COMPUTER ASSISTED TECHNIQUES IN WILDLIFE RESOURCE PLANNING

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Abstract: A computer technique (IMGRID) is available that produces quantitative interpretable maps for land management planning. Information from a variety of natural resource documents and field surveys is restructured into a computer compatible format. The computer is used to manipulate data and print the results and their geographical location on computer-generated maps. These maps are useful in a planning process that attempts to match resource management objectives with land capability. Computer-assisted resource management techniques are flexible and allow the wildlife manager to make operational prescription management decisions from quantified site specific data.

Proc. Annual Conf. S.E. Assoc. Fish & Wildlife Agencies 31:233-238

The essence of decision-making includes: (1) defining land-use objectives, (2) determining what information is necessary for decisions, (3) analyzing and interpreting information, (4) selecting among various management alternatives, and (5) implementing a final management plan. The intermediate steps between objective setting and plan implementation are the focus of this paper. A technique is described that can assist wildlife and other resource planners manipulate information into an analytical format that allows maximum input for decisions.

METHODS AND TECHNIQUES

Conventional techniques are frequently adequate to assist land managers in site specific management decisions. Field maps with hand-drawn information (DeVos and Mosby 1969) may be sufficient for small areas where geographical variation of resources is limited and analysis is relatively simple. For areas that are more complex or require more detailed analysis, transparent hand-drawn overlay maps may serve the intended purpose (Crozier, Fuhriman, and Robinette 1974). However, overlay maps have the following limitations:

1) Analysis is limited to the coincidence and proximity of resources.
2) Subtle value distinctions and quantification of data are difficult.
3) Visual interpretation of overlay maps becomes increasingly more difficult with each additional map.
4) Updating and maintaining current resource information and land-use changes on overlay maps are expensive.
5) Overlay maps become unwieldy, costly, and inefficient as land area increases in size, complexity, and land-use potential.

As information needed for resource decision-making increases, a point is reached where hand-drawn overlay maps become inadequate. At this point, computer-assisted techniques may become practical and increase resource-analysis capacity significantly.

Test and Demonstration Area

A study area was selected to test and demonstrate a computer-assisted spatial analysis technique in resource management. The Norris Demonstration Area is a 6,883 ha tract located in Anderson County, Tennessee. The area includes a large valley bound on both sides by steep ridges. While a variety of land uses is found, pasture dominates in the valley with a dominance of hardwoods on the ridges. Norris Reservoir and the Clinch River are the major water resources located within the boundaries of the Demonstration Area.

Existing resource documents and field surveys were used to collect information for existing resources and land uses. Analyses of this information are used as examples throughout the paper.

Computer Programs

The computer-assisted resource management technique described is a series of programs called IMGRID developed by Sinton (1976). Although IMGRID has been used primarily for assistance in land-use and project planning, 2 important attributes make it applicable to wildlife resource management planning. First, IMGRID allows highly efficient manipulation of geographical data for production of maps with site specific resource interpretations. Second, the operation of IMGRID is dependent on an understanding of wildlife ecology and not on training in computer programing.

IMGRID is only one of many computer-assisted geographical information systems. For a review of other systems see Wilcott and Gates (1977).

Data Base Structure

Resource and land-use information is generally available in documents that vary in scale, format, and detail. It is difficult to correlate information from a county soil survey with information from a 7½ minute USGS quadrangle map since the scale and detail of these 2 documents differ. In their original form, these maps cannot be overlayed to identify coincidental and proximal resources and land-use patterns. The problem is magnified when additional resource documents and field surveys, each with a different scale and format, are overlayed for particular resource analyses.

The IMGRID program uses variable sized grid cells to transform information from resource maps into a digital format. A grid is superimposed on each of the resource maps and forms the basic unit for coding. (Fig. 1). For the Norris Demonstration Area, each grid cell equals approximately 1.1 ha.

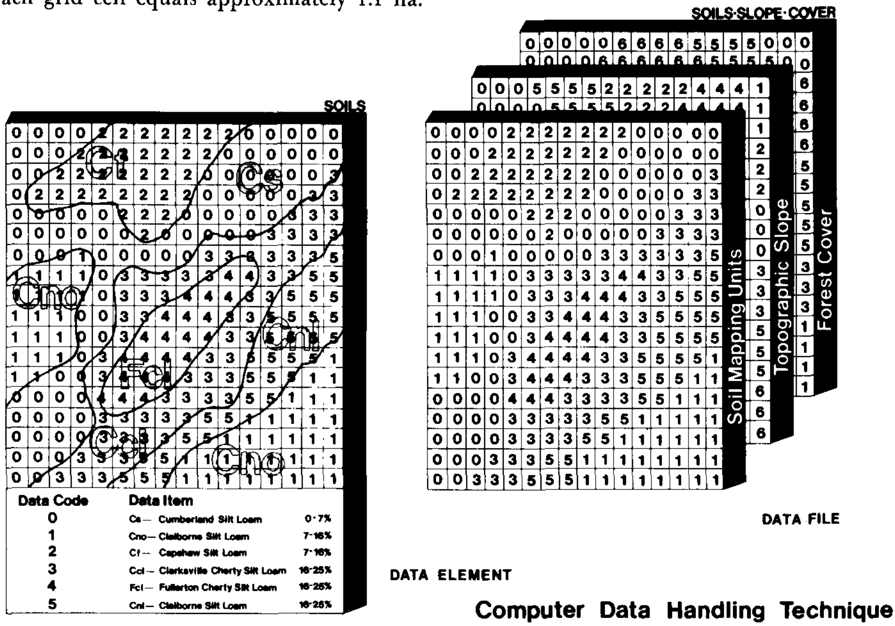

Fig. 1. Converting resource information into a computer-compatible format. Data items (descriptive information) are assigned data codes (numerical designation) for each data element (a mutually exclusive set of data such as soils). The collection of data elements creates the data file.

A conceptual understanding of 3 terms is necessary before proceeding (Fig. 1):

1) Data file —A collection of data elements that are stored as a unit for retrieval and processing.

2) Data element—A mutually exclusive set of information that describes a natural resource or land-use unit (e.g., soil-mapping units, forest cover, water resources, roads).

3) Data item —Data items represent the descriptive information in each grid cell which collectively make up a data element (e.g., oak-hickory forest type is one data item in the forest cover data element).

Map Display

The interpretation of resource maps involves recognition of particular patterns. Visual interpretation is impaired when irrelevant information clutters the resource map.

Data elements can be retrieved from the data file and symbolically displayed in computer-generated maps (Fig. 2). IMGRID has the option of projecting all of 1 data element on 1 map, or information can be limited to specified data items. This flexibility allows the creation of maps that are easy to translate and allows the wildlife manager to consider only the relevant information for each management decision.

Fig. 2. The entire forest-cover data element for the Norris Demonstration Area.

A summary of statistical information is presented in a histogram located on each map. The histogram shows the frequency of each defined category. In Fig. 2, 2,538 cells were printed as hardwood forest. By knowing the cell size—1.1 ha for the Norris Demonstration Area—the number of hectares in hardwood forest can be calculated easily. In the Norris area, 2,754 ha or 40 percent of the total area is in hardwood forest.

Data Management

Long-term comprehensive resource management requires a reliable information bank. To accommodate land-use policy changes or simply to have access to the geographic location of existing resources for management prescriptions, the manager needs permanent and retrievable records of resource inventories and analyses at his immediate disposal. This is especially valuable where land-use patterns are changing rapidly, or when outside interests are placing constant demands on the system for information.

Resource information is updated easily and economically using IMGRID. Rather than changing the entire data element, only the information in affected grid cells is updated. For example, if 100 ha of timber are clearcut in a mature forest stand, only those grid cells describing timber size in the clearcut area are updated in the timber size data element. This permits the manager to make site specific land management decisions with current and reliable information.

INTERPRETING INFORMATION

It is possible with IMGRID and frequently useful to make different interpretations from one data element. For example, each soil data item (soil mapping unit) has an interpretation for erosion, permeability, productivity, and other characteristics. Without the aid of the computer, it is necessary to reclassify and redraft manually the original soil survey map for each interpretation. By using IMGRID, the original soils document is handled only once for coding the soil units by grid cells. Interpretations are defined by the soil specialists while the mechanical steps of sorting, classifying, and mapping are executed by the computer.

Coincidence of Resources

IMGRID programs are designed to superimpose information from different data elements. For example, information describing timber stand type, timber stand size, and position on the slope could be superimposed to identify areas for hardwood mast production. Specifically, the occurrence of different combinations among these resources could be used to geographically locate potential mast yields of an area. The IMGRID programs allow superimposing any number of resources. However, complexity of interpreting the mapped results increases with each additional piece of information.

Proximity of Resources

The capability to identify proximal distributions of resources is another important attribute of IMGRID. Fig. 3 graphically displays areas that are not in close proximity to water. To identify these areas, a search was performed by the computer from permanent water sources. This map could be used to identify areas where constructed waterholes would enhance the habitat for certain species. The IMGRID user has complete control over distance of searches and can dictate practically any radius appropriate to the analysis.

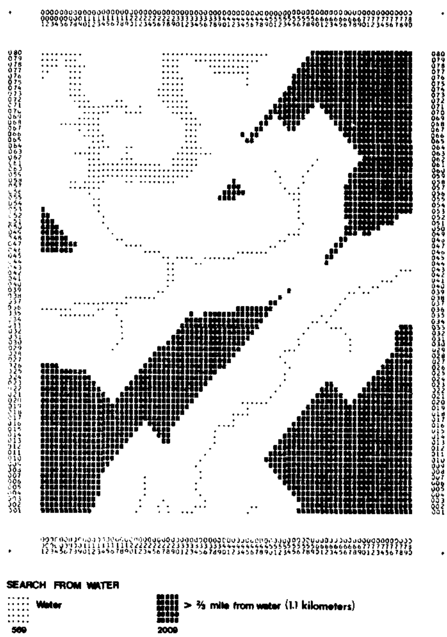

Fig. 3. Proximity search. Areas less than and greater than 0.7 miles (1.1 kilometers) from permanent water sources are identified.

Models For Wildlife Management Planning

Mathematical models provide a useful method for describing complex problems faced by the wildlife manager. Models can provide a formal system for matching land management objectives with resource suitability.

IMGRID can be used to weight resources mathematically according to their relative importance and map the results. Two types of weighting are possible, internal weighting of data items within a data element, and external weighting of data elements against each other. For example, a wildlife biologist might consider forest canopy closure and position on the slope as important ecological data elements for evaluating deer browse. Within forest canopy closure, the less dense canopies are more productive and are given a higher mathematical weight. The lower parts of slopes in the Norris area generally have more water available for plant growth and support lush vegetation. Therefore, lower slopes and bottomlands are weighted higher. Internal weighting, or evaluating the relative importance of data items within data elements, thus is accomplished. Next, the biologist may decide that forest canopy closure is actually the controlling factor and that it is significantly more important than position on slope. The final step, external weighting, involves converting the ranked importance of two related resources into mathematical weights. IMGRID sums the product of internal and external weighting, assigns each grid cell a numerical value, and prints the results as symbols on computer-generated maps.

Fig. 4 shows a deer habitat model. This model reflects the biologists' frequent desire for interspersion of important habitat parameters. For purposes of illustration, potential mast producing areas, browse availability, and pasture were identified as important habitat parameters for deer. "Submodels" were created for each habitat parameter by using coincidence of pertinent ecological information. The next step identified areas where the 3 habitat parameters exist in close proximity to one another. In other words, the model first evaluates the individual habitat parameters occur close together.

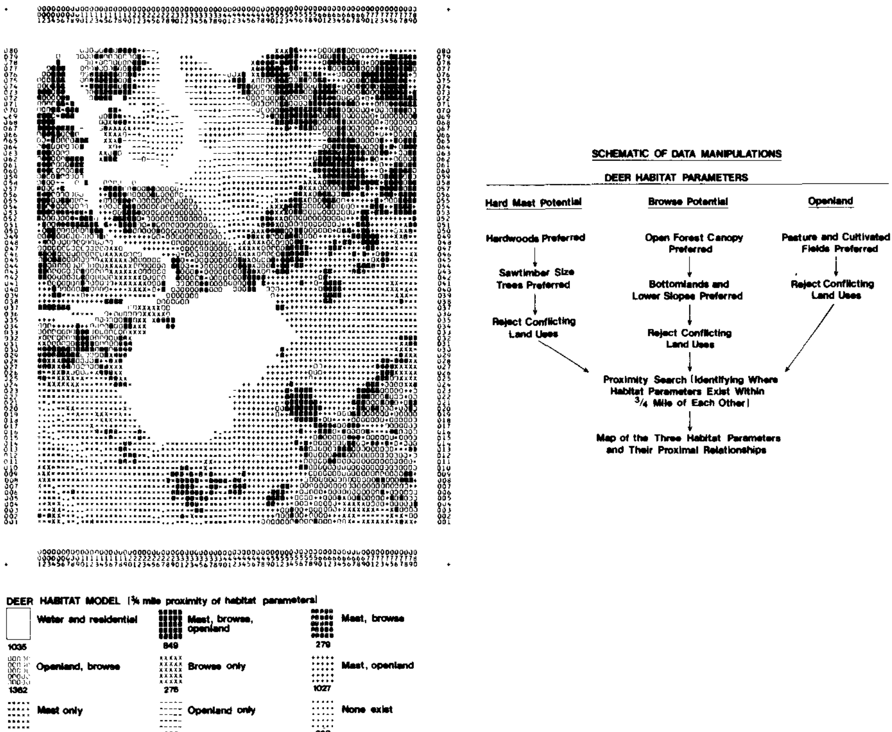

Fig. 4. Deer habitat quality model that first evaluates important habitat parameters and, second, identifies areas where these parmeters are found in close proximity.

This model could also be used to identify the "limiting factor" in areas that presently have low deer habitat quality. By having a map printed of each submodel or habitat parameter, the biologist can isolate deficient habitat features and prescribe site specific management to improve habitat.

SIMULATED MANAGEMENT SCENARIOS

Wildlife managers often are faced with conflicts of land use and trade-offs among different management alternatives. Each management decision causes a chain reaction and ultimately affects many resources. The selection among alternatives can be more objective by using simulated results that mimic management prescriptions. IMGRID can be used to display on computer maps the results of various management alternatives. For example, the effects of a prescribed clearcut on mast production or "edge" can be graphically displayed and easily communicated to wildlife managers.

COST OF IMGRID

The cost of implementing IMGRID is difficult to generalize. Costs are largely dependent on size of analysis area, grid size for coding data, and number and complexity of data elements. For the Norris Demonstration Area, 26 data elements were coded. These included natural resource information (e.g. land cover types, topographic features, water resources) and land-use features (e.g. roads, land ownership, zoning). The total cost of coding data, computer card punching, and entering data for the Norris Demonstration was approximately $2,500.

There are other costs associated with IMGRID. The cost of the computer programs is approximately $400. Collecting field inventory data is very expensive. However, field data collection is necessary for any comprehensive planning effort and is a fixed cost regardless of the data handling technique. Obviously, access to a computer and printer is necessary. For the Norris Demonstration, computer-generated maps cost $.40 to $.75 each, depending on the complexity of computer manipulations. Keeping resources in the data file updated is also an associated cost, although, as mentioned earlier, updating resource information is relatively minor and inexpensive.

CONCLUSION

IMGRID is a powerful resource management aid and not just a mapping tool. Wildlife biologists are still grappling with procedures through which they can inventory resources and make inferences about wildlife habitat suitability. While the biologist undoubtedly uses a complex reasoning process when judging habitat conditions, there is likely a fundamental methodology underlying his actions. Specifically, the biologist is likely going through a system of "resource pattern recognition" (coincidental and proximal relationships) and determining the relative importance of resources (mathematical weighting).

IMGRID can be used to aid and formalize the thought process of judging habitat suitability. It can manipulate data under the direction of the biologist and display the results. Besides forcing the biologists to think clearly, concisely, and comprehensively, the maps offer quantitative interpretable information that is easily examined, compared, and communicated.

IMGRID or other computer-assisted techniques are not applicable in many planning processes. Manual techniques are frequently adequate. The appropriate data handling technique depends largely on the quantity of data, the detail of analysis, the output best suited for the decisions being made, the financial constraints, and the time frame.

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