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LEAST TERN NESTING HABITAT IN THE MISSISSIPPI RIVER VALLEY ADJACENT TO MISSOURI

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Abstract.—Habitat characteristics of interior Least Tern (*Sterna antillarum*) colony sites in the Mississippi River valley adjacent to Missouri were examined during 1985–1989. During 1985, Least Tern nesting colonies were located on sand islands and sandbars that differed from unused sand islands by the length of time sites were continuously exposed above the river. Sites used by Least Terns were more likely than unused sites to be continuously exposed for at least 100 d during the period 15 May–31 August. Colony sites did not differ from unused sites in general habitat type (sand island, sandbar on wooded island or sand island accreted to the shore), nor in the amount of vegetation cover (≤ or >10% vegetation cover). Within the study region, only one unused site that appeared to be suitable for tern nesting could be identified. The majority (87%) of 2027 nests located during 1986–1989 were on fine (52%) or coarse sand (35%) substrates. Fifty-two percent of 1690 nests located in 1986–1989 were ≤25 cm from a stick or other drift material. Sand islands and sandbars in the Mississippi River that could be restored as tern colony sites should be elevated by the construction of chevron dikes to remain exposed at least 100 continuous days during the Least Tern breeding season.

HABITAT DE ANIDAMIENTO DE *STERNA ANTILLARUM* EN EL VALLE DEL RIO MISSISSIPPI ADYACENTE A MISSOURI

Sinopsis.—De 1985–1989 se examinaron las características del habitat ocupado por colonias de la gaviota chica (*Sterna antillarum*) en el valle del Río Mississippi adyacente a Missouri. Durante el 1985, las colonias de gaviotas fueron localizadas en islas de arena o depósitos de arena que difirieron de islas de arenas no utilizadas por el lapso de tiempo en que estuvieron expuestas sobre el agua del río. Las áreas utilizadas por las gaviotas estuvieron expuestas por lo menos 100 d, durante el periodo que comprende entre el 15 de mayo–31 de agosto. No se encontró diferencia entre lugares usados y no utilizados en lo que se refiere a a tipo de habitat en general (islas de arena), depósitos de arena en islas cubiertas con vegetación, o islas de arena unidas a la playa, ni tampoco en lo referente a la cobertura de la vegetación (≤ 0 >10% de cobertura de vegetación). Dentro del área de estudio tan solo se pudo identificar una localidad aparentemente apropiada para el anidamiento, pero que no fue utilizada por las aves. La mayoría (87%) de los 2027 nidos localizados durante el 1986–1989, se encontraron en arenas finas (52%) o sustratos de tosca (35%). El 52% de los 1690 nidos localizados entre 1986–1989 estaban a ≤25 cm de palillos o material traído por el agua. Islas o depósitos de arenas en el Río Mississippi que quieran ser restaurados como lugares de anidamientos para colonias de gaviotas chicas, deben ser elevados para que queden expuestos de forma continua por lo menos 100 d durante la época de reproducción de las aves.

The interior population of the Least Tern (*Sterna antillarum*) is on the United States list of endangered wildlife (U.S. Fish and Wildlife Service 1985). In the central United States, Least Terns typically nest on sand islands or sandbars in the low- or no-grade portions of major rivers (e.g., Missouri and Mississippi rivers), or in river systems that receive little summer rain (e.g., Platte River) (Hardy 1957). In the Mississippi River valley, Least Terns historically nested on sandbars and sand islands from

Lee County, Iowa to Jefferson County, Mississippi (Hardy 1957). Currently, the breeding range is from Scott County, Missouri to Madison Parish, Louisiana (Rumancik 1988). Since 1900, much of the riverine island and sandbar habitat historically used by interior Least Terns has been lost or modified by impoundment, channelization, and bank stabilization projects (Smith and Stucky 1988). For example, 43% of the sandbar and sand island area in the Mississippi River adjacent to Tennessee was lost during 1937–1973 because of changing river flow regimes (P. Hamel, pers. comm.). The loss of habitat within the historic range and apparent dwindling numbers of Least Terns resulted in the 1985 listing of the interior population (U.S. Fish and Wildlife Service 1989). Today, a possible limitation on the distribution of nesting Least Terns is the availability of suitable riverine sites.

Numbers of Least Terns in the Mississippi River valley appeared to remain relatively constant during the 1986–1989 study period. Army Corps of Engineers surveys of the Mississippi River valley from Cape Girardeau, Missouri to Vicksburg, Mississippi suggested Least Tern numbers have remained at 2188–2356 birds during 1986–1988 (Rumancik 1986, 1987, 1988). The Least Tern population in our study region adjacent to Missouri averaged 429 pairs during this period (Smith and Renken 1990).

During 1985–1989, the Missouri Department of Conservation (MDC) conducted research to determine the distribution of nesting terns and to describe environmental characteristics of Least Tern nesting habitat within the Mississippi River valley.

STUDY AREA AND METHODS

During 1985, we flew systematic aerial surveys along the Mississippi River adjacent to Missouri to locate and map sandbars and other potential Least Tern nesting habitat. Surveys were flown twice during the breeding season (in May, then in June/July). Sites (defined throughout this paper as islands or sandbars) considered to be potential tern colony sites were marked on river charts and U.S. Geological Survey topographic maps. Each potential colony site was inspected once or twice by ground observers during the tern nesting season (June–August) to determine if it was used for nesting and to evaluate habitat suitability. At each potential colony site, we visually estimated the height of the sand island or sandbar above river level, and percent and type of vegetation cover. We also described the general habitat type (e.g., sand island, sandbar on a wooded island or sandbar with a connection to the shoreline) and counted the number of tern nests.

During 1986–1989, we monitored Least Tern colonies and measured the height of each island or sandbar above the river and recorded the number of nests. We also recorded the following at Least Tern nests: soil substrate (fine sand, coarse sand, gravel, mixed sand and gravel) and presence of drift material (e.g., logs, sticks) within 25 cm of the nest scrape.

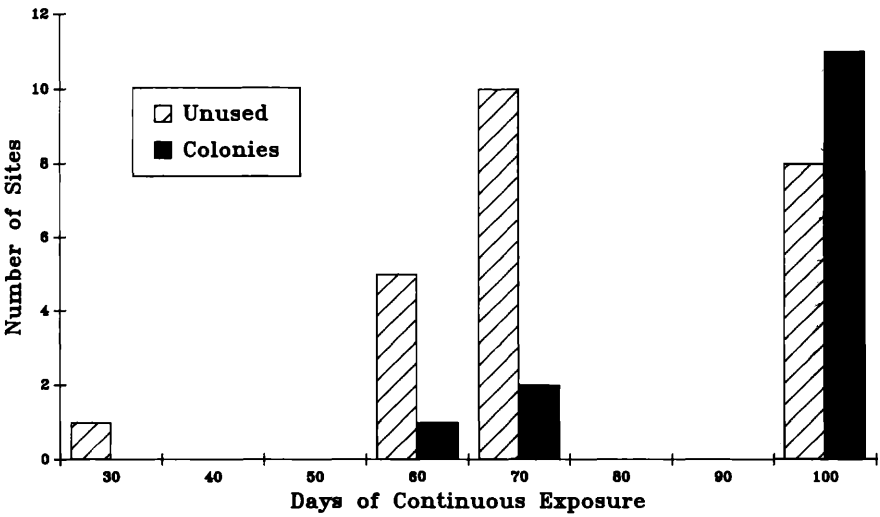

FIGURE 1. Distribution of interior Least Tern colonies and unused sites by category of days of continuous exposure, lower Mississippi River, 1985.

We summarized frequencies of habitat features within the breeding range adjacent to Missouri (hereafter referred to as the breeding range) from the 1985 survey data and used *G*-tests (Sokal and Rohlf 1981) to determine if tern colonies and unused sites differed. We also summarized the frequencies of habitat features of sites outside of the current breeding range of terns and compared them in *G*-tests to frequencies of sites within the breeding range. Frequencies of habitat features recorded on visits to colony sites during 1986–1989 were also summarized.

The number of days sites were continuously exposed above the river during 15 May–31 August was calculated using data on the height of the island or sandbar above the river, and river flow and gauge data obtained from the U.S. Army Corps of Engineers. We assumed Least Terns require at least 50 d to complete courtship, lay eggs, incubate a clutch (21 d), and raise young to fledging (approximately 21 d). Hence, in our first analyses to determine differences between colony and unused sites, we used 50 continuous days of exposure above the river as a break point in *G*-test analyses. After plotting the frequency of days of continuous exposure values for colony and unused sites (Fig. 1), we chose 100 d as a better threshold value for separating tern colonies from unused sites in *G*-tests. A threshold value of $\leq 10\%$ vegetation cover was used in *G*-tests to compare colony and unused sites because colony sites averaged 8.9% vegetation cover during 1985. In *G*-tests, we compared the frequency of sand islands and sandbars without a connection to the shore to the frequency of accreted sandbars and sand islands among colony and unused sites to determine if Least Terns typically used sites that would be less likely to have ground predators.

TABLE 1. Mean ± SE of habitat characteristics of interior Least Tern colonies and unused islands or sandbars in the Mississippi River within the region where Least Terns nest (Lower River Mile 827 to Upper River Mile 30), and sites outside the breeding range (Upper River Mile 31 to Upper River Mile 361).

	Colonies (n = 14)	Unused islands (n = 24)	Outside breeding region (n = 48)
Mean days of continuous exposure during 15 May–31 August	101.6 ± 4.0	83.7 ± 4.1	85.4 ± 3.8
Mean % vegetation cover	8.9 ± 4.2	4.5 ± 2.2	16.8 ± 12.3

As a final step to document habitat use by Least Terns in the Mississippi River valley, we considered why unused sites that appeared to be suitable nesting habitat were not used. We examined aerial photographs of unused sites, and reviewed data on human activities, area size and amount of vegetation cover. We considered unused sites unsuitable if they had more vegetation cover (>50%) than the maximum observed at colonies, were smaller (<4.05 ha) than the minimum-sized colony site, had signs of substantial human activity, or were narrow strips (<200 m) of sand along the forested shore of an island or river bank, a situation we envision was not a secure nesting area for Least Terns.

RESULTS

Averages for habitat characteristics of the 14 colony and 24 unused sites within the Least Tern breeding range, and 48 unused sites outside of the breeding range are listed in Table 1. In the 249-km portion of the river within the Least Tern breeding range (Lower River Mile 827 to Upper River Mile 30), colonies did not differ from unused sites in general habitat type (G = 0.09, P = 0.76) nor in the amount of vegetation cover (G = 0.32, P = 0.57). In 1985, the major difference between tern colonies and unused sites was the number of days sites were continuously exposed above the river. Colony sites were not more likely to be exposed for at least 50 continuous days than unused sites (G = 0.94, P = 0.33), but significantly more colony sites than unused sites were continuously exposed for at least 100 d (G = 7.58, P = 0.006). If we used the minimum number of days (69) colony sites were continuously exposed above the river as the threshold to test between colony and unused sites, colonies again were more likely than unused sites to be exposed longer (G = 3.95, P = 0.05). Colony sites averaged 2.8 m in height (SD = 1.8, range = 0.5–6.8 m) above the river on 1 June 1985, whereas unused sites averaged 1.7 m (SD = 2.1, range = −1.4–8.0 m) on that date.

Only 8 of 24 sites not used for nesting in 1985 had ≥100 d of continuous exposure. Three of these eight were used for nesting in subsequent years, but the remaining five sites were unsuitable because they were too small,

had human disturbance or were narrow strips of sand adjacent to a forested shoreline.

During 1987 and 1988, Least Tern colonies were typically located on sites continuously exposed for at least 100 d (73% and 94% of 11 and 18 colony sites, respectively). A mid-nesting season flood (10 June–3 July) in 1989 caused the opposite effect with only 28% of the Least Tern colony sites ($n = 18$) continuously exposed for ≥ 100 d. The flooding also affected production. Chick production in 1989 was half that observed during the previous 3 yr (Smith and Renken 1990).

In the 531-km (Upper River Miles 31–361) portion of the Mississippi River valley outside of the current Least Tern breeding range, the 48 sites potentially available for Least Tern nesting were as likely as sites within the breeding range to have $\leq 10\%$ vegetation cover ($G = 1.7$, $P = 0.19$) and to be continuously exposed for at least 50 and 100 d ($G = 0.32$, $P = 0.57$, and $G = 0.00$, $P = 1.00$, respectively).

Twenty-three of the 48 unused sites outside of the breeding range were continuously exposed ≥ 100 d during the breeding season. Of these, five were unsuitable for tern nesting because of excessive human disturbance (as evidenced by footprints and all-terrain-vehicle tracks), seven had vegetative cover exceeding 50%, and 10 were <4.05 ha or were linear sandy areas adjacent to riparian forest. Hence, of the original 48 sites potentially available for Least Tern nesting outside of the tern breeding range, only one site was considered suitable for nesting.

Least Tern nests consisted of shallow, unlined scrapes in loose sand or gravel. Of 2027 nests for which substrate categories were recorded, 1047 (52%) were in fine sand, 714 (35%) in coarse sand, 188 (9%) in predominantly sand with a mixture of gravel and 73 (4%) in predominantly gravel with a mixture of sand. Only five nests were on gravel substrates with no sand component.

An important feature of nesting habitat at Mississippi River colonies was the presence of large amounts of drift wood deposited by receding river levels. Tern nests were often distributed along an elevational gradient where drift material was deposited. A high proportion of nests (52% of 1690 nests during 1986–1989) were ≤ 25 cm from a small stick or other drift material.

DISCUSSION

During 1985, sandbars and sand islands used as Least Tern colony sites were more likely than unused sites to remain continuously exposed above water for at least 100 d. Even though these sites were exposed longer than the time necessary for Least Terns to lay eggs, incubate a clutch, and raise the young to fledging (approximately 50 d), we believe these sand islands and sandbars were probably used because they were taller and the first sites to be exposed above the water after spring floods. This belief is supported by our observation that tern colony sites were higher above the river than unused sites on 1 June 1985.

Our assessment that at least 100 d of continuous exposure is an im-

portant feature of Least Tern colony sites complements conclusions drawn by P. Hamel (pers. comm.) concerning the availability of sandbar or sand island habitat in the Mississippi River during 1965–1985. Hamel noted that sites 9.1 m above the low water reference plane (LWRP) and exposed for at least 90 continuous days during 1 June–1 September were available as habitat for nesting Least Terns during the entire 21-yr period. Sites 9.1 m above the LWRP and continuously exposed for at least 100 d were available in 18 of 21 yr during 1965–1985. It appears that sand islands and sandbars continuously exposed for at least 100 d are important to terns not only because they are the first sites to be exposed in the spring, but they are also available to nesting terns in most years.

There is a reproductive advantage for Least Terns to nest as soon as suitable sites are available. We have noted that Least Terns nesting early in the season experience greater daily nest survival rates (in 1987, 0.99 vs. 0.94, early vs. late nesters, respectively, $Z = 6.1$, $P < 0.001$) and produce more young (in 1987, 2.2 vs. 0.5 chicks/pair, early vs. late nesters, respectively; Smith and Renken, unpub. data) than late nesters. Other workers have observed that early nesters experience greater nesting success (Gauthier 1989). In many species of birds, young hatched early in the season often experience greater survival rates than later hatched young (Arcese and Smith 1985, Dow and Fredga 1984, Perrins 1970) and are more likely to be recruited into the breeding population than late-hatched young (Cooke et al. 1984, Gauthier 1989).

Least Tern colony site characteristics in other regions were similar to those observed in our study. Colony sites have been characterized as having short (<21 cm), sparse (<10%) vegetation cover (Kirsch 1990, Kotliar and Burger 1986, Schwalbach 1988) and an open environment (Burger and Gochfield 1990, Kotliar and Burger 1986). In addition, South Dakota's Missouri River Least Tern colonies ranged in size from 0.2–4.4 ha, and the characteristics of sandbar elevation and size were most important in distinguishing between colony sites and potential sites (Schwalbach 1988). Typically, colony sites were of greater elevation and larger in area than potential sites (Schwalbach 1988).

Other workers have noted that terns often nest near drift material (Grover and Knopf 1982). The existence of drift material near nests, especially larger pieces of drift wood, may be important for incubating adults and chicks. Sticks near incubating adults may provide protection from wind and reduce the amount of sand blown into the nest. Drift material also provides shade and shelter for chicks during the brood-rearing period.

We determined that of the unused Mississippi River sand islands and sandbars adjacent to Missouri, only one unused site appeared to be suitable for nesting terns. The reason why this site remained unused was not apparent, but it is possible the fishery resource or foraging habitat near the site was unsuitable. Nevertheless, it does appear that suitable Least Tern nesting habitat is limited in this region.

A logical first step to assisting Least Tern populations in meeting

recovery plan goals (U.S. Fish and Wildlife Service 1989) is to provide more suitable colony sites. To encourage terns to nest at sites outside of their present distribution, we recommend identifying sandbars and sand islands in the Mississippi River that possess the potential of remaining continuously above river levels for ≥100 d during 15 May–31 August. In portions of the Mississippi River deficient in potential colony sites, management should be directed toward enhancing the value of existing sandbars and islands or creating new habitat where appropriate. Sandbars that are too low to meet the continuous exposure criteria might be raised to a suitable elevation by modifying dike structures (Smith and Stucky 1988) or by constructing chevron dikes at the upstream end of existing sites to allow the river to deposit sand and gravel on those sites.

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