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# WIND ENERGY DEVELOPMENT, PRESCRIBED FIRE AND MIGRATORY LAND BIRDS IN THE SOUTHEASTERN UNITED STATES: BREEDING, STOPOVER, AND WINTERING HABITAT RELATIONSHIPS

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*Abstract.* Fire is a landscape disturbance that historically was more widespread and pervasive than it is today. Restoring fire to the landscape is desirable in many cases, but problematic almost everywhere. The proposed extensive wind energy developments on the Gulf Coast is a new factor that will most likely further limit applications of prescribed fire for ecosystem management objectives. Despite the anthropogenic reduction of fire, we should not continue to overlook the past and potential importance of fire and how fire influences habitat resources needed by resident, migrating, and wintering land birds. How fire influences stopover and wintering migratory bird populations and habitats is unclear, and needs more attention from researchers and managers. Because the ecology of fire and the biology of migration are complex topics, understanding the interactions between migratory birds and fire is a daunting task. Adding the potential negative impacts of wind farms to this already complex mix makes this problem more onerous. Nevertheless, a series of future research strategies to better understand this topic in the context of how wind farm developments might impact ecosystem management of coastal forests and rangelands in the southeastern United States should include: (1) an approximation of historic fire regimes in tropical, subtropical and barrier island habitats, (2) how anthropogenic disturbances have influenced these fire regimes, (3) how prescribed fire applications mimic such historic regimes by using manipulative field experiments on the wintering grounds and in areas known to provide critical stopover habitat resources, and, most importantly, (4) how to continue to implement prescribed fire in light of increased fragmentation from infrastructure associated with wind farm energy development.

*Key Words*: breeding habitat, fire, mangrove, migratory birds, pine savanna, prescribed fire, rangeland, research priorities, stopover habitat, wind farms, wintering habitat.

## DESARROLLO DE LA ENERGÍA EÓLICA, FUEGO PRESCRITO Y AVES TERRESTRES MIGRATORIAS EN EL SURESTE DE ESTADOS UNIDOS: RELACIONES DE REPRODUCCIÓN, PARADA, INVERNADA Y HÁBITAT

*Resumen*. El fuego es una perturbación del paisaje, históricamente más predominante y generalizada que lo que es hoy. La restauración de fuegos en el paisaje es algo apetecido en muchos casos, pero asimismo, en casi todas las áreas, resulta un asunto problemático. El extenso plan de desarrollo de energía eólica propuesto para la Costa del Golfo, constituye un nuevo factor que probablemente limitará, aún más, la aplicación de fuegos prescritos con objetivos de manejo de ecosistemas. Pese a la reducción antropogénica de fuegos, no debemos seguir pasando por alto la importancia anterior y potencial del fuego, ni tampoco, su influencia sobre los recursos del hábitat necesarios para las aves terrestres residentes, migratorias, e invernantes. La manera en que el fuego influencia a las poblaciones y el hábitat de las aves de parada e invernantes no está clara. En tal sentido se necesita más atención por parte de investigadores y gestores. Debido a que la ecología del fuego y la biología de las migraciones son temas complejos, comprender las interacciones entre las aves migratorias y el fuego es una tarea ingente. Añadir las posibles consecuencias negativas de los parques eólicos a esta ya compleja mezcla, convierte al problema en otro más oneroso. Por ello, una futura serie de estrategias de investigación con el fin de comprender mejor este tema, en el contexto de cómo la creación de parques eólicos podrían afectar el manejo de ecosistemas de bosques costeros y pastizales en el sureste de Estados Unidos, debería incluir: (1) Una aproximación histórica de regímenes de incendios en los hábitats de bosques tropicales, subtropicales e islas barradas, (2) cómo los disturbios antropogénicos han influenciado estos regímenes de incendios, (3) cómo la aplicación de fuegos prescritos

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imita a esos regímenes históricos, utilizando experimentos de campo manipulados en las zonas de hibernación y en áreas conocidas por proporcionar recursos de hábitat de parada críticos; y lo más importante, (4) cómo continuar aplicando fuegos prescritos, en vista del incremento de la fragmentación, provocada por la infraestructura asociada al desarrollo de parques de energía eólica.

## INTRODUCTION

As if the situation with respect to applications of prescribed fire and sustainability of migratory bird populations was not already complicated enough, the widespread and extensive proposed development of wind energy generators—hereafter wind farms—further complicates this challenging situation (Kuvlesky et al 2007). Clearly, the need for sustainable and renewable sources of energy is arguably one of the most pressing cultural needs of our society. However, our need to produce sustainable energy should not be engineered and implemented in an arbitrary and capricious manner that results in widespread loss and local extinction of native fauna.

Wildlife scientists and ornithologists are rapidly developing and implementing methods that can serve to assess risks and mitigate the impacts of wind energy development on wildlife, especially migratory birds (Kunz et al. 2007). These methods can and should be used in the process of determining where to place wind farms so as to minimize their effects on migratory birds and allow land managers to continue to apply prescribed fire whenever and wherever such applications are appropriate.

Fire is a landscape disturbance that was once much more widespread and pervasive than it is today. As a landscape process, fire has shaped the biota of many regions of the world for millennia (Pyne 1982, 1995). While the influence of fire has been pervasive on an evolutionary time scale, anthropogenic influences have greatly altered how fire presently influences terrestrial vertebrates and their habitats (Baker 1992). Today, fire on the southeastern landscape, as well as in neotropical habitats that provide wintering and stopover habitats for migrant birds, is vastly different from the natural fire regimes that developed over an evolutionary time scale.

The widespread lack of prescribed fire is one of the major wildlife management problems in the Southeastern U.S. (Brennan et al. 1998). Only three states in this region (Georgia, Florida and Texas) regularly prescribe burn more than 100 000 ha per year. It is estimated that only 2.5 to 3.0%, or about 400 000 ha, is exposed to prescribed burning in Texas on an annual basis and this includes both forests and rangelands (Texas Department of Agriculture 2005). Even at this level, only about 2.5% of the land areas in these states are burned on a regular basis. In other states, such as Mississippi and the Carolinas, only about 0.3% of the total land area is burned annually by prescription. The result is a landscape where only small islands of habitat—usually on public lands—are being treated by fire on a regular basis. Most (90%) of the landownership in the Southeast is private. Use of fire by landowners is inhibited by potential liability, by a belief that fire limits tree growth, and by the concern that fire burns up grass that is better used for livestock feed.

In the southeastern U.S., lightning-ignited fires burned frequently and regularly—almost annually—throughout the upland pine forests and rangelands that once dominated the coastal plain. During periods of prolonged drought such fires also had significant impacts on bottomland hardwood forests and associated wetland systems (Cerulean and Engstrom 1995). The combination of extensive fire suppression, and limited applications of prescribed fire, has created a landscape where only small pockets of frequently burned habitats exist in a much broader matrix of unburned areas (Brennan et al. 1998).

In the Neotropics, natural fire regimes are highly complex and, in most places, poorly understood (Means 1995). To a significant extent—although on a smaller scale than in the U.S.—fire suppression has become institutionalized by many national governments, e.g., Costa Rica, Mexico, and Cuba. However, the extensive use of slash-and-burn agriculture, along with a diverse cultural milieu, makes it extremely difficult to obtain a comprehensive picture of how fire influences Neotropical habitats.

Despite the complexity wrought by anthropocentric influences, it is essential to understand how fire as a landscape process—in the context of both prescribed fire and wildfire—influences populations of terrestrial vertebrates. From the standpoint of migratory land birds, it is important to understand how fire influences habitat and populations, both directly and indirectly. We need to understand issues for breeding, migratory stopover, and wintering habitats. Therefore, our objectives in this chapter are to: (1) assess and briefly review the general state of knowledge about these issues, and (2) outline some practical research priorities that can be used to solve these management problems in the context of impending development of wind farms in the coastal region of the western Gulf

of Mexico. Using a perspective based on ecosystem management (Christensen et al. 1996), we discuss how contemporary land use patterns are influencing migratory land birds on forest and grassland habitats in the southeastern U.S. (Atlantic and Gulf of Mexico Coastal Plains) and nearby tropical and subtropical wintering habitats.

## WIND FARMS IN THE MIX: CRITICAL KNOWLEDGE GAPS

The primary focus on the impact of wind farms on bird migratory bird mortality is related to collisions with turbine blades (Kuvlesky et al. 2007). Documented rates of avian collisions with wind turbines ranges from 0 collisions per turbine per year to more than 30 (Kuvlesky et al. 2007). One of the huge problems with assessing generality of conclusions from the literature on the effects of wind farms on bird populations is that observational or experimental designs are wildly inconsistent among studies. Further complicating this problem is that much of the literature on this topic exists in proprietary format as consulting reports, administrative assessments, and other elements of gray literature that have not undergone peer review.

## EFFECTS OF FIRE ON BREEDING HABITATS

A major, initial emphasis of Partners in Flight has been on habitat and population ecology of migrant land birds during the breeding season. For example, in the volume by Finch and Stangel (1993) at least 50 of 55 papers addressed or focused on issues related to breeding habitat or biology of migrant land birds. Despite this complexity, we tend, in some ways, to discount the importance of fire. For example, there is no mention of fire in a recent series of articles on ornithology and bird conservation in Central America (Komar 1998, Miller and Miller 1998, and Peterson et al. 1998), even though fire undoubtedly plays a major ecological role in the dry forests and scrub habitats of this region. The lack of attention to fire, both from the standpoint of understanding historic fire regimes, as well as how prescribed fires might be used to mimic historic fire regimes, results in a biased perspective on the habitat ecology of migrant land birds.

### Effects of Fire Exclusion

In the southeastern U.S., a series of ongoing projects and research initiatives during the past several decades has resulted in a significant clarification of the relationships between fire and breeding biology of migrant land birds, especially in upland pine forests. At least one of these projects, the "NB-66" (not burned since 1966) experiment at Tall Timbers Research Station near Tallahassee, Florida, has documented how elimination of fire over a nearly 40-year period, has influenced dozens of vertebrate species, including several species of migratory land birds.

Results from the first 15 years of fire exclusion on NB-66 were summarized by Engstrom et al. (1984). The NB-66 experiment documents turnover in a breeding bird community from one dominated by open habitat species (e.g, Eastern Kingbird [*Tyrannus tyrannus*] and Loggerhead Shrike [*Lanius ludovicianus*]), to one dominated by species typically associated with mesic hardwood forests (e.g., Yellow-billed Cuckoo [*Cozzyzus americanus*], Wood Thrush [*Hylochila mustelina*], Red-eyed Vireo [*Vireo olivaceous*], and Hooded Warbler [*Wilsonia citrina*]).

Like the bird communities of upland pine forests, the composition of bird communities on coastal prairies and associated upland habitats may change relative to the presence or absence of fire events. Most of the coastal prairie and upland savanna vegetation communities along the Lower Gulf Coast of Texas have been invaded by woody plants during the past 150 years due to the absence of fire, which formerly suppressed woody invasions. Fire suppression favored certain bird species at the expense of others so the composition of bird communities gradually changed as woody plants invaded the coastal prairies and savannas.

For example, several recent studies have examined the effects of fire on coastal prairie and savanna bird communities in south Texas. Van't Hul et al. (1997) quantified the impact of winter and summer prescribed burning on 8 breeding bird Families inhabiting the grasslands of Matagorda Island on the central Gulf Coast of Texas. They reported that Troglodytidae (wren) abundance was reduced on winter burn areas compared to control sites whereas Emberizinae (sparrow) abundance was higher on the burned areas.

Additionally, Reynolds and Krausman (1998) examined the effect of winter prescribed burning on mesquite (*Prosopis glandulosa*) grassland breeding and wintering bird communities and reported that burning appeared to have little impact on bird communities. Relative abundance and species richness of breeding birds was similar between burned treatments and unburned controls, and though relative abundance of wintering birds was greater on burned treatments, species diversity was similar on treatments and controls. Mix (2004) also

found that the composition of bird communities inhabiting mesquite grasslands within 15–25 km of coastal prairie in south Texas did not change significantly as a result of a single summer fire event.

### Relationships with Use of Fire for Management of Other Species

Habitat management for both the endangered Red-cockaded Woodpecker (RCW; *Picoides borealis*) and northern bobwhite (*Colinus virginianus*), a popular game bird, requires use of frequent (every 1–3 years in pine forest habitats) prescribed fire. The indirect effects of using frequent applications of prescribed fire on nontarget birds, including migratory land birds—or the impact of fire exclusion management depending on your perspective—have been obtained by contrasting bird census from plots managed for RCWs with those not managed for the species (Brennan et al. 1995, Burger et al. 1998). Results from these studies generally support the results from the long-term data generated from the NB-66 plot. Forest patches subjected to frequent applications of prescribed fire tend to support species of migratory birds that have a clear affinity for habitats dominated by an open, parklike forest with an understory dominated by a diverse community of native grasses and forbs. In contrast, forest stands with a fire-return interval generally greater than 5–7 years typically provide breeding habitats for birds that are common in mixed pine-hardwood forests.

Van't Hul et al. (1997) believed that prescribed burn frequencies as short as 2 years could be applied without negatively impacting the coastal prairie bird community on Matagorda Island because their results indicated that with exception of wrens, bird abundance returned to pre-burn levels 18–22 months post-fire. Mix (2004) believed that a prescribed burn frequency of 2–3 years over at least a 10-year planning horizon would be required to reduce brush density and cover sufficiently to increase abundance and species diversity of breeding and wintering grassland birds. A longer prescribed burning frequency would likely maintain shrub-obligate bird abundance and species diversity similar to pre-burn levels, though these might gradually decline over time.

### Seasonality of Fire Application

During the past two decades, there has been a surge of interest in the use of prescribed fire during the peak of lightning activity (mid-April through mid-August) in the Southeastern Coastal Plain for the management of vegetation and wildlife habitat. Prior to this newfound interest, game managers in the Southeast had established a 75-year tradition of burning—primarily for bobwhite management—during late winter (February and March). There were numerous cultural reasons why burning during late winter developed into such a management tradition. The two primary reasons were: (1) the old-field vegetation burned best during these months because >99% of the native, pyrophyllic ground cover that can carry a fire during the lightning season had been eliminated by the early 20th century, and (2) it was thought that burning during the lightning season would be disastrous for ground-nesting game birds such as the Northern Bobwhite and Wild Turkey (*Meleagris gallopavo*).

In a comprehensive review of seasonal fire effects, Robbins and Myers (1992:57) stated "no one really knows what the long-term effect [of lightning-season fire] would be…on ground-nesting birds." Recently, research initiatives in the Southeast (Engstrom et al. 1986, King et al. 1998) have explored the impacts of late winter- versus lightning-season fires on birds. Results from these studies indicate that the treatment impacts of late winter- versus lightning-season fires on birds are relatively subtle and usually not biologically significant (Brennan et al. 1998, King et al. 1998).

### Effects of Catastrophic Wildfires

Surprisingly, there is little information on the effects of catastrophic wildfire on any birds in the Southeast, much less migratory land birds (Rotenberry et al. 1993, 1995). The late spring and early summer months in northern and central Florida were abnormally dry during 1998. One result of this drought was that hundreds of thousands of acres of public and private upland forests were destroyed as a result of wildfires. The vast majority of these catastrophic fires were anthropogenic in a rather unusual way. Ignition, in nearly all cases, was natural (caused by lightning). However, the anthropogenic factor that exacerbated this situation was the combination of excessive fuel accumulation, especially in extensive stands of planted pine where fire had been excluded for >10–15 years, and abnormally dry conditions, resulted in catastrophic crown and stand-replacing fires across vast areas in northern and central Florida.

During recent years, catastrophic, stand-replacing fires were relatively rare in the Southeast, compared to Western states (cf., Pruden and Brennan 1998). However, such fires do occur within an historic range of natural

conditions, especially in sand pine (*Pinus clausa*) forests (Outcalt and Greenberg 1998).

## EFFECTS OF FIRE ON MIGRATORY BIRD STOPOVER HABITATS

The debate over factors that influence populations of migratory land birds usually focuses on breeding and wintering habitats. Stopover habitats are often overlooked, despite the fact that they may often be a critical bottleneck during the annual cycle (Moore et al. 1994). The logistical and technical problems that must be solved in studying stopover ecology and behavior are daunting. Migratory stopover events are usually fleeting, and we don't always know where on the landscape these habitats are. Fortunately, there is growing interest in stopover ecology (Moore 2000, Hegland and Skagen 2005).

Factors that influence how fire influences avian habitats are complex. Factors that influence migratory stopover events and resulting avian habitat use are also complex. Thus, attempts to understand relationships between these phenomena is more difficult yet. Despite these difficulties, there are some seminal studies that have provided a basis for synthesis and future direction.

Moore et al. (1990, 1995) observed that shrub-scrub habitats represented 14% of the available habitat area (based on 5 different habitat types) on Horn Island, Mississippi. Shrub-scrub habitats are developed and maintained in response to fire (Myers and Ewell 1990). Although it occupies only 14% of the available habitat area, 45% of the total number of individual birds and 43% of the total number of species of birds use shrub-scrub habitats on Horn Island (Moore et al. 1990).

Given this disproportionate use of available habitat, the role of fire on the maintenance of shrub-scrub habitat is clearly important. Evidently, fire has played a significant role in the ecology of pine and scrub vegetation on Horn Island and other barrier islands. Pessin and Burleigh (1941) hypothesized that the long-term (20-year) exclusion of fire allowed dense stands of slash pine (*Pinus elliotii*) to develop, along with unusually tall (>3.5 m) shrubby vegetation. Prescribed fire that mimics historic, lightning-ignited fires on barrier islands and in coastal pine-scrub habitats might have significant management value if such actions could be used to maintain shrub-scrub habitats. Again, however, it remains unknown if the presence of wind farms will permit or limit applications of prescribed fire in these habitats and circumstances.

### Food Availability and Habitat Structure

It is clear from many previous studies that the use of different en-route migratory bird habitats is tied to food availability (Hutto 1985, Moore and Yong 1991). Additionally, both the physical and floristic structure of the habitat, including microhabitat features such as foliage structure, influence how birds use habitat and obtain food (Robinson and Holmes 1984). Fire can exert major influences on both vegetation structure and floristics, as well as on arthropod occurrence and abundance. The latter are important food resources for migratory land birds, especially passerines and particularly in upland pine forests (Folkerts et al. 1993). For example, upland pine forests can provide stopover habitat for nearly 20 species of trans-gulf migrants and nearly 20 species of winter coastal plain residents (Crawford and Stevenson 1984). The combined effects of fire on the physical and structural characteristics of habitats, and on the food resources in those habitats, suggest that there should be some significant relationships between fire and the maintenance of stopover habitats that are critical to the lives of migratory birds. But the effects that fire suppression and subsequent landscape fragmentation have had on habitat quantity and quality at critical stopover areas is not known.

## EFFECTS OF FIRE ON WINTERING HABITATS

The landmark study by Marra et al. (1998) provides strong evidence for the potentially widespread importance of wintering habitat for wintering birds. They found that American Redstarts (*Setophaga ruticilla*) that wintered in dry scrub forests arrived on their northern breeding grounds later, and in poorer physical condition, than those individuals that wintered in more productive wet mangrove forests.

Although the role of fire in the ecology of both mangrove and dry scrub habitats was not mentioned by Marra et al. (1998), it is potentially significant in both instances. In dry scrub vegetation, fire has played a significant role as a major disturbance factor (Myers and Ewell 1990). In mangroves, as in most other vegetation, the result of a single fire event can be subtle—formation of a 0.1-ha canopy gap from a lightning strike—or catastrophic and widespread—such as in a mangrove crown fire (Wade et al. 1980). Lightning strikes are frequent in mangrove stands (Wade et al. 1980). The small canopy gaps generated from fires in the immediate vicinity of the lightning strikes may be important with respect to regeneration

and maintenance of mangroves, although this certainly needs more study.

Extraction of soil cores from mangrove peat deposits provides evidence that fire has been a persistent disturbance factor in these habitats for millennia (Cohen 1974). The implications of this are: (1) the study by Marra et al. (1998) points to mangroves as providing critical habitat for migratory land birds, (2) although catastrophic when they occur, stand replacing fires are a rare event in mangroves, and (3) small-scale, canopy gaps are created in mangroves by lightning-ignited fires and such gaps may play a role in the maintenance of these habitats. Therefore, although not initially intuitive because mangroves are wetlands, a renewed look at the role of fire in mangroves may be essential to their stewardship and conservation.

### Pine Savannas

Pine savanna habitats are present throughout the Southeastern U.S. and in many regions of the tropics and subtropics. Plants and animals that live in pine savannas have evolved in response to frequent, lightning-ignited fire. The value of frequently burned savannas as breeding habitat is clear (Engstrom et al. 1984, Burger et al. 1998). In Belize, Petit et al. (1992) found that pine savanna habitat was used in greater proportion than availability by Yellow-breasted Chat (*Ictera virens*), Common Yellowthroat (*Geothlyois trichias*), White-eyed Vireo (*Vireo griseus*), Ovenbird (*Seiurus aurocapillus*).

As part of an investigation into seasonal fire effects on bird populations in northern Florida, Engstrom and McNair (unpublished data) discovered that a significant, and previously unknown population of Henslow's Sparrow (*Ammodramus henslowii*) winters in longleaf pine savannas on the Apalachicola National Forest. The winter habitat use pattern of Henslow's Sparrows is a classic example of how important the role of fire can be in providing critical wintering habitat. Without frequent application of prescribed fir, longleaf pine forests in the flatwoods of Florida invaded by hardwoods within 5–7 years. They are thereby rendered unsuitable for a suite of wildlife species, not the least of which is the Henslow's Sparrow.

### Rangelands

Grassland birds have shown more drastic and conformable declines than other groups of birds on a continental level (Knopf 1994) and worldwide (Goriup 1988). Additionally, rangelands habitats along the Texas Gulf Coast are one of the primary areas targeted for the development and placement of wind farms (Kuvlesky et al 2007). The loss and degradation of grassland habitats throughout many regions of North America, and particularly in temperate breeding areas, have been implicated as primary causes of decline in some grassland bird populations (Knopf 1994, Igl and Johnson 1997). However, there is some indication that trends for some grassland bird populations are being strongly driven by factors associated with nonbreeding habitats (Basili 1997).

The coastal plain of southern Texas is geographically situated where it serves as a funnel for many migrant birds that use this region as migratory stopover or wintering habitat. There has been considerable change to the landscape in southern Texas since settlement (Johnston 1963, Box et al. 1979). Most notably, the vast coastal prairie that once dominated the region has been transformed into a either a brush-dominated or an intensively farmed landscape (Rappole et al. 1986). Livestock grazing that reduces fuel loads compounded with suppression of natural prairie fires are most likely the primary vehicle that has reshaped the southern Texas landscape. Because most birds that are grassland specialists on the breeding grounds share similar habitat affinities during the nonbreeding period (Grzybowski 1976, Best et al. 1998, Igl and Ballard 1999), it is reasonable to assume that landscape-level declines in grassland habitats and a reciprocating increase in brush-dominated habitats has most likely had negative affects on grassland bird populations wintering in or migrating through this region (Grzybowski 1982).

Little research had been conducted on the relationship between fire and rangeland bird communities in Texas, and even less research has focused on the timing and spatial extent of migratory bird movements in locations where wind farms are being built in this region. The few research projects that have been conducted have evaluated bird community responses to a single winter or summer fire event, and the results of these studies indicate that bird communities 1–2 years post-fire are generally similar to pre-fire bird communities (Reynolds and Krausman 1997, Van't Hul et al. 1997, Mix 2003). Nevertheless, individual species responses to prescribed fire vary. Species that prefer dense herbaceous cover or shrublands decline in response to fire, particularly at high burning frequencies (2 yr), while species that prefer shorter, structurally diverse herbaceous vegetation along with more bare ground tend to increase (Bock and Bock 1992, Van't Hul et al. 1997, Lloyd et al. 1998, Reynolds and Krausman 1998).

Reynolds and Krausman (1998) believed that it is important to consider the responses of individual species to rangeland prescribed fires because measurements of community abundance and diversity may obscure the responses of species of management concern. For example, wintering species with small home ranges and/or those that display philopatry, such as Grasshopper Sparrow (*Ammodramus savannarum*), LeConte's Sparrow (*A. lecontii*), and Sedge Wren (*Cistothorus platensis*), are particularly vulnerable to prescribed fires. Their responses to winter burning might not be detected if community abundance and diversity were the only variables measured. Reynolds and Krausman (1998) believed that the spatial and habitat needs of bird species like these could effectively be addressed by maintaining unburned areas adjacent to burned areas. Creating a mosaic of burned and unburned areas would likely benefit the entire wintering bird community on these rangelands close to the Gulf Coast because the habitat and spatial requirements of mobile species and those that have large home ranges, as well as species that display philopatry and have smaller home ranges, would be fulfilled.

## SOME PRACTICAL ECOSYSTEM MANAGEMENT RESEARCH PRIORITIES

1. Conduct investigations that will result in a first approximation (cf., Frost 1998) of historic fire regimes in tropical and subtropical habitats that support wintering migrant birds. This has been done by Frost (1998) for the continental U.S., and it needs to be done for the Neotropics.
2. Further develop fire histories of barrier islands and coastal zone forests and rangelands that provide important stopover habitats for migratory land birds.
3. Expand the landmark work by Marra et al. (1998) to broaden understanding of wintering habitat use—and hence the role of fire in habitats such as mangroves—of other migratory land birds.
4. Using information from #1 above, examine opportunities for employing prescribed fire in ways that mimic historic fire regimes.
5. Continue experiments similar to long-term experiments, such as the NB-66 study at Tall Timbers Research Station on the role of fire in the breeding ecology of migratory land birds.
6. Establish manipulative experiments to examine how applications of fire influence food availability and habitat structure on the wintering grounds of selected migratory species.
7. Encourage authors who work on winter habitat ecology of birds in the Neotropics to include 1–2 paragraphs on fire history, and other aspects of ecosystem management and disturbance dynamics of their study sites when they prepare study area sections of their manuscripts for publication.
8. Conduct pre-siting studies of the spatial timing and extent of spring and fall bird migration using state of the art radar technology to identify migratory corridors where wind farms should not be located. Our research institute is presently involved in this kind of investigation in the Texas Coastal Bend. Companion studies elsewhere in the coastal Gulf of Mexico region are sorely needed.

We understand that the list of research priorities for programs like Partners in Flight, not to mention other cooperative conservation and research initiatives, far exceeds the availability of existing resources. Nevertheless we believe it is incumbent when funding agencies and policy makers work through their respective political and budgeting processes they consider incorporating some of the practical concerns outlined in this chapter. While some projects, such as using radar technology to track timing of movements and migration are costly, others, such as developing fire histories or encouraging authors to include disturbance histories in study area descriptions of scientific papers, can be accomplished with little or no additional funding.

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