DELMARVA'S WILDLIFE WORK GROUP'S PROCEDURE FOR HABITAT ANALYSIS[a]

BRUCE E. NICHOLS, Soil Conservation Service, 116 South Boulevard, Salisbury, MD
JOSHUA L. SANDT, Maryland Wildlife Administration, Tawes State Office Building, Annapolis, MD
GENE A. WHITAKER, U. S. Fish and Wildlife Service, Washington, DC

Abstract: The Delmarva Wildlife Work Group's procedure for wildlife habitat evaluation refined a procedure for comprehensible and sound development of data collection and analysis. This effort created an accepted format for communications between individual biologists and other professions. Work group consensus of particular wildlife habitat values including a quantity of land use, interspersion and management conditions were much more applicable than individual interpretations. This procedure permits prediction of future wildlife habitat values on lands with various planned activities versus unplanned activities. Application of the procedure involved 150 volunteer participants collecting data on 19,425 km² at 60,000 sites.

The Delmarva Peninsula is experiencing a growing conflict between agricultural, fish and wildlife, and environmental interests. An important goal of the Delmarva River Basins Survey has been to help resolve these conflicts and enhance the complementary situations. Data had to be developed to aid in identification of situations which were complementary or conflicting. There was also a need to identify habitat components of high value to fish and wildlife for their protection and to highlight these factors.

Proc. Annual Conf. S.E. Assoc. Fish & Wildlife Agencies 31:8-17

Major requirements of an analysis system are that it be comprehensible and sound so data can be supported. It should also be designed so individuals with different backgrounds can use the system, thus creating an acceptable tool of communication. To achieve this task a wildlife work group was established composed of: fishery biologists, wildlife biologists, botanists, foresters, mathematicians and personnel from other professions. The first task was to list the major environmental influences affecting the quality of the habitat. Various factors that needed to be surveyed such as hedgerow position, edge effect, management or vegetative condition, size of units, spatial relationships between land uses, human population and development related disturbance factors were identified.

A procedure was needed to establish a data base to quantify, appraise, and compare areas for their relative wildlife habitat values. The scope of the project was to gather data on 19,425 km² or approximately 1,902,063 ha of land and water comprising the Delmarva Peninsula, so accurate evaluations could be made for any land unit of 6,070 ha or larger. A methodology was needed to analyze the data and display land based fish and wildlife habitat relations. The basic model developed by Whitaker and McCuen (1975) was modified for use by the work group. The sampling procedure and the methods for evaluating inventoried conditions were expanded and refined.

In the design of data collection and analysis the work group stressed the need to be able to retrieve data for any geographical or political unit. A stratified random point sampling procedure was used to sample conditions which could be proportionally displayed for analytical purposes. Distance measurements were applied to display the spatial relationships between land uses.

Personnel from the states of Maryland, Delaware, Virginia, private organizations, and federal agencies were involved in the survey and are too numerous to acknowledge individually. Special thanks go to John Wenderoth for implementation of the technique for deriving the species-habitat weights consensus from the work group and to Lawrence Robinson for his creativity and review of the procedure.

[a]The Wildlife Work Group was formed as part of the Delmarva River Basins Survey, a cooperative study by The United States Department of Agriculture with The Maryland Department of Natural Resources, The Maryland Department of Agriculture, The Delaware Department of Natural Resources and Environmental Control and The Virginia Soil and Water Conservation Commission.

METHODS

Appropriate scale conversions were selected to produce two overlay stencils on a stable mylar base, one for aerial photos of 1:15840 scale and one for use as a control with USGS topographic sheets (quad sheet) of 1:24000 scale. The topographic sheets were also used to stratify the sampling procedure. The point numbering procedure was designed to allow ease of data retrieval and analysis. Six hundred sample points were randomly placed on the quad sheet mylar forming a stencil. Another stencil was produced by expanding these points to the mylar. Points were transferred to actual photos after formation of a mosaic.

Each point was given an identification number. A reference list was developed using the identification numbers as each point was pinpricked through the stencil and the point identification number recorded on the back of the photo. This recorded list was referenced when key punching identification on specially developed IBM Z26208 port-a-punch cards. The cards were selected to increase efficiency in handling field data. All data, including measurements were documented on the cards.

Data collection was organized by quads for ease of field use.

Inventory Key

A major task of the wildlife work group was defining land use and management or vegetative conditions that were meaningful divisions relative to wildlife habitat values. Creation of a land use and management condition key was the result of this effort. Five major land uses were defined: (1) Cropland, (2) Herbaceous land, (3) Rural residential-commercial, (4) Water dominated areas (wetlands), (5) Woodland.

Woodland was further subdivided to segregate values generally held by various habitat components for wildlife. Other components of the inventory key included vegetative strips and important miscellaneous field observations.

A dichotomous key was designed for the inventory of land use types by the Delmarva Wildlife Work Group in 1976. The key segregated types and established subdivisions under each major habitat component. Cropland was differentiated into 21 subdivisions. Herbaceous land, rural residential-commercial, and water dominated areas had 10 divisions each. Woodland, the most diverse of the groups was divided into: (1) Understory density, with 3 divisions, (2) Woody understory composition, with 8 divisions, (3) Dominant species group, with 10 divisions, (4) Dominant tree size, with 7 divisions.

The woodland key was developed by a woodland subcommittee over a 2-week field review and development period. Foresters and wildlife biologists were involved in the formation of the key. A wildlife subcommittee developed and tested the rest of the key using similar procedures.

The dichotomous key was field tested by three groups of professionals. A sample set of points was observed and interpreted by each group independently. The groups compared codes they assigned to each site. Results indicated agreement in almost all cases. Field application of a random point survey stresses the need to locate each point in the field realizing that it is a random point and any point chosen becomes representative of an area unit.

Point Definition

A point was defined as that location on the photo which had been designated by the pinprick. The woodland interpretation required investigation of additional surrounding area to develop a better insight to habitat values.

Understory determination was achieved by investigating the area surrounding the point irrespective of the size of the area. Generally, the determination of the tree species and tree size was achieved by investigating within a radius of 30.5 m of the pinpricked point. The dominant species and size were determned by viewing trees which comprised 50 percent or greater of an aerial view.

Field Procedure and Materials

All of approximately 150 participants worked in natural resource oriented jobs and were equipped with necessary equipment and materials. Participants were instructed in the use of the key by the same individual to limit variance of interpretation. At least one day of field instruction was included in the orientation to insure a uniform working knowledge of the procedure. Assignments for collection of data were distributed by quad sheets. Field investigations were performed in December, 1975 and January, February, 1976, due to the static nature of vegetation.

Field procedure was to locate the general area by use of the quad sheet and road maps and then refer to the aerial photo index sheet to determine the exact photo needed for specific locations. The next step was to locate the pinprick sample site. The IBM card for the point was then retrieved from the deck of IBM cards which had been pre-punched with quad sheet, point and photo identification numbers. The field site was located by the investigator from features on the photo and examined. Determinations were coded according to the key and recorded on the IBM card. This process was repeated until approximately 60,000 sites had been sampled.

Office Procedure

Each point was inspected using various resource reference materials to determine the county, soil type, river basin and watershed for inventory and analysis. This information was also punched on the IBM card.

All cards were subsequently transferred to an IBM diskpack to reduce storage space and facilitate data retrieval.

Value Judgment Procedure

The wildlife work group implemented a sampling procedure to express variability of habitats. Any given area can be significantly different in its ability to sustain wildlife from another area or that same area with manipulation.

Indicator species were used to develop an index of total habitat value for wildlife. Sixteen species were chosen for appraisal. Species were selected to appraise a wide range of habitat values, some associated with openland areas, others with woodland and still others with edge.

Indicator species included representatives from game and nongame to achieve a rounded interpretation. Additional species could be easily included in the appraisal. Species chosen were: bobwhite quail (*Colinus virginianus*), cottontail rabbit (*Sylvilagus floridanus*), gray squirrel (*Sciurus niger*), whitetailed deer (*Odocoileus virginianus*), mourning dove (*Zenaidura macroura*), Canada goose (*Branta canadensis*), eastern wild turkey (*Meleagris gallopavo*), meadow vole (*Microtus pennsylvanicus*), deer mouse (*Peromyscus leucopus*), meadowlark (*Sturnella magna*), mockingbird (*Mimus polyglottos*), wood thrush (*Hylocichla mustelina*), red fox (*Vulpes fulva*), raccoon (*Procyon lotor*), kestrel (*Falco sparverius*), black racer (*Coluber constrictor*).

The basic requirements of a species are food, cover and water (Leopold 1936). How well an area supplies these requirements can be indexed through interpretation of three major factors: (1) management condition or vegetative type, (2) interspersion of land uses, (3) quantity of land use.

These factors vary in relative importance when assessing habitat for any particular species. Based on the importance to a species each factor was assigned a numerical weight such that the sum of the three factors weights equalled 100.

The degree of disturbance by man is an additional factor which affects the ability of the habitat to sustain wildlife and was applied in development of transformation curves.

Management Condition. The relative value of each land-use management condition or vegetative type (habitat component) will differ for each species (Table 1) (woodland table and other supportive information is available in Appendix 1)[a]. The importance of each land use must also be quantified as a weight to be applied in the evaluation procedure. The relative value of each management condition or vegetative type and the magnitude of weights is only indirectly available from the literature on various species. Ultimately, the assignment of weights must be derived from the experience and knowledge of wildlife biologists familiar with each species and its habitat requirements.

Both to reduce the time involved in committee and to accurately account for a range of diverse opinions, an independent evaluation of habitat components was requested from each wildlife biologist with working field knowledge of the selected species and the habitat definitions employed during the survey. Each biologist was asked to assign weights, ranging from 1 to 99, to habitat components for a given species (Table 2) (graphs for each species in Appendix 2)[a]. Emphasis was placed on the species needs during critical periods of the year. The categories of each major habitat type were evaluated assuming an optimum condition of the other types. Among the cropland types, quail might receive a high score of 99 for "soybean stubble in old grain stubble (no-till)" and a low score of 1 for "ground tilled with essentially bare earth remaining." Other components of the cropland type would be arrayed on an interval scale between 1 and 99. Each biologist was asked to consider the total range of use of a habitat component when assessing the relative scores he assigned for a species.

Table 1. Rural residential-commercial land habitat components with an interpretive relative management value for each species. This value will be applied to derive an overall index to the rural residential-commercial management condition by multiplying it times the rate of occurrence and dividing that quotient by the total number of rural residential-commercial points investigated.

	Species															
Habitat Component	*Quail*	*Rabbit*	*Squirrel-Gray*	*Deer*	*Dove*	*Geese*	*Turkey*	*Field Mice*	*Deer Mice*	*Meadowlark*	*Mockingbird*	*Wood Thrush*	*Fox*	*Raccoon*	*Kestrel*	*Black Racer*
Commercial area <10% woody vegetation	.05	.08	.03	.07	.04	.09	.01	.20	.11	.19	.29	.01	.04	.08	.16	.17
Commercial area >10% woody vegetation	.20	.37	.22	.14	.37	.08	.02	.27	.36	.22	.75	.46	.24	.35	.27	.20
Roads, parking lots, etc. (per unveg.)	.02	.01	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.02	.01
Construction area and misc. unveg. area	.01	.01	.01	.01	.06	.01	.01	.01	.02	.01	.02	.02	.01	.01	.01	.01
Farm headquarters—reg. mowed <25% woody	.25	.21	.14	.11	.56	.50	.07	.36	.15	.27	.52	.12	.14	.22	.22	.42
Farm headquarters—weedy areas abundant >25% woody	.99	.99	.26	.14	.99	.28	.08	.76	.99	.30	.88	.87	.48	.81	.51	.78
Rural residential-commercial area—<25% woody	.18	.22	.19	.10	.23	.16	.04	.38	.28	.27	.79	.24	.11	.32	.17	.25
Rural residential-commercial area—>25% woody	.85	.73	.99	12.	.45	.11	.04	.52	.63	.25	.99	.99	.21	.76	.17	.33
Roads & rights-of-way—vegetated	.80	.97	.16	.99	.98	.41	.99	.99	.88	.99	.57	.37	.99	.72	.99	.99
Misc. principally vegetated areas (ball fields, parks, etc.)	.89	.79	.81	.64	.92	.99	.61	.50	.89	.88	.67	.96	.78	.99	.79	.71

The scores from such an evaluation could simply be averaged to summarize opinion. However, a simple average does not account for extreme variation in opinion. Knowledge of this variation can be used to isolate misinterpretations of habitat components or misunderstanding concerning the scoring procedure as well as account for divergent opinions in deriving a composite score.

Table 2. Cropland habitat components with an interpretive relative management value for each species. This value will be applied to derive an overall index to the cropland management condition by multiplying it times the rate of occurrence and dividing that quotient by the total number of cropland points investigated.

	Species															
Habitat Component	*Quail*	*Rabbit*	*Squirrel-Gray*	*Deer*	*Dove*	*Geese*	*Turkey*	*Field Mice*	*Deer Mice*	*Meadowlark*	*Mockingbird*	*Wood Thrush*	*Fox*	*Raccoon*	*Kestrel*	*Black Racer*
Crop not identifiable (grd. tilled)	.01	.01	.01	.01	.04	.14	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
Vegetables, live, perennial	.06	.84	.10	.73	.01	.28	.13	.39	.14	.14	.08	.10	.26	.63	.24	.16
Veg., residue, annual weeds abundant	.75	.67	.16	.43	.72	.25	.92	.96	.74	.99	.56	.66	.99	.60	.99	.79
Veg., residue, no annual weeds	.12	.27	.06	.28	.21	.20	.09	.31	.26	.34	.18	.18	.24	.34	.25	.12
Veg., residue, lightly tilled (cover and seeds sparse)	.15	.16	.05	.12	.14	.18	.09	.16	.07	.21	.08	.06	.12	.12	.15	.10
Veg., residue in cover or grain crop	.11	.57	.15	.50	.32	.59	.50	.43	.26	.38	.09	.12	.48	.25	.47	.36
Sm. grain or cover crop—prev. crop unidentifiable	.10	.52	.11	.52	.12	.68	.46	.29	.17	.21	.07	.11	.20	.09	.29	.14
Sm. grain stubble (sorghum, buckwheat, etc.)	.68	.26	.04	.11	.81	.44	.76	.79	.57	.93	.45	.51	.71	.43	.84	.59
Corn harvested—silage	.40	.08	.17	.13	.52	.50	.39	.32	.16	.34	.13	.10	.24	.22	.33	.15
Corn picked or combined	.92	.29	.99	.89	.99	.99	.99	.74	.46	.73	.36	.43	.67	.99	.79	.58
Corn lightly tilled, grazed or mowed	.50	.12	.78	.61	.82	.85	.65	.44	.28	.48	.15	.23	.45	.58	.51	.23
Corn in cover crop, residue plentiful	.65	.62	.89	.99	.71	.98	.95	.64	.44	.51	.27	.27	.62	.88	.65	.49
Corn in cover crop, residue scarce	.11	.50	.26	.56	.37	.75	.70	.32	.16	.16	.14	.21	.29	.27	.39	.23
Soybeans, no-till, old grain stubble evident	.99	.42	.55	.57	.84	.70	.69	.76	.49	.77	.33	.32	.73	.58	.80	.69
Soybeans stubble only	.97	.22	.42	.49	.55	.72	.60	.41	.26	.28	.25	.23	.39	.25	.47	.29
Soybeans lightly tilled, grazed or mowed	.66	.14	.32	.32	.43	.58	.39	.24	.10	.12	.17	.10	.23	.15	.25	.15
Soybeans in cover crop	.74	.58	.19	.75	.35	.83	.64	.36	.20	.14	.22	.26	.30	.30	.42	.29
Nursery multi-species >25% herbaceous growth	.55	.99	.36	.80	.62	.03	.49	.97	.98	.74	.99	.99	.94	.66	.79	.99
Nursery multi-species <25% herbaceous growth	.35	.57	.30	.50	.24	.02	.19	.49	.61	.31	.89	.88	.39	.39	.27	.52
Mono-species or orchard >25% herbaceous growth	.45	.82	.27	.76	.61	.01	.48	.99	.99	.73	.83	.82	.88	.64	.77	.97
Mono-species or orchard <25% herbaceous growth	.30	.35	.23	.45	.21	.01	.23	.48	.58	.28	.70	.63	.37	.42	.27	.51

The technique used for developing composite scores, which summarized the opinions of all biologists, first required the computation of a correlation matrix. These correlations show how well each biologist agreed with the others in the group and helped to identify misunderstanding in the application of the procedure. Anonymity was preserved so that in group discussions of an initial evaluation, each participant could adjust his scores with respect to group opinion without being pressured to agree if he chose to continue to disagree. The primary purpose of an intermediate committee discussion was to insure more uniform understanding of definitions and scoring procedures.

Correlations among biologists' scores were then used to determine the degree to which each biologists' opinion would be incorporated in the final score. This technique produces weights which are determined by the calculation of loadings on a principal axis in vector space (Gould and White 1974, Gould 1967). Each weight assigned by the biologist is multiplied by his score for a particular habitat component. These are summed over all biologists to produce a weighted habitat score. After all habitat scores are computed, they are rescaled to the range of 1 to 99. This procedure was applied to derive weights for habitat components within each major land use type.

Each major land use was then similarly weighted. The product of major land use weight and each individual component weight produced the final weight for that land use habitat component.

Some land use categories for certain species were designated as not applicable due to total nonuse of that habitat component or insufficient use to warrant discussion.

Interspersion Evaluation. Interspersion of land uses was considered one of the key indications of value to many species including quail (Baxter and Wolfe 1972). The random sample points were used to derive distance between land uses by measuring distances to formulate data which interpreted spatial distribution of land uses (habitat components) so that meaningful inferences could be drawn expressing habitat variances. Distance measurements were taken from each of the 60,000 points to the closest cropland, woodland, hedgerow (if woodland was not closer), herbaceous area, residential site, and road. The mean of the distance from one land use to another was determined by measuring from each point to surrounding land uses and can be applied as an indicator of the interspersion for that land use.

The sensitivity of wildlife species to spatial relationships or interspersion of land uses was displayed in graphic form by plotting transformation curves. Blank graphs were distributed to participants with the request that they use personal knowledge and literature research to plot the effects of distance relations on each of the 16 species. Each of the major land use divisions was considered being in optimum condition for any species when constructing the curve. For any given major land use category there is a range of values which becomes difficult to comprehend. By considering the optimum condition, the work group took the best possible situation for the species and assigned it the highest value. Lower value management conditions lower the overall value through application of the equation. *The three major factors; quantity of land use, interspersion, and management condition are all interrelated in the framework of the developing mathematical model and none are valid if considered alone.* The relative importance of each of these three factors as interpreted by the work group is displayed in Table 3 for each species.

The transformation curves display the sensitivity of a species to interspersion. The mean distance was used as the index to interspersion. The curve is structured to visually display the effects of the mean condition on use of the habitat by a species. As the curve decreases from 1 to 0, it displays sensitivity, 1 meaning no sensitivity to distance or complete utilization and 0 meaning due to great sensitivity species has essentially no use of major land use type at the expressed distance (Fig. 1).

The following distance relationships were chosen by the work group to apply in the analysis because of their demonstrated effects on various species. The mean distances used are from: (1) Cropland to woody cover, (2) Cropland to herbaceous cover, (3) Herbaceous land to cropland, (4) Herbaceous land to woody cover, (5) Woodland to cropland, (6) Woodland to herbaceous cover, (7) Distance from any point to rural residential-commercial, (8) Distance from any point to road.

Conceptually, the curves are structured displaying the distance a species will normally venture and utilize from land use Type A into land use Type B. This is displayed at the .5 value intersect. If the .5 value intersect had a corresponding distance measurement of 45.7 m and the mean measurement from land use Type A into land use Type B was also 45 m then one-half of the area would be utilized completely while the other half is unused. This same curve would be extended realizing that at 91.4 m only 25 percent of the area would be less than 45.7 m; and at 182.9 m only 12.5 percent would be less than

Table 3. Relative weights app lied in model to interpret importance of management condition, quantity and interspersion to each species. Once the index numbers for management condition, quantity and interspersion are derived each is raised to the power of the weight and multiplied together. The product is the overall index to total habitat conditions.

	Species															
Habitat Characteristic	*Quail*	*Rabbit*	*Squirrel-Gray*	*Deer*	*Dove*	*Geese*	*Turkey*	*Field Mice*	*Deer Mice*	*Mockingbird*	*Meadowlark*	*Wood Thrush*	*Fox*	*Raccoon*	*Kestrel*	*Black Racer*
Management condition	.30	.32	.43	.34	.52	.43	.33	.70	.55	.45	.62	.46	.39	.39	.36	.72
Quantity	.21	.22	.47	.36	.39	.49	.56	.25	.34	.45	.11	.45	.32	.17	.49	.12
Interspersion	.49	.46	.10	.30	.09	.08	.11	.05	.11	.10	.27	.09	.29	.44	.15	.16

45.7 m; and at 365.8 m only 6.25 percent is being used. The upper construction of the curve would be designed to fit the species. Conceptually, if the species would fully utilize 22.9 m out from land use A into B, the curve would be started at 22.9 m and proportionally develop it to meet the 45.7 m intersect.

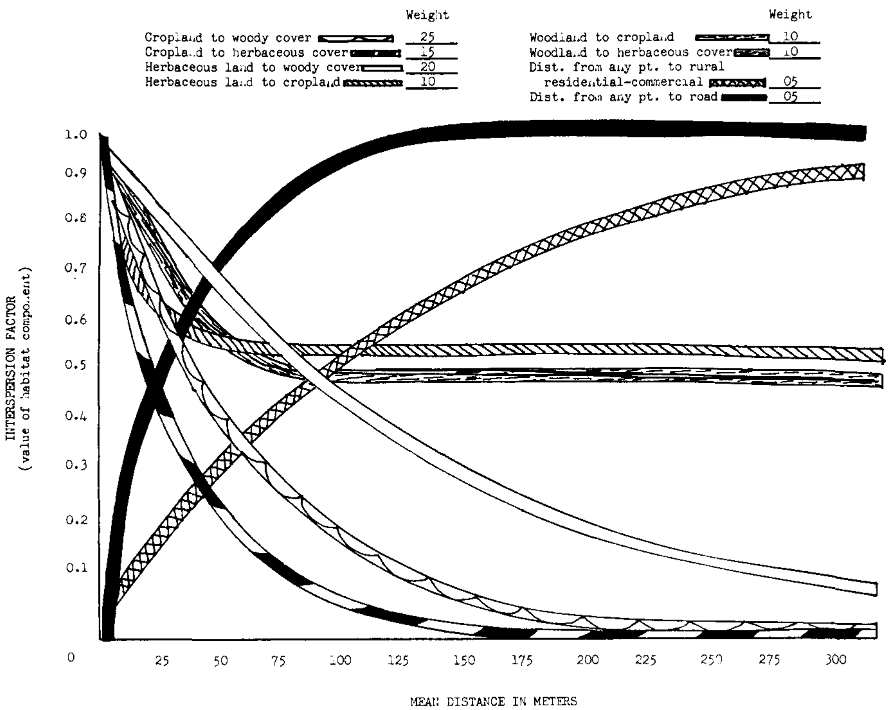

Figure 1. Curves used for quail to transform mean distance measurements into relative values. Values are extrapolated for each of the eight measurements and raised to the power of the weight and multiplied together producing an overall index to interspersion.

For some species interspersion is not important and is displayed in a straight line. The line should decline showing a decrease in value if there is any benefit from an edge effect to the species. The declining line would signify that as the distance increases a smaller percentage of the land use type is adjacent to the edge.

A rabbit in an optimum herbaceous land unit has a slightly higher use along a woodland edge with a limited benefit interiorally to approximately 61 m. After the 61 m limit is reached, the use of the herbaceous area becomes equal and is plotted as a straight line slightly declining as the distance from herbaceous land to woodland becomes greater.

Each of these measurements has a weight relative in importance to the others that must sum to one which is equivalent to the total effect on any particular species. Some become nonapplicable while others are equal in their display and can be expressed jointly by one curve. Some distance measurements seem to have no effect on a species and therefore were not plotted.

Quantity Land Use Curves. Some species such as gray squirrels, require a certain amount of a particular land use type and do not require additional diversity of other types. Other species such as white-tailed deer, may utilize a more diverse habitat; deer can survive in woodland but benefit from the existence of cropland and herbaceous land. The assumption is made that for any particular species there is an ideal condition where each land use becomes proportional for theoretical optimum habitat of that species.

The work group determined that to reflect the effect of land use quantities on the quality of habitat, curves would have to be structured showing the relative quantities of the following five land uses: (1) Cropland, (2) Herbaceous land, (3) Rural residential-commercial, (4) Water dominated areas, (5) Woodland.

These quantities should have an optimum level of existence for each species. The limitation of the survey is 6,070 ha. The range of the percentage land use is expressed on the graph with this in mind. On the graph the percentage of land use signifies to the interpretor the relative value expressed as a coefficient from 0 to 1. A scaled coefficient near 1 indicates an ideal quantity of a specific land use and a value near 0 indicates an inadequate quantity of a land use. Knowing that for certain species one land use can substitute for others, it is possible to have various situations of percentages of land uses with similar values. Within some curves plateaus are structured showing little to no variance of value to the range of land use percentages. Some species do not require curve developments for water or wetlands due to a lack of importance for that species (Fig. 2). Other species possess relative values for various land uses compared to other land uses (Table 4).

Table 4. Weights applied to develop relative indices of land use percentages on each species. Extrapolate from the curves found in example, figure 1 the quantity factors for each major land use category and raise them to the power of the weight and multiply. The product is the index of the value of land use percentages to the selected species.

	Species															
Land-use	*Quail*	*Rabbit*	*Squirrel-Gray*	*Deer*	*Dove*	*Geese*	*Turkey*	*Field Mice*	*Deer Mice*	*Meadowlark*	*Mockingbird*	*Wood Thrush*	*Fox*	*Raccoon*	*Kestrel*	*Black Racer*
Cropland	.25	.15	.08	.29	.59	.88	.19	.31	.09	.40	.15	.04	.20	.22	.42	.17
Herbaceous land	.45	.60	.05	.22	.18	.10	.11	.53	.15	.47	.25	.07	.43	.21	.44	.45
Rural residential-commercial	.05	.05	.07	.05	.08	.02	.00	.11	.10	.09	.30	.07	.05	.10	.07	.15
Woodland	.25	.20	.80	.44	.15	.00	.70	.05	.66	.04	.30	.82	.32	.47	.07	.23

DISCUSSION

The Delmarva Wildlife Work Group refined a procedure for comprehensible and sound development of collection and analysis of data. The data was collected over 19,425 km^2 at 60,000 sites. Involvement of over 150 participants led to wide acceptance and use of the procedure. Computerized retrieval of data led to increased use of data due to a minimal time requirement for extraction of information.

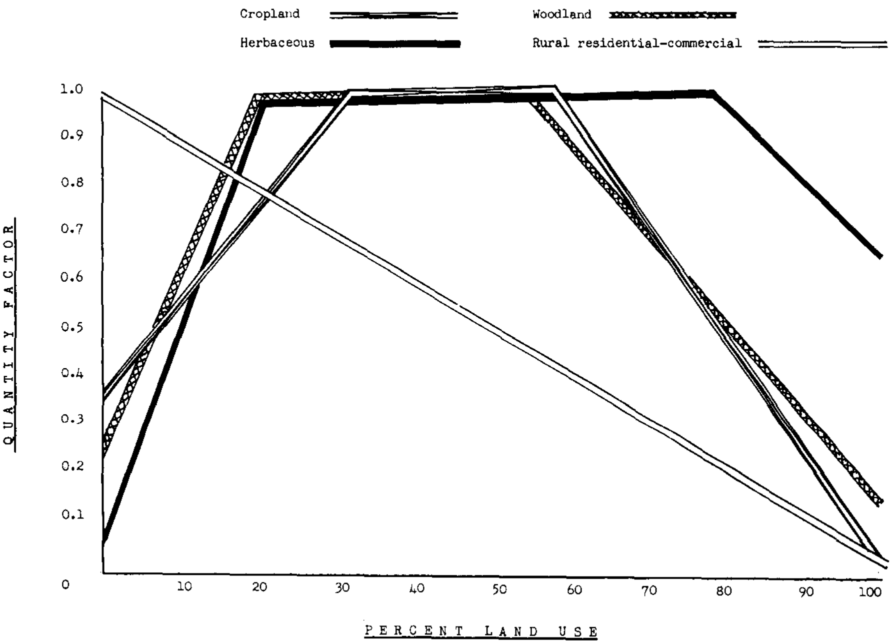

Figure 2. Curves to transform percent land use occurrences into relative values for quail. Values are extrapolated for each of the major land use types and raised to the power of the weight found in Table 4. The product of these indices determines the overall index value for quantity of land use.

The data bank will serve as a baseline data set for future investigations. This correlated with predictive modeling of habitat changes enables biologists to predict effects on wildlife populations of any project activity or on trends such as development. The data collection, due to time restraints, was developed to satisfy areas of 6,070 ha. The reliability of data analysis on units of smaller size depends on sample size and variables addressed.

Interpretation of wildlife values can be developed for each of the 16 species for any area of interest. Additional species can be entered with development of management weights, interspersion values and quantity curves. The basic data can be applied for interpretive habitat analysis for most species.

The total analysis procedure was consolidated through implementation of a computerized equation. Existing data was used to develop an index of existing conditions and their inherent values for wildlife. Predictive modeling of future conditions which depends on various controls such as project activities or successional stages were entered into the equation for development of index values. Index values could then be used to describe the effects of various future conditions. Decisions on various activities or modification of activities to obtain the desired future are then possible.

Through the application of this analysis procedure, the Delmarva region developed a cooperative working atmosphere among many varied interests and a data base to apply in decision making which was a consensus interpretation. Conflicts have been pointed out and attempts at solution are more successful due in part to greater knowledge and a better working relation.

The procedure applied in Delmarva takes considerable time to implement and it is tempting to use shortcuts. In smaller areas there are techniques for accomplishing this task. However, the habitat needs of all wildlife species are complex and often not fully understood. Temptation to oversimplify a procedure in the interest of time must be withstood to maintain credibility. Until we better define habitat needs for each species in measurable terms we must measure the management condition or vegetative type, interspersion and relative quantity of each land use to be able to formulate a valid index value.

LITERATURE CITED

Baxter, W. L., and C. W. Wolfe. 1972. The interspersion index as a technique for evaluation of bobwhite quail habitat. Nebraska Game and Park Commission, Lincoln. 11 pp.

Gould, P. 1967. On the geographic interpretation of eigenvalues. Trans. Inst. British Geographers. 42:53-86.

----------, and R. White. 1974. Mental maps. Penquin Books, Inc., New York. 204 pp.

Leopold, A. 1933. Game Management. Charles Scribner's Son, New York. 481 pp.

Soil Conservation Service. 1967. U.S. Dept. Agric. conservation needs inventory. College Park, Md. 92 pp.

Whitaker, G. A., and R. H. McCuen. 1975. A proposed methodology for assessing the quality of wildlife habitat. Tech. Rept. Dept. of Civil Engrg., Univ. of Md., College Park. 34 pp.