3 Wildlife and Fire in the Upper Midwest

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Abstract: Fire plays an important role in the perpetuation of forests, prairies, and wetlands in the Upper Midwest. The effects of fire in these habitats have profound implications to wildlife because of the dynamic changes in plant species composition and habitat structure. At the same time, wildlife species may be instrumental in the regeneration of forests, prairies, and wetlands following fire, through enhancement of seed dispersal, seed viability, and the development of soils. Hence, the role that fire plays in altering plant and soil ecosystem structure is closely intertwined with the dynamic processes that take place in the animal communities. These interactions represent complex feedback loops that affect forests, prairies, and wetlands following fire. Many species of wildlife (e.g., Kirtland's warbler [*Dendroica kirtlandii*], sharptailed grouse [*Tympanuchus phasianellus*], yellow rail [*Coturnicops noveboracensis*], black-backed woodpecker [*Picoides tridactylus*], and moose [*Alces alces*], likely depend on fire conditions for their continued existence, and it is prudent to include fire as an active component in the dynamic management of wildlife in the Lake States area. However, the role that fire plays in the continued management of these areas should be scrutinized where humans and important natural resources are located.

The forest fires that raged through Yellowstone National Park in 1988 created a renewed interest and concern about how we deal with fire in resource management. Although the destruction and loss of resources from fire seem immense, it is generally accepted that fires have long been a part of the natural ecology of forest and prairie ecosystems in the Lake States area (e.g., Daubenmire 1936, Curtis 1959, Ahlgren and Ahlgren 1960, Frissel 1973, Heinselman 1973, Wright and Heinselman 1973). Moreover, it is generally accepted that most wildlife species have lived with fire for thousands of years and may even be considered "adapted" to fire (e.g., Kelsall et al. 1977). The role of fire in wetland habitats is less clear because it has been little studied (Weller 1981), but recent studies on fire regimes and climate change indicate that fire must have been frequent in many habitats during dry years (Clark 1988). Hence, fire has become an integral part of many wildlife management practices (Lotan 1979).

Intense crown fires in forests will result in early successional stages of vegetation consisting of open grassy areas and shrublands. In prairies, fires

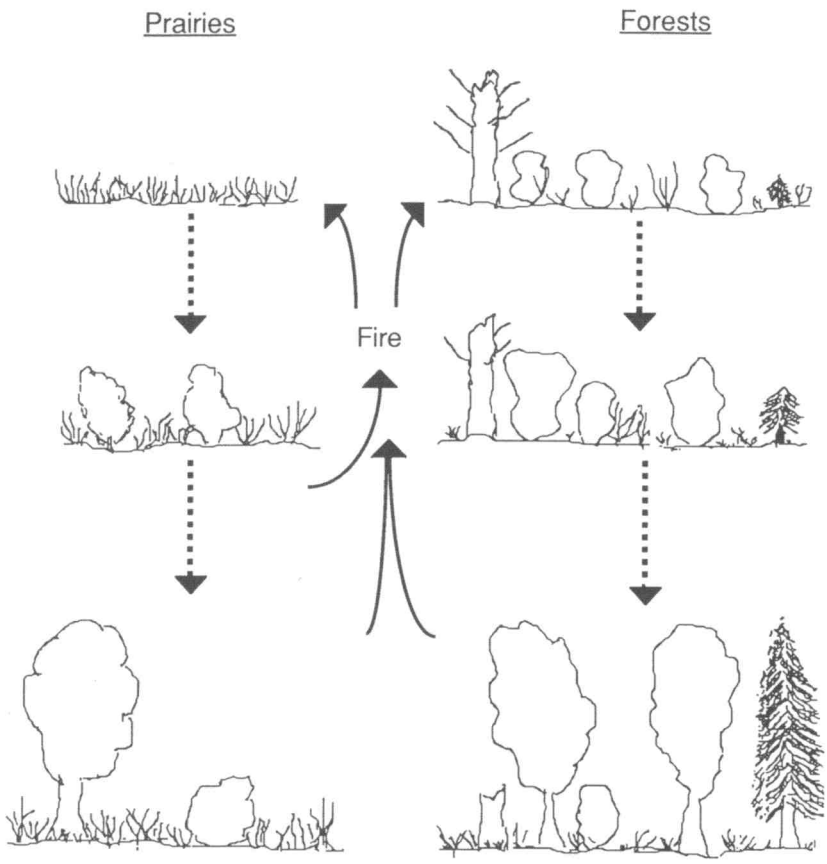

Fig. 1. Vegetation development after fire.

maintain open areas by eliminating woody vegetation such as shrubs and trees (Fig. 1). In wetlands, fires burn standing crops of cattails (*Typha* spp.), sedges (*Carex* spp.), and shrubs (Weller 1981) and, if intense enough, can burn well into the moss of peatland habitats (Anderson 1982).

There is sometimes direct mortality to wildlife from fire especially if suitable refugia are not available or if dispersal from the fire is impossible (Bendell 1974). The major effects on wildlife, however, are due to changes that occur in the habitats (Anderson 1982). Species that favor young forests will be positively affected, while those favoring old growth forests will be negatively impacted. Similarly in prairies or wetlands, those species requiring shrubs or trees within their habitats likely will be eliminated, while those favoring grass or sedge dominated habitats will be positively affected. Here

we provide an overview of fire and how it affects wildlife in the Upper Midwest area (see also Bendell 1974). By Upper Midwest we refer to the general area consisting of Michigan, Wisconsin, Minnesota, Iowa, Illinois, and Indiana. Rather than focusing entirely on a species-specific approach, we discuss potential feedback loops and interactions between vegetation, wildlife, and fire within these ecosystems. Moreover, given that "fire suppression" is generally the rule for most of the Upper Midwest, it is time to review the role of fire in relation to the species and communities that may need fire in a landscape context. For a more complete review the reader should see Kelsall et al. (1977), Viereck and Schandelmeier (1980), or Wein and MacLean (1983).

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Fire Effects on Habitat

Landscape Patterns

Fires create a complex mosaic of burned and unburned patches of habitat with the actual juxtaposition of these areas depending on such factors as the patchiness and intensity of the fire, topography, soil moisture patterns, and weather patterns during the burn. Hence, each species responds to the conditions left by the fire in a manner consistent with its needs and the spatial scale with which those needs are met. The size of the burn is less important to a species with a small home range (e.g., < 2 ha) such as a deer mouse (*Peromyscus* spp.) or chestnut-sided warbler (*Dendroica pensylvanica*). In contrast, size and orientation of a fire is more important for wide-ranging species such as moose or hawks that move over several square kilometers of area. In the latter case a small fire would likely have only a minor effect on the species. For instance, the frequency and spatial pattern of fires in coniferous forests can profoundly affect population dynamics of wildlife species that depend on early successional deciduous species for food. Geist (1974) hypothesized that moose populations find refuge in habitats of continuous but small disturbances, but expand into habitats with an abundance of food created by large disturbances such as fire. The ability of a moose to affect recovery of the forest also depends on the size of the burn. Pastor and Naiman (1988) show that browsing by moose in large disturbances does not alter species composition because of the abundance of food regenerated and the lack of seed dispersal to the center of the distur-

bance. Recovery of small disturbances, in contrast, can be greatly affected by intense moose browsing.

Few studies have considered the effects of wildfire over large landscapes (Erskine 1977, Anderson 1982). The difficulties and costs of conducting such studies have usually prohibited this kind of landscape approach. At a landscape level, the relative effects of forest fire are obviously different from those resulting from logging activity. Where forest fires tend to be large with complex mosaics, logging produces landscape patches that are rectangular or square. How these differences in shapes, scales, and frequency of disturbance between logging and fire affect wildlife are relatively unexplored, as are related ecological processes such as nutrient dynamics.

Several studies on endangered species have indicated the importance of examining habitat requirements for species on a landscape basis (e.g., Noss 1983). Studies of the red-cockaded woodpecker (*Picoides borealis*) in the southeastern United States (Baker 1983) and the spotted owl (*Strix occidentalis* in the northwest (Simberloff 1987) have shown the importance of old growth forests in a landscape perspective. The most prominent example for the Upper Midwest area is the Kirtland's warbler (Probst 1986, 1988), which is typically a fire-dependent species requiring jack pine (*Pinus banksiana*) stands 6 to 23 years old regenerated naturally after fire.

The nature of wildfire has potential implications to habitat fragmentation patterns. Several studies have examined the effects of fragmentation on animals from a landscape perspective in the Upper Midwest area (e.g., Blake and Karr 1984). Land fragmentation is more acute in southern Michigan, Ohio, Indiana, and Illinois, than in the northern portions which have not experienced this intensity of fragmentation. Fragmentation patterns in the southern portion of the Upper Midwest result from agricultural and urban development where woodlots are left as islands in the landscape. In the north, forest habitat patterns are created by fire, roads, and logging activities.

More information is needed to assess the various roles that wildlife play in the regeneration of forests following wildfire and other disturbances in the Upper Midwest area. It is especially important to attempt to understand how small mammals (e.g., Sims and Buckner 1973), moderately sized mammals (e.g., snowshoe hare [*Lepus americanus*], Keith and Surrendi 1971), large mammals (e.g., moose, Pastor et al. 1988) and birds (e.g., Johnson and Adkisson 1985) aid in the regeneration of forests through enhanced seed dispersal. There are many wildlife and plant species that are affected by fire, and many complex interactions among these species currently are not well understood. Furthermore, the role of nutrients and how they are affected by fire varies with season, soil, weather, the nature of the fire, and

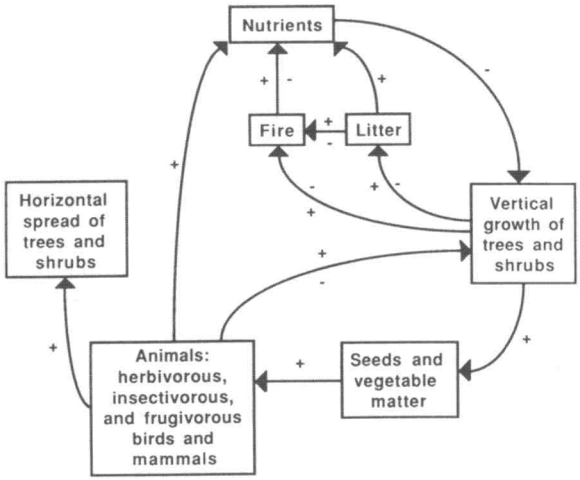

Fig. 2. Potential feedback loops in the vertical growth and horizontal spread of forests as affected by fire and wildlife.

a variety of other factors (e.g., Daubenmire 1968, Smith 1978, Bendell 1974). What is needed is the identification of a conceptual framework which will enable us to understand the interrelationships among the components (Fig. 2) and then to test the magnitude of the relationships under a variety of conditions.

Stand Regeneration, Species Composition, and Succession

Forested Areas.—Central hardwood forests are composed chiefly of mixed oaks (*Quercus* spp.), with hickory (*Carya* spp.) as a minor component. Succession results in gradual replacement of oaks by American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) in the eastern part of the region, but fire promotes vigorous oak sprouting and allows invasion by aspen (*Populus tremuloides* and *P. grandidentata*), cherry (*Prunus serotina* and *P. pensylvanica*), red maple (*Acer rubrum*), and more xeric oaks such as black (*Quercus velutina*) and post (*Q. stellata*). The southern portion of the Upper Midwest have many species in common with the Central States, but northern pin oak (*Q. ellipsoidallis*) often replaces post oak in more xeric situations. Forested habitats in southern Minnesota are similar to the mixed mesophytic forests in the Eastern Central Hardwoods and the Northern Hardwoods. Big Woods-type habitat is found in areas favored by fire breaks due to topography and bodies of water (Grimm 1984). Much of

the southern portion of the Upper Midwest before settlement was drier forest transitional to adjacent barrens, savannahs, or prairies.

Northern hardwood forests dominate a majority of sites in the northern part of the Upper Midwest, but most of the area is in early succession aspen-birch (*Betula papyrifera*). Further north and on wetter sites aspen-conifer types (especially aspen-fir) or conifer bogs are common. Drier sites are characterized by oak or jack pine barrens and savannahs. The major effect of fire in mesic forests is to favor oaks and pines or to perpetuate aspen-birch. However, wind also has a major influence on northern hardwood composition and structure. In the absence of disturbance and depending on site, early succession broad-leaf trees can be replaced by conifers such as balsam fir (*Abies balsamifera*), white pine (*Pinus strobus*), white spruce (*Picea glauca*), and eastern hemlock (*Tsuga canadensis*), as well as hardwoods such as sugar maple and basswood (*Tilia americana*).

Open Lands.—Prairies, savannahs (Nuzzo 1986), and barrens were more common in the southern part of the Upper Midwest during presettlement times, but agriculture, fire control, and tree planting have reduced natural open lands (Tester and Marshall 1963). Oaks tend to invade prairies unless suppressed by drought or fire. Climate and fire frequently are highly variable, so savannahs and prairies share a dynamic spatial relationship. Topographic relief and microsites accentuate differences in tree spatial pattern of grassland-savannah zones. Oak barren communities develop where moisture is sufficient for woody plants to become established, but where fire is frequent enough to prevent forest development. In the absence of fire, oak barrens may be invaded by aspen and cherry, which tend to form scattered clumps of trees. In the Central hardwood states, barrens may have a shrubland physiognomy similar to old fields and Eastern red cedar (*Juniperus virginiana*) is often a dominant tree species.

In the Upper Midwest, dense jack pine barrens are associated with wildfire, but also may form an open shrubland in clearcut forests. Barrens, savannahs, and dry prairies share some common ground plants. Barrens frequently are characterized by low-growing shrubs such as blueberries (*Vaccinium* spp.), prostrate cherries (e.g., *Prunus pumila*), sweet fern (*Comptonia peregrina*), and bearberry (*Arctostaphylos uva-ursa*). Fire promotes ground vegetation diversity by preventing dominance of grasses and sedges and by allowing invasion of forbs and small shrubs.

Primary and Secondary Productivity

Fire can substantially increase the quantity and quality of plant material available for animal consumption. More specifically, fire releases nutrients

held in dead and living plants, increases soil temperature, promotes seed germination, and reduces competition for water and light. These factors allow smaller, younger plants to thrive. A short-term "nutrient pulse" can be especially important on poor-quality soils. Younger plant communities can have higher net productivity than older ones, so more plant production can be channeled into high quality wildlife foods such as berries, seeds, nuts, and herbaceous forage. Furthermore, forage quality is often improved after fire (Hobbs and Spowart 1984). Fire may improve longer-term secondary productivity indirectly by increasing snags for cavity nesters and den trees, and by providing perches for raptors, flycatchers, and avian territorial display. As a result, use of plant and animal resources is increased because the spatial complexity of the habitat increases which allows more diverse use of space by wildlife species.

Post-fire Species Interactions

Plant Dispersal.—Seeds of early-successional plant species are usually disseminated by wind or animals. Larger, winged seeds (e.g., ashes [*Fraxinus spp.*], basswood, and maples) generally do not travel long distances unless transported by animals. Frugivorous birds are particularly effective disperses of seeds found in the fruit of many shrubs and trees. Blue jays (*Cyanocitta cristata*) can disperse beech nuts (Darley-Hill and Johnson 1981, Johnson and Adkisson 1985) and acorns over long distances and may be responsible for speeding forest migration (Johnson and Webb, 1989), especially during periods of climatic change. Seeds from herbs and berries also are dispersed by omnivorous mammals such as black bears (*Ursus americanus*). Small mammals are important dispersers of seeds and spores of fungi which are often symbionts that increase plant productivity (Maser et al. 1978). Squirrels and chipmunks (Sciuridae) help move acorns away from forest edges into clearcuts, burns, and other openings.

Herbivory and Omnivory.—Many wildlife species are temporarily eliminated from a large wildlife area. Some species do not return until the forest becomes mature (e.g., some woodpeckers and canopy-foraging birds), but others (e.g., raptors, wild turkey [*Meleagris gallopavo*]) return quickly after fire to scavenge on plants and animals killed or exposed by the fire. Prairie and savannah wildlife, and early-succession species on forested sites, colonize burns as herbaceous vegetation recovers or thrives during the post-burn years. Small mammal herbivores usually do not appear in burns until 2 or 3 years after a fire (Buech et al. 1977). Prairie chickens (*Tympanuchus* spp.) may use newly-burned areas for dancing grounds, and benefit from higher productivity of recently-burned grasslands. Cottontail rabbits (*Sylvilagus floridanus*), snowshoe hare (*Lepus americans*), white-tailed deer

(*Odocoileus virginiana*), and moose respond favorably to new herbaceous growth and woody sprout-growth. Middle stages of forest regeneration (3–15 years) create habitat for omnivores such as black bears, finches, and sparrows.

Fire Effects on Wildlife

Deciduous Forest

Broadleaf coppice results from fire in deciduous forests in the Midwest. Deciduous shrublands can also appear after fire in some coniferous or mixed forest types as well. In addition to herbivores and omnivores discussed above, regenerating burns in the Upper Midwest provide abundant habitat for birds such as chestnut-sided warblers, mourning warblers (*Oporornis philadelphia*), song sparrows (*Melospiza melodia*), and white-throated sparrows (*Zonotrichia albicollis*) in northern areas (Niemi 1978, Anderson 1982, Apfelbaum and Haney, 1986) and prairie warblers (*Dendroica discolor*) in the southern oak barrens. Middle stages of forest development tend to have few distinctive species, but share species found in younger and older habitats. However, chestnut-sided warbler and American redstart (*Setophaga ruticila*) are numerically dominant species (Back 1979; Probst, pers. obs.). Aerial foragers such as swallows are found more commonly in regenerating burns and seldomly in mature forests.

Periodic fires help maintain a diversity of stand ages that are important for ruffed grouse (*Bonasa umbellus*) (Gullion 1984). Snags left standing after a fire are used for perches and cavity nesting by American kestrels (*Falco sparverius*), Eastern bluebirds (*Sialia sialis*), and many woodpeckers such as the red-headed woodpecker (*Melanerpes erythrocephalus*) in the southern ranges and the black-backed woodpecker in the northern portions (Niemi 1978, Anderson 1982, Apfelbaum and Haney 1986). Equally important, many snags of fire origin persist for long periods and are used by cavity nesters. These snags represent the only places that cavity nesters can use until the forest matures and often are used by birds in mature forests (e.g., chickadees [*Parus* spp.]). Open country raptors such as red-tailed hawk (*Buteo jamaicensis*) often use areas after burns. Other higher level carnivores (e.g., weasels [*Mustela* spp.]) and omnivores (e.g., black bears) may benefit from greater secondary productivity in burns, but supporting data are scarce.

Coniferous Forests

The response of wildlife shortly after fire in coniferous forests is similar to that described for deciduous forests. The specific response of wildlife

species after fire depends on the conditions in the stand affected by fire and whether the successional pattern of the vegetation proceeds to deciduous or coniferous dominated vegetation. During the first 10–15 years following a fire, the wildlife communities associated with early successional deciduous habitats will be similar to those found in coniferous areas. As the conifer tree species become more prominent in the community, wildlife that use coniferous species will become more common and begin to distinguish themselves from the deciduous community. Characteristic birds found in conifer-dominated forests in the Upper Midwest include the magnolia warbler (*Dendroica magnolia*), yellow-rumped warbler (*Dendroica coronata*), hermit thrush (*Catharus guttata*), blackburnian warbler (*Dendroica fusca*), chipping sparrow (*Spizella passerina*), and dark-eyed junco (*Junco hyemalis*) (Green and Niemi 1977). In the southern part of the Upper Midwest area, conifer forests are not common except near urbanized areas. An exception is the extensive pine habitats in the central Michigan area where the Kirtland's warbler (Probst 1986) is found. Similarly, mammalian communities would differ between deciduous and coniferous forest where red squirrels (*Tamiasciurus hudsonicus*), red-backed voles (*Clethrionomys gapperi*), and moose become more dominant in the coniferous forest zones. The role of small mammals may be especially important for dispersal and regeneration of the conifer community (Maser et al. 1978). Although most effects of fire on wildlife are positive (except for species that require more mature forests), fires that are too frequent and intense can actually reduce the production of grasses, herbs, and shrubs; and hence reduce vegetation available for browsing (Bendell 1974).

Wetlands

The role of fire in structuring wetland communities is not well understood. One of the more comprehensive studies of the effect of fire on wildlife was conducted by Anderson (1982) in the Seney National Wildlife Refuge in northern Michigan. Many parts of the refuge affected by fire were wetland communities, including bogs. Anderson (1982) indicated that fire changed many of the wetland communities. Changes included substantial burning of the *Sphagnum* itself and reductions in the canopy of forested bogs. In these areas the wildlife community will change from species preferring forested canopies (e.g., boreal chickadee [*Parus borealis*], ruby-crowned kinglet [*Regulus calendula*], and yellow-rumped warbler) to those of open wetlands (e.g., common yellowthroat [*Geothlypis trichas*], song sparrow, and swamp sparrow [*Melospiza georgiana*]).

Additional studies by Niemi and Hanowski (1991) in the Red Lake Peatland of northern Minnesota indicated that many peatland habitats may be

dependent on fire for their maintenance. In habitats such as sedge fen, a variety of sensitive and threatened wildlife species like the short-eared owl (*Asio flammeus*), northern harrier (*Circus cyaneus*), yellow rail, and LeConte's Sparrow (*Ammodramus leconteii*) may be dependent upon the periodic burning of these open habitats to suppress shrub development. The clumped distribution of the yellow rail in particular may indicate that this species is dependent on these periodically burned habitats. Population centers for this species are found in the Red Lake peatland area of northern Minnesota (Niemi and Hanowski 1991), the extensive sedge wetlands in central Minnesota near McGregor (Janssen 1987), and in the Seney National Wildlife Refuge in the upper peninsula of Michigan (Bart et al. 1984). The role that fire plays in wetland communities is still largely unknown and its importance likely has been unappreciated in past wetland management activities.

Many peatland habitats, such as black spruce (*Picea mariana*) forests, regenerate slowly (> 100 years) in contrast with upland terrestrial habitats. Wetlands in the northern portion of the Upper Midwest area are predominantly of the peatland-acidic type, and in the southern portion cattail marshes and shrubby wetlands are predominant. In southern areas, fire primarily affects cattails and shrubs. Reductions in this vegetation negatively affect species that use them for nesting such as the red-winged blackbird (*Agelaius phoeniceus*), swamp sparrow, and common yellowthroat. However, burning opens up dense marsh vegetation and has been reported to stimulate the development of seed-bearing plants which are used by many waterfowl species (Vogl 1969, Bendell 1974). In general, fire plays a role in maintaining and regenerating wetland habitats in the Upper Midwest area. The role of fire may be especially important during times of drought when water levels are low or nonexistent (Clark 1988).

Open Lands

Fire creates and maintains large openings as barrens or prairies throughout most of the Upper Midwest area. Many of the subsequent effects identified are positive and important for large shorebirds (e.g., upland plover [*Bartramia longicauda*] and marbled godwit [*Limosa fedoa*]), upland gamebirds (e.g., sharp-tailed grouse, Bergerud and Gratson 1988), raptors (e.g., short-eared owl and red-tailed hawk), and non-game birds such as Kirtland's warbler, Eastern bluebird, and red-headed woodpecker (Probst 1979, 1986). Most larger or medium-sized mammals use open lands as part of a larger habitat mosaic (Bendell 1974).

As trees and shrub understories in open areas are reduced, species favoring closed forests and shrublands will be negatively affected (e.g., ovenbird

[*Seiurus aurocapillus*], red-eyed vireo [*Vireo olivaceous*], and catbird [*Dumatella carolinensis*]). Furthermore, intense fires that reduce the mat of stems and debris on the surface of grasslands or open forests result in the disappearance of several sparrows (Fringillidae), bobolink (*Dolichonyx oryzivorus*), and voles (*Microtus* spp.) (e.g., Bendell 1974).

Integrating Fire Management with Wildlife and Timber Management

Wildfires, Clearcuts, and Prescribed Burns

A "let burn" policy for wildfire is rarely practiced except in areas set aside for permanent preservation, such as wilderness areas or where fuel loads need to be reduced. Resource management for objectives best achieved by fire must be accomplished by well-planned prescribed burn programs. Although fire is critical for management of species such as prairie chickens, black-backed woodpeckers, and Kirtland's warblers, few species are "wildfire obligates." It is often impractical to burn large parcels to provide habitat required by many species that benefit from fire. Thus, it is necessary to maintain some permanent openings without fire and integrate prescribed burning with timber harvesting. Forest regeneration can sometimes be compatible with prescribed burning or even benefit from fire treatment for site preparation. Even where plant species composition may be different, clearcuts and burns often have similar vegetation structure and animal communities. For example, small mammal species found in burns (Buech et al. 1977) are similar to those in clearcuts (Kirkland 1977, Probst and Rakstad 1987). Songbirds found in burns (Niemi 1978) are nearly the same as those listed in aspen clearcuts (Back 1979; Probst, unpubl. data) or in oak clearcuts outside the Midwest (Probst 1979). Thus, early successional wildlife species are often widespread species with general habitat requirements. The most obvious difference between logged areas and burned areas is that many dead trees (snags) will remain in an area after fire, and hence habitat for nesting, perching, and territorial display will remain. Additional complexity in these habitats (partly due to snags) are associated with higher densities of birds (e.g., Niemi and Hanowski 1984). Moreover, the importance of removing the boles from logged areas is still unclear with respect to nutrient cycling and long term sustainability of forest systems.

Planning and Spatial Considerations

Management for the biogeography and local habitat needs of early succession species requiring large blocks of open lands should integrate

planning for permanent and temporary openings. Most wildlife species that prefer permanent openings (e.g., sharp-tailed grouse, upland plover) can use regenerating habitat for 5 to 20 years. Location of permanent openings should be planned within the context of all open habitats. Planning, stand scheduling, and management should involve federal, state, county, and private owners to provide habitat area requirements for targeted species.

Management of land for permanent and temporary openings of larger areas than previously practiced has potential to reduce edge impacts of openings on mature forests and their associated wildlife and plants. Large temporary openings will regenerate into larger stands of mature forest, which can benefit area-sensitive, mature forest plants and animals. The spatial arrangement of these areas in a landscape context and its importance to the long term survival of wildlife and plant biodiversity is essential, but only beginning to be appreciated (Crow 1988).

The strategy outlined above is targeted toward maintaining habitat area requirements of species, but could be interpreted in a way that ignores local habitat quality. Thus, managers should focus efforts on prescribed burning of permanent and temporary openings, where appropriate, to provide wildlife with the benefits of fire such as desired plant species composition, plant and animal productivity, and habitat quality. The establishment of common objectives at local and regional scales for game species, non-game wildlife, plant species, and timber management could serve as a prototype for integrated management of selected habitat types by application of biogeographic principles on a regional scale.

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