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Source: Waterbirds, 35(2) : 185-193

Published By: The Waterbird Society

URL: https://doi.org/10.1675/063.035.0201

WATERBIRDS

JOURNAL OF THE WATERBIRD SOCIETY

VOL. 35, NO. 2 JUNE 2012 PAGES 185-360

Population Decline of Black Terns in Wisconsin: A 30-Year Perspective

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Abstract.—Point-count surveys of Black Terns (*Chlidonias niger surinamensis*) were conducted in Wisconsin from 1980 to 2011 to assess statewide population trends of this declining species. The survey program consisted of 19 roadside transects, each with 15 stops (N = 285 stops total), spread across 15 counties throughout the state. Surveys were conducted at the same sites each year during three periods (1980-1982, 1995-1997, 2009-2011) by observers who visited each site once during the breeding season (25 May to 24 June) and counted the number of Black Terns seen during a 5-min interval. Over the three survey periods, statistically significant changes in abundance occurred on 14 of the 19 transects, most of which either were linear or exponential declines; no significant increases were evident. Survey-wide, the population declined in abundance by nearly 70% over the past 30 years and site occupancy declined by a similar percentage. Complete extirpation was recorded on four transects. Nest counts in two intensive study areas were consistent with the declining trend indicated by the point-count surveys. Likely causes of the decline include continued loss and degradation of breeding habitat and low annual adult survival probability, the latter for which reasons currently are unknown. Protection of remaining breeding colonies and restoration of degraded wetlands are recommended conservation measures for this species in Wisconsin and elsewhere. *Received 26 October 2011, accepted 20 January 2012.*

Key words.—Black Tern, *Chlidonias niger surinamensis*, distribution, population trend, survey counts, wetland birds, Wisconsin.

Waterbirds (35(2): 185-193, 2012

The North American Black Tern (*Chlidonias niger surinamensis*) breeds in freshwater wetlands throughout the northern United States and southern Canada (Heath *et al.* 2009). The Black Tern once was a fairly common summer resident in wetlands of the Upper Midwest region of the United States and also in the prairie provinces of Canada. Breeding populations in these regions, however, have experienced considerable declines over the past century (Heath *et al.* 2009), most likely due to extensive loss and degradation of wetland habitat (Dahl 1990). More recently, trend analysis from data gathered by the North American Breeding Bird Survey (NABBS) indicates a continued annual decline of 3.5% (95% CI: -27.9 to -1.5%) continent-wide from 1966 to 2009 (Sauer *et al.* 2011). The NABBS was designed primarily to survey passerines, however, and has long been known to be deficient in surveying wetland birds and colonial nesting species, including Black Terns (Bystrak 1981; Peterjohn and Sauer 1997).

Because of its abundant glacial wetlands, the Prairie Pothole region of the Upper Midwest and adjacent Canada is an important breeding area for Black Terns. Available evidence, however, suggests that continued declines occurred in this region throughout the 1980s (Hands *et al.* 1989), although NABBS data indicate no significant trend since then (Sauer *et al.* 2011). Black Terns currently are listed as threatened or endangered in many parts of their U.S. range, and various conservation assessments and action plans have been produced (e.g. Shuford 1999; Kudell-Ekstrum and Rinaldi 2004; Naugle 2004). Much of the data gathered to date about the status and trends of Black Terns in North America, however, consists of "gray literature" reports, anecdotal accounts, and local or regional surveys of short duration and questionable reliability. Nisbet (1997) stressed the urgent need for reliable assessments of abundance and population trends of Black Terns within the main breeding range.

Wetlands in Wisconsin cover over two million hectares of the landscape, and Black Terns once were considered a "very common resident in all inland ponds, sloughs, wet marshes, and lakes . . ." (Kumlien and Hollister 1951). Currently, however, they are listed as a Species of Special Concern and a Species of Greatest Conservation Need in Wisconsin and their Natural Heritage rank is Imperiled (WDNR 2011). Because of concerns about population declines suggested by the Wisconsin Breeding Bird Survey (Robbins 1977) and other sources, the Wisconsin Black Tern Survey was initiated in 1979 to serve as an index of statewide distribution and abundance and to provide baseline data for long-term monitoring (Tilghman 1980). In that year, state and federal agency personnel and volunteers conducted surveys of over 300 wetland sites. Based on the 1979 surveys and other sources, permanent road survey transects were established in 1980. Systematic surveys then were conducted each year from 1980 to 1982, 1995 to 1997, and 2009 to 2011. The survey program has generated a number of technical reports and two publications in a regional ornithological journal (Tilghman 1980; Graetz and Matteson 1996). This paper summarizes the results from the entire survey program, spanning more than 30 years, and provides a comprehensive view of the status and population trends of Black Terns in Wisconsin during this period.

METHODS

Survey Establishment

In 1980, 19 permanent road survey transects were established in 15 counties across Wisconsin, extending from Bayfield County in the extreme northwestern part of the state to Kenosha County in the extreme southeastern region (Fig. 1). Transects were selected to represent areas of the state with known historical and extant breeding populations, where volunteers could be secured, and were neither stratified nor randomized. Six of the routes were concentrated in two intensive study areas in Columbia and St. Croix/Polk counties (Fig. 1), where complete nest counts also were conducted each year following the surveys. Each survey transect consisted of 15 stations that were accessible from roads or by a short walk to a designated viewing area. The sites established along each transect were not selected randomly; rather, they included a range of "suitable" to "marginal" habitat based on the 1979 survey and historical records, as well as subjective evaluations and information provided by local cooperators about sites that were deemed suitable as nesting or feeding habitat, or which could conceivably be so in future years with normal, periodic changes in water levels and wetland condition (Mossman 1980). As such, the distance between survey points for each transect varied according to the abundance and distribution of available habitat. Transects included all ecoregions of Wisconsin except the driftless area in the southwestern part of the state where wetland habitat is scarce away from river margins. The majority of the stations consisted of shallow-water marshes, but wetland sites also included stream edges, flooded meadows and areas of open water (Tilghman 1980). Emergent vegetation in these wetlands consisted primarily of roundstem bulrush (*Scirpus* spp.), river bulrush (*Scirpus fluviatilis*), cattails (*Typha* spp.), burreed (*Sparganium* spp.), sedges (*Carex* spp.), pond lilies (*Nuphar* spp. and *Nymphaea odorata*), grasses (Poaceae), water plantain (*Alisma plantago*) and arrowhead (*Sagittaria* spp.).

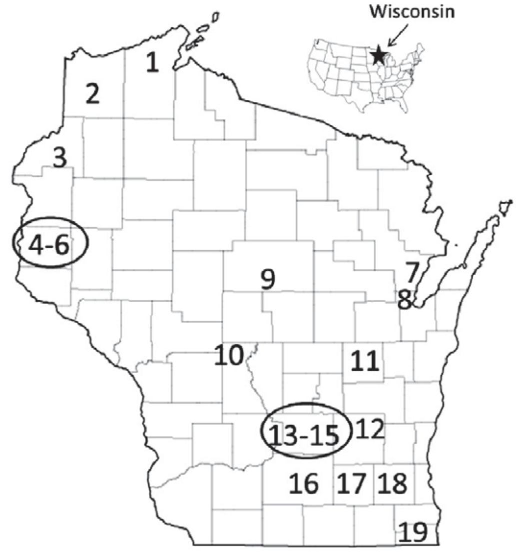

Figure 1. Map of Wisconsin showing locations of transect surveys. Numbers correspond to transect names by county as listed in Table 1. Circled numbers represent nest census plots in St. Croix/Polk counties (transects 4-6) and Columbia County (transects 13-15).

Survey participants included volunteers from federal, state, and private wildlife and conservation agencies, biologists and private citizens that were part of the Wisconsin birding community. All observers were familiar with Black Terns and had prior experience with point-count surveys of this type. Before the survey period, each participant received a packet of materials that included instructions, data sheets, written and legal descriptions and county road maps of all stations on the transects, and photocopies of topographic maps delineating station locations and areas to be viewed (location information for all sites on the transect survey is available from the corresponding author upon request).

Survey Protocols

In each year of the program, transects were surveyed once between 0600 and 1900 hrs between 25 May and 24 June to coincide with the peak nesting season of Black Terns in Wisconsin. At each station on the transect route, an observer or pair of observers scanned the prescribed wetland area with the unaided eye, binoculars, or a spotting scope for 5 min, and recorded the total number of Black Terns seen during the time interval. Thus, these surveys consisted of variable-radius plots, which included the entire wetland area, if small, or as much of the wetland as could be seen from the observation point, if large. All birds visible to an observer were recorded, including birds in flight over the wetland and those standing on the surface vegetation or attending nests. To reduce bias associated with double counting birds, particularly at large colonies, single observers were instructed to conduct 2-3 continuous scan samples and to use the arithmetic mean as the count total; at smaller colonies or at sites where birds were highly dispersed, observers recorded the maximum number of individuals seen following repeated scan sampling during the 5-min interval. For observer teams, individual high counts were averaged when estimates differed between observers. Surveys were conducted only during fair weather and when wind speed did not exceed 32 km/hr. Each transect generally was surveyed by different observers, although some observers surveyed more than one transect in a particular year.

Several authors have challenged the validity of point-count surveys that employ a single-observer or single-visit approach (e.g. Bart and Earnst 2002; Thompson 2002; Smith *et al.* 2009) because these approaches do not permit estimation of detection probability, which has been shown to be < 1.0 in nearly every case examined (Kéry and Schmidt 2008). Although such criticism has been directed more specifically toward surveys of passerines and secretive marsh birds, we recognize that use of a double-sampling or multiple-observer approach would have improved the precision of our estimates. Because of the relative openness of the wetland areas surveyed and the visual and vocal conspicuity of the target species, however, inter-observer variation in detection probability was assumed to be negligible and unlikely to bias the results in any meaningful way. As Thompson (2002) noted, unadjusted counts may be sufficient to detect large changes in a population that is abundant initially.

Survey Periods

The transect survey was conducted in nine different years over a 32-yr time span. The three primary survey periods, each consisting of three consecutive annual surveys, were separated by at least eleven years. Hereafter, the first three years of the survey (1980-1982) are referred to as Period 1, the second three years (1995-1997) as Period 2, and the final three years (2009-2011) as Period 3. Despite the long timeframe of this study, consistency among participants was high. Seven people conducted the same transects in Periods 2 and 3, and four of these observers also participated in the original surveys during Period 1.

Nest Counts

In 1980, two circular nest census plots were established, each 310 km^2 in total area: one in St. Croix and Polk counties, comprising all wetlands on roadside transects 4-6; and one in Columbia County, comprising all wetlands comprising transects 13-15 (Fig. 1). The plots were censused in each year of the roadside surveys, except in 1982, by conducting thorough nest searches, by foot and canoe, at all wetlands where terns were recorded during the survey and where they appeared to be nesting or exhibiting territorial behavior. For expediency, nest counts were conducted by at least two people and as many as six people in some of the larger colonies. To avoid double counting, nests were marked temporarily with surveyor's tape or mapped with a GPS receiver. Nest sites without eggs but with evidence of recent occupancy (e.g. fresh feces) or the presence of a defensive adult or adult pair also were included in the count total for each site. Due to logistical constraints, nest census dates varied between the two plots and among years, but all counts were conducted between mid-June and the first week of July in all years. This period typically coincides with the late incubation to early chick-hatching stages of the nesting cycle (authors' unpublished data).

Data Analysis

Counts of Black Terns at each of the 15 stops on each of the 19 transects were summed in each year of the survey, and these untransformed values were used as the statistical unit for comparison. Survey Period was treated as a factor at three levels (1980-1982, 1995-1997, 2009-2011). Counts of birds or nests in the two census plots, for each of the three years within a period, were treated as replicates for that period. Least-squares regression was used to explore trends in abundance separately for each of the 19 transects and two nest census plots. For each transect, linear, quadratic and exponential models were fitted to the data and the most appropriate model was selected based on comparisons among the coefficients of determination and F-tests of significance. One-factor Analysis of Variance was used to test for survey-wide differences in abundance and site occupancy during the three survey periods, again treating Survey Period as the factor and years within period as replicate counts. A significant ($P \leq 0.05$) Period effect was followed by Tukey pairwise mean difference tests.

RESULTS

Transect Surveys—Abundance

The count results of the transect surveys are shown in Table 1. Between survey Period 1 and Period 3, statistically significant changes in abundance occurred on 14 of the 19 transects. Most (9/14) of these significant changes were either exponential or linear declines; the remainder exhibited more complex quadratic relationships, indicating either a decline between Period 1 and Period 2 followed by recovery or abatement in decline by Period 3 (U-shaped) or the converse (inverse U-shaped). By Period 3, 13 of the 19 transects averaged ten or fewer birds per year, with complete extirpation recorded on four transects. Most notable were local extinctions of terns on the Oconto and Brown transects, both of which are along the western shoreline of Green Bay and which produced some of the highest counts of terns during Period 1 (Table 1).

Only one transect (Jefferson) returned a positive linear increase over the three survey periods, but the trend was not significant and the difference involved very few birds (Table 1). Only the Dodge Co. transect returned higher average numbers of birds during Period 3 than in Period 1, but this result was due entirely to 152 birds counted at one stop (Horicon Marsh) in 2011. Note also that this one stop produced nearly half (44%) of all birds recorded on the transect surveys in 2011.

For all transects combined, a significant difference in abundance was found among the three survey periods ($F_{2,6}$ = 140, P < 0.0001), with Tukey post-hoc tests indicating that survey-wide abundance was significantly greater during Period 1 than the other two periods, which were not significantly different. On average, abundance declined by 63% between Period 1 and Period 2 and a further 12% between Periods 2 and 3. Variance-to-mean ratios, however, differed substantially between Period 3 ($s^2/\overline{x}$ = 14.9) and the other two periods (Period 1 = 0.03, Period 2 = 1.3), indicating that total annual abundance estimates during the final three years of the survey were highly disparate (Table 1).

Site Occupancy

The mean number of occupied sites differed significantly among the three periods ($F_{2,6}$ = 361, P < 0.0001), declining by nearly 60% between Period 1 and Period 2 and another 34% between Period 2 and Period 3 (Table 2). Of the 33 survey stops where terns were detected in 2011, two managed wetland complexes (Crex Meadows SWA [Burnett Co.] and Mead SWA [Marathon Co.]) accounted for nearly half the total (N = 16, 48%), and only one or two sites (out of 15) were occupied by terns on most of the remainder of the transects (Douglas, St. Croix North, St. Croix South, Winnebago, Dodge, Columbia East, Columbia South, Kenosha) during the Period 3 surveys.

Nest Counts

Nest count results for the Columbia and St. Croix/Polk county census plots (Fig. 2) were consistent with trends indicated by the roadside surveys. For the St. Croix/Polk census, there was a significant linear decline ($F_{1,6}$ = 17.7, P = 0.006, estimate of slope, $\hat{\beta}$ = -11.4 ± 2.7 [SE]) in the number of nests recorded over the three periods, with no evidence of nesting by terns at any of the 45 wetlands included in the census plot during the final 3-yr period (Fig. 2). Although there was no significant trend in the mean number of nests recorded in the Columbia census plot over the three survey periods (least-squares regression, quadratic model: $F_{2,5}$ = 3.45, P = 0.11), the mean number of breeding colonies exhibited a significant exponential decline ($F_{1,6}$ = 30.3, P = 0.002, r^2 = 0.84) from ten in Period 1 to four in Period 3 (Fig. 2), with over 70% of the nests in Period 3 found at only one site (Grassy Lake).

DISCUSSION

The results of the Wisconsin Black Tern survey clearly indicate a substantial decline in abundance and site occupancy over the past 30 years among the 285 wetland sites on the transects. The largest (~60%) decline in abundance occurred between survey peri-

Table 1. Black Tern abundance indices, defined as the number of individuals detected per 15 roadside stops, by route name and year, and best fitting least-squares regression model describing population trends over the three primary survey periods (1980-1982, 1995-1997, 2009-2011).

	Period 1			Period 2			Period 3						
Transect	1980	1981	1982	1995	1996	1997	2009	2010	2011	Model	r^2	F(P)[1]	Trend
1. Bayfield	14	3	0	3	0	0	0	0	0	linear	0.28	2.8	decline
2. Douglas	26	43	42	41	15	28	7	8	10	exponential	0.75	21.4(***)	decline
3. Burnett	78	62	70	14	20	23	25	47	53	quadratic	0.87	19.4(***)	U-shaped
4. St. Croix N	9	18	5	0	1	3	0	2	0	exponential	0.64	12.4(**)	decline
5. St. Croix W	6	13	11	17	20	6	0	0	0	quadratic	0.71	7.2(*)	inverted U
6. St. Croix S	12	24	6	0	0	0	1	0	0	exponential	0.62	11.4(**)	decline
7. Oconto	132	100	166	14	10	27	0	0	0	exponential	0.98	290(***)	decline
8. Brown	76	41	50	11	3	2	0	0	0	exponential	0.94	112(***)	decline
9. Marathon	122	164	158	20	39	28	30	40	47	quadratic	0.94	50.3(***)	U-shaped
10. Juneau	82	104	87	20	15	28	9	9	3	quadratic	0.97	97(***)	decline
11. Winnebago	30	47	30	19	16	7	40	3	28	quadratic	0.42	2.2	U-shaped
12. Dodge	93	74	32	21	20	21	60	30	152	quadratic	0.37	1.8	U-shaped
13. Columbia N	30	22	32	15	17	10	1	5	4	linear	0.91	66.4(***)	decline
14. Columbia E	50	63	91	39	44	89	51	23	22	exponential	0.47	6.1(*)	decline
15. Columbia S	37	48	37	18	14	19	26	1	0	linear	0.70	16.2(**)	decline
16. Dane	15	10	11	18	19	24	6	8	12	quadratic	0.80	12.2(**)	inverted U
17. Jefferson	10	2	0	4	2	10	13	10	8	linear	0.35	3.8	increase
18. Waukesha	21	23	31	7	36	10	9	4	3	exponential	0.64	12.2(**)	decline
19. Kenosha	10	3	4	18	10	7	19	1	3	quadratic	0.16	0.6	inverted U
Total	853	864	863	299	301	342	297	191	345	quadratic	0.98	140(***)	U-shaped

[1](*), $0.05 \geq P > 0.01$; (**), $0.01 \geq P > 0.001$; (***), $P \leq 0.001$.

Table 2. Number of sites (out of 285 possible) at which Black Terns were detected by observers during roadside surveys in each year of the three main survey periods. For means, numbers followed by different letters indicate significant differences (P ≤ 0.05) among primary survey periods, as revealed by Tukey post-hoc pairwise comparisons.

	Period 1 (1980-1982)	Period 2 (1995-1997)	Period 3 (2009-2011)
Year 1	121	58	33
Year 2	127	47	38
Year 3	120	54	33
Mean ± sd	123 ± 4 (A)	53 ± 6 (B)	35 ± 3 (C)

ods 1 (1980-1982) and 2 (1995-1997). Since then, the decline has abated somewhat, whereas site occupancy has continued to decrease, with the population continuing the trend toward increased concentration in a few large wetland complexes, such as Horicon Marsh (Dodge Co.), Crex Meadows SWA (Burnett Co.) and Mead SWA (Marathon Co.). Aside from these managed refuges, the only known large (> 25 pairs) breeding colonies of Black Terns now found consistently on unmanaged public or private wetlands are located in the southeastern part of the state, from Columbia to Waukesha counties. Black Terns have virtually disappeared along the Green Bay and Lake Superior shorelines (Shealer and Matteson 2011), and they persist only at scattered locations throughout the northern and central regions of the state.

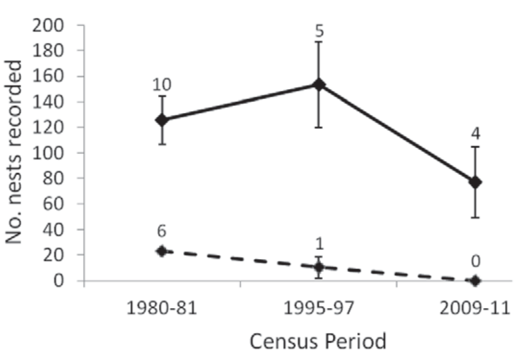

Figure 2. Mean (± sd) number of nests recorded in the Columbia (upper series, solid lines) and St. Croix/Polk (lower series, dashed lines) nest census plots during the three survey periods. Numbers above whiskers indicate mean number of colony sites detected for a particular census plot and survey period. Lines connecting dots are for visual aid only and do not imply interpolation between periods.

Although concentrated in only two areas of the state, the nest census results provide corroboration for the overall trend indicated by the roadside surveys. A few Black Terns were recorded on the St. Croix/Polk county surveys (Transects 4-6) during Period 3 (Table 1), but we found no evidence of nesting at any of the sites where birds were detected. Faanes (1979) confirmed breeding at seven selected colony sites in this census plot between 1975 and 1977, where the population declined from 42 to 18 breeding pairs over his three-year study. Our follow-up census work indicates that Black Terns ceased breeding in this region between 1997 and 2009. In Columbia County, where there were as many as eleven separate colony sites in the early 1980s, there now are only 3-4 annually, with most (> 70%) of the nesting attempts restricted to Grassy Lake, an unmanaged but state-owned waterfowl production area (Shealer and Matteson 2011).

Reasons for the apparent statewide population decline over the past 30 years may be attributed in part to successional changes in wetland vegetation structure and composition, shifting hydrological conditions and general degradation of wetland quality. The disappearance of Black Terns from sites along the Green Bay shoreline probably is related to the degradation of wetlands due to pollution discharge, human activities, an extended period of high water during the 1980s and the subsequent spread of giant reed grass (*Phragmites australis*) that first invaded the area around 1985 and now covers up to 75% of what was once productive wetland habitat (Epstein *et al.* 2002). Whereas wetland habitat decline along Green Bay was extreme and potentially permanent, changes in other areas have been more cyclical. For example, water levels in the southern ecoregions of Wisconsin have been abnormally high due to recent flooding events. High water impedes the growth of emergent vegetation and may delay nesting by terns (Shealer *et al.* 2006), as they must wait for enough plant growth to provide adequate substrate on which to lay eggs. Conversely, the northern ecoregions have been under moderate to extreme drought conditions over the past several years (Svoboda 2011), and many of the wetlands used historically as breeding sites, particularly in St. Croix County, were mostly dry in 2009-2011.

Despite the large geographic scope of the survey program and the diversity of wetland types included in it, the fact that site selection was neither stratified nor random creates some uncertainty as to whether the results truly are representative of the population trend statewide. Black Terns prefer to nest in wetlands in either a regenerative or degenerative "hemi-marsh" state, consisting of an approximately equal mix of open water and emergent aquatic vegetation (Weller and Spatcher 1965; Dunn 1979; Hickey and Malecki 1997; Mazzochi *et al.* 1997). Glacial wetlands cycle through various stages over time, due to local or regional hydrological conditions and relatively predictable successional changes in vegetation type and structure (van der Valk 1989). Over a 30-yr period, unmanaged regenerative wetlands may become occluded with rank vegetation and degenerative wetlands may revert to open water. In essence, then, many sites chosen for the survey in 1980 may no longer provide suitable breeding or foraging habitat for Black Terns, and what appears to be a large-scale population decline may instead result from birds shifting to sites not included in the survey.

Several lines of reasoning and evidence, however, argue against compensatory site use as an explanation for the severe decline as indicated by the survey. First, the issue of habitat degradation is mitigated somewhat by the initial inclusion of survey sites without existing Black Tern populations, but for which historical information suggested that habitat suitability might improve as a result of normal hydrological dynamics. Second, for the "colony shift" hypothesis to be reasonable, degradation among surveyed wetlands would have to be substantially greater than degradation among wetlands not surveyed. Because the survey included a variety of wetland types and sizes throughout most ecoregions of the state, such an explanation seems unlikely at best. Third, Black Terns have disappeared recently from other sites and regions that were not included in the survey. These sites include wetlands along the entire Lake Superior shoreline of Wisconsin between 1982 and 1995 and several wetlands in Oneida and Vilas counties between 1997 and 2009 (Shealer and Matteson 2011), without any obvious habitat changes during those intervals. Fourth, although permanent emigration of birds to neighboring states could account for the decline in Wisconsin, population trends in Illinois, Michigan and Minnesota appear to mirror that of Wisconsin (Shuford 1999), all of which show statistically significant declines since 1980, according to NABBS trend analysis (Sauer *et al.* 2011).

We also dismiss increased human disturbance as an explanation for the decline in Wisconsin. Acute, short-term disturbances at the nesting colony, as might occur due to recreational boat traffic, do not promote abandonment or affect reproductive success (Shealer and Haverland 2000). At a larger scale, Black Tern populations appear to be most stable in the extreme southeastern part of the state, which is its most densely human-populated area. Peters (2001) found little evidence of a change in abundance between her surveys of this region in 2000 and the original surveys reported by Tilghman (1980), suggesting that Black Terns are not particularly bothered by human encroachment.

Currently, the most compelling explanation for the large-scale population decline in Wisconsin relates to adult survival probability and natal recruitment into the breeding population. In an eight-year mark-recapture study of more than 700 Black Tern adults and 1,200 nestlings banded at Horicon Marsh, one of the largest remaining breeding colonies in the state, annual adult survival probability was estimated at 62%, and nestling survival to recruitment age (2 yr) was < 2% (Shealer 2007). Coupled with chronically low annual reproductive success at this site, these estimates are far below the minimum parameters necessary to maintain a stable population over time (Servello 2000). Moreover, these low survival and recruitment estimates could not be accounted for by permanent emigration because intensive recapture efforts were made yearly at several nearby colony sites. In his modeling analysis, Servello (2000) found that population growth rate in Black Terns was highly sensitive to adult survival, more so than reproductive parameters. If poor adult survival is indeed a contributing cause of the population decline in Wisconsin, the problem may not originate on the breeding grounds because very few adult birds are found dead or disappear while they are tending nests (DAS, personal observation). Little is known, however, about the migratory and winter ecology of Black Terns or the threats they may face during this stage of their life cycle (Nisbet 1997), and there currently are no data to substantiate a causal connection to the decline noted in Wisconsin since 1980.

Naugle (2004) argued that loss of remaining wetland habitats to agriculture or development represents the greatest threat to Black Terns, and suggested that conservation of these remaining wetlands is likely to provide the greatest benefit to this and other wetland-dependent species. Restoration of wetlands in areas where loss and degradation have been severe also is a potential management option, although careful consideration is necessary to provide both local- and landscape-scale habitat characteristics suitable for nesting (Brown and Dinsmore 1986; Naugle *et al.* 2000). Numerous wetlands have been restored in Wisconsin since 1980, and Black Terns seem to respond positively to rehabilitated wetlands that provide suitable habitat (Delhanty and Svedarsky 1993; Delphey and Dinsmore 1993; Linz and Blixt 1997). We are aware of two wetland sites in particular that were colonized by Black Terns within a few years following restoration, so this type of management approach appears to hold some promise.

Because Black Terns require highly productive and ecologically diverse wetlands for breeding, their presence at a site may serve as a conspicuous and reliable indication of the overall health and vitality of freshwater wetlands within their summer range. As such, their continued decline in Wisconsin and elsewhere is cause for concern. An essential next step is to determine whether the decline is due to habitat or resource limitation on the breeding grounds, in the winter quarters, or to some set of factors intrinsic and unique to the species, so that restoration efforts can be directed accordingly. Nisbet (1997) and Naugle (2004) outlined the types of research investigations necessary to inform management decisions, but progress has been slow in addressing the issues facing this imperiled species.

ACKNOWLEDGMENTS

We thank the many volunteer observers who contributed to the Black Tern transect survey over the past 32 years, especially K. Etter Hale, F. Strand, R. Thiel and R. Verch who, along with the senior author, participated in all three survey periods. Funding and other support for the Black Tern survey was provided by the Wisconsin Department of Natural Resources' Endangered Resources Fund, the U.S. Fish and Wildlife Service's Migratory Nongame Bird Program and the Pittman-Robertson Federal Aid-In-Restoration Act. We appreciate the comments of the Editor and two anonymous reviewers, which improved the content and clarity of the manuscript.

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