		
Increase	*	Bay-breasted Warbler	1		

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Conifer - dependent
(continued)

Impact	Both	Species	Base	Medium	High
Increase	*	Connecticut Warbler	1		
Increase	*	Chipping Sparrow	7,9	5,7,9	5,7
Increase	*	Lincoln's Sparrow			3
Increase	*	Red Crossbill	1		
Increase	*	White-winged Crossbill	1		
Increase	*	Pine Siskin	9	9	9

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Hardwood - dependent

Impact	Both	Species	Base	Medium	High
Decrease	*	Cooper's Hawk	4	1,4	1,4
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S*
Decrease	*	Eastern Screech-Owl	4	4	4
Decrease	*	Barred Owl		6	1,3,4,5,6,*S*
Decrease	*	Whip-poor-will	7	7	7
Decrease	*	Red-headed Woodpecker		3,4	1,3,4
Decrease	*	Red-bellied Woodpecker			4
Decrease	*	Yellow-bellied Sapsucker		4	1,3,4,*S*
Decrease	*	Hairy Woodpecker	6	3,6	3,6
Decrease	*	Pileated Woodpecker	6	1,6	1,3,4,5,6,*S*
Decrease		Acadian Flycatcher	6	6	5,6,*S*
Decrease	*	Least Flycatcher			1,3,4,*S*
Decrease	*	Great Crested Flycatcher			1,3,4,*S*
Decrease	*	Blue Jay		4	3,4,*S*
Decrease	*	White-breasted Nuthatch		4	1,3,4,*S*
Decrease	*	Blue-gray Gnatcatcher		4	4,*S*
Decrease	*	Veery			1
Decrease	*	Wood Thrush		4,*S*	3,4,*S*
Decrease	*	Yellow-throated Vireo	4,6,*S*	1,4,5,6,*S*	1,4,5,6,*S*
Decrease		Black-throated Blue Warbler			3,*S*
Decrease		Cerulean Warbler	6	6,*S*	5,6,*S*
Decrease	*	Louisiana Waterthrush	7	7	7
Decrease		Hooded Warbler	6,*S*	6,*S*	5,6,*S*
Decrease	*	Northern Oriole	4	4,*S*	1,3,4,*S*
Increase	*	Cooper's Hawk	5,7,9	7,9	7,9
Increase		Black-billed Cuckoo	2,3,5,7	2,3,5,7	2,3,5,7,9
Increase		Yellow-billed Cuckoo	4,5,7,*S*	4,5,7,*S*	4,5,7,*S*
Increase	*	Eastern Screech-Owl	5,7	7	7
Increase	*	Barred Owl	2	2	
Increase	*	Whip-poor-will	5	5	5
Increase	*	Red-headed Woodpecker	7,9	7,9	7
Increase	*	Red-bellied Woodpecker	7	7	7
Increase	*	Yellow-bellied Sapsucker	2,7,9	7,9	7,9
Increase		Downy Woodpecker	5,7,9	5,7,9	7,9
Increase	*	Hairy Woodpecker	5,7,9	7,9	7,9
Increase	*	Pileated Woodpecker	9	9	9
Increase	*	Least Flycatcher	2,7,9	2,7,9	2,7,9
Increase	*	Great Crested Flycatcher	7,9	7,9	7,9
Increase	*	Blue Jay	7,9	7,9	7
Increase	*	White-breasted Nuthatch	5,7,9	7,9	7
Increase	*	Blue-gray Gnatcatcher	7	7	7
Increase	*	Veery	6	6	5,6,9
Increase	*	Wood Thrush	7	7	7

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Hardwood - dependent
(continued)

Impact	Both	Species	Base	Medium	High
Increase	*	Yellow-throated Vireo	9	9	
Increase		Warbling Vireo	9	9	9
Increase	*	Louisiana Waterthrush	5	5	5
Increase		Rose-breasted Grosbeak	7,9	7,9	2,7,9
Increase		Orchard Oriole	5,7	7	7
Increase	*	Northern Oriole	7	7	7

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Forest raptors

Impact	Both	Species	Base	Medium	High
Decrease		Sharp-shinned Hawk		3	3,4,*S*
Decrease	*	Cooper's Hawk	4	1,4	1,4
Decrease		Northern Goshawk	4	4	1,3,4,*S*
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S*
Decrease	*	Broad-winged Hawk		4	1,3,4,*S*
Decrease		Merlin		4	3,4,*S*
Decrease	*	Eastern Screech-Owl	4	4	4
Decrease	*	Great Horned Owl		4	1,3,4
Decrease	*	Barred Owl		6	1,3,4,5,6,*S*
Decrease	*	Great Gray Owl	3	3	3,4
Decrease	*	Long-eared Owl		3,4	3,4,*S*
Decrease		Boreal Owl		3,4	3,4,*S*
Decrease		Northern Saw-whet Owl		3	3,4,*S*
Increase		Osprey	1,2,3,4,5,*S*	1,2,3,4,5,*S*	1,2,3,4,5,*S*
Increase		Bald Eagle	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*
Increase	*	Cooper's Hawk	5,7,9	7,9	7,9
Increase	*	Broad-winged Hawk	5,9	9	9
Increase		Red-tailed Hawk	3,7,9	3,7,9	3,7
Increase	*	Eastern Screech-Owl	5,7	7	7
Increase	*	Great Horned Owl	5,7,9	7,9	7
Increase	*	Barred Owl	2	2	
Increase	*	Great Gray Owl	1		
Increase	*	Long-eared Owl	5,7,9	7,9	7

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

--- EQB=Mature forest ---

Impact	Both	Species	Base	Medium	High
Decrease	*	Wood Duck		3	3
Decrease	*	Common Goldeneye		3	3
Decrease		Sharp-shinned Hawk		3	3,4,*S*
Decrease	*	Cooper's Hawk	4	1,4	1,4
Decrease		Northern Goshawk	4	4	1,3,4,*S*
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S*
Decrease	*	Broad-winged Hawk		4	1,3,4,*S*
Decrease	*	Eastern Screech-Owl	4	4	4
Decrease	*	Great Horned Owl		4	1,3,4
Decrease	*	Barred Owl		6	1,3,4,5,6,*S*
Decrease	*	Great Gray Owl	3	3	3,4
Decrease	*	Long-eared Owl		3,4	3,4,*S*
Decrease		Boreal Owl		3,4	3,4,*S*
Decrease		Northern Saw-whet Owl		3	3,4,*S*
Decrease	*	Chimney Swift			3,4
Decrease	*	Yellow-bellied Sapsucker		4	1,3,4,*S*
Decrease	*	Hairy Woodpecker	6	3,6	3,6
Decrease	*	Black-backed Woodpecker		3,4	3,4
Decrease	*	Pileated Woodpecker	6	1,6	1,3,4,5,6,*S*
Decrease	*	Eastern Wood-Pewee	4	4	1,3,4,*S*
Decrease	*	Yellow-bellied Flycatcher			3,4
Decrease		Acadian Flycatcher	6	6	5,6,*S*
Decrease	*	Least Flycatcher			1,3,4,*S*
Decrease	*	Great Crested Flycatcher			1,3,4,*S*
Decrease	*	Gray Jay	3	3	3,4
Decrease		Common Raven		4	3,4,*S*
Decrease	*	Black-capped Chickadee			1,3,4,*S*
Decrease	*	Boreal Chickadee	3	3	3,4
Decrease	*	Red-breasted Nuthatch			1,3,4
Decrease	*	White-breasted Nuthatch		4	1,3,4,*S*
Decrease	*	Brown Creeper		4	2,3,4,*S*
Decrease	*	Golden-crowned Kinglet		3	3,4,*S*
Decrease	*	Ruby-crowned Kinglet		3	3,4
Decrease	*	Blue-gray Gnatcatcher		4	4,*S*
Decrease	*	Swainson's Thrush	3	3	3,4
Decrease		Hermit Thrush			3,4,*S*
Decrease	*	Wood Thrush		4,*S*	3,4,*S*
Decrease	*	Solitary Vireo		3	3,4,*S*
Decrease	*	Yellow-throated Vireo	4,6,*S*	1,4,5,6,*S*	1,4,5,6,*S*
Decrease	*	Northern Parula			3,4,*S*
Decrease	*	Cape May Warbler		3	3,4
Decrease		Black-throated Blue Warbler			3,*S*
Decrease		Yellow-rumped Warbler	3	3	3,4

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Mature forest (continued)

Impact	Both	Species	Base	Medium	High
Decrease		Black-throated Green Warbler		4	2,3,4,*S*
Decrease		Blackburnian Warbler			3,4,*S*
Decrease		Pine Warbler		1,3	1,3,4,*S*
Decrease		Cerulean Warbler	6	6,*S*	5,6,*S*
Decrease	*	Connecticut Warbler	3	3	3,4
Decrease		Hooded Warbler	6,*S*	6,*S*	5,6,*S*
Decrease	*	Scarlet Tanager	6	4,6	1,3,4,5,6,*S*
Decrease	*	Chipping Sparrow			3
Decrease	*	Red Crossbill		3	3,4
Decrease	*	White-winged Crossbill		3	3,4
Increase		Double-crested Cormorant	1,9	1,9	1,9
Increase		Great Blue Heron	1,9	1,9	1,9
Increase		Black-crowned Night Heron	1	1	1
Increase	*	Wood Duck	1,2,3,9	1,2,3,9	1,2,3,9
Increase	*	Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S*
Increase		Bufflehead	1,*S*	1,*S*	1,*S*
Increase		Hooded Merganser	1,3,4,5,6,7,9	1,4,5,6,7,9	1,3,4,5,6,7,9
Increase		Common Merganser	1,2,3,4,*S*	1,2,4,*S*	1,2,4,*S*
Increase		Bald Eagle	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*
Increase	*	Cooper's Hawk	5,7,9	7,9	7,9
Increase	*	Broad-winged Hawk	5,9	9	9
Increase	*	Eastern Screech-Owl	5,7	7	7
Increase	*	Great Horned Owl	5,7,9	7,9	7
Increase	*	Barred Owl	2	2	
Increase	*	Great Gray Owl	1		
Increase	*	Long-eared Owl	5,7,9	7,9	7
Increase	*	Chimney Swift	1,2,3,4,5,7,9,*S*	1,2,3,4,5,7,9,*S*	1,2,3,4,5,7,9,*S*
Increase	*	Yellow-bellied Sapsucker	2,7,9	7,9	7,9
Increase		Downy Woodpecker	5,7,9	5,7,9	7,9
Increase	*	Hairy Woodpecker	5,7,9	7,9	7,9
Increase	*	Black-backed Woodpecker	1		
Increase	*	Pileated Woodpecker	9	9	9
Increase	*	Eastern Wood-Pewee	5,7,9	5,7,9	7,9
Increase	*	Yellow-bellied Flycatcher	1,2,*S*	2	
Increase	*	Least Flycatcher	2,7,9	2,7,9	2,7,9
Increase	*	Great Crested Flycatcher	7,9	7,9	7,9
Increase	*	Gray Jay	1		
Increase	*	Black-capped Chickadee	7,9	7,9	7
Increase	*	Boreal Chickadee	1,5	5	5
Increase	*	Red-breasted Nuthatch	5	5	5
Increase	*	White-breasted Nuthatch	5,7,9	7,9	7
Increase	*	Brown Creeper	3		

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Mature forest (continued)

Impact	Both	Species	Base	Medium	High
Increase	*	Golden-crowned Kinglet	1		
Increase	*	Ruby-crowned Kinglet	1		
Increase	*	Blue-gray Gnatcatcher	7	7	7
Increase	*	Swainson's Thrush	1		
Increase	*	Wood Thrush	7	7	7
Increase	*	Solitary Vireo	1		
Increase	*	Yellow-throated Vireo	9	9	
Increase	*	Northern Parula	1		
Increase	*	Cape May Warbler	1		
Increase	*	Connecticut Warbler	1		
Increase	*	Scarlet Tanager	9	9	9
Increase	*	Chipping Sparrow	7,9	5,7,9	5,7
Increase	*	Red Crossbill	1		
Increase	*	White-winged Crossbill	1		

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=Riparian

Impact	Both	Species	Base	Medium	High
Decrease	*	Green-backed Heron	3,6	6	6
Decrease	*	Wood Duck		3	3
Decrease	*	Common Goldeneye		3	3
Decrease		Eastern Phoebe	2	2	2
Decrease	*	Louisiana Waterthrush	7	7	7
Increase		Double-crested Cormorant	1,9	1,9	1,9
Increase		Great Blue Heron	1,9	1,9	1,9
Increase	*	Green-backed Heron	1	1	1
Increase		Black-crowned Night Heron	1	1	1
Increase	*	Wood Duck	1,2,3,9	1,2,3,9	1,2,3,9
Increase		American Black Duck	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S*
Increase	*	Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S*
Increase		Bufflehead	1,*S*	1,*S*	1,*S*
Increase		Hooded Merganser	1,3,4,5,6,7,9	1,4,5,6,7,9	1,3,4,5,6,7,9
Increase		Common Merganser	1,2,3,4,*S*	1,2,4,*S*	1,2,4,*S*
Increase		Osprey	1,2,3,4,5,*S*	1,2,3,4,5,*S*	1,2,3,4,5,*S*
Increase		Bald Eagle	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S*
Increase		Warbling Vireo	9	9	9
Increase	*	Louisiana Waterthrush	5	5	5

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

-- EQB=Cavity dependent --

Impact	Both	Species	Base	Medium	High
Decrease	*	Wood Duck		3	3
Decrease	*	Common Goldeneye		3	3
Decrease	*	American Kestrel	2		
Decrease	*	Eastern Screech-Owl	4	4	4
Decrease	*	Barred Owl		6	1,3,4,5,6,*S*
Decrease		Boreal Owl		3,4	3,4,*S*
Decrease		Northern Saw-whet Owl		3	3,4,*S*
Decrease	*	Red-headed Woodpecker		3,4	1,3,4
Decrease	*	Red-bellied Woodpecker			4
Decrease	*	Yellow-bellied Sapsucker		4	1,3,4,*S*
Decrease	*	Hairy Woodpecker	6	3,6	3,6
Decrease	*	Black-backed Woodpecker		3,4	3,4
Decrease	*	Northern Flicker	2	2	
Decrease	*	Pileated Woodpecker	6	1,6	1,3,4,5,6,*S*
Decrease	*	Great Crested Flycatcher			1,3,4,*S*
Decrease	*	Tree Swallow	2		
Decrease	*	Black-capped Chickadee			1,3,4,*S*
Decrease	*	Boreal Chickadee	3	3	3,4
Decrease	*	Red-breasted Nuthatch			1,3,4
Decrease	*	White-breasted Nuthatch		4	1,3,4,*S*
Decrease	*	Eastern Bluebird	2	2	
Increase	*	Wood Duck	1,2,3,9	1,2,3,9	1,2,3,9
Increase	*	Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S*
Increase		Bufflehead	1,*S*	1,*S*	1,*S*
Increase		Hooded Merganser	1,3,4,5,6,7,9	1,4,5,6,7,9	1,3,4,5,6,7,9
Increase		Common Merganser	1,2,3,4,*S*	1,2,4,*S*	1,2,4,*S*
Increase	*	American Kestrel	1,3,4,5,6,7,*S*	1,3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*
Increase	*	Eastern Screech-Owl	5,7	7	7
Increase	*	Barred Owl	2	2	
Increase	*	Red-headed Woodpecker	7,9	7,9	7
Increase	*	Red-bellied Woodpecker	7	7	7
Increase	*	Yellow-bellied Sapsucker	2,7,9	7,9	7,9
Increase		Downy Woodpecker	5,7,9	5,7,9	7,9
Increase	*	Hairy Woodpecker	5,7,9	7,9	7,9
Increase	*	Black-backed Woodpecker	1		
Increase	*	Northern Flicker	5,6,7	3,4,5,6,7	1,3,4,5,6,7,*S*
Increase	*	Pileated Woodpecker	9	9	9
Increase	*	Great Crested Flycatcher	7,9	7,9	7,9
Increase	*	Tree Swallow	1,3,4,5,6,7,*S*	1,3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S*
Increase	*	Black-capped Chickadee	7,9	7,9	7
Increase	*	Boreal Chickadee	1,5	5	5
Increase	*	Red-breasted Nuthatch	5	5	5
Increase	*	White-breasted Nuthatch	5,7,9	7,9	7

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

-- EQB=Cavity dependent --
(continued)

Impact	Both	Species	Base	Medium	High
Increase		House Wren	1,6,7	1,6,7	1,2,3,6,7
Increase	*	Eastern Bluebird	4,5,6,7	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

-- EQB=All others --

Impact	Both	Species	Base	Medium	High
Decrease	*	Olive-sided Flycatcher			3
Decrease	*	American Crow			1,3,4,*S*
Decrease	*	Gray Catbird	2	2	
Decrease	*	Brown Thrasher	2	2	
Decrease	*	Loggerhead Shrike	7	7	
Decrease	*	Nashville Warbler			3
Decrease	*	Yellow Warbler	2	2	
Decrease	*	Common Yellowthroat	2	2	
Decrease	*	Wilson's Warbler	2,*S*	2,*S*	
Decrease	*	Northern Cardinal		4	4
Decrease	*	Indigo Bunting			1
Decrease	*	Song Sparrow	2	2	
Decrease	*	Common Grackle	2	2	
Decrease	*	Purple Finch	3	3,4	3,4,*S*
Decrease	*	American Goldfinch	2	2	
Decrease		Evening Grosbeak		3	3,4,*S*
Increase		Turkey Vulture	6	6	6
Increase		Mourning Dove	1,4,5,6,7,*S*	1,4,5,6,7,*S*	1,4,5,6,7,9,*S*
Increase		Ruby-throated Hummingbird	5,7,9	5,7,9	5,7
Increase	*	Olive-sided Flycatcher		4	4,*S*
Increase		Black-billed Magpie	1,4,9,*S*	1,4,9,*S*	1,4,9,*S*
Increase	*	American Crow	7,9	7,9	7
Increase		Winter Wren	1,4		
Increase		American Robin	6,7	5,6,7	3,4,5,6,7,*S*
Increase	*	Gray Catbird	4,5,6,7,*S*	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*
Increase	*	Brown Thrasher	4,5,6,7	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*
Increase		Cedar Waxwing	7	7	7
Increase	*	Loggerhead Shrike	5,6,7,*S*	5,6,7,*S*	5,6,7,*S*
Increase		Bell's Vireo	6,*S*	6,*S*	6,*S*
Increase		Blue-winged Warbler	5,6,*S*	5,6,*S*	6,*S*
Increase		Golden-winged Warbler	3,4,5,*S*	3,4,5,*S*	1,3,4,5,*S*
Increase	*	Nashville Warbler	5	5	5
Increase	*	Yellow Warbler	5,6,7	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*
Increase		Chestnut-sided Warbler			2,3,4,5,*S*
Increase		Mourning Warbler		4,5	4,5,*S*
Increase	*	Common Yellowthroat	5,6,7	3,5,6,7	1,2,3,4,5,6,7,*S*
Increase	*	Wilson's Warbler			2,*S*
Increase		Yellow-breasted Chat	6,*S*	6,*S*	6,*S*
Increase	*	Northern Cardinal	5,7	7	7
Increase	*	Indigo Bunting	2,6,7	2,3,5,6,7	2,3,4,5,6,7,*S*
Increase		Rufous-sided Towhee	4,5,6,*S*	4,5,6,*S*	1,4,5,6,*S*
Increase	*	Song Sparrow	4,5,6,7	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*
Increase	*	Common Grackle	4,5,6,7	3,4,5,6,7	1,2,3,4,5,6,7,9,*S*

Table 6a. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on all forest land. Species are grouped by EQB group.

EQB=All others (continued)

Impact	Both	Species	Base	Medium	High
Increase		Brown-headed Cowbird	6,7	4,5,6,7	4,5,6,7,*S*
Increase	*	Purple Finch	5		
Increase	*	American Goldfinch	4,5,6,7,*S*	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

--- EQB=Forest interior ---

Impact	Both	Species	Base	Medium	High
Decrease		Red-Shouldered Hawk	4,5,6,*S	4,5,6,*S*	4,5,6,*S
Decrease		Barred Owl	6,	6,	1,2,3,4,5,6,*S
Decrease	*	Pileated Woodpecker	6,	3,6,	1,2,3,4,5,6,*S
Decrease		Acadian Flycatcher	6,	6,	5,6,*S
Decrease	*	Yellow-throated Vireo	4,5,6,*S*	4,5,6,*S*	1,4,5,6,*S
Decrease	*	Red-eyed Vireo	6,	6,	1,2,3,4,5,6,*S
Decrease	*	Northern Parula		4,	2,3,4,*S
Decrease		Black-throated Blue Warbler			2,3,*S
Decrease		Cerulean Warbler	6,	6,*S*	5,6,*S
Decrease	*	Black-and-white Warbler			5,
Decrease	*	American Redstart			1,2,6,
Decrease	*	Ovenbird	6,	4,6,	1,2,3,4,5,6,*S
Decrease	*	Louisiana Waterthrush	7,	7,	7,
Decrease		Hooded Warbler	6,	6,*S*	5,6,*S
Decrease	*	Scarlet Tanager	6,	4,6,*S*	1,2,3,4,5,6,*S
Increase	*	Pileated Woodpecker	9,	9,	
Increase	*	Yellow-throated Vireo	9,	9,	
Increase	*	Red-eyed Vireo	7,9,	7,9,	9,
Increase	*	Northern Parula	1,		
Increase	*	Black-and-white Warbler			2,
Increase	*	American Redstart	9,	9,	
Increase	*	Ovenbird	9,	9,	
Increase		Northern Waterthrush	2,*S*	2,*S*	2,*S
Increase	*	Louisiana Waterthrush	5,	5,	5,
Increase	*	Scarlet Tanager	9,	9,	

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Conifer - dependent --

Impact	Both	Species	Base	Medium	High
Decrease		Sharp-shinned Hawk			2,3,4,*S
Decrease		Merlin		3,4,	1,2,3,4,*S
Decrease		Great Gray Owl	3,4,	3,4,	2,3,4,*S
Decrease		Three-toed Woodpecker			2,*S
Decrease	*	Black-backed Woodpecker		3,4,	2,3,4,*S
Decrease	*	Yellow-bellied Flycatcher			2,3,4,*S
Decrease	*	Gray Jay	3,	3,	2,3,4,*S
Decrease		Common Raven		4,	1,2,3,4,*S
Decrease	*	Boreal Chickadee		3,	1,2,3,4,*S
Decrease	*	Red-breasted Nuthatch			1,2,3,4,*S
Decrease	*	Golden-crowned Kinglet		3,	1,2,3,4,*S
Decrease	*	Ruby-crowned Kinglet		3,	2,3,4,*S
Decrease	*	Swainson's Thrush	3,	3,	2,3,4,*S
Decrease	*	Solitary Vireo		3,4,	2,3,4,*S
Decrease		Tennessee Warbler			2,3,4,*S
Decrease	*	Northern Parula		4,	2,3,4,*S
Decrease		Magnolia Warbler		3,	3,
Decrease	*	Cape May Warbler		3,4,	1,2,3,4,*S
Decrease		Yellow-rumped Warbler	3,	3,	2,3,4,*S
Decrease		Blackburnian Warbler		3,4,	1,2,3,4,*S
Decrease		Pine Warbler		1,3,	1,2,3,4,*S
Decrease	*	Palm Warbler			2,4,*S
Decrease		Bay-breasted Warbler		3,	1,2,3,*S
Decrease	*	Connecticut Warbler	3,	3,	2,3,4,*S
Decrease	*	Chipping Sparrow			3,4,
Decrease	*	Lincoln's Sparrow	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Decrease		Dark-eyed Junco	3,4,	3,	2,3,
Decrease	*	Red Crossbill		3,	2,3,4,*S
Decrease	*	White-winged Crossbill		3,	2,3,4,*S
Decrease	*	Pine Siskin	5,	1,3,5,*S*	1,2,3,4,5,*S
Increase	*	Black-backed Woodpecker	1,		
Increase	*	Yellow-bellied Flycatcher	1,2,*S*	2,	
Increase	*	Gray Jay	1,		
Increase	*	Boreal Chickadee	1,5,	5,	5,
Increase	*	Red-breasted Nuthatch	2,5,	5,	5,
Increase	*	Golden-crowned Kinglet	1,		
Increase	*	Ruby-crowned Kinglet	1,		
Increase	*	Swainson's Thrush	1,2,		
Increase	*	Solitary Vireo	1,		
Increase	*	Northern Parula	1,		
Increase	*	Cape May Warbler	2,		
Increase	*	Palm Warbler	1,2,4,*S		

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Conifer - dependent --
(continued)

Impact	Both	Species	Base	Medium	High
Increase	*	Connecticut Warbler	1,2,		
Increase	*	Chipping Sparrow	7,	5,7,	5,7,
Increase	*	Lincoln's Sparrow			3,
Increase	*	Red Crossbill	1,		
Increase	*	White-winged Crossbill	1,		
Increase	*	Pine Siskin	9,	9,	9,

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Hardwood - dependent --

Impact	Both	Species	Base	Medium	High
Decrease	*	Cooper's Hawk	1,4,	1,4,	1,4,*S
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S
Decrease	*	Eastern Screech-Owl	4,	4,	4,
Decrease		Barred Owl	6,	6,	1,2,3,4,5,6,*S
Decrease	*	Whip-poor-will	7,	7,	7,
Decrease	*	Red-headed Woodpecker	4,	1,3,4,	1,2,3,4,
Decrease	*	Red-bellied Woodpecker			4,
Decrease	*	Yellow-bellied Sapsucker		4,	1,2,3,4,*S
Decrease	*	Hairy Woodpecker	6,	3,6,	3,6,
Decrease	*	Pileated Woodpecker	6,	3,6,	1,2,3,4,5,6,*S
Decrease		Acadian Flycatcher	6,	6,	5,6,*S
Decrease	*	Least Flycatcher			1,2,3,4,*S
Decrease	*	Great Crested Flycatcher		4,	1,3,4,*S
Decrease	*	Blue Jay	4,	4,	1,2,3,4,*S
Decrease	*	White-breasted Nuthatch		4,	1,2,3,4,*S
Decrease	*	Blue-gray Gnatcatcher		4,	4,*S
Decrease	*	Veery			1,
Decrease	*	Wood Thrush		4,*S*	3,4,*S
Decrease	*	Yellow-throated Vireo	4,5,6,*S*	4,5,6,*S*	1,4,5,6,*S
Decrease		Black-throated Blue Warbler			2,3,*S
Decrease		Cerulean Warbler	6,	6,*S*	5,6,*S
Decrease	*	Louisiana Waterthrush	7,	7,	7,
Decrease		Hooded Warbler	6,	6,*S*	5,6,*S
Decrease	*	Northern Oriole	4,	4,*S*	1,2,3,4,*S
Increase	*	Cooper's Hawk	7,9,	7,9,	7,9,
Increase		Black-billed Cuckoo	2,3,5,7,	2,3,5,7,9,	2,3,5,7,9,
Increase		Yellow-billed Cuckoo	4,5,7,*S*	4,5,7,9,*S*	4,5,7,9,*S
Increase	*	Eastern Screech-Owl	7,	7,	7,
Increase	*	Whip-poor-will	5,	5,	5,9,
Increase	*	Red-headed Woodpecker	7,9,	7,9,	7,
Increase	*	Red-bellied Woodpecker	7,	7,	7,
Increase	*	Yellow-bellied Sapsucker	7,9,	7,9,	7,9,
Increase		Downy Woodpecker	5,6,7,9,	5,7,9,	7,9,
Increase	*	Hairy Woodpecker	5,7,9,	5,7,9,	5,7,9,
Increase	*	Pileated Woodpecker	9,	9,	
Increase	*	Least Flycatcher	7,9,	7,9,	7,9,
Increase	*	Great Crested Flycatcher	7,9,	7,9,	7,
Increase	*	Blue Jay	7,9,	7,9,	7,
Increase	*	White-breasted Nuthatch	7,9,	7,9,	7,
Increase	*	Blue-gray Gnatcatcher	7,	7,	
Increase	*	Veery	6,	6,	2,5,6,9,
Increase	*	Wood Thrush	7,	7,	7,
Increase	*	Yellow-throated Vireo	9,	9,	

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

EQB=Hardwood - dependent
(continued)

Impact	Both	Species	Base	Medium	High
Increase		Warbling Vireo	9,	9,	9,
Increase	*	Louisiana Waterthrush	5,	5,	5,
Increase		Rose-breasted Grosbeak	7,9,	7,9,	7,9,
Increase		Orchard Oriole	7,	7,	7,
Increase	*	Northern Oriole	7,	7,	7,

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Forest raptors --

Impact	Both	Species	Base	Medium	High
Decrease		Sharp-shinned Hawk			2,3,4,*S
Decrease	*	Cooper's Hawk	1,4,	1,4,	1,4,*S
Decrease		Northern Goshawk	4,	1,4,*S*	1,2,3,4,*S
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S
Decrease	*	Broad-winged Hawk		4,	1,2,3,4,*S
Decrease		Merlin		3,4,	1,2,3,4,*S
Decrease	*	Eastern Screech-Owl	4,	4,	4,
Decrease	*	Great Horned Owl		3,4,	1,2,3,4,
Decrease		Barred Owl	6,	6,	1,2,3,4,5,6,*S
Decrease		Great Gray Owl	3,4,	3,4,	2,3,4,*S
Decrease	*	Long-eared Owl		4,	1,2,3,4,*S
Decrease		Boreal Owl		4,	1,2,3,4,*S
Decrease		Northern Saw-whet Owl		3,	2,3,4,*S
Increase		Osprey	1,2,3,4,5,*S*	1,2,3,4,5,*S*	1,2,3,4,5,*S
Increase		Bald Eagle	1,2,3,4,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S
Increase	*	Cooper's Hawk	7,9,	7,9,	7,9,
Increase	*	Broad-winged Hawk	9,	9,	
Increase		Red-tailed Hawk	3,7,9,	3,7,9,	3,7,
Increase	*	Eastern Screech-Owl	7,	7,	7,
Increase	*	Great Horned Owl	7,9,	7,9,	7,
Increase	*	Long-eared Owl	5,7,	7,	7,

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Mature forest --

Impact	Both	Species	Base	Medium	High
Decrease	*	Great Blue Heron			3,
Decrease		Sharp-shinned Hawk			2,3,4,*S
Decrease	*	Cooper's Hawk	1,4,	1,4,	1,4,*S
Decrease		Northern Goshawk	4,	1,4,*S*	1,2,3,4,*S
Decrease		Red-Shouldered Hawk	4,5,6,*S*	4,5,6,*S*	4,5,6,*S
Decrease	*	Broad-winged Hawk		4,	1,2,3,4,*S
Decrease	*	Eastern Screech-Owl	4,	4,	4,
Decrease	*	Great Horned Owl		3,4,	1,2,3,4,
Decrease		Barred Owl	6,	6,	1,2,3,4,5,6,*S
Decrease		Great Gray Owl	3,4,	3,4,	2,3,4,*S
Decrease	*	Long-eared Owl		4,	1,2,3,4,*S
Decrease		Boreal Owl		4,	1,2,3,4,*S
Decrease		Northern Saw-whet Owl		3,	2,3,4,*S
Decrease	*	Chimney Swift			2,3,4,
Decrease	*	Yellow-bellied Sapsucker		4,	1,2,3,4,*S
Decrease	*	Hairy Woodpecker	6,	3,6,	3,6,
Decrease		Three-toed Woodpecker			2,*S
Decrease	*	Black-backed Woodpecker		3,4,	2,3,4,*S
Decrease	*	Pileated Woodpecker	6,	3,6,	1,2,3,4,5,6,*S
Decrease	*	Eastern Wood-Pewee		4,	1,2,3,4,*S
Decrease	*	Yellow-bellied Flycatcher			2,3,4,*S
Decrease		Acadian Flycatcher	6,	6,	5,6,*S
Decrease	*	Least Flycatcher			1,2,3,4,*S
Decrease	*	Great Crested Flycatcher		4,	1,3,4,*S
Decrease	*	Gray Jay	3,	3,	2,3,4,*S
Decrease		Common Raven		4,	1,2,3,4,*S
Decrease	*	Black-capped Chickadee		3,4,	1,2,3,4,*S
Decrease	*	Boreal Chickadee		3,	1,2,3,4,*S
Decrease	*	Red-breasted Nuthatch			1,2,3,4,*S
Decrease	*	White-breasted Nuthatch		4,	1,2,3,4,*S
Decrease	*	Brown Creeper		4,*S*	2,3,4,*S
Decrease	*	Golden-crowned Kinglet		3,	1,2,3,4,*S
Decrease	*	Ruby-crowned Kinglet		3,	2,3,4,*S
Decrease	*	Blue-gray Gnatcatcher		4,	4,*S
Decrease	*	Swainson's Thrush	3,	3,	2,3,4,*S
Decrease	*	Hermit Thrush		4,	2,3,4,*S
Decrease	*	Wood Thrush		4,*S*	3,4,*S
Decrease	*	Solitary Vireo		3,4,	2,3,4,*S
Decrease	*	Yellow-throated Vireo	4,5,6,*S*	4,5,6,*S*	1,4,5,6,*S
Decrease	*	Northern Parula		4,	2,3,4,*S
Decrease	*	Cape May Warbler		3,4,	1,2,3,4,*S
Decrease		Black-throated Blue Warbler			2,3,*S
Decrease		Yellow-rumped Warbler	3,	3,	2,3,4,*S

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

EQB=Mature forest
(continued)

Impact	Both	Species	Base	Medium	High
Decrease		Black-throated Green Warbler		4,*S*	2,3,4,*S
Decrease		Blackburnian Warbler		3,4,	1,2,3,4,*S
Decrease		Pine Warbler		1,3,	1,2,3,4,*S
Decrease		Cerulean Warbler	6,	6,*S*	5,6,*S
Decrease	*	Connecticut Warbler	3,	3,	2,3,4,*S
Decrease		Hooded Warbler	6,	6,*S*	5,6,*S
Decrease	*	Scarlet Tanager	6,	4,6,*S*	1,2,3,4,5,6,*S
Decrease	*	Chipping Sparrow			3,4,
Decrease	*	Red Crossbill		3,	2,3,4,*S
Decrease	*	White-winged Crossbill		3,	2,3,4,*S
Increase		Double-crested Cormorant	1,2,9,	1,2,9,	1,2,9,
Increase	*	Great Blue Heron	1,2,9,	1,2,9,	1,2,9,
Increase		Black-crowned Night Heron	1,	1,	1,
Increase		Wood Duck	1,2,3,9,	1,2,3,9,	1,2,3,9,
Increase		Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Bufflehead	1,*S*	1,*S*	1,*S
Increase		Hooded Merganser	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S
Increase		Common Merganser	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Bald Eagle	1,2,3,4,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S
Increase	*	Cooper's Hawk	7,9,	7,9,	7,9,
Increase	*	Broad-winged Hawk	9,	9,	
Increase	*	Eastern Screech-Owl	7,	7,	7,
Increase	*	Great Horned Owl	7,9,	7,9,	7,
Increase	*	Long-eared Owl	5,7,	7,	7,
Increase	*	Chimney Swift	1,2,3,4,5,7,9,*S*	1,2,3,4,5,7,9,*S*	1,2,3,4,5,7,9,*S
Increase	*	Yellow-bellied Sapsucker	7,9,	7,9,	7,9,
Increase		Downy Woodpecker	5,6,7,9,	5,7,9,	7,9,
Increase	*	Hairy Woodpecker	5,7,9,	5,7,9,	5,7,9,
Increase	*	Black-backed Woodpecker	1,		
Increase	*	Pileated Woodpecker	9,	9,	
Increase	*	Eastern Wood-Pewee	5,7,9,	5,7,9,	7,
Increase	*	Yellow-bellied Flycatcher	1,2,*S*	2,	
Increase	*	Least Flycatcher	7,9,	7,9,	7,9,
Increase	*	Great Crested Flycatcher	7,9,	7,9,	7,
Increase	*	Gray Jay	1,		
Increase	*	Black-capped Chickadee	7,9,	7,9,	7,
Increase	*	Boreal Chickadee	1,5,	5,	5,
Increase	*	Red-breasted Nuthatch	2,5,	5,	5,
Increase	*	White-breasted Nuthatch	7,9,	7,9,	7,
Increase	*	Brown Creeper	3,		
Increase	*	Golden-crowned Kinglet	1,		
Increase	*	Ruby-crowned Kinglet	1,		

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

-- EQB=Riparian --

Impact	Both	Species	Base	Medium	High
Decrease	*	Great Blue Heron			3,
Decrease	*	Green-backed Heron	3,	3,	
Decrease	*	Eastern Phoebe	2,	2,	2,
Decrease	*	Louisiana Waterthrush	7,	7,	7,
Increase		Double-crested Cormorant	1,2,9,	1,2,9,	1,2,9,
Increase	*	Great Blue Heron	1,2,9,	1,2,9,	1,2,9,
Increase		Great Egret	4,	4,	
Increase	*	Green-backed Heron	1,6,	1,6,	1,6,
Increase		Black-crowned Night Heron	1,	1,	1,
Increase		Wood Duck	1,2,3,9,	1,2,3,9,	1,2,3,9,
Increase		American Black Duck	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Bufflehead	1,*S*	1,*S*	1,*S
Increase		Hooded Merganser	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S
Increase		Common Merganser	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Osprey	1,2,3,4,5,*S*	1,2,3,4,5,*S*	1,2,3,4,5,*S
Increase		Bald Eagle	1,2,3,4,6,*S*	1,2,3,4,5,6,*S*	1,2,3,4,5,6,*S
Increase	*	Eastern Phoebe		3,	3,
Increase		Warbling Vireo	9,	9,	9,
Increase		Northern Waterthrush	2,*S*	2,*S*	2,*S
Increase	*	Louisiana Waterthrush	5,	5,	5,
Increase		Rusty Blackbird	2,*S*	2,*S*	2,*S

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

--- EQB=Cavity dependent ---

Impact	Both	Species	Base	Medium	High
Decrease	*	Eastern Screech-Owl	4,	4,	4,
Decrease		Barred Owl	6,	6,	1,2,3,4,5,6,*S
Decrease		Boreal Owl		4,	1,2,3,4,*S
Decrease		Northern Saw-whet Owl		3,	2,3,4,*S
Decrease	*	Red-headed Woodpecker	4,	1,3,4,	1,2,3,4,
Decrease	*	Red-bellied Woodpecker			4,
Decrease	*	Yellow-bellied Sapsucker		4,	1,2,3,4,*S
Decrease	*	Hairy Woodpecker	6,	3,6,	3,6,
Decrease		Three-toed Woodpecker			2,*S
Decrease	*	Black-backed Woodpecker		3,4,	2,3,4,*S
Decrease	*	Northern Flicker	2,		
Decrease	*	Pileated Woodpecker	6,	3,6,	1,2,3,4,5,6,*S
Decrease	*	Great Crested Flycatcher		4,	1,3,4,*S
Decrease	*	Black-capped Chickadee		3,4,	1,2,3,4,*S
Decrease	*	Boreal Chickadee		3,	1,2,3,4,*S
Decrease	*	Red-breasted Nuthatch			1,2,3,4,*S
Decrease	*	White-breasted Nuthatch		4,	1,2,3,4,*S
Increase		Wood Duck	1,2,3,9,	1,2,3,9,	1,2,3,9,
Increase		Common Goldeneye	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		Bufflehead	1,*S*	1,*S*	1,*S
Increase		Hooded Merganser	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S*	1,3,4,5,6,7,9,*S
Increase		Common Merganser	1,2,3,4,*S*	1,2,3,4,*S*	1,2,3,4,*S
Increase		American Kestrel	1,2,3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S
Increase	*	Eastern Screech-Owl	7,	7,	7,
Increase	*	Red-headed Woodpecker	7,9,	7,9,	7,
Increase	*	Red-bellied Woodpecker	7,	7,	7,
Increase	*	Yellow-bellied Sapsucker	7,9,	7,9,	7,9,
Increase		Downy Woodpecker	5,6,7,9,	5,7,9,	7,9,
Increase	*	Hairy Woodpecker	5,7,9,	5,7,9,	5,7,9,
Increase	*	Black-backed Woodpecker	1,		
Increase	*	Northern Flicker	5,6,	3,4,5,6,*S*	1,2,3,4,5,6,7,*S
Increase	*	Pileated Woodpecker	9,	9,	
Increase	*	Great Crested Flycatcher	7,9,	7,9,	7,
Increase		Tree Swallow	1,2,3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S
Increase	*	Black-capped Chickadee	7,9,	7,9,	7,
Increase	*	Boreal Chickadee	1,5,	5,	5,
Increase	*	Red-breasted Nuthatch	2,5,	5,	5,
Increase	*	White-breasted Nuthatch	7,9,	7,9,	7,
Increase		House Wren	1,5,6,7,9,	1,2,5,6,7,9,	1,2,3,5,6,7,
Increase		Eastern Bluebird	4,5,6,7,*S*	3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S

Table 6b. Species projected to increase or decrease by ecoregion or statewide (*S*) for three harvest levels on timberland. Species are grouped by EQB group.

EQB=All others					
Impact	Both	Species	Base	Medium	High
Decrease	*	Olive-sided Flycatcher			3,
Decrease	*	Black-billed Magpie	9,		
Decrease	*	American Crow			1,2,3,4,*S
Decrease	*	Winter Wren			1,
Decrease	*	Cedar Waxwing			1,
Decrease	*	Loggerhead Shrike	7,	7,	
Decrease	*	Nashville Warbler			3,
Decrease	*	Northern Cardinal	4,	4,	4,
Decrease	*	Indigo Bunting			1,
Decrease		Purple Finch	3,	3,4,*S*	2,3,4,6,*S
Decrease	*	American Goldfinch	2,	2,	
Decrease		Evening Grosbeak		3,	2,3,4,*S
Increase		Turkey Vulture	6,	6,	6,
Increase		Mourning Dove	1,4,5,6,7,*S*	1,4,5,6,7,*S*	1,4,5,6,7,9,*S
Increase		Ruby-throated Hummingbird	7,9,	7,9,	2,7,
Increase	*	Olive-sided Flycatcher	2,	4,	4,*S
Increase	*	Black-billed Magpie	1,4,*S*	1,4,9,*S*	1,4,9,*S
Increase	*	American Crow	5,7,9,	7,9,	7,
Increase	*	Winter Wren	1,4,		
Increase		American Robin	6,7,	5,6,7,	2,3,4,5,6,7,*S
Increase		Gray Catbird	4,5,6,7,*S*	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S
Increase		Brown Thrasher	4,5,6,7,*S*	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S
Increase	*	Cedar Waxwing	7,	7,	
Increase	*	Loggerhead Shrike	5,6,7,*S*	5,6,7,*S*	5,6,7,*S
Increase		Bell's Vireo	6,*S*	6,*S*	6,*S
Increase		Blue-winged Warbler	6,*S*	6,*S*	6,*S
Increase		Golden-winged Warbler	3,4,5,*S*	3,4,5,*S*	1,3,4,5,*S
Increase	*	Nashville Warbler	5,	5,	5,
Increase		Yellow Warbler	4,5,6,	3,4,5,6,9,*S*	1,2,3,4,5,6,7,9,*S
Increase		Chestnut-sided Warbler	5,	5,9,	3,4,5,9,*S
Increase		Mourning Warbler	4,5,	4,5,	4,5,*S
Increase		Common Yellowthroat	5,6,7,	3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S
Increase		Wilson's Warbler			2,*S
Increase		Yellow-breasted Chat	6,*S*	6,*S*	6,*S
Increase	*	Northern Cardinal	7,	7,	7,
Increase	*	Indigo Bunting	2,6,7,9,	2,3,6,7,9,	2,3,4,5,6,7,9,*S
Increase		Rufous-sided Towhee	4,5,6,*S*	4,5,6,*S*	1,4,5,6,*S
Increase		Song Sparrow	4,5,6,7,	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S
Increase		Common Grackle	4,5,6,7,	3,4,5,6,7,*S*	1,2,3,4,5,6,7,9,*S
Increase		Brown-headed Cowbird	6,7,	5,6,7,	4,5,6,7,*S
Increase	*	American Goldfinch	4,5,6,7,*S*	3,4,5,6,7,9,*S*	1,2,3,4,5,6,7,9,*S

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Double-crested Cormorant	Base	32 (30)	0 (10)	13 (50)	17 (40)	11 (20)	-7 (10)	-7 (20)	33 (30)	21 (30)
	Medium	28 (30)	0 (10)	0 (10)	14 (30)	11 (20)	-7 (10)	10 (40)	33 (40)	18 (30)
	High	26 (20)	0 (10)	-13 (40)	12 (20)	-16 (50)	-7 (10)	10 (40)	33 (30)	18 (20)
Great Blue Heron	Base	33 (20)	23 (50)	0 (10)	14 (40)	10 (20)	-9 (10)	-9 (20)	42 (50)	10 (40)
	Medium	25 (20)	23 (50)	-20 (30)	14 (40)	14 (20)	-9 (10)	13 (40)	33 (30)	10 (40)
	High	25 (20)	21 (50)	-20 (10)	11 (30)	14 (20)	-9 (10)	13 (40)	33 (30)	8 (30)
Great Egret	Base				15 (30)	-17 (50)	-8 (10)	20 (40)		7 (50)
	Medium				15 (20)	-17 (50)	-8 (10)	20 (30)		6 (40)
	High				15 (20)	-17 (50)	-8 (10)	20 (30)		5 (30)
Green-backed Heron	Base	30 (20)		-25 (10)	21 (40)	0 (10)	-33 (20)	8 (30)		16 (30)
	Medium	30 (20)		0 (10)	20 (40)	0 (10)	-33 (20)	8 (30)		17 (40)
	High	30 (20)		0 (10)	18 (30)	20 (20)	-33 (20)	8 (30)		16 (30)
Black-crowned Night Heron	Base	29 (30)				14 (20)	-6 (10)	0 (10)		14 (30)
	Medium	31 (30)				14 (20)	-6 (10)	0 (10)		14 (30)
	High	31 (20)				14 (20)	-6 (10)	0 (10)		13 (30)
Yellow-crowned Night Heron	Base	0 (10)			0 (10)	11 (10)	-10 (10)	0 (10)		13 (30)
	Medium	0 (10)			0 (10)	11 (10)	-10 (10)	0 (10)		16 (20)
	High	0 (10)			0 (10)	11 (10)	-10 (10)	0 (10)		16 (20)
Wood Duck	Base	25 (20)	71 (50)	33 (40)	20 (50)	12 (20)	-8 (10)	14 (40)	39 (50)	13 (50)
	Medium	25 (20)	71 (50)	33 (10)	18 (40)	18 (20)	-8 (10)	18 (40)	35 (50)	11 (40)
	High	25 (20)	71 (50)	33 (10)	16 (30)	18 (20)	-8 (10)	18 (40)	35 (30)	9 (30)
American Black Duck	Base	292 (50)	1200 (40)	329 (30)	150 (50)					262 (50)
	Medium	292 (50)	1300 (50)	329 (40)	150 (50)					262 (50)
	High	283 (40)	1200 (50)	329 (30)	142 (50)					248 (50)
Common Goldeneye	Base	50 (30)	59 (50)	33 (40)	33 (20)	0 (10)				60 (50)
	Medium	50 (30)	59 (50)	33 (10)	33 (10)	0 (10)				60 (50)
	High	50 (30)	59 (50)	33 (10)	33 (10)	0 (10)				57 (50)
Bufflehead	Base	50 (30)								37 (40)
	Medium	50 (30)								37 (40)
	High	50 (30)								42 (40)
Hooded Merganser	Base	62 (30)	-9 (10)	36 (30)	52 (50)	33 (20)	100 (30)	67 (40)	77 (40)	20 (50)
	Medium	62 (50)	-9 (10)	23 (40)	41 (30)	33 (20)	100 (30)	67 (40)	69 (40)	16 (50)
	High	49 (30)	-9 (10)	36 (30)	41 (50)	33 (20)	100 (30)	67 (40)	69 (30)	13 (50)

Table 7a. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Common Merganser	Base	64 (30)	60 (50)	33 (30)	50 (20)					60 (50)
	Medium	64 (50)	60 (50)	22 (40)	50 (20)					59 (50)
	High	55 (40)	57 (50)	22 (30)	50 (20)					57 (50)
Turkey Vulture	Base	5 (10)	2 (10)	-9 (50)	-3 (50)		38 (40)			3 (10)
	Medium	5 (10)	2 (10)	-9 (50)	-3 (50)		38 (40)			3 (10)
	High	5 (10)	2 (10)	-9 (50)	-2 (50)		38 (50)			4 (10)
Osprey	Base	167 (40)	138 (50)	100 (30)	131 (50)	57 (40)				127 (50)
	Medium	167 (50)	138 (50)	100 (40)	125 (50)	57 (20)				121 (50)
	High	133 (40)	138 (50)	100 (40)	119 (50)	57 (20)				114 (50)
Bald Eagle	Base	233 (50)	150 (50)	100 (30)	129 (50)	100 (50)	60 (20)			140 (50)
	Medium	200 (50)	150 (50)	100 (50)	124 (50)	100 (20)	60 (20)			134 (50)
	High	200 (50)	140 (50)	100 (50)	119 (50)	100 (20)	60 (20)			130 (50)
Sharp-shinned Hawk	Base	25 (50)	7 (40)	0 (10)	7 (50)					8 (50)
	Medium	15 (50)	7 (50)	-25 (40)	-11 (50)					-6 (50)
	High	-4 (20)	-14 (40)	-45 (50)	-31 (50)					-26 (50)
Cooper's Hawk	Base	-13 (20)			-25 (30)	25 (50)	-12 (40)	100 (30)	67 (50)	-11 (40)
	Medium	-25 (30)			-32 (30)	17 (50)	-17 (40)	100 (30)	67 (50)	-15 (40)
	High	-25 (30)			-50 (50)	8 (20)	-19 (40)	100 (30)	33 (10)	-24 (50)
Northern Goshawk	Base	-17 (40)	9 (20)	0 (10)	-26 (30)	17 (30)				-15 (30)
	Medium	-17 (20)	9 (30)	-20 (30)	-34 (50)	17 (40)				-21 (30)
	High	-25 (30)	-9 (30)	-40 (30)	-53 (50)	17 (20)				-37 (50)
Red-Shouldered Hawk	Base				-30 (20)	-25 (30)	-36 (40)	0 (10)		-26 (40)
	Medium				-50 (30)	-25 (30)	-36 (40)	0 (10)		-29 (40)
	High				-60 (30)	-50 (50)	-43 (40)	0 (10)		-36 (50)
Broad-winged Hawk	Base	-14 (30)	0 (10)	-6 (40)	-24 (30)	25 (50)	-12 (40)		36 (50)	-12 (30)
	Medium	-23 (30)	0 (10)	-21 (40)	-29 (30)	17 (50)	-17 (40)		36 (50)	-17 (30)
	High	-33 (50)	-15 (40)	-43 (50)	-48 (50)	8 (20)	-19 (40)		25 (50)	-32 (50)
Red-tailed Hawk	Base	8 (10)	6 (10)	33 (40)	8 (10)	21 (50)	14 (50)	46 (50)	25 (50)	6 (50)
	Medium	12 (10)	12 (10)	70 (40)	8 (10)	21 (50)	14 (50)	45 (50)	25 (50)	7 (50)
	High	16 (40)	12 (10)	126 (50)	8 (10)	21 (50)	14 (50)	41 (50)	24 (50)	8 (50)
American Kestrel	Base	39 (20)	-25 (50)	27 (20)	60 (30)	25 (10)	186 (40)	67 (20)	12 (40)	41 (30)
	Medium	57 (30)	15 (10)	76 (40)	72 (30)	25 (10)	206 (40)	67 (20)	24 (40)	59 (30)
	High	77 (50)	65 (40)	141 (50)	124 (50)	150 (40)	247 (50)	67 (20)	33 (40)	99 (50)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Merlin	Base	11 (50)	8 (30)	-17 (10)	-22 (30)					-9 (30)
	Medium	-11 (40)	8 (40)	-17 (20)	-31 (50)					-16 (30)
	High	-21 (50)	-15 (40)	-50 (50)	-50 (50)					-34 (50)
Mourning Dove	Base	25 (20)			59 (30)	25 (30)	178 (40)	40 (30)	11 (40)	54 (30)
	Medium	30 (30)			78 (30)	42 (50)	215 (40)	38 (30)	21 (40)	72 (30)
	High	45 (50)			119 (50)	92 (50)	252 (50)	53 (50)	26 (40)	113 (50)
Black-billed Cuckoo	Base	9 (10)	37 (20)	25 (20)	13 (20)	49 (40)	20 (50)	50 (30)	15 (40)	15 (50)
	Medium	18 (10)	37 (20)	56 (40)	14 (20)	54 (40)	20 (50)	45 (30)	23 (40)	16 (50)
	High	18 (10)	89 (40)	100 (50)	17 (50)	60 (50)	17 (50)	59 (30)	30 (40)	22 (50)
Yellow-billed Cuckoo	Base	12 (10)			50 (50)	33 (40)	13 (40)	42 (50)	14 (40)	25 (50)
	Medium	16 (10)			67 (50)	48 (50)	13 (40)	42 (50)	19 (40)	35 (50)
	High	16 (10)			100 (50)	112 (50)	13 (50)	38 (50)	24 (40)	58 (50)
Eastern Screech-Owl	Base				-27 (30)	27 (50)	-12 (40)	46 (50)		-9 (40)
	Medium				-33 (40)	18 (50)	-16 (40)	45 (50)		-14 (40)
	High				-47 (50)	-9 (50)	-19 (40)	36 (50)		-17 (40)
Great Horned Owl	Base	-14 (30)	10 (40)	-9 (20)	-21 (30)	27 (50)	-12 (40)	44 (50)	33 (50)	8 (50)
	Medium	-23 (30)	10 (50)	-18 (20)	-29 (30)	18 (50)	-17 (40)	43 (50)	33 (50)	-5 (10)
	High	-33 (50)	-10 (30)	-45 (50)	-45 (50)	9 (20)	-19 (40)	35 (50)	21 (50)	-13 (50)
Barred Owl	Base	-6 (20)	43 (50)	19 (30)	-8 (30)	11 (20)	-22 (40)	17 (20)		4 (10)
	Medium	-14 (40)	43 (50)	8 (10)	-19 (50)	8 (10)	-30 (50)	17 (20)		-13 (50)
	High	-27 (50)	14 (10)	-38 (50)	-40 (50)	-31 (50)	-37 (50)	17 (20)		-32 (50)
Great Gray Owl	Base	27 (40)	0 (10)	-25 (10)	0 (10)					17 (50)
	Medium	9 (30)	0 (10)	-33 (40)	0 (10)					-4 (10)
	High	-9 (10)	0 (10)	-63 (50)	-25 (40)					-16 (50)
Long-eared Owl	Base	9 (50)	20 (50)	0 (10)	-16 (30)	25 (50)	-11 (10)	50 (30)	40 (50)	-5 (20)
	Medium	-9 (40)	12 (50)	-25 (40)	-25 (50)	17 (40)	-11 (10)	50 (30)	40 (50)	-11 (30)
	High	-20 (50)	-8 (50)	-45 (50)	-42 (50)	8 (20)	-11 (10)	50 (20)	20 (20)	-26 (50)
Boreal Owl	Base	9 (50)	12 (40)	0 (10)	-15 (20)					-7 (20)
	Medium	-9 (40)	12 (50)	-25 (40)	-28 (30)					-12 (30)
	High	-20 (50)	-8 (40)	-45 (50)	-44 (50)					-29 (50)
Northern Saw-whet Owl	Base	13 (50)	17 (40)	-15 (50)	-3 (10)					-4 (10)
	Medium	-5 (40)	8 (30)	-29 (50)	-13 (40)					-10 (40)
	High	-15 (50)	-8 (30)	-46 (50)	-35 (50)					-29 (50)

Table 7a. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Whip-poor-will	Base	-16 (50)	-10 (40)	9 (10)	-9 (40)	72 (30)	-5 (10)	-29 (10)	7 (40)	-3 (10)
	Medium	3 (10)	5 (10)	9 (10)	0 (10)	93 (40)	-5 (10)	-29 (10)	18 (40)	-4 (10)
	High	3 (10)	5 (10)	9 (10)	0 (10)	200 (50)	-8 (10)	-29 (10)	24 (40)	8 (50)
Chimney Swift	Base	33 (10)	200 (50)	100 (30)	39 (20)	60 (50)	19 (30)	100 (50)	225 (50)	47 (50)
	Medium	33 (10)	200 (50)	67 (10)	27 (10)	47 (40)	15 (20)	100 (50)	200 (50)	34 (40)
	High	33 (10)	150 (50)	67 (10)	35 (20)	30 (20)	13 (20)	86 (50)	150 (40)	31 (20)
Ruby-throated Hummingbird	Base	-14 (50)	-24 (50)	0 (10)	-15 (50)	31 (50)	-13 (10)	35 (50)	26 (50)	-7 (50)
	Medium	2 (10)	-19 (50)	0 (10)	-15 (30)	31 (50)	-13 (10)	38 (50)	26 (50)	-6 (50)
	High	12 (50)	14 (40)	9 (50)	-15 (30)	31 (50)	-13 (10)	29 (50)	23 (50)	-5 (30)
Red-headed Woodpecker	Base	-19 (30)	15 (50)	13 (10)	-24 (30)	24 (50)	-13 (40)	36 (50)	35 (50)	-6 (30)
	Medium	-19 (30)	15 (50)	-25 (40)	-30 (30)	18 (50)	-17 (40)	41 (50)	35 (50)	-11 (40)
	High	-31 (50)	8 (10)	-38 (30)	-46 (50)	6 (20)	-20 (40)	32 (50)	21 (50)	-18 (50)
Red-bellied Woodpecker	Base				-13 (30)	24 (50)	-15 (40)	44 (50)		12 (50)
	Medium				-22 (30)	12 (40)	-15 (40)	43 (50)		5 (50)
	High				-30 (50)	6 (20)	-23 (40)	35 (50)		-9 (50)
Yellow-bellied Sapsucker	Base	-14 (30)	25 (50)	-6 (10)	-21 (30)	20 (50)	-12 (40)	50 (20)	46 (50)	-9 (20)
	Medium	-23 (40)	24 (50)	-17 (20)	-25 (30)	12 (50)	-17 (40)	50 (20)	45 (50)	-15 (30)
	High	-32 (50)	9 (10)	-41 (50)	-42 (50)	-8 (50)	-19 (40)	50 (20)	27 (50)	-29 (50)
Downy Woodpecker	Base	10 (10)	18 (50)	5 (10)	2 (10)	36 (50)	24 (50)	56 (50)	41 (50)	4 (50)
	Medium	10 (10)	17 (50)	5 (10)	-5 (50)	32 (50)	20 (50)	58 (50)	41 (50)	2 (10)
	High	-2 (50)	7 (20)	-15 (50)	-12 (50)	23 (40)	16 (40)	53 (50)	35 (50)	-8 (50)
Hairy Woodpecker	Base	6 (40)	10 (50)	-5 (20)	17 (20)	29 (50)	-48 (10)	44 (50)	33 (50)	11 (30)
	Medium	1 (20)	9 (50)	-25 (50)	17 (20)	24 (50)	-48 (10)	44 (50)	33 (50)	10 (30)
	High	-4 (50)	-1 (40)	-45 (50)	13 (20)	24 (50)	-48 (10)	35 (50)	33 (50)	7 (20)
Three-toed Woodpecker	Base		17 (50)							12 (50)
	Medium		8 (40)							6 (50)
	High		-8 (10)							-14 (50)
Black-backed Woodpecker	Base	30 (50)	9 (30)	0 (10)	-16 (10)					8 (50)
	Medium	13 (30)	9 (40)	-50 (50)	-26 (30)					-8 (10)
	High	10 (30)	-15 (50)	-33 (40)	-40 (50)					-22 (50)
Northern Flicker	Base	-17 (50)	-42 (50)	13 (20)	16 (20)	26 (40)	96 (40)	25 (30)	-18 (30)	10 (30)
	Medium	7 (20)	-34 (50)	46 (40)	41 (30)	42 (50)	119 (50)	25 (30)	-11 (30)	24 (30)
	High	27 (50)	23 (40)	97 (50)	74 (50)	105 (50)	133 (50)	34 (30)	14 (50)	56 (50)

Table 7a. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Pileated Woodpecker	Base	-14 (30)	20 (40)	0 (10)	-10 (20)	8 (10)	-30 (40)	-20 (10)	47 (50)	-8 (20)
	Medium	-27 (30)	20 (40)	-13 (20)	-21 (50)	-15 (50)	-35 (40)	-20 (10)	44 (50)	-17 (50)
	High	-29 (40)	5 (10)	-38 (40)	-43 (50)	-35 (50)	-40 (40)	-20 (10)	28 (50)	-38 (50)
Olive-sided Flycatcher	Base	4 (20)	-8 (10)	-18 (10)	18 (20)					10 (30)
	Medium	5 (30)	-8 (10)	-22 (50)	27 (30)					17 (30)
	High	8 (30)	-8 (10)	-29 (50)	55 (50)					27 (50)
Eastern Wood-Pewee	Base	-11 (20)	11 (40)	-9 (10)	-27 (30)	47 (50)	-15 (40)	44 (50)	44 (50)	-13 (30)
	Medium	-22 (40)	11 (40)	-20 (40)	-33 (30)	37 (50)	-15 (40)	44 (50)	41 (50)	-20 (30)
	High	-33 (40)	-11 (40)	-44 (50)	-47 (50)	16 (20)	-23 (40)	35 (50)	27 (50)	-33 (50)
Yellow-bellied Flycatcher	Base	42 (50)	40 (50)	-14 (10)	13 (20)					34 (50)
	Medium	16 (30)	30 (40)	-20 (30)	-4 (50)					14 (40)
	High	16 (30)	10 (10)	-46 (50)	-27 (50)					10 (30)
Acadian Flycatcher	Base					-12 (30)	-32 (40)			-19 (40)
	Medium					-16 (40)	-36 (40)			-24 (40)
	High					-36 (50)	-39 (40)			-39 (50)
Least Flycatcher	Base	-18 (20)	44 (50)	13 (10)	-10 (50)	18 (50)	-12 (10)	44 (50)	50 (50)	-4 (30)
	Medium	-21 (30)	44 (50)	-13 (40)	-22 (50)	12 (50)	-18 (40)	44 (50)	42 (50)	-13 (50)
	High	-29 (40)	26 (10)	-46 (50)	-44 (50)	-6 (10)	-18 (40)	36 (50)	25 (30)	-34 (50)
Eastern Phoebe	Base	-12 (20)	-39 (40)	0 (10)	-15 (40)	-3 (40)	-6 (10)	12 (40)	6 (30)	-16 (50)
	Medium	-12 (30)	-39 (50)	20 (50)	-15 (50)	-3 (40)	-6 (10)	12 (40)	6 (30)	-14 (50)
	High	-12 (20)	-35 (40)	20 (40)	-15 (50)	-3 (40)	-6 (10)	12 (40)	6 (40)	-13 (50)
Great Crested Flycatcher	Base	-18 (30)		9 (10)	-10 (50)	17 (50)	-12 (40)	44 (50)	42 (50)	-7 (40)
	Medium	-20 (30)		-18 (40)	-23 (50)	12 (50)	-16 (40)	44 (50)	42 (50)	-18 (50)
	High	-28 (40)		-42 (50)	-44 (50)	-7 (30)	-19 (40)	35 (50)	26 (50)	-34 (50)
Tree Swallow	Base	33 (20)	-27 (50)	27 (20)	57 (30)	46 (30)	150 (40)	50 (10)	17 (40)	51 (40)
	Medium	57 (30)	-18 (50)	81 (40)	80 (30)	74 (50)	183 (40)	50 (10)	25 (40)	75 (40)
	High	73 (40)	65 (40)	139 (50)	113 (50)	180 (50)	206 (50)	75 (30)	33 (40)	130 (50)
Gray Jay	Base	29 (30)	15 (50)	-37 (50)	-9 (10)					16 (50)
	Medium	16 (30)	13 (50)	-44 (50)	-20 (40)					-4 (10)
	High	8 (30)	-12 (50)	-60 (50)	-37 (50)					-18 (50)
Blue Jay	Base	10 (30)	11 (40)	20 (30)	-25 (30)	20 (50)	-15 (40)	44 (50)	31 (50)	-12 (30)
	Medium	-4 (40)	11 (50)	-10 (20)	-30 (30)	12 (50)	-15 (40)	48 (50)	34 (50)	-18 (30)
	High	-18 (50)	-11 (40)	-33 (50)	-45 (50)	-10 (50)	-23 (40)	39 (50)	19 (50)	-30 (50)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Black-billed Magpie	Base	36 (30)			60 (20)				50 (40)	41 (30)
	Medium	60 (30)			80 (30)				50 (40)	58 (40)
	High	73 (50)			100 (40)				50 (40)	83 (50)
American Crow	Base	-17 (20)	6 (40)	-6 (40)	-13 (30)	24 (30)	-8 (10)	44 (50)	40 (50)	-6 (10)
	Medium	-22 (30)	6 (50)	-20 (40)	-20 (30)	21 (20)	-15 (40)	44 (50)	36 (50)	-13 (30)
	High	-30 (40)	-13 (40)	-43 (50)	-43 (50)	21 (20)	-15 (30)	35 (50)	24 (50)	-27 (50)
Common Raven	Base	-9 (20)	8 (50)	-6 (40)	-17 (30)					-7 (30)
	Medium	-18 (30)	-4 (10)	-21 (40)	-25 (30)					-13 (30)
	High	-24 (40)	-17 (40)	-43 (50)	-42 (40)					-30 (50)
Black-capped Chickadee	Base	-5 (10)	7 (40)	-8 (40)	-12 (30)	15 (50)	-15 (40)	44 (50)	36 (50)	-4 (10)
	Medium	-15 (30)	7 (50)	-20 (40)	-24 (50)	15 (50)	-15 (40)	44 (50)	36 (50)	-11 (40)
	High	-26 (50)	-14 (40)	-44 (50)	-43 (50)	-8 (50)	-23 (40)	36 (50)	20 (50)	-26 (50)
Boreal Chickadee	Base	30 (50)	15 (50)	-30 (50)	-9 (10)	150 (20)				11 (50)
	Medium	10 (30)	7 (50)	-30 (30)	-13 (40)	150 (20)				-6 (50)
	High	10 (30)	-15 (50)	-60 (50)	-35 (50)	150 (20)				-24 (50)
Tufted Titmouse	Base					18 (40)	-12 (40)			10 (50)
	Medium					18 (50)	-17 (40)			-4 (10)
	High					-9 (50)	-19 (40)			-11 (50)
Red-breasted Nuthatch	Base	-6 (10)	24 (40)	-8 (10)	17 (40)	62 (50)	-12 (40)			16 (50)
	Medium	-13 (40)	24 (50)	-20 (40)	-3 (10)	59 (50)	-17 (40)			1 (50)
	High	-25 (50)	6 (10)	-44 (50)	-30 (50)	47 (30)	-19 (40)			-20 (50)
White-breasted Nuthatch	Base	-18 (30)	8 (10)	6 (10)	-20 (30)	31 (50)	-12 (40)	44 (50)	33 (50)	-12 (30)
	Medium	-20 (30)	8 (10)	-21 (40)	-28 (30)	23 (50)	-16 (40)	44 (50)	33 (50)	-16 (30)
	High	-28 (40)	8 (10)	-42 (50)	-48 (50)	8 (20)	-19 (40)	35 (50)	19 (50)	-28 (50)
Brown Creeper	Base	-6 (20)	-16 (20)	26 (30)	-15 (50)	18 (40)	-12 (40)			-13 (50)
	Medium	-9 (40)	-19 (20)	-9 (30)	-28 (50)	18 (50)	-17 (40)			-25 (50)
	High	-18 (50)	-29 (40)	-32 (50)	-45 (50)	-9 (50)	-19 (40)			-42 (50)
House Wren	Base	25 (20)	11 (10)	9 (10)	-6 (50)	24 (50)	25 (50)	40 (50)	24 (50)	16 (50)
	Medium	42 (30)	11 (10)	18 (20)	-8 (50)	24 (50)	38 (50)	40 (50)	24 (50)	18 (50)
	High	58 (40)	26 (40)	27 (40)	-10 (50)	24 (50)	38 (50)	36 (50)	21 (50)	20 (50)
Winter Wren	Base	29 (40)	0 (10)	-8 (40)	27 (30)					20 (40)
	Medium	14 (30)	0 (10)	-8 (40)	18 (20)					12 (30)
	High	7 (20)	-7 (20)	-8 (40)	18 (20)					10 (20)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Golden-crowned Kinglet	Base	27 (40)	12 (50)	-17 (10)	-5 (10)					-7 (10)
	Medium	9 (20)	-10 (10)	-29 (50)	-13 (40)					-8 (10)
	High	9 (20)	-16 (50)	-44 (50)	-33 (50)					-26 (50)
Ruby-crowned Kinglet	Base	31 (50)	20 (50)	-19 (10)	14 (50)					21 (50)
	Medium	12 (30)	14 (50)	-29 (50)	-5 (50)					7 (30)
	High	10 (30)	-8 (50)	-47 (50)	-29 (50)					-14 (50)
Blue-gray Gnatcher	Base				-24 (30)	20 (50)	-20 (10)	33 (40)		-10 (30)
	Medium				-29 (30)	11 (50)	-20 (10)	44 (50)		-14 (30)
	High				-47 (50)	-9 (50)	-20 (10)	33 (50)		-26 (50)
Eastern Bluebird	Base	-21 (50)	-42 (50)	16 (20)	33 (30)	32 (30)	184 (40)	3733 (30)	14 (40)	23 (30)
	Medium	11 (20)	-33 (50)	62 (40)	52 (30)	53 (40)	218 (50)	3567 (20)	24 (40)	40 (30)
	High	28 (50)	30 (40)	126 (50)	82 (50)	158 (50)	241 (50)	3733 (30)	33 (40)	78 (50)
Veery	Base	-18 (30)	6 (10)	-11 (40)	11 (20)	18 (30)	327 (40)		20 (40)	7 (20)
	Medium	-20 (30)	7 (10)	-11 (30)	13 (20)	18 (30)	353 (40)		20 (40)	10 (30)
	High	-28 (40)	18 (50)	-8 (20)	18 (50)	40 (50)	393 (50)		25 (50)	16 (50)
Swainson's Thrush	Base	34 (50)	20 (40)	-28 (50)	-17 (10)					13 (40)
	Medium	10 (30)	20 (40)	-36 (50)	-18 (40)					-4 (10)
	High	-9 (50)	-9 (50)	-51 (50)	-38 (50)					-19 (50)
Hermit Thrush	Base	7 (50)	20 (50)	-8 (10)	-8 (10)					-6 (10)
	Medium	-9 (40)	15 (50)	-21 (30)	-21 (50)					-16 (40)
	High	-21 (50)	-10 (50)	-43 (50)	-42 (50)					-36 (50)
Wood Thrush	Base			9 (10)	-22 (30)	24 (50)	-13 (40)	44 (50)		-23 (30)
	Medium			-18 (40)	-28 (30)	18 (50)	-17 (40)	44 (50)		-29 (30)
	High			-42 (50)	-45 (50)	6 (20)	-20 (40)	34 (50)		-45 (50)
American Robin	Base	-14 (50)	-12 (50)	-10 (30)	20 (30)	18 (50)	135 (40)	33 (50)	16 (50)	7 (30)
	Medium	3 (10)	4 (10)	10 (30)	20 (20)	29 (50)	165 (50)	33 (50)	18 (40)	15 (40)
	High	14 (50)	20 (40)	43 (50)	40 (50)	53 (50)	176 (50)	37 (50)	23 (50)	32 (50)
Gray Catbird	Base	-21 (50)	-44 (50)	15 (20)	39 (30)	31 (30)	175 (40)	55 (30)	-6 (20)	27 (30)
	Medium	11 (40)	-35 (50)	62 (40)	54 (30)	50 (40)	213 (50)	48 (30)	22 (40)	42 (30)
	High	28 (50)	26 (40)	129 (50)	92 (50)	150 (50)	233 (50)	64 (30)	28 (40)	85 (50)
Brown Thrasher	Base	-16 (50)	-44 (50)	16 (20)	33 (30)	32 (30)	186 (40)	58 (30)	8 (40)	22 (30)
	Medium	11 (40)	-35 (50)	62 (40)	51 (30)	53 (40)	221 (50)	50 (20)	20 (40)	41 (40)
	High	32 (50)	26 (40)	126 (50)	92 (50)	153 (50)	239 (50)	67 (30)	28 (40)	77 (50)

Table 7a. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Cedar Waxwing	Base	-3 (20)	-2 (30)	-5 (30)	-11 (20)	21 (50)	13 (50)	35 (50)	14 (50)	-9 (30)
	Medium	-10 (40)	-2 (30)	-5 (40)	-11 (20)	15 (50)	13 (50)	35 (50)	14 (50)	-8 (20)
	High	-19 (50)	-2 (40)	-5 (40)	-11 (20)	-5 (50)	11 (50)	29 (50)	11 (50)	-9 (20)
Loggerhead Shrike	Base					25 (10)	233 (40)	300 (20)		100 (40)
	Medium					25 (10)	233 (40)	300 (20)		132 (40)
	High					150 (40)	233 (40)	300 (20)		153 (40)
Bell's Vireo	Base						186 (40)			171 (40)
	Medium						186 (30)			214 (40)
	High						186 (30)			243 (50)
Solitary Vireo	Base	32 (50)	10 (50)	-22 (10)	-10 (20)					-6 (10)
	Medium	12 (30)	-7 (10)	-32 (50)	-25 (40)					-8 (30)
	High	13 (30)	-16 (50)	-47 (50)	-42 (50)					-26 (50)
Yellow-throated Vireo	Base	-20 (20)			-29 (40)	-20 (30)	-33 (40)	0 (10)	32 (50)	-28 (50)
	Medium	-27 (40)			-38 (50)	-25 (30)	-36 (40)	0 (10)	32 (50)	-35 (50)
	High	-33 (40)			-54 (50)	-40 (50)	-42 (50)	-20 (30)	16 (50)	-52 (50)
Warbling Vireo	Base	13 (30)			19 (40)	16 (20)	-6 (10)	17 (40)	30 (30)	11 (40)
	Medium	13 (20)			21 (40)	17 (20)	-6 (10)	17 (40)	30 (30)	12 (40)
	High	13 (20)			19 (30)	17 (20)	-6 (10)	17 (40)	30 (30)	12 (20)
Philadelphia Vireo	Base	-16 (50)	-10 (40)	9 (10)						-11 (50)
	Medium	3 (10)	5 (10)	9 (10)						4 (10)
	High	3 (10)	5 (10)	9 (10)						6 (50)
Red-eyed Vireo	Base	-7 (20)	33 (30)	20 (30)	-5 (50)	11 (20)	-23 (40)	29 (50)	71 (50)	5 (20)
	Medium	-15 (30)	33 (30)	9 (10)	-16 (50)	7 (10)	-28 (50)	29 (50)	65 (50)	-6 (50)
	High	-30 (40)	16 (50)	-29 (50)	-34 (50)	-26 (50)	-34 (50)	21 (50)	53 (50)	-25 (50)
Blue-winged Warbler	Base					25 (50)	78 (40)			44 (50)
	Medium					25 (50)	100 (40)			52 (50)
	High					19 (40)	111 (50)			56 (50)
Golden-winged Warbler	Base	-21 (50)		25 (10)	41 (30)	32 (30)				43 (30)
	Medium	11 (20)		50 (20)	57 (30)	58 (40)				54 (30)
	High	28 (50)		100 (40)	73 (50)	150 (50)				77 (50)
Tennessee Warbler	Base	-2 (40)	23 (50)	-13 (40)	-7 (10)					-4 (20)
	Medium	2 (10)	15 (50)	-23 (40)	-20 (50)					-10 (50)
	High	0 (10)	8 (20)	-39 (50)	-33 (50)					-23 (50)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Nashville Warbler	Base	7 (20)	-6 (10)	-18 (50)	-6 (20)	139 (50)				-6 (50)
	Medium	7 (20)	-6 (10)	-18 (40)	-6 (20)	139 (50)				-4 (50)
	High	7 (20)	-6 (10)	-27 (50)	-3 (10)	128 (20)				-3 (20)
Northern Parula	Base	27 (40)	-6 (30)	12 (30)	-11 (50)					-4 (50)
	Medium	9 (20)	-12 (20)	-13 (30)	-24 (50)					-17 (50)
	High	9 (20)	-19 (40)	-39 (50)	-45 (50)					-35 (50)
Yellow Warbler	Base	-21 (50)	-45 (50)	15 (20)	18 (20)	33 (30)	150 (40)	25 (30)	-8 (30)	20 (30)
	Medium	11 (40)	-35 (50)	62 (40)	44 (30)	53 (40)	186 (40)	25 (30)	21 (40)	41 (40)
	High	28 (50)	27 (40)	129 (50)	82 (50)	155 (50)	221 (50)	33 (30)	32 (40)	82 (50)
Chestnut-sided Warbler	Base	-14 (40)	20 (20)	-6 (50)	15 (30)	15 (30)			18 (40)	11 (30)
	Medium	-7 (30)	20 (20)	13 (30)	23 (30)	23 (40)			18 (40)	16 (30)
	High	-7 (30)	30 (40)	31 (50)	36 (50)	54 (50)			24 (40)	30 (50)
Magnolia Warbler	Base	-7 (10)	-4 (10)	-27 (40)	-14 (40)					-13 (50)
	Medium	-10 (50)	-4 (10)	-27 (40)	-15 (50)					-14 (50)
	High	-12 (50)	-9 (10)	-33 (50)	-14 (10)					-15 (50)
Cape May Warbler	Base	27 (50)	12 (40)	-19 (10)	-11 (10)					9 (50)
	Medium	-4 (10)	8 (40)	-29 (50)	-23 (40)					-6 (10)
	High	-12 (50)	-15 (50)	-47 (50)	-39 (50)					-18 (50)
Black-throated Blue Warbler	Base		8 (10)	-8 (40)						-6 (40)
	Medium		8 (10)	-23 (40)						-19 (40)
	High		8 (10)	-45 (50)						-40 (50)
Yellow-rumped Warbler	Base	19 (50)	13 (40)	-29 (50)	-5 (10)					7 (50)
	Medium	-3 (10)	-13 (10)	-39 (50)	-12 (40)					-8 (10)
	High	-10 (50)	-13 (10)	-52 (50)	-29 (50)					-22 (50)
Black-throated Green Warbler	Base	-8 (20)	-7 (20)	8 (10)	-23 (50)					-15 (50)
	Medium	-8 (20)	-14 (40)	-13 (40)	-33 (50)					-24 (50)
	High	-18 (50)	-25 (40)	-38 (50)	-48 (50)					-43 (50)
Blackburnian Warbler	Base	23 (50)	14 (50)	-13 (50)	-14 (50)					-5 (20)
	Medium	-7 (10)	10 (50)	-24 (40)	-23 (50)					-11 (50)
	High	-15 (50)	-10 (40)	-46 (50)	-41 (50)					-29 (50)
Pine Warbler	Base	-10 (10)	15 (30)	-22 (10)	-7 (30)					-5 (10)
	Medium	-27 (40)	15 (40)	-28 (50)	-23 (40)					-14 (40)
	High	-40 (50)	-9 (40)	-44 (50)	-41 (40)					-33 (40)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Palm Warbler	Base	34 (50)	30 (50)		23 (30)					32 (50)
	Medium	16 (30)	20 (50)		13 (20)					15 (30)
	High	13 (30)	10 (20)		-23 (50)					13 (30)
Bay-breasted Warbler	Base	26 (50)	-6 (10)	-19 (10)						-8 (10)
	Medium	-5 (10)	-6 (10)	-29 (50)						-9 (10)
	High	-11 (50)	-19 (50)	-47 (50)						-22 (50)
Cerulean Warbler	Base					-16 (30)	-34 (40)	-18 (40)		-23 (40)
	Medium					-19 (40)	-37 (40)	-18 (40)		-27 (40)
	High					-38 (50)	-42 (50)	-24 (50)		-38 (50)
Black-and-white Warbler	Base	7 (10)	8 (10)	9 (10)	8 (40)	-16 (30)				6 (10)
	Medium	7 (10)	8 (10)	9 (10)	12 (40)	-18 (40)				10 (40)
	High	11 (10)	23 (40)	6 (10)	16 (40)	-38 (50)				17 (40)
American Redstart	Base	-18 (30)	26 (30)	9 (10)	13 (10)	-6 (10)	-19 (40)	-15 (40)	33 (50)	11 (20)
	Medium	-19 (30)	26 (50)	9 (10)	13 (20)	-6 (10)	-22 (40)	-14 (40)	33 (50)	9 (20)
	High	-27 (50)	18 (10)	9 (10)	13 (20)	-6 (10)	-24 (40)	-20 (50)	26 (50)	-9 (50)
Prothonotary Warbler	Base					0 (10)	-8 (10)			-6 (10)
	Medium					0 (10)	-8 (10)			-5 (10)
	High					0 (10)	-8 (10)			-5 (10)
Ovenbird	Base	-12 (20)	10 (40)	-8 (40)	-19 (30)	-15 (30)	-30 (40)	0 (10)	42 (50)	-12 (30)
	Medium	-22 (30)	10 (50)	-17 (40)	-27 (50)	-20 (40)	-33 (40)	0 (10)	38 (50)	-18 (40)
	High	-29 (40)	-10 (40)	-32 (50)	-42 (50)	-40 (50)	-37 (40)	-20 (30)	27 (50)	-33 (50)
Northern Waterthrush	Base	6 (10)	21 (40)	11 (30)	5 (40)					21 (50)
	Medium	6 (10)	21 (40)	8 (30)	5 (10)					21 (50)
	High	6 (10)	17 (30)	5 (30)	5 (10)					19 (50)
Louisiana Waterthrush	Base				20 (10)	50 (10)	0 (10)	-100 (10)		12 (50)
	Medium				20 (20)	50 (10)	0 (10)	-100 (10)		11 (40)
	High				20 (10)	50 (10)	0 (10)	-100 (10)		9 (50)
Connecticut Warbler	Base	33 (50)	24 (50)	-30 (50)	18 (30)					24 (50)
	Medium	17 (30)	12 (50)	-37 (50)	6 (10)					9 (30)
	High	13 (30)	8 (20)	-61 (50)	-29 (50)					-17 (50)
Mourning Warbler	Base	-8 (50)	13 (20)	-11 (40)	21 (20)	17 (30)	-13 (10)			13 (20)
	Medium	-2 (30)	19 (50)	4 (10)	32 (30)	25 (40)	-13 (10)			18 (30)
	High	5 (50)	23 (50)	19 (50)	42 (50)	58 (50)	-13 (10)			28 (50)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Common Yellowthroat	Base	-21 (50)	-42 (50)	21 (10)	10 (20)	31 (30)	164 (40)	56 (30)	-6 (10)	-10 (50)
	Medium	11 (40)	-32 (50)	42 (20)	23 (30)	46 (40)	200 (50)	50 (20)	18 (40)	19 (30)
	High	28 (50)	25 (30)	79 (40)	45 (50)	146 (50)	218 (50)	67 (30)	24 (40)	48 (50)
Hooded Warbler	Base					0 (10)	-25 (10)			-26 (40)
	Medium					0 (10)	-25 (10)			-31 (40)
	High					-33 (40)	-50 (40)			-40 (50)
Wilson's Warbler	Base		-50 (50)							-45 (50)
	Medium		-38 (50)							-34 (50)
	High		25 (30)							27 (40)
Canada Warbler	Base	-7 (40)	5 (10)	-6 (30)	-14 (50)					-11 (50)
	Medium	-2 (20)	5 (10)	6 (10)	-8 (50)					-7 (50)
	High	2 (10)	5 (10)	-11 (30)	3 (10)					3 (10)
Yellow-breasted Chat	Base						200 (40)			160 (40)
	Medium						200 (40)			190 (40)
	High						200 (40)			220 (50)
Scarlet Tanager	Base	-11 (30)	9 (50)	-4 (40)	-20 (30)	-17 (30)	-33 (40)	0 (10)	50 (50)	-16 (30)
	Medium	-21 (40)	7 (50)	-20 (40)	-28 (30)	-20 (40)	-36 (40)	0 (10)	43 (50)	-23 (30)
	High	-34 (50)	-13 (40)	-42 (50)	-44 (50)	-42 (50)	-42 (50)	-20 (30)	29 (50)	-39 (50)
Northern Cardinal	Base				-24 (30)	27 (50)	-12 (40)	44 (50)		-8 (40)
	Medium				-30 (30)	18 (50)	-16 (40)	43 (50)		-13 (40)
	High				-46 (50)	9 (20)	-19 (40)	35 (50)		-16 (40)
Rose-breasted Grosbeak	Base	-14 (30)	17 (20)	7 (10)	9 (20)	17 (50)	13 (40)	44 (50)	25 (50)	8 (20)
	Medium	-11 (30)	17 (10)	-7 (20)	13 (20)	13 (40)	13 (40)	43 (50)	25 (50)	10 (20)
	High	-13 (30)	26 (50)	-13 (30)	14 (50)	13 (50)	13 (40)	35 (50)	25 (50)	12 (50)
Indigo Bunting	Base	-17 (30)	55 (20)	12 (20)	9 (20)	21 (50)	170 (40)	29 (50)	24 (50)	8 (20)
	Medium	-19 (30)	64 (20)	39 (40)	16 (30)	26 (50)	202 (50)	29 (50)	24 (50)	14 (30)
	High	-27 (50)	100 (20)	84 (50)	30 (50)	37 (50)	217 (50)	41 (50)	24 (50)	28 (50)
Rufous-sided Towhee	Base	-17 (50)			125 (30)	29 (30)	175 (40)			123 (30)
	Medium	9 (40)			142 (30)	50 (40)	217 (50)			144 (30)
	High	26 (50)			163 (50)	150 (50)	233 (50)			168 (50)
Chipping Sparrow	Base	16 (50)	-6 (10)	-13 (10)	-4 (50)	20 (50)	-10 (10)	44 (50)	27 (50)	-1 (10)
	Medium	5 (20)	-6 (10)	-21 (50)	-11 (50)	28 (50)	-13 (40)	44 (50)	26 (50)	-6 (50)
	High	5 (30)	-12 (40)	-33 (50)	-24 (50)	45 (50)	-16 (40)	40 (50)	24 (50)	-15 (50)

Table 7a. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Song Sparrow	Base	-21 (50)	-42 (50)	12 (20)	28 (30)	32 (30)	176 (40)	55 (30)	-9 (30)	16 (30)
	Medium	11 (40)	-32 (50)	56 (40)	47 (30)	53 (40)	210 (40)	45 (20)	18 (40)	33 (30)
	High	28 (50)	28 (40)	118 (50)	84 (50)	153 (50)	233 (50)	60 (30)	26 (40)	71 (50)
Lincoln's Sparrow	Base	-63 (50)	-80 (50)	-52 (10)	-53 (40)					-66 (50)
	Medium	-39 (30)	-72 (50)	-57 (10)	-37 (20)					-48 (50)
	High	-38 (30)	-54 (20)	50 (50)	-37 (20)					-43 (20)
White-throated Sparrow	Base	3 (20)	0 (10)	-8 (50)	-10 (20)	20 (50)				-8 (50)
	Medium	11 (40)	0 (10)	3 (30)	-8 (20)	20 (40)				-5 (30)
	High	14 (50)	8 (30)	20 (50)	-8 (20)	20 (50)				-4 (20)
Dark-eyed Junco	Base	-7 (10)	8 (30)	-41 (50)	-30 (50)					-17 (50)
	Medium	-7 (10)	0 (10)	-43 (50)	-22 (20)					-15 (50)
	High	-13 (50)	-8 (10)	-46 (50)	-17 (10)					-13 (20)
Rusty Blackbird	Base		0 (10)							-5 (10)
	Medium		0 (10)							-10 (10)
	High		0 (10)							-5 (10)
Common Grackle	Base	-16 (50)	-44 (50)	16 (20)	33 (30)	31 (30)	191 (40)	55 (30)	-7 (10)	-9 (50)
	Medium	11 (40)	-35 (50)	60 (40)	52 (30)	50 (50)	227 (50)	52 (30)	14 (40)	15 (30)
	High	32 (50)	31 (40)	125 (50)	82 (50)	150 (50)	245 (50)	66 (30)	29 (40)	62 (50)
Brown-headed Cowbird	Base	-16 (30)	-17 (50)	5 (10)	20 (20)	21 (50)	30 (50)	42 (50)	23 (50)	7 (30)
	Medium	-13 (30)	-13 (50)	-6 (40)	30 (30)	29 (50)	30 (40)	42 (50)	23 (50)	13 (50)
	High	-16 (30)	-3 (20)	-10 (40)	50 (50)	45 (50)	30 (40)	39 (50)	21 (50)	26 (50)
Orchard Oriole	Base					25 (50)	-12 (40)	43 (50)		-7 (10)
	Medium					13 (40)	-16 (40)	43 (50)		-8 (10)
	High					-13 (50)	-20 (40)	36 (50)		-10 (40)
Northern Oriole	Base	-18 (30)	15 (50)	9 (10)	-26 (50)	20 (50)	-12 (40)	41 (50)	17 (50)	-22 (30)
	Medium	-20 (30)	15 (50)	-18 (40)	-32 (50)	13 (50)	-17 (40)	47 (50)	20 (50)	-27 (30)
	High	-28 (40)	8 (10)	-42 (50)	-49 (50)	-9 (50)	-20 (40)	35 (50)	7 (30)	-43 (50)
Purple Finch	Base	6 (50)	10 (50)	-33 (20)	-21 (40)	25 (50)	-14 (10)			-14 (50)
	Medium	-11 (40)	7 (50)	-42 (40)	-32 (40)	13 (40)	-14 (10)			-23 (40)
	High	-20 (50)	-12 (40)	-55 (50)	-46 (40)	-13 (50)	-14 (10)			-38 (50)
Red Crossbill	Base	33 (50)	17 (50)	0 (10)	-6 (10)					16 (50)
	Medium	18 (30)	8 (40)	-50 (50)	-11 (30)					-5 (10)
	High	11 (30)	-8 (10)	-33 (40)	-33 (50)					-18 (50)

Table 7a. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for all forest lands.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
White-winged Crossbill	Base	25 (50)	17 (50)	0 (10)	-6 (10)					13 (50)
	Medium	10 (30)	8 (40)	-50 (50)	-11 (30)					-7 (10)
	High	-10 (10)	-8 (10)	-33 (40)	-33 (50)					-20 (50)
Pine Siskin	Base	-12 (10)	-6 (10)	-22 (10)	-10 (10)	-100 (10)			80 (40)	-12 (40)
	Medium	-29 (50)	-7 (10)	-30 (50)	-27 (40)	-100 (10)			60 (40)	-24 (40)
	High	-43 (50)	-19 (40)	-42 (50)	-43 (40)	-100 (10)			60 (20)	-41 (40)
American Goldfinch	Base	-21 (50)	-52 (50)	15 (20)	38 (30)	29 (30)	184 (40)	56 (30)	-9 (10)	27 (30)
	Medium	11 (40)	-52 (50)	64 (40)	52 (30)	65 (50)	218 (50)	50 (20)	18 (40)	44 (30)
	High	28 (50)	50 (40)	129 (50)	95 (50)	159 (50)	241 (50)	67 (30)	27 (40)	86 (50)
Evening Grosbeak	Base	-13 (10)	11 (50)	-22 (10)	13 (30)					12 (50)
	Medium	-17 (40)	6 (50)	-29 (50)	-6 (30)					-4 (50)
	High	-21 (50)	-16 (50)	-44 (50)	-38 (50)					-30 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Double-crested Cormorant	Base	34 (30)	100 (20)	-14 (10)	17 (40)	11 (20)	-7 (10)	7 (40)	33 (30)	22 (30)
	Medium	27 (30)	100 (20)	-14 (10)	15 (30)	17 (20)	-7 (10)	11 (40)	33 (40)	19 (30)
	High	27 (20)	100 (30)	-14 (10)	12 (20)	17 (20)	-7 (10)	11 (40)	33 (30)	18 (20)
Great Blue Heron	Base	36 (20)	44 (50)	0 (10)	15 (30)	15 (20)	-10 (10)	-9 (20)	33 (30)	10 (40)
	Medium	36 (30)	44 (50)	0 (10)	15 (40)	15 (20)	-10 (10)	13 (40)	33 (30)	10 (40)
	High	27 (20)	39 (50)	-25 (10)	12 (20)	15 (20)	-10 (10)	13 (40)	33 (30)	7 (20)
Great Egret	Base				25 (30)	20 (10)	-6 (10)	20 (40)		5 (50)
	Medium				25 (30)	20 (10)	-6 (10)	20 (30)		5 (40)
	High				17 (10)	20 (10)	-6 (10)	20 (30)		5 (30)
Green-backed Heron	Base	33 (20)		-33 (10)	19 (30)	-20 (50)	50 (30)	8 (30)		15 (30)
	Medium	33 (20)		-33 (10)	21 (40)	-20 (50)	50 (30)	8 (30)		16 (30)
	High	33 (20)		0 (10)	19 (20)	-20 (50)	50 (30)	8 (30)		16 (30)
Black-crowned Night Heron	Base	31 (30)				14 (20)	-6 (10)	0 (10)		14 (30)
	Medium	33 (30)				14 (20)	-6 (10)	0 (10)		15 (30)
	High	33 (20)				14 (20)	-6 (10)	0 (10)		14 (30)
Yellow-crowned Night Heron	Base	11 (20)			0 (10)	11 (10)	-20 (40)	0 (10)		14 (20)
	Medium	11 (20)			0 (10)	11 (10)	-20 (40)	0 (10)		17 (20)
	High	11 (20)			-10 (10)	11 (10)	-20 (40)	0 (10)		17 (20)
Wood Duck	Base	29 (20)	82 (50)	200 (10)	17 (40)	12 (20)	-9 (10)	16 (40)	37 (30)	10 (50)
	Medium	29 (20)	89 (50)	200 (10)	17 (40)	12 (20)	-9 (10)	20 (40)	33 (40)	9 (40)
	High	43 (20)	86 (50)	200 (40)	14 (30)	-18 (50)	-9 (10)	20 (40)	35 (30)	8 (30)
American Black Duck	Base	318 (50)	614 (50)	186 (20)	142 (50)					229 (50)
	Medium	318 (50)	614 (50)	186 (20)	142 (50)					229 (50)
	High	309 (40)	614 (50)	186 (30)	133 (50)					216 (50)
Common Goldeneye	Base	50 (30)	92 (50)	200 (10)	33 (20)	0 (10)				86 (50)
	Medium	50 (30)	92 (50)	200 (10)	33 (20)	0 (10)				84 (50)
	High	50 (30)	84 (50)	200 (40)	33 (10)	0 (10)				76 (50)
Bufflehead	Base	50 (30)								50 (30)
	Medium	50 (30)								50 (30)
	High	50 (30)								50 (30)
Hooded Merganser	Base	74 (50)	20 (40)	43 (30)	43 (30)	33 (20)	100 (30)	67 (40)	77 (40)	45 (50)
	Medium	59 (30)	17 (40)	28 (50)	43 (40)	33 (20)	100 (30)	67 (40)	69 (40)	38 (50)
	High	59 (50)	21 (40)	31 (30)	43 (50)	33 (20)	100 (30)	67 (40)	69 (30)	33 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Common Merganser	Base	70 (30)	82 (50)	43 (30)	50 (20)					85 (50)
	Medium	70 (50)	82 (50)	29 (50)	50 (20)					83 (50)
	High	60 (40)	90 (50)	29 (30)	50 (20)					76 (50)
Turkey Vulture	Base	5 (10)	4 (10)	10 (10)	-3 (50)		57 (50)			3 (10)
	Medium	5 (10)	4 (10)	10 (10)	-3 (50)		57 (50)			3 (10)
	High	5 (10)	4 (10)	0 (10)	-2 (50)		57 (50)			4 (10)
Osprey	Base	300 (50)	200 (50)	200 (30)	131 (50)	57 (40)				124 (50)
	Medium	250 (40)	200 (40)	200 (40)	125 (50)	57 (20)				118 (50)
	High	250 (40)	200 (50)	200 (30)	119 (50)	57 (20)				109 (50)
Bald Eagle	Base	350 (50)	300 (50)	80 (30)	124 (50)	0 (10)	40 (20)			143 (50)
	Medium	350 (50)	167 (50)	40 (40)	119 (50)	100 (20)	40 (20)			135 (50)
	High	300 (40)	300 (50)	40 (30)	114 (50)	100 (20)	40 (20)			130 (50)
Sharp-shinned Hawk	Base	19 (50)	-8 (10)	-9 (20)	-3 (10)					-4 (10)
	Medium	6 (50)	-8 (10)	-18 (30)	-16 (50)					-14 (50)
	High	-6 (40)	-43 (50)	-45 (40)	-40 (50)					-39 (50)
Cooper's Hawk	Base	-25 (30)			-26 (30)	17 (50)	-15 (40)	100 (30)	33 (10)	-12 (40)
	Medium	-25 (30)			-33 (50)	8 (20)	-20 (40)	100 (30)	33 (10)	-17 (40)
	High	-25 (30)			-52 (50)	-8 (50)	-22 (40)	100 (30)	33 (10)	-26 (50)
Northern Goshawk	Base	-17 (20)	0 (10)	0 (10)	-27 (30)	17 (40)				-18 (30)
	Medium	-25 (30)	-20 (30)	-20 (20)	-35 (50)	17 (50)				-25 (30)
	High	-33 (40)	-40 (30)	-40 (30)	-54 (50)	-17 (50)				-43 (50)
Red-Shouldered Hawk	Base				-30 (20)	-25 (30)	-36 (40)	0 (10)		-27 (40)
	Medium				-50 (30)	-25 (30)	-43 (40)	0 (10)		-31 (40)
	High				-60 (30)	-50 (50)	-43 (40)	0 (10)		-38 (50)
Broad-winged Hawk	Base	-14 (20)	-10 (20)	-8 (40)	-24 (30)	17 (50)	-15 (40)		26 (30)	-17 (30)
	Medium	-24 (40)	-12 (20)	-22 (40)	-33 (50)	8 (20)	-20 (40)		26 (50)	-24 (30)
	High	-33 (40)	-44 (40)	-46 (50)	-48 (50)	-8 (50)	-22 (40)		15 (50)	-43 (50)
Red-tailed Hawk	Base	13 (10)	11 (10)	30 (40)	0 (10)	23 (40)	15 (50)	41 (50)	26 (50)	5 (50)
	Medium	13 (10)	11 (10)	67 (40)	0 (10)	23 (40)	15 (50)	45 (50)	26 (50)	6 (50)
	High	17 (10)	11 (10)	126 (50)	0 (10)	23 (40)	15 (50)	36 (50)	23 (50)	8 (50)
American Kestrel	Base	36 (20)	33 (20)	27 (20)	61 (30)	25 (20)	226 (40)	67 (30)	15 (40)	49 (30)
	Medium	57 (40)	50 (20)	81 (40)	79 (30)	25 (20)	249 (40)	33 (10)	28 (40)	69 (30)
	High	77 (50)	113 (40)	141 (50)	128 (50)	150 (40)	295 (50)	67 (30)	38 (40)	113 (50)

Table 7b. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Merlin	Base	6 (50)	-17 (10)	0 (10)	-24 (50)					-13 (30)
	Medium	-13 (40)	-17 (10)	-33 (30)	-32 (50)					-23 (50)
	High	-25 (50)	-50 (40)	-40 (40)	-53 (50)					-44 (50)
Mourning Dove	Base	25 (20)			65 (30)	30 (40)	219 (40)	42 (30)	11 (40)	56 (30)
	Medium	30 (30)			85 (30)	43 (50)	262 (40)	37 (30)	22 (40)	75 (30)
	High	45 (50)			127 (50)	96 (50)	304 (50)	58 (50)	28 (40)	118 (50)
Black-billed Cuckoo	Base	9 (10)	59 (20)	27 (20)	15 (30)	49 (40)	18 (50)	55 (30)	19 (40)	15 (50)
	Medium	18 (40)	74 (20)	67 (40)	16 (30)	51 (40)	18 (50)	50 (30)	28 (40)	17 (50)
	High	18 (10)	146 (40)	113 (50)	20 (50)	60 (50)	18 (50)	65 (30)	33 (40)	22 (50)
Yellow-billed Cuckoo	Base	8 (10)			52 (50)	31 (40)	16 (50)	44 (50)	15 (40)	27 (50)
	Medium	12 (20)			72 (50)	49 (50)	16 (50)	44 (50)	25 (40)	37 (50)
	High	16 (50)			107 (50)	116 (50)	16 (50)	44 (50)	30 (40)	60 (50)
Eastern Screech-Owl	Base				-27 (30)	18 (50)	-14 (40)	46 (50)		-11 (40)
	Medium				-33 (30)	9 (40)	-20 (40)	45 (50)		-16 (40)
	High				-47 (50)	-12 (50)	-22 (40)	36 (50)		-19 (40)
Great Horned Owl	Base	-14 (20)	-11 (20)	-10 (20)	-23 (30)	18 (50)	-15 (40)	39 (50)	35 (50)	5 (50)
	Medium	-24 (40)	-13 (20)	-27 (40)	-30 (30)	9 (30)	-20 (40)	39 (50)	35 (50)	-6 (30)
	High	-33 (40)	-45 (40)	-40 (40)	-47 (50)	-9 (50)	-22 (40)	30 (40)	17 (30)	-17 (50)
Barred Owl	Base	-6 (20)	12 (50)	20 (50)	-12 (50)	14 (20)	-26 (50)	17 (20)		-11 (50)
	Medium	-15 (30)	9 (50)	11 (10)	-23 (50)	11 (10)	-33 (50)	17 (20)		-22 (50)
	High	-29 (50)	-46 (40)	-40 (50)	-44 (50)	-29 (50)	-41 (50)	17 (20)		-42 (50)
Great Gray Owl	Base	22 (40)	0 (10)	-25 (10)	-25 (10)					11 (40)
	Medium	-11 (10)	0 (10)	-33 (10)	-25 (10)					-12 (50)
	High	-22 (10)	-55 (40)	-63 (50)	-50 (50)					-34 (50)
Long-eared Owl	Base	-7 (20)	21 (50)	-9 (20)	-19 (30)	25 (50)	-11 (10)	50 (30)	20 (20)	-8 (20)
	Medium	-13 (40)	8 (50)	-18 (30)	-27 (50)	17 (40)	-22 (40)	50 (30)	20 (30)	-16 (40)
	High	-30 (50)	-38 (50)	-45 (40)	-47 (50)	8 (20)	-22 (40)	50 (20)	20 (30)	-36 (50)
Boreal Owl	Base	-7 (20)	-8 (10)	-9 (20)	-21 (50)					-11 (20)
	Medium	-13 (40)	-8 (10)	-18 (30)	-29 (30)					-20 (50)
	High	-30 (50)	-42 (40)	-45 (40)	-47 (50)					-41 (50)
Northern Saw-whet Owl	Base	9 (50)	19 (50)	-16 (10)	-7 (10)					-6 (10)
	Medium	-9 (40)	7 (50)	-28 (50)	-21 (40)					-16 (40)
	High	-24 (50)	-41 (50)	-47 (50)	-41 (50)					-40 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Whip-poor-will	Base	-12 (40)	-17 (50)	9 (10)	-10 (50)	79 (30)	-5 (10)	-29 (10)	12 (40)	-4 (10)
	Medium	-3 (20)	-8 (40)	9 (10)	-9 (30)	100 (40)	-8 (40)	-29 (10)	24 (40)	-3 (10)
	High	9 (50)	17 (50)	9 (10)	0 (10)	211 (50)	-8 (10)	-29 (10)	31 (40)	9 (50)
Chimney Swift	Base	33 (10)	33 (10)	100 (40)	40 (20)	57 (50)	17 (20)	100 (50)	200 (50)	38 (50)
	Medium	33 (10)	33 (10)	33 (10)	32 (10)	43 (40)	13 (20)	100 (50)	200 (50)	27 (30)
	High	33 (10)	-67 (30)	33 (10)	36 (10)	30 (20)	13 (20)	86 (50)	150 (40)	26 (20)
Ruby-throated Hummingbird	Base	-13 (50)	-15 (50)	10 (10)	-8 (30)	23 (50)	14 (50)	32 (50)	28 (50)	-6 (50)
	Medium	5 (50)	8 (10)	10 (10)	-8 (30)	23 (50)	14 (50)	35 (50)	27 (50)	-6 (50)
	High	18 (50)	38 (40)	10 (10)	-17 (50)	23 (50)	14 (50)	26 (50)	24 (50)	-4 (30)
Red-headed Woodpecker	Base	-19 (20)	-17 (20)	-13 (20)	-25 (30)	18 (50)	-14 (40)	36 (50)	33 (50)	-7 (30)
	Medium	-25 (30)	-17 (20)	-25 (30)	-31 (30)	12 (50)	-19 (40)	36 (50)	33 (50)	-13 (40)
	High	-31 (40)	-33 (30)	-50 (40)	-49 (50)	-12 (50)	-21 (40)	27 (40)	18 (50)	-21 (50)
Red-bellied Woodpecker	Base				-14 (30)	18 (50)	-15 (10)	39 (50)		10 (50)
	Medium				-23 (30)	12 (50)	-23 (40)	39 (50)		-4 (10)
	High				-32 (50)	-12 (50)	-24 (40)	30 (40)		-12 (50)
Yellow-bellied Sapsucker	Base	-14 (30)	-13 (20)	-6 (10)	-21 (20)	21 (50)	-15 (40)	50 (20)	36 (50)	-15 (30)
	Medium	-23 (40)	-13 (20)	-18 (30)	-29 (30)	13 (50)	-20 (40)	50 (20)	36 (50)	-22 (30)
	High	-34 (50)	-46 (40)	-42 (50)	-46 (50)	-13 (50)	-22 (40)	50 (20)	27 (50)	-39 (50)
Downy Woodpecker	Base	3 (50)	7 (50)	5 (10)	2 (10)	32 (50)	25 (50)	57 (50)	35 (50)	2 (20)
	Medium	2 (10)	3 (50)	5 (10)	-7 (50)	27 (50)	21 (50)	60 (50)	35 (50)	-3 (50)
	High	-7 (50)	-16 (50)	-16 (50)	-14 (50)	18 (40)	17 (30)	55 (50)	29 (50)	-10 (50)
Hairy Woodpecker	Base	5 (40)	6 (50)	-5 (20)	17 (20)	31 (50)	-49 (10)	41 (50)	46 (50)	11 (30)
	Medium	-2 (50)	-3 (20)	-30 (50)	17 (20)	31 (50)	-49 (10)	41 (50)	36 (40)	9 (30)
	High	-7 (50)	-18 (40)	-47 (50)	14 (20)	31 (50)	-50 (10)	32 (50)	36 (50)	7 (20)
Three-toed Woodpecker	Base		20 (20)							20 (20)
	Medium		-17 (10)							-17 (10)
	High		-40 (40)							-40 (40)
Black-backed Woodpecker	Base	31 (50)	21 (50)	0 (10)	-17 (20)					-9 (10)
	Medium	10 (30)	8 (50)	-50 (50)	-28 (40)					-12 (30)
	High	-21 (50)	-42 (50)	-33 (40)	-42 (50)					-37 (50)
Northern Flicker	Base	-15 (50)	-26 (50)	16 (20)	24 (30)	27 (40)	108 (40)	24 (30)	-17 (30)	16 (30)
	Medium	16 (40)	-14 (50)	47 (40)	38 (30)	46 (50)	136 (50)	24 (30)	-12 (30)	31 (40)
	High	38 (50)	69 (40)	100 (50)	73 (50)	111 (50)	152 (50)	44 (50)	22 (50)	69 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Pileated Woodpecker	Base	-14 (20)	-11 (20)	-13 (20)	-12 (20)	9 (10)	-35 (40)	-20 (10)	41 (50)	-11 (30)
	Medium	-21 (30)	-13 (20)	-25 (30)	-24 (50)	-15 (50)	-40 (40)	-20 (10)	38 (50)	-21 (50)
	High	-36 (50)	-48 (40)	-50 (50)	-45 (50)	-34 (50)	-45 (50)	-20 (10)	22 (30)	-43 (50)
Olive-sided Flycatcher	Base	5 (20)	28 (40)	-18 (10)	20 (20)					16 (30)
	Medium	6 (30)	21 (40)	-23 (10)	35 (30)					25 (30)
	High	9 (30)	12 (20)	-30 (50)	60 (50)					38 (50)
Eastern Wood-Pewee	Base	-17 (20)	-10 (20)	-3 (20)	-21 (30)	42 (50)	-15 (10)	41 (50)	40 (50)	-16 (30)
	Medium	-22 (30)	-12 (20)	-25 (40)	-30 (30)	32 (50)	-23 (40)	41 (50)	39 (50)	-22 (30)
	High	-39 (50)	-45 (40)	-43 (50)	-47 (50)	16 (40)	-24 (40)	32 (50)	23 (50)	-37 (50)
Yellow-bellied Flycatcher	Base	46 (40)	46 (50)	-15 (10)	15 (30)					36 (50)
	Medium	15 (20)	27 (50)	-21 (10)	-11 (50)					9 (30)
	High	15 (30)	-38 (50)	-46 (50)	-41 (50)					-27 (50)
Acadian Flycatcher	Base					-13 (30)	-33 (40)			-19 (40)
	Medium					-18 (40)	-37 (40)			-25 (40)
	High					-39 (50)	-42 (40)			-40 (50)
Least Flycatcher	Base	-19 (30)	-18 (20)	9 (10)	-12 (50)	18 (50)	-18 (40)	42 (50)	42 (50)	-8 (50)
	Medium	-22 (30)	-18 (20)	-17 (50)	-24 (50)	12 (50)	-18 (40)	42 (50)	42 (50)	-19 (50)
	High	-30 (40)	-55 (40)	-48 (50)	-46 (50)	-12 (50)	-24 (40)	33 (50)	25 (50)	-41 (50)
Eastern Phoebe	Base	-13 (20)	-54 (50)	0 (10)	-16 (50)	-3 (40)	-6 (10)	12 (40)	8 (30)	-15 (50)
	Medium	-13 (50)	-55 (50)	25 (40)	-11 (40)	-3 (40)	-6 (10)	12 (40)	6 (30)	-13 (50)
	High	-6 (10)	-47 (50)	25 (40)	-11 (40)	-3 (40)	-6 (10)	12 (40)	6 (40)	-12 (50)
Great Crested Flycatcher	Base	-19 (30)		-9 (20)	-13 (50)	15 (50)	-14 (40)	41 (50)	37 (50)	-8 (40)
	Medium	-22 (40)		-25 (40)	-27 (50)	10 (50)	-19 (40)	41 (50)	37 (50)	-20 (50)
	High	-31 (50)		-48 (50)	-46 (50)	-10 (30)	-21 (40)	32 (50)	21 (50)	-37 (50)
Tree Swallow	Base	33 (20)	37 (20)	27 (20)	61 (30)	47 (30)	175 (40)	50 (20)	17 (40)	59 (40)
	Medium	57 (30)	47 (20)	81 (40)	82 (30)	79 (50)	219 (50)	50 (20)	25 (40)	83 (40)
	High	73 (50)	126 (40)	139 (50)	117 (50)	188 (50)	244 (50)	75 (50)	33 (40)	143 (50)
Gray Jay	Base	34 (50)	18 (40)	-40 (50)	-11 (10)					13 (50)
	Medium	9 (30)	14 (50)	-48 (50)	-23 (40)					-8 (50)
	High	-16 (50)	-45 (50)	-62 (50)	-43 (50)					-32 (50)
Blue Jay	Base	9 (50)	-8 (20)	17 (30)	-27 (30)	18 (50)	-15 (10)	44 (50)	25 (50)	-16 (30)
	Medium	-15 (50)	-11 (20)	11 (10)	-33 (30)	10 (50)	-23 (40)	43 (50)	28 (50)	-23 (30)
	High	-30 (50)	-43 (40)	-34 (50)	-48 (50)	-13 (50)	-24 (40)	35 (40)	13 (50)	-37 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Black-billed Magpie	Base	36 (30)			100 (20)				-50 (20)	45 (30)
	Medium	60 (30)			125 (30)				50 (40)	63 (40)
	High	73 (50)			150 (40)				50 (40)	90 (50)
American Crow	Base	-18 (30)	-7 (20)	-7 (40)	-13 (20)	25 (40)	-15 (40)	41 (50)	32 (50)	-7 (20)
	Medium	-23 (40)	-13 (20)	-23 (40)	-23 (50)	21 (20)	-15 (30)	41 (50)	32 (50)	-14 (30)
	High	-32 (50)	-43 (40)	-46 (50)	-44 (50)	18 (20)	-23 (40)	32 (50)	16 (30)	-29 (50)
Common Raven	Base	-9 (20)	10 (40)	-8 (40)	-17 (30)					-11 (30)
	Medium	-18 (30)	10 (40)	-22 (40)	-29 (30)					-19 (30)
	High	-25 (40)	-45 (40)	-46 (50)	-43 (40)					-43 (50)
Black-capped	Base	-6 (10)	17 (40)	-8 (20)	-12 (30)	18 (50)	-15 (10)	42 (50)	32 (50)	-6 (10)
Chickadee	Medium	-22 (40)	8 (40)	-27 (40)	-26 (50)	8 (50)	-23 (40)	42 (50)	30 (50)	-15 (40)
	High	-35 (50)	-42 (40)	-50 (50)	-45 (50)	-10 (50)	-24 (40)	33 (50)	16 (50)	-33 (50)
Boreal Chickadee	Base	27 (40)	17 (50)	-22 (20)	-9 (10)	150 (20)				8 (50)
	Medium	9 (30)	-8 (30)	-40 (50)	-17 (40)	150 (20)				-15 (50)
	High	-26 (50)	-44 (50)	-56 (50)	-41 (50)	150 (20)				-38 (50)
Tufted Titmouse	Base					18 (50)	-15 (40)			8 (50)
	Medium					9 (40)	-20 (40)			-4 (10)
	High					-12 (50)	-22 (40)			-13 (50)
Red-breasted	Base	-7 (10)	25 (50)	-9 (50)	14 (40)	59 (50)	-15 (40)			13 (50)
Nuthatch	Medium	-14 (40)	18 (50)	-24 (40)	-3 (30)	56 (50)	-20 (40)			-6 (30)
	High	-31 (50)	-32 (40)	-45 (50)	-34 (50)	47 (30)	-22 (40)			-32 (50)
White-breasted	Base	-19 (30)	-19 (20)	-7 (40)	-24 (50)	23 (50)	-14 (40)	41 (50)	30 (50)	-12 (30)
Nuthatch	Medium	-22 (40)	-17 (20)	-23 (40)	-32 (50)	15 (50)	-19 (40)	41 (50)	30 (50)	-17 (30)
	High	-31 (50)	-45 (40)	-46 (50)	-48 (50)	-8 (50)	-21 (40)	32 (50)	11 (30)	-30 (50)
Brown Creeper	Base	-7 (20)	-14 (10)	28 (30)	-17 (50)	18 (50)	-15 (40)			-15 (50)
	Medium	-11 (40)	-21 (20)	14 (10)	-30 (50)	9 (40)	-20 (40)			-27 (50)
	High	-22 (50)	-45 (40)	-34 (50)	-47 (50)	-12 (50)	-22 (40)			-45 (50)
House Wren	Base	25 (20)	18 (10)	9 (10)	-8 (50)	28 (50)	29 (50)	42 (50)	25 (50)	17 (50)
	Medium	42 (40)	27 (20)	9 (10)	-8 (50)	28 (50)	30 (50)	42 (50)	25 (50)	19 (50)
	High	58 (40)	64 (40)	27 (50)	-11 (50)	28 (50)	30 (40)	38 (50)	21 (50)	21 (50)
Winter Wren	Base	32 (40)	-2 (10)	-8 (40)	30 (30)					21 (40)
	Medium	-13 (50)	-4 (30)	-8 (40)	20 (20)					12 (30)
	High	-27 (50)	-17 (50)	-8 (40)	20 (20)					10 (20)

Table 7b. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Golden-crowned Kinglet	Base	29 (50)	23 (50)	-19 (10)	-9 (10)					-8 (10)
	Medium	-12 (50)	9 (40)	-27 (50)	-20 (40)					-14 (50)
	High	-26 (50)	-41 (50)	-47 (50)	-44 (50)					-41 (50)
Ruby-crowned Kinglet	Base	29 (50)	21 (50)	-20 (10)	8 (30)					19 (50)
	Medium	10 (30)	9 (50)	-31 (50)	-15 (50)					-5 (50)
	High	-21 (50)	-42 (50)	-48 (50)	-40 (50)					-35 (50)
Blue-gray Gnatcatcher	Base				-25 (30)	21 (50)	-20 (10)	33 (40)		-11 (30)
	Medium				-32 (30)	12 (50)	-20 (10)	33 (40)		-15 (30)
	High				-47 (50)	-12 (50)	-20 (10)	22 (40)		-28 (50)
Eastern Bluebird	Base	-13 (50)	-22 (50)	16 (20)	37 (30)	32 (30)	212 (40)	3567 (20)	21 (40)	32 (30)
	Medium	17 (40)	18 (20)	68 (40)	57 (30)	53 (40)	264 (50)	3567 (20)	37 (40)	51 (30)
	High	46 (50)	78 (40)	126 (50)	92 (50)	158 (50)	290 (50)	3733 (30)	47 (40)	95 (50)
Veery	Base	-19 (30)	-14 (50)	-14 (40)	11 (20)	20 (30)	377 (40)		21 (40)	7 (20)
	Medium	-20 (30)	-7 (50)	-11 (40)	14 (20)	20 (30)	415 (40)		21 (40)	11 (30)
	High	-31 (50)	26 (50)	-11 (20)	19 (50)	41 (50)	469 (50)		26 (40)	17 (50)
Swainson's Thrush	Base	27 (40)	30 (50)	-30 (50)	-15 (10)					15 (40)
	Medium	6 (30)	18 (40)	-38 (50)	-21 (40)					-8 (10)
	High	-20 (50)	-42 (50)	-54 (50)	-44 (50)					-36 (50)
Hermit Thrush	Base	7 (50)	26 (50)	-8 (20)	-8 (10)					-8 (20)
	Medium	-11 (40)	15 (50)	-23 (40)	-26 (50)					-22 (50)
	High	-22 (50)	-38 (50)	-43 (50)	-48 (50)					-45 (50)
Wood Thrush	Base			-9 (20)	-22 (30)	18 (50)	-14 (40)	41 (50)		-24 (30)
	Medium			-25 (40)	-33 (30)	12 (50)	-19 (40)	44 (50)		-30 (50)
	High			-48 (50)	-48 (50)	-12 (50)	-21 (40)	34 (50)		-47 (50)
American Robin	Base	-10 (50)	13 (10)	-10 (30)	10 (10)	18 (50)	144 (40)	33 (50)	19 (50)	10 (30)
	Medium	9 (50)	13 (10)	16 (40)	21 (30)	33 (50)	175 (50)	33 (50)	19 (40)	19 (40)
	High	22 (50)	47 (50)	45 (50)	30 (40)	57 (50)	194 (50)	37 (50)	24 (50)	37 (50)
Gray Catbird	Base	-13 (50)	-22 (50)	17 (20)	42 (30)	32 (30)	210 (40)	61 (30)	12 (40)	33 (30)
	Medium	22 (40)	20 (20)	66 (40)	58 (30)	56 (50)	257 (50)	53 (30)	24 (40)	50 (30)
	High	46 (50)	76 (40)	134 (50)	100 (50)	160 (50)	281 (50)	76 (50)	35 (40)	98 (50)
Brown Thrasher	Base	-13 (50)	-22 (50)	16 (20)	38 (30)	32 (30)	220 (40)	64 (30)	11 (40)	30 (30)
	Medium	19 (40)	20 (20)	68 (40)	57 (30)	53 (50)	260 (50)	55 (20)	24 (40)	53 (40)
	High	44 (50)	76 (40)	126 (50)	100 (50)	153 (50)	280 (50)	73 (30)	34 (40)	96 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Cedar Waxwing	Base	-7 (20)	0 (10)	-5 (40)	-9 (20)	21 (50)	11 (50)	35 (50)	13 (50)	-9 (30)
	Medium	-15 (40)	0 (10)	-5 (50)	-9 (20)	14 (50)	11 (50)	35 (50)	14 (50)	-9 (20)
	High	-26 (50)	0 (10)	0 (10)	-9 (20)	-7 (50)	11 (50)	24 (40)	9 (50)	-9 (20)
Loggerhead Shrike	Base					25 (20)	67 (30)	150 (20)		100 (30)
	Medium					25 (20)	233 (40)	400 (20)		133 (30)
	High					150 (40)	233 (40)	400 (20)		156 (40)
Bell's Vireo	Base						186 (40)			186 (40)
	Medium						186 (40)			186 (40)
	High						186 (30)			186 (40)
Solitary Vireo	Base	33 (50)	21 (50)	-18 (10)	-13 (20)					-9 (10)
	Medium	10 (30)	8 (50)	-32 (50)	-28 (40)					-15 (30)
	High	-21 (50)	-42 (50)	-47 (50)	-46 (40)					-44 (50)
Yellow-throated Vireo	Base	-21 (30)			-33 (50)	-25 (30)	-34 (40)	0 (10)	30 (50)	-29 (50)
	Medium	-21 (30)			-38 (40)	-25 (30)	-37 (40)	0 (10)	30 (50)	-36 (50)
	High	-30 (50)			-58 (50)	-40 (50)	-43 (50)	-20 (30)	14 (30)	-54 (50)
Warbling Vireo	Base	7 (20)			17 (40)	15 (20)	-6 (10)	11 (40)	30 (30)	10 (20)
	Medium	7 (20)			17 (30)	16 (20)	-6 (10)	17 (40)	30 (30)	12 (20)
	High	7 (10)			17 (30)	17 (20)	-6 (10)	17 (40)	30 (30)	12 (20)
Philadelphia Vireo	Base	-12 (40)	-17 (50)	9 (10)						-10 (50)
	Medium	-3 (20)	-8 (40)	9 (10)						4 (10)
	High	9 (50)	17 (50)	9 (10)						10 (50)
Red-eyed Vireo	Base	-8 (20)	10 (50)	17 (30)	-7 (50)	7 (10)	-26 (40)	26 (50)	65 (50)	3 (10)
	Medium	-15 (30)	7 (50)	9 (10)	-18 (50)	7 (10)	-32 (50)	26 (50)	59 (50)	-13 (50)
	High	-31 (40)	-37 (40)	-33 (50)	-36 (50)	-30 (50)	-36 (50)	20 (50)	47 (50)	-33 (50)
Blue-winged Warbler	Base					19 (50)	100 (40)			47 (50)
	Medium					19 (50)	125 (50)			56 (50)
	High					19 (50)	138 (50)			60 (50)
Golden-winged Warbler	Base	-13 (50)		25 (10)	43 (30)	37 (30)				46 (30)
	Medium	17 (40)		50 (20)	57 (30)	64 (40)				57 (30)
	High	46 (50)		100 (40)	76 (50)	160 (50)				82 (50)
Tennessee Warbler	Base	-2 (40)	21 (50)	-15 (50)	-8 (10)					-7 (20)
	Medium	-2 (40)	11 (50)	-25 (40)	-15 (30)					-17 (50)
	High	-2 (40)	-26 (50)	-41 (50)	-32 (50)					-33 (50)

Table 7b. Maximum percent change and decade (in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Nashville Warbler	Base	9 (10)	-11 (50)	-16 (50)	-6 (20)	139 (50)				-6 (50)
	Medium	18 (30)	-11 (50)	-22 (50)	-6 (20)	139 (50)				-4 (50)
	High	18 (30)	-5 (10)	-26 (50)	-3 (20)	128 (20)				-3 (20)
Northern Parula	Base	32 (50)	-22 (20)	13 (30)	-13 (50)					-7 (50)
	Medium	12 (30)	-24 (20)	-13 (30)	-27 (50)					-23 (50)
	High	-20 (50)	-47 (40)	-39 (50)	-49 (50)					-45 (50)
Yellow Warbler	Base	-13 (50)	-22 (50)	17 (20)	25 (30)	26 (30)	180 (40)	18 (10)	11 (40)	23 (30)
	Medium	22 (40)	18 (20)	66 (40)	44 (30)	58 (50)	220 (40)	18 (10)	28 (40)	47 (40)
	High	46 (50)	82 (40)	134 (50)	94 (50)	163 (50)	260 (50)	45 (50)	28 (40)	91 (50)
Chestnut-sided Warbler	Base	-13 (40)	-8 (50)	-4 (50)	16 (20)	25 (40)			19 (40)	11 (30)
	Medium	-8 (30)	8 (20)	15 (30)	24 (30)	33 (40)			25 (40)	17 (30)
	High	-6 (30)	23 (50)	35 (50)	37 (50)	67 (50)			31 (50)	33 (50)
Magnolia Warbler	Base	-11 (10)	-8 (20)	-21 (40)	-15 (40)					-17 (50)
	Medium	-15 (50)	-17 (50)	-29 (50)	-16 (50)					-19 (50)
	High	-17 (50)	-17 (10)	-29 (50)	-15 (10)					-19 (50)
Cape May Warbler	Base	20 (30)	27 (50)	-20 (10)	-14 (10)					13 (50)
	Medium	-14 (50)	9 (40)	-31 (50)	-25 (40)					-8 (10)
	High	-25 (50)	-40 (50)	-48 (50)	-44 (50)					-42 (50)
Black-throated Blue Warbler	Base		-19 (20)	-8 (40)						-8 (40)
	Medium		-17 (20)	-24 (40)						-23 (40)
	High		-45 (40)	-47 (50)						-47 (50)
Yellow-rumped Warbler	Base	17 (40)	19 (50)	-27 (10)	-8 (10)					-8 (10)
	Medium	-9 (50)	7 (50)	-38 (50)	-16 (40)					-13 (50)
	High	-22 (50)	-28 (50)	-51 (50)	-34 (50)					-31 (50)
Black-throated Green Warbler	Base	9 (50)	-8 (10)	9 (10)	-24 (50)					-16 (50)
	Medium	0 (10)	-15 (10)	-13 (40)	-32 (50)					-27 (50)
	High	-15 (50)	-44 (40)	-43 (50)	-52 (50)					-48 (50)
Blackburnian Warbler	Base	15 (40)	13 (50)	-13 (50)	-16 (50)					-9 (20)
	Medium	-19 (50)	-8 (10)	-25 (40)	-27 (50)					-20 (50)
	High	-30 (50)	-39 (40)	-48 (50)	-44 (50)					-43 (50)
Pine Warbler	Base	-10 (10)	21 (40)	-20 (10)	-7 (30)					-6 (40)
	Medium	-29 (50)	15 (40)	-26 (10)	-24 (40)					-19 (40)
	High	-40 (50)	-42 (40)	-43 (50)	-43 (40)					-42 (40)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Palm Warbler	Base	38 (50)	44 (50)		25 (30)					32 (50)
	Medium	16 (30)	18 (50)		17 (20)					13 (30)
	High	-18 (50)	-34 (50)		-33 (50)					-25 (50)
Bay-breasted Warbler	Base	20 (40)	18 (50)	-20 (10)						-10 (10)
	Medium	-7 (10)	7 (50)	-31 (50)						-13 (10)
	High	-27 (50)	-42 (50)	-48 (50)						-42 (50)
Cerulean Warbler	Base					-15 (30)	-36 (40)	-18 (40)		-24 (40)
	Medium					-18 (40)	-40 (40)	-18 (40)		-28 (40)
	High					-39 (50)	-45 (50)	-24 (50)		-40 (50)
Black-and-white Warbler	Base	8 (10)	10 (10)	6 (10)	4 (10)	-16 (30)				6 (10)
	Medium	8 (10)	13 (20)	9 (10)	13 (30)	-20 (40)				10 (40)
	High	15 (50)	34 (40)	3 (10)	16 (40)	-40 (50)				18 (40)
American Redstart	Base	-18 (30)	13 (10)	9 (10)	13 (20)	-6 (10)	-21 (40)	-15 (40)	31 (50)	11 (20)
	Medium	-20 (30)	13 (10)	9 (10)	6 (10)	-6 (10)	-22 (40)	-14 (40)	31 (50)	9 (20)
	High	-28 (40)	-29 (40)	0 (10)	-13 (50)	-6 (10)	-26 (50)	-20 (50)	24 (50)	-11 (50)
Prothonotary Warbler	Base					0 (10)	9 (50)			-6 (10)
	Medium					0 (10)	0 (10)			-6 (10)
	High					0 (10)	0 (10)			-5 (10)
Ovenbird	Base	-12 (20)	-9 (20)	-9 (40)	-21 (50)	-11 (30)	-32 (40)	0 (10)	35 (50)	-15 (30)
	Medium	-24 (40)	-11 (20)	-18 (40)	-29 (50)	-16 (30)	-34 (40)	0 (10)	35 (50)	-23 (40)
	High	-35 (50)	-39 (40)	-33 (50)	-44 (50)	-37 (50)	-40 (50)	-20 (30)	19 (50)	-40 (50)
Northern Waterthrush	Base	6 (40)	43 (40)	8 (30)	3 (10)					33 (50)
	Medium	6 (50)	43 (40)	6 (30)	5 (50)					34 (50)
	High	6 (50)	30 (40)	-5 (40)	5 (50)					28 (50)
Louisiana Waterthrush	Base				20 (20)	50 (10)	0 (10)	-100 (10)		11 (50)
	Medium				20 (20)	50 (10)	0 (10)	-100 (10)		10 (30)
	High				20 (20)	50 (10)	0 (10)	-100 (10)		7 (20)
Connecticut Warbler	Base	34 (40)	30 (50)	-32 (50)	23 (30)					22 (50)
	Medium	14 (30)	-7 (40)	-39 (50)	15 (20)					7 (20)
	High	-20 (50)	-39 (50)	-65 (50)	-38 (50)					-37 (50)
Mourning Warbler	Base	-7 (40)	-7 (40)	-12 (40)	28 (20)	27 (40)	-13 (10)			13 (20)
	Medium	3 (50)	4 (10)	8 (50)	33 (20)	36 (50)	-13 (10)			19 (30)
	High	7 (50)	11 (10)	19 (50)	44 (50)	73 (50)	-13 (10)			29 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Common Yellowthroat	Base	-13 (50)	-19 (50)	21 (10)	15 (20)	33 (30)	183 (40)	59 (30)	20 (40)	15 (20)
	Medium	22 (40)	23 (20)	50 (20)	29 (30)	58 (40)	233 (50)	53 (30)	33 (40)	29 (30)
	High	46 (50)	79 (40)	79 (40)	58 (50)	167 (50)	254 (50)	76 (50)	40 (40)	64 (50)
Hooded Warbler	Base					0 (10)	-25 (10)			-25 (40)
	Medium					0 (10)	-50 (40)			-30 (40)
	High					-33 (40)	-50 (40)			-41 (50)
Wilson's Warbler	Base		20 (10)							20 (10)
	Medium		20 (10)							20 (10)
	High		100 (40)							100 (40)
Canada Warbler	Base	-5 (30)	0 (10)	-6 (30)	-14 (50)					-11 (50)
	Medium	-3 (30)	0 (10)	-6 (20)	-10 (50)					-7 (50)
	High	3 (10)	9 (10)	-12 (40)	4 (10)					4 (10)
Yellow-breasted Chat	Base						233 (40)			233 (40)
	Medium						233 (40)			233 (40)
	High						233 (40)			233 (50)
Scarlet Tanager	Base	-12 (20)	-7 (10)	-6 (40)	-22 (30)	-17 (30)	-34 (40)	0 (10)	43 (50)	-19 (30)
	Medium	-23 (40)	-13 (20)	-22 (40)	-30 (30)	-21 (40)	-37 (40)	0 (10)	43 (50)	-26 (40)
	High	-36 (50)	-43 (40)	-45 (50)	-46 (50)	-43 (50)	-43 (50)	-20 (30)	21 (30)	-44 (50)
Northern Cardinal	Base				-26 (30)	18 (50)	-14 (40)	39 (50)		-10 (40)
	Medium				-32 (30)	9 (30)	-19 (40)	39 (50)		-15 (40)
	High				-49 (50)	-9 (50)	-21 (40)	30 (40)		-18 (40)
Rose-breasted Grosbeak	Base	-13 (30)	-14 (50)	-7 (20)	10 (20)	18 (50)	17 (50)	39 (50)	26 (50)	6 (10)
	Medium	-11 (30)	7 (10)	7 (10)	13 (20)	14 (40)	17 (50)	39 (50)	26 (50)	7 (20)
	High	-12 (30)	14 (10)	-20 (30)	15 (40)	14 (50)	17 (50)	30 (40)	26 (50)	9 (50)
Indigo Bunting	Base	-19 (30)	105 (20)	12 (20)	10 (20)	16 (50)	209 (40)	38 (50)	25 (50)	9 (20)
	Medium	-21 (40)	118 (20)	40 (40)	17 (30)	21 (50)	245 (50)	38 (50)	25 (40)	16 (30)
	High	-27 (40)	182 (30)	86 (50)	33 (50)	37 (50)	264 (50)	44 (50)	25 (40)	31 (50)
Rufous-sided Towhee	Base	-15 (50)			130 (30)	33 (30)	230 (40)			131 (30)
	Medium	16 (40)			152 (30)	56 (50)	270 (50)			153 (30)
	High	35 (50)			174 (50)	159 (50)	300 (50)			179 (50)
Chipping Sparrow	Base	-7 (10)	-6 (10)	-12 (10)	-5 (50)	21 (50)	-12 (40)	40 (50)	24 (50)	-2 (10)
	Medium	-7 (10)	-6 (10)	-20 (50)	-12 (50)	28 (50)	-16 (40)	40 (50)	24 (50)	-8 (50)
	High	-20 (50)	-19 (30)	-33 (50)	-26 (50)	46 (50)	-18 (40)	36 (50)	21 (50)	-19 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
Song Sparrow	Base	-13 (50)	19 (20)	12 (20)	32 (30)	32 (30)	216 (40)	61 (30)	-9 (20)	22 (30)
	Medium	22 (40)	22 (20)	56 (40)	53 (30)	53 (50)	255 (50)	56 (30)	22 (40)	41 (40)
	High	42 (50)	81 (40)	118 (50)	94 (50)	153 (50)	282 (50)	78 (50)	31 (40)	84 (50)
Lincoln's Sparrow	Base	-72 (50)	-75 (50)	-56 (10)	-54 (40)					-66 (50)
	Medium	-44 (30)	-62 (50)	-56 (10)	-34 (20)					-41 (50)
	High	-43 (30)	-45 (20)	60 (50)	-36 (20)					-41 (20)
White-throated Sparrow	Base	7 (20)	-7 (50)	-9 (50)	-11 (30)	20 (50)				-9 (50)
	Medium	14 (40)	-6 (50)	5 (30)	-11 (30)	20 (50)				-6 (30)
	High	21 (50)	13 (40)	21 (50)	-8 (20)	20 (50)				-4 (20)
Dark-eyed Junco	Base	-10 (10)	11 (50)	-43 (50)	-30 (40)					-21 (50)
	Medium	-17 (50)	-5 (20)	-46 (50)	-20 (20)					-19 (50)
	High	-22 (50)	-29 (50)	-48 (50)	-20 (20)					-16 (20)
Rusty Blackbird	Base		60 (20)							60 (20)
	Medium		80 (50)							80 (50)
	High		100 (40)							100 (40)
Common Grackle	Base	-13 (50)	-23 (50)	16 (20)	37 (30)	32 (30)	213 (40)	56 (30)	15 (40)	20 (30)
	Medium	19 (40)	21 (20)	66 (40)	57 (30)	56 (50)	254 (50)	52 (30)	23 (40)	35 (30)
	High	44 (50)	74 (40)	125 (50)	92 (50)	160 (50)	284 (50)	74 (50)	38 (40)	97 (50)
Brown-headed Cowbird	Base	-17 (30)	-18 (50)	4 (10)	20 (20)	24 (50)	30 (50)	40 (50)	22 (50)	8 (30)
	Medium	-13 (30)	-12 (40)	-8 (40)	20 (20)	32 (50)	30 (50)	39 (50)	22 (50)	15 (50)
	High	-17 (30)	18 (50)	-12 (40)	40 (40)	46 (50)	30 (50)	37 (50)	22 (50)	29 (50)
Orchard Oriole	Base					13 (40)	-15 (40)	43 (50)		-8 (10)
	Medium					13 (50)	-18 (40)	43 (50)		-8 (40)
	High					-13 (50)	-22 (40)	29 (40)		-11 (40)
Northern Oriole	Base	-19 (30)	-17 (20)	-9 (20)	-26 (30)	21 (50)	-14 (40)	41 (50)	14 (30)	-22 (30)
	Medium	-22 (40)	-17 (20)	-25 (40)	-32 (30)	13 (50)	-18 (40)	41 (50)	17 (50)	-27 (50)
	High	-31 (50)	-33 (30)	-48 (50)	-49 (50)	-10 (50)	-22 (40)	35 (50)	7 (30)	-44 (50)
Purple Finch	Base	4 (50)	-6 (20)	-35 (40)	-22 (40)	13 (40)	-14 (10)			-18 (50)
	Medium	-13 (40)	-11 (30)	-44 (40)	-36 (40)	13 (50)	-14 (10)			-28 (40)
	High	-23 (50)	-44 (40)	-55 (50)	-48 (50)	-13 (50)	-29 (40)			-45 (50)
Red Crossbill	Base	39 (50)	20 (20)	0 (10)	-13 (10)					14 (50)
	Medium	8 (20)	-17 (10)	-50 (50)	-19 (30)					-10 (50)
	High	-15 (50)	-40 (40)	-33 (40)	-40 (50)					-33 (50)

Table 7b. Maximum percent change and decade(in parenthesis) by ecoregion and statewide for three harvest scenarios for timberland.

Species	Harvest scenario	Ecoregion 1	2	3	4	5	6	7&8	9	Statewide
White-winged Crossbill	Base	27 (50)	20 (20)	0 (10)	-13 (10)					10 (50)
	Medium	-7 (10)	-17 (10)	-50 (50)	-19 (30)					-13 (50)
	High	-20 (50)	-40 (40)	-33 (40)	-40 (50)					-35 (50)
Pine Siskin	Base	-12 (10)	11 (40)	-20 (10)	-14 (20)	-100 (10)			80 (40)	-13 (40)
	Medium	-30 (50)	-9 (10)	-28 (10)	-24 (30)	-100 (10)			60 (40)	-26 (40)
	High	-44 (50)	-46 (40)	-43 (50)	-48 (40)	-100 (10)			60 (20)	-44 (40)
American Goldfinch	Base	-13 (50)	-45 (50)	17 (20)	40 (30)	34 (30)	212 (40)	59 (30)	10 (40)	33 (30)
	Medium	22 (40)	-41 (50)	64 (40)	60 (30)	71 (50)	264 (50)	53 (30)	30 (40)	51 (30)
	High	46 (50)	76 (40)	134 (50)	100 (50)	168 (50)	290 (50)	76 (50)	40 (40)	99 (50)
Evening Grosbeak	Base	-18 (40)	22 (50)	-17 (10)	14 (50)					11 (50)
	Medium	-24 (50)	-7 (10)	-28 (50)	-14 (40)					-11 (50)
	High	-24 (40)	-41 (50)	-43 (50)	-45 (50)					-45 (50)

Table 8a. Projection of number of acres within habitats and size classes for the fifth decade for three harvest levels on all forest lands.

Forest Covertype	Timber Size Class			
	Seedling/sapling	Pole	Saw	Total
Base Scenario				
Pines	166,890	177,137	758,962	
Black spruce/tamarack	555,555	1,521,863	363,387	
Balsam fir/white spruce	158,489	211,995	712,933	
Northern white cedar	35,774	67,131	307,166	
Oak/hickory	412,596	138,294	856,734	
Elm/ash/cottonwood	330,782	392,084	1,151,802	
Maple/basswood	223,958	149,851	1,123,324	
Aspen/balsam poplar	3,027,742	1,912,869	1,166,155	
Paper birch	170,095	146,764	616,647	
Total	5,081, 881	4,717,988	7,057,110	16,856,979
Medium Scenario				
Pines	178,578	194,086	705,050	
Black spruce/tamarack	897,624	1,249,666	263,438	
Balsam fir/white spruce	185,653	253,527	559,988	
Northern white cedar	67,970	67,431	284,229	
Oak/hickory	487,787	140,158	731,841	
Elm/ash/cottonwood	496,192	378,653	970,652	
Maple/basswood	354,995	136,933	913,544	
Aspen/balsam poplar	3,226,733	2,037,788	1,138,107	
Paper birch	259,592	138,540	538,224	
Total	6,155,124	4,596,782	6,105,073	16,856,979
High Scenario				
Pines	308,299	229,345	468,332	
Black spruce/tamarack	1,183,903	1,107,763	128,745	
Balsam fir/white spruce	330,699	174,656	440,543	
Northern white cedar	109,250	62,113	248,450	
Oak/hickory	586,325	161,615	643,547	
Elm/ash/cottonwood	706,834	404,877	740,409	
Maple/basswood	553,063	147,326	591,739	
Aspen/balsam poplar	4,105,735	1,538,096	1,013,503	
Paper birch	346,585	184,701	340,526	
Total	8,230,693	4,010,492	4,615,794	16,856,979

Table 8b. Projection of number of acres within habitats and size classes for the fifth decade for three harvest levels on timberlands.

	Timber Size Class			
Forest Covertype	Seedling/sapling	Pole	Saw	Total
Base Scenario				
Pines	166,890	177,137	579,062	
Black spruce/tamarack	383,351	936,463	360,087	
Balsam fir/white spruce	158,489	173,995	552,833	
Northern white cedar	35,774	51,231	273,866	
Oak/hickory	412,596	130,882	826,721	
Elm/ash/cottonwood	330,782	347,139	1,066,094	
Maple/basswood	223,958	144,572	1,091,712	
Aspen/balsam poplar	3,027,742	1,876,832	747,866	
Paper birch	170,095	137,233	496,047	
Total	4,909,677	3,975,484	5,994,288	14,879,449
Medium Scenario				
Pines	178,578	194,086	525,150	
Black spruce/tamarack	725,420	664,266	260,138	
Balsam fir/white spruce	185,653	215,527	399,888	
Northern white cedar	67,970	51,531	250,929	
Oak/hickory	487,787	132,746	701,828	
Elm/ash/cottonwood	496,192	333,708	884,944	
Maple/basswood	354,995	131,654	881,932	
Aspen/balsam poplar	3,226,733	2,001,751	719,818	
Paper birch	259,592	129,009	417,624	
Total	5,982,920	3,854,278	5,042,251	14,879,449
High Scenario				
Pines	308,299	229,345	288,432	
Black spruce/tamarack	1,011,699	522,363	125,445	
Balsam fir/white spruce	330,699	136,656	280,443	
Northern white cedar	109,250	46,213	215,150	
Oak/hickory	586,325	154,203	613,534	
Elm/ash/cottonwood	706,834	359,932	654,701	
Maple/basswood	553,063	142,047	560,127	
Aspen/balsam poplar	4,105,735	1,502,059	595,214	
Paper birch	346,585	175,170	219,926	
Total	8,058,489	3,267,988	3,552,972	14,879,449

Table 9. Species placement within cells defined by vulnerability index and projected changes under three harvest scenarios. See Figure 5 for interpolation of cells. Cell 1 = low vulnerability and projected decrease, Cell 2 = low vulnerability and projected increase, Cell 3 = high vulnerability and projected decrease, Cell 4 = high vulnerability and projected increase.

	Cell 1			Cell 2			Cell 3			Cell 4		
Species	Base	Medium	High	Base	Medium	High	Base	Medium	High	Base	Medium	High
American Black Duck										x	x	x
Common Goldeneye										x	x	x
Bufflehead										x	x	x
Common Merganser										x	x	x
Osprey										x	x	x
Bald Eagle										x	x	x
Sharp-shinned Hawk			x									
Northern Goshawk									x			
Red-Shouldered Hawk							x	x	x			
Broad-winged Hawk			x									
American Kestrel										x	x	x
Merlin									x			
Mourning Dove				x	x	x						
Yellow-billed Cuckoo										x	x	x
Barred Owl			x									
Long-eared Owl			x									
Boreal Owl									x			
Northern Saw-whet Owl									x			
Chimney Swift										x	x	x
Yellow-bellied Sapsucker			x									
Northern Flicker						x						
Pileated Woodpecker			x									
Olive-sided Flycatcher						x						
Eastern Wood-Pewee			x									
Yellow-bellied Flycatcher										x		
Acadian Flycatcher									x			
Least Flycatcher			x									
Great Crested Flycatcher			x									
Tree Swallow				x	x	x						
Blue Jay			x									
Black-billed Magpie										x	x	x
American Crow			x									
Common Raven			x									
Black-capped Chickadee			x									
White-breasted Nuthatch			x									
Brown Creeper			x									
Golden-crowned Kinglet									x			
Blue-gray Gnatcatcher									x			
Eastern Bluebird					x	x						
Hermit Thrush			x									
Wood Thrush								x	x			
American Robin						x						
Gray Catbird				x	x	x						

Table 9. Species placement within cells defined by vulnerability index and projected changes under three harvest scenarios. See Figure 5 for interpolation of cells. Cell 1 = low vulnerability and projected decrease, Cell 2 = low vulnerability and projected increase, Cell 3 = high vulnerability and projected decrease, Cell 4 = high vulnerability and projected increase.

	Cell 1			Cell 2			Cell 3			Cell 4		
Species	Base	Medium	High	Base	Medium	High	Base	Medium	High	Base	Medium	High
Brown Thrasher					x	x						
Loggerhead Shrike										x	x	x
Bell's Vireo										x	x	x
Solitary Vireo									x			
Yellow-throated Vireo							x	x	x			
Red-eyed Vireo			x									
Blue-winged Warbler										x	x	x
Golden-winged Warbler										x	x	x
Northern Parula			x									
Yellow Warbler					x	x						
Chestnut-sided Warbler						x						
Black-throated Blue Warbler									x			
Black-throated Green Warbler			x									
Blackburnian Warbler			x									
Pine Warbler									x			
Palm Warbler										x		
Cerulean Warbler								x	x			
Ovenbird			x									
Mourning Warbler						x						
Common Yellowthroat						x						
Hooded Warbler							x	x	x			
Wilson's Warbler							x	x				x
Yellow-breasted Chat										x	x	x
Scarlet Tanager			x									
Indigo Bunting						x						
Rufous-sided Towhee										x	x	x
Song Sparrow					x	x						
Lincoln's Sparrow							x	x	x			
Common Grackle						x						
Brown-headed Cowbird						x						
Northern Oriole		x	x									
Purple Finch			x									
Pine Siskin									x			
American Goldfinch				x	x	x						
Evening Grosbeak									x			

APPENDIX 6
Small- and Medium-sized Mammal Impact Matrices

A L M H
0 2 5 10

Table A. Matrix of projected presence and density of mammals in different forest types and sizes (ages). A = absent; L = low abundance; M = medium abundance; and H = high abundance. Under specific conditions the value in parentheses is the projected density as follows: a = moist sites; b = sites where white spruce trees are present; c = sites where at least 40 oak trees per acre are present; d = sites near agriculture; e = site which are tree plantations.

Forest type	Size	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Jack pine	Saw	A (L)[a]	H	A	M	A (H)[c]	A (M)[c]	A	H	A	L	L
	Pole	A (L)[a]	M	L	L	A (L)[c]	A (L)[c]	A	M	A	L	L
	Seed/Sap	L (M)[a]	M	L	A	A	A	A	A	A (L)[a]	L	L
Red pine	Saw	A (L)[a]	H	A	H	A (M)[c]	A (L)[c]	A	M	A	H	L
	Pole	A (L)[a]	M	L	M	A (L)[c]	A (L)[c]	A	M	A	H	L
	Seed/Sap	L (M)[a]	M	L	A	A	A	A	A	A	M	L
White pine	Saw	A (L)[a]	H	A	H	A (M)[c]	A (L)[c]	A (M)[c]	M	A	H	L (H)[c]
	Pole	A (L)[a]	M	L	M	A (L)[c]	A (L)[c]	A (M)[c]	M	A	H	L (H)[c]
	Seed/Sap	L (M)[a]	M	L	A	A	A	A	A	A (L)[a]	M	L
Black spruce	Saw	M (H)[a]	A	A	H	A	A	A	H	A (L)[a]	M (L)[a]	L
	Pole	M (H)[a]	A	A	M	A	A	A	M	A (L)[a]	M (L)[a]	L
	Seed/Sap	M (H)[a]	A	A	A	A	A	A	A	A (L)[a]	M (L)[a]	L
Balsam fir	Saw	H	A	A	L (H)[b]	A	A	A	H	A (L)[a]	H (M)[a]	L
	Pole	H	A	A	L (M)[b]	A	A	A	M	A (L)[a]	M (L)[a]	L
	Seed/Sap	H	A	A	A	A	A	A	A	A (L)[a]	M (L)[a]	L

Table A. Continued.

Forest type	Size	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Jack pine	Saw	L (M)[a]	A	A (L)[a]	L	L	L (M)[d]	L	H (M)[e]	M (L)[e]	L	L
	Pole	L (M)[a]	A	A (L)[a]	L	L	L (M)[d]	A	L (A)[e]	M (L)[e]	L	L
	Seed/Sap	L (M)[a]	A (L)[a]	A (L)[a]	A (L)[a]	A	L (M)[d]	A	A	L	L	L
Red pine	Saw	L (M)[a]	A	A (L)[a]	L	L	L (M)[d]	L	H (M)[e]	M (L)[e]	L	L
	Pole	L (M)[a]	A	A (L)[a]	L	L	L (M)[d]	A	L (A)[e]	M (L)[e]	L	L
	Seed/Sap	L (M)[a]	A (L)[a]	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	L	L	L
White pine	Saw	L (M)[a]	A	A (L)[a]	L (M)[a]	H	L (M)[d]	L	H (M)[e]	M (L)[e]	L	L
	Pole	L (M)[a]	A	A (L)[a]	L (M)[a]	H	L (M)[d]	A	L (A)[e]	M (L)[e]	L	L
	Seed/Sap	L (M)[a]	A (L)[a]	L (M)[a]	A (L)[a]	L	L (M)[d]	A	A	L	L	L
Black spruce	Saw	L	L	A (L)[a]	L (M)[a]	A	L	A	M	M	H	H
	Pole	L	L	A (L)[a]	L (M)[a]	A	L	A	L	M	H	H
	Seed/Sap	L	M	L (M)[a]	L	A	L (M)[d]	A	A	L	H	H
Balsam fir	Saw	L	L	A (L)[a]	L (M)[a]	L	L	A	H	H	H	H
	Pole	L	L	A (L)[a]	L (M)[a]	L	L (M)[d]	A	L	H	H	H
	Seed/Sap	L	A (L)[a]	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	L	H	H

Table A. Continued.

Forest type	Size	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Northern white-cedar	Saw	H	A	A	H (L)[b]	A	A	A	H	A (L)[a]	M (L)[a]	L
	Pole	H	A	L	L	A	A	A	M	A (L)[a]	M (L)[a]	L
	Seed/Sap	H	A	L	A	A	A	A	A	A (L)[a]	M (L)[a]	L
Tamarack	Saw	L	A	A	L	A	A	A	M	A (L)[a]	M (L)[a]	M
	Pole	L	A	L	L	A	A	A	L	A (L)[a]	M (L)[a]	L
	Seed/Sap	M	A	L	A	A	A	A	A	A (L)[a]	M (L)[a]	L
White spruce	Saw	M (H)[a]	A	A	H	A	A	A	M	A (L)[a]	H (M)[a]	L
	Pole	M (H)[a]	L	L	M	A	A	A	M	A (L)[a]	H (M)[a]	L
	Seed/Sap	M (H)[a]	M	L	A	A	A	A	A	A (L)[a]	M (L)[a]	L
Oak	Saw	L	H	A	M	H	H	H	M	A	M	H
	Pole	L	H	L	L	H	H	H	M	A	L	H
	Seed/Sap	L	H	L	A	L	L	L	L	A	L	H
Elm-ash-cottonwood	Saw	L	M	A	L (M)[b]	A (L)[c]	A (L)[c]	M	L	A	L	H
	Pole	L	L	L	L (M)[b]	A (L)[c]	A (L)[c]	M	L	L	L	H
	Seed/Sap	L	L	L	A	A	A	A	A	L	L	H

Table A. Continued.

Forest type	Size	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Northern white-cedar	Saw	H	A	A (L)[a]	L (M)[a]	L	L	A	H	H	H	H
	Pole	H	A	A (L)[a]	L (M)[a]	L	L (M)[d]	A	L	H	H	H
	Seed/Sap	M	A (L)[a]	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	L	H	H
Tamarack	Saw	H	A	L	L	A	A	A	L	H	L	L
	Pole	H	A	M	L	A	A	A	A	H	L	L
	Seed/Sap	H	A (L)[a]	M	L	A	A	A	A	L	L	L
White spruce	Saw	M (H)[a]	A	A	L (M)[a]	L	L (M)[d]	A	H (M)[c]	H (M)[c]	M (H)[a]	M (H)[a]
	Pole	M (H)[a]	A	A	L (M)[a]	L	L (M)[d]	A	L (A)[c]	L (A)[c]	M (H)[a]	M (H)[a]
	Seed/Sap	L (M)[a]	A (L)[a]	L (M)[a]	A	A	L (M)[d]	A	A	A	M (H)[a]	M (H)[a]
Oak	Saw	L	A	A (L)[a]	L	M	L (M)[d]	H	A	A	L	L
	Pole	L	A	A (L)[a]	L	M	M (H)[d]	H	A	A	L	L
	Seed/Sap	L	A	L	A (L)[a]	L	M (H)[d]	M	A	A	L	L
Elm-ash-cottonwood	Saw	L (M)[a]	A	L (M)[a]	M	M	L	H	M	L	L	L
	Pole	L (M)[a]	A	L (M)[a]	M	M	L (M)[d]	H	L	L	L	L
	Seed/Sap	L (M)[a]	A	M (H)[a]	L	A	L (M)[d]	M	A	L	L	L

Table A. Continued.

Forest type	Size	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Maple-basswood	Saw	L	M	A	L (M)[b]	A (H)[c]	A (H)[c]	H	L	A	M	H
	Pole	L	L	A	L (M)[b]	A (M)[c]	A (M)[c]	M	L	A	M	M
	Seed/Sap	L	L	L	A	A	A	A	A	A	M	M
Aspen-birch	Saw	L	H	A	L (M)[b]	A (L)[c]	A (L)[c]	M	L	L	H	H
	Pole	L (M)[a]	H	A	L	A (L)[c]	A (L)[c]	M	L	M (H)[a]	M	H
	Seed/Sap	L (M)[a]	M	M	A	A	A	A	A	M (H)[a]	L	M
Aspen	Saw	L	H	A	L (M)[b]	A (L)[c]	A (L)[c]	M	L	L	H	H
	Pole	L (M)[a]	H	A	L	A (L)[c]	A (L)[c]	M	L	M	M	H
	Seed/Sap	L (M)[a]	M	M	A	A	A	A	A	H	L	M
Paper birch	Saw	L	H	A	L (M)[b]	A (L)[c]	A (L)[c]	M	L	L	H	H
	Pole	L (M)[a]	H	A	L	A (L)[c]	A (L)[c]	M	L	M	M	H
	Seed/Sap	L (M)[a]	M	M	A	A	A	A	A	M	L	L
Balsam poplar	Saw	M (H)[a]	L	A	L (M)[b]	A	A	L	L	L	L	H
	Pole	M (H)[a]	L	A	L	A	A	L	L	M	L	H
	Seed/Sap	M (H)[a]	L	M	A	A	A	A	A	H	L	L

Table A. Continued.

Forest type	Size	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Maple-basswood	Saw	L (M)[a]	A	A (L)[a]	L (M)[a]	H	L (M)[d]	H	L	M	A	A
	Pole	L (M)[a]	A	A (L)[a]	L (M)[a]	H	M (H)[d]	M	A	L	A	A
	Seed/Sap	L (M)[a]	A	L (M)[a]	L	M	M (H)[d]	L	A	L	A	A
Aspen-birch	Saw	M (H)[a]	A	A (L)[a]	L (M)[a]	M	L (M)[d]	H	M	M	A (L)[a]	L
	Pole	M (H)[a]	A	A (L)[a]	L (M)[a]	M	M (H)[d]	M	L	L	A (L)[a]	L
	Seed/Sap	M (H)[a]	A (L)[a]	L (M)[a]	L	L	M (H)[d]	M	A	L	A (L)[a]	M
Aspen	Saw	M (H)[a]	A	A (L)[a]	L (M)[a]	M	L (M)[d]	H	M	M	A (L)[a]	L
	Pole	M (H)[a]	A	L (M)[a]	L (M)[a]	M	M (H)[d]	M	L	L	A (L)[a]	L
	Seed/Sap	M (H)[a]	A	M (H)[a]	L	L	M (H)[d]	M	A	L	A (L)[a]	L
Paper birch	Saw	M (H)[a]	A	A (L)[a]	L (M)[a]	L	L (M)[d]	M	M	M	A (L)[a]	L
	Pole	M (H)[a]	A	A (L)[a]	L (M)[a]	L	M (H)[d]	L	L	L	A (L)[a]	L
	Seed/Sap	M (H)[a]	L	L (M)[a]	L	A	M (H)[d]	L	A	L	A (L)[a]	L
Balsam poplar	Saw	M (H)[a]	A	L (M)[a]	L (M)[a]	L	L (M)[d]	M	M	M	A (L)[a]	L
	Pole	M (H)[a]	A	L (M)[a]	L (M)[a]	L	M (H)[d]	L	L	L	A (L)[a]	L
	Seed/Sap	M (H)[a]	L	M (H)[a]	L	A	M (H)[d]	L	A	L	A (L)[a]	L

Table B. Matrix of projected presence and density of mammals in different forest types and stand sizes of unproductive forest lands; note that not all forest types are represented in unproductive forests. A = absent; L = low abundance; M = medium abundance; and H = high abundance.

Forest type	Size	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Black spruce	Saw	H	A	A	H	A	A	A	M	L	L	L
	Pole	H	A	A	M	A	A	A	L	L	L	L
	Seed/Sap	H	A	L	A	A	A	A	A	L	L	L
Balsam fir	Saw	H	A	A	L	A	A	A	M	L	L	L
	Pole	H	A	A	L	A	A	A	L	L	L	L
	Seed/Sap	H	A	A	A	A	A	A	A	L	L	L
Northern white cedar	Saw	H	A	A	M	A	A	A	M	L	M	L
	Pole	H	A	A	M	A	A	A	L	L	L	L
	Seed/Sap	H	A	A	A	A	A	A	A	L	A	A
Tamarack	Saw	M	A	A	M	A	A	A	M	L	M	L
	Pole	M	A	A	M	A	A	A	L	L	L	L
	Seed/Sap	M	A	A	A	A	A	A	A	L	L	L

Table B. continued.

Forest type	Size	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Black spruce	Saw	M	A	L	L	A	L	A	L	H	H	H
	Pole	M	L	M	L	A	L	A	A	M	H	H
	Seed/Sap	L	L	M	A	A	L	A	A	M	H	H
Balsam fir	Saw	M	A	L	L	A	L	A	L	H	H	H
	Pole	M	L	M	L	A	L	A	A	M	H	H
	Seed/Sap	L	L	M	A	A	L	A	A	L	H	H
Northern white cedar	Saw	H	A	L	L	L	L	A	L	H	H	H
	Pole	M	L	M	L	A	L	A	A	M	H	H
	Seed/Sap	L	L	M	A	A	L	A	A	M	H	H
Tamarack	Saw	M	A	L	L	L	L	A	A	M	H	H
	Pole	M	A	M	A	A	L	A	A	L	H	H
	Seed/Sap	L	L	M	A	A	L	A	A	L	H	H

Table B. continued.

Forest type	Size	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Oak	Saw	A	M	A	L	L	M	M	A	A	A	M
	Pole	A	M	A	L	L	M	L	A	A	A	L
	Seed/Sap	A	L	A	A	A	A	A	A	A	A	L
Elm-ash-cottonwood	Saw	L	M	A	L	A	A	L	L	A	L	M
	Pole	L	L	A	L	A	A	L	A	L	L	M
	Seed/Sap	L	L	A	A	A	A	A	A	L	L	A
Maple-basswood	Saw	L	M	A	L	L	L	L	L	A	M	H
	Pole	L	L	A	L	A	A	L	A	L	M	M
	Seed/Sap	L	A	A	A	A	A	A	A	L	L	M
Aspen	Saw	L	M	A	L	L	L	M	L	L	M	H
	Pole	L	M	A	L	A	A	L	L	M	M	M
	Seed/Sap	L	L	L	A	A	A	A	A	M	L	L
Paper birch	Saw	A	L	A	L	A	A	L	A	L	A	M
	Pole	A	L	A	A	A	A	L	A	L	A	M
	Seed/Sap	A	A	A	A	A	A	A	A	L	A	L

Table B. continued.

Forest type	Size	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Oak	Saw	L	L	A	A	L	L	L	A	A	A	A
	Pole	L	M	L	A	A	L	L	A	A	A	A
	Seed/Sap	A	M	L	A	A	M	L	A	A	A	A
Elm-ash-cottonwood	Saw	M	L	L	L	L	L	L	A	L	L	L
	Pole	M	L	M	L	L	L	L	A	L	L	L
	Seed/Sap	A	M	M	A	A	L	L	A	A	L	L
Maple-basswood	Saw	L	A	A	L	M	L	M	A	L	A	A
	Pole	L	A	A	L	M	M	M	A	A	A	A
	Seed/Sap	L	L	L	A	A	M	L	A	A	A	A
Aspen	Saw	M	A	A	L	M	L	M	L	M	L	L
	Pole	M	L	L	L	M	M	M	L	L	L	L
	Seed/Sap	M	M	M	A	A	M	A	A	L	L	L
Paper birch	Saw	L	A	A	L	L	L	M	A	A	A	A
	Pole	L	L	L	L	L	M	L	A	A	A	A
	Seed/Sap	L	L	M	A	A	M	L	A	A	A	A

Table C. Matrix of projected densities of mammals in different forest types during the first decade following clearcutting; see text for further detail. Density codes and superscripts are as indicated for table 1.

Forest type	Snowshoe Hare	Eastern Chipmunk	Least Chipmunk	Red Squirrel	Gray Squirrel	Fox Squirrel	Southern Flying Squirrel	Northern Flying Squirrel	Beaver	Woodland Deer Mouse	White-footed Mouse
Jack pine	L	M	H	A	A	A	A	A	A	M	A
Red pine	L	M	H	A	A	A	A	A	A	M	A
White pine	L	M	H	A	A	A	A	A	A	M	A
Black spruce	M	A	H	A	A	A	A	A	A	M (L)[a]	A
Balsam fir	M	A	H	A	A	A	A	A	A	L	A
Northern white-cedar	M	A	M	A	A	A	A	A	A	M (L)[a]	A
Tamarack	L	A	L	A	A	A	A	A	A	L	A
White spruce	M	L	H	A	A	A	A	A	A	M (L)[a]	A
Oak	L	L	A	A	A	A	A	A	A	L	L
Elm-ash-cottonwood	L	L	A	A	A	A	A	A	A	L	L
Maple-basswood	L	L	L	A	A	A	A	A	A	L	L
Aspen-birch	L	L	L	A	A	A	A	A	L (M)[a]	L	L
Aspen	L	L	M	A	A	A	A	A	L (M)[a]	L	L
Paper birch	L	L	M	A	A	A	A	A	L (M)[a]	L	L
Balsam poplar	L	L	L	A	A	A	A	A	L (M)[a]	L	L

Table C. Continued.

Forest type	Southern Red-backed Vole	Meadow Vole	Meadow Jumping Mouse	Woodland Jumping Mouse	Porcupine	Red Fox	Gray Fox	Marten	Fisher	Lynx	Bobcat
Jack pine	L	L (M)[a]	A (L)[a]	A (L)[a]	A	L (M)[d]	A	A	A	A (L)[a]	A (L)[a]
Red pine	L	L (M)[a]	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	A (L)[a]	A (L)[a]
White pine	L	M	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	A (L)[a]	A (L)[a]
Black spruce	M	M	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	L (M)[a]	L (M)[a]
Balsam fir	M	M	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	L (M)[a]	L (M)[a]
Northern white-cedar	M	M	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	L (M)[a]	L (M)[a]
Tamarack	M	H	M	L	A	A	A	A	A	L	L
White spruce	L	A (L)[a]	L (M)[a]	A (L)[a]	A	L (M)[d]	A	A	A	L (M)[a]	L (M)[a]
Oak	L	A	A (L)[a]	A (L)[a]	A	M (H)[d]	L	A	A	A	A
Elm-ash-cottonwood	L	M	M (H)[a]	L	A	L (M)[d]	L	A	A	A	A
Maple-basswood	L	A (L)[a]	L (M)[a]	A (L)[a]	A	M (H)[d]	L	A	A	A	A
Aspen-birch	L	L	L (M)[a]	L	A	M (H)[d]	L	A	A	A (L)[a]	L
Aspen	A (L)[a]	A (L)[a]	M (H)[a]	A (L)[a]	A	M (H)[d]	L	A	A	A (L)[a]	L
Paper birch	A (L)[a]	A (L)[a]	L (M)[a]	A (L)[a]	A	M (H)[d]	L	A	A	A (L)[a]	A (L)[a]
Balsam poplar	A (L)[a]	A (L)[a]	A (L)[a]	A (L)[a]	A	L (M)[d]	L	A	A	A (L)[a]	A (L)[a]