Transactions of the Illinois State Academy of Science
(1997), Volume 90, 3 and 4, pp. 123-133

received 12/20/96
accepted 3/13/97

Impact of Flooding on Illinois River Wading Bird Colonies

Richard G. Bjorklund[1]
Department of Biology
Bradley University
Peoria, Illinois 61625

Daniel J. Holm
Illinois Department of Natural Resources
700 South 10th Street
Havana, Illinois 62644

[1]Current address: 26034 East Harris Lane, Topeka, Illinois 61567

ABSTRACT

Effects of severe and protracted flooding on two mixed-species colonies of wading birds were assessed in central Illinois. Both colony sites have been monitored since 1962. Historically, Great Blue Herons, *Ardea herodias*, Great Egrets, *Casmerodius albus* (threatened in Illinois), and Black-crowned Night-Herons, *Nycticorax nycticorax* (endangered in Illinois), nested in each colony. Annual ground censuses revealed declines in breeding populations following years when prolonged high water events occurred during the period of nestling development and fledging. High water appeared to disadvantage all three species, especially the Black-crowned Night-Heron. At the more affected of the two colonies, prolonged spring/summer flooding killed many nest trees, and the Double-crested Cormorant, *Phalacrocorax auritus* (threatened in Illinois), became a breeding resident in standing dead trees. The recent pattern of frequent and prolonged spring flooding in the Illinois River basin appears to be altering long-term stability and integrity of heron colonies.

INTRODUCTION

Historically, the frequency and duration of annual flood pulses generally were predictable. Consequently, plants, animals, and even human societies adapted to take advantage of them (Sparks 1995). In the Illinois River basin, flooding typically began with water rising slowly in the fall. Water levels kept rising gradually through winter, merging with the spring pulse; water levels receded slowly during summer and remained low throughout the growing season (Sparks 1995).

The frequent and rapid flood peaks that now characterize hydrologic patterns along the Illinois River occur as a result of floodplain constriction with mainstream levees, increased sedimentation, channelization of tributary streams, and other human activities. In addition, Singh and Ramamurthy (1990) found that from 1970 to 1990 the northern half of the Illinois River basin experienced a wetter and cooler weather cycle than in the past. This climate change also has contributed to the increasing magnitude and duration of Illinois River flows and flood peaks. Currently, flood peaks often extend into the growing season, altering the ecological integrity of the river system (Havera and Bellrose 1985, Sparks 1995).

U.S. Army Corps of Engineer records from to 1844 to 1986 show that half of the major floods at Peoria occurred from 1970 to 1986 (Bjorklund 1986a). High water also prevailed in 1990 when an all-time record precipitation of 135.4 cm was recorded at Peoria (National Weather Service Records, Peoria Office), and again in 1993, 1995, and 1996. The flood of 1993 in midwestern United States surpassed all previous floods in amount of precipitation, river levels, flood duration, and area of flooding (Custer et al. 1996). In 1995, the flood crest at Havana was 3.7 m above flood stage; this level exceeded the 1993 flood crest by approximately 0.9 m, and it was just 0.3 m below the all-time record. In 1996, the flood crest at Havana was 2.4 m above flood stage, and the river did not fall below flood stage until early-July; by 23 July the river again rose above flood stage.

Flooding of feeding habitat presumably results in a dispersed food source for wading birds, and it seems to influence nest initiation and clutch size for nesting Great Blue Herons, *Ardea herodias* (GBHE), in the upper Mississippi River (Custer et al. 1996). In addition, studies from other geographical locations have indicated that availability of suitable feeding habitat may be an important factor limiting growth of GBHE populations (Butler 1991, Gibbs 1991). Powell (1987) and David (1994) found that water level fluctuations altered the amount of preferred foraging habitat available to several species of wading birds, including the Great Egret, *Casmerodius albus* (GREG). For the Black-crowned Night Heron, *Nycticorax nycticorax* (BCNH), the quality of the foraging area may be more important than the strict nest site requirements to their breeding presence (Bjorklund 1986a, Graber et al. 1978). Although the decline of one of the largest heron colonies in Illinois was initiated by clear cutting of timber at its margin, protracted spring/summer flooding probably was an important factor contributing to its abandon-ment (Bjorklund 1975).

In this paper, we document effects of recent severe and protracted flooding on two mixed-species colonies of wading birds that have been monitored since 1962.

STUDY AREA AND METHODS

Initially, both colonies were located in the LaGrange Pool of the Illinois River on natural levees that formed between the river and backwater lakes. One colony site, at Worley Lake (river mile 156) about 8 km south of Peoria, was acquired by the Illinois Department of Natural Resources (formerly the Illinois Department of Conservation) in 1966 after it was severely disturbed by clear cutting and other anthropogenic factors. Nesting herons abandoned this colony after 1973 (Bjorklund 1975). In 1986, the Worley Lake colony was reestablished in regenerated timber near the original site (Bjorklund 1986a). The second colony was located on private property adjacent to Clear Lake, approximately 32.2 km downriver from the Worley Lake colony and about 20.8 km north of Havana, near river mile 133. A large portion of the Clear Lake colony occurred on a natural levee approximately 1.5 m above the surrounding floodplain.

Annual ground censuses were used to locate nest trees, document tree status, and enumerate active heron nests by species. All nest trees were marked with uniquely numbered aluminum tags. At the time of marking, each tree was identified to species and a measurement of trunk diameter at breast height (DBH) was recorded. Although censuses usually were made during June, occasionally they were delayed until the first week of July because of protracted spring flooding.

A continuous direct measure of water elevation at each colony site was not made; however, flood crests were detected from the level at which sediment was deposited on standing tree trunks. We used the daily record of open pass at the Peoria and LaGrange lock and dam sites as an index of water level within the LaGrange Pool (U.S. Army Corps of Engineers Peoria Project Office). Generally, when water levels at the Peoria lock and dam site reached an elevation of 439-440 mean sea level (MSL), approximately 3.5 m river depth, wickets were lowered so river traffic could pass over the dam without going through the locks (Jean M. Dorethy, pers. comm.). At the LaGrange lock and dam site 125 km downstream from Peoria, wickets were lowered when water levels reached an elevation of 428-429 MSL. An open pass indicated a water level that was sufficiently high to cause flooding at the Worley Lake colony site, and it usually indicated that the Clear Lake colony site was inundated as well.

GBHE, GREG, and BCNH have nested in both colonies. Some GBHE wintered in central Illinois and were observed at the colony sites in late February. In contrast, GREG did not arrive at the colony sites until the last week of March. The average arrival date of BCNH was 10 April. Thus, some GBHE commenced egg-laying before GREG and BCNH arrived at the colony sites.

Relationships between water levels and nesting of herons and egrets were examined with linear regression and correlation analyses (Zar 1974). A $\underline{P}<0.05$ was considered significant.

RESULTS

In the decade prior to recent major flooding, the Clear Lake colony breeding population tended to increase in years following low water levels (1985, 1987-1989) during the June through August period (Table 1). Decreases in breeding populations followed years with high water (1986, 1990) during June through August, corresponding to the portion of the breeding cycle when nestlings were completing development and fledging. We found a significant negative correlation between percentage of the June through August period that open pass occurred and percentage change in active nests the following year for GBHE ($r=-0.782$, $\underline{P}<0.05$, $n=9$, Figure 1). Correlation coefficients for GREG ($r=-0.543$) and BCNH ($r=-0.489$) were not significant ($\underline{P}>0.05$). Linear regression analysis indicated that a June through August period of open pass ≤59 percent was necessary to prevent a decline in the breeding GBHE population, 1983-1992 (Figure 1).

A similar comparison of open pass during the March through May portion of the breeding cycle and change in active nests the following year did not reveal a similar indicator of subsequent breeding population suppression ($\underline{P}$>0.05) for GBHE (r=-0.018), GREG (r=-0.302), or BCNH (r=-0.594).

Because the colony at Worley Lake was not reestablished until 1986 (Bjorklund 1986a), a comparable record of growth prior to recent major flooding was not available.

The status of nest trees and their avian occupants were examined following recent (1993-1996) major flooding (Table 2). Although 10 to 12 nest trees were dying annually at each site, nests rarely were maintained in dead trees when numerous live alternatives were available. After the 1993 flood, a large number of trees began dying at Worley Lake (Table 3). In 1994, we noted 11 nest trees with limbs completely defoliated, and many other trees were dying. A stand of 25 cm DBH eastern cottonwood, *Populus deltoides*, in nearby regenerating woodland also was observed to be dying. Thus, tree mortality at Worley Lake apparently was due to drowning and not to activities of nesting herons and egrets, which sometimes kill vegetation, including trees, with their guano (Volkert 1992).

By 1996, 48 percent of the nest trees at Worley Lake were dead (Table 3). Only 58 of the 129 (45 percent) dead trees used for nesting in 1996 were dead trees also used in 1995. Many of the trees observed dead or dying in 1994 and 1995 were blown over or were broken off at what was the high water line of past floods. In addition, the Double-crested Cormorant, *Phalacrocorax auritus* (DCCO), breeding population increased more than fourfold and all of their nests were built in standing dead trees (Table 2).

Although BCNH are opportunistic foragers (Bjorklund 1986b), they failed to nest at Clear Lake in 1996 even though suitable previously used live nest trees were available. Moreover, very few BCNH were observed in backwaters associated with the Clear Lake colony site. At the Worley Lake colony, the 1996 BCNH population declined by 74 percent (Table 2).

DISCUSSION

Observed breeding population declines of herons and egrets along the Illinois River appears to be, in part, the result of feeding habitat modifications. Prolonged elevated water levels during the June through August period, when developing nestlings were nearing fledging, had a negative impact on size of the nesting population the following year. Conversely, prolonged flooding during the March-May period, prior to or at the beginning of the nesting cycle, had little measurable impact on the breeding population outcome. The favorable energetics of a nearby concentrated food source, as opposed to a dispersed food source during flooding, should be examined further.

The breeding population decrease that we documented was not restricted to the LaGrange Pool of the Illinois River. For example, the next colony site upriver from Worley Lake is in the Peoria Pool near Lacon, and GBHE have declined each year since 1993 (Larry Rice, pers. comm.). A colony of GBHE downriver in the Alton Pool near Meredosia was ground censused in 1994. Nesting occurred in 1995, but the colony subsequently was abandoned, apparently because of drowned timber and salvage timbering (Vernon Kleen and Russ Engelke, pers. comm.). Thus, three Illinois River wading bird colonies monitored by annual ground censuses during 1993 to 1996 exhibited population declines during this period and a fourth colony was abandoned.

Because GBHE, GREG, and BCNH typically do not nest until two years of age (Butler 1992, Davis 1993, Kahl 1963), the breeding population decrease that we documented probably resulted from a combination of factors across age groups, not just poor recruitment. GBHE, GREG, and BCNH are relatively long-lived species (Butler 1992, Davis 1993, Kennard 1975), and learning experiences may play a role in breeding. As Custer et al. (1996) detected, GBHE are capable of altering nest initiation and clutch size in response to environmental variables.

Based on the Worley Lake and Clear Lake census data, it appears that individual birds may move to alternate colony sites in unfavorable years or may defer nesting altogether. Rapid growth of the Clear Lake colony from 231 nests in 1964 to 934 nests in 1968 coincided with severe logging disturbance and subsequent colony abandonment at Worley Lake. By 1981, when floods were becoming increasingly frequent and severe, the Clear Lake colony decreased to 181 nests (R. G. Bjorklund, unpubl. data). Moreover, from 1975-1985, GBHE, GREG, and BCNH were observed foraging at Worley Lake, but they did not nest regularly. Only BCNH, which twice established very small colonies in regenerating timber, nested successfully during this period (Bjorklund 1986a). After the Worley Lake colony was reestablished in 1986, low water years (1987-89) appeared to allow for rapid growth of the nesting population at both Clear and Worley lakes.

Some individuals of these species wander northward in postbreeding flights (Graber et al. 1978), providing an opportunity to locate more favorable foraging and nesting areas. Graham et al. (1996) noted that GBHE nesting populations were increasing in Ontario, and that a similar demographic trend had occurred in Alberta and upstate New York. In addition, Castrale (1994) and Iverson (1993) documented significant increases in Indiana GBHE breeding populations. However, at Fourmile Island rookery, Horicon Marsh, Wisconsin, Volkert (1992) found that nesting GREG and BCNH were declining significantly, GBHE were decreasing, and DCCO were increasing. Volkert (1992) indicated that the death of diseased trees and accumulation of guano contributed to the population shifts. A more system-wide and regional nest monitoring program is needed to ascertain how herons and egrets are reacting to recent flood-related challenges, and whether they are profiting from their experiences.

Our observations indicate that stability and integrity of the colony site and associated foraging areas influence the number of yearly nesting attempts. Severe flooding may have caused significant negative effects by reducing the quality of foraging areas and killing nest trees. In any case, fewer foraging herons and egrets were seen throughout the periods of flooding at traditional Worley Lake and Clear Lake foraging sites. Although drowned timber resulted in improved nesting conditions for the state threatened DCCO at Worley Lake, it represents a short-term unstable habitat. As stressed trees continue to die and dead trees disappear, herons and egrets will find fewer and fewer suitable nest trees. Finally, excessive sedimentation is filling in backwater lakes not protected by levees along the Illinois River and altering both feeding and nesting areas (Bellrose et al. 1983, Havera and Bellrose 1985). We noted up to 5 cm of sediment deposited under and near the colony sites as a result of a single major flood event.

In summary, if the recent trend of frequent, prolonged, and severe unseasonal water level fluctuations continues, breeding populations of wading birds in the Illinois River valley, including state threatened (GREG) and state endangered (BCNH) species, will face the ultimate challenge by dying, adapting, or emigrating.

ACKNOWLEDGMENTS

We thank Frank Bellrose, Jean and Richard Graber, Steve Havera, and two anonymous reviewers who read a draft of this paper and made helpful suggestions. Vernon Kleen, Larry Rice, Angella Moorehouse, and Russ Engelke shared unpublished information on Illinois River heron colonies. Personnel from Chautauqua National Wildlife Refuge and the Illinois Department of Natural Resources, students from Bradley University, and members of the Peoria Chapter of the National Audubon Society assisted in collecting data, 1962-1996. We thank the Clear Lake Outing Club for permission to access the colony site on their property. Lori Sanders and Jean M. Dorethy of the U.S. Army Corps of Engineers Project Office in Peoria kindly provided the open pass data.

LITERATURE CITED

Bellrose, F.C., S.P. Havera, F.L. Paveglio, Jr., and D.W. Steffeck. 1983. The fate of lakes in the Illinois River Valley. Biol. Notes 119. Illinois Natur. Hist. Surv., Champaign. 27pp.

Bjorklund, R.G. 1975. On the death of a midwestern heronry. Wilson Bull. 87:284-287.

Bjorklund, R.G. 1986a. On the rebirth of an Illinois River Valley heronry. Illinois Birds and Birding 2:68-69.

Bjorklund, R.G. 1986b. Opportunistic foraging behavior of the Black-crowned Night-Heron. Illinois Birds and Birding 2:70.

Butler, R.W. 1991. Habitat selection and time of breeding in the Great Blue Heron (*Ardea herodias*). Ph.D. thesis, Univ. Brit. Col., Vancouver.

Butler, R.W. 1992. Great Blue Heron. in A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 25. The Academy of Natural Sciences, Philadelphia; The American Ornithologists' Union, Washington, D.C.

Castrale, J.S. 1994. Survey of Great Blue Heron nesting colonies in Indiana 1983-1993. Indiana Audubon Quart. 72:133-140.

Custer, T.W., R.K. Hines, and C.M. Custer. 1996. Nest initiation and clutch size of Great Blue Herons on the Mississippi River in relation to the 1993 flood. Condor 98:181-188.

David, P.G. 1994. Wading bird use of Lake Okeechobee relative to fluctuating water levels. Wilson Bull. 106:719-732.

Davis, W.E., Jr. 1993. Black-crowned Night-Heron, *Nycticorax nycticorax*. in A. Poole, and F. Gill, eds. The Birds of North America, No. 74. The Academy of Natural Sciences, Philadelphia; The American Ornithologists' Union, Washington, D.C.

Gibbs, J.P. 1991. Spatial relationships between nesting colonies and foraging areas of Great Blue Herons. Auk 108:764-770.

Graber, J.W., R.R. Graber, and E.L. Kirk. 1978. Illinois Birds: Ciconiiformes. Biol. Notes No. 109. Illinois Natur. Hist. Survey, Champaign. 80pp.

Graham, K., B. Collier, M. Bradstreet, and B. Collins. 1996. Great Blue Heron, *Ardea herodias*, populations in Ontario: data from and insights on the use of volunteers. Colonial Waterbirds 19:39-44.

Havera, S.P., and F.C. Bellrose. 1985. The Illinois River: A lesson to be learned. Wetlands 4:29-41.

Iverson, G.C. 1993. Status and distribution of the Great Blue Heron in Indiana. Proc. Indiana Acad. Sci. 102:47-58.

Kahl, M.P. 1963. Mortality of Common Egrets and other herons. Auk 80:295-300.

Kennard, J.H. 1975. Longevity records of North American birds. Bird Banding 46:55-73.

Powell, G.V.N. 1987. Habitat use by wading birds in a subtropical estuary: implications of hydrography. Auk 108:740-749.

Singh, K.P., and G.S. Ramamurthy. 1990. Climate change and resulting hydrologic response: Illinois River basin. Pp. 28-37 in R. E. Riggins et al., eds. Watershed Planning and Analysis in Action: Symp. Proc. Illinois River Conf. Watershed Manage. American Soc. Civil Engineers, New York.

Sparks, R.E. 1995. Need for ecosystem management of large rivers and their floodplains. Bioscience 45:168-182.

Volkert, W.K. 1992. Population trends and proposed management plans for fourmile island rookery at Horicon Marsh Wildlife Area. Passenger Pigeon 59:51-57.

Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Englewood Cliffs, New Jersey. 620 pp.

Table 1. Relationship between water levels and the number and percentage change (in parentheses) of active heron nests at the Clear Lake colony site. A zero percent open pass indicates continuous low water.

Year	Percent of period open pass at lock		Number (and percentage change) of active nests			
	March-May	June-August	Great Blue Heron	Great Egret	Black-crowned Night-Heron	Total
1983	100.0	43.5	152	58	42	252
1984	100.0	38.5	171 (+13)	49 (-16)	44 (+5)	264 (+5)
1985	77.2	0.0	241 (+41)	102 (+108)	37 (-16)	380 (+44)
1986	70.7	62.0	348 (+44)	83 (-19)	27 (-27)	458 (+21)
1987	35.8	19.6	315 (-9)	61 (-27)	28 (+4)	404 (-12)
1988	45.7	0.0	533 (+69)	101 (+66)	54 (+93)	688 (+70)
1989	0.0	15.2	921 (+73)	176 (+74)	79 (+46)	1,176 (+71)
1990	84.8	88.0	911 (-1)	244 (+39)	90 (+14)	1,245 (+6)
1991	100.0	24.0	564 (-38)	92 (-62)	36 (-60)	692 (-44)
1992	28.3	19.6	950 (+68)	96 (+4)	27 (-25)	1,073 (+55)
Mean ±SD =	64.3 ±35.0	31.0 ±27.7				

Table 2. Status of trees with active nests in years following major flooding of the Clear Lake and Worley Lake colonies, 1993-1996. Dying trees that retained some live foliage were recorded as live to reflect leaf-out conditions at the initiation of nesting.

		Number of nest trees		Number of nests							
				Great Blue Heron		Great Egret		Black-crowned Night-Heron		Double-crested Cormorant	
Colony	Year	Live	Dead	Live trees	Dead trees	Live trees	Dead trees	Live trees	Dead trees	Live trees	Dead trees
Clear Lake											
	1993	463	3	734	4	190	0	66	0	0	0
	1994	544	5	918	5	234	0	23	0	0	0
	1995	396	2	674	2	126	3	3	0	0	0
	1996	195	2	324	3	104	0	0	0	0	0
Worley Lake											
	1993	295	1	475	2	137	0	50	0	0	0
	1994	319	11	451	20	142	16	72	1	0	0
	1995	205	127	262	201	134	106	46	16	1	8
	1996	138	129	233	216	90	64	12	4	0	41

Table 3. Species composition and status of nest trees at the Worley Lake colony site preceding and following major flooding (major flooding occurred in 1993 and 1995).

	1993		1996		
Species	Live	Dead	Live	Dead	Percent dead
Silver Maple (*Acer saccharinum*)	265	1	131	110	46
Green Ash (*Fraxinus pennsylvanica*)	26	0	7	18	72
Eastern Cottonwood (*Populus deltoides*)	2	0	0	1	100
Pecan[a] (*Carya illinoensis*)	2	0	0	0	0

[a]Although pecan trees were alive in 1996, they were not used for nesting.

Figure 1. Effect of prolonged flooding during June through August in a given year on the percentage change in total number of active GBHE nests the following year at the Clear Lake colony site, 1983-1992. The regression equation is: Y=-1.046x + 63.28; r=-0.782, P<0.05.