INTRINSIC RATING (IR) OF A TRACT OF FOREST

The IR provides a measure of the value of a tract of forest for wildlife based solely on the features of the forest itself. To obtain a simple yet reasonable index, we have focused on six features of a forest important for wildlife, as described previously and in Table 2.. For each feature, we have assigned a numerical weight or value to each possible condition. For instance, one important feature of a forest is its maturity. The forest maps show four stages of maturity: forests that are mostly pine (more than 50% of the canopy); forests that are mostly but not entirely hardwoods (50-90% of the canopy); and forests that are almost entirely or entirely hardwoods (more than 90% of the canopy). These three types of forest are rated 1, 2, and 3, respectively, for maturity. Areas with no tall forest receive a rating of 0 for this feature. See Table 2 for our methods of scoring five other features of forests.

The Intrinsic Rating (IR) of a tract of forest is obtained by multiplying the six numbers together:

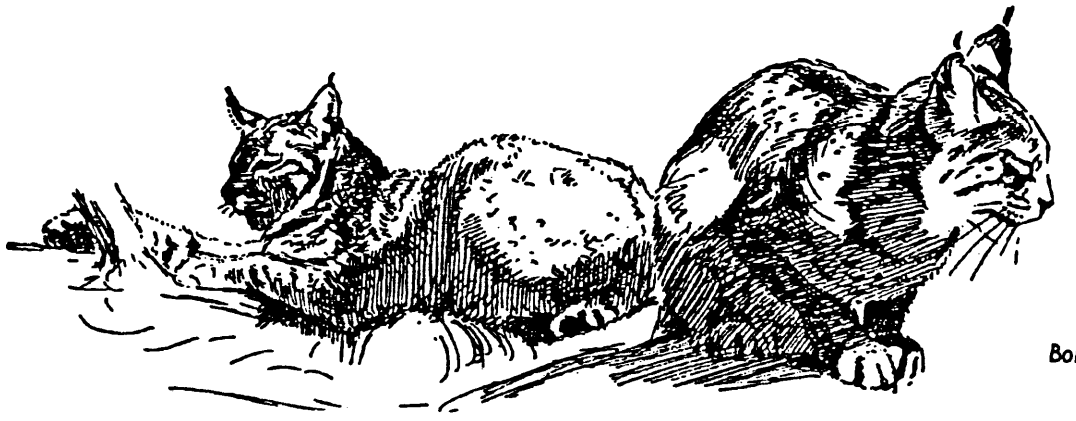
$$IR = A \times M \times D \times E \times S \times I$$

with A = acreage, M = maturity, D = disturbance, E = edginess, S = stream, I = inventoried natural area. Each number is explained further in Table 2 and in the following paragraphs.

In calculating the IR, the basic feature of a forest is its area or acreage (A). As we have seen the size of a forest is the primary determinant of how many individuals of each species it can contain.

The other five numbers serve to adjust the rating based on the acreage. For instance, mature forests (almost entirely hardwoods) have three times the rating of predominantly pine forests (M). Forests with no human disturbance of the canopy have twice the rating of those with a lot of disturbance (D). Forests with a high proportion of edge to area have ratings that are decreased proportionately (E). Forests that overlap areas with inventoried natural areas (I) of regional or state-wide significance (as classified by the N. C. Natural Heritage Program) have ratings 2 and 3 times as high, respectively, as otherwise comparable areas with special significance. Forests that include streams or other known bodies of water (S) have ratings that are twice as high as areas without those features.

A large, mature, undisturbed, compact forest that includes a stream and an inventoried natural area has a very high rating. The highest IR for a single tract of forest in Orange County is 48,260. In contrast, a small disturbed patch of pines with an irregular shape and no water or inventoried natural area has a very low rating. The Intrinsic Ratings of tracts of forest in Orange County in 1988 appear in Map 1.



Bobcats

Table 2
FEATURES OF FORESTS USED TO CALCULATE THE INTRINSIC RATING FOR A TRACT

Area (A)

the size in acres of a tract of forest

Maturity (M)

3 — more than 90% hardwoods in the canopy
2 — 50-90% hardwoods in the canopy
1 — less than 50% hardwoods (more than 50% pines) in the canopy
0 — no closed canopy of full-grown trees)

Disturbance (absence of) (D)

3 — no breaks in the canopy for small roads or buildings
2 — few breaks in canopy
1 — many breaks in canopy

Edginess (minimization of) (E)

the perimeter of the tract divided by the circumference of a circle of equal area.
(A circular disc has the shortest edge in relation to its area. The longer, narrower, and more convoluted a tract is, the greater is its perimeter in relation to its area. So E equals 1 for a circular tract and decreases toward 0 as a tract becomes narrower and more convoluted in shape.)

Inventoried natural areas (I)

3 — tract overlaps or includes an inventoried natural area of state-wide significance
2 — tract overlaps or includes an area of regional significance
1 — tract does not overlap or include an area of state-wide or regional significance

Stream present (S)

2 — a mapped stream, river, vernal pool, or lake within or adjoining the tract
1 — no known body of water

INTRINSIC RATING FOR WILDLIFE (IR) = A x M x D x E x S x I

CONTEXTUAL RATING (CR) OF A TRACT OF FOREST

The value of a forest also depends on its context in a landscape and especially on possible connections and corridors to other tracts of forest. We need a way to evaluate the contribution of the context of a forest to its value for wildlife. A simple procedure is to consider several zones at different distances from the "target" tract.

To calculate a Contextual Rating for a particular target tract of forest, we chose zones extending from 0 to 0.5 miles, 0.5 to 1.0 miles, and 1.0 to 2.0 miles around the tract. We then calculated the average Intrinsic Rating for each acre in each of these doughnut-shaped zones (some details of this calculation are explained in Appendix II). The average IR/acre for each zone (AVIR1, AVIR2, and AVIR3) tells us what an individual animal migrating outward from the target tract can expect to find in each of the zones around its origin.

A dispersing individual is more likely to move a shorter distance than a longer one (if only because an animal must first cross the nearer zone before reaching the farther one). Consequently, in calculating the Contextual Rating for the target tract, we gave the nearer zones heavier weight. The average IR/acre for the closest zone (AVIR1) was multiplied by 4, that for the middle zone (AVIR2) by 2, and that for the farthest zone (AVIR3) by 1. We added the three resulting numbers together to obtain a Contextual Rating (CR) for the target tract:

$$CR = (AVIR1 \times 4) + (AVIR2 \times 2) + (AVIR3 \times 1)$$

This rating indicates the chance that an animal dispersing from the target tract will find suitable habitat nearby.

As emphasized above, little is known about the ways animals move between patches of habitat. Of course, different species have very different chances of moving to any particular distance. It is only necessary to think about a Box Turtle and a Pileated Woodpecker to realize these differences between species. Nevertheless, any animal is more likely to move a shorter distance than a longer distance. In addition, a dispersing animal is more likely to find suitable habitat when there is on average more suitable habitat in the surrounding zones. Thus this Contextual Rating incorporates the basic features that might influence these movements.

The Contextual Rating is incomplete near the boundaries of the County, because parts of the three zones fall outside the County. The County's maps of forests in Orange County extend far enough over the boundaries to alleviate this problem. Regional efforts to plan for preservation of forest would eliminate this problem altogether.

Contextual Ratings for tracts of forest in Orange County in 1988 appear in Map 2.

COMBINING INTRINSIC RATING AND CONTEXTUAL RATING INTO A TOTAL RATING (TR)

The Contextual and Intrinsic Ratings for a tract of land can be combined into a Total Rating by adding 1 to the Contextual Rating and then multiplying the two ratings together:

$$\text{Total Rating} = IR \times (CR + 1)$$

The Contextual Rating, after all three zones are combined, is a weighted average rating per acre. Like the maturity of a forest or its degree of "edginess", the context of a forest multiplies the overall value of the tract for wildlife.

The Contextual Rating would have a maximal value of about 42 in the extreme case of a tract entirely surrounded by undisturbed hardwood forest (see Appendix II). It would have a value of 0 in the other extreme case of a tract entirely surrounded by unforested land to a distance of 2 miles in all directions.

By adding 1 to the CR, the target tract in this latter case would have a Total Rating equal to its Intrinsic Rating: when CR = 0, TR = IR x (CR + 1) = IR. Thus when CR = 0, it has no effect on the Total Rating.

Total Ratings for tracts of forest in Orange County in 1988 appear in Map 3, and the sites with the highest Total Ratings are presented in Map 4.

HOW RATINGS HAVE CHANGED IN THE PAST DECADE

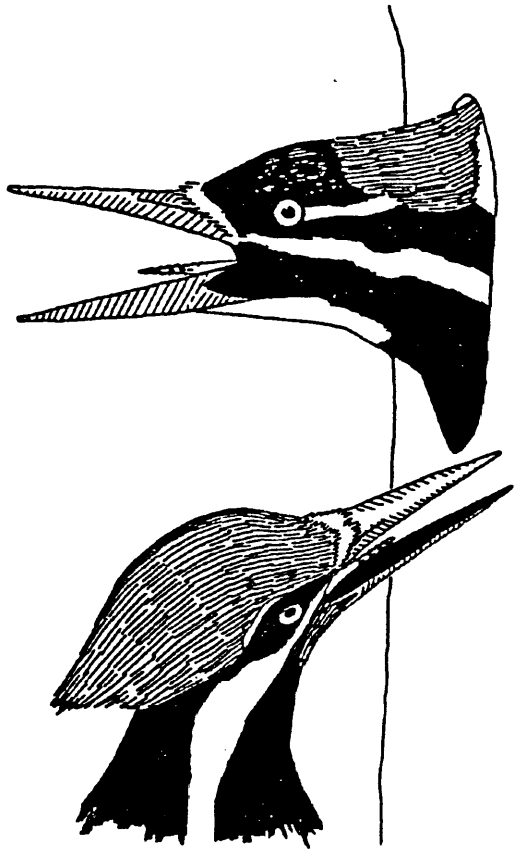
The aerial photos used for mapping the forests in Orange County date from 1988, the most recent available. In the past decade the Intrinsic Ratings of some tracts of forest have probably increased and others have decreased.

Undisturbed forests have continued to mature, so some have changed from predominantly pine to predominantly hardwood and thus have higher Intrinsic Ratings.

Other forests include properties that have been timbered or for which building permits have been issued in the past decade. Although a building permit does not necessarily mean that all forest on the property has been cleared, some clearing is usually the case. These tracts would now have lower Intrinsic Ratings.

To estimate the consequences of recent building for the wildlife value of forests, we have recalculated the ratings after subtracting all properties for which building permits were issued between 1988 and 1998 (except those tracts in the Chapel Hill Planning District, for which information on building permits was not available). The resulting ratings appear in Maps 5-8. Some statistics for these ratings before and after subtracting properties with building permits appear in Table 3.

It is important to emphasize that the statistics in Table 3 for forests in 1998 are based on incomplete information: they do not include the effects of timbering, the progressive maturity of undisturbed forests, nor the actual effects of building permits. Accurate assessment of the County's current forests will require an analysis of recent aerial photographs.



Male (bottom) and Female Pileated Woodpeckers

RATINGS FOR TRACTS DETERMINED BY PROPERTY BOUNDARIES

The preceding sections have applied these ratings to tracts of forest. Usually these tracts do not correspond to property boundaries, but no special problems arise in applying the IR and CR to parcels defined by property boundaries. A parcel of land would usually include several different tracts of forest or parts of tracts. To calculate an Intrinsic Rating for the entire parcel, we could recompute areas (GIS polygons) by using both the boundaries of forest tracts and the property boundaries in question.

Then we could find the IR for each polygon included within the property boundaries and sum them to obtain a total IR for the property. To obtain the Contextual Rating for the property, we could then follow the procedures described previously without modification. The Total Rating for the property would equal the product of IR and (1 + CR), as described above.

Table 3
STATISTICS FOR RATINGS OF FOREST FOR WILDLIFE

YEAR	1988*	1999**
INTRINSIC RATINGS		
Median (50th percentile)	803	713
Maximum	48260	40510
Overall Sum	941,547	789,077
Number of tracts over 15,000	7	5
CONTEXTUAL RATINGS		
Median (50th percentile)	22.3	25.6
Maximum	147	145
TOTAL RATINGS		
Median (50th percentile)	19045	14788
Maximum	1,385,000	1,098,000
Overall Sum	30,129,000	23,273,000
Number of tracts over 300,000	14	12

*Based on 1988 Aerial Photographs (689 tracts of forest over 40 acres)

**After subtracting properties with building permits issued 1988-1998 (653 remaining tracts of forest over 40 acres)

USING RATINGS FOR WILDLIFE

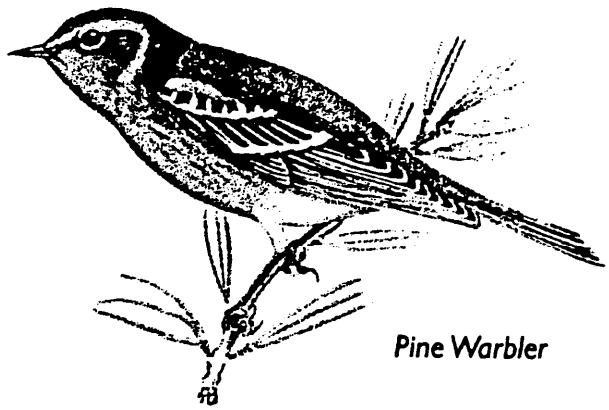
WAYS WILDLIFE RATINGS CAN HELP PLANNERS AND CONSERVATIONISTS

Preserve and restore large tracts of forest and other wildlife habitats. These areas make such important contributions to a Landscape with Wildlife that they merit acquisition for permanent protection. Map 8 shows the areas in Orange County with the highest Total Ratings after subtracting properties with recent building permits. Important priorities include both those areas that have high Intrinsic Ratings and those with high Contextual Ratings.

Preserve and restore connections between forests or other wildlife habitats. Contextual Ratings of forests are important because they indicate the opportunities for dispersal of animals between patches of habitat. These ratings can thus help to preserve the connections between forests.

Especially important are areas that have large influences on the Contextual Ratings of nearby natural areas In Orange County. Several important natural areas are already protected by public or institutional ownership. Nevertheless, even these areas can lose some of their value for native wildlife by changes in land use nearby. In order to retain our native wildlife, we must maintain the Contextual Ratings of important natural areas. Thus land within two miles of important natural areas requires special attention in planning.

Identify and preserve areas for wildlife within any proposed development. On a small as well as large scale, it is important to identify which land to set aside for wildlife. Within any one development, some areas are identified for active recreation and other community space.



Pine Warbler

Developments should also plan to reserve areas for wildlife, particularly those areas with high Intrinsic and Contextual Ratings.

Subdivision of land for homes can lead to extreme fragmentation of forests. To minimize the effects of fragmentation on wildlife, it is important to keep the remaining forests as large and as close together as possible and to provide connections between forests. Hence the Contextual as well as the Intrinsic Ratings of forests are important in identifying land to set aside for wildlife.

Minimize impacts of development on nearby protected natural areas. The importance of natural areas for wildlife does not depend entirely on their intrinsic features. Turning a natural area into an isolated "island" diminishes its value for wildlife. In evaluating plans for development or public facilities, it is thus important to consider any changes in the Contextual Ratings of nearby protected areas.

When considering proposals for changes in land use, we routinely consider the consequences for neighboring land — not only for its property value but also for its water quality, noise, odor, traffic, schools, and other values. We should also consider changes in the wildlife value of nearby land. To do so, we can compute the changes expected in the Contextual Ratings of these areas for wildlife.

Require mitigation for major losses of forests for wildlife. Without planning, the proportion of land left for wildlife diminishes steadily. A solution is to negotiate mitigation for losses. Imagine a proposal to develop a tract of land in a way that decreases its Intrinsic Rating for wildlife or decreases the Contextual Rating of a nearby protected area. The County might require the developer or agency to protect land with equal ratings elsewhere. A requirement of this sort would also create an incentive to minimize any decrease in wildlife ratings for the property under development.

For successful mitigation, we do not have to put a dollar value on the consequences for wildlife. Instead, it is enough to determine whether a decrease in value for wildlife in one place is matched by an increase somewhere else. For this purpose, we can use a wildlife value, such as the Total Rating for wildlife, rather than a dollar value.

Monitor how Orange County measures up as a Landscape for Wildlife. We can compute the grand total of the Total Ratings for all forests in Orange County. This grand total is an index of the County's overall suitability for native wildlife.

The grand total changes over time as the forested areas of Orange County and their arrangement change. If we subtract all forested tracts for which building permits were issued between 1988 and 1998, Orange County's overall Total Rating for wildlife decreases from 30,130,000 to 23,273,000 — over 25% (see Table 3). As explained above in the section, How Ratings Have Changed in the Past Decade, it is not clear that the actual decrease is this large. An accurate measure of changes in the County's forests will require analysis of a new set of aerial photographs.

It would take a person about one month, full-time, to identify and digitize the forests of the entire County. Eventually satellite photography might become detailed enough to permit this sort of mapping automatically, but the resolution of satellite photos is not high enough at the present time. By obtaining up-to-date information every decade, the County could identify developing problems and monitor its progress in maintaining a Landscape with Wildlife.

Promote a regional plan for a Landscape with Wildlife. A regional assessment of habitats for native wildlife, including large tracts of forest, will help Orange County to understand its own place in a Landscape with Wildlife. As described in the next section, some important wildlife areas in Orange County lie near county boundaries. Much of the Contextual Ratings for these areas will depend on land in adjacent counties. Without a regional perspective, these areas are in danger of falling between the cracks in planning for a Landscape with Wildlife.

CARE IS NECESSARY IN APPLYING WILDLIFE RATINGS

The ratings we have proposed represent a first step in evaluating land for wildlife. The ratings include those features of natural habitats that current evidence suggests are important for many kinds of native wildlife and for which we had information. Different kinds of wildlife have different requirements, and different tracts of land have special features. Any one rating system cannot apply equally well to all. We have proposed ratings in the conviction that the time to start thinking about the value of land for wildlife is now.

In using these ratings, it is important to keep several issues in mind.

Confirmation in the field. Any application of the ratings we have proposed to particular circumstances should always follow confirmation of the ratings by field work. For instance, identifying land for preservation or for mitigation of development should always include an assessment on the ground. There is no substitute for direct field studies in particular cases.

The ratings we propose can help planners make initial decisions about the value of land for wildlife, but these decisions always need confirmation in specific cases.

Artificial barriers affect the movement of wildlife. Our ratings do not take account of every influence on the suitability of forests for native wildlife. An example of a factor not included in these ratings is the presence nearby of an absolute barrier to movements of animals. Barriers such as fenced and heavily traveled highways, railroad tracks, or causeways lined with riprap can completely block some animals' movements. A large mature forest nearby would make little difference to a dispersing Box Turtle if it lay on the far side of a major highway. The Contextual Ratings presented here do not take these barriers into consideration.

As new information becomes available, it will allow development of better ratings in the future. Even so, to assure the continued presence of a full range of native wildlife, we must not ignore the special requirements of each species.

County boundaries affect wildlife ratings. As already mentioned, the Contextual Ratings of tracts near the edge of the County are too low because we currently lack maps of forests in adjacent counties. For instance, the Mason Farm Biological Reserve in the southeastern corner of Orange County would have higher Contextual and Total Ratings if we could include the influence of the extensive forests along the floodplain of Morgan Creek in Durham and Chatham Counties. Also the presence of floodplains, which are often rich wildlife habitats, are not included in our ratings.

The artificiality of political boundaries for wildlife can only be resolved by a regional effort. Regional planning would improve our understanding of Orange County as a Landscape with Wildlife.

Wildlife ratings depend on the arrangement of forests. Because the Total Rating for each tract of land depends in part on the features of neighboring tracts, the sum of the Total Ratings over any large area inevitably depends on the arrangement of tracts. In this respect, wildlife values calculated from our Total Ratings are like real estate property values. Both depend on intrinsic and contextual features of properties, and both consequently depend on the arrangement of properties.

OTHER VALUES FOR FOREST

The forests which once covered most of Orange County, and still cover nearly a third, have other advantages as well. They provide important benefits for water quality. Forests behave both like sponges and like filters. By absorbing rainfall and releasing it slowly into streams, they dampen floods and droughts. By removing most pollutants and silt from water flowing into streams, the soils of forests provide us with clean water.

Forests also provide much of the natural appeal of the landscapes of Orange County. Forests on rolling hills are what make the landscapes of the Piedmont distinctive.

We have focused here on the importance of forests for native wildlife. To protect our wildlife we must protect our forests, but if we protect our forests we will have protected much more as well.

APPENDIX I

PRELIMINARY SURVEYS OF BIRDS IN ORANGE COUNTY FORESTS

During the summer of 1998, Susan Campbell, an ornithologist who works for the N. C. State Museum of Natural Sciences, surveyed birds in forests in several areas of Orange County. The intent was to determine the species breeding in the different types of forest identified on the maps of forest in Orange County. There are nine such categores: hardwood, mixed, and pine forests, each undisturbed, slightly disturbed, and strongly disturbed by human activities.

PROCEDURES

The areas easily accesible for this work were Moorefields Estate, Occoneechee Mountain, Duke Forest (Durham and Korstian Divisions), Pickard's Mountain, Cane Creek Reservoir, University Lake, and Mason Farm Biological Reserve. In each of these areas, she received enthusiastic cooperation from the resident owners or managers.

Occurrence of birds was recorded during "point counts", a standard procedure for assessing the occurrence and density of birds. During each point count, the observer recorded all birds seen or heard within 50 meters of an arbitrarily selected point located as much as possible within a larger area of one type of forest. Points were never closer than 100 meters apart, to avoid overlap in individuals recorded. All counts were conducted during the morning between 6:00 and 11:00 a.m.

Altogether 84 point counts were obtained in May and June. The areas available for surveys provided fewer opportunities for studying disturbed forests than undisturbed ones. Consequently, most counts were obtained in undisturbed hardwood (31 counts), mixed (21), and pine (14 counts); there were 15 counts in slightly disturbed forests, and only 4 in strongly disturbed forests.

Only the counts in undisturbed hardwood and mixed forests adequately sampled the birds. Most of the censuses in undisturbed pine forests were conducted in Duke Forest, where most tracts of uniform forest are small. Consequently, the counts in these forests often included some species from adjacent hardwood forests. There were too few counts in disturbed forests for firm conclusions.

The data for these counts is on file in the office of the Triangle Land Conservancy. A summary of the results is presented here.

GENERAL OBSERVATIONS

It became clear that the County must update its maps of forests periodically. Campbell's notes repeatedly refer to recent loss of forest in the County. The maps do not reflect clearing for building since 1988 (although information about recent building permits indicates where such clearing has probably occurred). The maps also do not reflect clearing for timber sales. The State has information about timber sales in ArcInfo format, but the County has not yet been able to obtain this information.

In addition, some areas designated on the maps as Mixed Forests are now nearly pure Hardwood. Campbell noted that Hurricane Fran had blown down pines in some areas of Mixed Forest and thus accelerated the final stage of succession to Hardwood Forest. Of course, some Mixed Forests on the maps just missed the criterion for Hardwood Forests in 1988 and subse-

quently have lost enough of the last pines to have qualified as Hardwood Forests today.

BREEDING BIRDS IN ORANGE COUNTY FORESTS

The 84 point counts revealed a total of 72 species of birds that normally breed in Orange County. Some of these species do not usually use forests for nesting or feeding and were noted only while flying overhead or at the edges of the count areas in habitats other than forest.

Species that normally nest or feed in forests, or in the air above forests, totaled 51. Some nocturnal species (Whip-poor-will, Eastern Screech-Owl, Great Horned Owl) were no doubt also present but not detected in these counts. Among these 51 species, those that live entirely inside forests during the breeding season totaled 23 (Table A-1). Table A-2 presents a summary of the numbers of birds found in different kinds of Orange County forests.

Table A-1
BIRDS RECORDED IN ORANGE COUNTY FORESTS — 1998

The name of each species is followed by a standardized four-letter abbreviation and then two letters that indicate its habitat: F = regularly nests or feeds in forests (some also nest elsewhere); FI = nests only inside forests (with canopy mostly closed)

1	Sharp-shinned Hawk	SSHA	F	FI
2	Red-shouldered Hawk	RSHA	F	FI
3	Barred Owl	BAOW	F	FI
4	Yellow-billed Cuckoo	YBCU	F	FI
5	Hairy Woodpecker	HAWO	F	FI
6	Pileated Woodpecker	PIWO	F	FI
7	Eastern Wood-Pewee	EWPE	F	FI
8	Acadian Flycatcher	ACFL	F	FI
9	Great Crested Flycatcher	GCFL	F	FI
10	White-breasted Nuthatch	WBNU	F	FI
11	Wood Thrush	WOTH	F	FI
12	Solitary Vireo	SOVI	F	FI
13	Red-eyed Vireo	REVI	F	FI
14	Northern Parula	NOPA	F	FI
15	Pine Warbler	PIWA	F	FI
16	Black-and-white Warbler	BAWW	F	FI
17	American Redstart	AMRE	F	FI
18	Worm-eating Warbler	WEWA	F	FI
19	Ovenbird	OVEN	F	FI
20	Louisiana Waterthrush	LOWA	F	FI
21	Kentucky Warbler	KEWA	F	FI
22	Hooded Warbler	HOWA	F	FI
23	Scarlet Tanager	SCTA	F	FI
24	Green Heron	GRHE	F	
25	Turkey Vulture	TUVU	F	
26	Red-tailed Hawk	RTHA	F	
27	Northern Bobwhite	NOBO	F	
28	Mourning Dove	MODO	F	
29	Ruby-throated Hummingbird	RTHU	F	
30	Belted Kingfisher	BEKI	F	
31	Red-bellied Woodpecker	RBWO	F	
32	Downy Woodpecker	DOWO	F	
33	Northern Flicker	YSFL	F	
34	Blue Jay	BLJA	F	
35	American Crow	AMCR	F	
36	Carolina Chickadee	CACH	F	
37	Tufted Titmouse	ETTI	F	
38	Brown-headed Nuthatch	BHNU	F	
39	Carolina Wren	CARW	F	
40	Blue-gray Gnatcatcher	BGGN	F	
41	American Robin	AMRO	F	
42	Gray Catbird	GRCA	F	
43	Brown Thrasher	BRTH	F	
44	White-eyed Vireo	WEVI	F	
45	Summer Tanager	SUTA	F	
46	Northern Cardinal	NOCA	F	
47	Rufous-sided Towhee	RSTO	F	
48	Common Grackle	COGR	F	
49	Brown-headed Cowbird	BHCO	F	
50	Canada Goose	CAGO		
51	Mallard	MALL		
52	Killdeer	KILL		
53	Chimney Swift	CHSW		
54	Eastern Phoebe	EAPH		
55	Eastern Kingbird	EAKI		
56	Purple Martin	PUMA		
57	Northern Rough-winged Swallow	NRWS		
58	Cliff Swallow	CLSW		
59	Barn Swallow	BASW		
60	Fish Crow	FICR		
61	Eastern Bluebird	EABL		
62	European Starling	EUST		
63	Prairie Warbler	PRWA		
64	Common Yellowthroat	COYE		
65	Yellow-breasted Chat	YBCH		
66	Blue Grosbeak	BLGR		
67	Indigo Bunting	INBU		
68	Chipping Sparrow	CHSP		
69	Field Sparrow	FISP		
70	Red-winged Blackbird	RWBL		
71	House Finch	HOFI		
72	American Goldfinch	AMGO		

Table A-2

BIRDS RECORDED IN HARDWOOD, MIXED, AND PINE FORESTS OF ORANGE COUNTY

(UNDISTURBED, SLIGHTLY DISTURBED, AND DISTURBED BY HUMAN ACTIVITIES)

HARDWOOD UNDISTURBED	HARDWOOD SLIGHTLY DISTURBED	MIXED UNDISTURBED	MIXED SLIGHTLY DISTURBED	MIXED DISTURBED	PINE UNDISTURBED	PINE DISTURBED
POINTS 31	9	21	6	2	14	2
SPECIES 39	33	38	28	18	31	17
INDIVIDUALS (ALL SPECIES) 424	146	285	110	32	183	32
INDIVIDUALS/POINT 13.7	16.2	13.6	18.3	16	13.1	16

INDIVIDUALS/POINT FOR EACH SPECIES *

CARW	1.5	CARW	2.0	CARW	1.6	CARW	1.8	NOCA	2.0	NOCA	1.3	NOCA	2.0
REVI	1.2	REVI	1.6	REVI	1.0	NOCA	1.7	AMRE	1.5	CARW	1.2	ETTI	1.5
ETTI	1.0	NOCA	1.6	NOCA	1.0	REVI	1.5	BLJA	1.0	REVI	1.0	PIWA	1.5
CACH	0.9	ETTI	1.4	ETTI	0.9	WOTH	1.3	AMCR	1.0	CACH	0.9	DOWO	1.0
OVEN	0.9	ACFL	0.9	OVEN	0.8	OVEN	1.2	CACH	1.0	PIWA	0.9	BLJA	1.0
NOCA	0.9	AMCR	0.9	WOTH	0.8	ETTI	1.0	CARW	1.0	AMCR	0.8	CACH	1.0
DOWO	0.7	CACH	0.9	ACFL	0.7	RBWO	0.8	WOTH	1.0	BGGN	0.6	CARW	1.0
ACFL	0.7	BLJA	0.8	SUTA	0.7	CACH	0.8	BRTH	1.0	DOWO	0.6	WOTH	1.0
BLJA	0.6	BGGN	0.8	CACH	0.6	SUTA	0.8	REVI	1.0	ACFL	0.5	REVI	1.0
SUTA	0.6	WOTH	0.6	RBWO	0.5	ACFL	0.7	PIWA	1.0	ETTI	0.5	OVEN	1.0
WOTH	0.5	NOPA	0.6	DOWO	0.4	BLJA	0.7	SCTA	1.0	BLJA	0.4	RSTO	1.0
RBWO	0.4	RBWO	0.4	BLJA	0.4	BGGN	0.7	RBWO	0.5	OVEN	0.4	AMCR	0.5
BGGN	0.4	DOWO	0.4	BGGN	0.4	PIWA	0.7	DOWO	0.5	COYE	0.4	WBNU	0.5
SCTA	0.4	PIWA	0.3	SCTA	0.4	SCTA	0.7	ETTI	0.5	SCTA	0.4	GRCA	0.5
BHCO	0.4	OVEN	0.3	MODO	0.3	BHCO	0.7	BGGN	0.5	RSTO	0.4	COYE	0.5
NOPA	0.3	COYE	0.3	YBCU	0.3	DOWO	0.5	NOPA	0.5	PRAW	0.4	SUTA	0.5
YBCU	0.3	MODO	0.2	BHCO	0.3	AMCR	0.5	COYE	0.5	WOTH	0.3	SCTA	0.5
HAWO	0.3	SUTA	0.2	NOPA	0.2	MODO	0.3	SUTA	0.5	MODO	0.2	SSHA	0.0

AMCR	0.2	SCTA	0.2	RTHU	0.2	RTHU	0.3	SSHA	0.0	YBCU	0.2	RSHA	0.0
WBNU	0.2	RSTO	0.2	PIWO	0.2	COGR	0.3	RSHA	0.0	EAWP	0.2	RTHA	0.0
COYE	0.2	BHCO	0.2	EAWP	0.2	HAWO	0.2	RTHA	0.0	SUTA	0.2	MODO	0.0
HOWA	0.2	RSHA	0.1	AMCR	0.2	YSFL	0.2	MODO	0.0	COGR	0.2	BAOW	0.0
WP SP.	0.2	RTHU	0.1	PIWA	0.2	EAWP	0.2	BAOW	0.0	RBWO	0.1	YBCU	0.0
MODO	0.1	YSFL	0.1	LOWA	0.1	GRCA	0.2	YBCU	0.0	PIWO	0.1	RTHU	0.0
EAWP	0.1	PIWO	0.1	KEWA	0.1	SOVI	0.2	RTHU	0.0	AMRO	0.1	RBWO	0.0
PIWA	0.1	EAWP	0.1	COYE	0.1	NOPA	0.2	HAWO	0.0	BHCO	0.1	HAWO	0.0
YSFL	0.1	GCFL	0.1	COGR	0.1	LOWA	0.2	YSFL	0.0	RTHA	0.1	YSFL	0.0
PIWO	0.1	WBNU	0.1	WBNU	0.1	RSTO	0.2	PIWO	0.0	HAWO	0.1	PIWO	0.0
GCFL	0.1	WEVI	0.1	HOWA	0.1	SSHA	0.0	WP SP.	0.0	WP SP.	0.1	WP SP.	0.0
RTHA	0.1	LOWA	0.1	RSTO	0.1	RSHA	0.0	EAWP	0.0	NOPA	0.1	EAWP	0.0
YTWA	0.1	KEWA	0.1	SSHA	0.0	RTHA	0.0	ACFL	0.0	HOWA	0.1	ACFL	0.0
COGR	0.1	HOWA	0.1	RSHA	0.0	BAOW	0.0	GCFL	0.0	SSHA	0.0	GCFL	0.0
RSHA	0.0	COGR	0.1	BAOW	0.0	YBCU	0.0	WBNU	0.0	RSHA	0.0	BHNU	0.0
RTHU	0.0	SSHA	0.0	YSFL	0.0	PIWO	0.0	BHNU	0.0	BAOW	0.0	BGGN	0.0
AMRO	0.0	RTHA	0.0	GCFL	0.0	WP SP.	0.0	AMRO	0.0	RTHU	0.0	AMRO	0.0
WEWA	0.0	BAOW	0.0	BAWW	0.0	GCFL	0.0	GRCA	0.0	YSFL	0.0	BRTH	0.0
LOWA	0.0	YBCU	0.0	AMRE	0.0	WBNU	0.0	SOVI	0.0	GCFL	0.0	SOVI	0.0
KEWA	0.0	HAWO	0.0	WEWA	0.0	BHNU	0.0	WEVI	0.0	WBNU	0.0	WEVI	0.0
RSTO	0.0	WP SP.	0.0	RTHA	0.0	AMRO	0.0	YTWA	0.0	BHNU	0.0	NOPA	0.0
SSHA	0 .0	BHNU	0.0	HAWO	0.0	BRTH	0.0	PRAW	0.0	GRCA	0.0	YTWA	0.0
BAOW	0.0	AMRO	0.0	WP SP.	0.0	WEVI	0.0	BAWW	0.0	BRTH	0.0	PRAW	0.0
BHNU	0.0	GRCA	0.0	BHNU	0.0	YTWA	0.0	WEWA	0.0	SOVI	0.0	BAWW	0.0
GRCA	0.0	BRTH	0.0	AMRO	0.0	PRAW	0.0	OVEN	0.0	WEVI	0.0	AMRE	0.0
BRTH	0.0	SOVI	0.0	GRCA	0.0	BAWW	0.0	LOWA	0.0	YTWA	0.0	WEWA	0.0
SOVI	0.0	YTWA	0.0	BRTH	0.0	AMRE	0.0	KEWA	0.0	BAWW	0.0	LOWA	0.0
WEVI	0.0	PRAW	0.0	SOVI	0.0	WEWA	0.0	HOWA	0.0	AMRE	0.0	KEWA	0.0
PRAW	0.0	BAWW	0.0	WEVI	0.0	KEWA	0.0	RSTO	0.0	WEWA	0.0	HOWA	0.0
BAWW	0.0	AMRE	0.0	YTWA	0.0	COYE	0.0	COGR	0.0	LOWA	0.0	COGR	0.0
AMRE	0.0	WEWA	0.0	PRAW	0.0	HOWA	0.0	BHCO	0.0	KEWA	0.0	BHCO	0.0

*LIMITED TO 49 SPECIES THAT NEST OR FEED INSIDE FORESTS (SOME ALSO OCCUR OUTSIDE FORESTS).
EACH SPECIES IS INDICATED BY ITS FOUR-LETTER ABBREVIATION (SEE TABLE A-1).

APPENDIX II

CALCULATING THE CONTEXTUAL RATING FOR A TARGET TRACT BY MEANS OF THREE BUFFER ZONES AROUND THE TRACT

The procedure we suggest here is easy to calculate in ArcInfo and produces an intuitively understandable rating for the context of a target tract of forest.

THREE BUFFERS AROUND THE TARGET TRACT

First, ArcInfo finds three buffer zones around a target tract. These three buffers extend outward 0.5, 1, and 2 miles from the target tract. Within each buffer, we consider all tracts of forest and non-forest (non-forest is a tract with a Maturity value of 0, as explained in Table 2). The IR for each tract is computed, the resulting numbers are summed, and the sum is divided by the total acreage in the buffer.

The result is an average IR for each acre in each buffer. Notice that the IR for each tract in a buffer includes the acreage of the tract. When we divide by the total acreage in the buffer, we end up with an average IR for the buffer or an IR per acre in the buffer.

To visualize what an average IR means, consider an extreme case. If a buffer were completely forested with undisturbed Hardwood Forest, with no bodies of water or inventoried natural areas, the average IR in the zone would equal about 6 (3 for Hardwood Forest, times 2 for no disturbance).

TWO COMPLICATIONS

There are two complications when ArcInfo calculates an average IR in this way. First, ArcInfo can quickly identify buffers around a target tract, but it cannot quickly identify concentric doughnut-shaped zones. A buffer with a narrower width is thus completely included within a buffer with a wider width. We actually want the information for concentric doughnut-shaped zones, rather than for buffers. This problem is easily solved. The average IR of a doughnut-shaped zone is quickly obtained by subtracting the values for a narrower buffer from the values for a wider buffer. For instance, the average IR for the zone from 1.0 to 2.0 miles from a target tract equals

$$\frac{\text{(total IR for 2-mile-wide buffer) - (total IR for 1-mile-wide buffer)}}{\text{(total area for 2-mile-wide buffer) - (total area for 1-mile-wide buffer)}}$$

There is a second complication. ArcInfo can easily determine the set of all polygons that overlap a buffer, but it cannot easily determine the set that are entirely included within a buffer. Consequently, in computing the average IR for any buffer, we have included tracts that overlap that buffer. The buffer "gets credit" for some forest outside the buffer. Tracts of forest that overlap two doughnut-shaped zones get "counted" in the nearer zone.

This problem, in most cases, is not a large one. In examing the maps of Contextual Ratings for Orange County forests, we have not noticed distortions in ratings as a result of this complicaton. From a biological point of view, this situation is not unreasonable. Once an animal finds a patch of suitable habitat, it might easily move throughout it. Although more complicated calculations could remove this problem, they do not seem justified on the basis of our present knowledge.

THE CONTEXTUAL RATING (CR)

After summing the results for each of the three doughnut-shaped zones, with their respective weights, the maximal value of the Contextual Rating for a target tract is about 42. This value is 6 x 4 for the innermost zone, plus 6 x 2 for the middle zone, plus 6 x 1 for the outer zone. The minimal value of the Contextual Rating is 0, when there is no forest within 2 miles of the target tract in any direction.

The Contextual Rating we present here thus combines the advantages of (1) agreement with general features of biological dispersal between patches of habitat, (2) intuitively understandable results, and (3) easy computation by ArcInfo.

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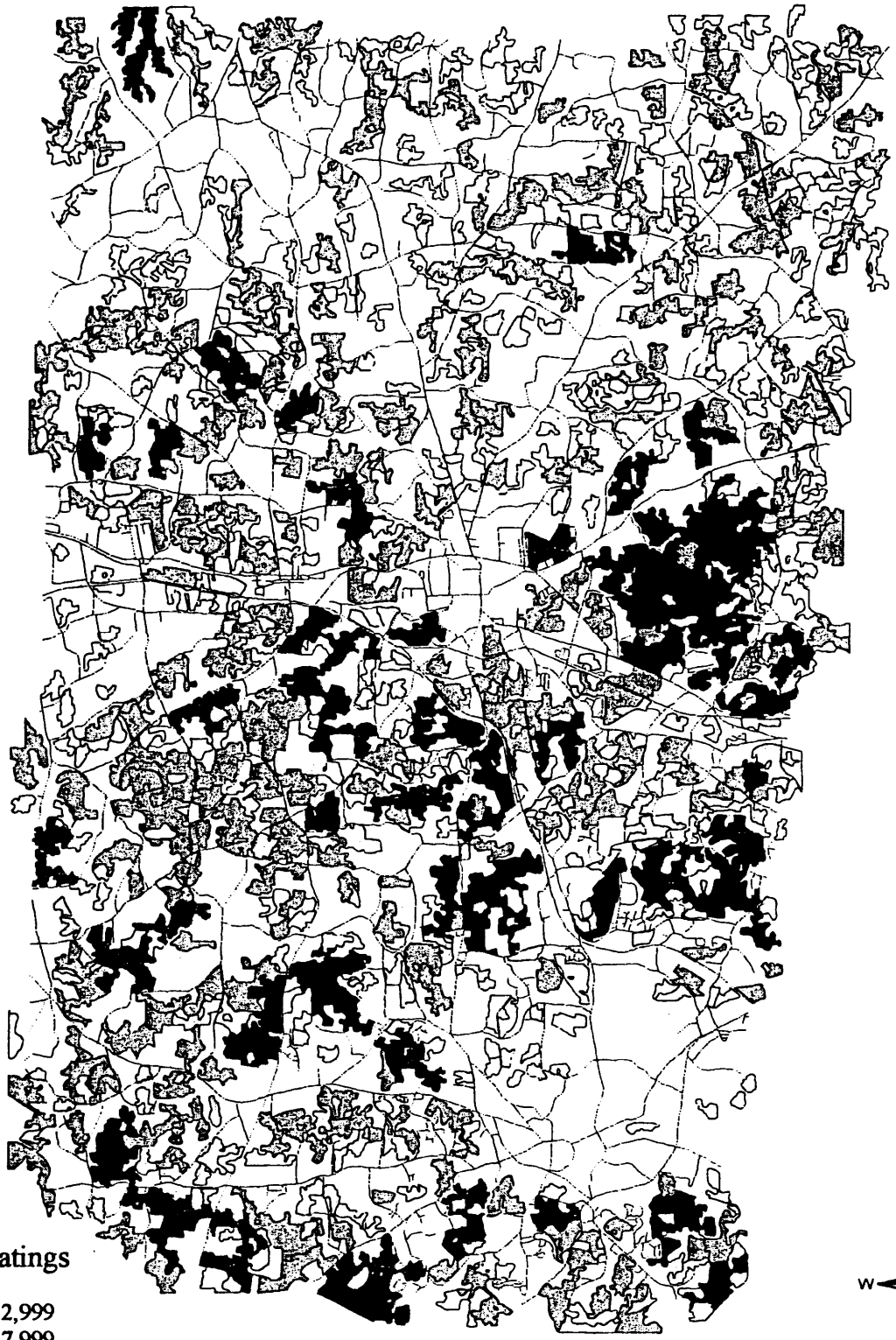
Susan Campbell, N. C. State Museum of Natural Sciences, conducted the surveys of birds in forests of Orange County and prepared a database with the results. Stephanie Wilds, Blue Star Consulting, Inc., prepared the maps and transferred the ARCINFO files and programs to the Orange County Planning Department. Beth Young, Orange County Planning Department, provided the ARCINFO files of forests in Orange County (those prepared by the first phase of this project) and printed the maps for the present report. We thank them all for their enthusiastic participation in this project.

Map 1

Wildlife Ratings for Orange County Forests
(Based on 1988 Aerial Photographs)
Intrinsic Ratings



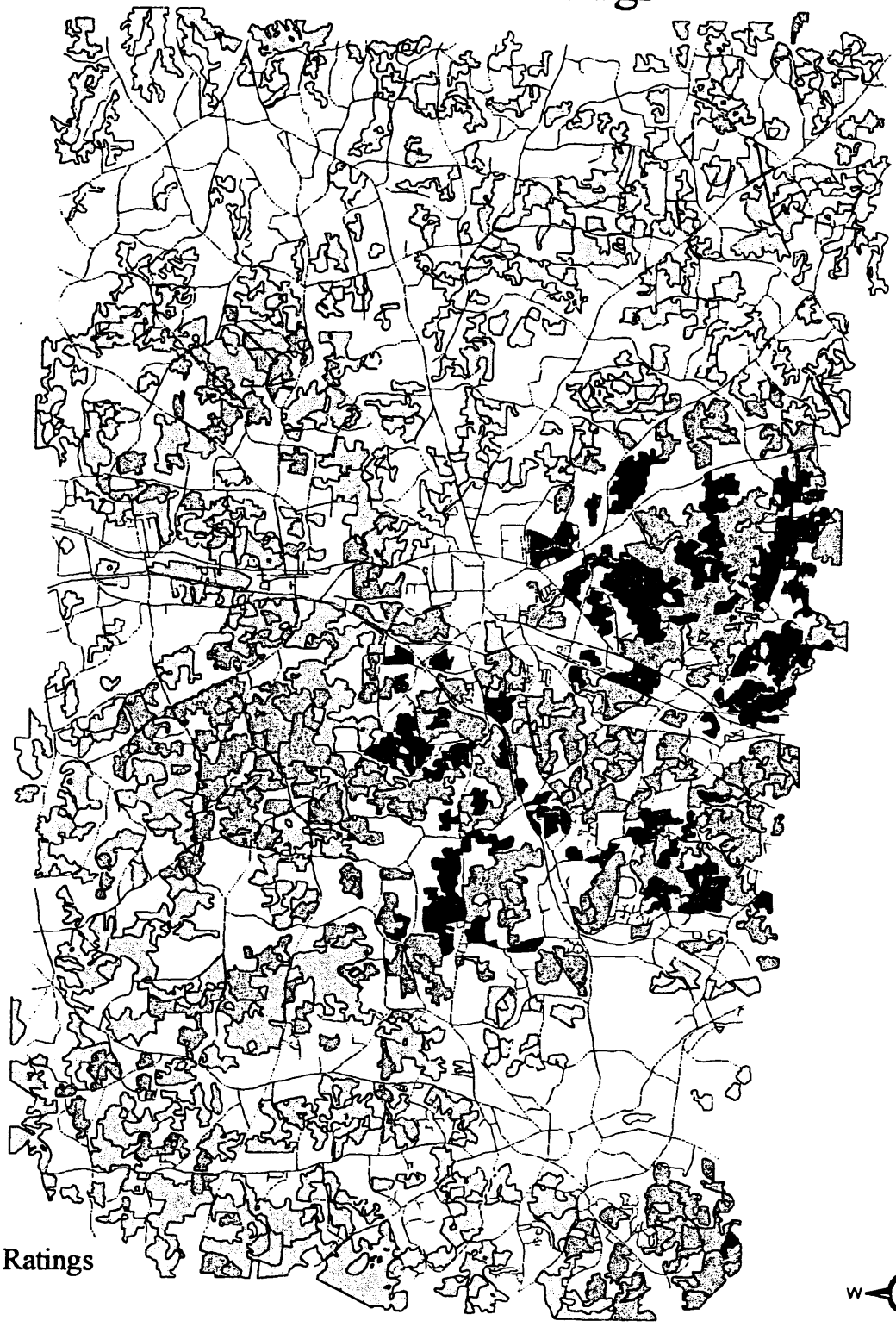
Intrinsic Ratings
- 0 - 999
- 1,000 - 2,999
- 3,000 - 7,999
- 8,000 - 19,999
- 20,000 - 48,260

2 0 2 4 6 8 10 Miles

N W E S

Map 2

Wildlife Ratings for Orange County Forests
(Based on 1988 Aerial Photographs)
Contextual Ratings



Contextual Ratings
- 0 - 9
- 10 - 24
- 25 - 49
- 50 - 99
- 100 - 152

2 0 2 4 6 8 10 Miles

N W E S

Map 3

Wildlife Ratings for Orange County Forests
(Based on 1988 Aerial Photographs)
Total Ratings

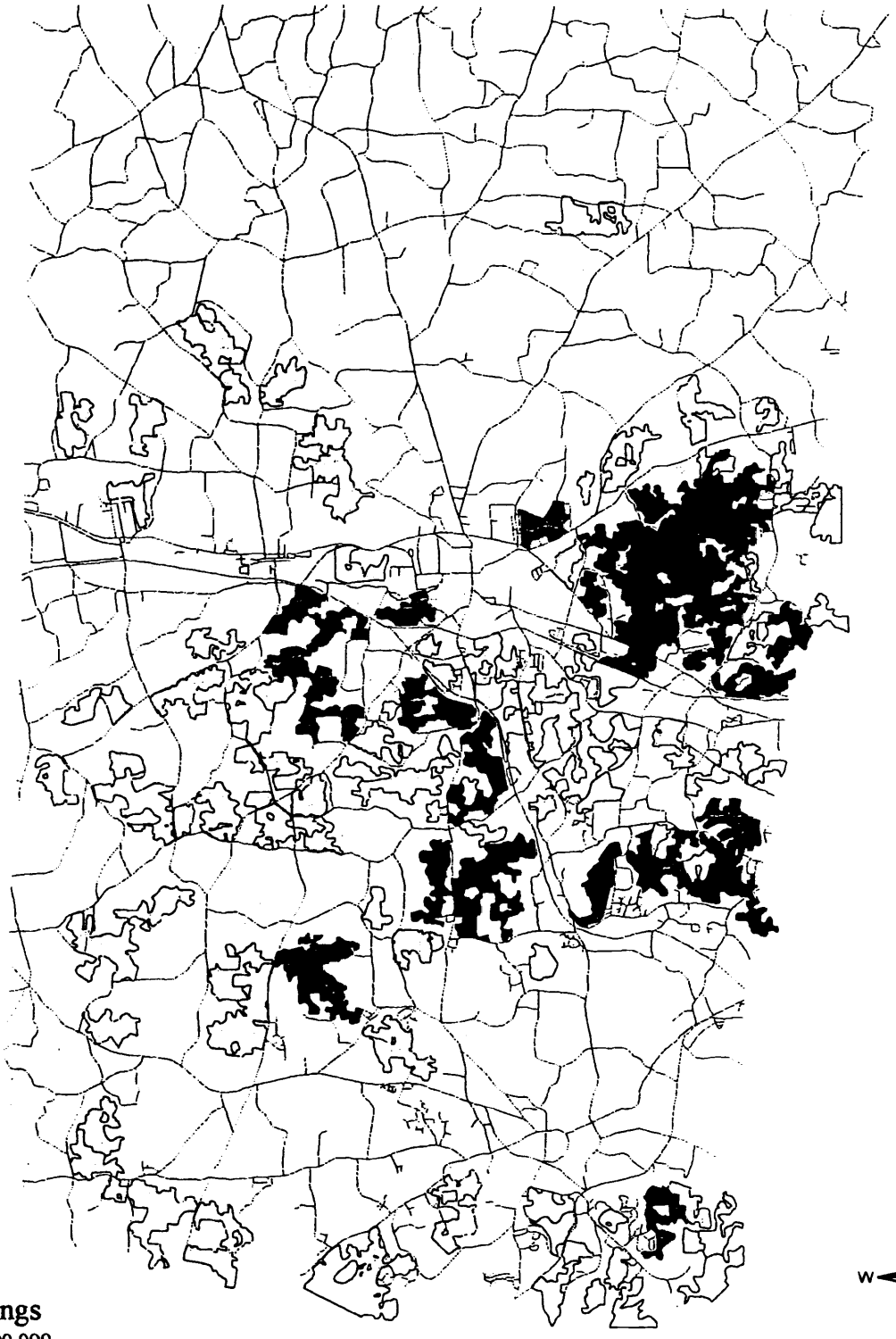
Total Ratings
- 0 - 24,999
- 25,000 - 74,999
- 75,000 - 149,999
- 150,000 - 399,999
- 400,000 - 1,384,523

Scale 1 Inch = 16,000 Feet

Map produced by
Beth Young
Orange County
Environment &
Resource Conservation
Department

Map 4

Wildlife Ratings for Orange County Forests
(Based on 1988 Aerial Photographs)
Areas with the Highest Ratings



Highest Ratings
- 50,000 - 199,999
- 200,000 - 349,999
- 350,000 - 1,384,523

2 0 2 4 6 8 10 Miles

N W E S