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Beaver Relative Abundance in Southern Illinois Watersheds

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ABSTRACT

We conducted aerial surveys of 8 southern Illinois watersheds to estimate and compare regional differences in relative abundance of beaver (*Castor canadensis*). We randomly selected township sections to sample wetland habitats within a unit. Sample blocks were searched with a Bell Model 206-L helicopter between 24 November 2000 and 19 March 2001 to detect sign of beaver presence associated with wetland classes within the blocks. Geographical information system (GIS) software was used to compute area of each wetland class in the entire watershed. Density of sign associated with each wetland type was calculated by summing the amount of sign associated with a wetland type and dividing by its total area in the watershed. We found evidence of beaver in 43.5% of blocks surveyed. Stream habitats accounted for ~84% of the number of estimated colonies in all watersheds; and in spite of variability, we concluded that colonies/km stream was a useful measure of beaver relative abundance between watersheds. The Cache, Vermillion, and Bay Creek watersheds had the highest stream densities, but the Embarras and Big Muddy watershed had greater numbers of estimated colonies inhabiting streams.

INTRODUCTION

Conservation programs that succeeded in restoring beavers (*Castor canadensis*) after their near extirpation in many parts of North America are now expected to accommodate diverse and sometimes divergent interests. For example, dams created by beavers can affect humans positively by improving wildlife diversity, storing runoff, trapping sediment, and reducing erosion, or negatively by flooding crops, roads, residences, and critical habitats for endangered and threatened species (Hill 1982, Hammerson 1994). Public agencies that are responsible for maintaining ecosystem benefits while minimizing human conflicts usually rely on regulated trapping and wildlife damage management programs to resolve local problems and, at times, manipulate population levels on a broader scale (Organ et al. 1998).

Information about population levels allows agencies to establish responsible limits on harvest and document progress toward broader management objectives (Novak 1987). Aerial counts of beaver lodges, food caches and cuttings have been used for this purpose for more than a half century (Swank and Glover 1948). Although some studies have reported poor relationships between numbers of colonies detected from the air and those located by intensive ground searches (Novak 1987, Langlois 1999), the method generally is considered reliable for boreal forest and montane habitats (Hill 1982) where, despite varied protocols, observers typically detect 70-100% of active colonies (e.g., Fuller 1953, Hay 1958, Bergerud and Miller 1977, Payne 1981, Swenson et al. 1983).

Few studies have evaluated aerial surveys in central and southern portions of the beaver's range. Intuitively, the method might perform poorly compared to northern latitudes because beavers are less likely to construct lodges and caches in areas with mild climates (Hill 1982). Topography, vegetative cover, and chronology of leaf drop, cache building activities, and ice formation also affect detection rates (Brown and Parsons 1982, Novak 1987, Broschart et al. 1989, Robel and Fox 1993) so protocols might need to be tailored to regional conditions. Given these uncertainties, we initiated a study to evaluate methods to monitor the relative abundance of beavers in Illinois, recommend methods and sampling strategies adequate to detect a 20% change in the statewide population, and estimate and compare regional differences in relative abundance. Woolf and Nelson (2002) reported study results in a Federal Aid in Wildlife Restoration Final Performance Report; here we present results of aerial surveys in 8 southern Illinois watersheds.

METHODS

Sample Plot Selection

Maps of 8 southern Illinois watersheds (Bay Creek, Big Muddy, Cache, Embarras, Kaskaskia, Little Wabash, Saline, and Vermilion) were prepared using ArcView (Environmental Systems Research Institute, Redlands, California, USA) Geographical Information System (GIS) software. Wetlands identified in the Illinois land cover database (Luman et al. 1996) were aggregated into the following classes: streams, permanent wetlands (wooded and other), and intermittent wetlands (wooded and other). Streams included perennial waterways, ditches, and the shorelines of large rivers identified from the 1994 Topologically Integrated Geographic Encoding and Referencing data files (TIGER, 1:1,000,000 scale). Wooded palustrine wetlands included riparian woods and palustrine forested wetlands. The category "other" consisted of ponds and lakes >1 ha in size and all other classes of non-wooded permanent wetlands. Intermittent wetlands consisted of wooded and non-wooded intermittent wetlands >5 ha in size. We then used the GIS software to compute area of each wetland class in the entire watershed.

We randomly selected townships and township sections in the watershed to sample habitats within the unit. Individual township sections were kept as sampling units as long as areas classified as water were within their boundaries; sections without water were discarded. We traced boundaries of retained township sections to clip the water grid. The number of pixels in each category was recorded for each sampling block. We chose additional township sections until the total percent composition of pixels within the sampling blocks approximated the percent composition of pixels in the entire watershed.

Preliminary trials indicated that 20 blocks per watershed approximated wetland composition of the entire watershed, except that 30 blocks were selected for the Kaskaskia Watershed (the largest). Sampling blocks were identified by the number assigned to the township by the Illinois Department of Natural Resources (1996) and the number of the township section chosen (1-36).

Aerial Survey

We delineated sample blocks on United States Geological Survey (USGS) 7.5 minute topographic maps. Coordinates of 1 corner were determined and entered into a Global Positioning System (GPS) unit to facilitate navigation from block to block. We flew the survey with a Bell Jet Ranger (Model 206-L) helicopter and a crew consisting of the pilot and 2 observers. The observers sat in front and back seats on the left side of the aircraft so both could search the same area and verify sightings. All aquatic habitats within a plot were searched at slow airspeeds (<50 knots) and low altitudes (<100 m above ground level) selected to optimize observations consistent with safety. Sign of beaver presence was classified as cuttings, food cache/lodge, dams, or other and recorded on the 7.5 minute topographic map. We also recorded crew, weather conditions (ceiling, visibility, and wind direction/velocity), and flight times (block searches and total).

Data Management and Analyses

Beaver sign observed and mapped on printed topographic maps during the aerial surveys was digitized from an on-screen display of the topographic map using ArcView and ArcMap (Environmental Systems Research Institute, Redlands, California, USA). Digital versions of the USGS 7.5' topographic maps and digital orthophotographic quarter quadrangles (DOQQ) for each sample unit were downloaded from the Illinois Natural Resources Geospatial Data Clearinghouse (http://www.isgs.uiuc.edu/nsdihome/ISGS index.html). Sign was classified as dam, cache/lodge, and other. Bank dens were included as cache/lodge, and other included cuttings, peeled sticks, and slides. Additional information added to the attribute table for the locations included sample unit number, topographic map name, type of sign, survey type, and time of survey.

Sign was assigned an association based on the closest proximity to one of the categories (streams, lacustrine <10 ha, lacustrine 10 - 100 ha, lacustrine >100 ha, and palustrine-emergent). Beaver sign density was calculated on a regional basis by watershed. We calculated the density of sign associated with each wetland type by summing the amount of each type of sign associated with the wetland type and dividing by its total area in the watershed . Sign classified as "other" was considered a single occurrence when it occurred as a group >750 m from another occurrence of sign classed in the "other" category. Presence of 2 types of sign at the same location (e.g., a food cache and a dam or cuttings) also was considered a single occurrence.

RESULTS

Aerial Survey

The aerial survey included 170 2.59-km^2 plots (township sections) randomly selected in 8 southern Illinois watersheds (Bay Creek, Big Muddy, Cache, Embarras, Kaskaskia, Little Wabash, Saline, and Vermilion; Fig. 1). The blocks were sampled between 24 November 2000 and 19 March 2001; 44.5 hrs flight time were required. Evidence of beaver occupancy was detected in 43.5% of blocks surveyed (Table 1). Blocks (n = 30) where beaver sign was not detected were ground searched in the Big Muddy, Cache, and Saline watersheds to evaluate reliability of the aerial search; negative aerial results were correct (absence of beaver sign confirmed by ground search) 80% (range 75-90%) of the time.

Surveys of the Embarras Watershed in blocks east of Olney, Illinois and the upper half of the Wabash Watershed were flown during high water conditions that made sighting food caches difficult and may have covered fresh cuttings at the base of trees. Ice and snow cover precluded surveys in December; these conditions persisted in January and increased the probability that sign was missed during survey flights of Wabash, Saline, and Bay Creek watersheds. By late January, ice/snow cover and high water were no longer a factor and the final 5 surveys were flown under good to excellent conditions except for high water in a few blocks of the Big Muddy Watershed. Overall, ambient weather or flight conditions adversely affected results of surveys of 3 watersheds and portions of 2 others. Hence, estimates of sign abundance in these watersheds are conservative.

Regional Relative Abundance

The estimated number of beaver colonies in a watershed is a function of quantity and suitability (quality) of available habitat. Greatest variability was in stream habitats and that is reflected in the stream density estimates based on observed sign and sign/unit area multiplied by quantity of that habitat in the watershed (Table 2). The Cache, Vermilion, and Bay Creek watersheds had the highest estimated stream densities, but 2 other watersheds (Embarras and Big Muddy) had greater numbers of estimated colonies inhabiting streams than either Cache, Vermillion, or Bay Creek; and Bay Creek had the lowest estimated number of colonies among the 8 watersheds surveyed (Table 2).

DISCUSSION

Our aerial survey reliably detected presence of beaver in sample blocks, and the sample scheme proportionally represented the type and quantity of wetland habitats in watersheds (see Woolf and Nelson 2002 for supporting data). Stream habitats accounted for ~84% of the number of estimated colonies in all watersheds (Table 2); only in the Big Muddy Watershed were other habitats a relatively important contributor (~35%) to the estimated total number of colonies. Therefore, we suggest that colonies/km stream is a useful measure of beaver relative abundance between watersheds.

We excluded large lakes (which we defined as >100 ha) from the watershed-based sampling scheme we used to estimate and compare regional abundance although we recognized they could be important components of the total beaver population in some watersheds. Woolf and Nelson (2002) justified their exclusion because their distribution was restricted (none were present in many watersheds), and they were not amenable to the aerial sampling scheme. For example, there were 9 such lakes in the Big Muddy Watershed, 2 in the Cache, and 1 in the Saline and our sample blocks only included small portions of 2 lakes in the Big Muddy and 1 in the Cache. Only 1 other large lake (in the Little Wabash) was included in the randomly selected aerial survey blocks. Further, data presented by Woolf and Nelson (2002) revealed greater than 2-fold differences in number of food caches/lodges/km shoreline among lakes, and observations revealed clumped distribution of sign based on physical and biotic features of individual lakes. Such variation and non-random distribution would not be adequately sampled in our aerial survey design. Finally, in our limited evaluation, beaver colonies inhabiting large lakes only accounted for <15% of the total number of colonies estimated to be present in other habitats. Importantly, addition of the estimated number of colonies associated with large lakes in the 8 watersheds we studied would not change the rankings of relative abundance.

Although not an objective of this project, our findings afforded opportunity to assess validity of previously reported rankings of 7 of the 8 (Vermilion excluded) watersheds based on models to predict habitat suitability for river otter (Woolf 1997). When developing the otter models, we had assumed that similar attributes defined habitat quality for both beavers and otters, and data supported that assumption (Schieler 1995). If this assumption was correct, and our models had validity, we hypothesized that watersheds ranked according to beaver abundance (colonies/km stream) would be similar to rankings from otter models (Woolf 1997). Indeed, this was the case; the top 3 watersheds were similar in all comparisons, albeit rankings did not agree 100%. Further, the Saline Watershed ranked in the middle of all comparisons and the bottom grouping was similar (Table 3). These comparisons support our conclusions concerning both the otter habitat models and the aerial survey for beaver sign; both appear to offer valid tools for science-based management.

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Table 1. Aerial search of sample blocks to detect beaver sign in 8 southern Illinois watersheds, November 2000 - March 2001.

Watershed	Number of blocks	Blocks with sign	Sign present (%)
Bay Creek	20	10	50
Big Muddy	20	14	70
Cache	20	11	55
Embarrass	20	8	40
Kaskaskia	30	5	17
Little Wabash	20	7	35
Saline	20	11	55
Vermilion	20	8	40
	170	74	43.5

Table 2. Estimated number of beaver colonies in 8 southern Illinois watersheds calculated from density estimates derived from helicopter aerial survey conducted 24 November 2000 – 19 March 2001.

	Streams		Lacustrine <10 ha		Lacustrine 10 - 100 ha		Palustrine-emergent	
Watershed	Number/km	Number	Number/ha	Number	Number/ha	Number	Number/ha	Number
Bay Creek	0.495	359						
Big Muddy	0.414	1,095	0.168	115	0.146	479		
Cache	0.601	652					0.013	17
Embarras	0.360	1,223	0.668	121	0.092	32		
Kaskaskia	0.123	616	0.161	105	0.024	33		
Little Wabash	0.109	388			0.084	61		
Saline	0.391	411			0.094	90		
Vermilion	0.539	592						
Total Colonies		5,336		341		695		17

Table 3. Watershed (PMU) rankings (colonies/km stream) derived from the November 2000 - March 2001 aerial survey (excluding the Vermilion Watershed) compared to the rankings of the watersheds from Woolf (1997).

Watershed (PMU)	Colonies/km stream	Average Rank Score[a]	HIS>80[b]
Bay Creek (17)	2	1	2
Big Muddy (15)	3	2	1
Cache (16)	1	3	3
Embarras (20)	5	7	7
Kaskaskia (14)	6	5	5
Little Wabash (19)	7	6	6
Saline (18)	4	4	4

[a]Woolf (1997:144)
[b]Woolf (1997:145)

Figure 1. Location of beaver aerial survey blocks in 8 southern Illinois watersheds.