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Cartographic Trend Analysis of Furbearer Harvest Distributions in Arkansas

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A CARTOGRAPHIC TREND ANALYSIS OF FURBEARER HARVEST DISTRIBUTIONS IN ARKANSAS

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ABSTRACT

Average by-county fur harvest for the last nine harvest seasons (1977-1985) was used as data points to be interpolated using nearest neighbor algorithms in computer-assisted trend analyses. COMPLOT maps were produced which represented a surface of harvest densities drawn over a map of Arkansas. Twelve furbearer species are examined, and "topographic" features of harvest density for each are interpreted in terms of ecology and/or buyer distribution. The trend surface technique removed some of the error inherent to harvest records, and produced an aesthetic graphical display of the information that was more easily interpreted and explained than other methods of analysis usually allow.

INTRODUCTION

Furbearer harvest records in Arkansas have received an appreciable amount of attention in recent years (Bailey and Heidt, 1978; Tumlison *et al.*, 1981; Tumlison *et al.*, 1982; Heidt *et al.*, 1984; Clark *et al.*, 1985; Heidt *et al.*, 1985; Peck and Heidt, 1985; Peck *et al.*, 1985; Tumlison and McDaniel, 1986). Analyses have examined questions of species distribution, effect of price on harvest level, and effect of furbuyer distribution on reported harvest. Heidt *et al.* (1985) and Peck *et al.* (1985) analyzed Arkansas fur harvests at a state and regional level, both using harvest records collected by the Arkansas Game and Fish Commission (AGFC) since 1942. The purposes of this paper are: 1) to analyze harvest records at a by-county level and 2) to demonstrate a new technique that may be applied to analysis of harvest records.

Fur harvest records have been compiled, by county, by the AGFC for each of the last nine harvest seasons (1977-78 through 1985-86). During the first few of these years, by-county results were displayed in tabular form, and in the latter years results were displayed on Arkansas maps. The use of maps rather than tables enhances interpretation, but yearly fluctuations obscure long-term trends, as they are affected by market trends, weather, furbearer population densities, and furbuyer distribution. Some of the annual variation may be decreased by averaging reported harvest levels for each ccounty over a period of several years. We used such averages as input data for computer-assisted cartographic analyses of harvest trends for twelve Arkansas furbearers.

METHODS AND MATERIALS

Several computer packages (e.g., SYMAP, SURFACE II, SASGRAPH, CALFORM) are available for generating maps. SYMAP fits a surface to data points located within a map outline, and one of the electives provides a plot of residuals which can be analyzed to show strengths and weaknesses in the fit of the generated surface to the data (in a manner similar to regression analysis of bivariate data). A more asesthetic map, albeit with less statistical information, is produced using the SURFACE II algorithm. This program generated the maps presented here.

The SURFACE II program requires two data sets: 1) an outline map obtained by identifying cartesian coordinates of landmark points around the map perimeter, and 2) a set of data to be plotted. Three values (identified as X, Y, and Z) are required in this data set. The X and Y values are cartesian coordinates of the data points, and the Z value is the datum to be placed at the coordinates. We approximated the centroid of each of the 75 counties on an Arkansas map and used the coordinates of these centroids as X and Y values, and used the nine-year means for each county as Z values. The SURFACE II program interpolated these points using nearest neighbor algorithms, and generated a contour surface similar to that seen in topographic maps. After the map was generated, it was drawn by a COMPLOT drum plotter to create a "publishable quality" map.

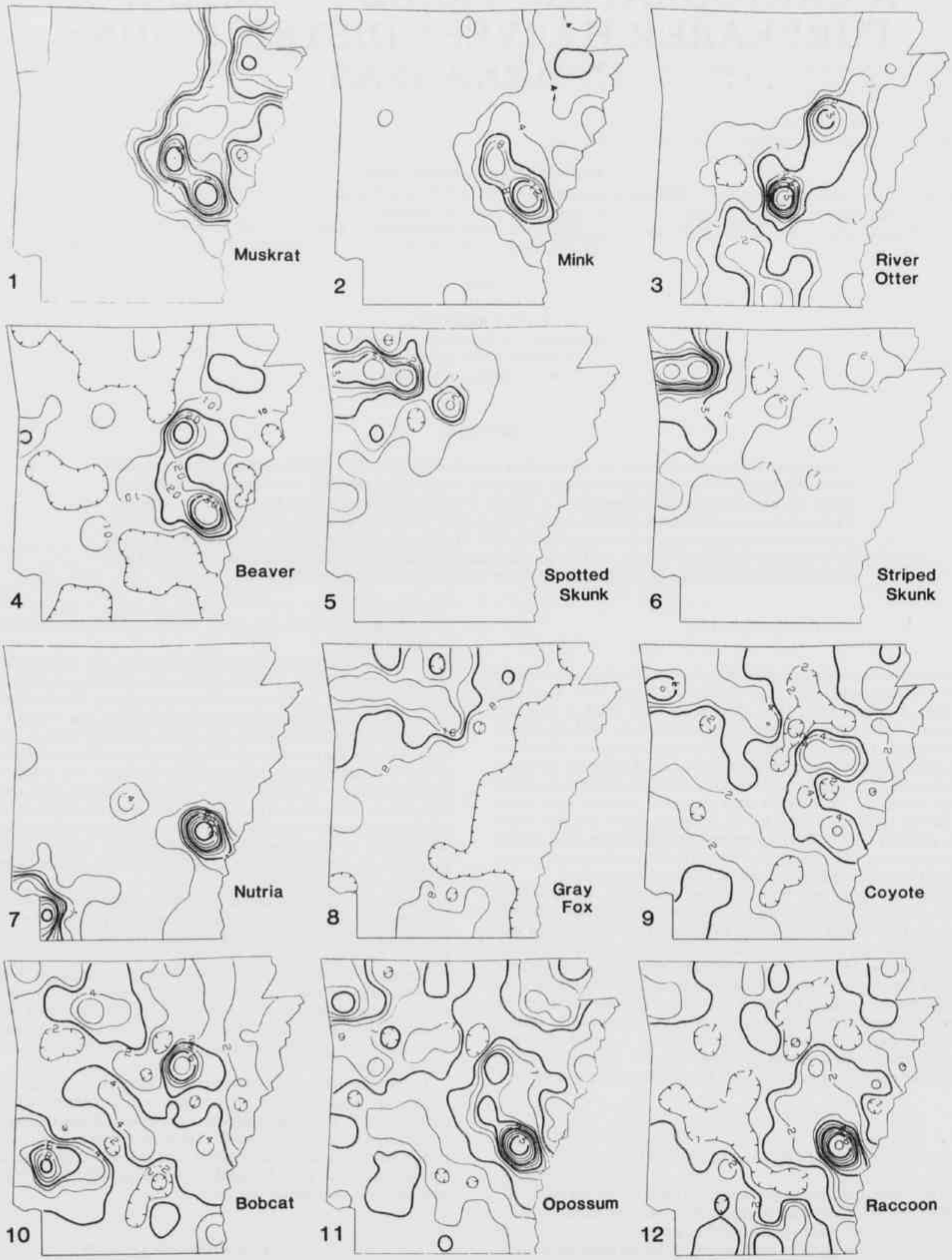
The user controls the number of contour intervals to be interpolated and drawn. Too many contours will isolate data points and are of little use, and too few may hide information. We found 8-12 intervals to be good for most cases.

The interpretation of contour lines is somewhat obscure. Technically, we would say that a contour of ten represents 10 individuals per area of the average size of a county. Rather than imposing this interpretation, it is more useful to envision contour lines as indicators of harvest density, paying more attention to the distribution of lines than to their numerical values.

The program has some idiosyncrasies. Hatchering always occurs in the lowest contour level of the map and is interpreted as base "topography". However, unclosed base contours (those that touch map boundaries) do not get hatchered. The map produced by the computer (rather than the COMPLOT) can be used to locate these contours, and we hatchered such areas by hand. As in topographic maps, hatchering also indicates depression contours.

RESULTS AND DISCUSSION

COMPLOT maps are provided for common furbearer species in Figs. 1-12. Below is a description and interpretation of each map, by species.



Figures 1-12. Contour maps for 1) muskrat, 2) mink, 3) river otter, 4) beaver, 5) spotted skunk, 7) nutria, 8) gray fox, 9) coyote, 10) bobcat, 11) opossum, and 12) raccoon, respectively.

Muskrat *(Ondatra zibethicus)*

The map (Fig. 1) has a contour interval of 0.25; each interval equaling 250 individuals. The muskrat is a wetland furbearer whose population level is determined largely by shoreline length (Glass, 1952); the map clearly depicts the large muskrat harvests in the Delta region. The area of greatest harvest density occurs in east central Arkansas, corresponding with the Grand Prairie region (Foti, 1974). Agricultural practices for rice have greatly increased shoreline habitat available to muskrats in this area, probably explaining the harvest distribution (Peck *et al.*, 1985).

Mink *(Mustela vison)*

The map (Fig. 2) has a contour interval of 2; each interval equaling 200 individuals. The mink is a wetland furbearer, and the map very closely resembles the map for muskrats, including a greatest density in the Grand Prairie area. Most individuals come from the Delta, but a few scattered locations also are suggested to produce several mink.

River Otter *(Lutra canadensis)*

The map (Fig. 3) has a contour interval of 0.5; each interval equaling 5 otters. Otters occur almost statewide (Tumlison *et al.*, 1981) but the map suggests that most individuals are trapped in the Delta and Gulf Coastal Plain, especially in the central portion of the southern two-thirds of the state. Comparison of the map with a map of river systems suggests most specimens are trapped from portions of the Ouachita, Saline, Arkansas, and White river systems. Tumlison *et al.* (1982) suggested increases in beaver populations in the Gulf Coastal Plain and Ouachita Mountains may account for otter expansion through habitat increases caused by beaver activity.

Beaver *(Castor canadensis)*

The map (Fig. 4) has a contour interval of 5; each interval equaling 50 beavers. Beavers were practically extirpated from Arkansas early in this century, but restocking efforts led to re-establishment (Holder, 1951). From 1942-1984, the Delta had yielded almost twice the harvest of each of the other three regions (Peck *et al.*, 1985), but the density suggested on the map reflects a trend even more highly favoring the Delta in the recent period of 1977-1985.

Spotted Skunk *(Spilogale putorius)*

The map (Fig. 5) has a contour interval of 0.5; each interval equaling 5 spotted skunks. Although spotted skunks are thought to occur almost statewide (Sealander, 1979), 92% of the harvest from 1942-1984 was from the mountainous regions of the state (Peck *et al.*, 1985). The map suggests the western Boston Mountains area to be the primary source of pelts in recent years.

Striped Skunk *(Mephitis mephitis)*

The map (Fig. 6) has a contour interval of 1; each interval equaling 10 individuals. The striped skunk occurs statewide (Sealander, 1979) but, like the spotted skunk, most of the harvest comes from the mountainous regions, especially the northwest corner of Arkansas. During the period 1942-1984, however, the Delta produced 54% of the total harvest and the Ozarks only 32% (Peck *et al.*, 1985). Peck *et al.*, (1985) suggested that a major decline in pelting was correlated with an epizootic of skunk rabies, which peaked in 1979 (Heidt, 1982; Heidt *et al.*, 1982). In recent years, only the trappers and buyers of the Ozark region appear to have continued a noticeable amount of pelting of striped skunks.

Nutria *(Myocastor coypus)*

The map (Fig. 7) has a contour interval of 2; each interval equaling 20 nutria. Bailey and Heidt (1978) noted that nutria were most solidly established in the southern portion of the West Gulf Coastal Plain, and in the southern and eastern Delta. The Arkansas River was also included in their proposed range. The map indicates that these observations remain true since 1978. The high harvest density in the vicinity of Arkansas County includes the Grand Prairie, used extensively for rice production. Further, the Arkansas and White rivers meet there, and form potential dispersal corridors. The two sets of contours near mid-state represent populations along the Arkansas River.

Gray Fox *(Urocyon cinereoargenteus)*

The map (Fig. 8) has a contour interval of 4; each interval equaling 40 foxes. Between 1942-1984, the Ozarks produced 55% of the harvest, followed by the Delta at 16% and the Gulf Coastal Plain at 15% (Peck *et al.*, 1985). Since 1977, the Delta produced the fewest gray foxes, but the Ozarks still contributed the most to the total harvest. The area of greatest harvest density corresponds with the Boston Mountains area.

Coyote *(Canis latrans)*

The map (Fig. 9) has a contour interval of 1; each interval equaling 10 coyotes. The primary harvest areas include much of the Ozarks and the west-central Delta. The coyote expanded into central Arkansas by the 1950's and became established throughout Arkansas in the early 1960's (Sealander, 1979), thus 37% of the harvest between 1942-1984 came from the Ozarks (Peck *et al.*, 1985). Poultry occurred often in coyote diets (Gipson and Sealander, 1976), thus coyotes may be more common in the Ozarks due to the poultry industry (Sealander, 1979) or because the Ozarks were the initial point of invasion by expanding populations of coyotes (Peck *et al.*, 1985). Coyotes are ubiquitous probably because they are opportunistic omnivores (King, 1981) and because agriculture and forest industries have provided suitable habitat to allow invasion.

Bobcat *(Felis rufus)*

The map (Fig. 10) has a contour interval of 1; each interval equaling 10 bobcats. The primary regions of harvest between 1942-1984 were the Ozarks (31%) and Delta (28%), with the Ouachitas and Gulf Coastal Plain even at about 20% of reported harvest (Peck *et al.*, 1985). However, in the period 1977-1985 the primary harvest has been in an area including portions of the Gulf Coastal Plain and Ouachitas in southwestern Arkansas, and an area including portions of the Ouachitas and Delta in central Arkansas.

Opossum *(Didelphis virginiana)*

The map (Fig. 11) has a contour interval of 0.25; each interval equaling 250 opossums. Peck *et al.* (1985) noted that 35% of the opossum harvest between 1942-1984 came from the Ozarks, and 32% from the Delta. Between 1977-1985, greatest opossum harvest has been reported from the central portion of the Delta.

Raccoon *(Procyon lotor)*

The map (Fig. 12) has a contour interval of 0.5; each interval equaling 500 raccoons. Raccoons have been harvested primarily from the Delta (42%) and Gulf Coastal Plain (23%) between 1942-1984 (Peck *et al.*, 1985), and the same trend appears to be true in the shorter, more recent, period. The greatest harvest density appears in the vicinity of Arkansas County, which includes the White River National Wildlife Refuge and part of the Grand Prairie sub-region.

Several questions can be addressed through a comparison of the maps. Perhaps the simplest question concerns ecological distribution. Harvest of wetland furbearers, such as muskrat and mink, are closely associated with the wet and agricultural Delta region. River otter, beaver, and nutria also are harvested most where their habitat preferences would suggest; however, maps for spotted and striped skunks do not fit well with their distributions. The latter case is probably effected by an epizootic of rabies (Peck *et al.*, 1985).

The effect of furbuyer distribution may be examined in some maps. Peaks in the vicinity of Arkansas County in the central Delta occur for muskrat, mink, beaver, nutria, coyote, opossum, and raccoon. This area could represent near optimal habitat for these species. The first four of these taxa are wetland species, and the rest are opportunistic omnivores. The area of interest has bottomland hardwoods along the Arkansas and White Rivers and their tributaries, and contains much of the Grand Prairie sub-region, which represents a unique habitat. Food supplies for these species are likely abundant. Thus, the greater number of buyers in this area may be a reflection of the availability of the fur resource due to habitat. Alternatively, there may be a greater harvest from this area because there are more markets therefore greater trapping pressure. Tumlison (1983) examined the distribution of furbuyers using the mean number licensed per county over four years (1977-1980). Several counties in the Delta (White, Lonoke, Prairie, Monroe, Arkansas, Lincoln, and Desha) were contiguous and had five or more buyers, whereas most other counties had two or less. This group of counties does much to explain the contours for beaver, coyote, opossum, and raccoon. From the data, however, it cannot be determined which factor drives the system.

Similarly, peaks in the Boston Mountains for spotted and striped skunks, gray fox, and coyote may be explained by buyer distribution. Washington, Madison, Searcy, and Van Buren counties, all in the Boston Mountains area, had 3-5 buyers each. Nine buyers in White County in the Delta may partially explain apparent harvest density peaks for river otter, beaver, coyote, and bobcat, but the peak for bobcat in southwestern Arkansas is not easily explained in this manner due to no correlates in other species maps.

If we predict that more pelts are reported from counties with many buyers, we must assume that fewer pelts were reported in areas with few buyers. Here, we examined ubiquitous species which occur in areas with many as well as few buyers. Coyote, bobcat, opossum, and raccoon occur statewide, but, in each case, there is a band with low harvest densities running through the southern half of the state in a northwest to southeast direction. Interestingly, six of the counties represented in these general bands had no buyers, five had one buyer, and one had two buyers. Apparently, a lack of buyers means low reported harvest and several buyers means high reported harvest. In some cases, more buyers may be able to operate in an area due to higher furbearer population densities, but more likely inaccurate reporting leads to incorrect placement of harvest densities.

CONCLUSIONS

The use of trend analysis maps allows questions to be asked and examined concerning harvest distributions. Trend maps can be used to establish trends through time or to compare across species in a particular time frame of interest. Trend maps can also suggest where emphasis in field studies should be made. This technique should prove quite useful in the continuing analysis of harvest data and population status of Arkansas furbearers.

In the present analysis, some harvest maps are consistent with species ecology. Maps for several species (i.e., coyote, bobcat, opossum, raccoon) suggest weaknesses may exist in the reporting of harvests on a county basis. It would be instructive to interview buyers and trappers in the low-harvest zone of southern Arkansas and in high-harvest zones of Arkansas and White counties and the Boston Mountains, to see whether harvest distributions are more biased through population density or reporting.

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