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ANALYSIS OF RADIOTRACKING DATA USING DIGITIZED HABITAT MAPS

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Abstract: A method is described that provides a rapid and accurate analysis of habitat used by radio-equipped animals. The digitizer (basically an X-Y plotter in reverse) converts maps into digital form by describing each habitat unit as a polygon that closely approximates the actual shape of the unit. The coordinates of each polygon are then stored on magnetic tape. Habitat classification data and other information are coded and combined with the proper polygon coordinates. This results in one file containing all habitat data. A computer program with inputs of tracking data and habitat data provides a listing of the habitat used by the animals studied. Analysis of habitat used by radio-equipped ducks is demonstrated using this method.

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Tracking radio-equipped animals often results in the accumulation of large numbers of fixes (animal locations) which are analyzed to determine information such as home range, movement patterns, and habitat use. Determining the habitat used by an animal in its daily and seasonal movements is of particular interest in ecological studies. Several methods have been used to analyze animal locations in relation to habitat. Most tracking studies involving fewer than several hundred fixes are efficiently handled by overlaying hand or computer drawn maps on habitat maps and visually determining the habitat for each fix. Another method is to record the habitat each time a location is obtained. In studies involving thousands of fixes, a more rapid and flexible method of data analysis is required. Siniff (1966:5) described a computer program which partitioned a study area into 0.65-hectare squares and determined the number of fixes in each square. An X-Y plotter produced a graphic display

of this information which could be overlaid on a habitat map. Nicholls and Warner (1972) used 0.65-hectare squares, each with an assigned code based on the dominant habitat in that square, to study habitat used by radio-equipped barred owls (*Strix varia*). The number and percentage of fixes occurring in each habitat type were then calculated by a computer. The method described in the present paper used a digitizer to convert habitat maps into digital form on magnetic tape. A computer program with inputs of converted map data and animal fixes determined the habitat type of each fix and provided a listing of the number and percentage of fixes occurring in each habitat type. This method is similar to that used by Gilmer (1971:23). Tomlinson (1968) described the use of a digitizer as a component of a system for storing and analyzing map information relating to rural development.

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PROCEDURE

The digitizer is basically an X-Y plotter in reverse. It converts locations on a map to numerical data and writes them on tape or punches cards. Several manufacturers produce digitizers, and numerous models are available. The machine we used is an Auto-trol Corp. Model 3400 equipped with a magnetic tape unit. (Use of trade names does not imply endorsement of commercial products by the Federal Government). The location of any particular point is determined by the X and Y positions of a cross hair reticle. Movement of the reticle is detected with an accuracy of 0.0025 centimeters. Coordinates of a point and up to 15 digits selected manually by the operator are transcribed to the tape when the operator places the reticle on a point and closes a switch (foot pedal or by hand). Digitizer output consists of a series of records with a format determined by an operator-wired patch panel.

Digitizing can be done directly from aerial photographs or other maps used for field tracking. Prior to digitizing a map, all habitat boundaries are redrawn using straight line segments which approximate the curvature of actual habitat boundaries. Thus, each habitat unit is enclosed within a polygon, and polygons can be nested one within the other. Tracking accuracy, resolution of animal locations, and the importance of specific boundaries must be

considered in deciding how accurately to describe habitat boundaries. Computer processing time increases as the number of sides per polygon increases. All boundary points defining a polygon should be clearly indicated on the habitat maps to avoid confusion when digitizing. Each habitat unit is assigned a unique polygon identifier (the map coordinates of a central point within the unit) and habitat classification codes.

A map with all habitat units clearly defined is fastened to the digitizer table with the north-south axis of the map parallel to the Y axis of the digitizer and a magnetic tape mounted on the tape unit. Settings are made on the digitizer control panel as recommended for POINT MODE operation (Hybrid Computer Lab., University of Minn., unpublished instructions).

The software system we developed for use with the digitizer and a CDC 1700 digital computer requires that the digitizer patch panel be wired to provide a record with a format of 4 (11, 216)16. Each record consists of four code fields: a pointer code (11) and X and Y readings (216); the fourth field in each record is followed by a six-digit polygon identifier (16). Pointer and polygon identifier codes are set manually by thumbwheels on the control panel. The pointer code is used to determine whether a point is the initial or a subsequent point defining a polygon, and this is reset only immediately before and after the initial point of a polygon is digitized. Polygon identifier codes are reset each time a new polygon is started.

The digitizer tape is generated by manually setting the polygon identifier code, placing the cross hair reticle over a point on the map defining the polygon to be digitized, closing the switch, and then proceeding to the next point, making any

necessary changes to the pointer code and again closing the switch. This process is continued until all polygons on the map are digitized. After digitizing the last polygon of a map, the reticle is placed in turn over each of the four corners of the map boundary and the coordinate values are read from the visual display counters (Nixie type) and manually recorded but not written on the magnetic tape. These values are later used to convert the digitizer coordinates into the coordinate system of the map. Upon completion of the map, an end-of-file mark is placed on the tape, and additional maps are started as previously described.

The only restrictions required by our software system are the following maximum numbers: (1) points used to define a single polygon, 92; (2) number of polygons per nest, 10; (3) number of polygons per map, 95; (4) number of maps, 47.

The digitizer tape is checked by a digital computer for parity errors and errors in digitizing (i.e. code omission or incorrect coding). A FORTRAN program converts these data into the coordinate system used in animal tracking and arranges the digitized data into the desired format. Inputs for this program are the digitizer tape and an identifier card for each digitized map. The identifier card contains the map identification coordinates and the digitizer coordinates of the map boundaries. As new maps are digitized, these are added to the file and an updated tape created. After all maps are digitized, the result is a tape containing map data which is now ready for the addition of habitat information. Habitat data are associated with each polygon identifier and placed on cards. A FORTRAN program reads these cards onto a disk file and combines the converted map data tape and the disk file to create a new

habitat tape containing polygon coordinates and habitat information. Polygon and habitat data can be corrected or added, and entire maps can be added to or deleted from this tape.

The final step in the procedure involves the analysis of radiotracking data. A FORTRAN program reads the habitat tape onto a disk for easy accessibility. The program then reads animal fixes from either cards or tape and determines into which polygon, if any, each fix falls. A rapid filtering process is accomplished using the following sequence: the program determines what map contains the fix and then determines whether the fix falls within the predetermined maximum and minimum values of any of the polygons that belong to that map. If the fix falls within the maximum and minimum values of one polygon, the sequence is completed; however, if the fix falls within the maximum and minimum values of several polygons, the program determines which is the innermost. Another location is read, and the process is repeated. The program output consists of a listing of polygon identifiers for the polygons containing animal fixes and the number of fixes in each polygon. Additional listings are provided depending on the habitat information provided for each polygon. An optional feature of the program enables the investigator to search data files for fixes occurring in certain habitats by specifying the desired polygon identifiers. Printed output consists of each polygon identifier followed by a listing of the fixes in that particular polygon.

RESULTS

Data obtained in a waterfowl tracking study conducted in north-central Minnesota were analyzed with respect to a classification system based on wetland plant

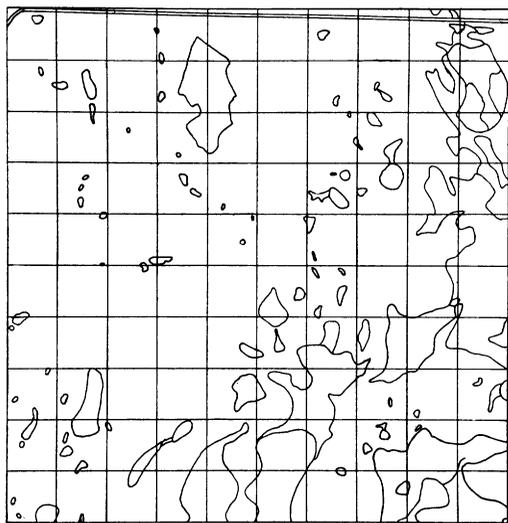


Fig. 1. Field map of 1 square mile indicating all wetlands.

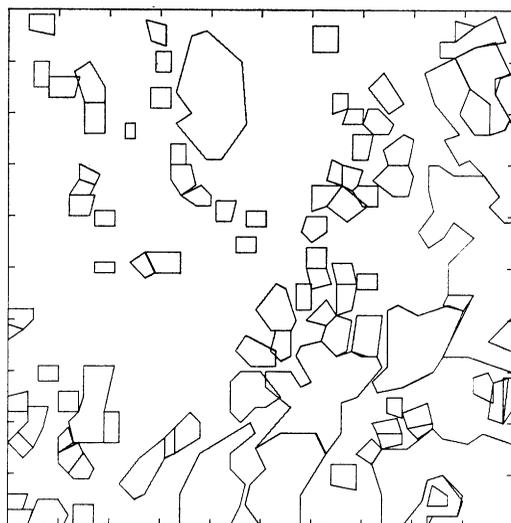


Fig. 2. Digitized version of the map in Fig. 1 reproduced on an X-Y plotter.

communities within wetland complexes (Cowardin and Johnson, in press). This classification was specifically designed for analysis of radio-tracking data. Some of the plant community names are equivalent to wetland type names used by Stewart and Kantrud (1971) or Martin et al. (1953) as used by Shaw and Fredine (1956). Names used for plant communities in lakes and along shorelines are new. Only wetland habitat was digitized because the waterfowl species studied did not use upland habitat except for some nesting sites. Polygons describing discrete habitat units were enlarged slightly to facilitate digitizing and to insure that fixes on the edge of these units fell within the polygon. These enlargements did not affect the interpretation of habitat use. Wetland stands with similar characteristics were assigned the same plant community. The stands were the units that were digitized. A field map indicating all wetlands in 2.59 km² and a digitized map of the same area reproduced on an X-Y plotter are shown in Figs. 1 and 2, respectively. An experienced operator required

approximately 30 minutes to set up and digitize this map. Habitat information for each stand consisted of a code for the community and complex to which it belonged, and a code based on the area of the stand. The total area digitized was 98 km² and contained more than 1600 individual polygons.

A radio-equipped mallard (*Anas platyrhynchos*) with a brood of ducklings was tracked from 19 July to 29 August 1971; habitat used by her is shown in Table 1. The computer listing provided a summary indicating the total number of locations in the data file. If some fixes were located outside the area digitized, these points were counted and listed as "number of points for which no map found." If the duck's location was within a digitized map but did not fall within a habitat polygon, the total was listed as "number of points outside polygons," and all identifying data relating to these fixes were printed out in order to permit checking their correctness. For this particular duck, five fixes were in this cate-

Table 1. Distribution of 122 locations of a radio-equipped mallard hen with a brood of ducklings from 19 July to 29 August 1971 according to wetland complex, plant community, and wetland size.^a

Locations visited by hen	No. fixes	Percent of fixes
Wetland complexes		
Nonpermanent	16	13.79
Sand lakes	68	58.62
River channel	9	7.76
River marsh	23	19.83
Total	116	100.00
Wetland plant communities		
Seasonal—patchy ^b	2	1.72
Semipermanent—open ^c	15	12.93
Hardwood swamp	1	.86
Open water	25	21.55
Bulrush (<i>Scirpus acutus</i>)	6	5.17
Phragmites (<i>Phragmites communis</i>)	1	.86
Wild rice (<i>Zizania aquatica</i>)	10	8.62
Sand bar—shrub swamp with bulrush (shoreline) ^d	1	.86
Sand bar—shrub swamp (shoreline)	3	2.59
Sand bar—pond with bulrush (shoreline)	2	1.72
Sand bar—pond (shoreline)	5	4.31
Sand or gravel with bulrush (shoreline)	9	7.76
Sand or gravel (shoreline)	2	1.72
Rock and boulder with bulrush (shoreline)	17	14.66
Rock and boulder (shoreline)	3	2.59
Overhanging brush with bulrush (shoreline)	4	3.45
Residential with bulrush shoreline	3	2.59
River (misc. communities) ^e	7	6.03
Total	116	99.99
Size of wetlands		
0.04– 0.40 hectares	8	6.90
0.40– 4.05 hectares	25	21.55
4.05– 40.50 hectares	17	14.66
40.50–405.00 hectares	66	56.90
Total	116	100.00

^a Total number of radiolocation points in data set, 122; number of points for which no map found, 1; number of points outside polygons, 5; number of points inside polygons, 116; number of polygons containing points, 39.

^b Patchy refers to interspersions of emergent vegetation and water and is equivalent to cover type 2 of Stewart and Kantrud (1971).

^c Open means there is no emergent vegetation at center of stand and is equivalent to cover type 3 of Stewart and Kantrud (1971).

^d Shoreline habitat includes the strip 20.1 m on either side on the water's edge.

^e Plant communities too complex to digitize.

gory, and the entire card image including information such as date–time group, coordinates, observer, and behavior codes were listed (not shown in Table 1). Also listed were the number of fixes falling inside polygons as well as the total number of polygons containing fixes.

The computer determined the number of fixes in each category (i.e. wetland com-

plex, plant community, and size) and for each subcategory printed the number and percent of the total (Table 1). For example, the mallard hen was found in nonpermanent wetlands 16 times, or 13.8 percent of the total number of fixes in all wetland complexes; in seasonal–patchy stands twice or 1.7 percent of the fixes in all wetland plant communities; in wetlands 0.04 to 0.40

hectares in size eight times or 6.9 percent of the fixes in all size classes. Listings of the use of combinations of plant communities within wetland complexes, for example, seasonal-patchy plant communities of nonpermanent wetland complexes, were also obtained, but are not given in Table 1.

DISCUSSION

The major advantages of this system over the other described methods of analyzing telemetry habitat data are: (1) the speed and accuracy with which habitat maps can be prepared for analysis, and (2) the ease with which map and habitat information can be added or changed.

Habitat use as determined by this method does not imply habitat selection. In order to draw conclusions concerning habitat selection, the habitat available to the animal must be defined based on criteria determined by the investigator.

FORTTRAN programs used by the authors were designed for use on a CDC 1700 computer but may be modified for use on other systems. These programs are available on request from the authors.

LITERATURE CITED

- GILMER, D. S. 1971. Home range and habitat use of breeding mallards (*Anas platyrhynchos*) and wood ducks (*Aix sponsa*) in north-central Minnesota as determined by radio tracking. Ph.D. Thesis. Univ. of Minnesota. 142pp. plus [22].
- COWARDIN, L. M., AND D. H. JOHNSON. 1973. Preliminary classification of wetland plant communities in north-central Minnesota. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. (In press.)
- MARTIN, A. C., N. HOTCHKISS, F. M. UHLER, AND W. S. BOURN. 1953. Classification of wetlands of the United States. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. 20. 14pp.
- NICHOLLS, T. H., AND D. W. WARNER. 1972. Barred owl habitat use as determined by radio telemetry. J. Wildl. Manage. 36(2):213-224.
- SHAW, S. P., AND C. G. FREDINE. 1956. Wetlands of the United States: their extent and their value to waterfowl and other wildlife. U.S. Fish Wildl. Serv. Circ. 39. 67pp.
- SINIFF, D. B. 1966. Computer programs for analyzing radio tracking data. Minnesota Mus. Nat. Hist. Tech. Rep. 12. 22pp. Mimeogr.
- STEWART, R. E., AND H. A. KANTRUD. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U.S. Bur. Sport Fish. Wildl. Resour. Pub. 92. 57pp.
- TOMLINSON, R. F. 1968. A geographic information system for regional planning. Pages 200-210 in G. A. Stewart, ed. Symposium on land evaluation. Macmillan, Australia. 392pp.

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