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HABITAT UTILIZATION BY BALD EAGLES WINTERING ALONG THE MISSISSIPPI RIVER

James D. Paruk

ABSTRACT

Patterns of habitat use of wintering Bald Eagles (*Haliaeetus leucocephalus*) were examined along 3 sections of the Mississippi River bordering Illinois, Iowa and Missouri. Data were derived from a winter aerial survey (Southern et al. 1985) and aerial photographs. Habitat characteristics evaluated included: 1) presence of a dam, 2) amount of woodland edge, and 3) degree of human disturbance. Twenty-one 1.6 km segments of river within the 3 sections were arbitrarily selected out of 143 for analysis. These segments were divided into areas receiving heavy, moderate, or light use by wintering eagles based on importance values. Importance values reflected density and frequency of occurrence of eagles. The habitat characteristics evaluated appeared valid for distinguishing between heavy and either moderate or light use areas. They did not, however, clearly distinguish moderate from light use areas.

Five of the 6 river segments containing dams ranked in importance value in the top 8% of 143 segments. River segments that included dams consistently had more eagles than river segments that lacked dams. River segments immediately below dams were used heavily by eagles because pools of open water below the dams provided eagles with food.

The amount of woodland edge was significantly positively correlated with number of eagles, regardless of the presence of dams. The amount of woodland edge below dams greatly influenced the distribution of eagles.

The degree of human disturbance also influenced the distribution of eagles. River segments having undergone some type of human disturbance (e.g. destruction of woodland edge for industrial, commercial or private development) typically had fewer eagles than areas which were less disturbed. Similarly, river segments having roads near the river and lacking vegetated buffer zones less than 100 m wide consistently had fewer eagles.

INTRODUCTION

Illinois hosts one of the major wintering populations of Bald Eagles in North America (Grier et al. 1983). It has been estimated that nearly 10% of the total wintering population in North America, excluding Alaska, resides along the state's rivers (Sweet 1983). The occurrence of wintering bald eagles in Illinois is dependent on the presence of suitable habitat, which may decline if industrial and residential areas continues to expand. To minimize the risk of this situation, it is necessary to identify zone of habitat that are essential to eagle survival.

Habitat requirements have not been identified for most eagle wintering areas in Illinois. Before resource managers can propose appropriate guidelines, critical eagle habitat must be identified and other factors (e.g. dams, woodland edge, human disturbance) which may affect eagle distribution, must be investigated. Dams, for example, along the Mississippi and Missouri Rivers are vital to wintering eagles (Jonen 1973, Steenhof et al. 1980, Dunstan and Fawks 1981, Southern et al. 1985). During the winter, open pools below dams provide food for gregarious wintering eagles (Southern 1963, 1964, Jonen 1973, Steenhof et al. 1980).

Three sections of the Mississippi River bordering Illinois, each having two dams, were studied to assess the importance of dams, amount of woodland edge, degree of human disturbance, and water surface area to wintering eagles. Areas receiving heavy, moderate, and light use by wintering eagles were then compared for the above variables.

STUDY AREA

Three sections along the Mississippi River bordering Illinois were studied: 1) the northern section (Bellevue-Clinton, 84.8 km, River Miles 513-566), including Lock and Dams 12 and 13 (Carroll and Whiteside counties), 2) the central section (Rock Island-Oquawka, 73.6 km, River Miles 420-466), including Lock and Dams 16 and 17 (Rock Island and Mercer counties), and 3) the southern section (Canton-Hannibal, 70.4 km, River Miles 300-344), including Lock and Dams 21 and 22 (Adams and Pike counties). These areas were chosen because they all contained dams, had at least one major eagle wintering ground (Southern et al. 1985), and because aerial photographs (USFWS) were available for most of these river miles.

Cottonwood (*Populus deltoides*) and Sugar Maple (*Acer saccharium*) were the dominant bottomland trees present in the three study areas. Silver Maple (*Acer saccharinum*), River Birch (*Betula nigra*), Ash (*Fraxinus* spp.), Willow (*Salix* sp.), Hackberry (*Celtis occidentalis*), and Bur Oak (*Quercus macrocarpa*) also occurred on the floodplain (United States Army Corps of Engineers, 1975).

METHODS

The data for eagle occurrence were derived from a statewide Bald Eagle aerial survey conducted by Northern Illinois University biologists from 2 November 1984 through 25 February 1985 (Southern et al. 1985). The aerial survey covered 7 census routes, 3 of which were located along the Mississippi River. The others were flown over the Illinois and Ohio rivers, and refuges in southern Illinois. Each census route was flown 12 times. The 3 sections of interest in this study fell within two of the 3 Mississippi River route censuses.

Importance values were calculated for all 143 river segments. A river segment is defined as the area between river markers as developed by the USFWS. Computations involved in calculating importance values were:

$$\text{Relative Density} = \frac{\text{Total \# of eagles in river segment during a census}}{\text{Total \# of eagles seen in all river segments during a census}}$$

$$\text{Weighted Frequency} = \frac{\text{Number of censuses which recorded at least one eagle in river segment}}{\text{Total \# of river segments in which at least one eagle was recorded during a census, summed over all 12 censuses}}$$

Importance values were calculated for each river segment by taking the relative density of eagles plus a weighted frequency × 100. A weighted frequency was used to minimize chances of areas receiving frequent, but consistently low eagle use from obtaining a high importance value.

In the present study, 21 1.6 km river segments out of a possible 143 within the 3 sections of the Mississippi River were designated as areas receiving heavy, moderate, or light use by eagles based on importance values. The top 4 river segments were arbitrarily assigned to heavy use areas. River segments having importance values less than 3.0 were then dropped from analysis. Then, 2 areas above and below the median were designated as moderate use areas. The bottom 11 river segments having aerial photographs out of a possible 18 (aerial photographs were not available for all areas) were designated as light use areas.

Four heavy (one of these was dropped from further analysis, River Mile 343, because the aerial photograph was not available), 6 moderate, and 11 light eagle use areas were identified and used for further analysis. Heavy use areas had appreciably more eagles than either moderate or light use areas (Table 1). Because of the disparity in eagle numbers among these areas, more river segments were included in the analysis of moderate and light use areas to more accurately assess habitat selection by wintering eagles in these areas. Two of these 6 dams studied (Lock and Dams 12 & 21) were not classified as either receiving heavy, moderate, or light use, but are listed in Table 1 for comparison with other dams.

Total area of surface water (before it was frozen) and length of woodland edge were determined for each river segment using a digitizer (Bioquant II, R & M Biometrics). Length of woodland edge was defined as any continuous stand of woody vegetation, at least 3 rows of trees deep, bordering the main river or side channel. Both sides of the main river, sloughs, and islands were measured for woodland edge in each river segment. The resulting data were used to determine if the area of water (e.g. sloughs, ponds) influenced eagle distribution early in the year or if the length of woodland edge was correlated with eagle occurrence and abundance.

Criteria for each river segment were established to assess the amount of human activity i.e. high, moderate, and low (Table 2). The amount of human activity was then compared to the total number of eagles observed in each river segment. Human disturbance also was assessed by measuring the distance from each perched eagle to the nearest paved road for one heavy use area (River Miles 436 and 522 were omitted from this analysis because they contained dams and had paved roads adja-

cent to the river which did not effect eagle aggregation at these areas) and 6 light use areas. In order to test for the effect of a roadside vegetation buffer zone on perching eagles, the distance from each eagle to the nearest road was measured, and the extent of vegetation between the eagle and the road was noted for one heavy use area (River Mile 550) and 6 light use areas (River Miles 320, 322, 325, 429, 440, and 514).

Length of woodland edge and average distance of perched eagles from roads between heavy and light use areas were tested using two-tailed T-tests and correlation analysis as described by Zar (1974).

RESULTS

Each of the 3 sections of the Mississippi River had at least one segment receiving heavy use by eagles. Three of the 4 heavy use segments were associated with dams (Table 1). Five of the 6 dams investigated in this study were ranked in the top 8% in importance values of all river segments (Table 1). Lock and Dam 16 received moderate use.

Length of woodland edge (Table 1) was positively correlated with number of eagles in each river segment (Table 1, $r^2 = 0.560, df = 18, p<0.05$). This correlation also persisted when river segments that included dams were excluded from the analysis ($r^2 = 0.643, df = 15, p<0.01$). Heavy use areas had significantly more woodland edge than low use areas ($t = 2.21, df = 13, p<0.05$).

Half (N = 6) of the moderate use areas (River Miles 435, 437, 456) were near dams, i.e. they were within 3.2 km of a dam (Table 1). The remaining moderate use areas (River Miles 431, 449, 513) were 9.6-14.4 km below dams that constituted heavy use areas (Table 1). River Miles (449, 456, 513 had high human activity ratings (Table 1). River miles 449 and 456 bordered the town of Muscatine, Iowa and River Mile 513 bordered the town of Clinton, Iowa.

Light use areas were not associated with habitats immediately below dams. Instead, 6 of the 11 (54%) light use areas ranged from 6.4-27.2 km below dams ($\bar{x} = 13.9$); the remaining areas (46%) were 1.6-4.8 km above dams. All light use areas were classified as having either high or moderate human activity ratings (Table 1).

There was a significant difference ($t = 2.25, df = 75, p<0.025$) between the average distance eagles were found from roads in heavy and light use areas. In the heavy use area, the average distance of birds from paved roads was 1.5 km ± 0.2 km, whereas in light use areas the average distance was 0.7 km ± 0.2 km.

There was no significant correlation with the total surface area of water in each river segment (before it was frozen) and total eagle numbers ($r^2 = 0.092$, $df = 18, p>0.50$). Eagles did not concentrate in river segments with large areas of water early in the year, (i.e. pre-ice cover) but instead were scattered along the main river channel.

DISCUSSION

Dams along the Mississippi and Missouri rivers are vital to wintering eagles (Jonen 1973, Steenhof et al. 1980, Dunstan and Fawks 1981, Southern et al. 1985). During winter, eagles forage at open pools below dams where fish, weakened by going over the dam, or killed by some dams turbines, are easy prey for scavenging eagles. Thus, it is not surprising that 5 of the 6 pools below dams in the present

study were ranked in the top 8% of all river segments in eagle use. Moreover, half of the moderate use areas also were associated with dams. River Mile 436 contained Lock and Dam 16 and River Miles 435 and 437 were immediately above and below Lock and Dam 17. Although most of River Mile 437 was above Lock and Dam 17, about 25% of it was below the dam. Seventy-eight percent (N = 18) of the eagles recorded here were found below the dam. This suggests that at least during mid-winter, when the main river channel is frozen, that areas above dams receive little use. River Mile 435 was 2.4 km below Lock and Dam 17. This area probably provided eagles with alternative diurnal perch sites and possible nocturnal roosting sites.

Eagles will forage at other areas of open water besides dam pools if they are protected from human disturbance, and contain readily available food and shelter (Steenhof et al. 1980, Sabine 1982, Southern and Southern 1984). River Mile 550, the only area identified as receiving heavy use that was not immediately below a dam (it was 9.6 km below the nearest dam), had the highest importance value of any area (Table 1). In an earlier study by Southern et al. (1985), this area was identified as the northernmost essential wintering area in Illinois. Historically, this area has received heavy use by wintering eagles for 3 reasons: 1) it contains numerous shallow lakes and sloughs which provides eagles with productive foraging areas (Southern 1963), 2) it is secluded from human disturbance during the winter (Koller et al. 1981), and 3) dense stands of riparian timber provide eagles with daytime perching and nocturnal roosting sites. It should be mentioned that this area received heavy use, in part, due to the management of Lock and Dam 12 by the U.S. Army Corps of Engineers. If the amount of water passing through the dam was reduced it would have pronounced effects on eagles downstream as pools below dams would freeze solid and the availability of food would decrease drastically.

Eagles preferred areas which not only had available food, but also had plenty of riparian woody vegetation nearby. Length of woodland edge was positively correlated with eagle numbers. Heavy use areas had significantly more woodland edge nearby than light use areas. Similarly, dams having more woodland edge nearby (e.g. Lock and Dams 13 and 17) had more eagles than dams which had less woodland edge (e.g. Lock and Dam 16). Lock and Dam 16 which had the lowest total of woodland edge for all river segments studied was the only dam which received moderate use. Wooded areas below dams received more use by eagles than less wooded areas (J. Paruk, pers. obs.). Because eagles need suitable daytime perching and nocturnal roosting sites (Jonen 1973, Steenhof 1978, Sabine 1982, Southern and Southern 1984) they would be expected to occur in areas offering this type of habitat.

The remaining moderate use areas (River Miles 431, 449, 513) were 9.6-14.4 km below dams identified as heavy use areas. Although these areas bordered towns, they still received appreciable use by eagles because they had more woodland edge than most other nearby river segments. These areas were below dams and it is possible eagles use these areas as resting spots because they have more woodland edge, i.e. protection from human disturbance and cold temperatures.

Two of the 3 heavy use areas had low human activity ratings whereas the moderate and light use areas did not. This supports the contention that human disturbance, near Bald Eagle wintering grounds, can have drastic effects on eagle dispersion (Stalmaster and Newman 1978, Griffen et al. 1980, Knight and Knight 1984, Southern and Southern 1984). Lock and Dam 13 (River Mile 522), however, received heavy use despite having a high human activity rating (Table 1). This may

be due to large islands immediately below the dam that provided eagles respite from human disturbance.

Sabine (1982) reported that perched bald eagles tolerated moving automobile traffic, but flushed when vehicles stopped or when people approached on foot. Stalmaster and Newman (1978) found that vegetated buffer zones around perched eagles, even if near roads, reduced the negative reaction of eagles to human interference. The heavy use areas (River Mile 550) had a densely vegetated buffer zone that was 0.9 ± 1.20 km wide, whereas the light use areas had vegetation that was only 0.1 ± 0.3 km wide. Similarly, the nearest paved road to the water edge of the heavy use areas was 1.5 km ± 0.2 km; whereas, paved roads were closer, 0.7 km ± 0.2 km, to light use areas. The results suggest eagles avoid well used roads if an adequate vegetated buffer zone does not exist. Bald Eagles are extremely sensitive to human disturbance (Stalmaster and Newman 1978, Knight and Knight 1984, Southern and Southern 1984) and in areas that are highly disturbed by humans (e.g. barge traffic, boating and fishing) feeding efficiency declines because eagles spend more time scanning as the possibility of human encounters increases (Knight and Knight 1984). Management strategies to protect Bald Eagles should include measures to reduce human activity in critical areas.

As riparian timber is destroyed during development, it becomes critical to preserve those areas with trees bordering the river, especially zones of riparian timber immediately below dams. These areas are vital to the survival of the Bald Eagle in the Mississippi and Missouri Valley Region. Areas between dams become more important where there is little woodland edge near the dam itself. Buffer zones of vegetation bordering winter eagle use areas can be effective in reducing human disturbance. Strips of vegetation which efficiently reduce line-of-sight contact will allow a closer presence of human activity to perched eagles. In Washington State, buffer zones of up to 100 m wide are recommended for protection of key wintering grounds where disturbances are common (Stalmaster and Newman 1978). If the Bald Eagle is to continue thriving in this region, resource managers must take proper steps to ensure the preservation of valuable riparian woodland edge, establish restrictions which limit the amount of human activities near zones of critical wintering grounds, and create or protect vegetation buffers where needed.

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Table 1. Total number of eagles, importance values, length of woodland edge, and human disturbance ratings for Mississippi River Miles having heavy, moderate, and light use by eagles.

River Mile	Total # of Eagles	Importance Values	Length of Woodland edge (km)	Human Disturbance
550 HEAVY USE	84	104.0	18.1	Low
436 (L&D 17)	70	62.8	17.0	Low
522 (L&D 13)	74	51.5	8.8	High
300 (L&D 22)**	54	44.0	—	—
MODERATE USE				
513	19	16.8	18.9	High
435	22	16.2	7.6	Moderate
449	16	16.1	9.0	High
431	22	16.1	8.0	Moderate
437	18	15.7	12.9	Moderate
456 (L&D 16)	18	15.2	4.2	High
LIGHT USE				
440	8	6.9	10.4	High
459	7	6.6	9.9	Moderate
514	8	6.1	10.7	Moderate
322	6	5.2	6.2	Moderate
515	6	5.1	6.7	Moderate
439	5	5.1	9.1	High
325	7	5.1	4.8	High
429	7	4.9	10.2	Moderate
566	7	4.7	9.4	High
445	5	4.0	7.5	Moderate
320	5	3.9	5.3	High
OTHER DAM AREAS				
324 (L&D 21)	43	31.0	—	—
555 (L&D 12)	50	30.3	—	—

*Abbreviated for 550-551, 436-437, etc.
**Aerial photograph could not be obtained.

Table 2. Criteria for classifying high, moderate, and low levels of human activity along the Mississippi River.

HIGH	MODERATE	LOW
Roads paralleling the river with little or no (0.0-0.2 km) vegetated buffer zone	Roads paralleling the river with some (0.3-0.7 km) vegetated buffer zone	Roads not paralleling the river and extensive (0.9-1.6 km) vegetated buffer zone
Habitat altered (e.g. cities, bridges, farms), numerous human developments 50-500 houses, 1-3 industrial plants	Habitat slightly altered (e.g. some farmland and residential housing), occasional human development (10-30 houses, 1-2 industrial plants	Habitat unaltered, human developed absent