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Wildlife Community Habitat Evaluation Using a Modified Species-Area Relationship

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Wildlife Habitat Evaluation

Wildlife Community Habitat Evaluation Using a Modified Species-Area Relationship (TR WRP-DE-12)

ISSUE:

Habitat assessment has typically focused on one or several individual species. Guidelines are needed for the development of community-level assessment methods.

OBJECTIVE:

These general guidelines for developing wildlife community habitat models will provide Corps field biologists with an improved understanding of applications of the principles of community ecology. These guidelines meet the need of the field biologist under Section 404 of the Clean Water Act to prevent or mitigate for habitat impacts to wetlands by aiding in the assessment of models to evaluate wildlife community habitat value under different spatial scales.

SUMMARY:

This document provides guidance on using species-area relationships to develop wildlife community habitat models. Establishing clear wildlife resource objectives is important prior to model development. Different measures of species richness can be used to meet different objectives. Species-area curves can be used independently or with either spatial or habitat modifiers. The use of spatial or habitat modifiers improves the power of the species-area relationship in predicting species richness. Limitations of using the species-area relationship include the possibility of overlooking the value of small areas for certain species and the difficulty in considering the effects of regional dynamics on species richness.

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Preface

The work described in this report was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Delineation and Evaluation Task Area of the Wetlands Research Program (WRP). The work was performed under Work Unit 32756, "Evaluation of Wetland Functions and Values," for which Mr. Ellis J. Clairain, Jr., was Technical Manager. Mr. John Bellinger (CECW-PO) was the WRP Technical Monitor for this work.

Mr. Dave Mathis (CERD-C) was the WRP Coordinator at the Directorate of Research and Development, HQUSACE; Mr. William L. Klesch (CECW-PO) served as the WRP Technical Monitor's Representative; Dr. Russell F. Theriot, U.S. Army Engineer Waterways Experiment Station (WES), was the Wetlands Program Manager. Mr. Clairain, WES, was the Task Area Manager.

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1 Introduction

The assessment and management of wildlife habitat has historically focused on individual species. The U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980) and over 150 Habitat Suitability Index Models (Schamberger, Farmer, and Terrell 1982) were developed primarily to provide a systematic, replicable, and quantitative method to evaluate species' habitat. In recent years, increasing numbers of scientists and field biologists have shifted their emphasis to investigation of community- and ecosystem-level habitat relationships.

A wealth of literature has been published that addresses both the theory and concepts of the emerging field of conservation biology, particularly that aspect dealing with community- and landscape-level issues (Samson and Knopf 1982; Harris 1984; Forman and Godron 1986; Noss 1990; and many others). On the other hand, the development of practical tools and methods for use of these concepts by field biologists has proceeded at a much slower pace. Several published community-level models were reviewed in an earlier report (Schroeder 1987), and additional community models are being developed (Schroeder, O'Neil, and Pullen, in preparation; Schroeder, in preparation).

For many locations, however, community-level models will not be available for several years. In the interim, much can be done to incorporate existing knowledge of the principles of community ecology into field office operations. The purpose of this report is to explore the feasibility of using the species-area relationship as a basis for assessing the quality of habitat for a specific wildlife community.

Many wildlife species are declining because of direct habitat losses, and because remaining habitat fragments are too small for their continued existence. Of special concern are certain bird species (Blake 1991) and large carnivorous mammals (Harris 1988). Wilson (1985) described the general principle from island biogeography that when the area of a regional habitat is reduced to one-tenth its original extent, the number of species will eventually decline to one-half the original number. In areas where habitat loss and fragmentation are considerably advanced, McLellan et al. (1986) recommended that special priority be given to maintaining the integrity of the remaining large fragments. Wilcox and Murphy

(1985:884) summarized the concerns of many ecologists in stating that "habitat fragmentation is the most serious threat to biological diversity and is the primary cause of the present extinction crisis." Application of knowledge gained from current understanding of the species-area relationship is an important starting point in decreasing this threat.

2 Influence of Area on Wildlife Community Composition and Productivity

Recent studies have indicated that the composition of wildlife communities varies in a nonrandom fashion with changes in area of habitat. Patterson and Atmar (1986) noted that the distribution of mammals in southwestern mountain ranges of various sizes occurred in a nested fashion. This nested distribution indicates that the species that occur in smaller sized habitat patches are a subset of the species that occur in larger patches. Birds in isolated woodlots in central Illinois also exhibited a nested subset pattern of distribution; small habitat patches contained more generalist bird species, whereas larger patches often contain species with more specialized resource requirements (Blake 1991). This nonrandom, nested pattern of occurrence has been observed in a variety of communities and geographic locations (e.g., bird communities in Missouri (Hayden, Faaborg, and Clawson 1985) and California (Bolger, Alberts, and Soule 1991), populations of mammals, passerine birds, and lizards in western Australia (Humphreys and Kitchener 1982), boreal mammals and birds in the Great Basin (Cutler 1991), and reptiles in western Arizona (Jones, Kepner, and Martin 1985)).

The implications of the nested subset distribution are important in understanding why area can be used as a basis for wildlife habitat evaluations in some communities. If the species that only occur in the large areas are of concern from a conservation viewpoint, then consideration of area is mandated. Two groups of species that have received the most attention in relation to their need for large areas are large mammalian carnivores and area-sensitive or forest interior birds.

Animals at higher trophic levels generally require larger areas than those at lower trophic levels (Harris 1988). It has been estimated that adequate protection of grizzly bears (*Ursus arctos*) would require an area several times larger than the 890,000 ha (2,200,000 acres) of Yellowstone

National Park (Clark and Zaunbrecher 1987). Zeveloff (1983) estimated that 40,000 ha (99,000 acres) per reserve area was needed to maintain a viable black bear population. Whereas very few habitats of these sizes exist, it is clear that long-term maintenance of these or smaller carnivores will require large habitat areas.

Studies of eastern forest bird communities have resulted in the classification of a large number of birds as either area sensitive or preferring forest interior conditions. Robbins, Dawson, and Dowell (1989) list 26 area-sensitive species, 19 of which are neotropical migrants. Freemark and Collins (1992) compiled a list of eastern forest birds classified as either area sensitive or preferring forest interior conditions (Table 1). Breeding success of neotropical migrants in forest fragments in Illinois was extremely low due to high predation rates (80 percent of all nests) and brood parasitism by brown-headed cowbirds (*Molothrus ater*) (76 percent of all nests) (Robinson 1990). Large forest plots had significantly higher nesting success for ovenbirds (*Seiurus aurocapillus*) than forest fragments (Porneluzi et al. 1993). Habitat patches necessary for supporting viable populations of certain bird species may need to be larger than the size expected based on surveys of singing males only (Gibbs and Faaborg 1990).

Table 1
Eastern Forest Birds Classified as Either Area Sensitive or Forest Interior Occupants (from Freemark and Collins 1992)

Species	Area Sensitive	Forest Interior
Cooper's hawk (*Accipiter cooperii*)		X
Red-shouldered hawk (*Buteo lineatus*)	X	
Broad-winged hawk (*Buteo platypterus*)		X
Barred owl (*Strix varia*)		X
Red-bellied woodpecker (*Melanerpes carolinus*)	X	
Hairy woodpecker (*Picoides villosus*)	X	X
Pileated woodpecker (*Dryocopus pileatus*)	X	X
Olive-sided flycatcher (*Contopus borealis*)		X
Acadian flycatcher (*Empidonax virescens*)	X	X
Least flycatcher (*Empidonax minimus*)	X	
Great crested flycatcher (*Myiarchus crinitus*)	X	
American crow (*Corvus brachyrhynchos*)	X	
Common raven (*Corvus corax*)		X
Tufted titmouse (*Parus bicolor*)	X	
Red-breasted nuthatch (*Sitta canadensis*)		X
White-breasted nuthatch (*Sitta carolinensis*)	X	X
Brown creeper (*Certhia americana*)	X	X
Winter wren (*Troglodytes troglodytes*)		X

(Continued)

Table 1 (Concluded)

Species	Area Sensitive	Forest Interior
Golden-crowned kinglet (*Regulus satrapa*)		X
Blue-gray gnatcatcher (*Polioptila caerulea*)	X	
Veery (*Catharus fuscescens*)	X	X
Swainson's thrush (*Catharus ustulatus*)		X
Hermit thrush (*Catharus guttatus*)	X	X
Wood thrush (*Hylocichla mustelina*)	X	
Yellow-throated vireo (*Vireo flavifrons*)	X	
Red-eyed vireo (*Vireo olivaceus*)	X	
Chestnut-sided warbler (*Dendroica pensylvanica*)	X	
Magnolia warbler (*Dendroica magnolia*)		X
Black-throated blue warbler (*Dendroica caerulescens*)	X	X
Yellow-rumped warbler (*Dendroica coronata*)		X
Black-throated green warbler (*Dendroica virens*)	X	X
Blackburnian warbler (*Dendroica fusca*)		X
Yellow-throated warbler (*Dendroica dominica*)		X
Pine warbler (*Dendroica pinus*)		X
Cerulean warbler (*Dendroica cerulea*)	X	X
Black and white warbler (*Mniotilta varia*)	X	X
American redstart (*Setophaga ruticilla*)	X	X
Worm-eating warbler (*Helmintheros vermivorous*)	X	X
Ovenbird (*Seiurus aurocapilus*)	X	X
Northern waterthrush (*Seiurus noveboracensis*)	X	X
Louisiana waterthrush (*Seiurus motacilla*)	X	X
Kentucky warbler (*Oporornis formosus*)	X	X
Mourning warbler (*Oporornis philadelphia*)	X	
Hooded warbler (*Wilsonia citrina*)	X	X
Canada warbler (*Wilsonia canadensis*)	X	X
Summer tanager (*Piranga rubra*)	X	
Scarlet tanager (*Piranga olivacae*)	X	X
Rose-breasted grosbeak (*Pheucticus ludovicianus*)	X	

To be most effective, management strategies should concentrate on the species most in need of protection (Blake and Karr 1984). Management for small areas often will not accomplish this objective. Data from Whitcomb et al. (1981) indicate that forest interior birds are rare at a regional scale. Local extinctions of birds requiring forest interior conditions have been documented (Newmark 1991). To conserve regional biodiversity, maintenance of habitats for species with large-area needs is essential.

3 Explanation of the Species-Area Relationship

The fact that the number of species increases in direct relation to the size of the area sampled has been clearly established in the study of community ecology. This relationship was explored on islands (MacArthur and Wilson 1967) and later extended to interior habitats, including isolated forests (Galli, Leck, and Forman 1976), prairies (Samson 1980), mountain ranges (Picton 1979), and wetlands (Tyser 1983). The species-area relationship has been demonstrated for birds (Blake and Karr 1987; Johns 1993), mammals (Lomolino 1982), reptiles (Jones, Kepner, and Martin 1985), amphibians (Laan and Verboom 1990), invertebrates (Murphy and Wilcox 1986), and plants (Wade and Thompson 1991). The general equation describing the species-area relationship is most often expressed as:

$$S = cA^z$$

where

S = number of species

c = a constant that varies with taxon and geographic region

A = area

z = a constant measuring the slope of the line relating S and A

The general shape of a species-area curve is shown in Figure 1. This curve was developed from data on bird use of shelterbelts in Kansas (Schroeder, unpublished data). The form of the curve indicates that the number of species increases very rapidly with initial increases in area, and then less rapidly for larger areas.

Conner and McCoy (1979) summarized three possible explanations for the fact that species numbers increase with area. First, larger areas increase the likelihood of colonization by new species and decrease the chances of extinction of existing species. Second, larger areas are more

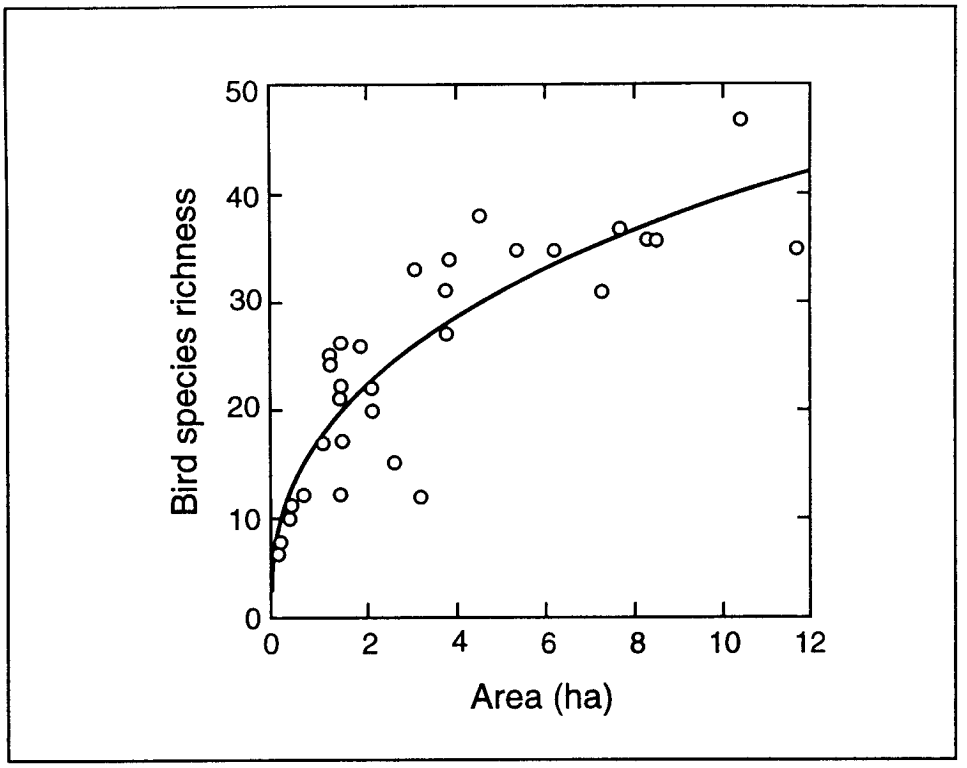

Figure 1. Example of a species-area curve using data from 34 Kansas shelterbelts

likely to contain a higher diversity of habitats than smaller areas. Third, larger areas are more likely to be filled by species dispersing randomly from a source pool of species. Regardless of the causal mechanisms of the species-area relationship, it has been shown to be true in a wide variety of situations.

Application of concepts from the species-area relationship and principles of island biogeography during the late 1970s often focused on the issue of whether a single large or several small reserves were the best for conservation (Simberloff and Abele 1976 and subsequent replies). Whereas various arguments have been presented to show that the numbers of species can vary in these two scenarios, the important issue for conservation is to identify the species composition of these communities and evaluate this information in relation to conservation goals.

4 Use of the Species-Area Relationship in Wildlife Community Habitat Evaluation

Defining Community Boundaries

Use of the species-area relationship requires that the boundaries of the area of concern be accurately delineated. The species-area relationship was first described for true island habitats, where boundaries were clearly marked by the water's edge. Defining boundaries for inland areas can be more difficult. Odum (1971) defines a community as an assemblage of populations living within a prescribed area or physical habitat. For most field applications, the area of concern can be identified by delineating specific vegetation communities. For example, the species-area relationship could be applied to a forest stand isolated by crops or pasture. In some situations, the area of concern could be defined by spatial limits, such as a wetland/upland complex defined as all habitats within 100 m of the wetland edge. In all cases, the definition of community boundaries is somewhat arbitrary and should be explained fully.

Defining Species Richness

Different measures of species richness can be used to meet different objectives. The most general measure of species richness is simply a count of all species occurring in the community of interest. Such a general measure provides only a broad view of the community. Two areas could contain the same number of species, but be quite different in terms of which species were present.

Species richness may be modified by describing a particular group or subset of the entire community that is of most interest and more closely

tied to the defined objectives. For example, Askins, Philbrick, and Sugeno (1987) found patch area to be positively related to the richness of forest interior birds, but not related to the richness of all forest birds combined. Possible modifiers for species richness measures include the following:

> native, endemic, forest interior, area sensitive, locally rare or threatened, cavity user, or taxonomic group (e.g., amphibians, breeding birds)

Use of these modifiers, where appropriate, will ensure that community habitat evaluations do not overlook critical components of the community and conform with defined objectives.

Developing and Using a Species-Area Curve

A species-area curve should be developed for the group of species that relate to the defined wildlife objectives. The first step in developing the species-area relationship is to determine the changes in species richness associated with changes in area for the community of concern. A species-area curve for the community may already exist, or may be constructed using data that describe the number of species found in different sized areas. For example, Samson (1980) presents data on the number of prairie bird species occurring on prairie islands in Missouri (Table 2). Entering this

Table 2
Species-Area Data for Tallgrass Prairie Islands in Central and Southwest Missouri (from Samson 1980)

Prairie Bird Species Richness	Area, ha
11	510.0
7	125.9
8	73.4
6	62.8
6	31.4
5	30.2
5	28.0
5	15.7
4	15.7
3	12.1
3	10.0
2	4.0
2	1.0
2	0.5

data into a statistical program (e.g., the Nonlin module of SYSTAT (Wilkerson 1988)) allows calculation of the species-area formula and curve for this community (Figure 2).

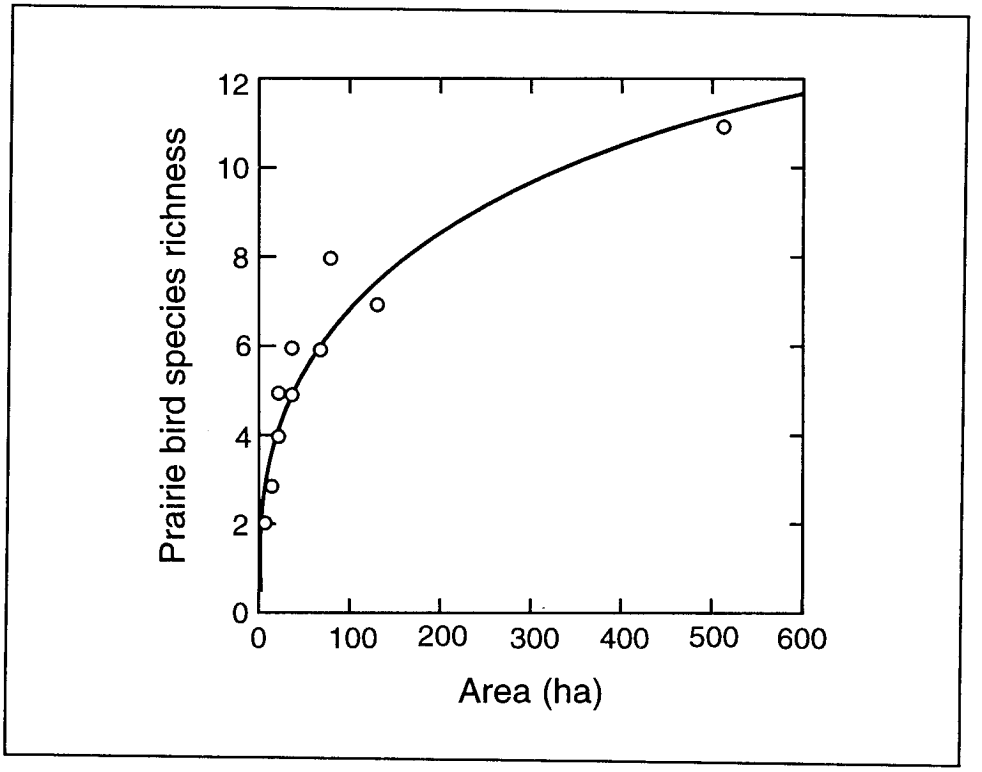

Figure 2. Species-area curve for prairie birds

Information on species-area relationships from a variety of geographic locations and community types across North America is provided in Table 3. This information, or similar data acquired from local studies, can be used to predict the effects of changes in area on species richness and incorporated into community-level habitat evaluations. Most of these data were derived from bird community studies. Species-area data for other wildlife groups are less common in the literature.

Developing an index from a species-area curve

Most habitat assessment models make use of simple unitless indices to rate and compare different habitats (e.g., the 0-1 scale of Habitat Suitability Index models (Schamberger, Farmer, and Terrell 1982)). Whereas most habitat variables have a logical point at which to assign a maximum index value, this is not true with the species-area relationship. In theory, species richness would continually increase with area, and, therefore, a maximum index value would never be obtained. In practice, however, it may be necessary to determine a specific size at which to assign a maximum index value.

Table 3
Species-Area Formulas for Various Habitats and Geographic Locations

Locations, Source	Richness Measure, Y	R^2	Formula
East-central Illinois woodlots - 1979 (Blake 1991)[1]	Breeding birds	0.828	$Y = 14.35 * (areaha)^{0.175}$
New Jersey oak forests (Galli, Leck, and Forman 1976)[1]	Breeding birds	0.962	$Y = 16.33 * (areaha)^{0.254}$
Missouri prairies (Samson 1980)[1]	Prairie birds	0.927	$Y = 1.94 * (areaha)^{0.282}$
Wisconsin cattail marsh (Tyser 1983)[1]	Wetland birds	0.921	$Y = 5.27 * (areaha)^{0.323}$
Kansas shelterbelts (Schroeder, unpubl. data)	Breeding birds	0.792	$Y = 17.36 * (areaha)^{0.359}$
Central Nevada riparian canyons (Murphy and Wilcox 1986)[1]	Birds	0.60	$Y = 1.46 * (areaha)^{0.349}$
Illinois southern lowland hardwoods (Graber and Graber 1976)[1]	Breeding birds	0.946	$Y = 12.8 * (areaha)^{0.275}$
Illinois upland hardwoods (Graber and Graber 1976)[1]	Breeding birds	0.948	$Y = 6.01 * (areaha)^{0.417}$
Illinois shrub habitats (Graber and Graber 1976)[1]	Breeding birds	0.869	$Y = 9.71 * (areaha)^{0.326}$
Illinois north and central pastures (Graber and Graber 1976)[1]	Breeding birds	0.948	$Y = 3.91 * (areaha)^{0.285}$
St. Lawrence River islands (Lomolino 1982)	Terrestrial mammals	0.86	$Y = 6.51 * (areaha)^{0.305}$
Iowa seasonal and semi-permanent marshes (Brown and Dinsmore 1988)	Breeding birds	0.68	$Y = 6.0 * (areaha)^{0.23}$
Iowa restored wetlands (Hemesath and Dinsmore 1993)	Breeding birds	0.24	$\log Y = \log 0.71 + 0.431 \log (areaha)$
Saskatchewan aspen groves (Johns 1993)[1]	Breeding birds	0.718	$Y = 11.79 * (areaha)^{0.203}$
Wyoming floodplains (Gutzwiller and Anderson 1987)[1]	Cavity nesting birds	0.792	$Y = 1.84 * (areaha)^{0.445}$

[1] Species-area formulas were calculated from raw data in sources noted, using the Nonlin program in SYSTAT (Wilkerson 1988).

The community model for bottomland hardwood forested wetlands being developed by Schroeder, O'Neil, and Pullen (in preparation) recommends that a maximum index (1.0) be assigned to 3,000-ha tracts (Figure 3). The 3,000-ha size was selected by determining which species were important and how large an area they would require to be present. In a test of a shelterbelt community model, Schroeder, Cable, and Haire (1992) recommend that the maximum index be assigned to the largest shelterbelt expected to be encountered in the area of application. The latter approach allows the index to be scaled to local or regional conditions, but makes it invalid to compare habitats outside of the designated area.

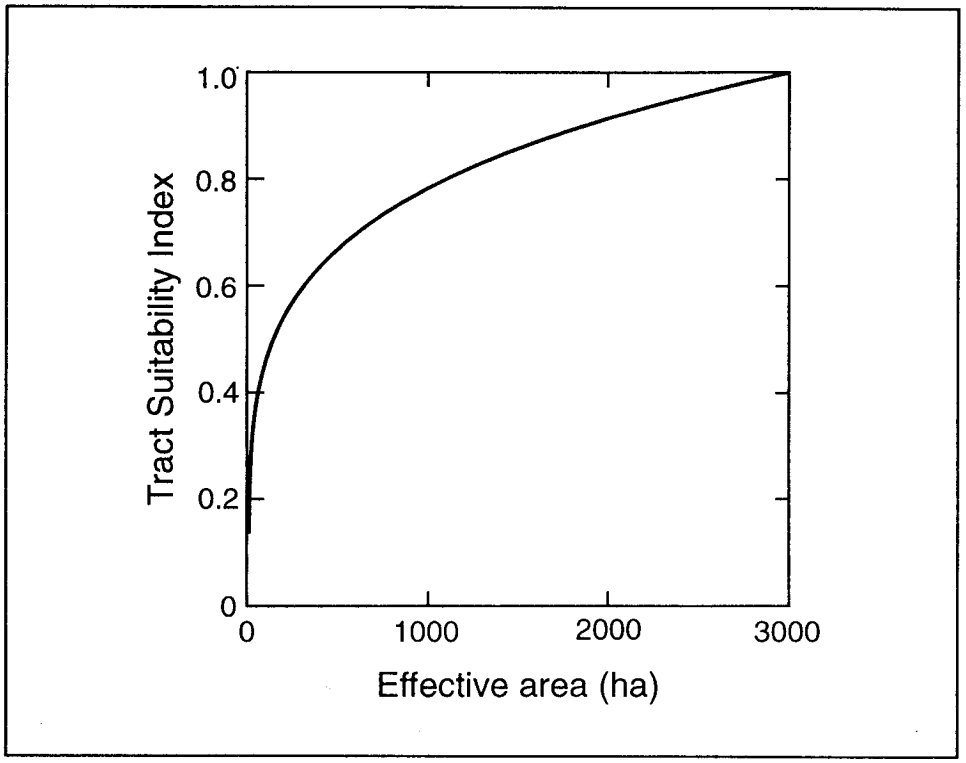

Figure 3. Scaling the species-area curve to yield a 0-1.0 index

It is not absolutely necessary to convert the species-area relationship to an index. The output can remain in direct units of species richness, and comparisons or decisions made from this basis.

Simple applications using a species-area curve

A community-level habitat evaluation could be conducted using only a species-area curve to rate and compare habitats. Such an evaluation would be most suited to situations where internal habitat conditions were reasonably similar, and where the landscape context was not an important factor. In such situations, area alone should be expected to account for most of the variation in the measure of richness being assessed.

A limitation of using only area is that species richness is often affected by the landscape context of an area and its internal habitat quality. An advantage of using only area is that it would allow a rapid evaluation of many sites over a large region. In addition, knowledge of the distribution of patch sizes in a specific region may be useful in conducting cumulative impact assessments (Gosselink and Lee 1987).

Applications using a species-area curve with modifications for landscape context

A basic premise of the theory of island biogeography is that the species richness of an island (habitat patch) is affected by its isolation from other patches (MacArthur and Wilson 1967). Isolated patches generally contain fewer species than nonisolated patches. Patch isolation is determined by several factors, including the distance to other patches (Lomolino 1982), the amount of similar habitat in the surrounding landscape (Brown and Dinsmore 1988), and the characteristics of the intervening landscape (Knaapen, Scheffer, and Harms 1992). Wilcove, McLellan, and Dobson (1986) believe the influence of corridors is debatable; they believe it is more useful if the land around patches allows species to exist at least marginally, and thus be able to diffuse into other patches.

Robbins, Dawson, and Dowell (1989), in a study of eastern forest birds, note that the proximity to other forests appears to enhance the effective area of an isolated patch. This author proposes that the concept of effective area can be used as a basis for modifying the area of a patch prior to predicting species richness from a species-area curve and uses two existing data sets to illustrate this point.

Brown and Dinsmore (1988) analyzed the species richness of breeding birds in Iowa marshes and determined that richness was a function of both area and isolation (expressed as the number of marsh hectares within 5 km). The species-area formula determined from their data was as follows:

$$\text{Breeding bird richness} = 7.797 \quad (\text{Area-ha})^{0.149}$$

$$\text{Corrected } r^2 = 0.584$$

This author used their measure of isolation (expressed as the number of marsh hectares within 5 km) to modify the actual area of each marsh and to determine its effective area. The area of marshes that were highly isolated was left unchanged, and the area of marshes that were the least isolated was arbitrarily increased by a factor of four. A linear relationship was assumed between these two extremes. Based upon a computation of effective marsh area, the revised species-area formula from their data was as follows:

$$\text{Breeding bird richness} = 7.161 \quad (\text{Effective Area-ha})^{0.154}$$

$$\text{Corrected } r^2 = 0.652$$

Lomolino (1992) analyzed the species richness of mammals on islands in the St. Lawrence River and determined that richness was also a function of area and isolation (expressed as the distance to the nearest mainland or large island). The species-area formula determined from their data was as follows:

$$\text{Mammalian richness} = 6.489 \quad (\text{Area-ha})^{0.352}$$

$$\text{Corrected } r^2 = 0.879$$

Again, this author used their measure of isolation (distance to nearest mainland or large island) to modify the actual area of each island and to determine its effective area. The area of islands that were highly isolated was left unchanged, and the area of islands that were the least isolated was increased by a factor of four. A linear relationship was assumed between these two extremes. Based upon a computation of effective island area, the revised species-area formula from their data was as follows:

$$\text{Mammalian richness} = 4.979 \quad (\text{Effective Area-ha})^{0.376}$$

$$\text{Corrected } r^2 = 0.936$$

In each of these two examples, the use of effective area provided a better fit than the use of area alone in estimating species richness.

The degree to which a patch boundary deflects the movement of an animal is known as the boundary permeability (Wiens, Crawford, and Gosz 1985). Permeability is related to characteristics of both the animal and the boundary itself. The intervening habitat structure, resource levels, and presence or absence of predators or competitors can influence the movement of an animal from one patch to another. Patches of habitat with ideal structural characteristics will not be usable unless the wildlife species of concern can move freely between patches and maintain genetic continuity with conspecifics (Harris and Kangas 1988). Knaapen, Scheffer, and Harms (1992) developed an index to evaluate permeability based on the characteristics of the intervening landscape. Their measure, the minimal cumulative resistance (MCR) index, is based upon the likelihood of dispersal of different species groups across various landscape types or barriers. Empirical data were not provided on species-area relationships and the MCR. It would seem likely, however, that patches in landscapes with high resistance values would have less effective area than patches in landscapes that were more permeable.

Applications of the species-area curve with landscape modifiers will be enhanced by use of Geographic Information Systems (GIS) technology. A model being develop for bottomland hardwoods of the Southeast (Schroeder, O'Neil, and Pullen, in preparation) incorporates measures of both isolation and permeability and has been fully automated for use with the ARC/INFO GIS software.

Applications using a species-area curve with habitat modifiers

The addition of measures of habitat heterogeneity into species-area models will provide a significant improvement in their power to predict species richness (Boecklen 1986). Boecklen and Gotelli (1984) determined that, for the 100 log-log species-area regressions reviewed by Conner and McCoy (1979), on average these models explained about one-half the variation in species richness (mean adj. $r^2 = 0.49$, standard deviation = 0.28). They recommend that other measures such as habitat heterogeneity or resource availability be incorporated into the models to improve their performance. In a test of a shelterbelt habitat model, Schroeder, Cable, and Haire (1992) found that the inclusion of habitat conditions provided more accurate predictions of breeding bird richness than area alone.

The effect of habitat quality on the species-area relationship was discussed by Zimmerman and Bierregaard (1986:139) in reference to central Amazon forest frogs. They concluded that 100 ha containing quality breeding habitat would preserve more species of frogs than 500 ha containing little, subquality, or even no critical habitat types. The implications of this conclusion can be illustrated on a series of hypothetical species-area curves (Figure 4). An area with low-quality habitat would be expected to have a lower species-area curve than an area with high-quality habitat. Thus, a small tract with high-quality habitat could have a higher suitability index (more species) than a large tract with poor-quality habitat. To effect this change in the species-area formula, simply add a factor (0-1.0) to account for habitat quality, as shown below:

$S = cA^z$ (habitat quality factor)

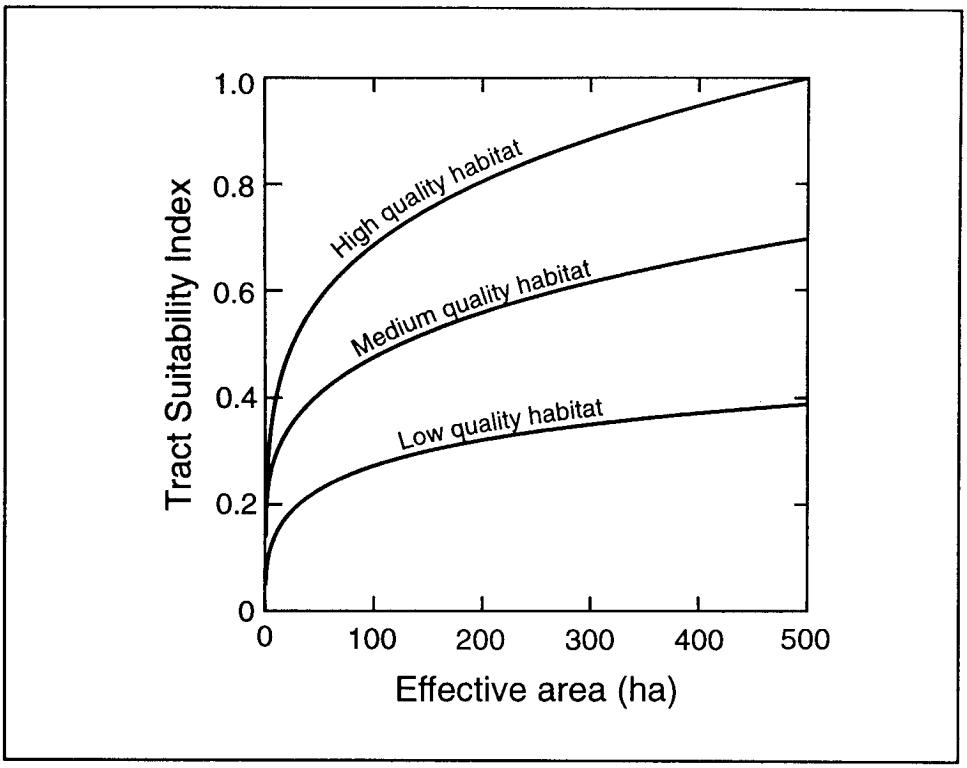

Figure 4. Hypothetical species-area curves, showing the effects of habitat quality

5 Limitations of Using the Species-Area Relationship

There are several potential limitations of using the species-area relationship as a basis for wildlife community habitat evaluation. First, most of the existing data for species-area relationships in North America is derived from avian studies. Information is especially weak on reptiles and amphibians, which are important vertebrate groups in many regions. Second, the emphasis on the value of large areas does not take into account the possible value of small areas for certain species. For example, Moler and Franz (1987) describe the value to amphibians and wading birds of small isolated wetlands in the southeastern coastal plain. They note that several species of amphibians are dependent on small, isolated wetland habitats that are free of predators. In addition, rare or endangered plants or animals may occur on small patches. As noted earlier, the critical question that must be addressed is the conservation goal for the region of concern. Whereas protection of large areas may be desired for many goals, it is essential not to ignore potential values of small, unique patches.

With multispecies assemblages as the focus of conservation efforts, the probability that community features will be affected by factors outside the specified boundaries increases dramatically with species number and variety (Van Horne and Wiens 1991). Models for regional populations should consider a landscape larger than a single patch and its immediate surroundings and should account for the interactions between patches (Kushlan 1983; Fahrig and Merriam 1994). Assessment of species richness on a regional scale will require a more complex approach than presented here for assessing species richness in individual patches. Additional research into factors affecting regional scale biodiversity is needed.

6 Summary and Recommendations

Based upon the literature and analyses of specific species-area data sets, it appears that it is feasible to use the species-area relationship as the basis for assessing wildlife community habitat. The essence of the approach recommended here is as follows:

a. Define the wildlife resource objectives for the region of interest. If these objectives include concerns about area sensitive species, interior species, species richness (overall or of selected groups), or habitat fragmentation, then use of the species-area relationship may be appropriate.

b. Develop a species-area curve for the defined objective.

c. Determine the need for computing the effective area, based on factors for isolation or permeability.

d. Determine the need to modify the species-area relationship based on habitat quality factors.

The essence of this approach is represented by a family of species-area curves (Figure 4). The input value on the x-axis is effective area, to take into account the effects of landscape context on species richness. The family of curves represents the effects of various levels of habitat quality on richness. This basic approach is supported both conceptually in the literature and by the independent data sets presented.

For users who will actually be developing their own community-level habitat assessment models, it is highly recommended that the models follow the guidelines presented in an earlier report (Schroeder and Haire 1993).

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