

SINGLE-SPECIES VERSUS MULTIPLE-SPECIES APPROACHES FOR MANAGEMENT

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INTRODUCTION

Neotropical migratory birds are major components of the avifauna in most North American terrestrial ecosystems. Over 150 species of Neotropical migratory birds are known to breed in North America (Finch 1991a). Given the large number of species, developing effective management strategies for Neotropical migratory birds is a monumental task because each species exploits a unique niche, and thus requires different considerations for the management of its habitats and populations. Management is complicated further by temporal and spatial variations in resource-use patterns by many species. Thus, detailed knowledge of a species' habitat and population ecology from one place and time might have little relevance to other locations or periods.

Managers have a continuum of options for managing wildlife resources. This continuum ranges from management for one or a few featured species to the management of entire communities, landscapes, ecosystems, or regions. Each approach has advantages and disadvantages, and the choice of one approach over another represents a series of tradeoffs. Resource managers must decide which approach meets their objectives and the level of risk that is acceptable.

We present a conceptual framework of alternative approaches to wildlife management, with special emphasis on the management of Neotropical migratory birds. In particular, we discuss the use of single-species approaches, management- and ecological-indicator species, the guild concept and some of its permutations, and ecosystem approaches. We outline these approaches and weigh their merits and

limitations. We also provide examples of how each has been and might be used in resource management.

CONCEPTUAL FRAMEWORK OF THE MANAGEMENT CONTINUUM

Single-species Approaches

Traditionally, the management of wildlife resources has emphasized single species. Initially, such management emphasized game, with the assumption that managing for game would provide suitable habitat for numerous other species as well (American Game Policy, 1930). Whereas this assumption is undoubtedly valid for some situations, the effects of game management also reduce habitat quality and quantity for populations of numerous other species. For example, managing for a game species that relies on early successional habitats will reduce habitat availability for species of Neotropical migratory birds that require late successional stages. The following case studies provide examples of how single-species management approaches can potentially influence populations of Neotropical migratory birds.

Case Studies

Northern Bobwhite and Red-cockaded Woodpecker

Management of game and Neotropical migratory birds is not mutually exclusive. As an example, we present preliminary results of an ongoing study by Brennan et al. (1995) of the effects of management actions for Red-cockaded Woodpeckers and Northern

Bobwhites on the habitats of Neotropical migratory birds in the southeast. In pine forests of the southeastern United States, situations exist where Northern Bobwhite and Red-cockaded Woodpecker management is complementary (Brennan and Fuller 1993). Management for either species has implications for Neotropical migratory birds. Therefore, this case study consists of two parts: (1) general effects of Northern Bobwhite habitat management on Neotropical migratory birds, and (2) how management actions beneficial to both Northern Bobwhites and Red-cockaded Woodpeckers may or may not benefit Neotropical migratory birds.

Most habitat management for the Northern Bobwhite is done in two types of environment: (1) old fields and field margins near cropland, and (2) pine and mixed pine-hardwood forests. The key to Northern Bobwhite habitat management is the frequent, periodic disturbance of vegetation in small, patchy mosaics (Stoddard 1931, Rosene 1969). In old-field habitats, the disturbance is accomplished by disking, prescribed fire, or combinations thereof. Widespread agricultural plantings of small (generally <0.5 ha) patches of corn, millet, milo, etc., are used in many bobwhite management efforts. In pine forests, prescribed fire and the reduction of tree basal area are primary bobwhite management tools. Regardless of the habitat type, the goal of the manager is to maintain approximately 70% of an area in understory plant communities that are 1–3 years of age. The remaining 30% is left as permanent cover areas, usually in the form of "cover blocks" of habitat that are allowed to develop more advanced seral stages of pine forests, or hedges and fencerows in old fields.

Understory and ground-cover plants are of the utmost importance to bobwhites. These plants produce seeds and provide substrates for insects needed by bobwhites for survival. This vegetation also provides escape cover for protection from predators. In pine forests, the tree canopy must remain open (<50% cover) to allow sufficient light to reach the ground and stimulate the growth of vegetation that produces food and cover for quail. One key factor in the recent bobwhite population decline in the south-

eastern United States is the proliferation of high-density pine plantations (Brennan 1991). This silvicultural practice results in a sterile understory that is dominated by decaying pine needles, and provides virtually no food resources for quail or other ground-foraging birds. Therefore, effective bobwhite management in pine forests requires the maintenance of an open-canopied forest with an understory that is disturbed on a frequent (1–3 years) basis.

Pine-forest habitats managed for the Northern Bobwhite will favor Neotropical migratory birds that are considered edge and open-country species, and will be detrimental to those that require dense, continuous, closed-canopy forests. In the southeastern United States, bobwhite management in pine forests will benefit species such as the Blue-gray Gnatcatcher, Common Yellowthroat, Eastern Wood-pewee, Indigo Bunting, and Great Crested Flycatcher. Species that would be likely to be impacted negatively by bobwhite management in pine forests include Wood Thrush, Black-and-White Warbler, Hooded Warbler, Red-eyed Vireo, and Yellow-throated Vireo.

Old-field and agricultural habitats managed for bobwhites will benefit Neotropical migratory species such as the Eastern Meadowlark, Mourning Dove, Indigo Bunting, and Yellow-breasted Chat. It is unknown whether bobwhite management in old, fallow-field environments has a negative impact on particular species of Neotropical migratory birds. With the recent widespread decline in Northern Bobwhite populations, efforts at habitat management will most likely increase because interest in quail hunting remains high, and membership of private organizations such as Quail Unlimited is increasing. Many people are interested in bobwhite management, and vast areas in the quail "plantation country" of southern Georgia and northern Florida continue to be managed for bobwhite.

The link between habitat management for the Northern Bobwhite and the endangered Red-cockaded Woodpecker presents a unique example of management for both game and endangered species (Brennan 1991). Habitat management for the woodpecker in pine-dominated systems entails

Table 16-1. Point counts of Neotropical migratory birds in forest stands managed for Red-cockaded Woodpeckers and unmanaged stands of similar age (> 50 years) at the Bienville National Forest and Noxubee National Wildlife Refuge, Mississippi, May-June 1992 (Brennan et al. 1995).

Species	Bienville		Noxubee	
	Managed	Unmanaged	Managed	Unmanaged
Mourning Dove	1 ^a	0		
Yellow-billed Cuckoo	0	1	0	2
Ruby-throated Hummingbird	2	0		
Great Crested Flycatcher	1	5	5	2
Eastern Wood-pewee	1	6	20	5
Blue-gray Gnatcatcher			11	0
Wood Thrush	8	7	0	14
Gray Catbird			0	1
White-eyed Vireo	2	7	1	3
Yellow-throated Vireo	0	2	1	13
Red-eyed Vireo	0	1	1	14
Black-and-white Warbler	5	6	2	11
Yellow-rumped Warbler			0	2
Pine Warbler	57	63	46	59
Palm Warbler	2	0		
Kentucky Warbler	6	15	2	5
Hooded Warbler	1	20	0	13
Common Yellowthroat	0	1	45	0
Yellow-breasted Chat	16	2	59	0
Indigo Bunting	14	1	52	2
Scarlet Tanager			0	2
Summer Tanager	7	0	9	14

^a Total number of birds detected from seven replicate surveys of seven points in each stand type (managed and unmanaged).

maintainance of low (generally < 14 m²/ha) basal area, and control of hardwood midstory by frequent fire, mechanical, or chemical means (Richardson and Smith 1992). Such techniques have also been widely successful in sustaining abundant populations of Northern Bobwhites at a variety of locations (Rosene 1969).

The effects of management in loblolly pine (*Pinus taeda*) forests for Red-cockaded Woodpeckers on other nontarget forest vertebrates, including Neotropical migratory birds, has been assessed at Bienville National Forest and Noxubee National Wildlife Refuge in Mississippi (Brennan et al., 1995). Unlike the Pacific Northwest, where interest in the Spotted Owl spurred comprehensive research efforts on terrestrial vertebrates in Douglas-fir (*Pseudotsuga menziesii*) forests (Ruggiero et al. 1991), wildlife researchers in the South have not conducted similar comprehensive assessments of the impacts of Red-cockaded Woodpecker habitat management on nontarget vertebrates.

At Bienville National Forest, Brennan et

al. (1995) found 14 species of Neotropical migratory birds in stands actively managed for Red-cockaded Woodpeckers (Table 16-1). Three of these species (Great Crested Flycatcher, Indigo Bunting, and Yellow-breasted Chat) were apparently favored by Red-cockaded habitat management. Hooded Warbler, Kentucky Warbler, and Summer Tanager were detected most frequently in mature pine stands that were not managed for the woodpecker (Table 16-1). At Noxubee, 14 species of Neotropical birds were detected in stands managed for the woodpecker (Table 16-1). Five of these species (Blue-gray Gnatcatcher, Common Yellowthroat, Eastern Wood-pewee, Indigo Bunting, and Yellow-breasted Chat) were apparently favored by Red-cockaded Woodpecker management. The Black-and-white Warbler, Hooded Warbler, Red-eyed Vireo, Summer Tanager, Wood Thrush, and Yellow-throated Vireo were detected most frequently in mature pine stands that were not managed for woodpeckers at Noxubee (Table 16-1).

The differences in the Neotropical migratory birds at Bienville and Noxubee may be partly a function of how the habitat is managed at each site (Brennan et al., 1995). At Noxubee, the hardwood midstory is sheared with a v-blade mounted on a bulldozer, then controlled by burning on 2–4 year intervals (Richardson and Smith 1992). At Bienville, the hardwood midstory is treated with herbicides and then controlled by burning at 5–7 year intervals (Brennan et al., 1995). These two different management approaches result in different vegetation structures, influencing Neotropical migratory birds differently at each site (Brennan et al., 1995).

Two major lessons can be learned from the case history described above. First, it is possible to integrate the management of endangered species, Neotropical migratory birds, and game in the pine-dominated forests of the southeastern coastal plain. Second, the particular way that endangered or game species are managed can have a major influence on populations and habitats of Neotropical migratory birds.

Several other issues have important implications for Neotropical migratory birds in the context of management for Red-cockaded Woodpeckers and Northern Bobwhites. Whether the patterns observed by Brennan et al. (1995) in loblolly-pine forests apply to wildlife-habitat relationships in longleaf pine (*Pinus longirostris*) is unknown and urgently needs to be investigated. Also unknown are the effects of the timing of prescribed fire on Neotropical migratory bird populations. Most prescribed fire in pine systems of the southeastern coastal plain has been conducted during February and March over the past 60 years rather than from May through August when most natural lightning-caused fires occur. The effects of this departure from the natural fire regime must be assessed as managers strive to return to a more "natural" use of fire in an ecosystem context. Clearly, research on how variations in Red-cockaded Woodpecker habitat and differences in management practices influence Neotropical migratory birds should be a high priority in the future.

Mountain Quail

Another study that compared habitats of Neotropical migratory birds with that of a game species requiring early successional vegetation was described by Block et al. (1991). They found extensive overlap in the habitats of ground-foraging birds (including Lazuli Bunting, Rufous-sided Towhee, Green-tailed Towhee, Chipping Sparrow) with that of the Mountain Quail in northern California (Fig. 16-1). Typically, Mountain Quail are found in early-successional montane brushfields that result from even-aged forestry practices (such as clearcutting) or stand-replacing fires.

Northern Spotted Owl

As populations of many species of plants and animals have declined to the point of concern, and even extinction, the public has become more concerned with conserving the extant biota. Enactment of the Endangered Species Act provided a legal framework under which such conservation efforts could be undertaken. Contained within the Endangered Species Act is a provision for the maintenance and enhancement of "critical habitat;" that is, "...physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection" (US Government Printing Office 1983, p. 2). Because enactment of management plans for threatened, endangered, and sensitive species is directed towards those species, effects on Neotropical migratory birds will be a byproduct of these management actions.

Frequently, management of habitat for threatened, endangered, and sensitive species requires setting land in reserved status and prohibiting activities other than those directed towards the target species. For example, the recovery plan for the Northern Spotted Owl sets aside large blocks of land as Designated Conservation Areas (Bart et al. 1992). These areas include existing owl habitat as well as large blocks of forest that have the capability of maturing into suitable owl habitat. The developers of the recovery plan recognized that its implementation would affect numerous other species, and

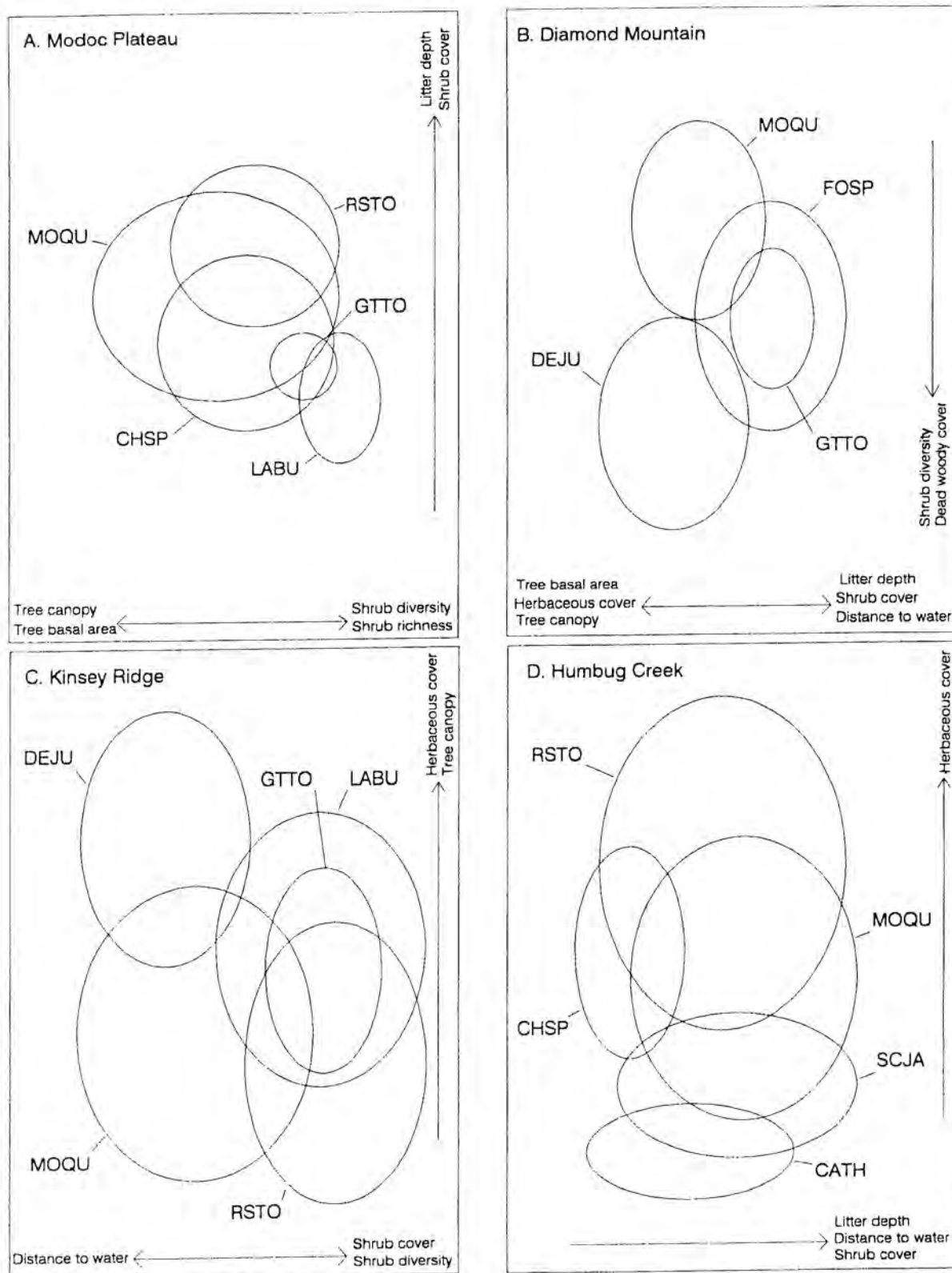


Figure 16-1. Ordinations depicting the first two canonical axes resulting from discriminant analyses of the habitats of ground-foraging birds found at four locations in northern California. Ellipses include 95% of all observations. Species codes are: MOQU, Mountain Quail; CATH, California Thrasher; SCJA, Scrub Jay; RSTO, Rufous-sided Towhee; GTTO, Green-tailed Towhee; CHSP, Chipping Sparrow; FOSP, Fox Sparrow; DEJU, Dark-eyed Junco; and LABU, Lazuli Bunting (from Block et al. 1991).

Table 16-2. Threatened, endangered, sensitive, candidate, and old-growth-associated birds within the range of the Northern Spotted Owl (from Bart et al. 1992).

Species	Status ^a			Old Forest Association ^b		
	WA	OR	CA	WA	OR	CA
Northern Goshawk	C	SC	SC	+	+	+
Flammulated Owl	C	SC		+	+	+
Vaux's Swift	C			*	*	?
Pacific-slope Flycatcher				+	+	*
Hammond's Flycatcher						*
Willow Flycatcher			E			
Hermit Thrush						*
Warbling Vireo						+
Hermit Warbler						*
Wilson's Warbler				+		+

^a WA (Washington); C = candidate; OR (Oregon); SC = sensitive (critical); CA (California); SC = species of concern.

^b + = old-growth associate; * = close old-growth associate; ? = insufficient data.

they attempted to evaluate those effects. The recovery team identified 23 bird species of special concern [e.g., threatened, endangered, and sensitive (TES) species, those whose distributions are endemic within that of the Northern Spotted Owl, those with greatest abundance in older forests, or those with greatest need of conservation], including ten Neotropical migratory birds, that would benefit from implementation of the recovery plan (Bart et al. 1992; Table 16-2). In addition to these species, numerous others that use mature and old-growth forest would also stand to benefit from this recovery plan—see Ruggiero et al. (1991) for papers that document species associated with mature forests in the Pacific Northwest.

In conclusion, single-species approaches to wildlife management contain many direct and indirect, positive and negative effects on other species. Usually, effects on other species are considered simply as byproducts of the intent of the management actions for the target species or are not considered at all. Only recently, with considerations of biological diversity and resultant conservation efforts for all native species, have single-species approaches (e.g., the Northern Spotted Owl) evaluated the needs of other species as well.

INDICATOR SPECIES

Indicator species mark a transition from single-species to multiple-species approaches

in wildlife management. Although a single species is emphasized, this species is used to index or represent specific environmental conditions or the population status of other, ecologically similar species.

Indicator species can be divided into two major categories: ecological indicators and management indicators. The concept of ecological indicators was formally proposed by Clements (1920) to explain plant distributions based on specific environmental conditions, most notably edaphic and moisture regimes. Birds are also tied to specific environmental conditions, as this provides the basis for describing species' habitats (Block and Brennan 1993). Birds, particularly migratory birds, are highly vagile and consequently can adjust to greater variations in environmental conditions than most plant species. Thus, the relationship between environmental conditions and the presence of a particular bird species is less predictable than for many plants. For this reason, the predictive value of birds as indicators of environmental conditions may be extremely limited (Morrison 1986).

Management Indicator Species

Regardless of these limitations, resource managers have endorsed the use of avian indicator species for land-use planning and decisions. For example, the USDA Forest Service has promoted the use of Management Indicator Species (MIS) in the forest-

planning process. Four broad categories of MIS are commonly used: (1) recovery species; (2) featured species; (3) specific habitat indicators; and (4) ecological indicators (Salwasser et al. 1982). Recovery species are those that are managed to increase their populations because they are recognized as threatened or endangered. Migratory species such as the Whooping Crane, Golden-cheeked Warbler, and Kirtland's Warbler are examples of recovery species. Featured species include those managed for consumptive purposes or those that are valued for nonconsumptive recreational use. Examples of featured migratory species are ducks, geese, Mourning Dove, and Elegant Trogon. Specific habitat indicator species are those with potentially limiting habitat needs that might be affected adversely by land-management practices. Forest-interior species might be regarded as a group of species with specific habitat needs (Robbins et al. 1989). Of course, it could be argued that all species have specific needs, and consequently might be regarded as specific habitat indicators.

Ecological indicator species are those whose populations can be used to index habitat quality and population status of other species. Guild-indicator species provide a typical example of how ecological indicators have been used. Essentially, a guild indicator is one species of a guild (discussed beyond) whose population and habitat can be monitored as an index for other members of the guild. This concept was initially proposed by Severinghaus (1981), but the validity of guild indicators has been questioned by many, including Verner (1983), Szaro (1986), and Block et al. (1987).

The value of birds, particularly migratory raptors such as the Peregrine Falcon and waterbirds, as indicators of contaminants and related environmental problems is well documented (Hickey 1969). The banning of dichlorodiphenyltrichloroethane (DDT) can be attributed largely to birds as indicators through eggshell thinning and nestling deformity. Presently, unregulated use of pesticides on the wintering grounds may be contributing to population declines in migratory birds. If so, population declines noted on the breeding grounds may be

indicators of factors occurring on the wintering grounds, such as the use of contaminants or deforestation.

Typically, indicator species are used to monitor population and habitats of ecologically similar species. Their use in these instances has been the subject of much criticism (Morrison 1986, Block et al. 1987, Landres et al. 1988). Morrison (1986) questioned the use of birds as environmental indicators because many factors affect birds. Thus, assessing cause-effect relationships may be muddled by the vast number of complicating factors affecting the species. Landres et al. (1988) felt that the use of indicators to assess population statuses and habitat suitabilities for other species was indefensible unless basic research had been done to document that the chosen species indicated the population and habitat status of other species. This is not surprising given that habitat requirements and population ecologies are specific to each species (Mannan et al. 1984, Block et al. 1987).

Standards for Indicator Species

Landres et al. (1988) concluded that, if indicators were used, they should meet the following rigorous standards. First, criteria to assess whether or not goals have been met should be stated clearly. Second, indicators should be used only when absolutely necessary. Third, selection of indicator species should be by clear and unambiguous rules. Subjectivity in the selection of indicator species should be minimized. In this regard, we know of no clear guidelines for the selection of indicator species. Odum (1953), Hill et al. (1975), and Graul and Miller (1984) suggested that indicators should be species that tolerated a narrow range of conditions, whereas Szaro and Balda (1982) felt that indicators should represent a wide range of conditions. Further, few investigators present quantitative methods for selecting indicators (cf. Hill et al. 1975, Szaro and Balda 1982), and most methods commonly used are qualitative (e.g., Salwasser et al. 1982). Fourth, all appropriate species must be included in the assessment process, and selection criteria for indicators must not be modified for convenience. Fifth, investigators

must have a thorough knowledge of the biology of the organism selected as the indicator. Sixth, all assessment programs that use indicator species must be reviewed and evaluated, particularly with reference to assessment design, data collection, and data analysis. Seventh, investigators must consider natural fluctuations in population parameters and incorporate concepts from landscape ecology when developing monitoring strategies. From the recommendations of Landres et al. (1988), it is clear that indicator species should not be used in an ad hoc, haphazard manner. Detailed evaluations must be undertaken prior to using indicators, and they should be used only when alternative strategies are not possible.

GUILDS

Guilds represent the most basic approach to true multiple-species management. The basis of the guild concept can be traced to Salt (1953, 1957), who grouped species of birds into functional units based on their general foraging ecologies. Salt used the functional-unit concept to compare general ecological attributes of avifaunas from different locations. Bock and Lynch (1970) applied this grouping procedure to explain change in a bird-community structure following forest fire in the Sierra Nevada. Root (1967), in his monograph on the niche of the Blue-gray Gnatcatcher, defined a guild as a group of species that exploit the same class of environmental resources in a similar fashion. He stressed that guilds were not restricted taxonomically to closely related species, but that guild membership should transcend taxonomic boundaries to include species representative of grossly different taxa such as avian and mammalian, or vertebrate and invertebrate. In practice, however, guilds are generally restricted within a taxonomic class (e.g., Aves, Mammalia) and frequently to birds (Verner 1984). Failure to include species from different taxa prompted Jaksic (1981) to coin a different term, the taxonomic assemblage, to reflect the common deviation from Root's intent of what species should comprise a guild. To our knowledge few investigators have defined guilds across

taxonomic boundaries; Jaksic and his coworkers are among the few researchers to have included species from different major taxa in their analyses of a predatory guild. Even Root did not apply the guild concept as he defined it. His foliage-gleaning guild included only birds that foraged by gleaning insects from the foliage of oaks (*Quercus* spp.).

Root's analysis of his foliage-gleaning guild clearly demonstrated that each species within the guild differed from the others, to varying degrees, in exactly how they obtained food. For example, species differed in foraging mode, foraging substrate, and the general location within a tree where they obtained food. He concluded that, although these species overlapped in their general foraging ecology, they differed when one examined aspects of their foraging in greater detail (i.e., a finer scale). Similar intraguild analyses have led to similar conclusions (e.g., Noon 1981, Block et al. 1991). This should come as no surprise because each species, even within a guild, has unique morphology and exhibits a unique pattern of extracting resources from the environment (Verner 1984, Block et al. 1991). Pianka (1978) concluded that species in a guild should exhibit relatively intense interspecific competition, forcing each species to diverge in its niche-utilization patterns. Thus, even though species in a guild share some general mode of exploiting resources, their intrinsic species-specific properties entail varying degrees of divergence in their ecologies.

Guild Delineation

Placing species in a guild is not a simple matter (Jaksic 1981, MacMahon et al. 1981). Frequently, investigators group species a priori according to some investigator-defined notion of resource use (MacMahon et al. 1981). Thus, guilds are essentially human constructs that hopefully have some relevance to ecological similarity of the species contained therein. Generally, these groupings are based on foraging (Verner 1984), although other aspects of resource use can provide equally valid bases for grouping. Unfortunately, a priori groupings may have little relevance to how and what resources

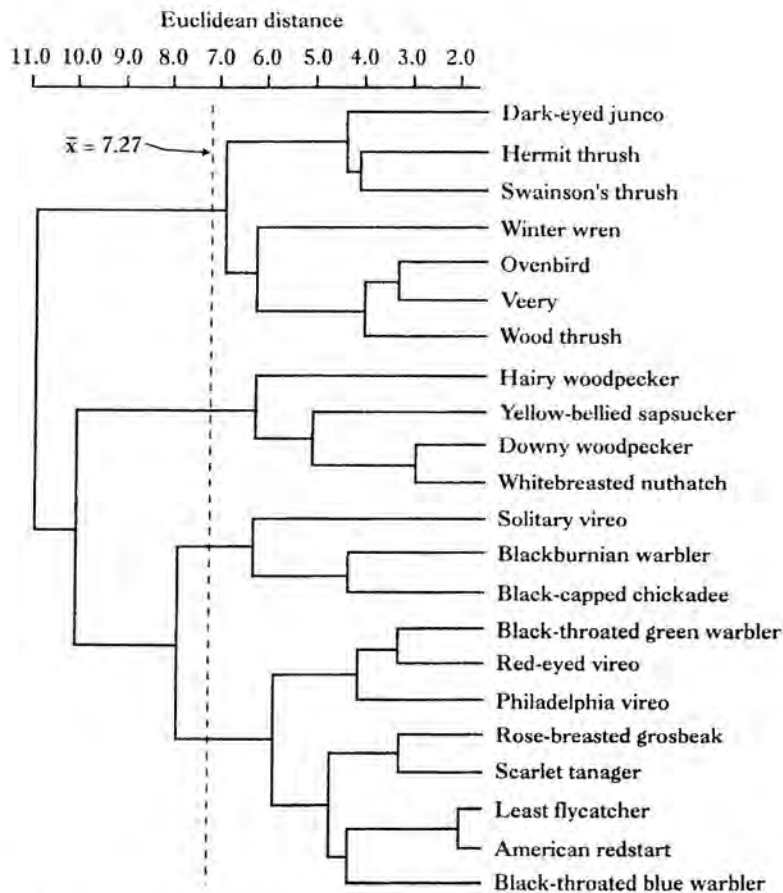


Figure 16-2. Dendrogram based on foraging behaviors of species from Hubbard Brook Experimental Forest, New Hampshire, used to group species into foraging guilds (from Holmes et al. 1979).

are actually used at a specific location or during a given time. Further, these groupings are generally based on expert opinion or on data obtained at different places or times. Temporal variations in ecologies of species occur within and among both seasons and years; spatial variations occur as well (cf. Block 1990, Hejl and Verner 1990, Szaro et al. 1990). Thus, guilds defined a priori may not be valid for the specific time or location where they are intended for use.

A more desirable approach is to group species into guilds based on time- and site-specific data (i.e., a posteriori groupings). Although this approach is still somewhat subjective (Morrison et al. 1992), it offers a more objective approach to developing guilds than those developed a priori. Holmes et al. (1979) provided an example of how to use empirical data to group species into guilds based on cluster analysis (Fig. 16-2). As Morrison et al. (1992) noted, however,

subjectivity still is involved in defining the level of similarity or dissimilarity for grouping or separating species into guilds. The primary difficulty with developing guilds a posteriori, however, is that it requires a great deal of field work to obtain adequate data upon which guilds can be defined. Resource managers rarely have the time, personnel, or monetary resources to obtain such data and are thus faced with the dilemma of relying on little, and perhaps inappropriate, information for defining guilds, or simply not using guilds at all. We believe that there is no correct solution to this problem, except to employ more rigorous a posteriori procedures for grouping species whenever possible.

Guild Dimensionality

Another important consideration is that guilds are generally based on few (usually

one or two) resource-use dimensions. Thus, even if species overlap greatly in one aspect of their niche utilization patterns, it is possible that they will differ substantially in other aspects of niche utilization (Schoener 1974, Pianka 1978). For example, species might forage in the same general fashion but have completely different nest requirements (Martin 1991). Consequently, management actions whose goals are to provide suitable foraging habitat may fail to provide or even decrease the value of the habitat for other life history needs.

Management Applications

The concept of the guild was viewed by many as a potential tool for the management of wildlife populations (Johnston 1981, Severinghaus 1981, Short and Burnham 1982, Verner 1984). Short and Burnham (1982) introduced the concept of "guild-blocking." This method involved developing a matrix based on the foraging and nesting location (according to height strata) and grouping species that appeared in the same matrix block. Short and Burnham recognized that some species nested and/or foraged within multiple-height strata allowing some species to be assigned to more than one guild. Again, a major problem with this approach was that species were assigned to guilds a priori, based on expert opinion and not on site-specific, empirical information.

Severinghaus (1981) suggested that guilds could be used to assess environmental impacts. He defined guilds based on general diet composition, foraging mode, activity patterns, and gross habitat structure. Amazingly, many of the guilds that he derived (Figs 1 and 2 in Severinghaus 1981) consisted of species that were allopatric rather than sympatric. Thus, his guilds deviated from the basic premise of guild analysis, namely that of sympatry (Verner 1984). Regardless, Severinghaus (1981) conjectured that environmental impacts that affected one member of a guild should affect other members of the guild similarly. This assumption, the basis for guild indicators, was discredited by Mannan et al. (1984), who observed that species in the guilds that they studied of the Coast Ranges and Blue

Mountains of Oregon exhibited different population responses to environmental change. Further, Block et al. (1987) noted that species within a ground-foraging guild differed in their use of microhabitat. They concluded that subtle changes in the environment would affect the habitat of species differently.

Szaro (1986) and Verner (1984) proposed grouping species according to similar population responses to environmental perturbations. This approach has some merit when considering the effects of pronounced habitat change (Knopf et al. 1988, Morrison 1991b, Morrison et al. 1992). For example, one would expect populations of canopy-dwelling birds to decline following the removal of a substantial percentage of trees as might result from crown thinning, clearcuts, shelterwood cuts, or seedtree harvest. However, population responses of birds to less pronounced habitat changes may not be so easy to predict with precision (Mannan et al. 1984). Thus, response guilds probably provide managers with only the most general information of population responses to the most severe forms of disturbance. Even so, managers rarely have information detailing population responses to even these severe disturbances. Thus, research that details species' responses and groups species into guilds could be useful.

Regardless of the plethora of criticisms, resource managers have embraced the concepts of guilds and of guild indicators in their management plans. We do not conclude that these approaches are without merit. Their utility, however, may be limited in situations of predicting effects of drastic or pronounced environmental perturbations. Their use in predicting the effects of subtle environmental change may be limited. Reliance on guilds as the sole management tool may be extremely misleading and potentially deleterious to population viability of many of the species contained within a guild. Guilds can be useful tools when reliable knowledge of joint relationships among habitats or species exists. However, when guilds and related concepts are used in ad hoc fashions and functional relationships have not been established, the risk of making ill-informed management decisions is

Managers should be aware of the limitations of guilds in land-use planning and assessment, and they should recognize that guilds are but one of many potential tools at their disposal.

MANAGEMENT ASSEMBLAGES

We define management assemblage as a grouping of species to meet specific management objectives (e.g., Verner 1984). Management assemblages differ from guilds in that the groupings need not be based on patterns of resource use. Frequently, it may be useful to group species according to other, more broad-based criteria for specific management purposes. For Neotropical migratory birds, a number of potential groupings may be useful such as long- and short-distance migrants, lowland and upland birds, or forest-interior and edge species. These are but a few examples of perhaps limitless possibilities.

The initial step in using this approach is to define the specific objective or rationale for grouping species in such a manner. For example, long-distance migrants might experience a different set of limiting factors than short-distance migrants, and thus should be managed differently. O'Connor (1991) suggested that short-distance migrants were more eurytopic in habitat use than were long-distance migrants, and thus were less vulnerable to habitat change. This was partly supported by the findings of Hussell et al. (1991) who noted that a greater proportion of long-distance migrants exhibited trends of declining populations than short-distance migrants. Hagan et al. (1991) noted that population declines during winter were greater for short-distance migrants that wintered in temperate regions than for long-distance migrants wintering in the tropics, although Hagan et al. (1991) were unable to document the underlying causal factors. Determining the common factors that affect members of such assemblages in a similar way is the critical step in developing appropriate management strategies. Obviously, this step is one of the most difficult to implement but, without it, management of

these types of assemblages would be tenuous, at best.

A potential problem with management assemblages is that they include species that respond to different ecological conditions. As noted in our discussion of guilds, species with different ecologies are likely to respond differently to environmental perturbations (Mannan et al. 1984, Block et al. 1987). Thus, changes that may cause a positive population response in some species might decrease populations of others. This does not necessarily negate the efficacies of this approach, but it does stress the need for detailed and accurate biological information about the species comprising the assemblage.

Certainly, use of the management assemblages holds some potential for Neotropical migratory birds. Exactly what that potential might entail is unknown. We feel that the development and testing of the use of these assemblages might provide some novel, yet useful, tools for the future management of Neotropical migratory birds. Management assemblages may be particularly useful as conceptual tools to focus on common links among species that can provide insights into limiting factors and management approaches to sustain their populations.

ECOSYSTEM APPROACHES

Neotropical migratory birds are just one component of the avian portion of the biotic community at any particular location or during a given time. This holds true on the breeding grounds, along spring and fall migration routes, and on the wintering grounds. Although Neotropical migratory birds frequently comprise a major portion of an avian community (Block et al. 1992; Table 16-3), management must account for residents and short-distance migrants as well.

Because an avian community can include a large number of species, management approaches cannot be concerned with species-specific habitat requirements. Rather, the approach that we advocate is one of providing diverse environmental conditions to meet the needs of a multitude of species. Such management cannot be limited to stand

Table 16-3. Numbers of resident and Neotropical migratory species found in the mountains of southeast Arizona during the 1991 breeding season and the oak woodlands of the Tehachapi Mountains, California, during the 1986, 1987, and 1988 breeding seasons.

Species	Arizona Mountains			Tehachapi Mountains
	Mixed conifer	Pine-oak	Oak	
Resident	33	43	31	24
Neotropical migrant	44	54	41	63

management but must consider broad-scaled landscape approaches (cf. Reynolds et al. 1992). Perhaps the most appealing aspect of the management of communities of Neotropical migratory birds is that it is consistent with the current trends towards ecosystem management for the maintenance and enhancement of biological diversity (Wilson 1986, USDA Forest Service 1992).

Ecosystem management is an ecological approach that incorporates both environmental values and the needs of people to sustain natural ecological systems. To implement ecosystem management, reference or desired future conditions must be defined at the onset of the planning process. These conditions must be within the natural ranges of variation, assuming that management within these bounds will sustain the ecosystem structure and function. Management activities are not implemented to meet commodity targets, but to move the ecosystem within these natural ranges.

Ecosystem management and inherent properties of ecosystems (i.e., processes and functions) must be considered along spatial and temporal hierarchies. The birds found within ecosystems at any particular spatial and temporal scale represent only a small part of the system in which they are found. Obviously, ecosystem management is not a direct approach for managing populations and habitats of Neotropical migratory birds. Managers must operate under the assumption that providing appropriate conditions for ecosystem sustainability will also provide adequate conditions for all component systems, including bird populations and communities. Thus, we view the primary role of birds in ecosystem management as monitors of the effectiveness of ecosystem

management. By monitoring populations and habitats of birds, managers can assess whether or not the ecosystem is within or approaching the desired target conditions. Admittedly, ecosystem approaches are in the development stage and their true efficacy is unknown. These approaches, however, hold great potential and must include considerations of the avian component in ecosystem evaluations and in applications of ecosystem management practices.

SYNTHESIS: WHERE DO WE GO FROM HERE?

As may be evident from our discussion above, no one management approach is a panacea for managing Neotropical migratory birds. If management is to be directed toward one species or a small subset of species, then we advocate that they be managed singly. If management is to be directed toward multiple species, then single-species approaches are not feasible and alternative methods must be employed. Undoubtedly, no single method will work for the management of large groups of Neotropical birds; rather, multiple approaches should be used simultaneously.

Any one approach contains advantages and disadvantages. For example, management of single species is based on very specific information about that species. We assume that the information used is appropriate for the place and time that it is used, and is in sufficient detail to allow informed and effective management to be initiated. The disadvantage of single-species management is simply that it targets only the species of interest. Further, monitoring population

changes of single species requires an extraordinary amount of effort (Verner 1983), generally far beyond what is possible with the logistic constraints faced by most resource management agencies. However, a certain amount of single-species management will continue to be conducted and we must come to terms with the implications of these management schemes for other species.

An advantage of multiple-species approaches is that managers can account for numerous species through management activities at a cost that is equal to or perhaps even less than that incurred for single species (Verner 1983). The primary disadvantage to these approaches is that little species-specific information is available upon which managers can base their decisions. A corollary to this disadvantage is that monitoring habitats and/or populations of species assemblages may mask trends affecting individual species. In the situation where the population of one species might be declining, this represents a potentially large risk. Thus, managers run the risk of invoking strategies that may not benefit, or may even work negatively on, the populations of species that they hope to improve.

Ultimately, the direction taken by managers will depend on their specific objectives. Inherent in this process is that management considers adequate spatial and temporal scales in the planning process. Plans restricted to a forest stand or even a Forest Service District, for example, often are too small for the proper management of certain species. Management considerations may need to be expanded to an entire National Forest, or to even regional or continental scales to manage a particular suite of Neotropical migratory birds adequately.

Presently, management is dictated by single-species management of TES species, and species of great consumptive or nonconsumptive value. Management of these species is either mandated by law, as in the case of TES species, influenced by economic issues (e.g., agriculture, development), or is deeply rooted in the history of wildlife management, particularly with respect to game species. Practices focused on the management of these species will define a set of constraints that will dictate future

management. Determining the appropriate strategy for the remaining species is more difficult. Certainly, the cost of managing each of these species singly would be prohibitive. That leaves the manager with alternatives of indicator species, guilds, management assemblages, and ecosystems. We agree with Landres et al. (1988) that the use of indicator species should be avoided if at all possible. As we discussed previously, guilds and management assemblages each contain numerous disadvantages that limit their effectiveness. That leaves ecosystem management as the most viable alternative.

We advocate that management of wildlife resources, including migratory birds, considers the concepts of ecosystem management. Theoretically, ecosystem management is a holistic approach aimed at sustaining natural resources by ensuring that ecosystem processes and functions operate within natural ranges of variation. By providing conditions that sustain ecosystems, avifaunas are sustained as a result. Traditional approaches that veer off from single-species management are compatible with ecosystem management. Single-species approaches are essentially fine-filter strategies to management (Hunter 1991). Ecosystem management involves a coarse-filter approach to evaluate biodiversity and environmental conditions across a landscape (Hunter 1991). Fine-filter approaches are then applied to species or groups of species that pass through the coarse filter; that is, species requiring additional management considerations. The Nature Conservancy estimated that up to 90% of all species would be managed sufficiently by the coarse-filter approach (Hunter 1991). The difference between single-species and ecosystem management is that fine filters are used first in single-species management, and last in ecosystem management.

Ecosystem management, however, cannot be applied to discrete communities in a piecemeal fashion. Rather, it must consider the effects of management along a spatial continuum ranging from the stand to the continental or even global levels. Many aspects of ecosystem management are still being developed but this system does offer possibilities for managing many species over broad, geographic areas. Only through such

an approach can management hope to provide for the wide diversity of Neotropical migratory birds found in North America.

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