

## Impacts of River Recreation on Birds at Fort Niobrara National Wildlife Refuge: 2000-2002

Christopher D. Anderson, C. Dustin Becker, and Philip S. Gipson

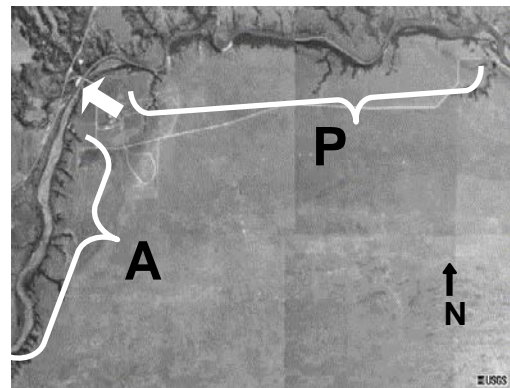
The Niobrara River in the sandhills region of north central Nebraska is a popular destination for canoeing, tubing, and kayaking. Nine miles of the river flow through the Fort Niobrara National Wildlife Refuge (NWR) and 5.1 of these are open to river recreation (Figure 1). With a public landing just below Cornell Dam, the refuge is a popular starting place for trips on the 76-mile stretch of the Niobrara National Scenic River. Its popularity increased from a few hundred visitors in the 1970's to a peak of 31,000 river enthusiasts in 1997, with most of the use concentrated on Saturdays (USFWS data). An average of 5 people/minute float past a fixed point along the river within the refuge on Saturdays (Davis 1999, USFWS data). Currently, annual river visitation ranges between 15,000 and 18,000 people (K. McPeak, refuge biologist, personal communication). Given the increase in river recreation and their responsibility for protecting wildlife, refuge managers requested a study of recreational impacts on birds that reside in habitats associated with the river.

In the summer 2000, the Kansas Cooperative Fish and Wildlife Research Unit (KCFWRU), based at Kansas State University, began a three-year study at the refuge. The purpose of the study was to gather information to inform managers about the extent to which river recreation influences birds that depend on the river. Species of concern included neotropical migrants, resident songbirds using riparian forest and shrub, and river-associated birds. Our study goals were to 1) determine which species were sensitive to river recreation and 2) determine if there were thresholds of recreational disturbance for birds. Such biological information would help refuge managers decide what quantity and type of river recreation was compatible with their primary goal of protecting birds and their habitats.

### STUDY METHODS

Data were collected from May to August 2000, 2001, and 2002 focusing on the bird community, population dynamics of a common breeding species, the Common Yellowthroat (*Geothlypis trichas*), and behavioral responses of waterbirds to river recreation.

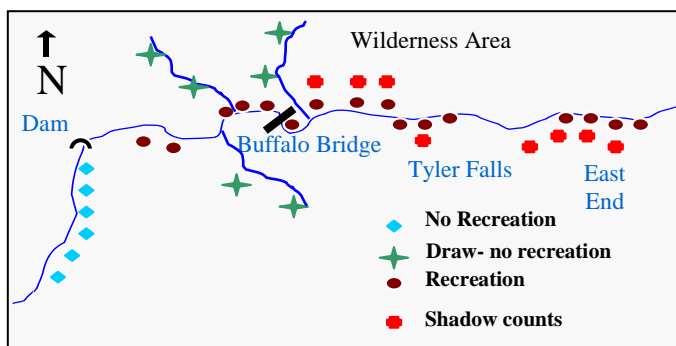
On the refuge, a dam partitions the Niobrara River such that a controlled study of the effects of river recreation on wildlife is possible (Figure 1). Above Cornell Dam, there is no river recreation. Below the dam, river recreation builds in intensity from June through August. Since our study was aimed at informing refuge managers specifically about processes on the refuge, this limited and localized experimental design was appropriate.



**Figure 1. Niobrara River on Fort Niobrara National Wildlife Refuge. Location of Cornell Dam (at arrow) separates where river recreation is absent (A) from where river recreation is present (P).**

Vegetation characteristics of areas in the refuge with recreation present or absent were surveyed using standard techniques (Lemmon 1956, James and Shugart 1970, Nudds 1977). Twenty-five 50 m vegetation plots were established in order to quickly assess canopy cover, shrub density and available habitat cover. All of these are important characteristics for breeding birds.

Field researchers used fixed-radius point counts during June and July 2000 to determine if songbirds, especially species of conservation concern like neotropical migrants, were abandoning their territories along the edge of the river as river recreation increased in intensity. Figure 2 is a schematic representation of the sampling strategy using point count plots on the refuge.



**Figure 2. Schematic diagram of point count sampling in recreated, non-recreated and shadow (> 150 m from river) areas at Fort Niobrara NWR.**

We used point count results to test a conceptual model of **community** responses of birds to river recreation. The model provides explicit predictions for three areas within the riparian zone on the refuge. It predicts that counts of individuals and species of birds in plots immediately adjacent to the recreated portion of the river decline as recreation increases. In contrast on "shadow" plots placed 150 m away from the river, counts of individuals and species are predicted to increase as individuals abandon riverside territories and move away from recreational disturbance. Along the non-recreated portion of the river, which includes the area above Cornell Dam and creek tributaries or "draws", the model predicts that counts of birds remain relatively constant throughout the breeding season.

To investigate whether river recreation had an impact on reproduction and survival at the **population level**, an abundant riparian nesting songbird on the refuge, the Common Yellowthroat, was studied in 2001 and 2002. Territorial males, pairs and nests were monitored using methods outlined in Martin and Geupel (1993) and behavioral observations were used to determine breeding success of pairs (Vickery et al. 1992). We predicted that productivity would be lower for pairs with territories where river recreation was present than for pairs with territories void of such disturbance.

To determine if predators of birds might have been attracted to areas used by recreationists, we established tracking stations (Sargeant et al. 1988) above and below Cornell Dam.

Disturbance from river recreation could also be costly for **individual** birds. If individual birds sacrifice feeding and resting time to flee from boats and people they could lose body mass, experience greater predation, or have lowered reproduction (Knight and Cole 1995, Gutzwiller et al. 1998). We compared flushing behavior of waterbirds in response to levels of recreation to determine which species were responding in a negative way to recreation. Since the number of people and watercraft type (tube, canoe, kayak) varied we standardized recreational disturbance by noise level. Noise categories utilized were: 1) No noise- little or

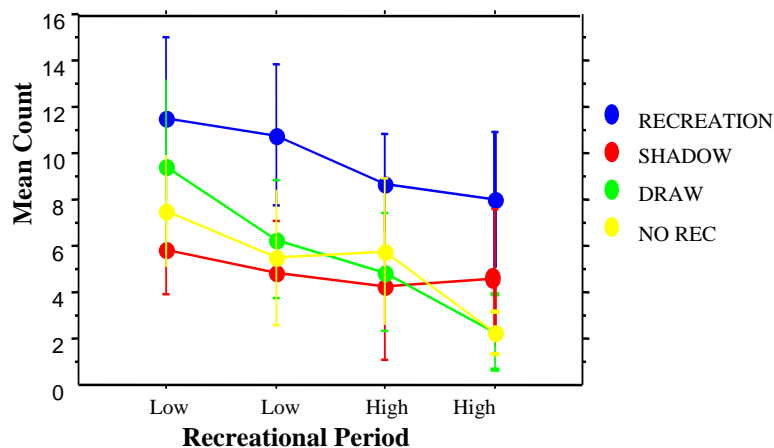
no recreation present and/or recreation present displaying complete silence; 2) Low noise- recreation present displaying very little noise (i.e. whispering or talking) and thus little overall activity and disturbance; and 3) High noise- recreation present displaying much noise disturbance (i.e. yelling and screaming, loud music, or other activity producing much noise).

Statistical analyses performed using SAS (SAS 2000) required 90% confidence for biologically meaningful trends and a 95% confidence for statistical significance.

## RESULTS

### Community Level Responses of Songbirds

The neotropical migrants most frequently counted in riparian forest along all study areas of the Niobrara river were Common Yellowthroat, Red-eyed Vireo (*Vireo olivaceus*), Ovenbird (*Seiurus aurocapillus*), and Black and White Warbler (*Mniotilta varia*). Yellow-breasted Chat (*Icteria virens*) and American Redstart (*Setophaga ruticilla*) were more frequently observed below the dam, whereas Great-crested Flycatcher (*Myiarchus crinitus*) was counted more often above the dam. The slight differences in avian communities were most likely due to habitat requirements of specific species. Vegetation analyses found that forest canopy and understory cover was similar throughout the refuge. However, more shrubs were found in recreated areas of the refuge. Also, forest patch size was larger and more contiguous in the recreated portion of the refuge.



**Figure 3. Mean count of birds at point counts throughout Fort Niobrara NWR given low (June) or high (July) recreational periods, Cherry Co., NE., 2000.**

Point counts of riparian songbirds (Figure 3) did not yield a pattern matching the predicted model. Although birds declined in recreated areas, they showed the same decline where no recreation was present. Counts of birds in shadow plots declined less than areas with or without recreation, but this result was not statistically significant. We interpreted these results as follows: 1) Birds may have left territories next to areas with river recreation, but more study is needed to verify this. 2) As summer progresses,

pairing and nesting behavior lowered detection rates of birds independently of river recreation. 3) River recreation appears to have had no significant effect on the distribution and abundance of songbirds using riparian forest adjacent to the river.

### Results of Common Yellowthroat Study

A total of 24 Common Yellowthroat nests were found and monitored during the breeding seasons of 2001 and 2002. Most of the nests (83%) failed. Only four nests produced fledglings. Program CONTRAST (Hines and Sauer 1989) showed that nesting and fledging rates were similar in recreated and non-recreated portions of the river ( $\chi^2 = 6.618$ ,  $p = 0.3576$ ), but that overall Mayfield estimated nest success in the refuge was only 2.0% (rec. vs. non-rec.:  $\chi^2 = 1.142$ ,  $p = 0.2851$ ) (Mayfield 1975, Johnson 1979). Nest success reported for Common Yellowthroats elsewhere in their range varies from 30-60% (Hofslund 1959, Guzy and Ritchison 1999).

The parallel study of the breeding status attained by 72 individual yellowthroats also indicates that pairs rarely reached the stage where they were carrying food to nestlings (Table 1). While pairs were successful at mating, building nests, and laying eggs, nests were destroyed prior to fledging. The final breeding stage achieved by birds in recreated areas versus those nesting in areas with recreation absent did not differ during the study as determined by the Cochran-Mantel-Haenszel categorical multivariate test of conditional association (CMH = 0.7553,  $p = 0.3848$ ). Only 3 nests fell to parasitism by Brown-headed Cowbird (*Molothrus ater*) during the entire study, all of which were later depredated. When nest parasitism and predation were evaluated, it became clear that predation was the dominant factor explaining the poor reproductive output of Common Yellowthroats in the refuge (Anderson 2003).

**Table 1. Breeding stage ranks utilized as a reproductive index based on behavioral observations of territorial Common Yellowthroats at Fort Niobrara National Wildlife Refuge, Cherry Co., NE.**

Rank	Definition
1	Territorial male.
2	Territorial male and female.
3	Pair nest building, laying or incubating eggs, or giving distraction display.
4	Adults carrying food to presumed nestlings.
5	Evidence of fledging success in one brood only.
6	Evidence of fledging success in either brood, plus evidence of nestling success in other brood.
7	Evidence of fledging in both broods.

Monitoring at tracking stations (Sargeant et al. 1998) suggested that the relative density of predators increases during the breeding season and was highest during the fledgling stage ( $\chi^2 = 5.69$ ,  $p < 0.02$ ). Predators detected

included bobcat (*Lynx rufus*), coyote (*Canis latrans*), domestic dog (*Canis familiaris*), American mink (*Mustela vison*), raccoon (*Procyon lotor*), as well as various small rodents and several species of snakes. Avian predators detected during point counts included American Crow (*Corvus brachyrhynchos*) and Blue Jay (*Cyanocitta cristata*), however these species were relatively uncommon.

The high loss of nests in Common Yellowthroats paired with a consistent presence of predators within the Niobrara River corridor strongly suggests that predator-prey interactions outweighed recreational impact and may not be influenced by recreation at current levels. Logistic regression modeling relating predation to recreational presence or absence, distance of sample from river, and nesting stage achieved by Common Yellowthroats found that only nesting stage (prenesting, peak nesting, and fledging) displayed a significant correlation to the probability of predators visiting tracking stations along the Niobrara River within Fort Niobrara NWR ( $\chi^2 = 6.06$ ,  $p = 0.048$ ). Recreational presence and distance from such disturbance were not significant explanatory variables in modeling the probability of detecting predators (Recreation presence/absence:  $\chi^2 = 0.01$ ,  $p > 0.908$ ; Distance from river:  $\chi^2 = 1.31$ ,  $p > 0.251$ ).

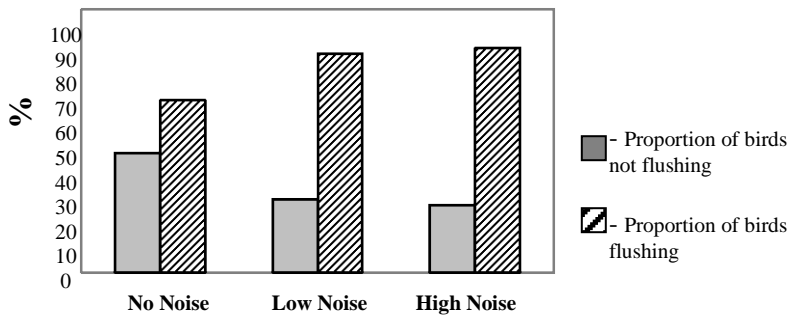
It seems that the limited riparian habitat found along the Niobrara River creates a concentration of nesting birds, which in turn concentrates predators, creating an ecological trap (Gates and Gysel 1978). Other studies of recreational impacts have shown that human presence can attract predators and increase nest depredation rates (Jokimaki and Huhta 2000, Miller and Hobbs 2000) devastating local populations of birds, especially those particularly vulnerable to depredation such as ground nesting species (e.g. Common Yellowthroat).

### Results of Waterbird Behavioral Study

A pilot study in 2000 indicated that waterbirds on the refuge including: Great Blue Heron (*Ardea herodias*), waterfowl (*Anatidae*), shorebirds (*Charadriiformes*) and Belted Kingfisher (*Ceryle alcyon*) flushed 50% of the time or more in reaction to a single canoe (Anderson 2003). During the summers of 2001-2002 the behavioral response of waterbirds was observed in relation to various levels of recreational activity within the refuge. Wilcoxon rank sum analysis and log-linear rate regression were used in statistical analyses.

Surveys in 2001 showed that in the presence of one canoe (research vessel) river birds were observed in areas of the refuge where recreation was not allowed 53% of the time, whereas birds were only seen 21% of the time in recreated areas. Wilcoxon rank sum tests showed a significant difference in waterbird abundance in these two riparian management areas on the refuge ( $p < 0.0001$ ).

Log-linear rate regression modeling (SAS Proc GENMOD) (SAS 2000) examined counts of species in response to recreational use. The model showed that birds increased in areas where there was no recreation as recreational intensity increased from June to July 2002 ( $\chi^2 = 46.87$ ,  $p = 0.0001$ ). Also, an increase in noise disturbance was observed as the number of boats increased and the recreational season intensified. Noise is widely accepted as a potential disturbance to wildlife as it may confuse animals or create altered behavior (Brattstrom and Bondello 1983, Bowles 1995). An increase in the proportion of birds flushing (birds either moved away from recreational presence or fled from the area completely) was observed as noise increased ( $\chi^2 = 3.65$ ,  $p = 0.0560$ ) (Figure 4). It is the presence of humans, paired with an additive disturbance of noise that causes this altered behavior in waterbirds.



**Figure 4. Avian behavioral response to recreational noise level during the 2001-2002 recreational season within Fort Niobrara NWR.**

Recreational river use at Fort Niobrara NWR has the potential to change waterbird use of the river. However, due to the sparse distribution and use of the refuge by many of the species observed, it is difficult to conclude what specific characteristics of recreational use trigger a displacement of individual birds from recreated to non-recreated areas. In this study, all levels of recreational intrusion caused birds to flush, indicating no threshold.

## CONCLUSION

At recreation levels of 15-18,000 people, we found no clear effects of recreational disturbance on songbirds breeding within Fort Niobrara NWR. However, there was a documented negative behavioral effect of recreation on waterbirds using the Niobrara River within the refuge.

Floating in the refuge occurs along the most contiguous and therefore most important area of riparian forest for songbirds within the refuge. Although study results indicated differences in the forest avian community due to forest patch size and proportion of shrubs, the study was not able to detect a clear effect of recreational disturbance. Further study of the forest songbird community at Fort Niobrara NWR should examine the influences of habitat,

territory size and availability, and responses to river recreation in greater detail.

Common Yellowthroat, a ground-nesting neotropical migratory songbird, was found to have high nest depredation. This is most likely due to the limited riparian habitat found in the sandhills region, which creates a concentration of wildlife specialized on these habitats and affords predatorial species an easy bank of prey species. As shown in other studies involving recreational intrusion and interactions with predator species, increased recreation may increase predator presence within the refuge. The response of predators to river recreation and the impact of predators upon the reproductive success of birds along the river clearly warrant further investigation.

Recreational presence creates an immediate behavioral disturbance to waterbirds found in the refuge (herons, waterfowl, shorebirds and Belted Kingfisher). These species flee from recreationists regardless of vessel number, type, or user behavior. This phenomenon may lead to longer-term impacts on the survival of such species due to the energetic stresses involved with continual disruption of daily activities and fleeing of the area. Further documentation of periods of use of the river corridor by wildlife should be undertaken to aid in determining whether concentrating or spreading out recreational disturbance would lessen the impact on waterbirds as well as other wildlife using the refuge.

Based on our results and thorough review of scientific literature, we suggest that a low impact recreational presence on Fort Niobrara NWR be promoted. Management actions should be implemented that minimize disturbance to wildlife. Acceptable levels of river recreation, both annual and daily, should be established. Encourage river recreation to occur when wildlife are less active and protect those time periods when wildlife are most active and therefore more likely to be disturbed (e.g. early morning and evening hours). Larger group sizes should be discouraged due to the increased potential for noise disturbance. River floaters should be encouraged to stay in their watercraft so as to not trample banks, destroy habitat, or further disturb birds or other wildlife. Visitors should be discouraged from leaving food or trash that may attract more predators. Finally, an education campaign to increase visitor awareness of the purposes of Fort Niobrara NWR should be implemented.

## LITERATURE CITED

- Anderson, C. D. 2003. Recreational pressure at Fort Niobrara National Wildlife Refuge: potential impacts on avian use and seasonal productivity along the Niobrara River. Thesis, Kansas State University.
- Bowles, A. E. 1995. Responses of wildlife to noise. Pages 109-156 in Knight, R. L. and K. J. Gutzwiller, editors. *Wildlife and Recreationists: Coexistence through management and research*. Island Press, Washington D.C.

- Brattstrom, B. H., and M. C. Bondello. 1983. Effects of off-road vehicle noise on desert vertebrates. Pages 167-206 in R. H. Webb and H. G. Wilshire, editors. Environmental effects of off-road vehicles: Impacts and management in arid regions. Springer-Verlag, New York, New York.
- Davis, J. B. 1999. Standards of quality for river use within the Fort Niobrara Wilderness Area. Unpublished memo.
- Gates, J. E., and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. *Ecology* 59(5):871-883.
- Gutzwiller, K. J., H. A. Marcum, H. B. Harvey, J. D. Roth, and S. H. Anderson. 1998. Bird tolerance to human intrusion in Wyoming montane forests. *Condor* 100(3):519-527.
- Guzy, M. J., and G. Ritchison. 1999. Common Yellowthroat (*Geothlypis trichas*). In *The Birds of North America*, No. 448, A. Poole and F. Gill, editors. The Birds of North America, Inc., Philadelphia, PA.
- Hines, J. E., and J. R. Sauer. 1989. Program CONTRAST- a general program for the analysis of several survival or recovery rate estimates. *Fish and Wildlife Technical Report* 24:1-7.
- Hofslund, P. B. 1959. A life history of the Common Yellowthroat, *Geothlypis trichas*. *Proc. Minn. Acad. Sci.* 27:144-174.
- James, Frances C. and Henry Herman Shugart, Jr. 1970. A quantitative method of habitat description. *Audubon Field Notes* 24(6):727-736.
- Johnson, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. *The Auk* 96:651-661.
- Jokimaki, J., and E. Huhta. 2000. Artificial nest predation and abundance of birds along an urban gradient. *Condor* 102(4):832-847.
- Knight, R. L., and D. N. Cole. 1995. Wildlife responses to recreationists. Pages 51-69 in Knight, R. L. and K. J. Gutzwiller, editors. *Wildlife and Recreationists: Coexistence through management and research*. Island Press, Washington D.C.
- Lemmon, Paul E. 1956. A spherical densiometer for estimating forest overstory density. *Forest Science* 2(1):314-320.
- Martin, T. E., and G. R. Geupel. 1993. Nest-monitoring plots: methods for locating nests and monitoring success. *Journal of Field Ornithology* 64(4):507-519.
- Mayfield, H. F. 1975. Suggestions for calculating nest success. *The Wilson Bulletin* 87(4):456-466.
- Miller, J. R., and N. T. Hobbs. 2000. Recreational trails, human activity and nest predation in lowland riparian areas. *Landscape and Urban Planning* 50:227-236.
- Nudds, Thomas D. 1977. Quantifying the vegetative structure of wildlife cover. *Wildlife Society Bulletin* 5(3):113-117.
- Sargeant, G. A., D. H. Johnson, and W. E. Berg. 1998. Interpreting carnivore scent-station surveys. *Journal of Wildlife Management* 62(4):1235-1245.
- SAS Institute Inc. 2000. SAS proprietary software release 8.1. Cary, NC, USA.
- Vickery, P. D., M. L. Hunter, Jr., and J. V. Wells. 1992. Is density an indicator of breeding success? *The Auk* 109(4):706-710.