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Central Platte River Forests: Breeding Birds and Woody Vegetation

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CENTRAL PLATTE RIVER FORESTS: BREEDING BIRDS AND WOODY VEGETATION

by

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CENTRAL PLATTE RIVER FORESTS: BREEDING BIRDS AND WOODY VEGETATION

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The character of the Central Platte River, situated in the southern half of Nebraska, and its associated habitat have changed dramatically over the last century. The former grassland/wet meadow habitat in this riparian landscape has essentially been replaced with long, narrow strips of patchy forests. Endemic grassland bird species have lost habitat in this area, just as many woodland avian species have lost habitat elsewhere. Some of those displaced species are now found in these relatively new woods. This study documents both the avian and woody vegetation species now occurring in the Big Bend Reach of the Platte River.

This two-part study was conducted on the Central Platte River in 1993 and 1994, and both breeding avian populations and woody vegetation were sampled on nine sites, extending from Elm Creek to Chapman, Nebraska. Avian species were censused during the breeding season both years and vegetation sampling was done at each censusing station.

The majority of the 51 species of birds recorded in these early successional woods are generalist species, utilizing edge and interior edge. The highest percentage of interior species at any site for either year was 6.7%. Neotropical migrants and permanent residents each comprise about one fourth of the birds and about half of the birds are short distance migrants. Densities, dominance, frequency and importance values of the 11 tree

species were calculated for several size classes. Eastern cottonwood, one of the pioneer successional species, is still dominant, but it is being replaced mainly by green ash, American elm and eastern red cedar. No eastern cottonwoods were recorded in the smallest size classes. Green ash was well-distributed across the study area, occurring at six of the nine sites and eastern red cedar and American elm each occur in five. Rough-leaved dogwood comprises most of the understory throughout the sites.

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Someone once said that the reason the world is round is so we can't see too far down the road. Indeed, if that were possible, there have been paths in my life I may not have attempted, had I known the obstacles that lay ahead. The journey down this thesis trail is one of them. The challenges have been many, but the rewards seem proportional. My deepest gratitude goes to the following people who have inspired, cheered or sustained me along the way:

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Table of Contents

Page

List of Tables

List of Figures

Figure Page

CENTRAL PLATTE RIVER FORESTS: BREEDING BIRDS AND WOODY VEGETATION

INTRODUCTION

Natural processes combined with human influences often produce rapid changes in ecosystems that create complex management challenges for wildlife managers. The Central Platte River region between Lexington and Grand Island, Nebraska, often referred to as the Big Bend Reach, is no exception. Wildlife habitat and associated species in this area have undergone dramatic changes in the past century (Williams 1978).

The Central Platte River is part of the greater Platte River system that begins in the Rocky Mountains as the North and South Platte Rivers and flow eastwardly across Wyoming and Colorado respectively. These rivers merge in southwest Nebraska to form the Platte River, which then continues to flow across the entire length of Nebraska to the Missouri River.

Prior to European settlement, wet meadows and lowland tall-grass prairies dominated the Central Platte River floodplain, and mid to short-grass prairie dominated the bordering uplands. Although few exist today, both temporary and permanent wetlands were common on bottomlands adjacent to the Central Platte River. Forests, which were scattered and few, now form a nearly continuous, woody corridor along the river. Recent GIS-based research clearly shows that only a few scattered patches of the once-expansive grasslands and meadows remain, and that cropland and forests now dominate the Platte Valley (Johnson 1990).

The character of the river channel has been transformed as well (Lyons and Randle 1988). Annual flows have decreased by approximately 70% (Kroonemeyer 1978), and channel width has diminished by as much as 90% in some places (Williams 1978). Due to lack of flooding and scouring, exposed sandbars and islands have become choked with willows, cottonwoods and other vegetation.

Biologists involved with management of the Central Platte River ecosystem, as well as others who have studied it, generally agree that hydrological development and other anthropological activities, such as agricultural conversions, grazing, and municipal and industrial development have caused the rapid and dramatic changes in this system's character. Readers may refer to Sidel et al. 1989; Currier et al. 1985; Faanes and Lingle 1982; Knopf 1986, 1989; Krapu et al. 1982; Lyons and Randall 1988; Williams 1978 and Eschner et al. 1983, for relevant in-depth discussion regarding the kinds, causes and degree of changes that have taken place. Johnson (1994) agrees that human impact has caused change in the system, but maintains that the changes may have occurred even without the hydrological development. Regardless of the exact causes for the changes, the Central Platte River ecosystem's transformation has far-reaching implications for avifaunal assemblages (Currier 1982; Knopf 1986; McDonald and Sidle 1992; Ziewitz et al 1992). Knopf (1990) estimates that 90% of the contemporary riparian avifauna on the western Great Plains were not present at the turn of the century and that changes in the next fifty years will be just as dramatic.

The combination of forestation and fragmentation of the Platte River valley habitat has had two major negative effects on avian species diversity. First, some species which historically used this area, such as the whooping crane (*Grus americana*), lesser

sandhill crane (*Grus canadensis*), least tern (*Sterna antillarum*) piping plover (*Charadrius melodus*), Eskimo curlew (*Numenius borealis*) and sedge wren (*Cistothorus platensis*) have lost valuable migratory or nesting habitat (Krapu et al. 1982; Sidle et al. 1989). Secondly, as birds of both eastern forests and Rocky Mountain forests migrate through the relatively new riparian forest corridors, hybridizations have occurred in species such as Bullock (*Icterus galbula bullockii*) and Baltimore (*Icterus galbula galbula*) orioles (Sibley and Short, Jr. 1964), blue (*Cyanocitta cristata*) and stellar (*Cyanocitta stelleri*) jays (Williams and Wheat 1971), and indigo (*Passerina cyanea*) and lazuli (*Passerina amoena*) buntings (Sibley and Short, Jr. 1959).

However, the forestation of this area has also positively affected avian species diversity. Forest and shrub-associated species not historically associated with this area, such as the eastern wood-peewee (*Contopus virens*), great-crested flycatcher (*Myiarchus crinitus*) and Bell's vireo (*Vireo bellii*) have gained habitat. Generalist species, which are considered common and abundant and have ubiquitous distribution, such as wild turkey (*Meleagris gallopavo*), northern cardinal (*Cardinalis cardinalis*) and northern flicker (*Colaptes auratus*) have also gained (Faanes and Lingle 1982; Currier et al 1985; Ducey 1988; Johnsgard 1979; Lingle 1994; Krapu 1982).

Some of the migratory landbirds that are now a component of the Platte River forests, such as the red-eyed vireo (*Vireo olivaceus*), yellow-billed cuckoo (*Coccyzus americanus*) and American redstart (*Setophaga ruticilla*) have demonstrated region-wide declines elsewhere, such as in the historically-wooded habitat on the Missouri River (Terborgh 1989; Finch 1991; Ambuel and Temple 1982; Robbins 1979). Recent studies indicate that as large forest tracts in eastern North American become fragmented or lost,

some of these migrants are no longer breeding in those areas (Finch 1991) -- particularly interior and interior-edge birds (Whitcomb et al. 1981). These species are concurrently losing tropical wintering habitat as well (Thompsen et al. 1992). Terborgh (1989) points out that neotropical migrants that breed in the West reside in riparian habitats and montane forests. He suggests that spatial factors that limit the eastern species populations may not apply to migrants that occupy western habitats of smaller sizes, such as narrow riparian zones.

Assuming that present land and water management practices will not change significantly and that natural disturbance regimes will not be restored, it is unlikely that the Platte River forests will diminish in the near future. They may, in fact, increase in extent (Johnson 1994). If further degradation of eastern forest habitat continues (Robbins 1979), the forests along the Central Platte River may become increasingly important as habitat for displaced avian species not historically associated with the area. While it is important to continue to manage for historical species, gaining a better understanding of the role of these woodlands as habitat for displaced avian species and quantitatively assessing their populations seems prudent in developing sound local conservation management plans.

As an initial step towards this end, this descriptive study is intended to provide baseline breeding bird and woody vegetation data to help understand how bird populations are responding and adapting to these relatively new woodlands. Although general birding guide books (Johnsgard 1979, Lingle 1994) are available, the Central Platte River forested region has lacked comprehensive ornithological study until very recently. After this project was initiated, another avian population study in this area was

conducted by Colt (1997), in which he related patterns of avian species richness and diversity to spatial and structural characteristics of the forests. Comparisons of the two studies provide additional information on the status of this area as bird habitat.

The specific objectives of this study were to:

1) document breeding avian species and abundances in the Central Platte River riparian forests

2) document the vegetation composition of the Central Platte River riparian forests

METHODS

Study Sites:

This study was conducted during avian breeding seasons in 1993 and 1994 in Dawson, Buffalo, Hall and Merrick counties, which are in the Big Bend Reach of the Central Platte River in south-central Nebraska. Seven forested sites, adjacent to the river, were selected along a 140-km area between Elm Creek and Chapman (Figure 1). Two additional sites were added to the study in 1994. These sites were not within isolated forest fragments, but rather within part of a continuous narrow band of shredded forests. Criteria for selection of the sites included 1) plot size of 700 x 100 m, 2) adjacency to the river, 3) closed-canopy vegetation, 4) non-fragmentation by roads, channels or other management practices and 5) willingness of landowners to permit access. Site management practices varied.

Birds:

At each site, a transect was established 50 m inland and parallel to the river, running the length of the 700-m plot. Four bird census stations were established and marked with steel fence posts along the transect. The first and last stations were placed 162.5 m from the ends of the study plot. The circles were spaced 25 m apart to minimize the probability of counting individual birds at more than one station (Reynolds et al. 1980, Faaborg and Chaplin 1988). Each censusing station was at the center of a 100-m-diameter (0.8-ha) circle. Only birds within this 50-m-radius circle were counted.

Birds were censused three times during each breeding season, 1 May to 1 July, of 1993 and 1994, on a rotational basis (Skirivin 1981). The two sites added in 1994, Moles 1 and Moles 2, were censused only in 1994. As detectability tends to decline from the first hour after sunrise to the fourth hour in forested areas (Robbins 1981; Skirivin 1981), censusing was conducted only between sunrise and three hours after sunrise. Censusing during heavy rain or in winds greater than 12 mph was avoided (Ambuel and Temple 1983). To minimize approach disturbance, a five-minute wait was allowed at each station before beginning the census. Censusing was then conducted for ten minutes. Birds seen or heard within 50 m of the station were recorded. Species such as red-winged blackbird (*Agelaius phoeniceus*) and dickcissel (*Spiza americana*) were included, as the narrow forests are often interspersed with sloughs and open grassy areas. Species generally associated with water but whose territories could include forest habitat, such as wood duck (*Aix sponsa*), belted kingfisher (*Ceryle alcyon*) and herons were included, but those such as killdeer (*Charadrius vociferus*) and spotted sandpiper (*Actitis macularia*)

were not. Care was taken not to double count species in which both the female and male may sing on territory, such as northern oriole (*Icterus galbula*) and rose-breasted grosbeak ((*Pheucticus ludovicianus*). Individuals were counted as pairs (Reynolds et al. 1980), even though some species such as the yellow-rumped warbler (*Dendroica coronata*) and black-throated green warbler (*Dendroica virens*) were most likely not nesting. All flyovers and any observed nocturnal species were noted but not included in counts.

Species abundances were calculated for each year by summing the highest number of individuals recorded at each census station and dividing that by the number of observation points (Blake and Karr 1987). These numbers were then extrapolated to hectares. Bird species were categorized by 1) migratory status: neotropical migrants (species winter in tropical and subtropical regions of Central and South America), short-distance migrants (species winter south of the study area but north of the tropics) and permanent residents (species remain in the study area throughout the year with, at most, small-scale movements) and by 2) preferred breeding habitat: forest edge (species typically use forest perimeters, nearby fields, or large clearings within a forest during breeding season), interior (species nest only within the interior of forests and rarely occur near the edge) and interior/edge (species have territories located entirely within the forest, but can also utilize forest edge, or in some cases, can extend a single territory across more than one forest fragment), as classified in the literature (Freemark and Collins 1989; Hayden et al. 1985). Relative abundance of birds in each migratory status and habitat preference categories were calculated and reported for each site by year. Species richness was calculated for each site. Differences between years and among sites

were analyzed using ANOVA (analysis of variance) for both habitat preference and migratory status categories.

Vegetation:

Woody vegetation variables were measured at each site. Two randomly selected 0.04- ha circles within each of the four 50-m-radius bird-censusing circles at each site were sampled, following the methods of James and Shugart (1970).

Within each 0.04-ha circle, the dbh (diameter at breast height) of all trees were identified to species and measured with a Biltmore stick. The species and measurement were recorded in one of seven size classes: A < 7.6 cm, B: 7.6 - 15.1 cm, C: 15.2 - 22.8 cm, D: 22.9 - 38 cm, E: 38.1 - 53.2 cm, F: 53.3 - 68.6 cm, and G > 68.6 cm. Snags (dead but standing trees) were also measured and classified according to size. Within each 0.04-ha circle, two transects were established perpendicular to each other. Shrubs (woody stems < 7.6-cm dbh and < 1.4 m above ground) within arm's length of the transects were identified to species and the number of each species was recorded. The density (number of trees), dominance or basal area (area in square meters of the cross-section at breast height) and frequency (number of sampling points in which species occurs divided by the total number of points sampled) of tree species were estimated from the sampling data and the values were extrapolated to a hectare basis. Relative density (numbers of a species relative to the total numbers of all trees), relative dominance (basal area of a species relative to the basal area of all trees), and the relative frequency (frequency value for a species relative to the frequency value of all trees) were calculated for each site. These three values were used to calculate the importance value

of each species at each site (Balda 1969; Beightol and Bragg 1993; Blake and Karr 1987). Importance values were also calculated for each size class of each species at each site. Differences in total basal area for each species within sites and among sites were analyzed using ANOVA.

Shrub density/ha was estimated by dividing the total number of shrubs for each study site by 0.32 (0.04-ha circles x 8), according to the method used by James and Shugart. Relative coverage was calculated from these numbers (James 1978).

DESCRIPTIONS OF SITES (east to west):

It is important to note that the forests along the Central Platte River are generally not insularized separate entities, but rather what Feinsinger (1997) describes as "shredded" habitat. These forests may appear "patchy," a familiar ecological concept, but are better described as shredded, as numerous long, narrow strips of woods extend into the remnants of original grassland and wet meadow habitat, thus creating a great deal of edge. According to Feinsinger (1997), habitat "shreds" may be several meters or several hundred meters wide and may encompass hectares or thousands of hectares, protruding as peninsulas, connecting with other complex networks, or perhaps running into another large tract

Chapman: This privately-owned easternmost study site is located 4.0 km south of Central City, Nebraska, on Highway 14, and 0.4 km east on the south side of the Wood River. Cattle grazed the site throughout both summers of the study. The few peach-leaf willows found on this site are located in a grassy swale that runs lengthwise through the center of the site. Mature eastern cottonwoods provide the upper canopy, but they are

dying, have many broken limbs and are being replaced by eastern red cedar. No Russian olive trees or seedlings were observed at this site. The understory is dominated by rough-leaved dogwood except at the center of the site where eastern red cedars are dense. This is the only site where catalpa occurs.

Mormon: Owned by The Platte River Whooping Crane Habitat Maintenance Trust, this site is located 8.8 km south of Grand Island, Nebraska, on Highway 281 and 0.4 km west on the north side of the Platte River. No management practices were implemented at this site during the study. A grassy swale borders the north side of this site where a few peach-leaf willows are found. Woody vegetation is most dense at the center of the site and becomes increasingly sparse towards the eastern end. Eastern cottonwood dominates the upper canopy. Both green ash and American elm contribute to the upper story and are well distributed throughout this site. Although none were present in the vegetation sample plots, a few eastern red cedar were noted. Rough-leaved dogwood and prickly ash dominate the understory. Russian olive was absent from this site.

Wild Rose: Owned by The Platte River Whooping Crane Habitat Maintenance Trust, this island site is located adjacent to the north bank of the Platte River on the parcel of land known as the Wild Rose Ranch. Located 4.0 km south of the Alda, Nebraska, Interstate 80 exit and 0.8 km of the ranch, this site is characterized by very patchy vegetation, with eastern red cedar dominating the western half and an even-age stand of green ash dominating the center of the island. In some areas, the eastern red cedar is being crowded out by green ash. Unlike most of the other sites, American elm, rather than eastern cottonwood, provides most of the upper canopy. No American elm

seedlings were noted. A few remaining large eastern cottonwoods occur here and the forest floor is heavily littered with large, dead trees and limbs. The only two honey locust trees observed throughout all study sites were noted outside the sampling area. The understory is mostly comprised of rough-leaved dogwood, which is particularly dense at the eastern end.

Audubon: Owned by The Audubon Society, this site is located 1.6 km south of the Gibbon exit on Interstate 80 and 0.8 km west, and is situated on the south side of the Platte River. No management practices were implemented during the study period. Eastern cottonwoods, generally in good condition, form a fairly even upper canopy throughout the site. Although smaller in size, American elm and green ash occur in patches throughout this site. Some of the young green ash stands appear to be dying. The small eastern red cedars occurring here are infrequent, and only one Russian olive sapling was noted. Rough-leaved dogwood, which provides the majority of the understory at this site, is well distributed throughout the site and seedlings are abundant.

Russian Olive: This site is on the north side of and adjacent to the south channel of the Platte River. The Platte River Whooping Crane Habitat Maintenance Trust owns this site located 0.8 km south of the Odessa on Interstate 80 exit, and 4.0 km west, and 0.8 km north. No management practices were implemented during the study period. The absence of cottonwood and rough-leaved dogwood, the dominance by Russian olive, and the occurrence of Siberian elm significantly differentiate this site from the others. The upper canopy coverage is spottily provided by red mulberry and Siberian elm, which are generally grouped together near the center of the site. This site's species composition may reflect initial plantings rather than a natural successional process from grassland.

The Russian olives on the western half of the site appear to be old and dying, in contrast to those at the eastern end, where young trees are dominant. A wet meadow runs through the center of the site and it also encompasses much of the eastern end. Western wild rose is abundant throughout this site and Siberian elm seedlings are abundant.

Moles 1 and Moles 2: These sites were added the second year of the study. Privately owned, these sites are located south of Odessa on the south side of the Platte River and about 0.4 km east, near the center of the largest forested area in the study. Moles 1 is adjacent to the river and Moles 2, just west of Moles 1, is near the center of the forest patch. No management practices were implemented on these sites during the study period.

Both sites are generally characterized by patchiness, with eastern cottonwood providing even canopy coverage in some places. Where eastern cottonwoods are absent, green ash is predominant and green ash seedlings are abundant. A few eastern red cedar seedlings were noted. Rough-leaved dogwood, the dominant understory shrub at both sites, is abundant at all stages, ranging from seedlings to 15' in height. False indigo is also common.

Elm Creek North: This site is located 3.2 km west and 0.4 km south of Elm Creek on the north side of the Platte River on land owned by the Nebraska Public Power District. This site was grazed throughout both summers of the study period. This site appears to be at an earlier successional stage than the others. An even-age stand of eastern cottonwood provides upper canopy coverage at the east end of the site, and shrub understory is absent. Woody vegetation is very patchily distributed throughout the eastern half of the site. Throughout the site, no eastern cottonwood seedlings were

observed and no eastern red cedar trees were noted or sampled, but eastern red cedar and American elm seedlings were observed in the shrub transects. Russian olive was absent from this site. Rough-leaved dogwood, occurring only at the west end of this site, is the dominant shrub and seedlings are abundant.

Elm Creek South: This site is located just across the river from the Elm Creek North site and about 0.2 km further south, adjacent to an old river channel. It is also owned by Nebraska Public Power District and was grazed during both summers of the study period. Eastern cottonwoods comprise the patchy upper canopy, but many of the crowns are broken out and they are generally in poor condition. No eastern cottonwood seedlings were noted, but eastern red cedar seedlings were common and abundant throughout the site. A stand of well-spaced eastern red cedars dominates one of the sampling circles. The few red mulberry trees appear to be dying. A great deal of slash and logs litters the forest floor throughout the site. Well-distributed rough-leaved dogwood provides the dominant understory foilage.

RESULTS AND DISCUSSION:

Birds:

A total of 50 bird species was censused (Table 2). The highest number of species at any one site for either year was 23, and the lowest was 12 (Table 1). Over all the sites, the house wren (*Troglodytes aedon*) was most abundant. Other common species were northern flicker, blue jay, northern oriole (*Icterus galbula*), American robin (*Turdus migratorius*) and black-capped chickadee (*Parus atricapillus*). These same species were

well distributed, occurring at all the sites, except for the northern oriole, which occurred in eight of the nine sites (Table 3).

Colt (1997) also found the house wren to be the most common species. He likewise reported blue jay, American robin and northern oriole among the most abundant species. Species observed only once in this study and not reported by Colt were eastern phoebe (*Sayornis phoebe*), yellow-rumped warbler (*Dendroica coronata*), and black-throated green warbler (*Dendroica virens*). Swainson's thrush (*Catharus ustulatus*) and American redstart were also not reported by Colt. Indigo bunting and wood thrush (*Hylocichla mustelina*) numbers were very low in both studies. Occasional species cited by Colt, but not observed during this study were willow flycatcher (*Empidonax trailii*), acadian flycatcher (*Empidonax virescens*), house sparrow (*Passer domesticus*), chipping sparrow (*Spizella passerina*), red-eyed vireo (*Vireo olivaceus*), black-billed cuckoo (*Coccyzus erythropthalmus*) and western kingbird (*Tyrannus verticalis*).

Neotropical migrants comprised 26% of the species in 1993 and 21% in 1994; short-distance migrants 53% in 1993 and 58% in 1994; and permanent residents 21% in 1993 and 22% in 1994 (Table 4). Edge species were the most abundant, comprising 64% of the species in 1993 and 54% in 1994. Interior species were least abundant, with <1% in 1993 and 4% in 1994. Interior-edge species accounted for 34% in 1993 and 41% in 1994. Other (unclassified) species comprised <2% both years (Table 5).

Colt (1994) reported 50 species in his study of woodland birds, with 42% neotropical migrants, 34% short-distance and 24% permanent residents. The differences between his findings and those in this study can be attributed to different classifications of species in the studies. According to appendix 2 of his study, he classified house wren,

the most abundant species in both studies, as a neotropical migrant species, while it was classified as a short-distance migrant in this study. Gray catbird was classified in the same manner, and Colt observed somewhat higher numbers of this species as well. Habitat preference categories cannot be compared between the two studies, as classifications were different.

Numbers of edge species differed between years at the Mormon site and for interior/edge species at the Wild Rose site (P= 0.046 and P = 0.044, respectively). Numbers of edge species also differed among sites in both 1993 and 1994 (P = 0.0003 and P = 0.0017, respectively). There was a difference for interior/edge species among sites in 1994 (P = 0.0525). Permanent resident species showed no differences among sites or between years. Numbers of both short distance migrants and neotropical migrants differed between years (P = 0.0001 and P = 0.0016, respectively) at some sites.

Woody Vegetation:

Trees: Over all the sites, the diversity of tree species was low, with a total of eleven (Table 6). Shrub species rough-leaved dogwood also occurred in the small size class. Table 7 shows the importance values for all species at all the sites. Eastern cottonwood, eastern red cedar, green ash and American elm and rough-leaved dogwood all have an importance value of >10 for two or more sites (Fig. 3). Snags are also an important component of these forest, having an importance value of >10 at four sites. Other species occurring in the sampling plots include peach-leaf willow, hackberry, Russian olive, catalpa, red mulberry, boxelder and Siberian elm. With the exception of these last two, Colt (1994) reported the same species. In addition, his sites include Kentucky coffee tree (*Gymnocladus dioica*), silver maple (*Acer saccharinum L.*) and

diamond willow (*Salix rigida*). In a study of the Platte River floodplain vegetation that included the same area as this study, but extending further west to Lake McConaughy, Currier (1982) found similar low tree species diversity. He also found eastern cottonwood, eastern red cedar, green ash, red mulberry and American elm to be common, as well as diamond willow and slippery elm (*(Ulmus rubra*); the latter two species were not found in this study. In addition, he listed black walnut (*Juglans nigras*), osage orange (*Maclura pomifera*), black locust (*Robinia pseudocacia*) and Chinese elm (*Ulmus parvifolia*) as occurring only in a few samples.

The Russian Olive site has a very different vegetational composition from the other sites, as its two most important species are Russian olive and Siberian elm. Eastern cottonwood has the greatest total basal area/ha of all the tree species at all but two sites (Table 8). Green ash is the most abundant species at four of the sites (Table 9), and it is one of the most evenly distributed species, occurring at eight sites and occurring in every sample at four of the sites (Table 10). Snags are also well distributed. Russian olive does not yet appear to be a major component of the Central Platte River forests, as Knopf (1986) has predicted, but it was sampled in three sites.

Figures 4-12 show the size classes of species with importance values >10 in at least one size class. Overall, and with the exception of the Russian Olive site, Green ash, eastern red cedar and American elm are generally the most important species in the smaller size classes. Eastern cottonwood occurs only in the larger classes.

Differences in total basal area occurred for several species among sites: eastern cottonwood (P=0.0002), green ash (P = 0.0085), eastern red cedar (P = 0.0002), Russian olive (P = 0.0001), and snags (P = 0.0267). These differences are not surprising and

reflect the patchy nature and successional processes occurring in these forests. Species such as box elder, catalpa and Siberian elm could not be analyzed, as observed numbers were too low.

Shrubs: The diversity of shrub species was low, with a total of five true shrub species: dogwood, western wild rose (*Rosa woodsii*), prickly ash (*Zanthoxylum americanum*), buckbrush (*Symphoricarpos orbiculatus*) and false indigo (*Amorpha fruiticosa*), and only one site had all five species. With densities ranging from 341 to 1534m^2/ha, rough-leaved dogwood was by far the most abundant and evenly-distributed shrub across the study area (Table 11). This shrub accounted for 47% to 99% of the shrub species and occurs at all but one site (Table 12). Western wild rose, false indigo and prickly ash were abundant only at Russian Olive, Chapman and Mormon Island sites respectively, but also occurred minimally in other sites. Buckbrush was sampled at two sites. Four species of small trees were also sampled in the shrub transects (Tables 11 and 12). Shrub species such as sandbar willow, coyote willow (*Salix exigua*) and diamond willow (*Salix rigida*) found by Currier (1982) and Colt (1994) were observed near the river, but did not occur within the sampling areas. Colt (1994) reported common elderberry (*Sambucus canadensis*) as a dominant shrub in his study area, but none were sampled or observed in this study. Tree species sampled in the shrub transects were Siberian elm, found only at one site, and eastern red cedar, Russian olive and green ash, occurring in several sites.

Conclusion: The Central Platte River forests are rich in bird species. About one fourth are neotropical migrants, most of which are generalists (those most tolerant of edge and fragmentation), such as the northern oriole, orchard oriole, and eastern kingbird.

This is not surprising, as the narrow Platte River forests have little interior habitat and a great deal of edge. Other edge and interior/edge neotropical migrants that have lower numbers than might be expected are red-eyed vireo, indigo bunting, rose-breasted grosbeak, wood thrush and yellow-billed cuckoo. Also having very low densities in these forests are interior neotropical migrant species Swainson's thrush and American redstart, as well as interior permanent resident species white-breasted nuthatch and hairy woodpecker. Given the distribution and numbers of snags throughout the study site, higher numbers of permanent resident species red-bellied woodpecker and downy woodpecker were expected. Neotropical migrant species whose populations are declining and which seem to be using the Central Platte River forests to the greatest extent are northern oriole, great-crested flycatcher and eastern wood-peewee.

Excluding the Russian Olive site, the overstory in these Central Platte River forest sites is still typically provided by eastern cottonwood. However, the changing composition of these early succesional forests is apparent (Schmidt, Wardle 1998; Johnson 1994). Even though eastern cottonwood and a few remaining peach-leaved willows are fairly well distributed across the study area, they are dying out and not reproducing. Eastern red cedar, green ash and American elm are replacing cottonwood as the most important species. Russian olive is a significant species only at the Russian Olive site. Other species, such as red mulberry, hackberry, box elder, Siberian elm and catalpa occur only minimally and are not reproducing to the extent of the eastern red cedar, green ash and American elm. Snags are well-distributed throughout all the sites.

Currier (1982) found a noticeable progressive decline of green ash and American elm numbers toward the west. American elm mostly in the eastern half of this study area, but green ash was found throughout. The difference may be due to the fact that his study extended further west, he had more samples, or it may be that green ash are now more numerous. The thinning of the shrub understory towards the west that he mentions is also not apparent from this study.

Management Implications: The highly linear Central Platte River forests are most likely not large enough to support area-sensitive neotropical migrant species during the breeding season, even though a few are present. Numbers of neotropical migrant species that are tolerant of edge are higher, but it is not known whether these forests are serving as sinks or sources. Species-specific data on species such as eastern wood-peewee and great-crested flycatcher would provide valuable information when considering whether or not to manage this area for these forest-dwelling neotropical migrants. Colt (1994) found that avian species richness and diversity in these Central Platte River forests was highly correlated with forest patch size and that species richness was also (to a lesser degree) correlated with forest structural diversity aspects. Studies linking other landscape and vegetation variables to species, as well as those on population trends, survivorship, habitat use, parasitism and predation rates would be helpful in assessing specific species requirements in this area.

It may be possible to manage for both newcomer forest species and the historic species that have lost habitat in this area. Consideration might be given to increasing the width of some of the larger forested areas, while simultaneously eliminating the narrower sections and allowing them to revert back to grassland. In addition, consideration might

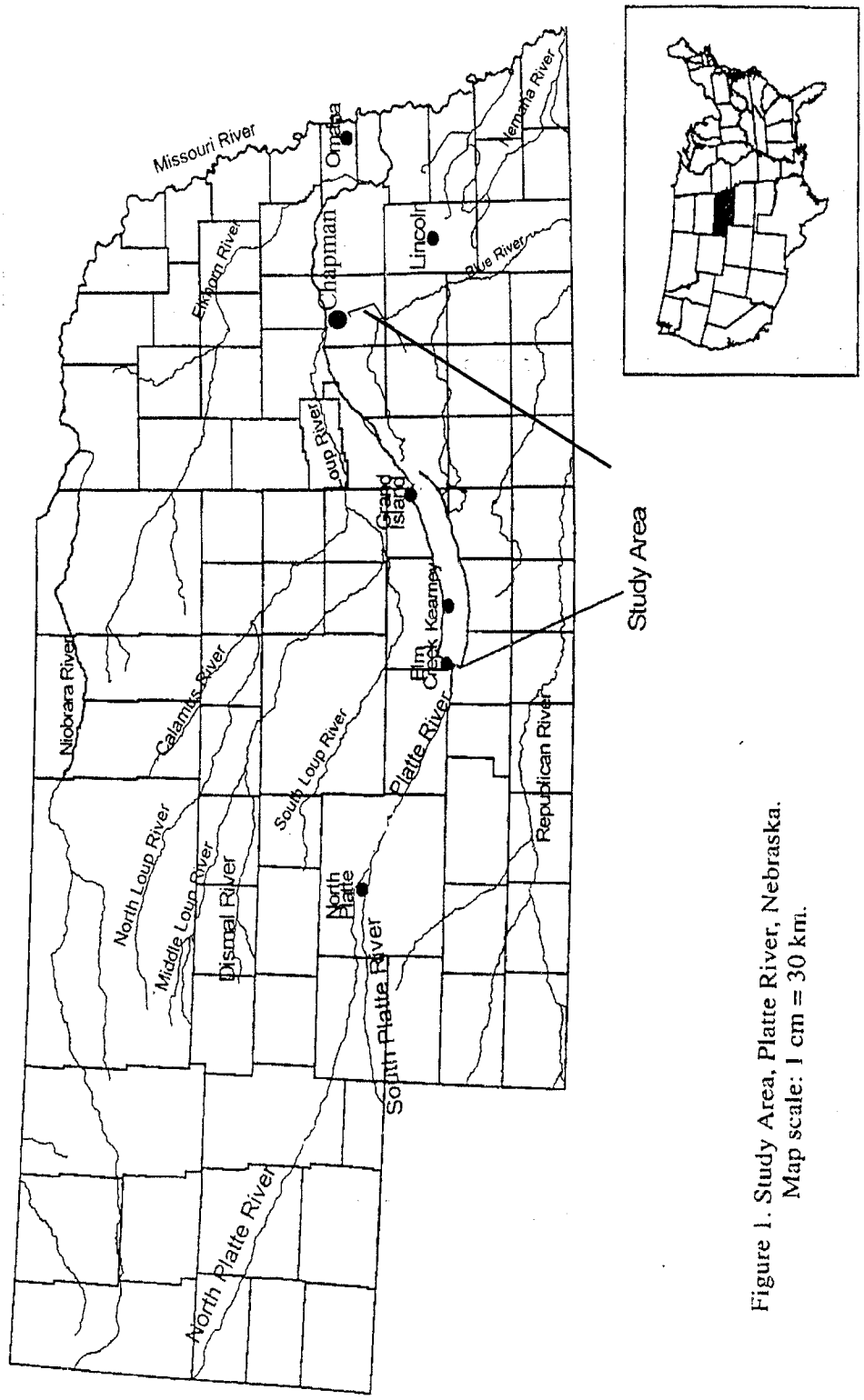


Figure 1. Study Area, Platte River, Nebraska.
Map scale: 1 cm = 30 km.

Table 1. Avian species richness (no. of species) at each site.

Site	1993	1994	Total No. Species Observed
Chapman	15	19	21
Mormon	20	22	29
Wild Rose	14	18	22
Audubon	19	21	27
Russian Olive	21	23	27
Elm Creek N.	21	23	29
Elm Creek S.	17	18	22
Moles 1	X	12	12
Moles 2	X	13	13

Table 2. Summary of bird species observed, including migratory status and habitat preference.

Species	Scientific Name	Code	Migratory Status	Habitat Preference
American Crow	*Corvus brachyrhynchos*	AMCO	S	E
American Goldfinch	*Carduelis tristis*	AMGO	S	E
American Redstart	*Setophaga ruticilla*	AMRE	N	I
American Robin	*Turdus migratorius*	AMRO	S	E
Bell's Vireo	*Vireo bellii*	BEVI	N	E
Belted Kingfisher	*Ceryle alcyon*	BEKI	S	X
Black-capped Chickadee	*Parus atricapillus*	BCCH	P	IE
Black-billed Magpie	*Pica pica*	BBMA	P	E
Black-throated Green Warbler	*Dendroica virens*	BTNW	N	I
Blue Jay	*Cyanocitta cristata*	BLJA	P	IE
Brown Thrasher	*Toxostoma rufum*	BRTJ	S	E
Brown-headed Cowbird	*Molothrus ater*	BHCO	S	E
Cedar Waxwing	*Bombycilla cedrorum*	CEDW	S	E
Chimney Swift	*Chaetura pelagica*	CHSW	N	X
Common Grackle	*Quiscalus quiscula*	COGR	S	E
Common Yellowthroat	*Geothlypis trichas*	COYE	N	IE
Dickcissel	*Spiza americana*	DICK	N	X
Downy Woodpecker	*Picoides pubescens*	DOWO	P	IE
Eastern Bluebird	*Sialia sialis*	EABL	S	E
Eastern Kingbird	*Tyrannus tyrannus*	EAKI	N	E
Eastern Phoebe	*Sayornis phoebe*	EAPH	S	IE
Eastern Wood-Peewee	*Contopus virens*	EAWP	N	IE
European Starling	*Sturnus vulgaris*	EUST	P	E
Field Sparrow	*Spizella pusilla*	FISP	S	E
Gray Catbird	*Dumetella carolinensis*	GRCA	S	IE
Great Blue Heron	*Ardea herodias*	GTBH	S	X

Migratory Strategy: S = short-distance migrant; N = neotropical migrant; P = permanent resident (Freemark & Collins, 1989; Hayden et al., 1985)
Habitat Preference: E = edge; I = interior; IE = interior/edge (Freemark & Collins, 1989; Hayden et al., 1985); X = unclassified

Table 2 continued. Summary of bird species observed, including migratory status and habitat preference.

Species	Scientific Name	Code	Migratory Status	Habitat Preference
Great-crested Flycatcher	*Myiarchus crinitus*	GCFL	N	IE
Green-backed Heron	*Butorides striatus*	GNBH	S	X
Hairy Woodpecker	*Picoides villosus*	HAWO	P	I
House Wren	*Troglodytes aedon*	HOWR	S	E
Indigo Bunting	*Passerina cyanea*	INBU	N	E
Mourning Dove	*Zenaida macroura*	MODO	S	E
Northern Bobwhite	*Colinus virginianus*	NOBO	P	E
Northern Cardinal	*Cardinalis cardinalis*	NOCA	P	IE
Northern Flicker	*Colaptes auratus*	NOFL	S	IE
Northern Oriole	*Icterus galbula*	NOOR	N	E
Orchard Oriole	*Icterus spurius*	OROR	N	E
Red-bellied Woodpecker	*Melanerpes carolinus*	RBWO	P	IE
Red-headed Woodpecker	*Melanerpes erythrocephalus*	RHWO	S	E
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL	S	E
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	N	IE
Rufus-sided Towhee	*Pipilo erythrophthalmus*	RSTO	S	IE
Song Sparrow	*Melospiza melodia*	SOSP	S	E
Swainson's Thrush	*Catharus ustulatus*	SWTH	N	I
Warbling Vireo	*Vireo gilvus*	WAVI	N	E
White-breasted Nuthatch	*Sitta carolinensis*	WBNU	P	I
Wood Duck	*Aix sponsa*	WODU	S	X
Wood Thrush	*Hylocichla mustelina*	WOTH	N	IE
Yellow Warbler	*Dendroica petechia*	YWAR	N	E
Yellow-billed Cuckoo	*Coccyzus americanus*	YBCU	N	IE
Yellow-rumped Warbler	*Dendroica coronata*	YWRW	N	I

Migratory Strategy: S = short-distance migrant; N = neotropical migrant; P = permanent resident (Freemark & Collins, 1989; Hayden et al., 1985)
Habitat Preference: E = edge; I = interior; IE = interior/edge (Freemark & Collins, 1989; Hayden et al., 1985); X = unclassified

Table 3. Species abundance (pairs/10 ha) observed >3 times during 1993 and 1994.

Species	Chapman		Mormon		Wild Rose		Audubon		R.Olive		E Creek N		E Creek S		Moles 1		Moles 2	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
American Goldfinch	-	3.1	9.5	3.1	-	-	3.1	9.5	12.7	15.9	-	-	-	-	-	-	-	-
American Robin	6.4	9.5	9.5	12.7	3.1	6.4	-	9.5	12.7	6.4	25.5	48	22.2	12.7	-	6.4	-	3.1
Black-capped Chickadee	22.2	12.7	3.1	9.5	3.1	6.4	6.4	9.5	12.7	9.5	12.7	9.5	12.7	3.1	-	3.1	-	6.4
Black-billed Magpie	-	-	-	-	9.5	-	3.1	-	-	-	-	-	-	-	-	-	-	-
Blue Jay	12.7	12.7	48	9.5	15.9	48	88	12.7	3.1	12.7	6.4	3.1	22.2	22.2	-	6.4	-	9.5
Brown Thrasher	-	6.4	-	9.5	-	-	3.1	6.4	72	9.5	6.4	9.5	9.5	3.1	-	-	-	3.1
Brown-headed Cowbird	-	-	15.9	3.1	-	-	-	-	6.4	6.4	-	3.1	-	3.1	-	-	-	6.4
Common Grackle	-	-	-	6.4	3.1	-	-	-	12.7	12.7	22.2	15.9	3.1	15.9	-	-	-	-
Common Yellowthroat	6.4	3.1	6.4	9.5	9.5	15.9	6.4	6.4	15.9	9.5	-	-	-	-	-	-	-	3.1
Dickcissel	-	-	-	6.4	-	-	-	-	-	6.4	-	-	-	-	-	-	-	-
Downy Woodpecker	-	12.7	3.1	3.1	-	6.4	6.4	9.5	-	-	3.1	6.4	3.1	-	-	-	-	3.1
Eastern Bluebird	-	-	-	-	-	-	-	-	-	-	9.5	-	-	-	-	6.4	-	-
Eastern Kingbird	-	-	6.4	-	-	-	3.1	-	12.7	12.7	3.1	-	12.7	-	-	-	-	-
Eastern Wood-Peewee	6.4	3.1	-	-	-	-	-	-	-	-	15.9	9.5	-	9.5	-	-	-	9.5
European Starling	-	3.1	-	3.1	-	-	-	-	9.5	-	3.1	-	72	12.7	-	-	-	-
Field Sparrow	-	-	-	-	-	-	-	-	12.7	-	-	-	-	-	-	-	-	-
Gray Catbird	-	-	6.4	12.7	6.4	6.4	-	9.5	6.4	3.1	6.4	3.1	-	-	-	-	-	-
Great Blue Heron	-	-	-	-	3.1	-	-	6.4	-	-	-	3.1	3.1	-	-	-	-	-
Great-crested Flycatcher	12.7	12.7	-	-	-	-	-	3.1	-	-	-	-	9.5	6.4	-	6.4	-	9.5
Hairy Woodpecker	-	6.4	-	3.1	-	3.1	-	3.1	-	-	-	6.4	-	-	-	-	-	-
House Wren	25.5	25.5	31.8	25.5	15.9	9.5	31.8	22.2	9.5	15.9	80	72	72	12.7	-	25.5	-	22.2
Mourning Dove	-	6.4	15.9	6.4	-	-	-	-	-	12.7	3.1	-	12.7	3.1	-	6.4	-	6.4
Northern Bobwhite	-	-	-	3.1	-	-	3.1		3.1	-	-	3.1	-	3.1	-	-	-	-
Northern Cardinal	9.5	3.1	3.1	-	3.1	3.1	3.1	3.1	3.1	9.5	-	3.1	3.1	3.1	-	3.1	-	-
Northern Flicker	6.4	15.9	12.7	12.7	6.4	9.5	15.9	15.9	15.9	9.5	25.5	15.9	48	25.5	-	15.9	-	22.2
Northern Oriole	6.4	12.7	15.9	9.5	3.1	9.5	12.7	15.9	3.1	12.7	22.2	48	22.2	9.5	-	3.1	-	-
Orchard Oriole	-	-	-	3.1	-	-	3.1	-	22.2	6.4	3.1	3.1	-	-	-	-	-	-
Red-bellied Woodpecker	3.1	3.1	-	-	-	3.1	-	6.4	-	-	-	-	-	3.1	-	-	-	-
Red-headed Woodpecker	9.5	3.1	-	-	-	-	3.1	-	3.1	12.7	12.7	25.5	15.9	6.4	-	-	-	-
Red-winged Blackbird	-	-	-	9.5	-	-	-	-	-	6.4	6.4	6.4	-	-	-	-	-	-
Rufus-sided Towhee	3.1	-	-	-	3.1	6.4	3.1	6.4	-	6.4	-	-	-	-	-	-	-	-
Swainson's Thrush	-	-	-	6.4	-	6.4	-	3.1	-	-	-	-	-	-	-	-	-	-
Warbling Vireo	-	-	48	-	-	-	3.1	3.1	-	-	9.5	9.5	-	-	-	-	-	-
White-breasted Nuthatch	3.1	9.5	-	-	-	3.1	-	9.5	-	3.1	-	-	-	-	-	6.4	-	-
Yellow Warbler	-	-	6.4	-	-	-	3.1	9.5	6.4	3.1	9.5	-	-	-	-	-	-	-

*Moles 1 and Moles 2 censused only in 1994.

Table 4. *Relative abundance of migratory status classifications at each site.

	Neotropical		Short Distance		Perm.Resident	
Site	1993	1994	1993	1994	1993	1994
Chapman	21.8	16.8	41.8	48.1	36.4	35.1
Mormon	31.9	16.8	55.3	66.2	12.8	16.9
Wild Rose	20	36.7	52.5	36.7	27.5	26.7
Audubon	21.9	23.4	46.9	49.4	31.3	27.3
Russian Olive	30.5	25.9	57.6	57.6	11.8	16.5
Elm Creek N.	31	21.6	61.1	68	8	11.3
Elm Creek S.	18.6	17.5	48.5	56.3	33	26.3
Moles 1	x	10.2	x	71.4	x	18.4
Moles 2	x	15.8	x	66.7	x	17.5

Table 5. * Relative abundance of habitat preference classifications at each site.

	Edge		Interior		Int/Edge		Other	
Site	1993	1994	1993	1994	1993	1994	1993	1994
Chapman	43.6	44.2	1.9	6.5	54.4	49.3	0	0
Mormon	70.2	59.7	1.1	6.4	27.7	32.5	0	2.5
Wild Rose	47.5	23.3	0	6.7	50	68.3	2.5	1.6
Audubon	53.1	49.4	0	6.5	45.3	41.5	1.5	2.5
Russian Olive	69.4	67.1	0	1.2	24.7	28.2	5.8	3.5
Elm Creek N.	75.2	73.1	0	2.1	23.9	21.6	0.8	4.1
Elm Creek S.	62.9	55	0	1.3	36	43.7	1	3
Moles 1	x	53.1	x	6.1	x	40.8	x	0
Moles 2	x	40.4	x	0	x	59.6	x	0

*Relative abundance = (No. of birds observed in category / total no. birds observed in category at site) x 100.

Table 6. Summary of woody species occurring in sample sites.

Tree Species
American elm (*Ulmus americana* L.)
Boxelder (*Acer negundo* L.)
Catalpa (*Catalpa speciosa* Warder)
Eastern cottonwood (*Populus deltoides* Marsh.)
Green ash (*Fraxinus pennsylvanica* Marsh.)
Hackberry (*Celtis occidentalis* L.)
Red mulberry (*Morus rubra* L.)
Peach-leaved willow *(Salix amygdaloides* Anderss.)
Eastern red cedar (*Juniperus virginiana* L.)
Russian olive (*Elaeagnus angustifolia* L.)
Siberian elm (*Ulmus pumila* L.)

Shrub Species:

Prickly Ash (*Zanthoxylum americanum* P. Mill.)
Rough-leaved dogwood (*Cornus drummondii* C. A. Mey.)
False indigo (*Amorpha fruiticosa* L.)
Western wild rose (*Rosa woodsii* Lindl.)
Buckbrush (*Symphoricarpos orbiculatus* Moench)

Table 7. *Importance values of tree species at each site.

Species	Chapman	Mormon	Wild Rose	Audubon	R. Olive	E.Creek S	E.Creek N	Moles 1	Moles 2
American Elm	8	21	6	21	0	0	2	0	2
Box Elder	0	3	0	2	0	0	0	4	0
Catalpa	4	0	0	0	0	0	0	0	0
E. Cottonwood	28	26	11	21	0	53	35	34	60
R.L.Dogwood	7	3	18	12	0	5	23	0	2
Green Ash	1	28	30	21	0	4	4	22	20
Hackberry	0	0	6	3	0	0	0	0	0
Mulberry	5	3	7	9	13	0	6	3	3
P.L. Willow	2	10	0	0	4	17	2	5	2
E.Red Cedar	37	0	11	2	6	0	22	7	4
R. Olive	0	0	1	0	46	0	1	8	3
Siberian Elm	0	0	0	0	20	0	0	0	0
Snag	8	6	10	9	11	21	5	17	6
Total	100	100	100	100	100	100	100	100	100

*Importance Value = Sum of relative density, relative dominance and relative frequency / 3.

Figure 3: Tree Species with Importance Value >10 at Two or More Sites

Importance Value = (relative dominance + relative density + relative frequency) / 3

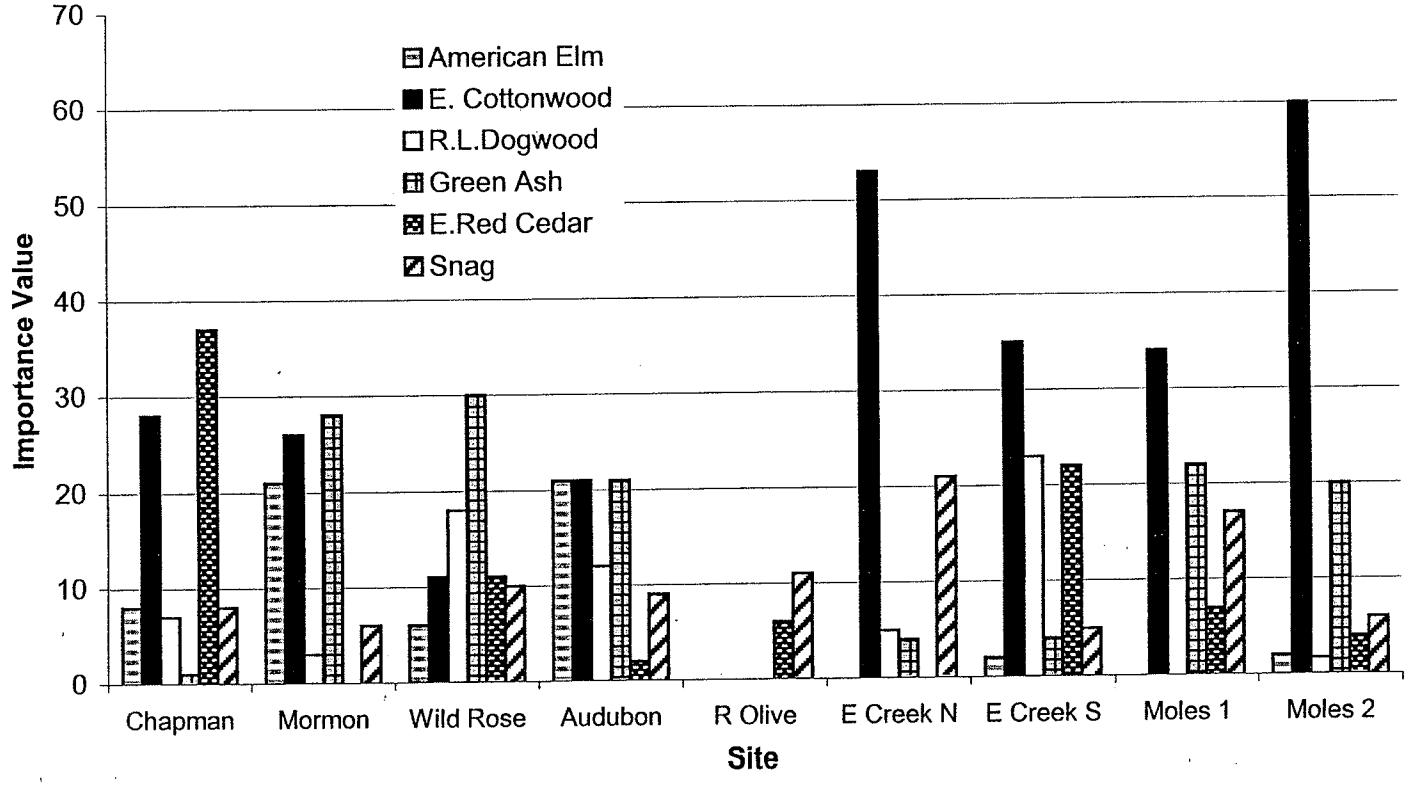


Table 8. Tree species *dominance/ha at each site.

Species	Chapman	Mormon	Wild Rose	Audubon	R.Olive	E. Creek N	E. Creek S	Moles 1	Moles 2
American Elm	12	24	18	31	0	0	2	0	0
Boxelder	0	1	0	2	0	0	0	4	0
Catalpa	5	0	0	0	0	0	0	0	0
E. Cottonwood	131	99	74	71	0	118	108	115	191
R.L.Dogwood	1	<1	8	4	0	<1	6	0	0
Green Ash	1	51	103	33	0	2	1	16	13
Hackberry	0	0	7	4	0	0	0	0	0
Red Mulberry	4	4	18	18	27	0	4	1	4
P.L.Willow	9	17	0	0	5	17	<1	2	0
E.Red Cedar	69	0	20	2	2	0	31	3	1
R. Olive	0	0	<1	0	63	0	1	4	2
Siberian Elm	0	0	0	0	40	0	0	0	0
Snag	15	2	6	7	7	20	3	52	5
Total	246	197	255	171	144	157	156	197	216

*Dominance = total basal area (m^2/ha)

Table 9 . Tree species density/ha at each site.

Species	Chapman	Mormon	Wild Rose	Audubon	R.Olive	E.Creek N	E Creek S	Moles 1	Moles 2
American Elm	87	185	31	349	0	0	6	0	3
Boxelder	0	6	0	9	0	0	0	22	0
Catalpa	25	0	0	0	0	0	0	0	0
E.Cottonwood	145	80	6	65	0	198	124	87	184
R.L.Dogwood	49	12	439	222	0	22	355	0	3
Green Ash	9	204	399	306	0	9	15	127	73
Hackberry	0	0	31	19	0	0	0	0	0
Red Mulberry	34	6	37	62	121	0	37	12	9
P.L. Willow	9	46	0	0	6	56	6	19	3
E. Red Cedar	763	0	111	15	34	0	213	22	11
R. Olive	0	0	3	0	751	0	3	31	8
Siberian Elm	0	0	0	0	151	0	0	0	0
Snag	56	31	136	117	87	65	12	40	11
Total	1177	571	1192	1165	1149	349	662	360	305

Table 10. Tree species *frequency at each site.

Species	Chapman	Mormon	Wild Rose	Audubon	R.Olive	E. Creek N	E. Creek S	Moles 1	Moles 2
American Elm	63	75	50	88	0	0	25	0	13
Boxelder	0	25	0	25	0	0	0	13	0
Catalpa	38	0	0	0	0	0	0	0	0
E.Cottonwood	100	63	13	88	0	75	100	75	100
R.L.Dogwood	88	25	88	88	0	25	100	0	13
Green Ash	13	100	100	100	0	25	50	88	100
Hackberry	0	0	63	25	0	0	0	0	0
Red Mulberry	63	25	63	63	38	0	50	25	13
P.L.Willow	13	63	0	0	25	63	25	38	13
E.Red Cedar	100	0	88	25	50	0	100	50	25
R. Olive	0	0	13	0	100	0	13	50	13
Siberian Elm	0	0	0	0	63	0	0	0	0
Snag	75	50	88	75	75	88	50	50	38

*Frequency = (total number of sampling points in which species occurs / total number of sampling points) x 100

Figure 4. Tree Species Importance Value (IV) in Each Size Class
Chapman

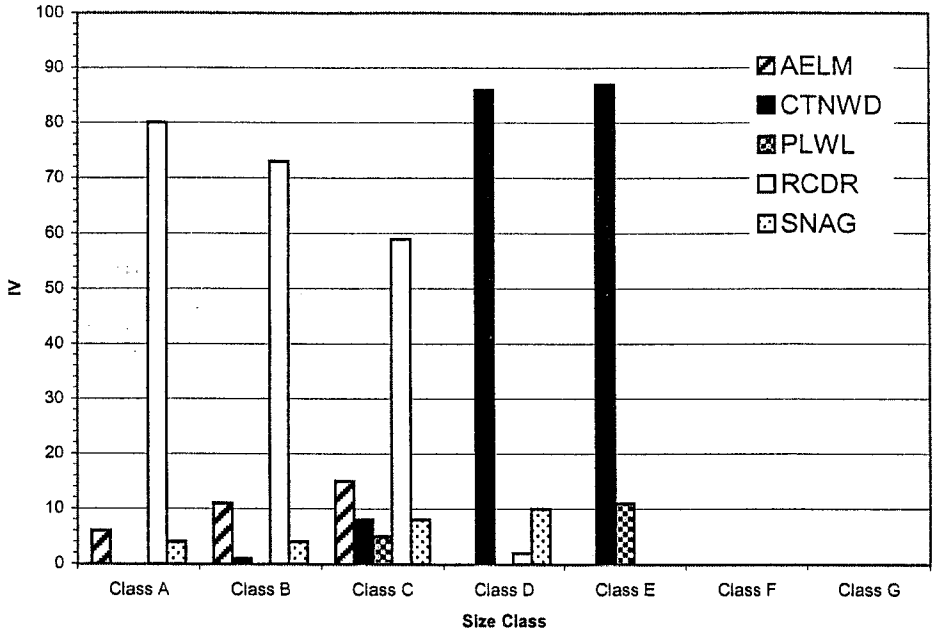
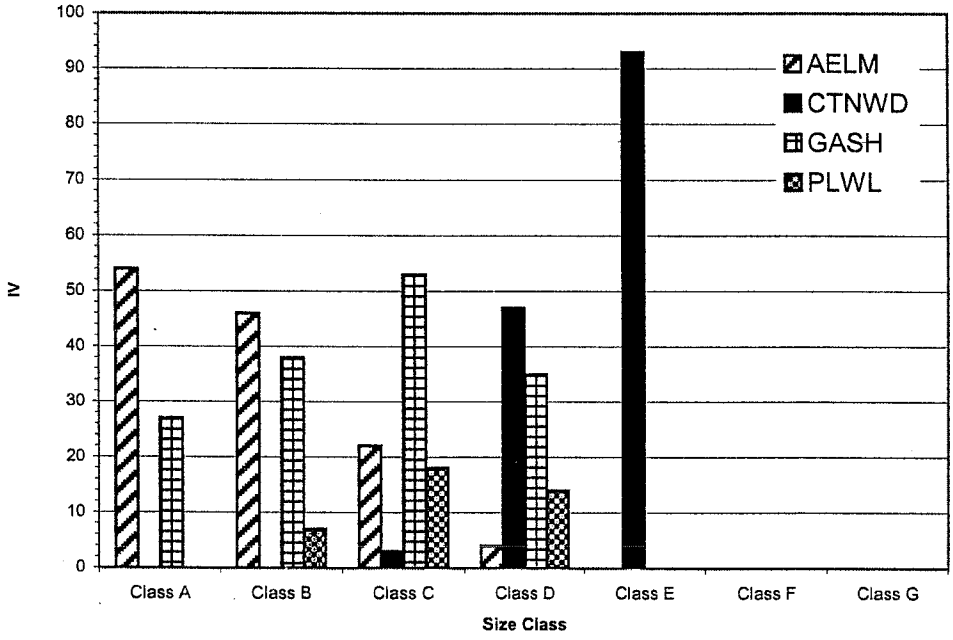


Figure 5. Tree Species Importance Value (IV) in Each Size Class
Mormon



Size Classes: A < 7.6 cm B= 7.6-15.0 cm C=15.2-22.0 cm D=22.9-38.0 cm
(DBH) E=38.1-53.2 cm F=53.3-68.6 cm G=> 68.6 cm

Figure 6. Tree Species Importance Value (IV) in Each Size Class
Wild Rose

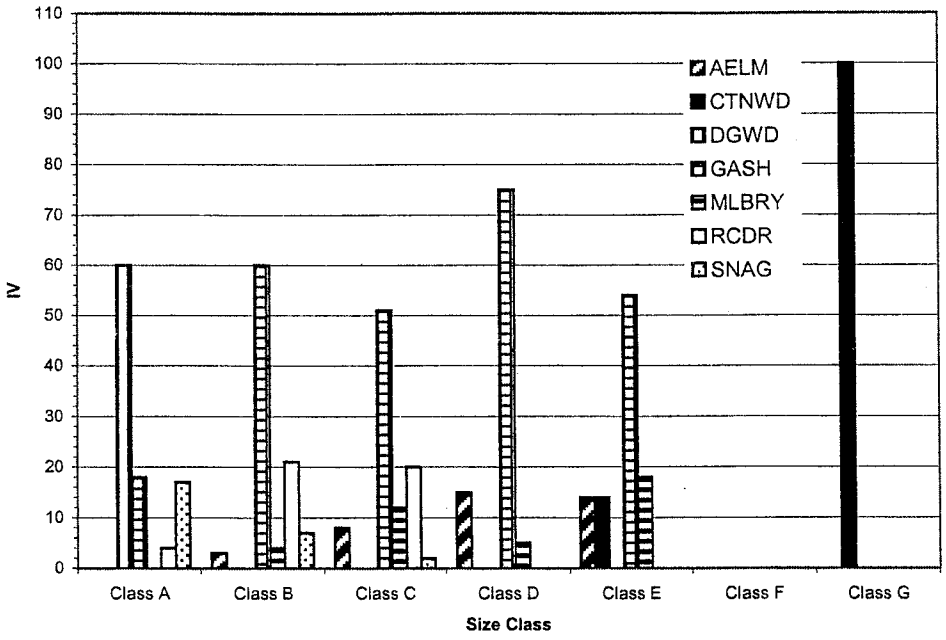
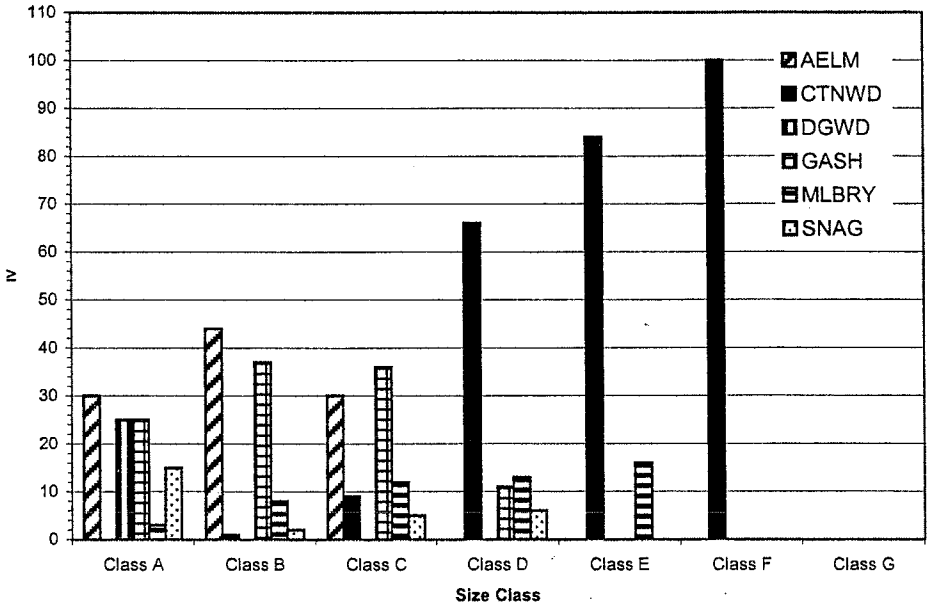


Figure 7. Tree Species Importance Value (IV) in Each Size Class
Audubon



Size Classes: A < 7.6 cm B= 7.6-15.0 cm C=15.2-22.0 cm D=22.9-38.0 cm
(DBH) E=38.1-53.2 cm F=53.3-68.6 cm G=> 68.6 cm

Figure 8. Tree Species Importance Value (IV) in Each Size Class
Russian Olive

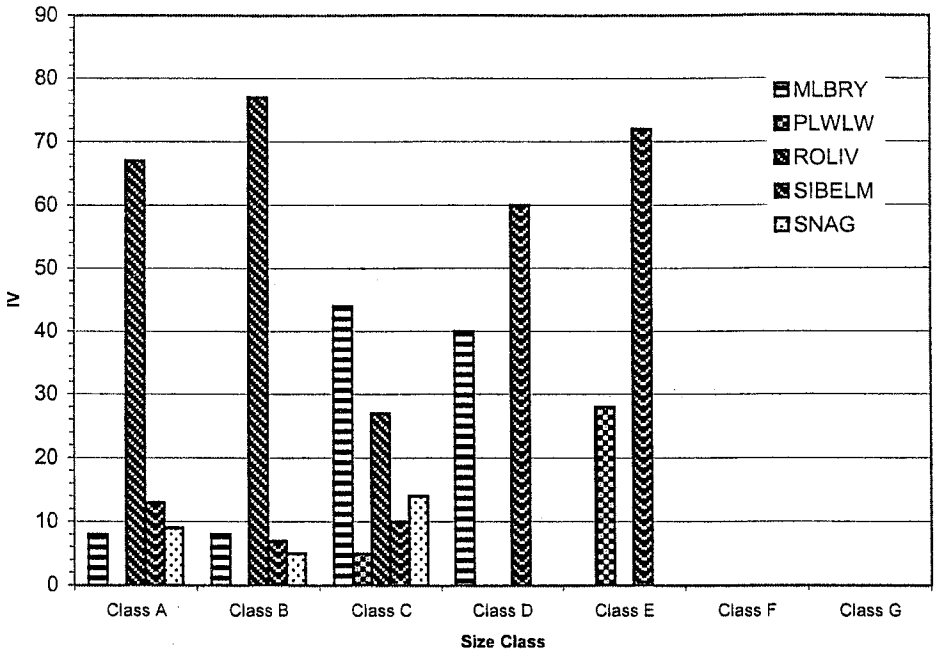
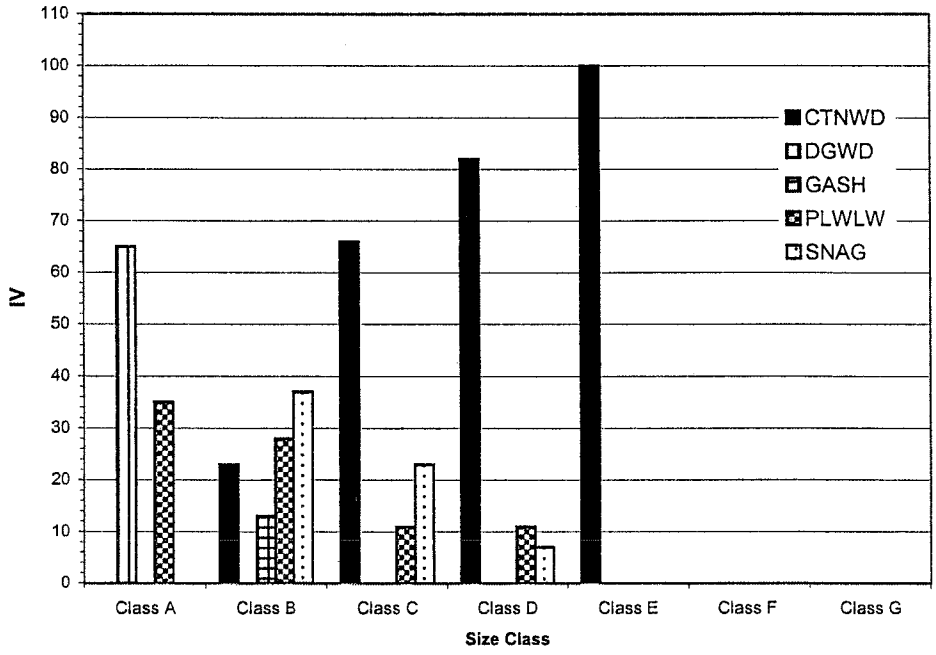


Figure 9. Tree Species Importance Value (IV) in Each Size Class
Elm Creek North



Size Classes: A < 7.6 cm B= 7.6-15.0 cm C=15.2-22.0 cm D=22.9-38.0 cm
(DBH) E=38.1-53.2 cm F=53.3-68.6 cm G=> 68.6 cm

Figure 10. Tree Species Importance Value (IV) in Each Size Class
Elm Creek South

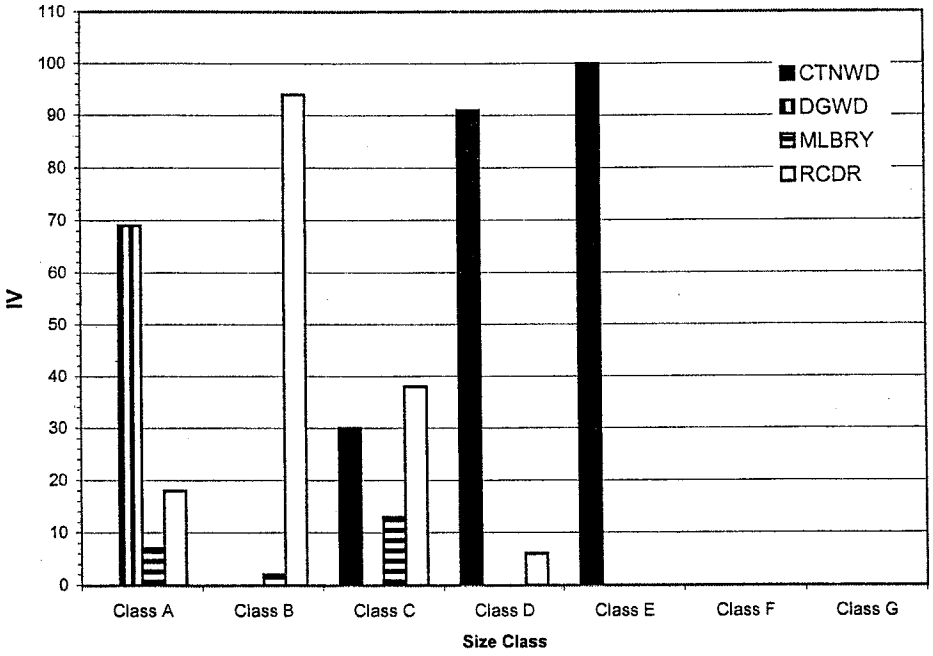
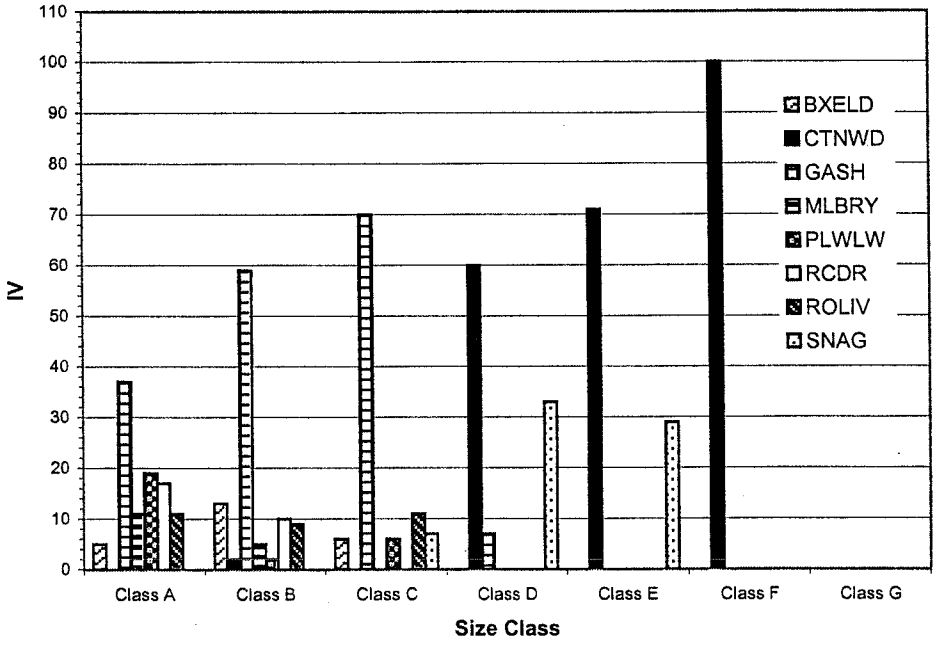
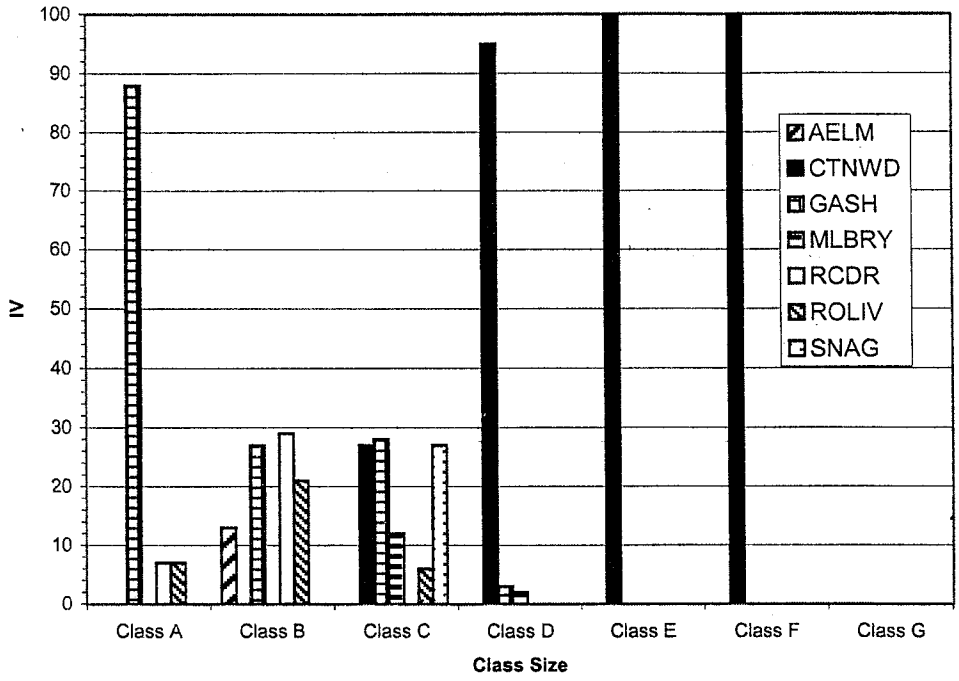


Figure 11. Tree Species Importance Value (IV) in Each Size Class
Moles 1



Size Classes: A < 7.6 cm B= 7.6-15.0 cm C=15.2-22.0 cm D=22.9-38.0 cm
(DBH) E=38.1-53.2 cm F=53.3-68.6 cm G=> 68.6 cm

Figure 12. Tree Species Importance Value (IV) in Each Class Size
Moles 2



Size Classes: A < 7.6 cm B= 7.6-15.0 cm C=15.2-22.0 cm D=22.9-38.0 cm
(DBH) E=38.1-53.2 cm F=53.3-68.6 cm G=> 68.6 cm

Table 11. Density/ha of shrub and tree species < 7.6 cm dbh and < 1.4 m above ground

Site	Shrubs					Trees				Total Stems/ha
	R.L.Dogwood	W.Wild Rose	False Indigo	Prickly Ash	Buckbrush	Siberian Elm	E.Red Cedar	Russian Olive	Green Ash	
Chapman	497	0	331	0	0	0	216	0	0	1044
Mormon Island	791	0	0	744	0	0	0	0	13	1548
Wild Rose	606	0	0	53	9	0	0	0	13	681
Audubon	1412	0	91	0	213	0	0	0	6	1722
Russian Olive	0	78	0	0	0	66	0	6	0	160
Moles 1	1534	0	69	0	0	0	9	3	0	1615
Moles 2	1088	28	275	0	0	0	0	3	53	1447
Elm Creek S.	1272	0	0	0	0	0	6	0	0	1278
Elm Creek N.	341	9	0	0	0	0	3	0	0	353

Table 12. *Relative Density of Shrub and Tree Species < 7.6 dbh and < 1.4 m above ground.

	Shrubs					Trees				Total
Site	R.L.Dogwood	W.Wild Rose	False Indigo	Prickly Ash	Buckbrush	Siberian Elm	E.Red Cedar	Russian Olive	Green Ash	
Chapman	47	0	32	0	0	0	21	0	0	100
Mormon Island	51	0	0	48	0	0	0	0	<1	100
Wild Rose	89	0	0	8	<1	0	0	0	2	100
Audubon	82	0	5	0	12	0	0	0	<1	100
Russian Olive	0	52	0	0	0	44	0	4	0	100
Moles 1.	95	0	4	0	0	0	<1	<1	0	100
Moles 2	75	2	19	0	0	0	0	<1	4	100
Elm Creek S.	99	0	0	0	0	0	<1	0	0	100
Elm Creek N.	96	3	0	0	0	0	1	0	0	100

*Relative density = (No. stems of species / total no. of stems) x 100

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List of Appendices

Appendix Page

Appendix 1. Number of times each species observed (over three censuses) each year at each site.

Species	Chapman		Mormon		Wild Rose		Audubon		R.Olive		E Creek N		E Creek S		Moles 1		Moles 2	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
American Crow	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
American Goldfinch	0	1	3	0	0	0	1	3	5	9	0	0	0	0	0	0	0	0
American Redstart	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
American Robin	2	4	3	9	1	3	0	5	5	3	0	3	7	6	0	3	0	1
Bell's Vireo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belted Kingfisher	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Black-capped Chickadee	8	6	2	2	1	2	2	3	4	3	0	1	6	1	0	1	0	3
Black-billed Magpie	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0
Black-throated Green Warbler	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue Jay	7	7	8	5	6	8	13	8	1	6	0	4	14	10	0	4	0	5
Brown Thrasher	0	3	0	1	0	0	1	2	10	3	0	0	3	0	0	0	0	1
Brown-headed Cowbird	0	0	9	1	0	0	0	0	2	4	0	0	0	1	0	0	0	2
Cedar Waxwing	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Common Grackle	0	0	0	2	1	0	0	0	16	4	0	0	1	9	0	0	0	0
Common Yellowthroat	2	2	5	4	6	12	3	2	6	4	0	0	0	0	0	0	0	1
Dickcissel	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Downy Woodpecker	0	5	1	1	0	2	2	3	0	0	0	0	1	0	0	0	0	2
Eastern Bluebird	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0
Eastern Kingbird	0	0	2	0	0	0	1	0	6	5	0	0	4	0	0	0	0	0
Eastern Phoebe	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Eastern Wood-Peewee	2	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
European Starling	0	1	0	0	0	0	0	0	3	0	0	0	10	6	0	0	0	0
Field Sparrow	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Gray Catbird	0	0	3	6	2	3	0	3	2	1	0	0	0	0	0	0	0	0
Great Blue Heron	0	0	0	0	1	0	0	2	0	0	0	0	1	0	0	0	0	0
Great-crested Flycatcher	4	6	0	0	0	0	0	1	0	0	0	2	4	3	0	2	0	3
Green-backed Heron	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hairy Woodpecker	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
House Wren	15	18	20	21	11	7	18	14	6	7	0	18	17	10	0	18	0	17
Indigo Bunting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mourning Dove	0	2	5	3	0	0	0	0	0	6	0	2	4	2	0	2	0	2
Northern Bobwhite	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0
Northern Cardinal	3	2	1	0	1	1	1	1	1	4	0	2	1	2	0	2	0	0
Northern Flicker	2	8	6	8	3	5	7	7	7	3	0	10	8	14	0	10	0	15
Northern Oriole	3	4	8	2	2	4	6	10	1	7	0	1	9	6	0	1	0	0
Orchard Oriole	0	0	0	0	0	0	2	0	11	3	0	0	0	0	0	0	0	0
Red-bellied Woodpecker	1	1	0	0	0	1	0	2	0	0	0	0	0	1	0	0	0	0
Red-headed Woodpecker	3	1	0	0	0	0	1	0	1	4	0	0	6	2	0	0	0	0
Red-winged Blackbird	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Rose-breasted Grosbeak	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Rufus-sided Towhee	1	0	0	0	1	3	1	2	0	2	0	0	0	0	0	0	0	0
Song Sparrow	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swainson's Thrush	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0
Warbling Vireo	0	0	10	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
White-breasted Nuthatch	1	3	0	1	0	1	0	3	0	1	0	3	0	0	0	3	0	0
Wood Duck	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
Wood Thrush	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	1
Yellow Warbler	0	0	3	0	0	0	1	3	2	1	0	0	0	0	0	0	0	0
Yellow-billed Cuckoo	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Yellow-rumped Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2. Density/ha, Dominance/ha and Frequency of Tree Species at Each Site.

	Chapman			Mormon			Wild Rose			Audubon			R.Olive			Elm Creek N			Elm Creek S			Moles 1			Moles 2		
Species	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency	Density	Dominance	Frequency
American Elm	87	12	63	185	24	75	31	18	50	349	31	88	0	0	0	0	0	0	6	2	25	0	0	0	3	0	13
Boxelder	0	0	0	6	1	25	0	0	0	9	2	25	0	0	0	0	0	0	0	0	0	22	4	13	0	0	0
Catalpa	25	5	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E.Cottonwood	145	131	100	80	99	63	6	74	13	65	71	88	0	0	0	198	118	75	124	108	100	87	115	75	184	191	100
R.L.Dogwood	49	1	88	12	<1	25	439	8	88	222	4	88	0	0	0	22	<1	25	355	6	100	0	0	0	3	0	13
Green Ash	9	1	13	204	51	100	399	103	100	306	33	100	0	0	0	9	2	25	15	1	50	127	16	88	73	13	100
Hackberry	0	0	0	0	0	0	31	7	63	19	4	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mulberry	34	4	63	6	4	25	37	18	63	62	18	63	121	27	38	0	0	0	37	4	50	12	1	25	9	4	13
P.L.Willow	9	9	13	46	17	63	0	0	0	0	0	0	6	5	25	56	17	63	6	<1	25	19	2	38	3	0	13
E. R.Cedar	763	69	100	0	0	0	111	20	88	15	2	25	34	2	50	0	0	0	213	31	100	22	3	50	11	1	25
R.Olive	0	0	0	0	0	0	3	<1	13	0	0	0	751	63	100	0	0	0	3	1	13	31	4	50	8	2	13
Siberian Elm	0	0	0	0	0	0	0	0	0	0	0	0	151	40	63	0	0	0	0	0	0	0	0	0	0	0	0
Snag	56	15	75	31	2	50	136	6	88	117	7	75	87	7	75	65	20	88	12	3	50	40	52	50	11	5	38

Density = Total number

Dominance = Total basal area (m^2)

Frequency = Total number of sampling points in which species occurs/total number of points sampled

Appendix 3. Relative Density, Rel. Dominance, Rel. Frequency and Imp. Values of Tree Species at Each Site.

	Chapman				Mormon				Wild Rose			
Species	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*
American Elm	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	6.1
Boxelder	0.0	0.0	0.0	0.0	1.1	0.5	5.9	2.5	0.0	0.0	0.0	0.0
Catalpa	2.1	1.8	6.8	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Cottonwood	12.3	53.2	18.2	27.9	14.1	50.0	14.7	26.3	0.5	29.0	2.2	10.6
Rough-Leaved Dogwood	4.2	0.3	15.9	6.8	2.2	0.1	5.9	2.7	36.8	3.3	15.6	18.4
Green Ash	0.8	0.4	2.3	1.2	35.7	25.8	23.5	28.3	33.4	40.5	17.8	30.4
Hackberry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.7	11.1	5.5
Mulberry	2.9	1.6	11.4	5.3	1.1	2.2	5.9	3.1	3.1	7.1	11.1	7.1
Peach-Leaved Willow	0.8	3.6	2.3	2.2	8.1	8.3	14.7	10.4	0.0	0.0	0.0	0.0
Eastern Red Cedar	64.7	28.1	18.2	37.0	0.0	0.0	0.0	0.0	9.2	8.0	15.6	10.9
Russian Olive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	2.2	0.9
Siberian Elm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snag	4.7	6.3	13.6	8.2	5.4	1.1	11.7	6.1	11.3	2.4	15.6	9.8
Total	100	100	100	100	100	100	100	100	100	100	100	100

Relative Density = (No. of individuals of a species/no. of individuals of all species) x 100
Relative Dominance = (Total basal area of a species/total basal area of all species) x 100
Relative Frequency = (Frequency value for a species/total frequency values of all species) x 100
Importance Value = Sum of relative density, relative dominance and relative frequency/3

Appendix 3 (cont). Relative Density, Rel. Dominance, Rel. Frequency and Imp. Values of Tree Species at Each Site

	Audubon				Russian Olive				Elm Creek North			
Species	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*
American Elm	0.8	18.4	15.2	21.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boxelder	29.9	1.1	4.3	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Catalpa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Cottonwood	5.6	41.3	15.2	20.7	0.0	0.0	0.0	0.0	56.6	75.2	27.3	53.0
Rough-Leaved Dogwood	19.1	2.2	15.2	12.2	0.0	0.0	0.0	0.0	6.2	0.2	9.1	5.2
Green Ash	26.2	19.2	17.4	20.9	0.0	0.0	0.0	0.0	2.7	1.0	9.1	4.3
Hackberry	1.6	2.4	4.3	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mulberry	5.3	10.5	10.9	8.9	10.5	18.5	10.7	13.2	0.0	0.0	0.0	0.0
Peach-Leaved Willow	0.0	0.0	0.0	0.0	0.5	3.7	7.1	3.8	15.9	11.0	22.7	16.5
Eastern Red Cedar	1.3	1.0	4.3	2.2	3.0	1.7	14.3	6.3	0.0	0.0	0.0	0.0
Russian Olive	0.0	0.0	0.0	0.0	65.3	43.5	28.6	45.8	0.0	0.0	0.0	0.0
Siberian Elm	0.0	0.0	0.0	0.0	13.2	27.8	17.9	19.6	0.0	0.0	0.0	0.0
Snag	10.1	4.0	13.0	9.0	7.5	4.8	21.4	11.2	18.6	12.6	31.8	21.0
Total	100	100	100	100	100	100	100	100	100	100	100	100

Relative Density = (No. of individuals of a species/no. of individuals of all species) x 100
Relative Dominance = (Total basal area of a species/total basal area of all species) x 100
Relative Frequency = (Frequency value for a species/total frequency values of all species) x 100
Importance Value = Sum of relative density, relative dominance and relative frequency/3

Appendix 3 (cont).Relative Density, Rel.Dominance, Rel. Frequency and Imp. Values of Tree Species at Each Site

	Elm Creek South				Moles 1				Moles 2			
Species	*Relative Density*	*Relative Dominance*	*Relative Frequency*	*Importance Value*	Relative Density	Relative Dominance	Relative Frequency	Importance Value	Relative Density	Relative Dominance	Relative Frequency	Importance Value
American Elm	0.8	1.0	4.9	2.2	0.0	0.0	0.0	0.0	1.0	10.0	4.0	1.7
Boxelder	0.0	0.0	0.0	0.0	6.1	2.1	3.3	3.8	0.0	0.0	0.0	0.0
Catalpa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Cottonwood	16.0	69.3	19.5	34.9	24.2	59.2	19.3	34.2	60.3	88.4	30.5	59.7
Rough-Leaved Dogwood	46.0	3.5	19.5	23.0	0.0	0.0	0.0	0.0	6.0	0.0	4.0	1.7
Green Ash	2.0	0.8	9.8	4.2	35.3	7.8	22.6	65.7	23.9	6.0	30.5	20.1
Hackberry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mulberry	4.8	2.4	9.8	5.7	3.3	0.5	6.4	3.4	3.0	1.9	4.0	2.9
Peach-Leaved Willow	0.8	0.1	4.9	1.9	5.3	0.5	9.7	5.2	1.0	0.0	4.0	1.7
Eastern Red Cedar	27.6	20.0	19.5	22.4	6.1	1.0	12.9	6.7	3.6	0.5	7.6	4.0
Russian Olive	0.4	0.7	2.4	1.2	8.6	2.1	12.9	7.9	2.6	0.9	4.0	2.5
Siberian Elm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snag	1.6	2.1	9.8	4.5	11.1	26.8	12.9	16.9	3.6	2.3	11.6	5.8
Total	100	100	100	100	100	100	100	100	100	100	100	100

Relative Density = (No. of individuals of a species/no. of individuals of all species) x 100
Relative Dominance = (Total basal area of a species/total basal area of all species) x 100
Relative Frequency = (Frequency value for a species/total frequency values of all species) x 100
Importance Value = Sum of relative density, relative dominance and relative frequency/3