Reliability of Avifauna Information in a Computerized Fish and Wildlife Information System

by

Katherine Grace Timothy

Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Fisheries and Wildlife Sciences

APPROVED:

Dr. Dean F. Stauffer, Chairman	Dr. Donald J. Orth
Dr. James D. Fraser	Dr. Robert H. Giles, Jr.

October, 1988

Blacksburg, Virginia

Reliability of Avifauna Information in a Computerized Fish and Wildlife Information System

by

Katherine Grace Timothy

Dr. Dean F. Stauffer, Chairman

Fisheries and Wildlife Sciences

(ABSTRACT)

This study was designed to test the reliability of avifauna information retrieved from Biota of Virginia, BOVA, a computerized fish and wildlife information system developed at Virginia Polytechnic Institute and State University. Reliability was defined as the percent of species that were detected during field surveys that also were listed by BOVA to occur. Six habitat types were selected for study within the Blacksburg Ranger District of the Jefferson National Forest in Southwestern Virginia. These were Mixed (oak-pine) Seedling/Sapling, Mixed Pole, Mixed Mature, Deciduous Pole, Deciduous Mature, and Coniferous Pole. Three stands of each type, each 8-20 hectares in area, were chosen randomly for study. Each stand was surveyed with 12 90-minute survey periods over 2 years. The random-walk technique was used to determine species occurrence. BOVA species lists were determined for comparison with lists of species detected in the field. All species detected in the field and(or) listed by BOVA were placed into at least one status category defined by BOVA (e.g., Federal Migratory, Game, Accidental) or the Virginia Society of Ornithology (e.g., Abundant, Permanent Resident, Transient Breeder).

The reliability test compared field data with BOVA data using an index, K, calculated as the percent of species detected in the field that was listed by BOVA. K values less than 60% were indicative of unreliable BOVA information and values of 60% or higher were indicative of reliable BOVA information. K values among habitat types and status categories were compared by analyses of variance with multiple comparisons. For all habitat types, fewer than 50% of the detected species were listed by BOVA ($K < 50$). However, there were no differences ($\underline{P} > 0.05$) in K among habitats. Species detected in the Mixed Seedling/Sapling habitat type were listed by BOVA least often ($K = 30.1$), and Mixed Pole species were listed most often ($K = 45.9$). BOVA

listed more ($\underline{P} < 0.05$) of the detected Abundant species than species of other tested status categories and fewer ($\underline{P} < 0.05$) detected Rare species.

K values resulting from BOVA species lists retrieved by various BOVA search strategies were compared. These showed that information in BOVA's tested habitat elements (e.g., the land use and land cover element, Land.Use) was more complete and hence, more reliable than BOVA's tested location elements (e.g., the U.S. Forest Service 7.5′ quadrangle element, Quad). Study results indicated that BOVA is unreliable for listing the species detected in the 6 tested habitat types. BOVA may provide unreliable information because needed data are unavailable in the literature, insufficient effort has been spent collecting and entering such data, or data have been gathered or entered in to the database incorrectly. BOVA information may be valuable however, when used in conjunction with other information sources.

Acknowledgements

I would like to thank my advisor, Dean F. Stauffer, for his guidance of my thesis study and all that he taught me over the past 3 years. Thanks to Drs. Orth and Fraser for their insight and assistance. To Dr. Giles, thank you for your adherence to high standards. I would also like to thank the Virginia Department of Game and Inland Fisheries for funding my 2 field seasons of survey effort.

Thanks to and for their knowledge of BOVA's history and idiosyncrasies. For his infinite wisdom of the mainframe system, thanks also to . For their assistance in the field, thamks to , , , , , , , , and . Thanks also to for his help with PC-slide.

I would especially like to thank for her special friendship throughout the last 3 years. Thanks also to (who was too long at the Bay) for her wonderful spirit and friendship.

I thank my parents and siblings for being so fantastic. Finally, I thank my husband who renewed my faith in myself and who fills my life with happiness.

Table of Contents

List of Tables

List of Illustrations

INTRODUCTION

Nationwide, there is a growing awareness of and concern for environmental quality. Concurrently, public demands on natural resources are increasing. To maintain the ecological integrity and vitality of natural resources in areas targeted for habitat modification, it is necessary to inventory the flora and fauna of these areas and determine the potential impacts of habitat alterations on them. These steps are important in contributing to land use decisions and actions based on sound knowledge of the environment.

Habitat inventories long have been a basic tool of wildlife management and over the years have become increasingly important. The Multiple Use - Sustained Yield Act of 1960 (Public Law 86-517) directed the U.S. Forest Service to adopt multiple use objectives for managing the natural resources of the National Forests (Dixon 1981). An increase in comprehensive information about fish and wildlife resources became necessary to facilitate this type of management. Hirsch et al. (1979) outlined the history of additional legislative actions that has stimulated the need for natural resources information. Among these is the National Environmental Policy Act of 1969 (Public Law 91-190), with requirements for environmental assessments and impact statements. The Endangered Species Act of 1973 (Public Law 93-205) emphasized identifying and protecting critical habitat for wildlife. The Forest and Rangeland Renewable Resources Planning Act of 1974 (Public Law 93-378) directed the Secretary of Agriculture to develop and maintain a comprehensive and appropriately detailed inventory of all rangeland and forest resources. These and numerous other legislative developments require information collection, processing, and analysis in planning the future of fish and wildlife resources.

Computerized fish and wildlife information systems (CFWIS) have been developed to help facilitate these data processing activities. A fish and wildlife information system is defined as a database, set, or file that contains various types of information about individual faunal species. The 5 major uses of natural resource information systems (of which a CFWIS is one) are inventory, reporting, planning, management, and policy making (Dangermond and Smith 1981). CFWIS also facilitate: 1) reviewing current knowledge of a species or group of species; 2) investigating or developing species interaction matrices; 3) identifying major gaps in information concerning a particular species or group of species; and, 4) grouping animals according to selected life history or distributional parameters for developing and testing ecological models (Cushwa and Kopf 1984). The advantages of CFWIS include: 1) analyzing large data sets efficiently; 2) reducing the time and cost of processing data; 3) facilitating ecological analysis; and, 4) rapidly testing fish and wildlife models to predict effects of alternative management scenarios (DuBrock et al. 1981). These systems may improve considerations for fish and wildlife in land-use planning and decision-making processes by providing sound species data in an efficient and expedient manner.

In the late 1970's, a task force consisting of U.S. Fish and Wildlife Service personnel established that fish and wildlife information needed in land-use decision making processes was not readily available (Anon. 1981). In 1977, the Office of Biological Services (OBS) and the U.S. Fish and Wildlife Service (FWS) established the Eastern Energy and Land Use Group (later known as the Eastern Energy and Land Use Team, or EELUT, now defunct). One of the activities of this group was to develop, implement, monitor, and evaluate a CFWIS in the United States (Anon. 1981). In cooperation with the FWS, EELUT identified two pilot states, Alabama and West Virginia, to implement and test "Run Wild", a CFWIS developed by the U.S. Forest Service in Arizona and New Mexico (Patton 1978). In 1978, the preliminary conclusions of the pilot projects indicated that Run Wild East was too labor-intensive and too limited to meet user needs (Anon. 1981).

In 1979, EELUT developed a "A Procedure for Describing Fish and Wildlife" (Mason et al. 1979). The objective of the "Procedure" was to develop a format or standardized set of categories and definitions for storing and retrieving wildlife data. Systems based on the "Procedure" format are perceived to be of value in: 1) summarizing fish and wildlife species information in a standard format using standard definitions (Cushwa 1983); 2) storing and retrieving fish and wildlife species data with efficiency; 3) facilitating the process of updating fish and wildlife information (Cushwa 1983); 4) guiding fish and wildlife agencies in land use planning and management; and 5) providing information for use in various recreational and educational arenas.

A "Procedure" system was implemented as a statewide CFWIS in Pennsylvania. It has served as the prototype for information systems in Alabama, Colorado, Illinois, Kansas, Kentucky, Maryland, Missouri, New Jersey, Tennessee, Virginia, Utah, and Wyoming, and also for the Endangered Species Information System (Cushwa and Kopf 1984, J. Waldon pers. commun., R. K. Wajda pers. commun.). In Virginia, the resulting CFWIS is Biota of Virginia, BOVA, a system developed at Virginia Polytechnic Institute and State University to list and document the occurrence of fish and wildlife in forested and unforested areas within the state. BOVA was conceived in 1981 by C.T. Cushwa (then of EELUT), the U.S. Fish and Wildlife Service, and R.H. Giles, Jr., who later became the principal investigator for the BOVA project (Terwilliger and Rasberry 1983). Currently (1988), R. K. Wajda, of the Virginia Department of Game and Inland Fisheries, is the BOVA project manager.

BOVA is a compilation of information about animal species occurring in Virginia. BOVA includes information on 977 animal species and subspecies (Table 1). The "Procedure" format allows data entry for a broad range of species distribution and life history parameters. Each BOVA species profile provides information on status, distribution, life history, and ecological affiliations (Table 2). For these categories, standard coding classifications are used. Data categories with no standard classification system are given codes developed by the FWS. These categories include taxonomy, seasonal occurrence, food habits, environmental associations, and management practices.

Table 1. Categories of species within BOVA.

Category	*N*
Amphibians	73
Reptiles	38
Fish	165
Birds	395
Mammals	110
Marine Mammals	30
Aquatic Crustaceans	19
Aquatic Mollusca	85
Aquatic Insects	6
Terrestrial Insects	49
Other Terrestrial Invertebrates	7
Total	**977**

Table 2. BOVA information categories and codes.

Information Categories:

Complete taxonomic description
Distribution by county, latitude and longitude, 7.5 minute quadrangles, hydrologic units, ecoregions, and potential natural vegetation
Legal status/use in the Commonwealth
Origin of species within the Commonwealth
Population trends, seasonal distribution, and relative abundance
General habitat associations and associations with major land use/land cover classes and wetland types
Food habits by lifestage
Environmental requirements by lifestage and activity
Management activities that potentially benefit or adversely affect the species
Bibliography of citations referencing the information in the species profiles

Selected Information Codes:

Federal Information Processing Standard (FIPS) Codes for Counties **(County)**[1]
U.S.G.S. Quadrangles (7.5') **(Quad)**
U.S.G.S. Office of Water Data Coordination Hydrologic Unit Classification
Bailey's Ecoregion Classification
Kuchler's Potential Natural Vegetation Codes
U.S.F.W.S. Land Use and Land Cover Classification System **(Land.Use)**
U.S.F.W.S. Endangered/Threatened Species List
Society of American Foresters' Forest Cover Types
U.S.F.W.S. Classification of Wetlands and Deep Water Habitats
U.S.F.S. Forest Inventory Size Classes **(Fsize)**
U.S.F.S. Ranger Districts **(Districts)**

[1]Bold type indicates the BOVA element codes used in this study.

BOVA by itself is not a model. It is an information system that contains, among other things, species occurrence data relative to location and habitat characteristics. However, BOVA can be used as a modeling and management tool. This premise is valid only if the information system is technically sound, well-tested, and properly applied (Toth and Baglien 1986). In this study, I assumed that BOVA is a technically sound database. It is also assumed that BOVA applications used in this study were proper.

The information within each of BOVA's species profiles has been gathered from literature sources. To be reliable, this information must be correct. However, it is inevitable that mistakes have been entered into the system. Inaccurate data entries, data omissions, and other potential limitations in the existing information system make it desirable to test BOVA's reliability.

There are numerous criteria by which database information can be evaluated, or tested (Marcot et al. 1983). Some are also appropriate for evaluating information systems. This study was designed to evaluate BOVA information based on the criterion of reliability. I defined reliability as the percent of species detected in a specific location and(or) habitat type that is listed by BOVA to occur in that same location and(or) habitat type. Thus, as used herein, reliability reflects the completeness of the database under certain applications. Testing BOVA serves 2 important purposes: 1) it provides information about BOVA reliability in specific applications, and 2) it supplies data that, if necessary, can be used to improve this reliability (Schamberger and O'Neil 1986).

BOVA can be used as a tool to answer many fisheries and wildlife questions. Using the appropriate commands, BOVA can be used to answer such questions as: What mammals occur in Floyd county? What species in Virginia have a status of Federally Endangered and are adversely affected by clearcutting? What citations were used to reference the habitat requirements of a Virginia threatened fish? This study was designed to test the reliability of the information retrieved from BOVA to answer the question: What bird species occur in each of 6 different habitat types in 3 counties of Southwestern Virginia? Birds were chosen for testing purposes because they are abundant, generally easy to detect and identify, and BOVA's avifauna information was believed to be relatively complete.

Specific objectives of this study were:

1. To determine the reliability of avifauna information within the BOVA elements Quad (U.S. Geological Survey 7.5 minute series quadrangle maps), Districts (U.S. Forest Service District), County (County), Land.Use (land use / land cover), and Fsize (U.S. Forest Service timber inventory size);
2. To evaluate the reliability of BOVA information for use in modeling the effects of habitat alterations on avifauna species richness;
3. To determine the avifauna species richness in 6 different forested habitat types;
4. To determine the influence of field survey duration on species richness estimates.

Knowledge gained through this study may be used to improve the existing information system. With further development, BOVA and similar data base systems in other states may serve as valuable tools for obtaining information that can be used to direct research, improve inventories, and estimate responses of wildlife species to land management actions.

STUDY AREA

The study was conducted on the Blacksburg Ranger District of the Thomas Jefferson National Forest in southwestern Virginia. Six habitat types were chosen within Montgomery, Craig, and Giles counties. These were:

1. Mixed Seedling/Sapling: mixed oak-pine vegetation of seedling/sapling stage (stands with a majority of trees < 12.5 cm in diameter at breast height, dbh) - stands of this type had been clearcut within 7 years prior to the study's initiation;
2. Mixed Pole: mixed oak-pine vegetation of pole stage (a majority of trees with dbh between 15.0 and 30.5 cm);
3. Mixed Mature: mixed oak-pine vegetation of mature stage (a majority of trees with dbh > 30.5 cm);
4. Deciduous Pole: oak vegetation of pole stage;
5. Deciduous Mature: oak vegetation of mature stage;
6. Coniferous Pole: pine vegetation of pole stage (a majority of trees with dbh between 13.0 and 23.0 cm).

Three replicates of each of the 6 habitat types were selected for field surveys. Stands ranged in elevation from 519 m to 976 m and varied in size from 8 to 20 hectares (20 to 50 acres) (Table

3). I chose 9 of the 18 stands from a randomly-ordered list of all 1523 stands within the district. The remaining 9 were chosen from this list with the specification that they were located within 8 km of one of the original 9 stands. This design allowed me to survey 2 stands on any given morning. I surveyed these stands from April to August during 1986 and 1987.

The Deciduous land use types of Pole and Mature forest size were dominated by red (Quercus rubra), white (Q. alba), and chestnut oaks (Q. prinus). Other important canopy species were tulip poplar (Liriodendron tulipifera), and hickories (Carya spp.). Subdominant trees were red maple (Acer rubrum) and black gum (Nyssa sylvatica). Dominant understory trees were flowering dogwood (Cornus florida), rosebay rhododendron (Rhododendron maximum), witch hazel (Hamamelis virginiana), and striped maple (A. pensylvanicum).

The Coniferous habitat was dominated by Virginia (Pinus virginiana), pitch (P. rigida), white (P. strobus), and table-mountain pines (P. pungens). Deciduous species, including white oak, red maple, and sugar maple (A. saccharum), were subdominant. Dominant understory trees included black cherry (Prunus serotina) and flowering dogwood.

The Mixed (oak-pine) land use types of Mature and Pole forest sizes, were dominated by table-mountain, pitch, white, and Virginia pines; red, white, and chestnut oaks; tulip poplar; and hickories. Chestnut oak, red oak, hickories, and white pine were also subdominants, along with hemlock (Tsuga canadensis) and red maple. Species that consistently dominated the understory were sourwood (Oxydendrum arboreum) and flowering dogwood.

The habitat type of Mixed land use and Seedling/Sapling forest size was not dominated by any one species. Common species were white, red, and chestnut oak species, red maple, flowering dogwood, Castanea spp., witch hazel, black locust (Robinia pseudoacacia), and sourwood.

The 3 stands of the Mixed Seedling/Sapling habitat type had more ($P < 0.05$) trees of the S-size category (3.0-8.0 cm dbh) than any other habitat type (Table 4). Deciduous Pole had more ($P < 0.05$) and Mixed Seedling/Sapling had fewer ($P < 0.05$) A-size trees (8.1-15.0 cm dbh) than the other types. Generally, the 3 Pole habitats had more B- (15.1-23.0 cm dbh) and C- (23.1-38.0 cm dbh) size trees than the Mixed Seedling/Sapling or Mature habitats. The Mixed Seedling/Sapling had fewest of these size trees. The Deciduous Mature habitat type had more D- (38.1-53.0 cm dbh),

Table 3. Location and characteristics of sites surveyed for avifauna during April to July, 1986 and 1987 in Blacksburg Ranger District, Jefferson National Forest, Virginia.

Site	Habitat Type	County	USGS Quadrangle	Latitude	Longitude	Elevation(m)	Aspect
1	mixed seedling/sapling	Montgomery	McDonalds Mill	37° 20′ 30″	80° 20′ 30″	610	south
2	mixed seedling/sapling	Montgomery	Newport	37° 15′ 30″	80° 29′ 30″	640	northeast
3	mixed seedling/sapling	Giles	Interior	37° 25′ 00″	80° 32′ 30″	940	south
4	mixed pole	Montgomery	Newport	37° 19′ 00″	80° 24′ 00″	610	south
5	mixed pole	Montgomery	Radford North	37° 14′ 30″	80° 31′ 30″	660	west
6	mixed pole	Montgomery	McDonalds Mill	37° 20′ 00″	80° 21′ 00″	580	south
7	mixed mature	Montgomery	McDonalds Mill	37° 19′ 30″	80° 19′ 30″	580	northwest
8	mixed mature	Montgomery	Newport/Eggleston	37° 15′ 30″	80° 30′ 00″	625	north
9	mixed mature	Craig	Craig Springs	37° 23′ 30″	80° 15′ 30″	610	southeast
10	deciduous pole	Montgomery	McDonalds Mill	37° 20′ 00″	80° 21′ 30″	580	south
11	deciduous pole	Giles	Interior	37° 25′ 30″	80° 33′ 30″	820	southeast
12	deciduous pole	Giles	Interior	37° 25′ 00″	80° 34′ 00″	760	north
13	deciduous mature	Montgomery	McDonalds Mill	37° 19′ 30″	80° 19′ 30″	560	north
14	deciduous mature	Craig	Craig Springs	37° 23′ 30″	80° 16′ 30″	730	southeast
15	deciduous mature	Giles	Interior	37° 25′ 00″	80° 32′ 30″	940	northeast
16	coniferous pole	Montgomery	Newport	37° 17′ 30″	80° 26′ 30″	650	southeast
17	coniferous pole	Montgomery	McDonalds Mill	37° 20′ 00″	80° 19′ 30″	550	north
18	coniferous pole	Montgomery	Radford North	37° 14′ 30″	80° 31′ 30″	660	southwest

Table 4. Summary of habitat measurements for 3 sites in each of 6 habitat types sampled in Southwest Virginia during 1986 and 1987.

Variable	Coniferous Pole		Mixed Pole		Deciduous Mature		Mixed Mature		Mixed Seedling/Sapling		Deciduous Pole		*Significance* Hab[1]/Site(Hab)
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Tree Density/0.04 ha													
S(3.0-8.0 cm)[2]	36.7	2.5(B)[3]	21.2	3.0(C)	32.6	4.9(BC)	35.0	5.7(B)	65.9	9.1(A)	26.1	3.3(BC)	0.0001 / 0.0029
A(8.1-15.0 cm)	12.3	2.2(B)	14.2	2.0(B)	11.2	1.2(B)	9.2	1.3(B)	1.6	0.6(C)	20.6	2.6(A)	0.0001 / 0.3497
B(15.1-23.0 cm)	8.8	1.5(A)	8.1	0.9(AB)	3.9	0.6(BC)	3.9	0.7(BC)	0.1	0.1(C)	11.7	3.8(A)	0.0001 / 0.0733
C(23.1-38.0 cm)	6.1	1.2(AB)	6.0	0.9(AB)	4.4	0.5(B)	4.9	0.6(B)	0.1	0.1(C)	7.7	1.4(A)	0.0001 / 0.2986
D(38.1-53.0 cm)	0.2	0.1(BC)	1.4	0.4(A)	1.8	0.5(A)	1.6	0.4(A)	0.0	0.0(C)	1.2	0.5(AB)	0.0029 / 0.1001
E(53.1-69.0 cm)	0.0	0.0(B)	0.0	0.0(B)	1.2	0.4(A)	0.1	0.1(B)	0.0	0.0(B)	0.2	0.2(B)	0.0001 / 0.0001
F(69.1-84.0 cm)	0.0	0.0(B)	0.0	0.0(B)	0.3	0.2(A)	0.0	0.0(B)	0.0	0.0(B)	0.0	0.0(B)	0.0027 / 0.1695
Canopy Height (m)													
Minimum	4.9	0.7(BCD)	3.4	0.3(CD)	7.3	1.3(BC)	8.9	0.9(AB)	1.2	0.1(D)	12.0	3.0(A)	0.0001 / 0.5861
Midcanopy	6.6	0.9(D)	4.7	0.2(E)	9.6	1.6(C)	12.9	0.7(A)	2.1	0.2(F)	11.0	1.2(B)	0.0001 / 0.0001
Maximum	8.8	1.3(C)	6.7	0.3(D)	12.6	1.9(B)	18.1	1.1(A)	3.4	0.3(E)	13.5	1.3(B)	0.0001 / 0.0001
% Canopy Cover	85.7	4.7(A)	88.4	2.3(A)	92.7	2.1(A)	86.2	2.3(A)	52.9	11.6(B)	94.8	0.9(A)	0.0001 / 0.8625
# Shrubs	28.3	2.7(B)	18.2	6.0(BC)	23.7	5.7(BC)	16.6	2.4(BC)	99.6	11.0(A)	11.3	3.4(C)	0.0001 / 0.0011
% Ground Cover	23.2	6.4(A)	30.7	7.5(A)	16.4	3.7(A)	30.5	8.8(A)	27.1	5.4(A)	26.1	9.7(A)	0.6545 / 0.0815
% Litter Cover	98.8	0.8(AB)	100.0	0.0(A)	89.4	6.6(B)	89.9	7.4(B)	95.3	2.4(AB)	99.4	0.6(A)	0.0894 / 0.0025

[1]Significance of differences among habitats / significance of differences among sites within habitats.
[2]Tree diameter at breast height size classes.
[3]Values with different letters within a row differ ($P < 0.05$).

E- (53.1-69.0 cm dbh), and F- (69.1-84.0 cm dbh) size trees than any of the 5 other habitat types (Table 4).

Minimum canopy height did not differ among any of the types except Deciduous Pole where it was significantly higher than in the other types (Table 4). The midcanopy height for the Deciduous Pole type was higher than that for the Deciduous Mature type. The other midcanopy heights differed from one another ($\underline{P} < 0.05$) as would be expected. Generally, maximum canopy height among the 6 habitats differed as expected (from $\bar{x} = 3.4$ m for the Mixed Seedling/Sapling habitat, to $\bar{x} = 18.1$ m for the Mixed Mature habitat). However, Deciduous Pole and Deciduous Mature heights were not detectably different ($\underline{P} < 0.05$) . Percent canopy cover was similar for all types except Mixed Seedling/Sapling, which was lower ($\underline{P} < 0.05$).

The number of shrubs was similar for each type except Mixed Seedling/Sapling, which had the most shrubs, nearly ten times the number as Deciduous Pole, which had the fewest. Percent ground cover did not differ among types ($\underline{P} > 0.05$). Litter cover was greater than 89% for all of the habitat types. Generally, Deciduous and Mixed Pole types had a greater percentage of litter cover than did Deciduous and Mixed Mature types. Mixed Seedling/Sapling and Coniferous Pole types were intermediate in their amount of litter cover (Table 4). Stands varied in slope, aspect, distance to water, and topography. However, I considered the 18 stands representative of the habitat types selected.

METHODS

The methods used in this study were based on the assumptions that: 1) forest stands within the Blacksburg Ranger District of the Jefferson National Forest are classified correctly (e.g., that what the U.S. Forest Service staff classifies as a Deciduous Pole stand actually is that type); 2) bird species identifications are unbiased and independent; 3) differences in detected species composition are a result of underlying habitat characteristics; 4) data collected during the springs of 1986 and 1987 are representative of long term avian habitat use patterns; 5) stands selected are representative of the 6 chosen habitat types; 6) analytical methods that help express and understand the association between sampled stands and avian occurrence are ecologically informative (Liverman 1986); and, 7) indices used to test BOVA information reflect the reliability of that information, as defined herein.

Avifauna Surveys

BOVA provides species presence/absence, not species abundance data. To test this information, I conducted field surveys to obtain a list of bird species occurring in each stand and habitat type. Many methods used to survey birds, such as sample plot, line transect, and variable circular plot, are appropriate when bird abundance information is desired (Edwards et al. 1981). However, to test BOVA's presence/absence data, the species richness of each stand and habitat type was desired. Species richness, S, is the number of species per unit area (Hair 1980). It has also been defined as $S/\sqrt{N}$ (S = number of species; N = total number of individuals) and (S-1)/logN (Odum 1971). These latter 2 definitions require total counts of birds which are not provided by BOVA species lists. However, S alone is easily determined from BOVA species lists, as well as from the field species lists. In this study, Hair's definition of species richness was used, with one hectare being the "unit area".

A random walk method was selected and used to detect S for each study stand. Random-walk techniques only recently have been used for species surveys. The rapid visual technique (RVT) was devised for aquatic environments to generate species occurrence data over time (Kimmel 1985). This method requires no specific transect line and allows divers to survey the aquatic environment, allowing their expertise to direct them. The assumption of this method is that divers can survey greater areas with the RVT than with more conventional survey methods, and are thus exposed to more species over time (Kimmel 1985). A random-walk method also has been used to survey the occurrence of threatened and endangered plants (Goff et al. 1982). With this technique, the examiner can be sensitive to habitat variation or unique areas that may yield species not yet recorded.

The random-walk survey technique is similar to the commonly used line transect (without distance estimates) survey technique (Verner 1985). The random-walk transect follows a meandering course through a particular area that changes with each visit to the area. In contrast, the line transect is run along a set, usually straight course. The line transect technique is an efficient method for quickly generating species lists (Verner 1985). A list is the record of all species detected in an area and is most useful when standardized by effort and area sampled. It provides information at the nominal scale (recording only presence or absence) useful in determining biogeographic, species richness, and frequency of occurrence information (Verner 1985). The random walk technique has these same attributes and was chosen over the line transect technique because it also permitted adjustment to local conditions and to bird behavior.

Each random walk survey lasted 90 minutes, during which time the stand was continually traversed and microhabitats within the area surveyed for birds. Distances covered differed by stand and day, but averaged approximately 800 meters. Occasionally during the walk, the surveyor remained stationary for 5 to 10 minutes to detect more secretive bird species. The survey was divided into 9 sections of 10 minutes each and each species' presence was recorded by the period during which it was first detected. Two stands were visited on mornings during which there was no rain, fog, or winds greater than 16 km/hr. Each stand was visited 10 times in the morning and twice at dusk over the 2 field seasons (6 times/year), April through July in 1986 and 1987.

The number of species detected in a stand was divided by the area, in hectares, of that stand to determine the number of species per unit area, S. Species richness among habitat types was compared with one-way analysis of variance (treatment being habitat type) with multiple comparisons.

Recording avian species occurrence by the 10-minute period during which species first were detected allowed the construction of curves depicting perceived species richness as a function of time spent in each stand. I fit curves with field data using the Michaelis-Menten model (Spain 1982). This model was developed in the early 1900's to describe the phenomenon of enzyme saturation and has been used to describe many other biological systems. In this study it was used to predict the maximum number of bird species, MS, that could be observed at each habitat type given unlimited survey effort and the time needed, T, to observe half of this number. With these curves I compared patterns of bird detectability among different habitat types and predicted detected avifaunal richness for a certain survey duration.

I used the Michaelis-Menten model at 2 scales, micro and macro. At the micro level, curves were developed based on species detection during 9 10-minute intervals of 1 stand survey. This modeled the expected number of detected species within one stand over a relatively short period.

At the macro level, curves were developed from species detected over the 12 surveys of each stand. This allowed the analysis of the increase in detected species richness as the number of surveys increased. The number of species detected over time was hypothesized to follow a typical asymptotic curve for both micro and macro scales.

BOVA Assessment

This study tested the reliability of the information in and the suitability of 5 BOVA categories, or elements. These are Quad, Districts, County, Land.Use, and Fsize. Quad contains information on species distribution within U.S. Geological Survey 7.5′ series quadrangle maps. The Districts element holds information on distribution by U.S. Forest Service Districts. County contains information on distribution within county. The Land.Use element holds information on species associated with the specific land use and land cover characteristics described by Anderson et al. (1978). Information on species associations with U.S. Forest Service timber inventory size (e.g., Mature, Pole, Seedling/Sapling) is in the element Fsize.

Species lists were retrieved in the following manner from the mainframe version of BOVA during August 1987. The FIND command initiates all BOVA searches, or queries. For instance, "FIND Category Birds and Districts Blacksburg" summons a BOVA record of all the birds in the Blacksburg Ranger District of Southwestern Virginia. The search command "FIND Category Birds and Districts Blacksburg and County Montgomery and Land.Use Coniferous and Fsize Pole" results in a record of all of the birds listed within the BOVA database that are expected to be in the Coniferous Pole forests of the Blacksburg Ranger District of Montgomery County.

Numerous element combinations can be used to retrieve information from BOVA. In this study, species lists were generated using 5 combinations of location and habitat elements to give insight to each element's reliability in determining expected species occurrence. The Districts-County-Land.Use-Fsize combination was used because it seemed the most direct and logical way to generate species lists of birds occurring within certain habitat types and counties of Southwestern Virginia. The element Quad was then added to this search (i.e., Districts-County-Quad-Land.Use-Fsize) to determine its effect on the resulting species lists. The Districts-County-Land.Use combination generated species lists for specific forest vegetation types, regardless of forest age or structure. The element combination Districts-County-Fsize generated lists of birds for a certain forest structure, regardless of forest vegetation type. The last element combination used was Land.Use-Fsize. This combination produced species lists from the habitat elements Land.Use and Fsize without the location elements Districts, County, and Quad. Lists of expected species were generated for each of the 18 study stands using each of these 5 element combinations.

BOVA species lists were scrutinized to eliminate species deemed unreasonable for use in testing BOVA reliability [e.g., lapland longspur (Calcarius lapponicus)]. The survey method used in this study was inappropriate for the detection of raptors. The habitat types were inappropriate for detecting waterfowl. Therefore, these species were excluded from lists used to evaluate BOVA reliability.

Through the techniques used in this study, data made available for the assessment of BOVA reliability are:

A = number of species detected in the field and listed by BOVA;

B = number of species detected in the field but not listed by BOVA;

C = number of species not detected in the field but listed by BOVA;

D = number of species listed by BOVA (A + C);

E = number of species detected in the field (A + B).

Reliability, as defined in this study, is the percent of species detected in a specific location and(or) habitat type that is listed by BOVA to occur in that same location and(or) habitat type.

Therefore, reliability is 100(A/E) which is represented by K [K = 100(A/E)]. Jaccard's Index, J, 100[A/(A + B + C)] (Pielou 1984) and the percent of species listed by BOVA that were detected in the field, H, 100(A/D) also can be calculated from the information obtained through the techniques used in this study. Both indices, J and H, consider the number of birds listed by BOVA that were not detected in the field. However, lack of field detection does not necessarily mean that the species were not present. Many factors could prevent species detection. These include the season or time of day during which surveying was conducted, survey duration, the secretive behavior of some species, and my level of expertise. One of the assumptions of this study is that index values reflect the reliability of BOVA information. For reasons outlined above, the Jaccard's index and the H index do not meet this assumption (i.e., do not add information useful in determining BOVA information reliability) and therefore will not be used in assessing BOVA reliability. Values for these 2 indices appear in Appendices 1 and 2.

K is a reasonable index of BOVA information reliability because birds detected in the field were identified with absolute certainty or not recorded and the K index does not violate any of the assumptions of this study. The K value yields a direct index of database completeness. Any value less than 100% indicates that species were detected that were not expected; i.e., that the BOVA database is incomplete for the particular species and habitat.

Species on expected and detected lists were placed into status categories to evaluate the reliability of BOVA information as a function of species characteristics. Four of the categories used were of the BOVA element Status: Federal Migratory (FM); Nongame-Protected (NG-P); Game (G); and Accidental (A-). Additional, non-BOVA status categories were used to group expected and detected species. These categories, used by the Virginia Society of Ornithology (VSO), were Breeder (B), Permanent Resident (P), Transient (T), Transient Breeder (TB), Abundant (A+), and Rare (R) (Larner 1979). All status categories (both BOVA and VSO) are not necessarily mutually exclusive. Categories may overlap one another, be nested within each other, or be discrete. For example, a Rare species may also be a Permanent Resident and a Nongame-Protected species. K was calculated for each combination of search strategy and status category for each habitat and stand.

The K index is sensitive to sample size; the influence of additional species can cause large shifts in K values calculated from small samples. Variations are much smaller for indices calculated from larger samples. Thus, the stability of the index increases with an increase in sample size. Each of the 10 status categories include varying numbers of species. For instance, the Nongame-Protected, Federal Migratory, and Common categories encompass a relatively large number of species. The Game, Rare, and Accidental categories encompass relatively few species. It can be expected that birds of status categories containing few species will be listed by BOVA and detected in the field less frequently than species of larger categories. Because of the influence of sample size on the K index, there is a higher confidence level associated with index values calculated from larger samples (i.e., for larger status categories).

K values were used in analyses of variance with Least Significant Difference comparisons to assess differences in completeness of BOVA element descriptors in listing field-detected species. The descriptors Seedling/Sapling, Pole, and Mature of the Fsize element and Coniferous, Deciduous, and Mixed of the Land.Use element were tested.

The findings of a thorough BOVA assessment should indicate the extent to which BOVA information can be used to model the effects of habitat manipulation on avifauna occurrence. By comparing the avifaunal species richness data of the Pole and Mature habitat types with the that of the Seedling/Sapling habitat type, the influence of clearcutting on the number of bird species can be inferred, and the reliability of BOVA information for modeling before-after scenarios assessed. BOVA's reliability in giving accurate avifauna occurrence information in forested and clearcut areas reflects a limit of the system's reliability in modeling the effects of clearcutting forested areas on bird populations.

BOVA was downloaded from the mainframe to the personal computer and recently (July, 1987), has been made available for use. This version of BOVA is referred to as PC-BOVA. Its structure and use is identical to that of the mainframe BOVA, yet PC-BOVA is more up-to-date in its information. To determine the reliability of its information, species lists were retrieved from PC-BOVA for each of the 6 habitat types using the standard Districts-County-Land.Use-Fsize search strategy. The species listed to occur in each type were compared with the species detected in each type and the percent of field-detected species that were listed by PC-BOVA was calculated. K, for these comparisons, was determined for each habitat type regardless of species status category. This analysis provided an evaluation of the increase in completeness of PC-BOVA over the previous mainframe version.

Habitat Analysis

A transect was placed randomly in each of the 18 stands. Along the transect, 3 points were chosen randomly. These points served as centers for 0.04 ha (11.3 m radius) circular plots. Within each plot, the following habitat characteristics were measured using techniques described by Noon (1981):

1. Dbh of all live saplings, live trees, and snags, recorded by species in the diameter categories of 3.0-8.0 cm, 8.1-15.0 cm, 15.1-23.0 cm, 23.1-38.0 cm, 38.1-53.0 cm, 53.1-69.0 cm, 69.1-84.0 cm, and > 84.0 cm.
2. Shrub density at breast height, estimated along 2 perpendicular belt transects approximately 160 cm wide, by the number of woody stems < 3 cm dbh intersected by the body and outstretched arms.
3. Percent tree canopy cover measured using a spherical densiometer.
4. Maximum, minimum, and medium canopy height (m) using a clinometer.
5. Maximum slope (%) estimated using a clinometer.

Means of the habitat characteristics measured at each survey stand were calculated for each stand and also for each habitat type. The means were analyzed using analysis of variance and multiple comparisons to assess the extent of within- and between-habitat type variability. Results of these analyses were used to describe the general vegetational characteristics of individual stands and habitat types, and to determine the consistency of these characteristics among stands of the same seral stage and forest cover type (Table 2).

The coefficient of variation, CV (Sokal and Rohlf 1969), was calculated to determine the variability of each habitat parameter measured. The vegetative structure of a habitat is important in determining bird species richness (James 1971, Anderson and Shugart 1974, Willson 1974, Roth 1976) and structural variation in forest stands yields variation in the species that occur within them. Detected species richness and K values were correlated with CV across stands to determine the relationship between habitat variation and these indices. An increase in habitat variation should lead to an increase in species richness and a consequent increase in detected species. Since species lists obtained through a specific BOVA query are fixed, and thus expected S is fixed, it was hypothesized that as habitat variation increases, detected S increases, and K values decline.

RESULTS

Overall K by Habitat

There was a tendency for the K index to be higher in 1987 than in 1986 (Tables 5 and 6). This trend of a higher index value in 1987 held for all habitat types except the Deciduous Mature type. In this type, a slightly higher K value for 1986 indicated that more of the birds detected during the 1986 field season were listed by BOVA than those detected during the 1987 field season. It is possible that K values from 1987 field data higher than those from 1986 field data were a result of the surveyor's biases in 1987 toward detecting BOVA-listed species not detected in 1986.

BOVA species lists were matched against composite 1986/1987 detected species lists to allow a thorough assessment of the completeness of the BOVA database. The BOVA species lists generated for Mixed Seedling/Sapling habitats were the least complete at only 30.1% (Table 7). Even the most complete list, that for Mixed Pole, included fewer than half the species detected (Table 7). The next highest values were held by Deciduous Pole, Deciduous Mature, Mixed Mature, and Coniferous Pole, respectively. Though the Mixed Seedling/Sapling type had an overall K value of 30.1%, 9.7 percentage points lower than type with the next highest K (Deciduous Mature with a K value of 39.8), the difference was not significant ($\underline{P} > 0.05$). This lack of

Table 5.Percent of species detected in the field also listed to occur by BOVA, K, for status categories in various habitat types using 1986 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat[2] based upon a composite species list from the 3 sites in the habitat).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						% of Detected Listed, K[3]						
Fed. Migr.	45[4]	24.3 / 28.9	37	48.5 / 40.5	37	42.0 / 37.8	33	43.9 / 36.4	37	44.3 / 40.5	37	33.8/32.4
Ngame-Prot.	38	27.2 / 31.6	31	56.2 / 48.4	31	47.5 / 45.2	29	51.4 / 41.4	31	51.4 / 48.4	30	38.9/40.0
Game	2	16.7 / 50.0	1	0.0 / 0.0	2	0.0 / 0.0	1	0.0 / 0.0	3	16.7 / 33.3	2	66.7/50.0
Breeder	5	26.1 / 20.0	4	55.6 / 50.0	5	55.6 / 40.0	4	72.2 / 50.0	4	66.7 / 50.0	4	19.4/25.0
Perm. Res.	14	35.4 / 42.9	16	57.4 / 50.0	14	51.7 / 42.9	11	64.3 / 45.5	14	62.3 / 42.9	15	56.1/40.0
Transient	2	0.0 / 0.0	3	0.0 / 0.0	2	33.3 / 50.0	0	0.0 / 0.0	3	50.0 / 66.7	3	0.0/0.0
Trans./Breed.	28	18.9 / 21.4	18	36.2 / 27.8	20	27.6 / 25.0	19	26.5 / 26.3	21	28.6 / 28.6	17	31.3/35.3
Abundant	8	55.6 / 62.5	8	100.0 / 75.0	7	73.9 / 71.4	5	100.0 / 100.0	6	69.5 / 66.7	8	83.8/75.0
Accidental	2	0.0 / 0.0	2	0.0 / 0.0	2	16.7 / 50.0	2	0.0 / 0.0	3	50.0 / 66.7	8	83.8/75.0
Common	22	16.9 / 18.2	22	43.8 / 36.4	22	41.6 / 31.8	18	41.3 / 33.3	21	50.0 / 33.3	20	26.5/25.0
Rare	16	17.0 / 25.0	9	14.3 / 11.1	10	0.0 / 10.0	9	15.9 / 11.1	12	9.3 / 25.0	8	22.2/25.0
Overall	49	22.9 / 26.5	41	44.4 / 36.6	41	39.1 / 34.1	34	43.3 / 35.3	42	43.2 / 38.1	39	35.5/33.3

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of species detected in the field and listed by BOVA(A) / [A + the number of species detected but not listed by BOVA(B)]).
[4]Number of species detected in the field.

Table 6. Percent of species detected in the field also listed to occur by BOVA, K, for status categories in various habitat types using 1987 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat[2] based upon a composite species list from the 3 sites in the habitat).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						% of Detected Listed, K[3]						
Fed. Migr.	47[4]	32.3 / 31.9	36	50.1 / 47.2	41	45.2 / 43.9	38	52.2 / 44.7	39	45.4 / 38.5	34	49.5/35.3
Ngame.-Prot.	41	36.9 / 36.6	29	57.5 / 58.6	34	44.4 / 52.9	31	61.3 / 51.6	34	51.4 / 44.1	28	48.2/42.9
Game	3	16.7 / 33.3	2	16.7 / 50.0	2	0.0 / 0.0	2	16.7 / 50.0	1	33.3 / 100.0	1	33.3/100.0
Breeder	4	33.3 / 25.0	3	66.7 / 66.7	4	61.1 / 50.0	3	83.3 / 66.7	4	55.6 / 50.0	3	38.9/33.3
Perm. Res.	19	48.3 / 47.4	16	70.9 / 62.5	16	50.1 / 50.0	13	63.2 / 53.9	12	66.7 / 58.3	14	60.1/50.0
Transient	4	33.3 / 25.0	1	0.0 / 0.0	2	16.7 / 50.0	6	33.3 / 50.0	3	66.7 / 66.7	1	0.0/0.0
Trans./Breed.	26	21.3 / 19.2	21	27.7 / 28.6	22	24.2 / 31.8	19	31.2 / 26.3	25	17.0 / 20.0	19	27.0/26.3
Abundant	9	69.5 / 66.7	7	87.9 / 85.7	8	73.8 / 75.0	6	100.0 / 100.0	5	88.9 / 80.0	7	85.7/85.7
Accidental	2	33.3 / 50.0	1	0.0 / 0.0	2	16.7 / 50.0	6	33.3 / 50.0	3	38.9 / 66.7	1	0.0/0.0
Common	28	22.0 / 25.0	22	47.3 / 40.9	23	42.5 / 39.1	18	51.1 / 38.9	23	48.6 / 34.8	20	34.2/25.0
Rare	14	15.6 / 14.3	11	23.6 / 27.3	11	3.3 / 18.2	11	4.2 / 9.1	13	4.8 / 15.4	9	23.3/22.2
Overall	53	30.9 / 30.2	41	47.3 / 43.9	44	43.0 / 40.9	41	48.9 / 41.5	44	42.1 / 36.4	37	47.9/35.1

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of species detected in the field and listed by BOVA(A) / [A + the number of species detected but not listed by BOVA(B)]).
[4]Number of species detected in the field.

Table 7. Percent of species detected in the field also listed to occur by BOVA, K, for status categories in various habitat types using 1986/1987 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat[2] based upon a composite species list from the 3 sites in the habitat).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						% of Detected Listed, K[3]						
Fed. Migr.	57[4]	31.8 / 31.6	44	49.6 / 38.6	47	42.5 / 40.4	46	46.9 / 41.3	46	44.1 / 34.8	44	40.0/29.6
Ngame.-Prot.	48	36.4 / 35.4	36	57.2 / 47.2	39	50.3 / 48.7	39	54.3 / 46.2	38	48.9 / 42.1	35	47.5/37.1
Game	4	27.8 / 50.0	2	16.7 / 50.0	2	0.0 / 0.0	2	16.7 / 50.0	3	50.0 / 33.3	2	66.7/50.0
Breeder	5	30.0 / 20.0	4	61.1 / 50.0	5	52.2 / 40.0	5	66.7 / 40.0	5	55.6 / 40.0	4	30.5/25.0
Perm. Res.	21	46.5 / 47.6	18	68.6 / 55.6	18	54.5 / 44.4	14	61.1 / 50.0	14	61.4 / 50.0	17	56.7/41.2
Transient	5	16.7 / 20.0	4	0.0 / 0.0	4	44.4 / 50.0	6	33.3 / 50.0	4	72.2 / 50.0	4	0.0/0.0
Trans./Breed.	33	22.3 / 21.2	24	30.6 / 25.0	25	25.9 / 28.0	24	30.0 / 29.2	28	21.6 / 21.4	22	33.2/27.3
Abundant	9	67.2 / 66.7	8	89.7 / 75.0	8	74.3 / 75.0	7	100.0 / 100.0	6	73.9 / 66.7	8	86.9/75.0
Accidental	4	16.7 / 25.0	3	0.0 / 0.0	3	33.3 / 66.7	6	27.8 / 50.0	4	50.0 / 50.0	4	0.0/0.0
Common	31	25.3 / 22.6	24	45.9 / 37.5	27	42.6 / 33.3	21	45.2 / 33.3	24	45.3 / 33.3	23	34.6/26.1
Rare	19	15.5 / 26.3	15	22.0 / 20.0	14	2.4 / 14.3	15	14.7 / 13.3	17	10.3 / 17.7	12	21.7/16.7
Overall	64	30.1 / 29.7	50	45.9 / 36.0	52	39.7 / 36.5	49	44.7 / 38.8	51	39.8 / 33.3	47	40.0/29.8

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of species detected in the field and listed by BOVA(A) / [A + the number of species detected but not listed by BOVA(B)]).
[4]Number of species detected in the field.

significance is not surprising because of the small number of replicates (n = 3) for each habitat type. An increased number of replicates would increase the probability that a difference of this magnitude (9.7 percentage points) would be significant ($\underline{P} < 0.05$).

I determined from the composite species lists of detected birds that a total of 64 species was seen in the 3 Mixed Seedling/Sapling stands. Only 19 of these were listed by BOVA. In the Mixed Pole and Mixed Mature habitat types, 18 of 50 and 15 of 42 species were listed respectively. In the Deciduous habitats, 19 of 49 species were listed in the Pole and 17 of 51 species were listed in the Mature forest sizes. Fourteen of 47 detected species were listed in the Coniferous Pole habitat type. These numbers clearly demonstrate the degree of BOVA's information deficiency at this scale of application.

K Values for Individual Status Categories Among Habitat Types

Overall K is the percent of the total number of detected species listed by BOVA regardless of status category. To assess the influence of avian classification groups, K was calculated by habitat for individual status categories (Table 7). The Federal Migratory, Nongame-Protected, Permanent Resident, and Common categories had indices similar to the Overall K trends (Table 7). K values for these 4 categories were calculated from large sample sizes, thus providing high confidence in these results. For these categories, Mixed Seedling/Sapling had the lowest index values (25.3 to 46.5) and Mixed Pole the highest (45.9 to 68.6). K for the Federal Migratory and Common categories was lower ($\underline{P} < 0.05$) in Mixed Seedling/Sapling than all other habitats except Coniferous Pole (Table 8). K values were also lowest ($\underline{P} < 0.05$) in Mixed Seedling/Sapling for the Nongame-Protected category (Table 8).

Table 8. Status categories with different index values ($P < 0.05$) among habitat types[1] for 1986-1987 data.

Category	Mixed Seedling/Sapling	Mixed Pole	Mixed Mature	Deciduous Pole	Deciduous Mature	Coniferous Pole
			% of Detected Listed, K			
Fed. Migr.	31.8(B)[2]	49.6(A)	42.5(A)	46.9(A)	44.1(A)	40.0(AB)
Ngame.-Prot.	36.4(B)	57.2(A)	50.3(A)	54.3(A)	48.9(A)	47.5(A)
Abundant	67.2(C)	89.7(A)	74.3(BC)	100.0(A)	73.9(BC)	86.9(AB)
Common	25.3(B)	45.9(A)	42.6(A)	45.2(A)	45.3(A)	34.6(AB)

[1]BOVA lists obtained by the element combination District-County-Land.Use-Fsize.
[2] Values with different letters within a row differ ($P < 0.05$).

The Abundant category had K values higher ($\underline{P} < 0.05$) than all other categories regardless of habitat type (Table 9). Detected species of the status category Abundant were listed more often ($\underline{P} < 0.05$) than species in any other category (Table 9, K = 82.0). Accidental and Rare species were listed by BOVA the least ($\underline{P} < 0.05$), having mean K values of 21.3 and 14.4, respectively. The mean K ranged from 27.3 to 58.1 for the other status categories. It is evident that the BOVA database has more complete information for Abundant species than for Rare species. This is not surprising because data on common species tend to be more abundant and complete than data on less common species.

Differences in K Within Habitat Type for Status Category

For each habitat type, the percent of birds detected in the field that were listed by BOVA, K, varied with status category in a pattern similar to that for all habitats combined (Table 7 and Table 9). In the Mixed Seedling/Sapling habitat, K was highest for Abundant and Permanent Resident species and was lowest for Rare, Accidental, and Transient species. In the Mixed Pole habitat, K was highest for Abundant, Permanent Resident, and Breeder birds while it was lowest for Accidental, Transient, and Game birds. K was highest for birds detected of the Abundant, Breeder, and Permanent Resident categories in Mixed Mature habitats. Also in this habitat, Rare and Game species had the lowest K. In Deciduous Pole habitats, Abundant and Breeder species had the highest K, Game and Rare the lowest. Permanent Resident and Abundant species had the highest K values in the Deciduous Mature habitat type. Rare species had the lowest K. In Coniferous Pole habitats, Abundant and Game species had the highest K values and Accidental and Transient species had the lowest.

For each of the 12 status categories, I correlated the number of species listed by BOVA with the number of species detected in the field across all habitat types. Correlations were positive, but

Table 9. Mean K (percent detected species listed by BOVA) for each status category (N = 18 sites) for combined 1986 and 1987 data.

Category	K
Abundant	82.0(A)[1]
Permanent Resident	58.1(B)
Breeder	49.4(BC)
Nongame-Protected	49.1(BC)
Federal Migratory	42.5(C)
Common	39.8(CD)
Game	29.6(DE)
Transient	27.8(DE)
Transient Breeder	27.3(DE)
Accidental	21.3(EF)
Rare	14.4(F)

[1]Values with different letters differ ($P < 0.05$).

none were significant ($\underline{P} > 0.05$; r range = .21 to .73; df = 4). This indicates that BOVA information, when used to generate the species richness of an area, may not correlate well with the detected species richness of that area.

K for species of the category Breeder ranged from 30.1 in Mixed Seedling/Sapling to 66.7 in Deciduous Pole with a mean K of 49.4. These figures are lower than those found by Raphael and Marcot (1986) in a field validation of the Forest Service's Wildlife-Habitat-Relationships (WHR) model. The WHR model listed 97% of the breeding species that were detected in their western mature, old-growth habitat (K = 97.0). In their grass-forb habitat, 65% of the detected breeding species were listed (K = 65.0) by WHR. The WHR model's capability of listing detected grass-forb species is comparable to the BOVA model's capability to list detected Deciduous Pole species. However, the capability of the WHR model to list detected species in the mature, old-growth habitat exceeded BOVA's capability in any of the 6 habitat types tested. These differences between WHR and BOVA may be a function, in part, of differences in scale used in the 2 studies. Stands used for the WHR model validation varied in size from 5 to 455 ha, while stands used in this study varied in size from 8 to 20 ha. It is also notable that for each study, the early successional habitats had the least complete data.

No species that are threatened or endangered, either in a federal or state classification, were detected over the 2 season study period. However, the peregrine falcon (Falco peregrinus) was listed by BOVA to occur potentially in Montgomery county in the Mixed Seedling/Sapling, Mixed Pole, and Mixed Mature habitat types.

The range of K (0-100) was divided subjectively into 2 categories to rate the reliability of BOVA listings. If BOVA listed fewer than 60% of the bird species that were detected in a single stand or in an overall habitat type (K < 60), its performance was ranked unreliable. If BOVA listed 60% or more of the detected bird species, its performance was ranked reliable and thus at least minimally acceptable for application. Sixty percent was used to separate reliable from unreliable BOVA information as it indicated that the majority of field-detected species were BOVA-listed. This is a very conservative cutoff point. However, for a preliminary test of BOVA information, it is appropriate. Future tests of the BOVA system should use standards no lower than 60%.

Within each habitat type, the reliability of the Status categories (e.g., Federal Migratory, Nongame-Protected, etc.) varied. For all of the habitat types, BOVA provided reliable information ($K \geq 60$) when listing Abundant species. BOVA information was unreliable ($K < 60$) in all of the tested habitat types for Rare species. This agrees with the mean K across all 6 habitat types (Table 9) and indicates that a deficiency in information of Rare species occurs within each of the habitat types studied. Of the 66 habitat type-by-status category assessments, 12 (18%) proved to have reliable BOVA listings.

Species Detected and Not Expected

A total of 109 species was listed by BOVA and(or) detected in the field (Table 10). Twenty-three species were detected in at least 5 of the the 6 habitat types but were listed by BOVA to occur in only one type (Table 11). Twelve of these were detected in all 6 habitat types and were not expected in any. According to the Virginia Society of Ornithology's Annotated Checklist (Larner 1979), 10 of the 12 were Common species and 2 were Rare. One of the 2 species listed as Rare by the VSO was the ruffed grouse, a Game species.

These 23 species represent information gaps in the BOVA database. The gaps may occur because needed information does not exist in the published literature. Information gaps could also occur because published information has not been researched thoroughly, the information has not been entered into the system accurately, BOVA or VSO categories may be inexact or inappropriate, the system has not been used properly, or the computer is not operating properly.

Table 10. List of field-detected and BOVA-listed species.

Species	Categories[1]	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
BLACKBIRD, RED-WINGED (*Agelaius phoeniceus*)	FM/NG-P/P2/C	D[2]		D			
BLUEBIRD, EASTERN (*Sialia sialis*)	FM/NG-P/P2/C	D L[3]	L	L	L	L	L
BOBOLINK (*Dolichonyx oryzivorus*)	FM/TB/CR	D					
BOBWHITE, NORTHERN (*Colinus virginianus*)	G/P2/A+	L	L				
BUNTING, INDIGO (*Passerina cyanea*)	FM/NG-P/B/A+	D L	D L	D L	D L	D L	D L
CARDINAL, NORTHERN (*Cardinalis cardinalis*)	FM/NG-P/P2/A+	D L	D L	D L	D L	L	D L
CATBIRD, GRAY (*Dumetella carolinensis*)	FM/TB/C	D	D	D		D	D
CHAT, YELLOW-BREASTED (*Icteria virens*)	FM/NG-P/TB/C	D					
CHICKADEE, BLACK-CAPPED (*Parus atricapillus*)	FM/P2/C	D			D	D	
CHICKADEE, CAROLINA (*Parus carolinensis*)	FM/P2/C	D	D	D	D	D	D
COWBIRD, BROWN-HEADED (*Molothrus ater*)	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
CREEPER, BROWN (*Certhia familiaris*)	FM/TB/A-		D	D	D	D	D
CROSSBILL, RED (*Loxia curvirostra*)	FM/NG-P/T/R		L	L	L	L	L
CROW, AMERICAN (*Corvus brachyrhynchos*)	FM/NG-P/P2/A+	D L	D L	D L	D L	D L	D L
CUCKOO, BLACK-BILLED (*Coccyzus erythropthalmus*)	FM/NG-P/TB/R	D	D	D		D	D
CUCKOO, YELLOW-BILLED (*Coccyzus americanus*)	FM/NG-P/TB/C	D	D	D	D	D	D
DOVE, MOURNING (*Zenaida macroura*)	FM/G/B/A+	D		D		D	
DUCK, AMERICAN BLACK (*Anas rubripes*)	FM/G/TB/R		L	L	L	L	L
DUCK, WOOD (*Aix sponsa*)	FM/G/TB/R		L	L	L	L	
*[4] FALCON, PEREGRINE (*Falco peregrinus*)	FE/FM/NG-P/T/R	L	L	L			
FINCH, HOUSE (*Carpodacus mexicanus*)	FM/NG-P/T/A-	L	L	L			

Table 10. (cont.).

Species	Categories	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
FINCH, PURPLE (*Carpodacus purpureus*)	FM/NG-P/TB/A-	L	L	L	L	L	L
FLICKER, NORTHERN (*Colaptes Auratus*)	FM/NG-P/P2/C	D L	L	L	L	L	L
FLYCATCHER, ACADIAN (*Empidonax virescens*)	FM/NG-P/TB/C	D	D L	D L	L	D L	D L
FLYCATCHER, GREAT CRESTED (*Myiarchus crinitus*)	FM/NG-P/TB/C	D	D L	D L	D L	D L	D L
FLYCATCHER, OLIVE-SIDED (*Nuttallornis borealis*)	FM/NG-P/T/R	D					
GNATCATCHER, BLUE-GRAY (*Polioptila caerulea*)	FM/NG-P/TB/C	D	D	D	D	D	D
GOLDFINCH, AMERICAN (*Carduelis tristis*)	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
GRACKLE, COMMON (*Quiscalus quiscula*)	FM/NG-P/P2/A+	L	L	L	L	L	L
GROSBEAK, EVENING (*Hesperiphona vespertina*)	FM/NG-P/T/A-		L	L	L	L	L
GROSBEAK, ROSE-BREASTED (*Pheucticus ludovicianus*)	FM/NG-P/TB/R	D	D	D	D	D	
GROUSE, RUFFED (*Bonasa umbellus*)	FM/G/P2/R	D	D	D	D	D	D
* HAWK, BROAD-WINGED (*Buteo platypterus*)	FM/NG-P/TB/CR		L	L	L	L	
* HAWK, RED-SHOULDERED (*Buteo lineatus*)	FM/NG-P/TB/R	L	L	L	L	L	L
* HAWK, RED-TAILED (*Buteo jamaicensis*)	FM/NG-P/P2/C		L	L	L	L	L
* HAWK, SHARP-SHINNED (*Accipiter striatus*)	FM/P2/R		L	L	L	L	L
HERON, GREEN-BACKED (*Butorides striatus*)	FM/NG-P/TB/R	L	L	L	L	L	L
HUMMINGBIRD, RUBY-THROATED (*Archilochus colubris*)	FM/NG-P/TB/R	D L	D L	L	D L	D L	D L
JAY, BLUE (*Cyanocitta cristata*)	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
JUNCO, DARK-EYED (*Junco hyemalis*)	FM/NG-P/T/A-	D L	L	D L	D L	D L	L
* KESTREL, AMERICAN (*Falco sparverius*)	FM/NG-P/TB/CR		L	L		L	L
KINGFISHER, BELTED (*Megaceryle alcyon*)	FM/NG-P/P2/R	L	D L	D L	L	L	L

Table 10. (cont.).

Species	Categories	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
KINGLET, RUBY-CROWNED (*Regulus calendula*)	FM/NG-P/T/A-	D					
MOCKINGBIRD, NORTHERN (*Mimus polyglottus*)	FM/NG-P/P2/A+	L	L	L	L	L	L
NIGHT-HERON, YELLOW-CROWNED (*Nyctanassa violacea*)	FM/NG-P/TB/R			D			
NUTHATCH, WHITE-BREASTED (*Sitta carolinensis*)	FM/P2/C		D	D	D	D	D
ORIOLE, NORTHERN (*Icterus galbula*)	FM/TB/C					D	
OVENBIRD (*Seiurus aurocapillus*)	FM/NG-P/TB/C	D	D	D	D	D	D
* OWL, BARRED (*Stix varia*)	FM/NG-P/P2/C	L	L	L	L	L	L
* OWL, GREAT HORNED (*Bubo virginianus*)	FM/NG-P/P2/C		L		L		L
* OWL, LONG-EARED (*Asio otus*)	FM/NG-P/P2/R	L	L	L	L	L	L
* OWL, NORTHERN SAW-WHET (*Aegolius acadius*)	FM/NG-P/TB/R	L	L	L	L	L	L
PEWEE, EASTERN WOOD (*Contopus virens*)	FM/NG-P/TB/C	D	D	D	D	D	D
PHOEBE, EASTERN (*Sayornis phoebe*)	FM/T/C	D		D	D	D	D
RAVEN, COMMON (*Corvus corax*)	FM/NG-P/P2/R	D L	D L	L			D
REDSTART, AMERICAN (*Setophaga ruticilla*)	FM/NG-P/TB/R	D		D	D	D	
ROBIN, AMERICAN (*Turdus migratorius*)	FM/NG-P/TB/A+	D L	D L	D L	D L	L	D L
* SCREECH-OWL, EASTERN (*Otus asio*)	FM/NG-P/P2/C	L	L	L	L	L	L
SANDPIPER, SPOTTED (*Actitis macularia*)	FM/NG-P/TB/R		D				D
SAPSUCKER, YELLOW-BELLIED (*Sphyrapicus varius*)	FM/NG-P/TB/A-				D	D	
SISKIN, PINE (*Carduelis pinus*)	FM/NG-P/T/A-	L	L	L			L
SORA (*Porzana carolina*)	FM/G/T/R		D				
SPARROW, CHIPPING (*Spizella passerina*)	FM/NG-P/TB/C	D					

Table 10. (cont.).

Species	Categories	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
SPARROW, FIELD (*Spizella pusilla*)	FM/NG-P/P2/A+	D					D
SPARROW, WHITE-THROATED (*Zonotrichia albicollis*)	FM/NG-P/T/A-	D					D
TANAGER, SCARLET (*Piranga olivacea*)	FM/NG-P/B/C	D	D L	D L	D L	D L	D
THRASHER, BROWN (*Toxostoma rufum*)	FM/TB/C	D					
THRUSH, HERMIT (*Catharus guttatus*)	FM/T/R						D
THRUSH, SWAINSON'S (*Catharus ustulatus*)	FM/T/A-		D		D		D
THRUSH, WOOD (*Hylocichla mustelina*)	FM/NG-P/TB/A+	D L	D L	D L	D L	D L	D L
TITMOUSE, TUFTED (*Parus bicolor*)	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D
TOWHEE, RUFOUS-SIDED (*Pipilo erythrophthalmus*)	FM/NG-P/TB/A+	D	D	D	D L	D	D
TURKEY, WILD (*Meleagris gallopavo*)	G/P2/R	D L	D L	L	L	D L	D L
VEERY (*Catharus fuscescens*)	FM/NG-P/TB/R	D				D	
VIREO, RED-EYED (*Vireo olivaceus*)	FM/NG-P/TB/A+	D L	D L	D L	D L	D L	D L
VIREO, SOLITARY (*Vireo solitarius*)	FM/NG-P/TB/R	D L	D	D L	D	D L	D
VIREO, WHITE-EYED (*Vireo griseus*)	FM/NG-P/P2/R	D		D			
VIREO, YELLOW-THROATED (*Vireo flavifrons*)	FM/NG-P/TB/R						D
* VULTURE, BLACK (*Coragyps atratus*)	FM/NG-P/P2/R	L	L	L	L	L	L
* VULTURE, TURKEY (*Cathartes aura*)	FM/NG-P/P2/C	L	L	L	L	L	L
WARBLER, BAY-BREASTED (*Dendroica castanea*)	FM/NG-P/T/R		D	D	D	D	
WARBLER, BLACK-AND-WHITE (*Mniotilta varia*)	FM/NG-P/TB/C	D	D	D	D	D	D
WARBLER, BLACK-THROATED-BLUE (*Dendroica ulescens*)	FM/NG-P/TB/R	D	D		D	D	
WARBLER, BLACK-THROATED-GREEN (*Dendroica virens*)	FM/NG-P/TB/C	D	D			D	

Table 10. (cont.).

Species	Categories	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
WARBLER, BLACKBURNIAN (*Dendroica fuscu*)	FM/NG-P/TB/R	D	D	D	D	D	
WARBLER, BLACKPOLL (*Dendroica striata*)	FM/NG-P/T/A-	L	L	L	D L	L	L
WARBLER, CANADA (*Wilsonia canadensis*)	FM/NG-P/TB/R				D		
WARBLER, CERULEAN (*Dendroica cerulea*)	FM/NG-P/B/R				D	D	
WARBLER, CHESTNUT-SIDED (*Dendroica pensylvanica*)	FM/NG-P/TB/R	D			D	D	
WARBLER, HOODED (*Wilsonia citrina*)	FM/NG-P/TB/C	D	D	D	D	D	D
WARBLER, MAGNOLIA (*Dendroica magnolia*)	FM/NG-P/TB/A-	D					D
WARBLER, NORTHERN PARULA (*Parula americana*)	FM/NG-P/TB/C		D	D	D	D	D
WARBLER, PINE (*Dendroica pinus*)	FM/NG-P/TB/C	D	D	D	D	D	D
WARBLER, PRAIRIE (*Dendroica discolor*)	FM/NG-P/TB/C	D L	L	D L	L	L	L
WARBLER, WORM-EATING (*Helmitheros vermivoris*)	FM/NG-P/B/R	D	D	D	D	D	D
WARBLER, YELLOW (*Dendroica petechia*)	FM/NG-P/TB/C	L	L		L		L
WARBLER, YELLOW-RUMPED (*Dendroica coronata*)	FM/NG-P/T/A-	L	L	D L	D L	D L	L
WARBLER, YELLOW-THROATED (*Dendroica dominica*)	FM/NG-P/TB/R	L	D L	L	L	L	L
WATERTHRUSH, LOUISIANA (*Seiurus motacilla*)	FM/NG-P/TB/R	D	D	D		D	
WAXWING, CEDAR (*Bombycilla cedrorum*)	FM/NG-P/P2/R	D		D	D	D	D
WHIP-POOR-WILL (*Caprimulgus vociferus*)	FM/NG-P/B/C	D	D	D	D		D
WOODCOCK, AMERICAN (*Philohela minor*)	FM/G/TB/R	D L	L	L	D L	L	
WOODPECKER, DOWNY (*Picoides pubescens*)	FM/NG-P/P2/C	D	D L	D L	D L	D L	D L
WOODPECKER, HAIRY (*Picoides villosus*)	FM/NG-P/P2/R	D	D	D	D	D	D
WOODPECKER, PILEATED (*Dryocopus pileatus*)	FM/NG-P/P2/C	D	D	D	D	D	D

Table 10. (cont.).

Species	Categories	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
WOODPECKER, RED-BELLIED (*Melanerpes carolinus*)	FM/NG-P/P2/C		D	D			
WREN, CAROLINA (*Thryothorus ludovicianus*)	FM/P2/C	D		D			D L
WREN, HOUSE (*Troglodytes aedon*)	FM/NG-P/TB/C	L	L	L	L	L	
YELLOWTHROAT, COMMON (*Geothlypis trichas*)	FM/NG-P/TB/C	D		D			

[1] FM: Federal Migratory; NG-P: Nongame-Protected; T: Transient; TB: Transient/Breeder; B: Breeder; C: Common; R: Rare; P2: Permanent Resident; A+: Abundant; A-: Accidental; G: Game; FE: Federally Endangered.
[2] Species detected in the field.
[3] Species listed by BOVA using the element combination: Districts-County-Land.Use-Fsize.
[4] Survey technique inappropriate for detecting these species.

Table 11. Species detected in ≥5 habitat types and listed[1] in ≤1 type.

Species	Categories[2]	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
CATBIRD, GRAY	FM/TB/C	D[3]	D	D		D	D
*[4] CHICKADEE, CAROLINA	FM/P2/C	D	D	D	D	D	D
CREEPER, BROWN	FM/TB/A-		D	D	D	D	D
CUCKOO, BLACK-BILLED	FM/NG-P/TB/R	D	D	D		D	D
* CUCKOO, YELLOW-BILLED	FM/NG-1/TB/C	D	D	D	D	D	D
* GNATCATCHER, BLUE-GRAY	FM/NG-P/TB/C	D	D	D	D	D	D
GROSBEAK, ROSE-BREASTED	FM/NG-P/TB/R	D	D	D	D	D	
* GROUSE, RUFFED	FM/G/P2/R	D	D	D	D	D	D
NUTHATCH, WHITE-BREASTED	FM/P2/C		D	D	D	D	D
* OVENBIRD	FM/NG-P/TB/C	D	D	D	D	D	D
* PEWEE, EASTERN WOOD	FM/NG-P/TB/C	D	D	D	D	D	D
PHOEBE, EASTERN	FM/T/C	D		D	D	D	D
TOWHEE, RUFOUS-SIDED	FM/NG-P/TB/A+	D	D	D	D L[5]	D	D
* WARBLER, BLACK-AND-WHITE	FM/NG-P/TB/C	D	D	D	D	D	D
WARBLER, BLACKBURNIAN	FM/NG-P/TB/R	D	D	D	D	D	
* WARBLER, HOODED	FM/NG-P/TB/C	D	D	D	D	D	D
WARBLER, NORTHERN PARULA	FM/NG-P/TB/C		D	D	D	D	D
* WARBLER, PINE	FM/NG-P/TB/C	D	D	D	D	D	D
* WARBLER, WORM-EATING	FM/NG-P/B/R	D	D	D	D	D	D
WAXWING, CEDAR	FM/NG-P/P2/R	D		D	D	D	D
WHIP-POOR-WILL	FM/NG-P/B/C	D	D	D	D		D
* WOODPECKER, HAIRY	FM/NG-P/P2/R	D	D	D	D	D	D
* WOODPECKER, PILEATED	FM/NG-P/P2/C	D	D	D	D	D	D

[1]Species listed by BOVA using the element combination Disctricts-County-Land.Use-Fsize.
[2]FM: Federal Migratory; NG-P: Nongame-Protected; T: Transient; TB: Transient/Breeder; B: Breeder; C: Common; R: Rare; P2: Permanent Resident; A+: Abundant; A-: Accidental; G: Game; FE: Federally Endangered.
[3]D represents detected.
[4]These species detected in all 6 habitat types yet not listed in any.
[5]L represents listed by BOVA.

Species Expected and Not Detected

Twenty-one species were listed by BOVA to occur in at least 5 of the 6 habitat types and generally not detected in any (Table 12). Ten of these were raptors and one was a duck. The random-walk survey method was not appropriate for detecting the presence of raptors. Also, the stands selected were not associated with still bodies of water, making it unreasonable to expect the detection of waterfowl. Therefore, raptors and waterfowl will not be included in the discussion of species expected yet not detected. The 11 remaining species (Table 12) do not reveal a flaw in BOVA information because species may actually be present yet not detected because of biases in survey technique.

Hypothetically, any of the 11 species could occur in all 6 habitat types. However, for 1 of these, the green heron, this is highly unlikely unless a marshy area is accessible. The detection of the eastern bluebird, common flicker, common grackle, northern mockingbird, and house wren in habitats other than Mixed Seedling/Sapling also seems improbable because they generally occur in open country, towns, and roadsides (Petersen 1980). Another species, the red crossbill, normally occurs only in conifer forests (Peterson 1980). It is reasonable that the remaining 4 species, the purple finch, evening grosbeak, blackpole warbler, and yellow-throated warbler, were listed in at least 5 of the 6 surveyed habitat types.

Table 12. Species listed[1] in ≥5 habitat types and detected in ≤1 type.

	Species	Categories[2]	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
	BLUEBIRD, EASTERN	FM/NG-P/P2/C	D[3] L[4]	L	L	L	L	L
*[5]	CROSSBILL, RED	FM/NG-P/T/R		L	L	L	L	L
	DUCK, AMERICAN BLACK	FM/G/TB/R		L	L	L	L	L
	FINCH, PURPLE	FM/NG-P/TB/A-	L	L	L	L	L	L
	FLICKER, NORTHERN	FM/NG-P/P2/C	D L	L	L	L	L	L
	GRACKLE, COMMON	FM/NG-P/P2/A+	L	L	L	L	L	L
	GROSBEAK, EVENING	FM/NG-P/T/A-		L	L	L	L	L
*	HAWK, RED-SHOULDERED	FM/NG-P/TB/R	L	L	L	L	L	L
*	HAWK, RED-TAILED	FM/NG-P/P2/C		L	L	L	L	L
*	HAWK, SHARP-SHINNED	FM/P2/R		L	L	L	L	L
	HERON, GREEN	FM/NG-P/TB/R	L	L	L	L	L	L
	MOCKINGBIRD, NORTHERN	FM/NG-P/P2/A+	L	L	L	L	L	L
*	OWL, BARRED	FM/NG-P/P2/C	L	L	L	L	L	L
*	OWL, LONG-EARED	FM/NG-P/P2/R	L	L	L	L	L	L
*	OWL, NORTHERN SAW-WHET	FM/NG-P/TB/R	L	L	L	L	L	L
*	SCREECH-OWL, EASTERN	FM/NG-P/P2/C	L	L	L	L	L	L
*	VULTURE, BLACK	FM/NG-P/P2/R	L	L	L	L	L	L
*	VULTURE, TURKEY	FM/NG-P/P2/C	L	L	L	L	L	L
	WARBLER, BLACKPOLL	FM/NG-P/T/A-	L	L	L	D L	L	L
	WARBLER, YELLOW-THROATED	FM/NG-P/TB/R	L	D L	L	L	L	L
	WREN, HOUSE	FM/NG-P/TB/C	L	L	L	L	L	

[1]Species listed by BOVA using the element combination Disctricts-County-Land.Use-Fsize.
[2]FM: Federal Migratory; NG-P: Nongame-Protected; T: Transient; TB: Transient/Breeder; B: Breeder; C: Common; R: Rare; P2: Permanent Resident; A+: Abundant; A-: Accidental; G: Game; FE: Federally Endangered.
[3]D represents detected.
[4]L represents listed by BOVA.
[5]Survey technique inappropriate for the detection of these species.

Expected and Detected

Thirteen species were listed in at least 5 habitat types and also were detected in at least 5 types (Table 13). Each of these species was a Common or Abundant species except the ruby-throated hummingbird which was listed in the Rare category. BOVA's information was reliable for each of these species.

Alternative Search Strategies

Alternative BOVA search strategies resulted in quite different K values (Table 14). Of the 5 search approaches evaluated, the strategy of Land.Use-Fsize generated BOVA species lists that contained more ($\underline{P} < 0.05$) of the detected species than any of the other search strategies, thus giving higher K values. The Districts-County-Land.Use strategy yielded the next highest K values. The Fsize search strategy (Districts-County-Fsize) and the "normal" search strategy (Districts-County-Land.Use-Fsize) yielded similar K values in all but the Coniferous Pole habitat type. The Quad search strategy however, yielded lower ($\underline{P} < 0.05$) K values in every habitat type over all status categories (Table 14). Avifauna information in this BOVA element is very incomplete (R. K. Wajda, pers. commun.). This condition is not surprising because bird watchers often record sitings by county, not Quad. Another factor that contributes to the paucity of information in the Quad element is the insufficient manner in which an important data source was used. Much of BOVA's avifauna information was retrieved from Bird - Habitat Associations on

Table 13. Species detected in $\geq$5 habitat types and listed[1] in $\geq$5 types.

Species	Categories[2]	Mix s/s	Mix pole	Mix mat	Dec pole	Dec mat	Con pole
BUNTING, INDIGO	FM/NG-P/B/A+	D[3] L[4]	D L	D L	D L	D L	D L
CARDINAL, NORTHERN	FM/NG-P/P2/A+	D L	D L	D L	D L	L	D L
COWBIRD, BROWN-HEADED	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
CROW, AMERICAN	FM/NG-P/P2/A+	D L	D L	D L	D L	D L	D L
FLYCATCHER, GREAT CRESTED	FM/NG-P/TB/C	D	D L	D L	D L	D L	D L
GOLDFINCH, AMERICAN	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
HUMMINGBIRD, RUBY-THROATED	FM/NG-P/TB/R	D L	D L	L	D L	D L	D L
JAY, BLUE	FM/NG-P/P2/C	D L	D L	D L	D L	D L	D L
ROBIN, AMERICAN	FM/NG-P/TB/A+	D L	D L	D L	D L	L	D L
THRUSH, WOOD	FM/NG-P/TB/A+	D L	D L	D L	D L	D L	D L
VIREO, RED-EYED	FM/NG-P/TB/A+	D L	D L	D L	D L	D L	D L

[1]Species listed by BOVA using the element combination Disctricts-County-Land.Use-Fsize.
[2]FM: Federal Migratory; NG-P: Nongame-Protected; T: Transient; TB: Transient/Breeder; B: Breeder; C: Common; R: Rare; P2: Permanent Resident; A+: Abundant; A-: Accidental; G: Game; FE: Federally Endangered.
[3]D represents detected in the field.
[4]L represents listed by BOVA.

Table 14. A comparison of K (percent detected species listed by BOVA) for different BOVA search strategies using 1986-1987 data.

	Mixed Seedling/Sapling					Mixed Pole				
Status	L[1]	F[2]	L/F[3]	Q[4]	H[5]	L	F	L/F	Q	H
Fed. Migr.	43.1(AB)[5]	34.0(B)	31.8(B)	5.0(C)	51.2(A)	52.8(B)	51.5(B)	49.6(B)	14.0(C)	78.2(A)
Ngame.-Prot	46.2(AB)	38.7(BC)	36.4(C)	5.8(D)	52.4(A)	61.0(B)	59.4(B)	57.2(B)	16.3(C)	81.0(A)
Game	88.9(B)	27.8(B)	27.8(B)	0.0(B)	38.9(A)	16.7(A)	16.7(A)	16.7(A)	0.0(A)	0.0(A)
Breeder	65.0(A)	30.0(B)	21.7(B)	0.0(C)	21.7(B)	61.1(A)	61.1(A)	61.1(A)	30.5(B)	69.5(A)
Perm. Res.	52.4(B)	47.4(B)	46.5(B)	10.9(C)	71.7(A)	68.6(B)	68.6(B)	68.6(B)	7.9(C)	87.0(A)
Transient	16.7(A)	16.7(A)	16.7(A)	0.0(A)	33.3(A)	0.0(A)	0.0(A)	0.0(A)	0.0(A)	0.0(A)
Trans./Breed	31.0(B)	27.9(B)	22.3(B)	2.8(C)	42.8(A)	36.7(B)	33.9(B)	30.6(BC)	13.9(C)	72.8(A)
Abundant	81.8(A)	85.5(A)	67.2(B)	0.0(C)	67.2(B)	89.7(A)	100.0(A)	89.7(A)	0.0(B)	89.7(A)
Accidental	16.7(A)	16.7(A)	16.7(A)	0.0(A)	50.0(A)	0.0(B)	0.0(B)	0.0(B)	0.0(B)	83.3(A)
Common	40.6(A)	22.9(B)	25.3(B)	6.2(C)	43.7(A)	52.7(B)	47.3(B)	45.9(B)	21.7(C)	79.0(A)
Rare	15.5(B)	15.5(B)	15.5(B)	6.7(B)	42.4(A)	22.0(B)	22.0(B)	22.0(B)	4.2(C)	57.1(A)
Overall	40.5(AB)	32.2(BC)	30.1(C)	4.7(D)	48.8(A)	48.9(B)	47.7(B)	45.9(B)	12.7(C)	74.7(A)

Table 14. (cont.).

	Mixed Mature					Deciduous Pole				
Status	L	F	L/F	Q	H	L	F	L/F	Q	H
Fed. Migr.	47.2(B)	42.5(B)	42.5(B)	14.5(C)	75.1(A)	50.2(B)	46.9(B)	46.9(B)	9.8(C)	81.6(A)
Ngame.-Prot	53.7(B)	50.3(B)	50.3(B)	17.3(C)	75.6(A)	58.1(B)	54.3(B)	54.3(B)	11.6(C)	83.6(A)
Game	50.0(A)	0.0(A)	0.0(A)	0.0(A)	50.0(A)	16.7(AB)	16.7(AB)	16.7(AB)	0.0(B)	66.7(A)
Breeder	67.2(A)	52.2(A)	52.2(A)	32.8(B)	58.9(A)	66.7(A)	66.7(A)	66.7(A)	33.3(A)	75.0(A)
Perm. Res.	54.5(B)	54.5(B)	54.5(B)	9.6(C)	91.1(A)	61.1(B)	61.1(B)	61.1(B)	9.2(C)	90.8(A)
Transient	44.4(A)	44.4(A)	44.4(A)	0.0(A)	44.4(A)	33.3(A)	33.3(A)	33.3(A)	0.0(A)	41.7(A)
Trans./Breed	31.3(B)	25.9(C)	25.9(C)	13.4(D)	64.1(A)	36.4(B)	30.0(B)	30.0(B)	6.4(C)	79.6(A)
Abundant	83.8(A)	74.3(B)	74.3(B)	0.0(C)	74.3(B)	100.0(A)	100.0(A)	100.0(A)	0.0(B)	100.0(A)
Accidental	33.3(AB)	33.3(AB)	33.3(AB)	0.0(B)	66.7(A)	27.8(B)	27.8(B)	27.8(B)	0.0(B)	91.7(A)
Common	47.2(B)	42.6(C)	42.6(C)	21.0(D)	80.3(A)	51.4(B)	45.2(B)	45.2(B)	18.6(C)	82.6(A)
Rare	2.4(B)	2.4(B)	2.4(B)	4.8(B)	44.7(A)	14.7(B)	14.7(B)	14.7(B)	0.0(B)	66.8(A)
Overall	44.1(B)	39.7(B)	39.7(B)	13.5(C)	72.7(A)	47.8(B)	44.7(B)	44.7(B)	9.3(C)	81.7(A)

Table 14. (cont.).

	Deciduous Mature					Coniferous Pole				
Status	L	F	L/F	Q	H	L	F	L/F	Q	H
Fed. Migr.	48.5(B)	44.1(C)	41.8(C)	11.7(D)	80.7(A)	43.4(B)	50.3(B)	40.0(B)	9.3(C)	64.3(A)
Ngame.-Prot	55.7(B)	48.9(C)	48.9(C)	13.6(D)	79.5(A)	51.6(B)	59.8(AB)	47.5(B)	11.0(C)	66.3(A)
Game	66.7(A)	50.0(AB)	50.0(AB)	0.0(B)	83.3(A)	66.7(AB)	66.7(AB)	66.7(AB)	0.0(B)	100.0(A)
Breeder	63.9(A)	55.6(A)	55.6(A)	27.8(B)	63.9(A)	30.5(B)	61.1(A)	30.5(B)	0.0(C)	38.9(B)
Perm. Res.	61.4(B)	61.4(B)	61.4(B)	8.4(C)	100.0(A)	56.7(B)	67.9(AB)	56.7(B)	8.5(C)	81.2(A)
Transient	72.2(A)	72.2(A)	72.2(A)	0.0(B)	83.3(A)	0.0(A)	0.0(A)	0.0(A)	4.4(A)	0.0(A)
Trans./Breed	31.7(B)	21.6(C)	21.6(C)	10.7(D)	70.3(A)	40.2(B)	38.0(B)	33.2(B)	7.4(C)	65.6(A)
Abundant	100.0(A)	73.9(B)	73.9(B)	0.0(C)	73.9(B)	86.9(A)	95.8(A)	86.9(A)	0.0(B)	86.9(A)
Accidental	50.0(B)	50.0(B)	50.0(B)	0.0(C)	100.0(A)	0.0(B)	0.0(B)	0.0(B)	0.0(B)	61.1(A)
Common	50.3(B)	45.3(B)	45.3(B)	20.1(C)	90.2(A)	40.7(B)	46.8(B)	34.6(B)	16.5(C)	62.1(A)
Rare	10.3(B)	10.3(B)	10.3(B)	0.0(C)	55.6(A)	21.7(B)	25.8(B)	21.7(B)	0.0(B)	60.0(A)
Overall	46.0(B)	39.8(C)	39.8(C)	10.6(D)	79.8(A)	43.2(B)	49.7(B)	40.0(B)	8.8(C)	65.3(A)

[1]BOVA lists obtained through the element combination of District, County, and Land.Use.
[2]BOVA lists obtained through the element combination of District, County, and Fsize.
[3]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[4]BOVA lists obtained through the element combination of District, Quad, County, Land.Use, and Fsize.
[5]BOVA lists obtained through the element combination of Land.Use and Fsize.
[6]Values with different letters within each habitat type and row differ ($P < 0.05$).

Southeastern Forest Lands (LeGrand and Hamel 1980). In this publication, range maps are included with the description of each species. Though county information was pulled from these maps and entered into the BOVA database, Quad information was not (Robert Giles, Jr., pers. commun.).

Using the habitat search strategy (Land.Use-Fsize), BOVA information over all status categories was more complete for Mixed and Deciduous, Pole and Mature stands (yielding higher [$\underline{P} < 0.05$] K values) than BOVA information for Mixed Seedling/Sapling and Coniferous Pole stands (Table 15). Generally, for each of the tested status categories, BOVA information was most complete in the Deciduous Pole habitat type and least complete in the Mixed Seedling/Sapling habitat type.

BOVA lists generated from Land.Use queries showed differences ($\underline{P} < 0.05$) only for Abundant species (Table 15). There were more differences in BOVA species list thoroughness in relation to forest size ($\underline{P} < 0.05$). Examination of the Fsize queried K values revealed that the Pole descriptor had the most complete species lists for 6 status categories (Table 15); i.e., K values were highest ($\underline{P} < 0.05$) in the these habitat types. The list for Mature forests was less complete than that for Pole forests, and that for Seedling/Sapling stands (used to describe Mixed Seedling/Saplings) was the least complete. Seedling/Sapling and Mature types had Overall K values that were lower ($\underline{P} < 0.05$) than those of Pole types. Though the Seedling/Sapling K values tended to be lower than the Mature K values, these differences were not significant. From these observations, I conclude that the species lists obtained from BOVA searches that employ the Fsize descriptor Pole are more complete than those using the Fsize descriptors Mature or Seedling/Sapling. This difference could result from the homogeneous nature of Pole habitats when compared with the more variable seedling/sapling or Mature habitats. Increased habitat variability yields an increase in species richness, which could increase detected species, and ultimately decrease K values.

For each habitat type, the Land.Use search strategy (Districts-County-Land.Use) generated species that the Fsize search strategy (Districts-County-Fsize) did not and vice versa. When the two elements are linked together with an "AND" (Districts-County-Land.Use-Fsize), these species are not included in the resulting species list. The Land.Use and Fsize elements, when used individually

Table 15. Status categories with different K values ($P < 0.05$) among habitat types for 1986-1987 data based on different search strategies.

Category	Mixed Seedling/Sapling	Mixed Pole	Mixed Mature	Deciduous Pole	Deciduous Mature	Coniferous Pole
Quad: District-County-Quad-Land.Use-Fsize						
Fed. Migr.	5.0(D)[1]	14.0(AB)	14.5(A)	9.8(BC)	11.7(ABC)	9.3(CD)
Ngame.-Prot.	5.8(C)	16.3(AB)	17.3(A)	11.6(B)	13.6(AB)	11.0(BC)
Breeder	0.0(B)	30.5(A)	32.8(A)	33.3(A)	27.8(A)	0.0(B)
Trans./Breed.	2.8(C)	13.9(A)	13.4(AB)	6.4(BC)	10.7(AB)	7.4(ABC)
Common	6.2(B)	21.7(A)	21.0(A)	18.6(A)	20.1(A)	16.5(A)
Overall	4.7(C)	12.7(AB)	13.5(A)	9.3(B)	10.6(AB)	8.8(BC)
Land.Use: District-County-Land.Use						
Abundant	81.8(B)	89.7(AB)	83.8(B)	100.0(A)	100.0(A)	86.9(B)
Fsize: District-County-Fsize						
Fed. Migr.	34.0(B)	51.5(A)	42.5(AB)	46.9(A)	41.8(AB)	50.3(A)
Ngame.-Prot.	38.7(B)	59.4(A)	50.3(A)	54.3(AB)	48.9(AB)	59.8(A)
Breeder	21.7(B)	61.1(A)	52.2(A)	66.7(A)	55.6(A)	61.1(A)
Abundant	85.5(B)	100.0(A)	74.3(C)	100.0(A)	73.9(C)	95.8(A)
Common	22.9(B)	47.3(A)	42.6(A)	45.2(A)	45.3(A)	46.8(A)
Overall	32.2(B)	47.7(A)	39.7(AB)	44.7(A)	39.8(AB)	49.7(A)
Habitat: Land.Use-Fsize						
Fed. Migr.	51.2(C)	78.2(A)	75.1(A)	81.6(A)	80.7(A)	64.3(B)
Ngame.-Prot.	52.4(D)	81.0(AB)	75.6(B)	83.6(A)	79.5(AB)	66.3(C)
Breeder	21.7(C)	69.5(A)	58.9(AB)	75.0(A)	63.9(A)	38.9(BC)
Perm. Res.	71.7(D)	87.0(BC)	91.1(AB)	90.8(B)	100.0(A)	81.2(C)
Trans./Breed.	42.8(C)	72.8(AB)	64.1(B)	79.6(A)	70.3(AB)	65.6(B)
Abundant	67.2(C)	89.7(A)	74.3(BC)	100.0(A)	73.9(BC)	86.9(AB)
Common	43.7(D)	79.0(B)	80.3(B)	82.6(AB)	90.2(A)	62.1(C)
Overall	48.8(D)	74.7(AB)	72.7(BC)	81.7(A)	79.8(AB)	65.3(C)

[1]Values with different letters within a row differ ($P < 0.05$).

with the Districts and County elements, resulted in species lists at least as thorough, and most often more thorough, than when the two were used together (Table 14). This suggests that when location elements (such as Districts and County) are included in a query, the Land.Use and Fsize elements should not be used together in a BOVA search. The Overall K values using the Land.Use query are higher than the Fsize query in 5 of the 6 habitat types (all but the Coniferous habitat), indicating that 2 of the 3 Land.Use descriptors (Mixed and Deciduous forest land) give BOVA species lists that are more complete than those generated by the 3 tested Fsize descriptors.

In all instances, when the Quad element was linked to the Land.Use/Fsize search with an "AND", the resulting species lists gave K values at least 26% lower than when the querie without Quad was used (Table 14). This is strong evidence that the Quad element is severely lacking in species records, greatly reducing the number of species listed by BOVA when used in a search.

From these data it is clear that, at the present level of BOVA development, the most complete BOVA species lists are generated through use of the element combination Land.Use-Fsize. Next, for 5 of the 6 habitat types, the Districts-County-Land.Use BOVA lists are most complete. At its present level of completeness, the information provided by the Quad element is unreliable for use in listing the species of the tested habitat types.

BOVA lists resulting from the habitat search strategy included more field detected species than any other query strategy for almost every tested scenario. Thus, habitat K values tended to be higher, often significantly, than K values resulting from the other 4 search strategies. It is evident that BOVA's tested habitat information (in the Land.Use and Fsize elements) is more thorough than BOVA's tested location information (in the Districts, County, and Quad elements). When information from the location elements Districts and County is linked to that from the habitat elements Land.Use and Fsize, the percent of species detected in the field that is listed by BOVA decreased in 65 of 72 (91.3%) tested status category-habitat type scenarios (Table 14).

Using the Land.Use, Fsize, and Land.Use/Fsize search strategies yielded Overall K values that indicated that BOVA information is unreliable for all 6 habitat types (Table 14). However, across status categories, 16.3% (n = 47) of the K values were at least 60, indicative of reliable BOVA information. The Deciduous Mature habitat had the highest number of status categories with K

$\geq$60 using the 3 search strategies. In this habitat type, Permanent Resident, Transient, and Abundant species had K values $\geq$60 for all 3 search strategies (Table 14). Over 60% of the detected Game and Breeder species, and 100% of the detected Abundant species were listed by BOVA when the Land.Use search strategy was used.

In the Deciduous Pole and Mixed Pole habitats, using Land.Use, Fsize, or Land.Use/Fsize search strategies, Breeder, Permanent Resident, and Abundant had K$\geq$60 (Table 14). Also in the Mixed Pole habitat, 61% of the detected Nongame species were BOVA listed when the Land.Use search strategy was used.

BOVA listed more than 60% of the detected species in Coniferous Pole habitats for game and Abundant species when any of the 3 strategies were used (Table 14). Greater than 60% of the Breeder and Permanent Resident species were listed only when the Fsize search strategy was used.

The Mixed Seedling/Sapling and the Mixed Mature types generally had the most reliable information. In both habitats, detected Abundant species were expected more than 60% of the time using any of the 3 search strategies. More than 60% of the Game species were expected in both habitats using the Land.Use strategy. In the Mixed Seedling/Sapling type, again using the Land.Use strategy, 65% of the detected Breeder species were expected (Table 14).

When the habitat search strategy was used, 70.8% (n = 51) of the K values across all tested habitat types and status categories were indicative of reliable BOVA information (K$\geq$60). There were more K values $\geq$60 for this single search strategy than the 4 other strategies combined. Again, the tested BOVA habitat elements contained more reliable information than did the tested location elements.

Differences in K Within Status Category Among Habitat Types in Relation to Search Strategy

Differences in K ($\underline{P} < 0.05$) were evident within status categories among habitat types depending on the BOVA search strategy used (Tables 8, 15). Using the Land.Use/Fsize strategy, 4 of the 12 status categories showed differences among habitat types (Table 8). For these categories, there was less similarity (based on K)($\underline{P} < 0.05$) between the Mixed Seedling/Sapling habitat and the other 5 habitat types except Coniferous Pole, which also was relatively low. Pole habitats tended to have significantly higher K values (K = 100 for "Deciduous Pole") than the Deciduous and Mixed Mature and the Mixed Seedling/Sapling habitats for Abundant species.

Similar patterns were evident for the Fsize search strategy (Table 15). For the 6 status categories having differences among habitat types, birds detected in the Mixed Seedling/Sapling type were listed by BOVA least often (resulting in low K values). Within the Abundant category, BOVA's information was reliable (K≥60) in 3 habitat types. In the Mixed Pole, Deciduous Pole, and Coniferous Pole habitat types, BOVA listed 100, 100, and 95.8% respectively, of the Abundant species detected. In the Mixed Seedling/Sapling habitat, K was lower ($\underline{P} < 0.05$, K = 85.5), and still lower ($\underline{P} < 0.05$) in the Mixed Mature habitat (K = 74.3, Table 15) for Abundant species.

The Land.Use search strategy yielded significant patterns among habitat types only in the Abundant status category (Table 15). Using this strategy, 100% of the Abundant species were listed in the 2 Deciduous habitat types. K for the Mixed Seedling/Sapling, Mixed Pole, and Coniferous Pole habitats were markedly lower than the Deciduous types, though Mixed Pole was not significantly ($\underline{P} < 0.05$) so.

Six status categories varied ($\underline{P} < 0.05$) in K among the 6 habitat types when the Quad search strategy was used(Table 15). For 5 of these, the Mixed Pole, Mixed Mature, and Deciduous Mature habitats had the highest values. Deciduous and Coniferous Pole had lower values than these and the Mixed Seedling/Sapling had the lowest. Exceptions were the Breeder and Common bird categories. K for Breeder species was not significantly different among Deciduous and Mixed Pole and Mature habitat types, but in Coniferous Pole and Mixed Seedling/Sapling types, K was lower ($P < 0.05$) than the other 4 types (Table 15). K for common species was significantly lower in Mixed Seedling/Saplings than any other of the 5 habitat types. Use of the element Quad in a BOVA query drastically reduces the number of species in the resulting BOVA species list which is illustrated by the low K values (all $\leq$ 33.3%, Table 14).

Differences were found among the 6 habitat types for 8 status categories when using the habitat search strategy (Table 15). For all 8 categories, birds detected in the Mixed Seedling/Sapling habitat type were listed by BOVA least often. K values for the Coniferous Pole habitat type consistently were next lowest. Mixed Pole, Deciduous Pole, and Deciduous Mature types had the highest ($\underline{P} < 0.05$) K values over all 8 categories (Table 15).

K in Relation to Stand Size

K (derived using the standard Districts-County-Land.Use-Fsize search strategy) for each habitat type (generated from composite species lists for the 3 stands representing each habitat type) was compared with K for the mean of the 3 individual stands within each type (Table 7). Mean K for stands tended to be higher than that based on composite lists for all 6 habitats. This indicates that for these habitat types, BOVA serves as a slightly better predictor for smaller areas than larger areas.

These results are not surprising considering island biogeographic theory (Ambuel and Temple 1983, Howe 1984). K for habitat was calculated from species lists obtained by surveying 24 to 60 hectares (3 stands). K for the mean of 3 individual stands was calculated from species lists obtained by surveying 8 to 20 hectares. With an increase in area, there should be an increase in detected species and because BOVA species lists are fixed for a given habitat, K values decline.

The comparisons of this study were made using mean K values for the 3 stands of each habitat type because specific management practices (e.g., forest harvesting) often directly affect parcels of land that range from 8-20 ha.

K and Habitat Variability

Variations (measured by coefficient of variation) of 3 habitat parameters were negatively correlated ($\underline{P} < 0.05$) with K. The coefficient of variation in the density of sapling size A (8.1 to 15.0 cm dbh) and pole size B (15.1 to 23.0 cm dbh) trees within a habitat type was correlated negatively with K for all 6 habitat types (size A trees: $r = -0.87$; size B trees: $r = -0.83$). Thus, as variation increased, K decreased; i.e., fewer of the detected species were listed by BOVA. The coefficient of variation in percent canopy cover also was correlated negatively with K ($r = -0.90$, $N = 6$).

These results indicate that BOVA may have too narrow a definition of these 6 habitat types. As the variability in a habitat increases, there is an increase in available niches. These niches could attract more species to an area resulting in the potential for a higher detected species richness. In the BOVA database, more narrowly defined habitats have fewer species associated with them, and fewer species are listed when that habitat is used in a BOVA query. Consequently, all of the species detected in a diverse habitat type may not be listed and lower K values would result. Such may be the case with the negative correlation between K values and variability in the 3 habitat parameters.

Species Richness

The Coniferous Pole habitat had the highest mean detected species richness over its 3 representative stands ($\overline{S}$ = 3.7 spp./ha) when compared with the other 5 habitat types. The total number of species detected in this habitat was 47. The Mixed Seedling/Sapling habitat had the next highest S value (S = 3.3 spp./ha), with a total of 64 detected species. Mixed Mature had a total of 52 detected species ($\overline{S}$ = 3.0 spp./ha), while Mixed Pole had 50 ($\overline{S}$ = 3.0 spp./ha). Deciduous Mature had a total of 50 detected species ($\overline{S}$ = 3.0 spp./ha), while Deciduous Pole had 49 ($\overline{S}$ = 2.7 spp./ha).

The results of the analysis of variance ($F = 1.52$, $df = 5$, $\underline{P} = 0.25$) indicated that the variations in detected species richness, S, over the 2 field seasons among the 6 habitat types were not different ($\underline{P} > 0.05$). This was surprising considering the differences in habitat characteristics among the 6 types. It is reasonable to assume that birds are more likely to be missed in habitats of denser vegetation and/or higher canopies (Verner 1985). Perhaps if survey effort were increased by adding more sites, significant differences in species richness among habitat types would become apparent.

Another factor that must be considered in determining species richness and abundance estimates is that the average song duration and even the proportion of birds that sing may change with avian density (Bart and Schoultz 1984). When species "compete" for detection during a survey, for example by suppressing other birds' songs, the survey tally will be underestimated (Bart and Schoultz 1984). The species richness values of this study are comparable to those of Hamel et al. (1986). Using spot-mapping censuses, they found that a typical oak-hickory stand of 20 ha in

South Carolina supported an average of 40 bird species, while in Kansas a 10 ha area averaged 41 species.

Modeling Habitat Alterations

The results of this study indicate that the capacity to model, using BOVA's information, the effects on avifauna species richness of changing a forested habitat to a Seedling/Sapling habitat is very limited. In the clearcut (Mixed Seedling/Sapling) habitat - a hypothetical, post-alteration type - BOVA listed only 30.1% of the species observed (Table 7). Even at the most general level of habitat description, only 49% of the detected species were listed (Table 14). Clearly, using the tested element combinations, the database is not sufficiently complete to model avian occurrence in any land use decisions for which the Mixed Seedling/Sapling habitat is the post-alteration type. However, with appropriate interpretation and consideration, BOVA may be used effectively as a tool in land use decision-making processes to provide indication of possible effects.

Species Richness as a Function of Survey Effort

There were no differences ($\underline{P} > 0.05$) among habitats in detected species richness over 54 hours of survey time spent in each type. However, the Michaelis-Menton model revealed trends in the maximum number of detected bird species given unlimited time, MS, within each of the 6 habitat types (Table 16, Fig. 1). Fit to data collected during the 10 minute time intervals of 1.5 hour

Table 16. Maximum number of birds species (MS) and minutes required to observe half of these (T) during 1 survey of a site within a specific habitat type as predicted by the Michaelis-Menten model (Spain 1982)[1] using 1986-1987 field data.[2]

Variable	Mixed Seedling/Sapling	Mixed Pole	Mixed Mature	Deciduous Pole	Deciduous Mature	Coniferous Pole
MS	16.1(.20)[3]	15.0(.21)	15.9(.28)	14.8(.46)	17.6(.30)	13.4(.24)
T	22(.08)	26(.11)	32(.15)	34(.27)	34(.15)	35(.15)

[1]NS = (MS x INTRVL) / (T + INTRVL)
where: NS = number of species;
MS = maximum number of species given unlimited survey time;
INTRVL = time interval;
T = time required to detect half of MS.
[2]Models were based on the number of birds detected in 9 consecutive 10 minute survey periods.
[3]Standard error in parentheses.

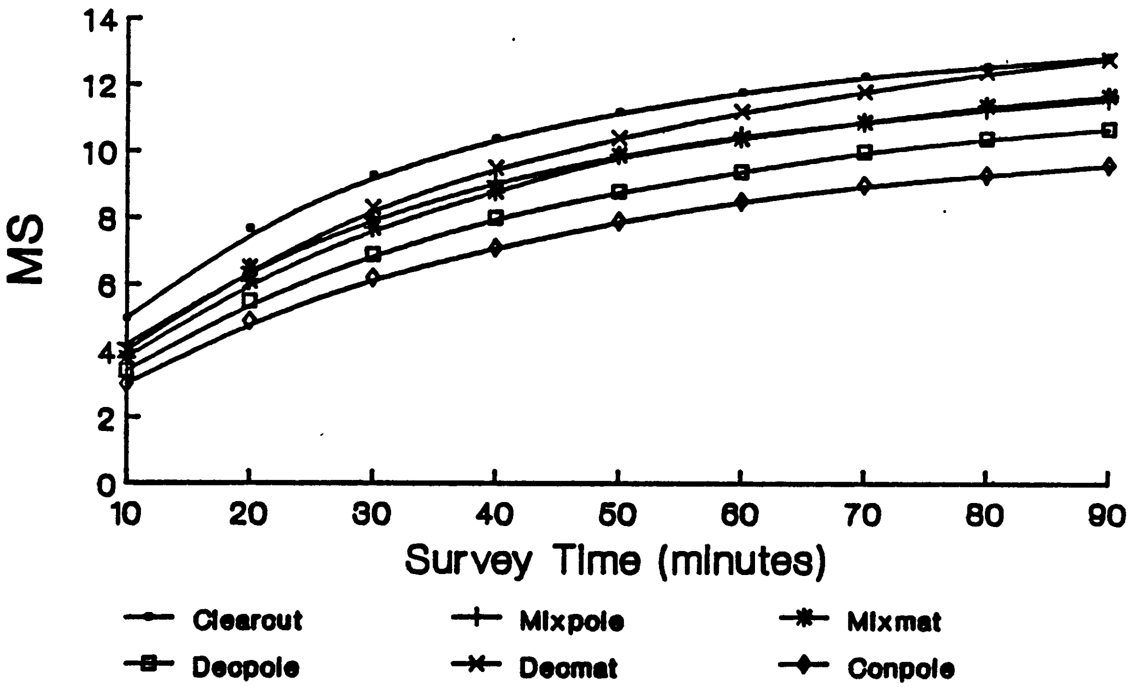

Figure 1. **Curves generated from models that relate the number of birds detected to the duration of effort during 1 morning survey for 6 habitat types (Michaelis-Menten model; Spain 1982).:** Clearcut: Mixed Seedling/Sapling; Mixpole: Mixed Pole; Mixmat: Mixed Mature; Decpole: Deciduous Pole; Decmat: Deciduous Mature; Conpole: Coniferous Pole. Number of birds = (MS x INTRVL)/(T + INTRVL). MS represents the maximum number of birds that can be detected in a specific habitat type given unlimited survey effort, INTRVL is the number of 10 minute observation periods (1-9) during a 1.5 survey, and T represents the time required to see half of MS. These curves were generated using 1986 and 1987 data.

surveys over the 1986 and 1987 field seasons, the model estimated that Deciduous Mature stands would have the highest MS detected during a single survey, and Mixed Seedling/Sapling and Deciduous Pole, the next highest given unlimited survey time (Table 16). It also estimated that MS would be lowest in Coniferous Pole stands and next lowest in Mixed Pole and Mixed Mature stands. The trends in estimated time required within a survey to see half of the species present, T, did not follow the same patterns (Table 16). The Coniferous Pole, Deciduous Pole, and Deciduous Mature stands required the longest time (35, 34, and 34 minutes, respectively). The Mixed Mature stands required less time, 32 minutes. Mixed Pole and Mixed Seedling/Sapling types needed the least time within a survey, each requiring 22 minutes.

Fit to collective data obtained during 12 1.5 hour surveys in each site over the 2 season survey period, the model estimated that the greatest mean number of species (57.1) could be detected in the Mixed Seedling/Sapling habitat, given an unlimited number of surveys (Table 17, Fig. 2). Next would be the Mixed Mature with 51.1 species, Deciduous Mature with 49.9 species, Mixed Pole with 45.7 species, Coniferous Pole with 40.9 species, and Deciduous Pole with 37.7 species.

The time required to detect half of the species was highest in the Mixed Seedling/Sapling habitat type, 7.8 hours (5.2 1.5-hour morning surveys). Coniferous Pole, Mixed Pole, and Deciduous Mature habitats required slightly less time, 6.6, 6.3, and 5.9 hours (4.4, 4.2, and 3.9 1.5-hour surveys), respectively. Mixed Mature and Deciduous Pole habitats required the least time, 4.0 and 3.8 hours (2.7 and 2.5 surveys), respectively (Table 17).

Results of species-effort modeling indicate that different habitat types warrant varying amounts of effort to detect the species present. Thus, species surveys of Mixed Seedling/Sapling habitats should include more sampling periods than species surveys of any of the other 5 tested habitat types (Table 17). Modeled data show that in the Mixed Seedling/Sapling type there is a high species richness (indicated by a high MS value) and a relatively long survey duration (indicated

Table 17. Maximum number of birds species (MS) and hours required to observe half of these (T) during 12 surveys of a site within a specific habitat type as predicted by the Michaelis-Menten model (Spain 1982)[1] using 1986-1987 field data.[2]

Site	Mixed Seedling/Sapling		Mixed Pole		Mixed Mature	
	MS	T	MS	T	MS	T
I	58.3(5.78)[3]	8.6(1.94)	45.9(2.82)	4.8(0.49)	64.9(6.60)	7.0(1.8)
II	66.0(4.39)	8.8(1.3)	55.3(2.38)	8.0(0.8)	45.0(2.63)	5.9(0.9)
III	47.1(2.40)	6.0(0.8)	36.0(3.38)	6.1(1.5)	43.3(2.56)	5.1(0.9)
Mean	57.1(5.49)	7.8(0.9)	45.7(5.57)	6.3(1.0)	51.1(6.93)	3.99(0.36)

Site	Deciduous Pole		Deciduous Mature		Coniferous Pole	
	MS	T	MS	T	MS	T
I	34.0(1.73)	3.3(0.6)	46.0(3.25)	3.7(0.9)	39.0(0.83)	2.0(0.21)
II	47.0(2.76)	5.4(0.9)	65.8(6.10)	12.2(2.2)	40.7(7.51)	8.6(3.6)
III	32.1(1.57)	2.5(0.5)	37.9(1.31)	1.7(0.3)	43.1(2.88)	9.3(1.4)
Mean	37.7(4.68)	3.8(0.9)	49.9(8.29)	5.9(3.2)	40.9(1.19)	6.6(2.3)

[1]NS = (MS x INTRVL) / (T + INTRVL)
where: NS = number of species;
MS = maximum number of species given unlimited survey time;
INTRVL = time interval;
T = hours required to detect half of MS.
[2]Models based on the number of birds detected in 12 consecutive 1.5 hour surveys of sites representing each habitat.
[3]Standard error in parentheses.

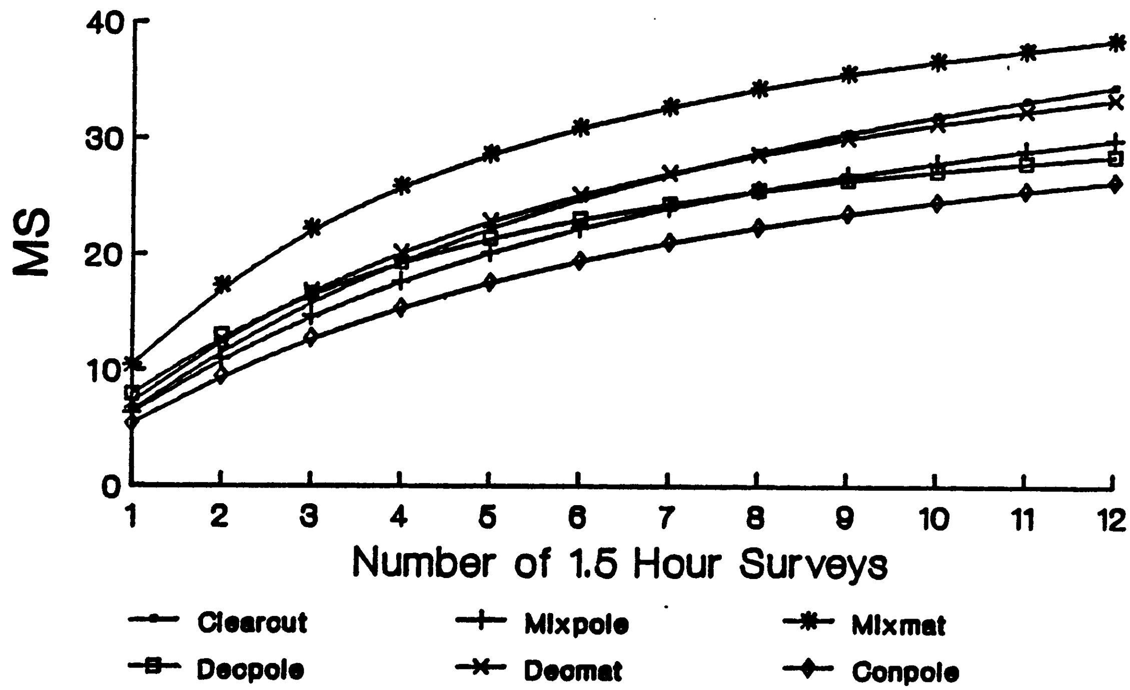

Figure 2. **Curves generated from models that relate the number of birds detected to the duration of effort over several morning surveys for 6 habitat types (Michaelis-Menten model; Spain 1982).:** Clearcut: Mixed Seedling/Sapling; Mixpole: Mixed Pole; Mixmat: Mixed Mature; Decpole: Deciduous Pole; Decmat: Deciduous Mature; Conpole: Coniferous Pole. Number of birds = (MS x INTRVL) / (T + INTRVL). MS represents the maximum number of birds that can be detected in a specific habitat type given unlimited survey effort, INTRVL represents the number of 1.5 hour morning surveys (1-12) conducted over the 2 season study period, and T represents the time required to see half of MS. These curves were generated using 1986 and 1987 data.

by a high T value) is required to detect half of them. Less time should be required to detect half the species in the other 5 habitat types, and the least time neccessary in the Deciduous Pole type.

Differences in both MS and T among the 6 habitat types could be a function, in part, of each type's vegetational structure and composition. Unfortunately, there have been relatively few studies that have quantitatively assessed biases in bird detectability attributable to habitat (Verner 1985). It has been noted in the literature that vegetational interference of avian songs influences species-specific detectability (Oelke 1981, Richards 1981, Rodgers 1981). Richards (1981) examined the specific effects that vegetation has on bird songs. However, his work compared the acoustics of forested versus open areas only. He found that a bird's song is degraded by attenuation (the decrease in sound intensity with distance), fluctuation (changes in amplitude and periodicity), and reverberation (echo). The presence of trunks, foliage, and ground increases scattering and reverberation. The higher frequencies of bird songs have wavelengths comparable to the size of deciduous leaves, are subject to absorption, and therefore are distorted more severely than are the lower frequencies. Increased vegetational interference causes an increase in these sources of song degradation and a decrease in accurate species identification through song recognition (Richards 1981). Vegetation composition and structure both detract from accurate species identification. However, information is not readily available to discern degrees of acoustic distortion within coniferous, deciduous, and mixed, as well as young and old forest types. The effects of dense vegetation on the detection of bird songs may partially explain why the greatest number of species were detected in the Mixed Seedling/Sapling habitat.

PC-BOVA Versus Mainframe BOVA

PC-BOVA listed more species than mainframe BOVA in all of the 6 tested habitat types (Table 18). K values for PC-BOVA followed the same general trend as those for mainframe

BOVA. The percent of species detected in the field that was listed to occur by PC-BOVA was the highest in the Deciduous Pole habitat type, and the lowest in the Mixed Seedling/Sapling type. Mainframe BOVA K values tended to be highest in the Deciduous and Mixed Pole habitat types, while PC-BOVA K values were the highest in the Deciduous habitat types (Table 18). Though PC-BOVA K values were higher than mainframe BOVA K values (by 1.6% in Mixed Seedling/Sapling to 25.5% in Mixed Mature), they still were below 60, and thus indicative of unreliable information.

Table 18. Comparison of K values calculated from mainframe BOVA species lists and PC-BOVA species lists.

Habitat Type	% of Detected Species Listed[1] PC-BOVA	Mainframe BOVA
Mixed Seedling/Sapling	31.3(33)[2]	29.7(31)
Mixed Pole	51.0(44)	36.0(39)
Mixed Mature	51.9(44)	36.5(35)
Deciduous Pole	59.2(44)	38.8(33)
Deciduous Mature	58.8(46)	33.3(32)
Coniferous Pole	42.6(38)	29.8(30)

[1]BOVA lists obtained using the Districts-County-Land.Use-Fsize search strategy.
[2]Number of species listed by BOVA.

DISCUSSION AND SUMMARY

As a CFWIS, BOVA is not a model. However, specific BOVA searches or queries and the occurrence information that they elicit can be considered models or representations of reality. The reality modeled in this study was the presence of bird species in specific habitat types. Thus the following discussion of models and model testing apply to the BOVA CFWIS as used here. In essence, models represent hypotheses about nature. Thus, model testing is similar to hypothesis testing. Models cannot be proven correct, but only supported by experience and tentatively accepted until proven false (Overton 1977, Holling 1978, Farmer et al. 1982, Marcot et al. 1983, Grant 1986). As simplifications of reality and being inevitably incomplete, models will be unreliable to some extent. Model testing serves to aid in understanding the degree of unreliability (Farmer et al. 1982).

BOVA is most reliable when used to estimate the presence of common species. This is important because many organizations, such as bird watching and garden clubs, may be interested in the occurrence of these species. However, common species seldom are considered when land-use decisions are being made. Therefore, although common species are important, for many situations less common species may be more so. The influence of a land use practice on relatively uncommon species that may be of special concern is of greater interest than effects on common species. From this latter point of view, BOVA should be evaluated for its ability to list uncommon species.

Hoekstra and Cushwa (1979) reported that avian information in computerized information systems generally has emphasized threatened and endangered species and game species. Emphasis on nongame categories has been limited. This trend was capsulized by Thomas (1979) when he quoted Orwell (1946): "ALL ANIMALS ARE EQUAL BUT SOME ANIMALS ARE MORE EQUAL THAN OTHERS." For example, federal agencies are required by law to account for threatened and endangered species much more closely than for more common species. Threatened and endangered species were not tested in this study because its design was not appropriate for detecting these species. To be appropriate, the study design would have to include a survey method of increased intensity. It should be noted that a conscientious effort should continue to be made to include in BOVA all available information on state- and federally-listed threatened and endangered species. This is important to ensure that thorough information is used for protecting Virginia's natural faunal diversity.

As well as threatened and endangered species, game species also are a major focus of wildlife management activities (Thomas 1979). It is of concern that BOVA did not list an important game species, ruffed grouse, under the tested scenarios. Biologically, game species are not more important than other species. However, they merit special attention because of their economic and recreational value. For the benefit of all species, information on game species should be very thorough in BOVA. All species, game and nongame, benefit from money obtained through taxes on firearms and from hunting license fees. They also benefit from an increase in public awareness of natural resources often associated with the hunting experience.

The low K values for Game species (29.6) and the higher values for the Nongame-Protected species (49.1) indicate that BOVA may not emphasize Game species in accordance with management directives. Also, VSO categories may be limited or adequate local field reports were not included in the system. It should be remembered, however, that there is a low level of confidence associated with the conclusions about Game species based on K values because the nature of this status category necessitated K values to be calculated from small sample sizes.

As a tool for making land use decisions, it would be preferable for BOVA to over-estimate the species that occur in a stand prior to stand alterations. However, it is not preferable to over-estimate species occurrence after land manipulation. Post-alteration over-estimating may indicate that a species persists after habitat manipulation, when in fact the manipulation may have eliminated the species from the area. Thus the inference could be made that the habitat alteration has a lesser impact than it in fact did have. The ideal situation would be to list accurately species for both pre- and post- alteration conditions, but at the least it seems better to conduct land use planning conservatively than risk eliminating a species from an area.

Because BOVA information is incomplete, it must be used as a inferential tool; the possible occurrence of additional species not on BOVA lists must be inferred from the BOVA information given. For example, if the downy woodpecker is listed by BOVA to occur in a specific area or habitat type, it is reasonable to infer the occurrence of the hairy woodpecker because of their similar habitat requirements. BOVA information must be entered accurately so these links can be made.

Literature searches should be conducted to determine the potential causes of information gaps. Searches on the 23 species listed in Table 13, (species detected in at least 5 of the 6 habitat types yet not listed by BOVA in more than 1 type) would be worthwhile in initiating this effort. If all published information has been collected and accurately entered to the system, then the gaps can be used to indicate areas of needed data and thus, direct research efforts. However, if the lacking information is available in a published form, this information must be entered into the BOVA database. Both approaches will increase the system's overall completeness.

Overall, the Districts-County-Land.Use-Fsize, Districts-County-Land.Use, and Districts-County-Fsize search strategies gave essentially unreliable information. Without supplemental data, the use of information retrieved from BOVA using these strategies is unacceptable. Information retrieved from BOVA using the Land.Use-Fsize search strategy is reliable and acceptable for use. It is optimal if any information retrieved also is supplemented with additional data.

It has been shown that the tested BOVA habitat elements contain information that is much more reliable than that contained in the tested BOVA location elements. However, without the use of location information in a BOVA query, the search may be too general. For instance, when the species of a coniferous pole habitat type are in question, without location information, it is not known if these are species of the coastal, mountainous, piedmont, northern, or southern regions of the state. BOVA location elements must be supplemented with accurate information to allow BOVA users to retrieve reliable information concerning habitat types within specific areas of Virginia.

More specific definitions of the Fsize categories should be developed to increase the suitability of this element for categorizing species information. Fsize should be defined by tree age, height, or dbh. I suggest that dbh be used to define Fsize. This measurement is easily attained and is more indicative of tree structure than is tree age, for which structure may vary with site index.

Though it is updated, PC-BOVA gave information that was unreliable for use under the tested scenarios. PC-BOVA is, however, an improvement over mainframe BOVA; its information, though still unsatisfactory, is more reliable. With additional effort, the BOVA system will become a more valuable tool for land use planning, education, research, and and other functions that require wildlife species information.

To use BOVA information in decision making is to accept BOVA's technology and use it to solve problems or improve upon current management procedures (Callaham 1984). However, it is clear that in its present state, the BOVA database alone does not provide adequate information for making land use decisions. BOVA's weakness is not a result of flaws in the system's design, but in its level of completeness. Though the database is incomplete, decisions using BOVA information will continue to be made. This is acceptable if all available information, including BOVA's, is combined with expert opinion to predict the consequences of alternative management scenarios (Farmer et al. 1982).

The inevitable simplicity of CFWIS in expressing species occurrence results in database outputs that are less than ideal. An acceptance level for model outputs must be defined. Grant (1986) stated that the process through which we define "acceptable" is perhaps the most controversial aspect of modeling. This problem also pertains to assessing the output of computerized information systems. Acceptance levels vary depending on the output reliability required when making a specific land use decision (Farmer et al. 1982) and define an operational endpoint of system development. Clearly, BOVA is not sufficiently reliable to stop system development. BOVA outputs could become more reliable for making management decisions, and thus more acceptable, through improved communications between information system d... and users focused at realistic, functional objectives (Farmer et al. 1982).

The results of this study indicate that BOVA information is not always reliable or accurate. However, used as one of many tools in a decision making process, BOVA is a useful and valuable contributor to wildlife management. Versatile and resourceful management does not presume that CFWIS provide statements of absolute truth. Instead, it uses these systems to help synthesize knowledge and to apply it to decision-making processes to guide management toward goals (Salwasser 1986).

Several characteristics of this study's design could detract from its findings. It has been suggested that information system testing should span at least 3 years to detect fluctuations in numbers and distribution (Marcot et al. 1986, Hurley 1986). Another way to expand the implications of this study would have been to survey more stands of each habitat type (Van Horne 1986). Also, the 6 habitat types defined in this study may not be defined identically in the database. For example, the ambiguity of BOVA Fsize definitions prevents adequate delineation between stand age types. The techniques used to measure habitat characteristics as described by Noon (1981) are modified, yet very similar to those of James and Shugart (1970). Anderson (1981) reported that results obtained through the James-Shugart technique do not provide sound information on habitat-species correlations because data are obtained from the macro-habitat level, not the micro-habitat level to which individual species respond.

This study has uncovered areas in the database where species information is lacking. If not found in the literature, research should be conducted to make this information available for use in management decisions. System testing brings us full circle to discover gaps in knowledge and mechanisms for filling those gaps (Overton 1977, Goldstein 1977). This type of feedback is critical to the development of reliable information.

When a CFWIS passes reliability tests, it is ready for the purpose for which it was constructed. This view of system testing, though often not acknowledged, is crucial to the effectiveness of CFWIS and the making of responsible decisions affecting our natural resources

(Overton 1977). With development, large, automated natural resource information systems such as BOVA may have an important impact on this planet's natural systems, on the preservation of species, and on the quality of the natural world surrounding us (Dangermond and Smith 1981).

LITERATURE CITED

Ambuel, B. A. and S. A. Temple. 1983. Area-dependent changes in the bird communities and vegetation of Southern Wisconsin forests. Ecology 64:1057-1068.

Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1978. A land use and land cover classification system for use with remote sensor data. U.S. Dept. Int., Geol. Surv. Prof. Pap. No. 964, 28pp.

Anderson, S. H. 1981. Correlating habitat variables and birds. Pages 538-542 in C. J. Ralph and J. M. Scott, eds. Estimating numbers of terrestrial birds. Studies in Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Anderson, S. H., and H. H. Shugart, Jr. 1974. Habitat selection of breeding birds in an east Tennessee deciduous forest. Ecology 55:828-837.

Anonymous. 1981. A summary of fish and wildlife species data base activities, 1977-1981. Unpubl. man., Eastern Energy and Land Use Team. 11pp.

Bailey, R. G. 1980. Description of the ecoregions of the United States. U. S. Dept. of Agric., Misc. Pub. No. 1391, 77pp.

Bart, J. and J. D. Schoultz. 1984. Reliability of singing bird surveys: changes in observer efficiency with avian density. Auk 101:307-318.

Berry, K. H. 1986. Introduction: development, testing, and application of wildlife-habitat models. Pages 3-4 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Callaham, R. Z. 1984. Managing for applications not just research and development. J. Forest. 82:224-227.

Chalk, D. E. 1986. Summary: development, testing, and application of wildlife-habitat models - the researcher's viewpoint. Pages 155-156 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Cushwa, C. T. 1983. Fish and wildlife information management - needs vs. availability. Pages 6-10 in National workshop on computer uses in fish and wildlife programs. Va. Polytech. Inst. and State Univ., Blacksburg, VA 327pp.

Cushwa, C. T. and V. E. Kopf. 1984. Computerized fish and wildlife information systems. MSFWIS-P, Va. Polytech. and State Univ., Blacksburg, VA. Spec. Rep. 6. 33pp.

Dangermond, J. and L. K. Smith. 1981. Concepts and issues in large area natural resource information systems. Pages 435-448 in T. B. Brann, L. O. House IV, and H. G. Lund, eds.

In-place Resource Inventories: Principles and Practises. Proceedings of a National Workshop. Soc. Am. For. 1101pp.

Dixon, G. E. 1981. Multiresource inventories: meeting challenging new information needs. Pages 383-388 in T. B. Brann, L. O. House IV, and H. G. Lund, eds. In-place Resource Inventories: Principles and Practises. Proceedings of a National Workshop. Soc. Am. For. 1101pp.

DuBrock, C. W., D. N. Gladwin, W. T. Mason, Jr., and C. T. Cushwa. 1981. State-of-the-art of fish and wildlife information systems in the United States. Trans. N. Am. Wildl. and Nat. Res.Conf. 46:156-170.

Edwards, D. K., G. L. Dorsey, and J. A. Crawford. 1981. A comparison of the three avian census methods. Pages 170-176 in C. J. Ralph and J. M. Scott eds. Estimating numbers of terrestrial birds. Studies in Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas

Farmer, A. H., M. J. Armbruster, J. W. Terrell, and R. L. Shroeder. 1982. Habitat models for land-use planning: assumptions and strategies for development. Trans. N. Am. Wildl. and Nat. Res. Conf. 47:47-56.

Gass, S. I. 1977. Evaluation of complex models. Comput. and Ops. Res. 4:27-35.

Goff, F. G., G. A. Dawson, and J. J. Rochow. 1982. Site examination for threatened and endangered plant species. Environ. Manage. 6:307-316.

Goldstein, R. A. 1977. Reality and models: difficulties associated with applying general ecological models to specific situations. Pages 207-215 in D. L. Solomon and C. F. Walter eds. Mathematical models in biological discovery. Springer-Verlag, New York.

Goodall, D. W. 1978. Sample similarity and species correlation. Pages 99-149 in R. H. Whittaker, ed. Ordination of plant communities. W. Junk, The Hague.

Grant, W. E. 1986. Systems analysis and simulation in wildlife and fisheries sciences. John Wiley and Sons, New York. 338pp.

Hair, J. D. 1980. Measurement of ecological diversity. Pages 269-275 in S. D. Schemnitz, ed. Wildlife management techniques manual. 4th ed. The Wildl. Soc., Washington, D.C.

Hall, C. A. S., and J. W. Day, Jr. 1977. Systems and models: terms and basic principles. Pages 6-36 in C. A. S. Hall and J. W. Day, Jr., eds. Ecosystem modeling in theory and practise. Wiley-Interscience, New York.

Hamel, P. B., N. D. Cost, and R. M. Sheffield. 1986. The consistent characteristics of habitats: a question of scale. Pages 121-128 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Hirsch, A., W.B. Krohn, D.L. Schweitzer, and C.H. Thomas. 1979. Trends and needs in federal inventories of wildlife habitat. Trans. N. Am. Wildl. and Nat. Res. Conf. 44:340-359.

Hoekstra, T. W., and C. T. Cushwa. 1979. Compilation of avian information in computerized storage and retrieval systems of the northeastern United States. Pages in R. M. DeGraaf (tech. coord.), Management of northcentral and northeastern forests for nongame birds: proceedings of the workshop. U. S. Dept. of Agric. Forest Serv., Gen. Tech. Rep. NC-51. North Central Forest Exp. Stat., St. Paul.

Holling, C. S., ed. 1978. Adaptive environmental assessment and management. John Wiley and Sons. New York. 377pp.

Howe, R. W. 1984. Local dynamics of bird assemblages in small forest habitat islands in Australia and North America. Ecology 65:1585-1601.

Hurley, J. A. 1986. Summary: development, testing, and application of wildlife-habitat models - the managers viewpoint. Pages 151-153 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

James, F. C. 1971. Ordinations of habitat relationships among breeding birds. Wilson Bull. 83:215-236.

James, F. C., and H. H. Shugart, Jr. 1970. A quantitative method of habitat description. Audubon Field Notes 24:727-736.

Kimmel, J. J. 1985. A new species-time method for visual assessment of fishes and its comparison with established methods. Environ. Biol. Fishes 12:23-32.

Larner, Y. L., chairman. 1979. Virginia's birdlife: an annotated checklist. Va. Soc. Ornith. Lynchburg. 177pp.

LeGrand, H. E., Jr., and P. B. Hamel. 1980. Bird - Habitat Associations on Southeastern Forest Lands. USDA For. Serv. Southeast. For. Exp. Sta. Final Rep. Suppl. 16, No. 18-409. 276pp.

Liverman, M. C. 1986. A keyword census method for modeling relationships between birds and their habitats. Pages 183-189 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Marcot, B. G., M. G. Raphael, and K. H. Berry. 1983. Monitoring wildlife habitat and validation of wildlife-habitat relationships models. Trans. N. Am. Wildl. and Nat. Res. Conf. 48:315-329.

Mason, W. T., Jr., C. T. Cushwa, L. J. Salashi, and D. N. Gladwin. 1979. A procedure for describing fish and wildlife: coding instructions for Pennsylvania. USDI, FWS/OBS 79/19. 21pp + 19 appendices.

Noon, B.R. 1981. Techniques for sampling avian habitats. Pages 42-52 in D.E. Capen, ed. The use of multivariate statistics in studies of wildlife habitat. U.S. Dept. Agric. For. Serv. Gen. Tech. Rep. RM-87. Rocky Mtn. Forest and Range Exp. Stat. Fort Collins.

Odum, E. P. 1971. Fundementals of ecology. W. B. Saunders Co., Philadelphia. 574pp.

Oelke, H. 1981. Limitations of estimating bird populations because of vegetation structure. Pages 316-321 in C. J. Ralph and J. M. Scott, eds. Estimating numbers of terrestrial birds. Stud. in Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Orwell, G. 1946. Animal farm. Harcourt, Brace and Co., Inc., New York. 118pp.

Overton,W. S. 1977. A strategy of model construction. Pages 49-74 in C. A. S. Hall and J. W. Day eds. Ecosystem modeling in theory and practice: an introduction with case histories. John Wiley and Sons, Inc., New York.

Patton, D.R. 1978. RUN WILD - a storage and retrieval system for wildlife habitat information. Gen. Tech. Rep. RM-51, USDA Forest Service, RMF & RES., Ft. Collins, Co. 8pp.

Pielou, E. C. 1984. The interpretation of ecological data. John Wiley and Sons, Inc., New York. 263pp.

Raphael, M. G., and B. G. Marcot. 1986. Validation of a Wildlife-Habitat-Relationships model: vertebrates in a douglas-fir sere. Pages 129-138 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Richards, D. G. 1981. Environmental acoustics and censuses of singing birds. Pages 297-300 in C. J. Ralph and J. M. Scott eds. Estimating numbers of terrestrial birds. Studies in Avian Biol. 6. Allen Press, Inc., Lawrence, Kansas.

Rodgers, R. D. 1981. Factors affecting ruffed grouse drumming counts in southwestern Wisconsin. J. Wildl. Manage. 45:409-418.

Roth, R. R. 1976. Spatial heterogeneity and bird species diversity. Ecology 57:773-782.

Salwasser, H. 1986. Modeling habitat relationships of terrestrial vertebrates - the manager's viewpoint. Pages 419-424 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Schamberger, M. L., and L. J. O'Neil. 1986. Concepts and constraints of habitat-model testing. Pages 5-10 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Schrank, W. E., and C. C. Holt. 1967. Critique of "verification of computer simulation models." Manage. Sci. 14:B104-B106.

Sokal, R. R., and R. J. Rohlf. 1969. Biometry: the principles and practice of statistics in biological research. W. H. Freeman, San Francisco. 776pp.

Spain, J. D. 1982. BASIC microcomputer models in biology. Addison-Wesley Publ. Co., Reading. 354pp.

Terwilliger, K. and A. Rasberry. 1983. BOVA - Virginia's computerized fish and wildlife information system. Pages 212-219 in National workshop on computer uses in fish and wildlife programs. Va. Polytech. Inst. and State Univ., Blacksburg, VA 327pp.

Thomas J. W., editor. 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. U.S. Dept. Agric., For. Serv., Agricultural Handb. 553. U.S. Government Printing Office, Washington, D.C. 512pp.

Toth, E. F., and J. W. Baglien. 1986. Summary: when habitats fail as predictors - the manager's viewpoint. Pages 255-256 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

U.S. Laws, Statutes, etc. Public Law 86-517. [H.R. 10572], June 12, 1960. In its United States statutes at large. 1960. Vol. 74, p. 215. U.S. Gov. Print. Off., Washington, D.C. 1961. [16 U.S.C. sec. 528-531 (1976).]

U.S. Laws, Statutes, etc. Public Law 91-190. [S. 1075], Jan. 1, 1970. In its United States statutes at large. 1969. Vol. 83, p. 852-856. U.S. Gov. Print. Off., Washington, D.C. 1970. [42 U.S.C. sec. 4321, et seq. (1970).]

U.S. Laws, Statutes, etc. Public Law 93-205. [S. 1983], Dec. 28, 1973. In its United States statutes at large. 1973. Vol. 87, p.884. U.S. Gov. Print. Off., Washington, D.C. 1970. [16 U.S.C. sec. 668, (1976).]

U.S. Laws, Statutes, etc. Public Law 93-378. [S. 2296], Aug. 17, 1974. In its United States statutes at large. 1974. Vol. 88, Part 1, p. 476-480. U.S. Gov. Print. Off., Washington, D.C. 1976. [16 U.S.C. sec. 160, (1976).]

Van Horne, B. 1986. Summary: when habitats fail as predictors - the researcher's viewpoint. Pages 257-258 in J. Verner, M. L. Morrison, and C. J. Ralph, eds. Wildlife 2000. Univ. Wisc. Press, Madison.

Verner, J. 1985. Assessment of counting techniques. Pp. 247-302 in R. F. Johnston ed. Current ornithology. Volume 2. Plenum, New York and London.

Willson, M. F. 1974. Avian community organization and habitat structure. Ecology 55:1017-1029.

APPENDICES

Appendix 1. Indices representing the similarity of species detected in the field and also listed to occur by BOVA for status categories in various habitat types using 1986 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat[2] based upon a composite species list from the 3 sites in the habitat).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						Jaccard's Index, J[3]						
Fed.												
Migr.	61[4]	13.4 / 21.3	59	22.6 / 25.4	57	20.4 / 24.6	53	21.6 / 22.6	53	25.1 / 28.3	54	15.6 / 22.2
Ngame-Prot.	54	14.2 / 22.2	52	24.6 / 28.9	50	22.1 / 28.0	48	24.1 / 25.0	46	28.0 / 32.6	47	16.8 / 25.5
Game	4	8.3 / 25.0	4	0.0 / 0.0	4	0.0 / 0.0	3	0.0 / 0.0	4	11.1 / 25.0	2	66.7 / 50.0
Breeder	5	26.1 / 20.0	4	50.0 / 50.0	5	55.6 / 40.0	4	72.2 / 50.0	4	61.1 / 50.0	4	19.4 / 25.0
Perm.Res.	22	12.9 / 27.3	24	25.5 / 33.3	22	21.4 / 27.3	19	29.6 / 26.3	21	30.8 / 28.6	21	23.9 / 28.6
Transient	7	0.0 / 0.0	12	0.0 / 0.0	8	3.7 / 12.5	5	0.0 / 0.0	6	10.3 / 33.3	9	0.0 / 0.0
Trans./Breed.	33	13.6 / 18.2	25	22.2 / 20.0	27	18.6 / 18.5	27	14.6 / 18.5	27	19.9 / 22.2	22	18.2 / 27.3
Abundant	12	26.8 / 41.7	11	40.7 / 54.6	10	39.2 / 50.0	9	48.1 / 55.6	10	31.8 / 40.0	10	39.8 / 60.0
Accidental	8	0.0 / 0.0	11	0.0 / 0.0	8	3.3 / 12.3	7	0.0 / 0.0	6	10.3 / 33.3	9	0.0 / 0.0
Common	27	11.4 / 14.8	28	28.8 / 28.6	27	28.8 / 25.9	25	24.6 / 24.0	26	37.1 / 26.9	26	15.5 / 19.2
Rare	19	10.9 / 21.1	15	8.10 / 6.7	17	0.0 / 5.9	14	6.7 / 7.1	16	5.4 / 18.8	11	12.2 / 18.2
Overall	67	12.5 / 19.4	65	20.8 / 23.1	62	19.4 / 22.6	55	21.0 / 21.8	58	24.7 / 27.6	56	16.7 / 23.2
						% of Listed Detected, H[5]						
Fed.												
Migr.	29[4]	23.0 / 44.8	37	29.7 / 40.5	34	28.7 / 41.2	32	29.9 / 37.5	31	36.5 / 48.4	29	22.9 / 41.4
Ngame.-Prot.	28	22.9 / 42.9	36	30.6 / 41.7	33	29.5 / 42.4	31	31.3 / 38.7	30	37.7 / 50.0	29	22.9 / 41.4
Game	3	11.1 / 33.3	3	0.0 / 0.0	2	0.0 / 0.0	2	0.0 / 0.0	2	16.7 / 50.0	1	66.7 / 100.0
Breeder	1	100.0 / 100.0	2	83.3 / 100.0	2	100.0 / 100.0	2	100.0 / 100.0	2	83.3 / 100.0	1	66.7 / 100.0
Perm.Res.	14	17.0 / 42.9	16	31.3 / 50.0	14	26.7 / 42.9	13	35.7 / 38.5	13	38.1 / 46.2	12	30.8 / 50.0
Transient	5	0.0 / 0.0	9	0.0 / 0.0	7	3.7 / 14.3	5	0.0 / 0.0	5	11.1 / 40.0	6	0.0 / 0.0
Trans./Breed.	11	32.4 / 54.6	12	36.1 / 41.7	12	36.4 / 41.7	13	24.5 / 38.5	12	39.4 / 50.0	11	30.3 / 54.6
Abundant	9	33.3 / 55.6	9	40.7 / 66.7	8	45.8 / 62.5	9	48.1 / 55.6	8	37.5 / 50.0	8	45.8 / 75.0
Accidental	6	0.0 / 0.0	9	0.0 / 0.0	7	3.7 / 14.3	5	0.0 / 0.0	5	11.1 / 40.0	6	0.0 / 0.0
Common	9	25.9 / 44.4	14	45.2 / 57.1	12	48.8 / 58.3	13	38.1 / 46.2	12	59.0 / 58.3	11	27.8 / 45.5
Rare	7	22.2 / 57.1	7	14.3 / 14.3	8	0.0 / 12.5	6	10.3 / 16.7	7	11.1 / 42.9	5	20.0 / 40.0
Overall	31	21.5 / 14.9	39	28.2 / 38.5	35	27.9 / 40.0	33	29.0 / 36.4	22	36.4 / 50.0	30	24.2 / 43.3

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of birds detected and listed by BOVA(A) / [A + number of birds listed by BOVA but not observed(B) + number observed but not predicted by BOVA(C)]).
[4]Jaccard's index: number of predicted species plus number of detected species, counting each species only once.
% of Listed Detected: number of species listed by BOVA.
[5]Represents A / (A + C).

Appendix 2. Indices representing the similarity of species detected in the field and also listed to occur by BOVA for status categories in various habitat types using 1987 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat based upon a composite species list from the 3 sites in the habitat[2]).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						Jaccard's Index, J^3						
Fed. Migr.	61[4]	20.1 / 24.6	56	26.9 / 30.4	57	26.3 / 31.6	53	27.4 / 32.1	55	27.3 / 27.3	51	22.2 / 23.5
Ngame.-Prot.	54	22.3 / 27.8	48	29.4 / 35.4	49	29.5 / 36.7	46	30.2 / 34.8	49	30.0 / 30.6	45	23.8 / 26.7
Game	5	8.3 / 20.0	4	8.3 / 25.0	4	0.0 / 0.0	3	11.1 / 33.3	2	16.7 / 50.0	1	33.3 / 100.0
Breeder	4	33.3 / 25.0	3	66.7 / 66.7	4	61.1 / 50.0	3	77.8 / 66.7	4	50.0 / 50.0	3	22.2 / 33.3
Perm.Res.	24	26.7 / 37.5	22	41.8 / 45.5	22	35.5 / 36.4	19	35.7 / 36.8	18	38.3 / 38.9	19	31.9 / 36.8
Transient	8	5.6 / 12.5	10	0.0 / 0.0	8	3.3 / 12.5	8	13.1 / 37.5	6	16.7 / 33.3	7	0.0 / 0.0
Trans./Breed.	32	16.1 / 15.6	27	17.7 / 22.2	27	19.8 / 25.9	27	16.9 / 18.5	32	16.5 / 15.6	25	23.7 / 20.0
Abundant	12	41.5 / 50.0	10	48.1 / 60.0	10	50.0 / 60.0	9	48.2 / 66.7	9	40.7 / 44.4	9	55.6 / 66.7
Accidental	7	4.8 / 14.3	10	0.0 / 0.0	8	3.3 / 12.5	8	13.1 / 35.7	6	14.3 / 33.3	7	0.0 / 0.0
Common	30	17.7 / 23.3	27	34.1 / 33.3	26	37.2 / 34.6	24	33.9 / 29.2	27	39.1 / 29.6	26	22.8 / 19.2
Rare	19	8.7 / 10.5	15	13.4 / 20.0	17	2.1 / 11.8	16	2.4 / 6.3	18	2.8 / 11.1	12	9.3 / 16.7
Overall	68	19.1 / 23.5	62	25.6 / 29.0	61	25.0 / 29.5	57	25.9 / 29.8	60	26.0 / 26.7	54	21.9 / 24.1
						% of Listed Detected, H^5						
Fed. Migr.	29[4]	33.3 / 51.7	37	36.9 / 46.0	34	38.9 / 52.9	32	36.5 / 53.1	31	40.6 / 48.4	29	30.2 / 41.4
Ngame.-Prot.	28	34.7 / 53.6	36	37.9 / 47.2	33	40.0 / 54.6	31	37.4 / 51.6	30	41.9 / 50.0	29	30.2 / 41.4
Game	3	11.1 / 33.3	3	11.1 / 33.3	2	0.0 / 0.0	2	16.7 / 50.0	2	16.7 / 50.0	1	33.3 / 100.0
Breeder	1	100.0 / 100.0	2	100.0 / 100.0	2	100.0 / 100.0	2	83.3 / 100.0	2	83.3 / 100.0	1	66.7 / 100.0
Perm.Res.	14	36.3 / 64.3	16	50.0 / 62.5	14	46.7 / 57.1	13	45.2 / 53.9	13	47.6 / 53.9	12	41.1 / 58.3
Transient	5	5.6 / 20.0	9	0.0 / 0.0	7	3.7 / 14.3	5	16.7 / 60.0	5	16.7 / 40.0	6	0.0 / 0.0
Trans./Breed.	11	36.4 / 45.5	12	33.3 / 50.0	12	42.5 / 58.3	13	26.9 / 38.5	12	36.4 / 41.7	11	36.4 / 45.5
Abundant	9	51.9 / 66.7	9	51.9 / 66.7	8	58.3 / 75.0	9	48.2 / 66.7	8	41.7 / 50.0	8	58.3 / 75.0
Accidental	6	4.8 / 16.7	9	0.0 / 0.0	7	3.7 / 14.3	5	16.7 / 60.0	5	16.7 / 40.0	6	0.0 / 0.0
Common	9	44.4 / 77.8	14	54.8 / 64.3	12	66.6 / 75.0	13	50.0 / 53.9	12	66.6 / 66.7	11	28.9 / 45.5
Rare	7	6.7 / 28.6	7	23.8 / 42.9	8	4.8 / 25.0	6	4.8 / 16.7	7	5.6 / 28.6	5	13.3 / 40.0
Overall	31	32.3 / 51.6	39	35.9 / 46.2	35	37.8 / 51.4	33	35.5 / 51.5	32	40.4 / 50.0	30	30.3 / 43.3

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of birds detected and listed by BOVA(A) / [A + number of birds listed by BOVA but not detected(B) + number detected but not listed by BOVA(C)]).
[4]Jaccard's index: number of listed species plus number of detected species, counting each species only once.
% of Listed Detected: number of species listed by BOVA.
[5]Represents 100(A / [A + B]).

Appendix 3. Indices representing the similarity of species detected in the field and also listed to occur by BOVA for status categories in various habitat types using 1986/1987 data (index for the mean of the 3 sites composing the habitat type[1] / index for habitat based upon a composite species list from the 3 sites in the habitat[2]).

Category	N	Mixed Seedling/Sapling	N	Mixed Pole	N	Mixed Mature	N	Deciduous Pole	N	Deciduous Mature	N	Coniferous Pole
						Jaccard's Index, J[3]						
Fed.												
Migr.	68[4]	21.7 / 26.5	64	29.0 / 26.6	62	26.4 / 30.7	59	28.2 / 32.2	61	27.6 / 26.2	60	23.6 / 21.7
Ngame.-Prot.	59	23.6 / 28.8	55	32.0 / 30.9	53	30.0 / 35.9	52	31.3 / 34.6	52	31.2 / 30.8	51	26.1 / 25.5
Game	5	16.7 / 40.0	4	8.3 / 25.0	4	0.0 / 0.0	3	11.1 / 33.3	4	27.8 / 25.0	2	66.7 / 50.0
Breeder	5	30.0 / 20.0	4	61.1 / 50.0	5	52.2 / 40.0	5	66.7 / 40.0	5	55.6 / 40.0	4	30.5 / 25.0
Perm.Res.	25	27.7 / 40.0	24	43.5 / 41.7	24	34.5 / 33.3	20	36.3 / 35.0	2 0	39.4 / 35.0	22	36.8 / 31.8
Transient	9	4.8 / 11.1	13	0.0 / 0.0	9	6.7 / 22.2	8	13.1 / 37.5	7	19.9 / 28.6	10	0.0 / 0.0
Trans./Breed.	37	18.0 / 18.9	30	21.2 / 20.0	30	19.6 / 23.3	30	19.1 / 23.3	34	16.2 / 17.7	27	23.2 / 22.2
Abundant	12	44.9 / 50.0	11	51.5 / 54.6	10	48.1 / 60.0	9	55.6 / 77.8	10	39.2 / 40.0	10	58.9 / 60.0
Accidental	9	4.2 / 11.1	12	0.0 / 0.0	8	6.7 / 25.0	8	12.5 / 37.5	7	18.5 / 28.6	10	0.0 / 0.0
Common	33	20.3 / 21.2	29	36.7 / 31.0	30	36.4 / 30.0	27	31.9 / 25.9	28	37.6 / 28.6	28	24.9 / 21.4
Rare	21	11.1 / 23.8	19	14.2 / 15.8	20	1.7 / 10.0	19	7.8 / 10.5	21	6.8 / 14.3	15	14.4 / 13.3
Overall	76	20.5 / 25.0	71	27.1 / 25.4	68	24.9 / 27.9	63	26.8 / 30.2	66	27.0 / 25.8	63	24.0 / 22.2
						% of Listed Species Detected[5]						
Fed.												
Migr.	29[4]	40.3 / 62.1	37	41.4 / 46.0	34	41.7 / 55.9	32	41.4 / 59.4	31	44.8 / 51.6	29	36.5 / 44.8
Ngame.-Prot.	28	40.5 / 60.7	36	42.6 / 47.2	33	42.9 / 57.6	31	42.4 / 58.1	30	46.3 / 53.3	29	36.5 / 44.8
Game	3	27.8 / 66.7	3	11.1 / 33.3	2	0.0 / 0.0	2	16.7 / 50.0	2	33.3 / 50.0	1	66.7 / 100.0
Breeder	1	100.0 / 100.0	2	100.0 / 100.0	2	100.0 / 100.0	2	100.0 / 100.0	2	100. / 100.0	1	100.0 / 100.0
Perm.Res.	14	40.5 / 71.4	16	54.2 / 62.5	14	48.9 / 57.1	13	47.6 / 53.9	13	52.4 / 53.9	12	57.3 / 58.3
Transient	5	5.6 / 20.0	9	0.0 / 0.0	7	7.4 / 28.6	5	16.7 / 60.0	5	22.2 / 40.0	6	0.0 / 0.0
Trans./Breed.	11	48.8 / 63.6	12	41.7 / 50.0	12	45.5 / 58.3	13	34.3 / 53.9	12	39.4 / 50.0	11	42.5 / 54.6
Abundant	9	57.0 / 66.7	9	55.6 / 66.7	8	58.3 / 75.0	9	55.6 / 77.8	8	45.8 / 50.0	8	66.7 / 75.0
Accidental	6	4.8 / 16.7	9	0.0 / 0.0	7	7.4 / 28.6	5	16.7 / 60.0	5	22.2 / 40.0	6	0.0 / 0.0
Common	9	52.4 / 77.8	14	61.9 / 64.3	12	71.8 / 75.0	13	52.4 / 53.9	12	69.2 / 66.7	11	47.2 / 54.6
Rare	7	27.8 / 71.4	7	28.6 / 42.9	8	4.8 / 25.0	6	15.1 / 33.3	7	16.7 / 42.9	5	26.7 / 40.0
Overall	31	39.1 / 61.3	39	40.2 / 46.2	35	40.5 / 54.3	33	40.2 / 57.6	32	45.5 / 53.1	30	37.4 / 46.7

[1]BOVA lists obtained through the element combination of District, County, Land.Use, and Fsize.
[2]BOVA lists obtained through the element combination of District, Land.Use,and Fsize.
[3]Represents 100(the number of birds detected and listed by BOVA(A) / [A + number of birds listed by BOVA but not detected(B) + number detected but not listed by BOVA(C)]).
[4]Jaccard's index: number of listed species plus number of detected species, counting each species only once.
% of Listed Detected: number of species listed by BOVA.
[5]Represents 100(A / [A + B]).

Appendix 4. Status categories with different index values ($P < 0.05$) among habitat types[1] for 1986-1987 data.

Category	Mixed Seedling/Sapling	Mixed Pole	Mixed Mature	Deciduous Pole	Deciduous Mature	Coniferous Pole
			Jaccard's Index, J			
Transient	4.8(BC)[2]	0.0(C)	6.7(BC)	13.1(AB)	19.9(A)	0.0(C)
Common	20.3(C)	36.7(A)	36.4(A)	31.9(AB)	37.6(A)	24.9(BC)
			% of Birds Listed that were Detected, H			
Accidental	4.8(BC)	0.0(C)	7.4(ABC)	16.7(AB)	22.2(A)	0.0(C)

[1] BOVA lists obtained by the element combination of District, County, Land.Use, and Fsize.
[2] Values with different letters within a row differ ($P < 0.05$).

The vita has been removed from the scanned document