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Distribution and Abundance of the Interior Population of the Least Tern (*Sternula antillarum*), 2005

A Review of the First Complete Range-Wide Survey in the Context of Historic and Ongoing Monitoring Efforts

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The Plains, VA 20198

Final report

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Abstract: The interior population of the Least Tern (*Sternula antillarum*) was added to the U.S. Fish and Wildlife Service (USFWS) list of threatened and endangered species in 1985 because of suspected low numbers and concerns about breeding season habitat loss or degradation on large interior rivers. Range-wide survey data were incomplete when Interior Least Terns (ILT) were originally listed. Although many ILT counts have been conducted over the past 20 years, regular survey coverage is still incomplete across the large breeding range of ILT, limiting the ability to assess the conservation status or trends for this population. During the last two weeks of June and the first week of July 2005, over 140 participants contributed to the first complete range-wide survey for ILT (see acknowledgments). The primary objectives of this survey were 1) to provide a minimum count of the number of adult ILT occurring in North America during the breeding season, 2) to document the range-wide distribution of nesting colonies, and 3) to describe the types of habitats that are being used for nesting. Survey crews covered ~4,700 river miles, 22 reservoirs, 62 sand pits, 12 industrial sites, 2 rooftop colonies, and over 16,000 acres of salt flats, counting a grand total of 17,591 ILT in association with 489 different colonies. Just over 62 percent of all adult ILT were counted on the “Lower” Mississippi River (10,960 birds on 770+ river miles). Four additional river systems accounted for 33.3 percent of the remaining ILT, with 11.6 percent on the Arkansas River system (including the Canadian and Cimarron Rivers and the Salt Fork of the Arkansas River), 10.4 percent on the Red River system, 6.9 percent on the Missouri River system, and 4.4 percent on the Platte River system. Lesser numbers of terns were counted on the Ohio River system (1.0 percent), the Trinity River system in Texas (1.0 percent), the Rio Grande/Pecos River system in New Mexico and Texas (0.8 percent), the Wabash River System (0.6 percent), two reservoirs in East Texas (0.3 percent), and the Kansas River system (0.3 percent). A majority of adult terns were counted on rivers (89.9 percent), with much smaller numbers at sand pits (3.6 percent), reservoirs (2.5 percent), salt flats (2.3 percent), industrial sites (1.4 percent), and rooftops (0.3 percent). This report discusses the results of the 2005 survey at three different spatial scales: 1) the entire breeding range for ILT and adjacent breeding populations on the Gulf Coast; 2) regional analyses by major river systems; and 3) individual survey segments (some of which have been combined into geographic segments comprised of more than 1 similar survey segment). Results of the 2005 survey are also compared with historic survey data from 1986 through 2004. The value of historic data for local, regional, and range-wide analyses of population trends is evaluated in the context of this first complete picture of the breeding distribution of ILT. Recommendations are made to 1) increase annual survey coverage for ILT to include several important breeding areas documented in this report that do not receive regular monitoring attention; 2) conduct additional large-scale surveys (such as the 2005 survey) during a standard survey window for long-term analyses of range-wide population trends; 3) conduct double-sampling to calculate detection ratios that will describe relative bias among survey segments with different survey methods; allowing unbiased estimation of population size and trend; and 4) improve long-term data storage for ILT count data through the development of a centralized data management system. The 2005 range-wide survey was a large collaborative effort that represents a major step forward toward developing the framework for a range-wide ILT monitoring program.

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Preface

The “big picture” presented in this report would not have been possible without the contributions and energy of an enormous number of individuals, agencies, and organizations. The author has attempted to list all contributors below and apologizes sincerely if anyone has been missed. The following people coordinated and/or reported 2005 survey data for the survey segments listed after their name: Greg Pavelka of the Corps’ Omaha District for all survey data from the Missouri River; Arnie Dood of Montana Fish, Parks, and Wildlife for the Yellowstone River; Monica Schwalbach of South Dakota Game Fish and Parks Department for the Cheyenne River; Garreth Welke and Stuart Schneider of the National Park Service for the Niobrara National Scenic River (between Norden and HWY 137); Jim Jenniges of Nebraska Public Power District for the Niobrara River between HWY 137 and Spencer Dam; Stephen Wilson of the National Park Service for the Niobrara National Recreational River and the 18 miles of river upstream of the NRR to Spencer Dam; Stephen Dinsmore of Iowa State University for the Mid-American Energy Plant at Council Bluffs, Iowa; Mark Peyton of the Nebraska Public Power and Irrigation District for Lake McConaughy, sandpits on the “Upper” Platte River, and sandpits on the South Platte River; Jim Jenniges of the Nebraska Public Power District, Mark Czaplewski of the Central Platte Natural Resources District, and Diane Beachley of the Nebraska Game and Parks Commission for “Central” Platte River and sandpits; Kari Andresen of the Nebraska Game and Parks Commission and Renae Held of the Tern and Plover Partnership, University of Nebraska, Lincoln, for the “Lower” Platte River and sandpits, the Loup River and sandpits, North Loup River sandpits, and the Elkhorn River sandpits; David Hoover of the Corps’ Kansas City District and Roger Boyd of Baker University, Kansas, for the Kansas River and Jeffrey Energy Center; John Castrale of the Indiana Department of Wildlife Resources for Gibson Lake, Cane Ridge Wildlife Management Area, and the Wabash River; Beth Ciuzio of the Kentucky Department of Wildlife Resources and Brainard Palmer-Ball, Jr. of the Kentucky State Nature Preserves Commission for the Ohio River and nearby industrial sites in Kentucky; John Rumancik of the Corps’ Memphis District and Ken Jones of Dyersburg State Community College, Tennessee, for the Mississippi River; Duane Nelson for the “Upper” Arkansas valley reservoirs in Colorado under contract with the Corps’

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In addition to the agencies listed as the affiliations of the 39 survey coordinators, the author thanks the USFWS office at Grand Island, Nebraska; the USFWS office at Manhattan, Kansas; Cinergy, Incorporated; the Corps’ Louisville, St. Louis, and Little Rock Districts; Fort Hays State University; Great Plains Nature Center in Wichita, Kansas; the USFWS office in Canadian, Texas; Gulf South Research Corporation; the USFWS New Mexico Ecological Services office; TXU power; Texas A&M University – Commerce campus; and American Bird Conservancy for their contributions (either logistical or financial) to these efforts.

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When this study was performed, COL Richard B. Jenkins was Commander and Executive Director of ERDC. Dr. James R. Houston was Director. Dr. Beth Fleming was director of the ERDC Environmental Lab.

1 Background and Problem Statement

The interior population of the Least Tern (*Sternula antillarum*) was added to the U.S. Fish and Wildlife Service (USFWS) list of threatened and endangered species in 1985 because of suspected low numbers and concerns about breeding season habitat loss or degradation, primarily on large rivers such as the Missouri, Platte, Mississippi, Arkansas, Cimarron, Canadian, and Red (USFWS 1985). Currently, five different subspecies of the Least Tern are recognized in North America, including the Interior Least Tern (*Sternula antillarum athalassos*) (Thompson et al. 1997). Arguments have been made both for and against the validity of this taxonomic designation without reaching consensus (Thompson et al. 1992, Johnson et al. 1998). Since the taxonomic status of the Interior Least Tern (ILT) was not resolved in 1985, the interior population was defined as any Least Tern nesting > 50 kilometers from the coast and this population was listed as endangered independent of taxonomic status (USFWS 1985). Nearby Least Tern breeding populations on the Gulf of Mexico coast are not federally listed as endangered and are considered the Coastal Least Tern subspecies (*Sternula antillarum antillarum*).

Knowledge of the range-wide distribution and abundance of ILT breeding populations was poor when the ILT recovery plan was written in 1990 (Downing 1980, Sidle et al. 1988, Whitman 1988, USFWS 1990). However, survey coverage has increased steadily since ILT were listed (Kirsch and Sidle 1999) and a large number of local or regional monitoring programs have been developed (Guilfoyle et al. 2004). Still, several important population segments receive little survey attention (Guilfoyle et al. 2004, USFWS 2005a). Reliable estimates of range-wide population size or trends cannot be made from existing data due to persistent problems with incomplete survey coverage, methodological problems with survey data collection, and poor long-term data management.

These deficiencies were discussed at a 2004 meeting in South Sioux City, Nebraska, that included participants from a large number of locations throughout the range of ILT (Guilfoyle et al. 2004). An Interior Least Tern working group (WG) was formed at this meeting to address these concerns and to work toward developing a range-wide strategy for monitoring ILT population status and trends (Appendix A). The WG now includes

91 members representing 11 Corps districts, 4 USFWS regions, 14 state wildlife agencies, 8 academic institutions, 4 USGS science centers, 3 Joint Ventures, and several non-profits. A monitoring program coordinator position was created by American Bird Conservancy, with the support of the Corps, to coordinate range-wide monitoring efforts.

As a major step toward better understanding the distribution and abundance of ILT, all known historic breeding areas and several suspected breeding areas were visited within a narrow survey window in late June and early July 2005 as part of a large-scale effort to count all ILT during their peak breeding season in North America. Comprehensive, range-wide surveys of this magnitude are rarely completed for widespread animal populations (but see Haig et al. 2005) and the first range-wide ILT survey represents an exceptionally large-scale collaborative effort. This document summarizes the results of the 2005 range-wide survey within the context of historic and ongoing efforts to monitor ILT populations.

2 Range-Wide Survey Methods

Between 20 June and 10 July 2005, a coordinated effort involving more than 140 individuals representing numerous federal and state agencies, NGOs, and private citizens surveyed all known nesting areas for ILT *(see acknowledgments)*. The primary objectives of this survey were (1) to estimate the number of adult ILT occurring in North America during the breeding season, (2) to document the range-wide distribution of nesting colonies, and (3) to describe the types of habitats that are being used for nesting. Surveys were scheduled to take place within a narrow two-week survey window in late June and early July (20 June to 3 July) that was chosen to coincide with peak nesting activity at as many sites as possible across the large breeding range of ILT (Thompson et al. 1997). An additional week was added to this window (4 July to 10 July) to complete surveys that were delayed by high water, bad weather, or other logistical problems. It was assumed that most breeding ILT would be either incubating eggs or brooding young chicks during this window. The entire range was surveyed during this narrow time frame to minimize biases associated with double-counting birds that move among survey segments during the breeding season (Greg Pavelka, U.S. Army Corps of Engineers, Omaha District; Eileen Kirsch, U.S. Geological Survey, Upper Midwest Environmental Science Center; Rochelle Renken, Missouri Department of Conservation, personal observations).

The survey identified 109 different survey segments where ILT have nested within the last 20 years or where ILT have not nested but apparently suitable habitat and a lack of extensive prior survey data suggested the need for survey attention (Macament and Thompson 1988, Boyd 2005) (Appendix B, also see maps in Figures 6-11). A "survey segment" is defined in this report as an area of any size that was covered by a discrete survey effort. Survey segments varied tremendously in size: from a single small reservoir to a 770-mile stretch of river. Some survey segment boundaries were more biologically relevant than others. For example, the "Missouri River below Fort Peck Dam" survey segment covers a number of tern colonies that are exposed to the same hydrologic and habitat conditions below Fort Peck Dam and are somewhat isolated in space from other nearby breeding populations. Other survey segment boundaries were determined by logistical and/or administrative considerations, and in some cases there are few biological differences among nearby survey segments, although they are covered by independent survey teams (such as the five contiguous survey segments on the Niobrara River, or the three contiguous survey segments of the “Lower” Red River between Denison Dam and the Red River Navigation System).

Therefore, data from 109 survey segments were consolidated into 68 different geographic segments (GS) by pooling adjacent survey segments with similar geography, habitat, or hydrologic conditions (Figure 1, Table 1). A full list of survey segments, including the GS to which each survey segment belongs is included as Appendix B. Nine of the 68 geographic segments were further subdivided (and assigned letters in addition to GS numbers) if different major nesting habitat types existed within the same GS. For example, the “Lower” Platte GS is subdivided into sandbar (23a) and sand pit (23b) categories. Geographic segments (and their habitat-based subdivisions) should provide more meaningful categories to discuss ILT distribution than names of survey segments.

Please note that the terms “Lower,” “Central,” and “Upper” are placed in quotations throughout this report when they are used to describe different sections of river because these relative terms are not recognized geographic place names. Technically, there are no rivers named the “Lower Platte River” or the “Upper Red River.” Rather, these relative terms are helpful, and have been used historically in different ways, to discuss the distribution of ILT relative to major water management structures. Applications of these relative terms, particularly the “Lower Red River,” have been used in different ways by various people in the past. Therefore, each of the names of geographic segments or survey segments used in this report is defined explicitly in Table 1 or Appendix B.

For each survey, observers were requested to report the total number of adult terns and the total number of active nesting colonies. All colonies were classified as either river/sandbar, reservoir, sand pit, salt flat, rooftop, or industrial. The industrial category included fly-ash deposits, dike fields near power plant cooling ponds, oil pads on reservoirs, gravel pits, or mine tailings. Geographic coordinates were reported for all colonies. In nearly all cases, the number of colonies reported reflects discrete colonies with direct evidence of breeding (e.g., incubating adults, eggs, or chicks). However, during aerial surveys on the Cimarron, “Upper” Canadian, and “Upper” Red Rivers, individual colonies were not visited. For these areas, the number of colonies was approximated by pooling all sightings from the air within 3 miles of each other, and reporting this as a single "colony" (Boyd 2005). Thus, the number of colonies reported on these rivers is not an actual count of colonies. This approach may provide inaccurate estimates of the total number of colonies for the three major rivers surveyed from the air (the "Upper" Red River above Lake Texoma, the "Upper" Canadian River above Eufaula Lake, and the Cimarron River). Appendix B provides detailed information on all survey segments, including whether or not each survey segment is covered by annual monitoring efforts. All other data summaries are based on GS.

3 Differences in Count Methods among Individual Surveys

Although all surveyors reported the total number of adults and colonies they counted, methods of counting adults and methods for locating tern colonies varied among surveys. Nearly all counts of adults were conducted from boats or on the ground. However, aerial counts via fixed-wing aircraft were conducted on the Cimarron River, the "Upper" Canadian River west of Eufaula Lake, and the "Upper" Red River (and tributaries) west of Lake Texoma (Boyd 2005). For all sites surveyed by boat or from the ground, the number of adults reported reflects the actual number of individuals counted. No correction factors were applied to ground counts. However, counts from aerial surveys were multiplied by two based on four years of ground-truthing data from prior aerial surveys of the Cimarron River that indicated aerial counts recorded approximately 50 percent (range 44.7–53.7 for all four years) of adult ILT counted on the ground (Boyd 2005).

The most commonly used survey method was to travel upriver or downriver across an entire survey segment by boat, locate a colony, land the boat, and then count the adult birds at the colony from the ground. This method minimizes the chance of missing any active colonies, particularly if colonies are located in different sites than in previous years. This method also allows for birds to be detected and counted while they are foraging and roosting away from colony sites. A common variation to this method occurred when colony locations were known prior to the survey (either from previous work or from aerial surveys that took place before boat-based surveys). When this was the case, surveyors frequently used boat ramps closest to known-location colonies to access these colonies. This resulted in incomplete coverage of large stretches of river between colonies where colony locations were far apart. The degree to which varying intensities of survey coverage of the areas between colonies affected overall range-wide count totals is unknown.

Different surveyors used two main types of methods to count adult birds. Some surveyors counted the total number of adult birds present at the colony and then added the number of birds counted away from the colony to get a total count for their survey segment. Other surveyors counted only the total number of active nests at each colony and multiplied this quantity by two (under the assumption that two adult birds are associated with each nest). Since direct counts of nests are able to account for birds that are away from the colony at the time of the count, additional birds counted away from the colony site were not added to this total (except, in some cases, when individuals were seen more than 3 river miles from an active colony). In surveys of colonial waterbirds, total counts of adult birds at colonies may be more varied and less accurate than direct nest counts because the number of birds attending the colony varies by time of day, nesting stage, and other factors (Erwin 1979, Walsh et al. 1995). Thus, counts of adults present at the colony at a single point in time will detect a variable fraction of the total nesting population depending on these factors, which are complex and difficult to control for in survey design.

Another factor that varied among surveys, and which may have had an effect on the accuracy of counts, was the amount of time surveyors spent counting individual colonies. This was affected by the difficulty of surveying multiple colonies on the same day with the requirement of traveling far enough downriver to make it from one boat ramp to another. When logistics permitted, surveyors spent as much time as was necessary to make accurate counts at each colony. Low water, bad weather, or unrealistic scheduling sometimes resulted in rushed counts of at least some colonies when not enough time was budgeted or available to thoroughly count all colonies. When this was the case, normal protocols were abandoned and some colonies were counted rapidly, from a distance, or without leaving the boat. This may have resulted in inaccurate counts in some locations. This problem could be avoided by planning extra survey days for bad weather or slow progress (which is inevitable) so that surveyors have adequate time to count all colonies using the same protocol. Data on the thoroughness of count effort at each colony were not recorded in 2005 and should be recorded in future surveys.

4 Historic Data Summaries: Data Sources

Historic annual count data came from a large number of sources (Appendices C and D). Three publications have presented tables summarizing annual counts for a large number of locations in an attempt to describe range-wide distribution and abundance of ILT (Kirsch and Sidle 1999, USFWS 2003, USFWS 2005a). When the author compared annual count totals in these three documents, several inconsistencies were found. In addition to these range-wide summaries, multiple published and unpublished sources of survey data at local and regional scales frequently presented different versions of annual count data for the same year. In an attempt to resolve discrepancies among summaries, count totals from these three documents were compared with a large number of original sources (peer-reviewed publications, unpublished reports, and regionally maintained databases). Where inconsistencies still existed among data sources, original count data were sought, or insights that could clarify discrepancies were solicited directly from the surveyors who collected the original data. Many errors were due to data being reported through a secondary or tertiary source. During this process, some additional historic data were acquired from surveyors that had not been reported in previously published documents (Appendix D). Recent survey data was also acquired from the Gulf of Mexico coast to provide a larger spatial context for interpretation of range-wide ILT distribution and abundance.

All sources used for this summary are presented in Appendix D. Here, the author describes briefly how decisions were made to present one or another version of historic data in instances where more than a single version existed. This issue was particularly acute for the “Upper” Missouri River, the Platte River system, and the Arkansas River system. American Bird Conservancy is currently working with the Corps’ Engineer Research and Development Center (ERDC) to create a web-driven database for the entry of range-wide adult count data. This database will be designed to improve long-term data storage for future ILT survey data, and will also be designed to archive historic survey data (Lott 2006). UPDATE: This database is now available at: *http://el.erdc.usace.army.mil/leasttern/*.

For the Missouri River (all river and reservoir survey segments), historic data were acquired from the threatened and endangered species data management system (DMS) at the U.S. Army Corps of Engineers, Omaha District. Count totals for many of these survey segments have been reported previously in Schwalbach (1988), Dirks (1990), Kruse (1993), Mayer (1993), Rabenberg et al. (1993), Kirsch and Sidle (1999), Pavelka and Kruse (1999), USFWS (2003), USFWS (2005a), and probably elsewhere. However, the Omaha DMS has consolidated previous historic survey data into well-defined, geographically meaningful survey segments that have been described in the most recent amendment to the Missouri River Biological Opinion (USFWS 2003); correcting errors in several previous data presentations (Greg Pavelka, U.S. Army Corps of Engineers, Omaha District, personal communication).

Given the large number of divergent data sources for the Platte River (see the Regional Results section for the Platte River) this report presents only data from the three years of the International Piping Plover Census (IPPC) (Haig et al. 2005) when there was nearly complete coverage of all historic nesting areas within the Platte River system and extra care was taken to enter all survey data into the NGPC database (John Dinan, NGPC, personal communication). Still, count totals from the 1991 IPPC in the NGPC database do not consistently match count totals for this same survey presented by Sidle et al. (1991) and the accuracy of the other count totals reported in this database is unknown.

For the Arkansas and “Lower” Canadian Rivers in Oklahoma, numerous versions of historic data were used (Hill 1993, USACE 2004, USFWS 2005a). Within this region, multiple counts per season are conducted for five different survey segments that are all within 200 km of each other and are not surveyed on the same day (Arkansas River–Kaw Dam to Keystone Lake; Arkansas River–Keystone Dam to Zink Lake; Zink Island on the Arkansas River near Tulsa; the Arkansas River from Tulsa to Muskogee, OK; and the “Lower” Canadian River from Eufaula Dam to the Arkansas River). Individual birds frequently move among these five survey segments within the same season in response to flood events (Kevin Stubbs, USFWS, Oklahoma, personal observation). Combining peak totals for each survey segment from multiple counts from different parts of the season in a given year probably results in double counting some individuals. Therefore, for this report, Kevin Stubbs provided count data from 2000 to 2004 for the time period as close to the end of June as possible when all five of these survey segments were conducted within a two-week window to minimize double counting.

5 Range-Wide Survey Results

During the 2005 range-wide survey, crews covered ~4,700 river miles, 22 reservoirs, 62 sand pits, 12 industrial sites, two rooftop colonies, and over 16,000 acres of salt flats. A grand total of 17,591 terns were counted in association with 489 different colonies (Figure 1, Table 1). Count totals for individual GS are included in the "Regional Summaries" section. Count totals by survey segment are presented in Appendix B. Out of 109 historic survey segments, 10 were not surveyed during the 2005 range-wide survey (see Appendix B). Interior Least Terns were detected on 80 out of 99 surveyed segments. Out of 99 surveys, 81 (81.8 percent) were completed within the original two-week survey window, and all but two surveys (98.0 percent) were completed within the three-week window ending 10 July. The Kaw Dam to Keystone Lake reach of the Arkansas River was surveyed on 12 July and the Keystone Dam to Zink Lake reach of the Arkansas River was not surveyed until 30 July.

Most adult terns were counted on rivers (89.9 percent), with much smaller numbers at sand pits (3.6 percent), reservoirs (2.5 percent), salt flats (2.3 percent), industrial sites (1.4 percent), and rooftops (0.3 percent) (Figure 2a). All sand pit sites were on the Platte River. Similarly, most colony sites were on rivers (82.0 percent) with fewer colonies occurring on reservoirs (7.0 percent), sand pits (5.9 percent), salt flats (2.7 percent), industrial sites (2.0 percent), and rooftops (0.4 percent) (Figure 2b).

Just over 62 percent of all adult ILT were counted on the "Lower" Mississippi River (10,960 birds on 770+ river miles). Four additional river systems accounted for 33.3 percent of the remaining ILT, with 11.6 percent on the Arkansas River system (including the Canadian and Cimarron Rivers and the Salt Fork of the Arkansas), 10.4 percent on the Red River system, 6.9 percent on the Missouri River system, and 4.4 percent on the Platte River system. Lesser numbers of terns were counted on sandbars and at industrial sites within the Ohio River system (1.0 percent); at urban, industrial, and reservoir sites on the Trinity River system in Texas (1.0 percent); at reservoirs along the Rio Grande/Pecos river system in New Mexico and Texas (0.8 percent); on natural, created, and industrial sites along the Wabash River System (0.6 percent); on two reservoirs in East Texas (0.3 percent); and on sandbars and nearby industrial sites on the Kansas River system (0.3 percent) (Figure 3a). Although more than 62 percent of all individual adult ILT were counted on the Mississippi River, the Mississippi River accounted for only 17.8 percent of all colony sites. Higher percentages of all colony sites were reported for the Arkansas River and Tributaries (25.4 percent), Red (25.4 percent), and Missouri (18.6 percent) River systems. Of all colonies, 7.4 percent were detected on the Platte River. All other river systems had less than 1.5 percent of all colonies (Figure 3b).

Only 19 of 68 different GS had more than 5 colony sites (Table 1). Average colony sizes for ILT were generally small (between 4 and 25 birds per colony for 13 of 14 GS with more than 5 colonies that reported colony size) (Table 2). A strong exception to this rule was the Mississippi River, where colony size average was 119 birds and a single colony had 700 birds. The maximum colony size at any location other than the Mississippi was 130 birds at the mouth of the "Upper" Canadian River at Eufaula Lake.

Only 13 different riverine GS provided enough emergent sandbar habitat (ESH) for more than 100 ILT (Table 3). More than 100 ILT were only recorded for two non-riverine GS: sand pits along the "Central" Platte River and salt flats adjacent to the Cimarron River. ILT were counted below seven major Corps-operated dams, on four different Corps-operated navigational systems, and on five different rivers where the major non-natural influence on flows is water diversion for irrigation (Figure 4).

Five of the top 20 GS (ranked by adult numbers) do not receive annual survey coverage and three additional GS only receive partial annual coverage. Ranked by the total number of colonies, three of the top 20 segments do not receive annual survey coverage and another three only receive partial survey coverage (Table 1, Figure 5). Overall, 91.0 percent of all ILT that were counted during the 2005 range-wide survey would have been counted by current annual survey efforts. However, only 70.6 percent of all colonies that were documented during the 2005 range-wide survey would have been documented by current annual survey efforts.

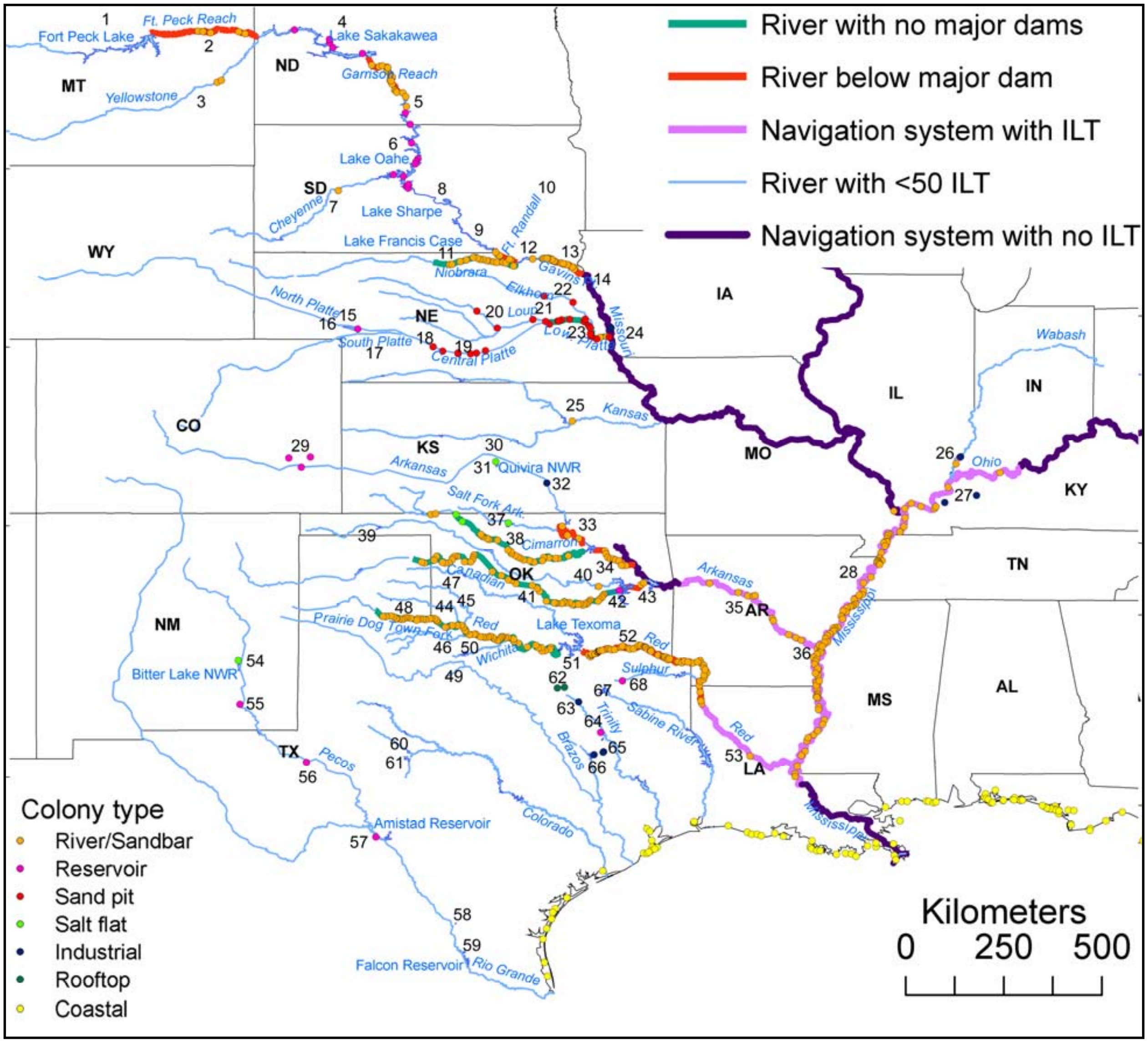

Figure 1. 2005 breeding distribution of the Interior Least Tern (ILT). See legends for colony types and river types. Numbers correspond to geographic segment numbers (see Table 1 for count totals by geographic segment). Colony locations > 50 km from the coast are from the 2005 range-wide ILT survey. Recent colony locations from the Gulf Coast are from the 2003 Texas Colonial waterbird survey (for Texas), the 2005 ILT census (for Mississippi), Zdravkovic (2005) (for Louisiana), and unpublished survey data from 2005 that has been compiled for the Southeast Region Waterbird Conservation Plan 2005 (Walker Golder, Audubon, North Carolina) (for the Florida Panhandle).

Table 1. Count totals by geographic segment (subdivided by habitat type) for the 2005 range-wide Interior Least Tern survey. Totals are organized by 1) river system/region, 2) river, and 3) geographic segment (subdivided by habitat type). G/B = ground or boat-based surveys, air = surveys by fixed-wing aircraft (Boyd 2005), RM = river miles, SM = shoreline miles, AC = acres.

GS #	Region/River System/Segment	# Adults	# colonies	Type	Extent	Unit	Surv. type	Annual?
MISSOURI RIVER SYSTEM								
"Upper" Missouri River and Tributaries								
2	Missouri River–Ft. Peck River, MT	34	5	River	203	RM	G/B	yes
3	Yellowstone River, MT	16	2	River	181	RM	G/B	yes
4	Missouri River–Lake Sakakawea, ND	26	5	Res.	350	SM	G/B	yes
5	Missouri River–Garrison River, ND	199	20	River	84	RM	G/B	yes
6	Missouri River–Lake Oahe, SD	89	12	Res.	470	SM	G/B	yes
7	Cheyenne River, SD	4	1	River	100	RM	G/B	yes
9	Lake Francis Case, SD	4	0	Res.	76	SM	G/B	yes
10	Missouri River–Ft. Randall River, SD	76	5	River	36	RM	G/B	yes
11	Niobrara River, Norden to Missouri River, NE	289	15	River	118	RM	G/B	partial
12	Missouri River–Lewis and Clark Lake (Niobrara River Mouth)	4	1	River	18	RM	G/B	yes
13	Missouri River–Gavins Point River, SD–NE	476	25	River	58	RM	G/B	yes
Subtotal, "Upper" Missouri River and Tributaries		1,217	91					
Platte River and Tributaries								
15	Lake McConaughy, NE	32	4	Res.	39,000	acres	G/B	yes
18b	"Upper" Platte River Sand Pits, NE	20	1	Pits	4	pits	G/B	yes
19a	"Central" Platte River, Lexington to Columbus, NE	3	0	River	142	RM	G/B	partial
19b	"Central" Platte River Sand Pits, Lexington to Columbus, NE	152	8	Pits	28	pits	G/B	yes
20	North Loup River Sand Pits, NE	14	2	Pits	2	pits	G/B	yes
21a	Loup River, NE	19	0	River	68	RM	G/B	no
21b	Loup River Sand Pits, NE	54	2	Pits	2	pits	G/B	yes
22b	Elkhorn River Sand Pits, NE	74	3	Pits	3	pits	G/B	yes
23a	"Lower" Platte River, NE	53	2	River	105	RM	G/B	yes
23b	"Lower" Platte River Sand Pits, NE	328	13	Pits	22	pits	G/B	yes
24	Mid-American Energy Plant, Council Bluffs, IA	33	1	Ind.	na	na	G/B	yes
Subtotal, Platte River and Tributaries		782	36					
Kansas River								
25a	Kansas River, KS	13	1	River	155	RM	G/B	yes
25b	Jeffrey Energy Center, KS	32	1	Ind.	na	na	G/B	yes
Subtotal, Kansas River		45	2					
SUBTOTAL, MISSOURI RIVER SYSTEM		2,044	129					

GS #	Region/River System/Segment	# Adults	# colonies	Type	Extent	Unit	Surv. type	Annual?
MISSISSIPPI-OHIO RIVER SYSTEM								
Wabash River								
26a	Wabash River, IN	14	1	River	82	RM	G/B	?
26b	Gibson Lake	10	1	Ind.			G/B	yes
26c	Cane Ridge Wildlife Management Area, IN	75	1	Res.			G/B	yes
Subtotal, Wabash River		99	3					
Ohio River								
27a	Ohio River sandbars, KY-IN-IL	132	5	River	255	RM	G/B	yes
27b	Ohio River Industrial Sites (2), KY	40	2	Ind.			G/B	yes
Subtotal, Ohio River		172	7					
Mississippi River								
28	Mississippi River, Cape Girardeau, MO to Baton Rouge, LA	10,960	87	River	770	RM	G/B	yes
SUBTOTAL, MISSISSIPPI-OHIO RIVER SYSTEM		11,231	97					
ARKANSAS RIVER SYSTEM								
Arkansas River								
29	"Upper" Arkansas Valley Reservoirs (3), CO	44	6	Res.	21,000	acres	G/B	yes
31	Quivira NWR, KS	40	2	Flats			G/B	yes
32	Arkansas River dredged-material disposal site, Wichita, KS	12	1	Ind.			G/B	yes
33	Arkansas River, Kaw Dam to Keystone Lake, OK	104	3	River	92	RM	G/B	yes
34	Arkansas River, Tulsa to Muskogee (Below Keystone Dam), OK	496	16	River	79	RM	G/B	partial
35	Arkansas River, McKlellen-Kerr Arkansas Navigation System, OK-AR	319	11	River	308	RM	G/B	partial
Subtotal, Arkansas River		1,015	39					
Salt Fork of the Arkansas River								
37	Salt Plains NWR, OK	90	8	Flats	10,000	acres	G/B	yes
Cimarron River								
38b	Cimarron Salt Flats (2), OK	242	2	Flats	4,300	acres	G/B	no
38a	Cimarron River, OK	186	27	River	220	RM	Air	no
Subtotal, Cimarron River		428	29					
North Canadian River								
40	North Canadian River, OK	6	1	River	100	RM	Air	no

GS #	Region/River System/Segment	# Adults	# colonies	Type	Extent	Unit	Surv. type	Annual?
	Canadian River							
41	"Upper" Canadian River, west of Eufaula Lake, TX-OK	342	46	River	300	RM	Air	no
42	"Upper" Canadian River mouth at Eufaula Lake, OK	130	1	River			G/B	no
43	"Lower" Canadian River, east of Eufaula Lake, OK	118	2	River	27	RM	G/B	yes
Subtotal, Canadian River		590	49					
SUBTOTAL, ARKANSAS RIVER SYSTEM		2,129	126					
	RED RIVER SYSTEM							
	Red River							
48	"Upper" Red River, west of Lake Texoma (including Prairie Dog Town Fork, TX-OK)	394	57	River	368	RM	Air	no
52	"Lower" Red River, Denison Dam to Red River Navigation System, TX-LA	1,376	66	River	382	RM	G/B	yes
53	Red River Navigation System, LA	51	1	River	142	RM	G/B	yes
SUBTOTAL, RED RIVER SYSTEM		1,821	124					
	NON-COASTAL TEXAS AND NEW MEXICO							
	Pecos-Rio Grande Rivers							
54	Bitter Lake National Wildlife Refuge, NM	28	1	Flats	9,000	acres	G/B	yes
55	Brantley Lake, Pecos River, NM	11	1	Res.	3400	acres	G/B	yes
56	Imperial Reservoir, Pecos River, NM	14	1	Res.	1,200	acres	G/B	no
57	Amistad Reservoir, Rio-Grande, TX	85	2	Res.	39,000	acres	G/B	yes
Subtotal, Pecos-Rio Grande Rivers		138	5					
	Trinity River and nearby							
62	North Dallas Rooftops (2)	58	2	Roof			G/B	yes
63	South Dallas wastewater treatment and gravel pits	28	1	Ind.			G/B	yes
64	Richland-Chambers Reservoir, TX	5	0	Res.	43,980	acres	G/B	no
65b	Big Brown Mine, TX	38	2	Ind.			G/B	yes
66b	Jewett Mine, Westmoreland Coal, TX	50	1	Ind.			G/B	yes
Subtotal, Trinity River		179	6					
	East Texas							
68	Cooper Lake, TX	49	2	Res.	19,300	acres	G/B	yes
SUBTOTAL, NON-COASTAL TEXAS AND NEW MEXICO		366	13					
RANGE-WIDE TOTAL		17,591	489					

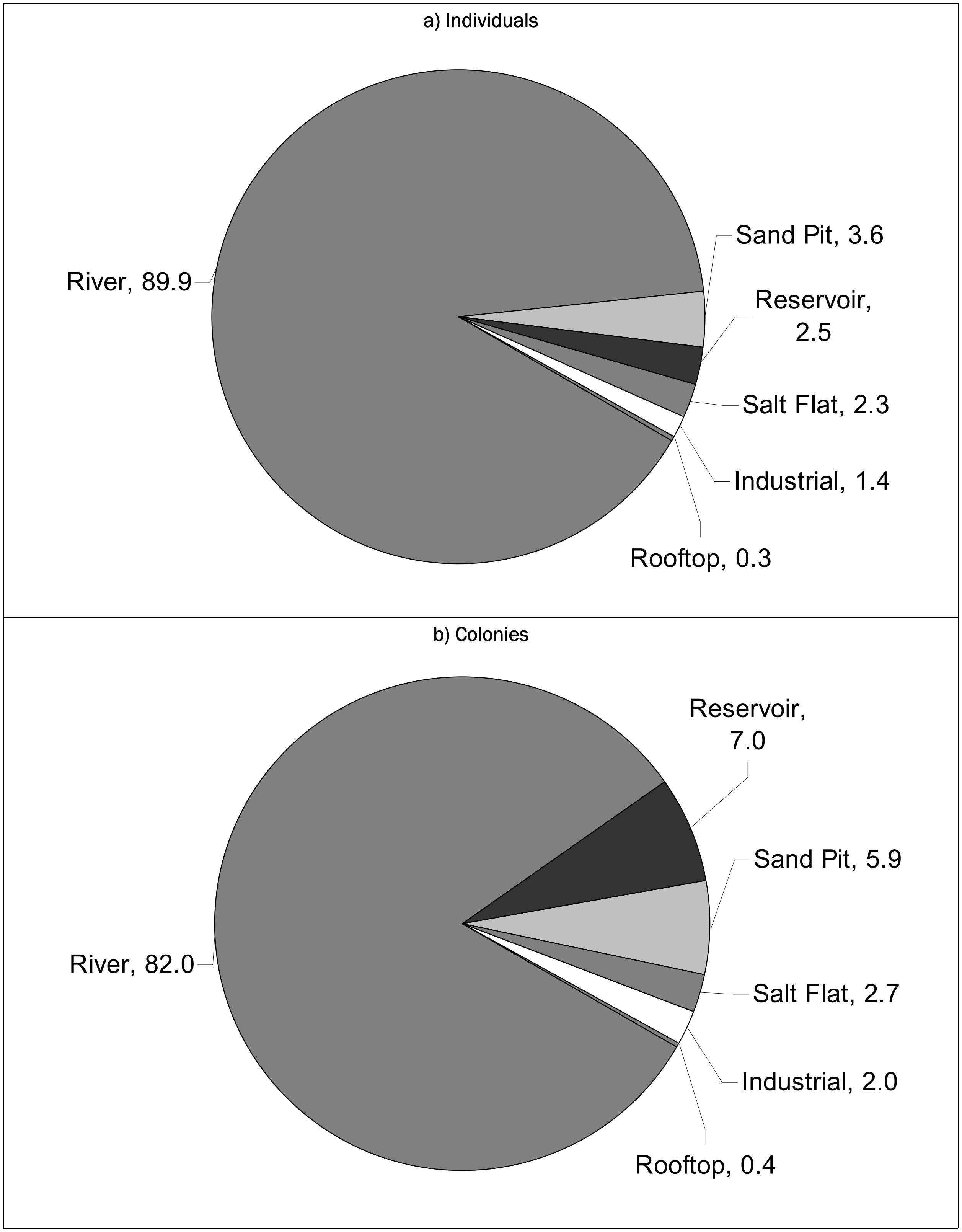

Figure 2. Percent counts by habitat type for (a) individuals and (b) colonies.

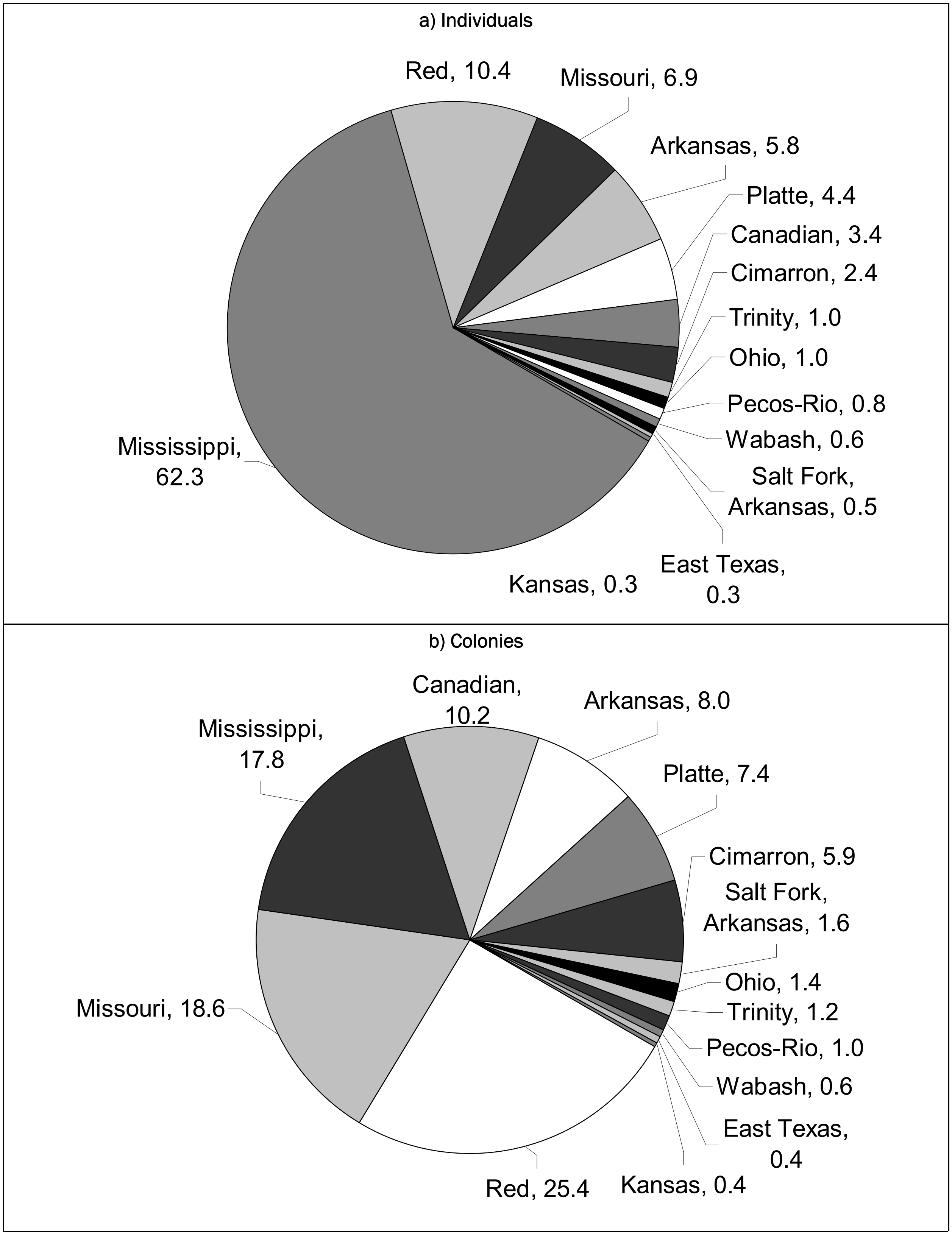

Figure 3. Percent counts by river system for (a) individuals and (b) colonies.

Table 2. Colony sizes for 15 geographic segments (subdivided by habitat type) where five or more colonies were located (sorted from highest to lowest mean colony size). Bolded entries represent numbers for aerial surveys, which represent sighting aggregations, not actual colonies (Boyd 2005). Italicized entries indicate boat-based survey segments that did not report colony size.

GHS #	Survey Segment	# Colonies	Colony Size				
			Mean	Median	Sd	Min	Max
28	Mississippi River, Cape Girardeau, MO to Baton Rouge, LA	87	119	72	131	9	700
23c	"Lower" Platte River sand pits, NE	13	25	20	26	6	106
35	Arkansas River, McKlellen-Kerr Arkansas Navigation System, AR	11	23	22	14	9	54
27a	Ohio River, KY-IN-IL	5	22	15	27	2	75
13	Missouri River- Gavins Point River, SD-NE	25	19	12	18	2	80
19c	"Central" Platte Sandpits, North Platte to Columbus, NE	9	18	13	15	6	56
11	Niobrara River, Norden to Missouri River, NE	15	16	12	11	5	45
52	"Lower" Red River, Denison Dam to Red River Navigation System, TX-OK-AR-LA	66	15	14	8	3	40
10	Missouri River- Ft. Randall River, SD	5	15	14	10	8	32
45	Salt Plains NWR, OK	8	11	10	6	6	20
5	Missouri River- Garrison River, ND	20	9	6	7	2	22
6	Missouri River- Lake Oahe, SD	12	7	5	5	2	17
2	Missouri River- Ft. Peck River , MT	5	6	6	3	2	10
4	Missouri River- Lake Sakakawea, ND	5	4	4	2	2	6
48	**"Upper" Red River, west of Lake Texoma, TX-OK**	**57**					
41	**"Upper" Canadian River, west of Eufaula Lake, TX-OK**	**46**					
38a	**Cimarron River, OK**	**27**					
34	*Arkansas River, Tulsa to Muskogee, OK*	*14*					
29	*"Upper" Arkansas Valley Reservoirs, CO*	6					

Table 3. The 14 major river segments that provide emergent sandbar habitat (ESH) for Interior Least Terns are listed below. River segments are ranked according to the number of adult ILT counted during the 2005 range-wide survey. The number of colonies per river segment is based on exact counts for all rivers except for the "Upper" Red River, the Cimarron River, and the "Upper" Canadian River, which were surveyed from the air. For these river segments, the number of colonies is based on pooled sighting of individuals seen with 3 river miles of one another (Boyd 2005). River segment rankings may differ slightly in other years. For example, 2005 totals for the "Lower" Platte River were low compared with long-term average totals of ~150 adults (Appendix C). A "Yes" in the "Annual survey" category indicates, at minimum, that there is a regular effort to count the total number of adult ILT within a standard survey window. Details are provided in footnotes for areas with partial annual survey coverage. A "Yes" in the "intensive monitoring" category indicates an area where monitoring programs attempt to document reproductive success through repeat visits to colonies that happen at a minimum of once every 10 days.

RIver Segment	# Adults	# colonies	# Miles	Annual survey?	Intensive monitoring?	Primary water management structures
Mississippi River, Cape Girardeau, MO to Baton Rouge, LA	10,960	87	770	Yes	No	Diked navigation system
"Lower" Red River, Denison Dam to Red River Navigation System, TX-LA	1,376	66	382	Partial[1]	No	Major dam, tributary dams, agricultural diversions
Arkansas River below Keystone Dam, OK	496	16	64	Yes	No	Major dam
Missouri River- below Gavins Point Dam, SD-NE	476	25	58	Yes	Yes	Major dam
"Upper" Red River, west of Lake Texoma, TX-OK	394	57	368	No	No	Small dams, tributary dams, agricultural diversions
"Upper" Canadian River, west of Eufaula Lake, TX-OK	342	46	300	No	No	Major dam agricultural diversions
Arkansas River, McKlellen-Kerr Arkansas Navigation System, AR	319	11	308	Planned[2]	No	Lock and dam navigation system
Niobrara River, Norden to Missouri River, NE	289	15	118	Partial[3]	Partial[3]	Small dam, agricultural diversions
Missouri River- below Garrison Dam, ND	199	20	84	Yes	Yes	Major dam
Cimarron River, OK	186	27	220	No	No	Agricultural diversions
Ohio River, KY-IN-IL	132	5	260	Yes	No	Lock and dam navigation system
"Lower" Canadian River, below Eufaula Dam, OK	118	2	27	Yes	No	Major dam
Arkansas River, below Kaw Dam to Keystone Lake, OK	104	3	92	Yes	No	Major dam
"Lower" Platte River below confluence with Loup River, NE	53	2	105	Yes	No	Agricultural diversions

[1]The Corps of Engineers, Tulsa District, does annual surveys of 240 river miles from Denison Dam to Index, Arkansas. Regular surveys of the 133 river miles from Index, Arkansas to the Red River Navigation System in Louisiana may be done in the future by the Corps of Engineers, Vicksburg District.
[2]Annual surveys of the entire McKlellen-Kerr Arkansas Navigation System may be done in the future by the Corps of Engineers, Little Rock District.
[3]Neither annual surveys nor intensive monitoring are not done for on the Niobrara River between HWY 137 and the lower 15 river miles of the Niobrara National Recreational River.

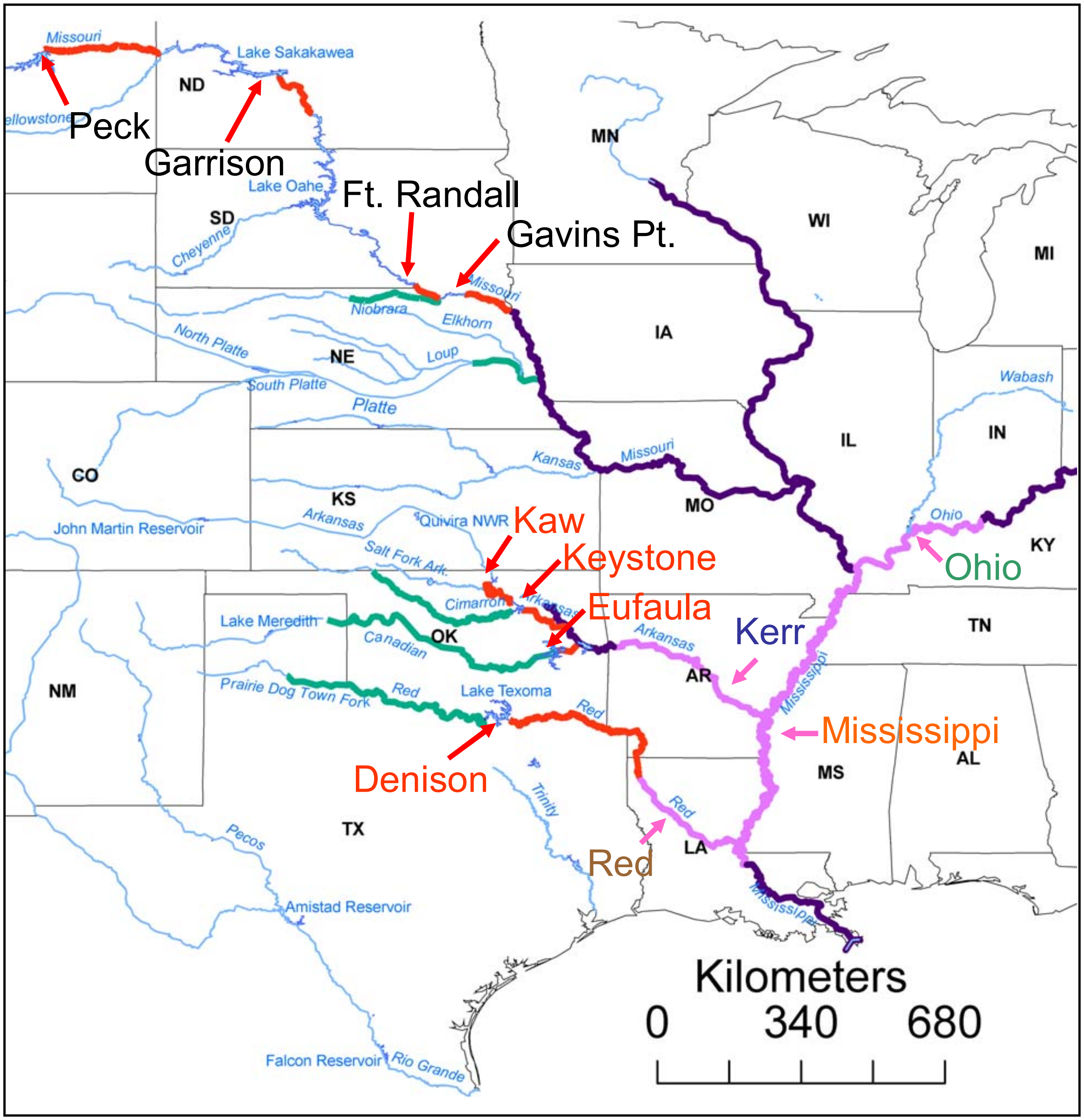

Figure 4. Rivers used (and not used) for nesting by the Interior Least Tern (ILT). Red lines (and arrows) indicate rivers below Corps-operated dams with nesting ILT populations. Pink lines (and arrows) indicate Corps-operated navigation systems with nesting terns. Dark purple lines are Corps-operated navigation systems with no nesting terns. Dark green lines are rivers with large nesting tern populations without major Corps structures, where the primary non-natural influence on flows is agricultural diversion. Light blue rivers do not have enough functional emergent sandbar habitat to support > 100 nesting terns. Text color indicates the Corps district with the monitoring lead for each area: Omaha District (black), Tulsa District (red), Little Rock District (dark blue), Louisville District (dark green), Memphis District (orange), Vicksburg District (brown).

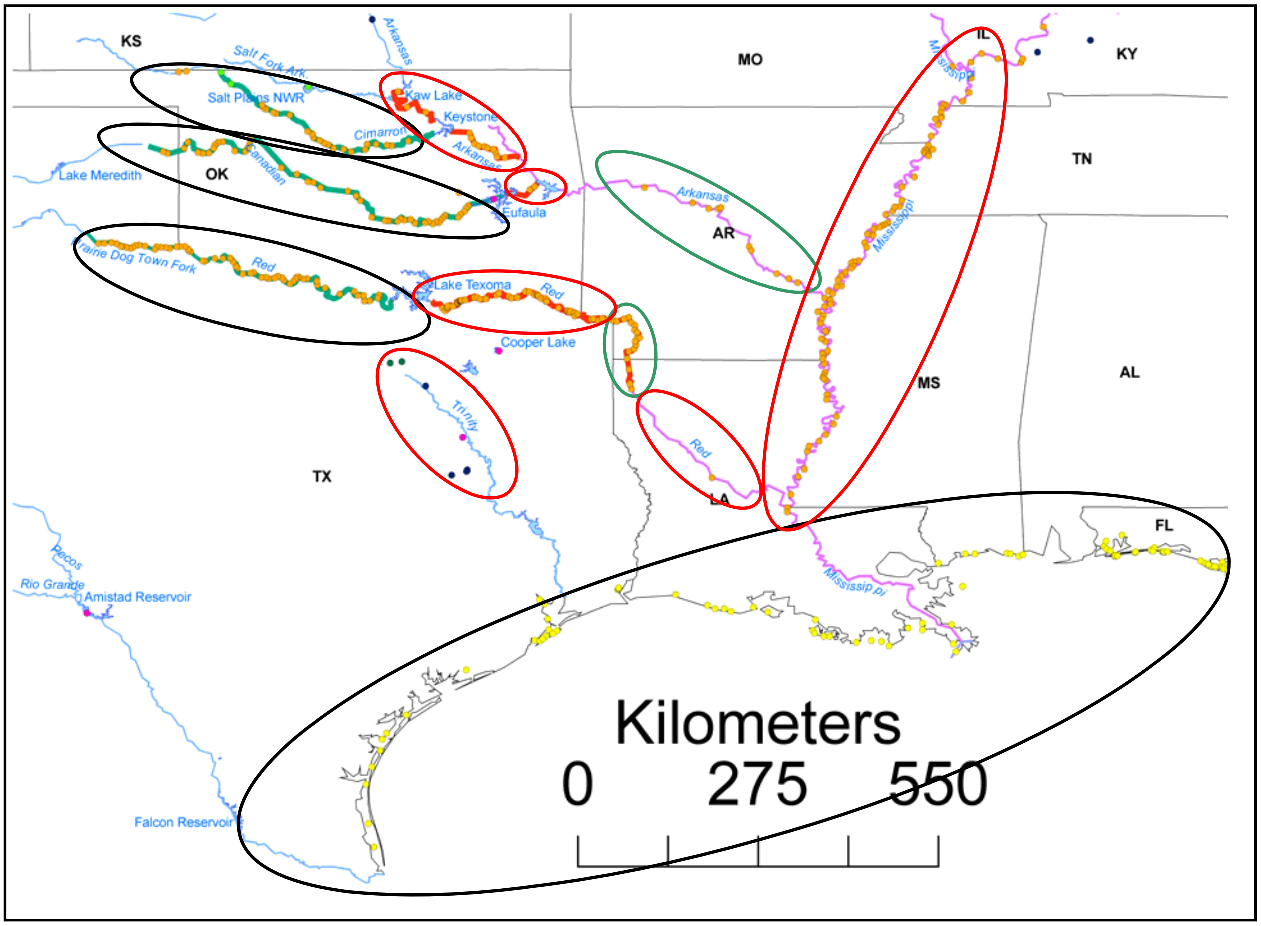

Figure 5. Map illustrating the major ILT breeding areas with insufficient survey and monitoring coverage. Areas circled in red are covered by annual monitoring efforts (the Mississippi River by the Memphis District/Mississippi Valley Division; the Arkansas River in Oklahoma, the "Lower" Canadian River, and the "Lower" Red River between Denison Dam (Lake Texoma) and Index, Arkansas by the Tulsa District; the Red River Waterway by the Vicksburg District; and the Trinity River system by a variety of cooperators). Areas circled in green have uncertain future survey coverage (the Arkansas River in Arkansas, which may be covered in future years by the Little Rock District; and the "Lower" Red River between Index, Arkansas and the Red River Navigation System, in Arkansas and Louisiana, may be covered in future years by the Vicksburg District. Areas circled in black have poor or non-existent annual survey coverage. The Cimarron, "Upper" Canadian, and "Upper" Red Rivers in Oklahoma were surveyed from the air in 2005 and future comparisons of aerial counts with ground-based counts would be necessary to determine if aerial counts of these rivers (with correction factors from ground-based surveys) would be accurate enough for long-term data collection using aerial counts. If not, ground-based counts would need to be implemented for these areas. Survey coverage on the Gulf Coast is currently poor, due to the difficulty of surveying extensive coastline and weak agency support for counts. Extensive coordination would be necessary to improve survey coverage on the Gulf Coast.

6 Regional Results

The Missouri River System

The 2005 survey and ILT distribution

The ILT count for the "Upper" Missouri River (above Sioux City, IA) and its tributaries was 1,217, with 904 adults counted on the Missouri, 289 on the Niobrara, and smaller numbers on the Cheyenne (4) and Yellowstone (16) Rivers (Figure 6, Table 4). ILT do not breed on the 738 river miles of the Missouri River between Sioux City, IA, and the Missouri River's confluence with the Mississippi River in St. Louis, MO. Suitable sandbar nesting habitat has been virtually eliminated on this part of the river because of channelization for navigation (Smith and Renken 1991, USFWS 2003). Along with the additional ~140 river miles of the Mississippi River between St. Louis and Cape Girardeau, MO (the approximate location of the first ILT colonies on the Mississippi River), this is the largest distributional gap on major interior rivers within the breeding range of the ILT. Upstream of Sioux City on the Missouri River, ILT breed primarily on four riverine sections below dams and secondarily on reservoir shorelines and islands. In 2005, counts of more than 50 adult ILT occurred only on the Gavins Point River segment, the Garrison River segment, Lake Oahe, and the Ft. Randall River segment. Many miles of former riverine habitat were eliminated on the Missouri River during the construction of Lewis and Clark Lake, Lake Francis Case, Lake Sharpe, Lake Oahe, and Lake Sakakawea.

Historic data

Survey coverage on the Missouri River from the Garrison River segment downstream to below Gavins Point Dam has been complete since 1986. In 1988, survey segments were added on Fort Peck Lake, the Fort Peck River, and Lake Sakakawea. Since 1988, the entire Missouri River has been surveyed from the Fort Peck Reservoir to below Gavins Point dam. Between 1988 and 2005, on average, 79 percent of all birds on the Missouri River have nested on river segments and the remaining 21 percent have nested on reservoirs. The percentage of birds nesting on the river was as low as 72 percent and as high as 86 percent in 2004. The 476 adults counted below Gavins Point Dam in 2005 were a record total for this stretch of river and may have been due to two new nesting islands created by the

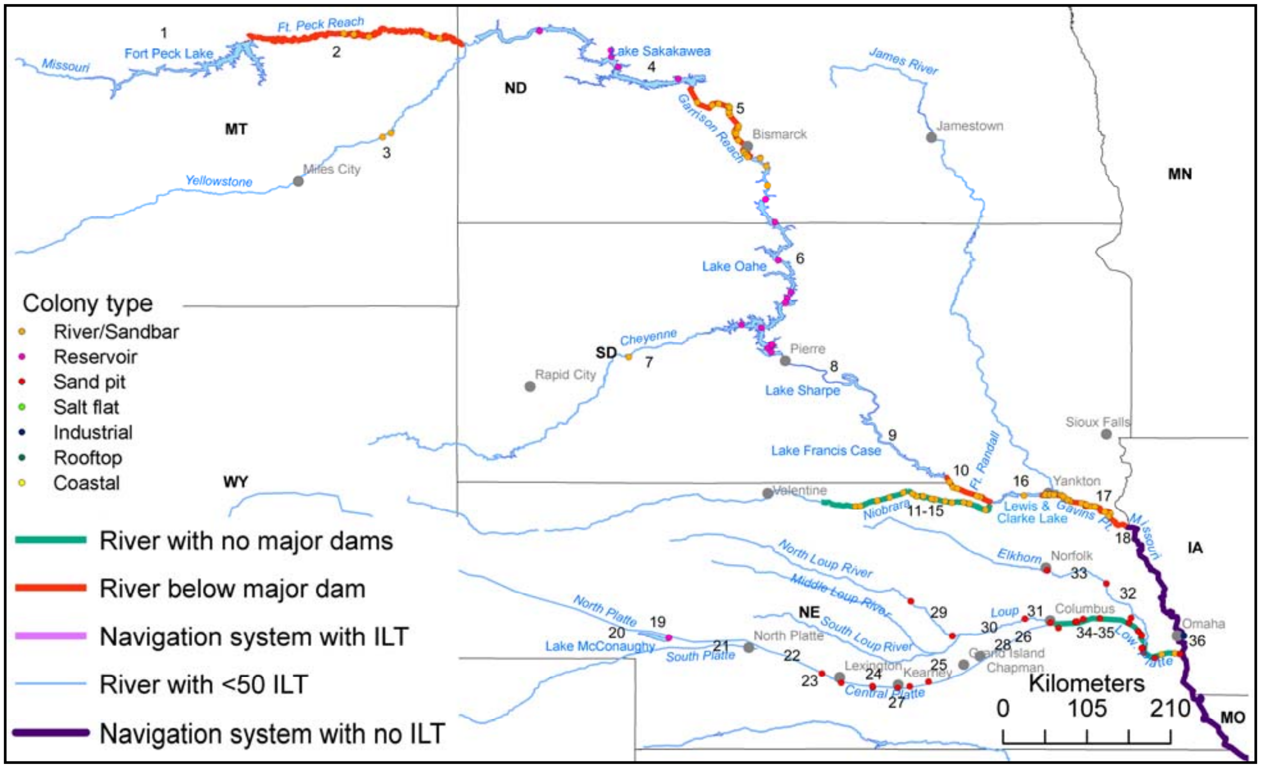

Figure 6. 2005 colony locations for the “Upper” Missouri River and four major tributaries: the Yellowstone, Cheyenne, Niobrara, and the Platte River system. Numbers correspond to survey segments in Appendix B.

U.S. Army Corps of Engineers, Omaha District, and used heavily by both ILT and Piping Plover (*Charadrius melodus*). Count totals for the Garrison River segment and the Ft. Randall River Reach were also above average in 2005. This produced a record count of 904 ILT for the entire Missouri River in 2005, eclipsing the previous high count of 777 in 1994. Long-term counts for individual survey segments within the Missouri River system are more variable than long-term counts for the entire region (compare coefficients of variation for annual counts in Table 3) suggesting that ILT may nest on different GS annually, while remaining within the Missouri River system.

Counts for the three “Upper” Missouri River tributaries with ILT were near recent historic averages. The Niobrara River has had complete survey coverage only during the three years of the International Piping Plover census (1991, 1996, and 2001). The count total of 289 birds on the Niobrara in 2005 was similar to two of the three years with full coverage (counts of 291 in 1991 and 321 in 1996) and higher than the low count of 150 in 2001. Annual counts of ILT have been conducted on the Yellowstone River since 1988. The 16 adults counted on the Yellowstone in 2005 were similar to historic totals between 1988 and 2004. Surveys for ILT have been conducted on the Cheyenne River in 11 of the 19 years since 1986. The four terns observed on the Cheyenne River in 2005 were similar to low count totals in recent years (range of 3 to 12 birds between 1998 and 2004). This is a decline, however, from the average of 34 birds observed between 1986 and 1996 (with a high of 54 birds in 1987 and 1995).

Current monitoring efforts and future considerations

Currently, intensive monitoring programs occur on all segments of the Missouri River from Fort Peck Lake to the river below Gavins Point Dam (except for Lake Sharpe); on 40 river miles (RM) of the Niobrara National Scenic River between Norden, NE, and HWY 137; and on the lower 15 RM of the Niobrara National Recreational River (upstream from the confluence with the Missouri River). However, neither of these monitoring efforts covers the 40 RM between HWY 137 and Spencer Dam, which has the highest number of terns on the Niobrara River, or the 5 upper river miles of the Niobrara National Recreational River (Appendix B). These monitoring programs all conduct an annual adult census within a standard survey window during the last two weeks of June and conduct intensive monitoring of reproductive success and nest fates following standardized protocols developed by the Corps' Omaha District.

Colonies on the Niobrara River are 5–100 km away from colonies on the Ft. Randall reach of the Missouri River; 50–200 km from colonies on the Gavins Point reach; and are within 250 km of other colony sites on Lake Oahe, the Elkhorn River, the North Loup River, the Loup River, and the Platte River. These distances are well within known dispersal distances for ILT and movements between colonies on the Niobrara and nearby river reaches of the Missouri (or the Platte River and its tributaries) seem likely (Boyd and Sexson 2004). The lack of annual survey coverage on the portion of the Niobrara River with the highest number of birds is the most important gap in survey coverage on the Missouri River system. Population trend analyses for the Missouri River system will need to be interpreted within the context of missing data from the Niobrara and compared with population trends on the nearby Platte River system (which also has problems with incomplete survey coverage). This caveat aside, since survey methods and coverage have been essentially the same on the Missouri River since 1988, and since data have been stored in a well-maintained database, population trend analyses would be possible using data from the Missouri River monitoring program.

Table 4. 2005 count totals for the "Upper" Missouri River and three major tributaries (the Yellowstone, Cheyenne, and Niobrara Rivers) with comparative historic data from 1986-2004. Totals for the Platte River system are presented in Table 5.

"Upper" Missouri River and Tributaries	2005 Survey		Historic Data for Comparisons						
	# Adults	# colonies	Mean	SD	low	high	CV	years	missing
Missouri River-Ft. Peck Lake, MT	0	0	3	3	0	10	106	1987-2004	
Missouri River-Ft. Peck River, MT	34	5	63	41	18	162	64	1988-2004	
Yellowstone River, MT	16	2	18	7	11	40	38	1988-2004	
Missouri River-Lake Sakakawea, ND	26	5	17	10	2	35	60	1988-2004	
Missouri River–Garrison River, ND	199	20	137	51	41	284	37	1986-2004	
Missouri River–Lake Oahe, SD	89	12	99	36	30	171	37	1986-2004	
Cheyenne River, SD	4	1	23	18	3	54	77	1986-2004	90-94, 97, 99, 02
Missouri River–Lake Francis Case, SD	0	0	4	5	0	10	122	2001-2005	
Missouri River–Ft. Randall River, SD	76	5	40	37	0	124	91	1986-2004	
Niobrara River, Norden to Missouri River, NE	289	15	254	91	150	321	36	91,96,01	all other years
Niobrara River (Norden–HWY 137)	15	2	18	7	12	26	46	2002-2004	
Missouri River–Lewis and Clark Lake	4	1	41	28	6	118	68	1986-2004	
Missouri River–Gavins Point River, SD-NE	476	25	209	79	82	366	38	1986-2004	
Subtotal, Missouri River only—Rivers and reservoirs combined	904	73	622	103	427	777	17	1988-2004	
Subtotal, Missouri River–River segments only	789	56	494	87	324	623	18	1988-2004	
Subtotal, Missouri River–Reservoir segments only	115	17	128	37	72	212	29	1988-2004	
Subtotal, percent of Missouri River birds counted on river	87	77	79		72	87		1988-2004	
Subtotal, "Upper" Missouri River and Tributaries	1,213	78	694	131	446	988	19	91,96,01	all other years

Platte and Kansas River Systems

The 2005 survey and ILT distribution

The moderately complex geography of the Platte River system geography is further complicated by terminology that has been used to divide the system into different survey segments in the past. The Platte River is frequently divided into three main reaches, the "Upper," "Central," and

"Lower" Platte relative to major water diversion structures and tributary inputs. Inconsistency in application of terms (such as alternate definitions of the "Central" Platte River as Lexington to Chapman or Lexington to Columbus) has led to confusion in discussions of historic totals from the Platte River system. Hereafter, the "Upper Platte River" designates the Platte River from its confluence with the North Platte River near North Platte, NE downstream to Lexington, NE. Water levels are typically very low in the "Upper" Platte due to diversion of water from the Platter River into the Tri-County Canal at RM 314. The remaining flow from this irrigation canal is returned to the Platte River near Lexington via the J-2 return. The "Central" Platte River has been variously defined as the J-2 return near Lexington, NE downstream to Chapman, NE or to the Loup River confluence near Columbus, NE. The area between Chapman and Columbus has received inconsistent survey coverage over the years and historic totals for "Central Platte River" sometimes do not include counts from the area between Chapman and Columbus. For this report, "Central" Platte River refers to the area between Lexington and Columbus, from the J-2 return to the Platte River's confluence with the Loup River. The "Lower Platte River" has been defined as the Platte River between its confluence with the Loup River near Columbus, NE to the Platte River's confluence with the Missouri River.

In 2005, 782 adult ILT were counted on the Platte River system, with a majority of these birds occurring on sand pits adjacent to the "Lower" Platte River, and sand pits along the "Central" Platte River (Figure 7, Table 5). Sandbar habitat is generally unsuitable for ILT nesting on the "Upper" or "Central" Platte River and ILT have only nested on the Platte River above the confluence with the Loup in some years on constructed islands. Therefore, ILT breeding is mostly confined to sand pits in these areas (Lingle 1993, Jenniges 2004, Czaplewski et al. 2005). Below the confluence with the Loup River, which bring additional water flow to the "Lower" Platte River, ILT nest on riverine sandbars, although they also frequently nest on sandpits adjacent to the river. Salt Creek and the Elkhorn River bring considerable sediment to the "Lower" Platte River and sandbars are most suitable for ILT nesting below the confluences with these rivers (Eileen Kirsch, US, Upper Midwest Environmental Sciences Center, personal communication). Lesser numbers of ILT were counted in 2005 on sandpits adjacent to the Elkhorn, Loup, and North Loup Rivers, all tributaries to the "Lower" Platte. Small numbers of terns occasionally nest on sandbars of the Loup River, and rarely, the Elkhorn River (John Dinan, NGPC, personal communication). The Elkhorn River was not surveyed in 2005 due to dangerously high water during the survey window. A small number of ILT breed on Lake McConaughy, a reservoir on the North Platte River. Forty-five ILT were counted on the Kansas River near its confluence with the Republican River, 13 on riverine sandbars and 32 at the Jeffrey Energy Center, a nearby power plant where ILT nest on fly-ash deposits (Boyd and Sexson 2004).

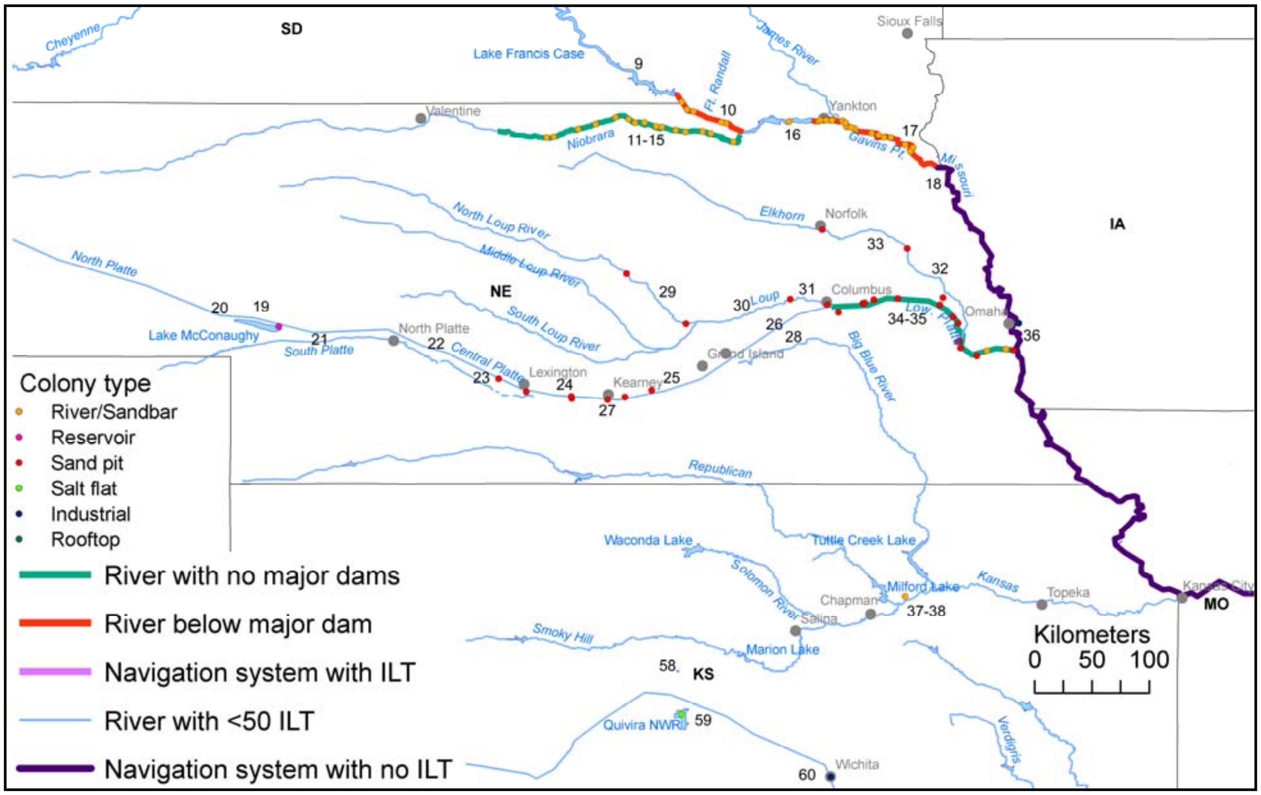

Figure 7. 2005 colony locations for the Platte River (and tributaries) and the Kansas River. Numbers correspond to survey segments in Appendix B.

Historic data

The author found many sources of historic data for the Platte River system, but there were a large number of inconsistencies in count totals. These discrepancies could not be reconciled and these historical data are not summarized in this report. Collaborative efforts are ongoing to discuss and resolve discrepancies among historic data within the Platte River system (Renae Held, Tern and Plover Partnership, personal communication). Hopefully, these efforts will reconcile the many different versions of historic data for the Platte River system that have been presented in Sidle et al. (1991), Dinan et al. (1993), Sidle and Kirsch (1993), Kirsch (1996), Kirsch and Sidle (1999), Kirsch (2000), Boyce et al. (2002), USFWS (2003), Jenniges (2004), Platte River Endangered Species Partnership (PRESP) Technical Advisory Committee (2004), Held et al. (2005), Czaplewski et al. (2005), and others. The Nebraska Game and Parks Commission (NGPC) maintains a central repository for ILT and Piping Plover count data for Nebraska; however, this database is incomplete. The historic data summaries presented in this report include only data from the 3 years of the International Piping Plover Census (Haig et al. 2005), when there was nearly complete coverage of all historic nesting areas within the Platte River system and extra care was taken to enter these data correctly into the NGPC database (John Dinan, NGPC, personal communication). Still, count totals from the 1991 surveys in the NGPC database do not match count totals for this same survey presented by Sidle et al. (1991) and the accuracy of IPPC totals from other years reported in this database is unknown.

Historic data exist for the Kansas River from 1995-2004. Use of riverine sandbars and the nearby industrial site at the Jeffrey Energy center is not separated out, although terns used both of these areas in most years. Historic totals for the Kansas River presented in this report include both of these areas. Eleven different sandbars have been used for nesting on the Kansas River between 1995 and 2004; however, in most years only a small number of sites are used. A sandbar near Belvue, KS, is the most consistent colony site for ILT on the Kansas River.

The small percentage of birds breeding on riverine sandbars of the "Lower" Platte River in 2005 is anomalous. Typically, about 58 percent of ILT nest on river sandbars on the "Lower" Platte, whereas only 53 of 381 birds (14 percent) were nesting on the river in 2005 (Appendix C). Count totals for the Loup River were low in 2005 compared to totals from IPPC counts in other years and count totals for Elkhorn River sandpits were high. Count totals for Lake McConaughy were high compared with previous IPPC counts. The total number of birds counted on the Platte River system was similar to the three years of the IPPC where survey coverage was nearly complete.

Current monitoring efforts and future considerations

An adult census is conducted on the "Central" and "Lower" Platte River annually during the first two weeks of June, and all sandpits and riverine colonies are counted during this window. Surveys on the Loup and Elkhorn Rivers are conducted only in years of the International Piping Plover census. Currently, intensive annual monitoring of productivity occurs at sandpit colonies on both the “Upper”/”Central” Platte River and the “Lower” Platte River, following standardized protocols of the Platte River Endangered Species Partnership (for the “Upper”/”Central” Platte) and the Tern and Plover Partnership (for the “Lower” Platte). Survey coverage of sandpits has improved in recent years for the Elkhorn, Loup, and the North Loup Rivers. Most of the sandpits on these three rivers are now being monitored by the Tern and Plover Partnership, some of which had been missed in the past (Renae Held, Tern and Plover Partnership, personal communication). Sandpit survey coverage on the “Central” and “Upper” Platte River has also increased since the mid-nineties (Jim Jenniges, Nebraska Public Power District, personal communication).

Protocols for assigning individual birds counted on adjacent riverine and sandpit surveys to one survey segment or the other have varied over the years and have never been formalized by all parties collecting ILT survey data on the Platte. The degree to which individual adults are double counted between adjacent riverine and sandbar survey areas is therefore unknown and is likely to have varied over the years. Annual monitoring of productivity does not currently occur on riverine segments of the “Lower” Platte. However, productivity monitoring occurs on riverine segments of the “Upper” and “Central” Platte in years when ILT nest in these areas.

Given the short distances among survey segments within the Platte River system, the sporadic annual coverage of the Loup and Elkhorn Rivers may compromise regional analyses of population trends. On these two rivers combined, 163 and 147 ILT were counted in the IPPC years of 2001 and 2005, respectively. These counts contributed an average of 23.7 percent to the total count for the entire Platte River system. Any analyses of population trends for the Platte River System will need to keep annual differences in survey coverage of these two rivers in mind. In addition, the number of sandpits monitored annually between 1986 and 2004 differed; however, important data on how many sandpits were monitored each year are not included in the current statewide database for ILT numbers maintained by NGPC. In addition to issues of variable survey coverage, issues of long-term data storage and divergent versions of historic data must be resolved before data from the Platte River system data can be used in analyses of regional population trends. Although the Platte River and Kansas River are technically tributaries to the Missouri River, they are treated separately here because they are somewhat geographically isolated from populations of ILT nesting on the "Upper" Missouri River and because ILT counts from these rivers are often considered independently from the Missouri (Kirsch and Sidle 1999, Kirsch 2000, USFWS 2003). However, band recoveries have indicated exchange of breeding birds among all three of these river systems (Boyd and Sexson 2004) and population trends from the Platte and Kansas River systems may need to be interpreted within the context of population trends on the "Upper" Missouri.

Table 5. 2005 count totals for the Platte River (and tributaries) and the Kansas River with comparative historic data from 1986-2004.

Platte River and Tributaries; and Kansas River	2005 survey		Historic data for comparisons						
	# Adults	# colonies	Mean	SD	low	high	CV	years	missing
Platte River and Tributaries									
Lake McConaughy, NE	32	4	17	7	10	24	42	91, 96, 01	all other years
South Platte River sandpits, NE	0	0	2	2	0	4	100	91, 96, 01	all other years
"Upper"/"Central" Platte River, North Platte to Columbus, NE	3	0	41	4	39	46	10	91, 96, 01	all other years
"Upper" Platte Sandpits, N.Platte to Lexington, NE	20	1	16	12	5	29	78	91, 96, 01	all other years
"Central" Platte Sandpits, Lexington to Columbus, NE	152	8	108	46	67	158	43	91, 96, 01	all other years
North Loup River Sandpits, NE	14	2						no data	
Loup River, NE	19	0	86	33	51	117	39	91, 96, 01	all other years
Loup River Sandpits, NE	54	2	56	13	46	65	24	91, 96, 01	91
Elkhorn River, NE	ns	ns	36	11	28	43	30	91, 96, 01	91
Elkhorn River Sandpits, NE	74	3	37	7	30	43	18	91, 96, 01	all other years
"Lower" Platte River, NE	53	2	223	94	163	331	42	91, 96, 01	all other years
"Lower" Platte River Sandpits, NE	328	13	149	19	127	163	13	91, 96, 01	all other years
Mid-American Energy Plant, Council Bluffs, IA	33	1	12	9	0	28	77	1986-1997	all other years
Subtotal, Platte River and Tributaries	782	36	749	134	640	898	18	91, 96, 01	some areas
Kansas River									
Subtotal, Kansas River	45	2	32	5	25	38	14	1995-2004	

Mississippi, Ohio, and Wabash River Systems

The 2005 survey and ILT distribution

In 2005, 11,231 adult ILT were counted on the Mississippi, Ohio, and Wabash River systems. The majority (10,960) of these birds were on Mississippi River sandbars, with lesser numbers at river and industrial sites on the Ohio River (172 birds) and a variety of sites along the Wabash River in Indiana (99 birds) (Figure 8, Table 6). ILT on the Mississippi River nest on large sandbars (mostly associated with dike fields) primarily between the confluence with the Ohio River at Cairo, IL, and Baton Rouge, LA. Smaller numbers of ILT nest on sandbars upstream of the confluence to around Cape Girardeau, MO. In 2005, counts on the Mississippi River accounted for over 62 percent of the range-wide count for all ILT. On the Ohio River, ILT nest on sandbars, dredged-material islands, and on fly-ash disposal piles at industrial plants. Historically, ILT have nested on dikes and islands within the cooling ponds of a power plant at Gibson Lake, near the Wabash River, in Indiana. However, in 2005 ILT nested on a newly created island at Cane Ridge Wildlife Management Area (WMA), adjacent to Gibson Lake, and a small number of birds nested on a sandbar of the Wabash River (which was available due to unusually low water in 2005).

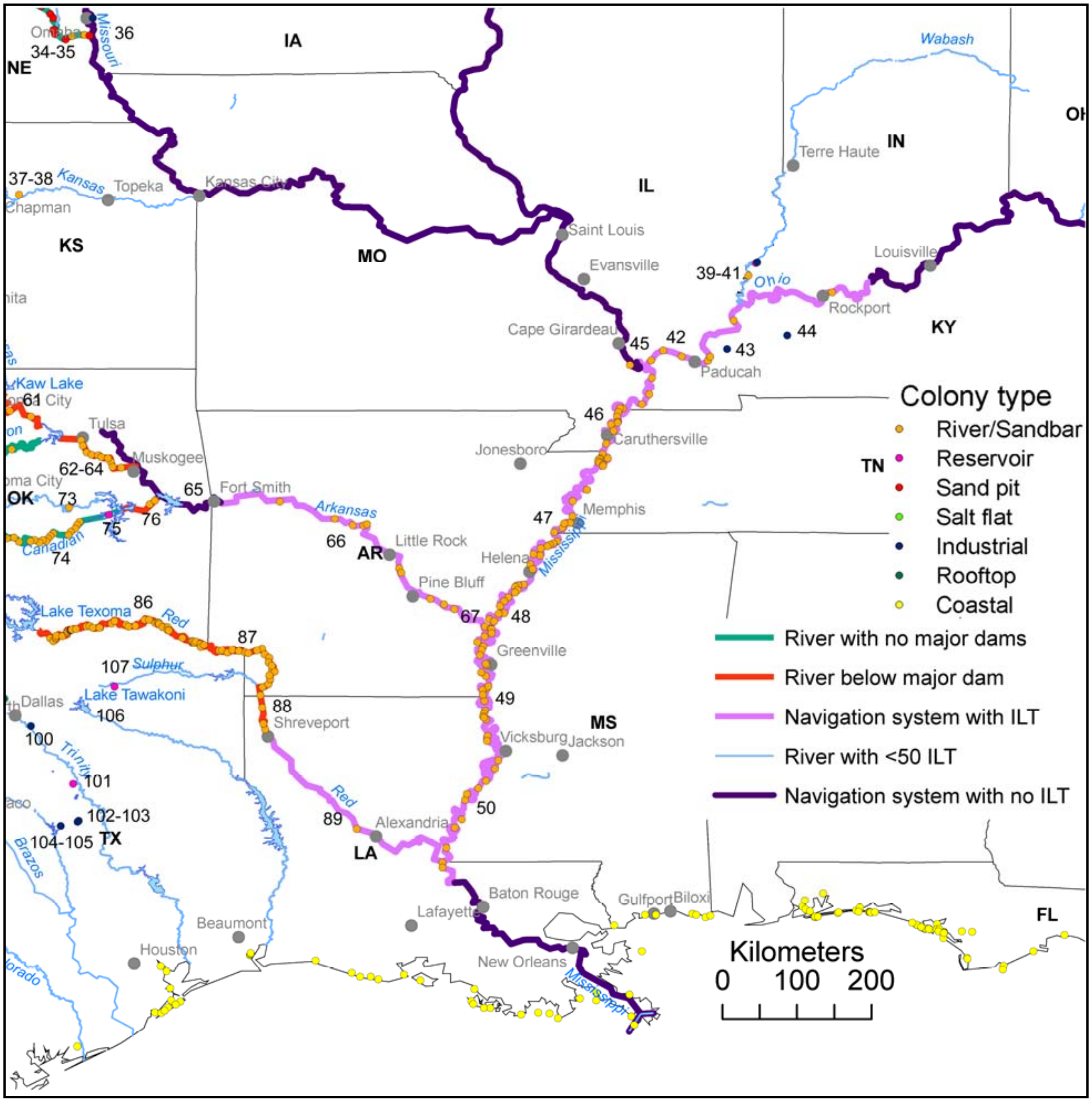

Figure 8. 2005 colony locations for the Mississippi, Ohio, and Wabash Rivers. Numbers correspond to survey segments in Appendix B.

Historic data

Since 1986, the Corps of Engineers has conducted lengthy, single annual surveys for ILT on the Mississippi River from Cape Girardeau, MO to at least Greenville, MS (1986-1987), further downstream to Vicksburg, MS (1988-2003), and finally, further downstream to Baton Rouge, LA (starting in 2004). Any analysis of long-term data from the Corps' counts on the Mississippi will need to take annual differences in survey termination points into account. Early Corps surveys were conducted from the air, by towboat, and by small boat; however, only small boat surveys are considered accurate for the Mississippi River (Jones 2005) and therefore, this report presents data only from small boat surveys between 1986 and 2005. Due to extreme flooding, Mississippi River sandbars were underwater for the entire summer of 1993 and boat-based counts were not conducted due to dangerously high water levels. However, aerial surveys were flown in 1993 to search both banks (and adjacent agricultural fields) for nesting ILT and no ILT were located (John Rumancik, U.S. Army Corps of Engineers, Memphis District). Average counts from Cape Girardeau to Vicksburg have increased and then remained somewhat stable four different times during this period (1988-1989: 2,181; 1990-1997: 4,300; 1998-2002: 5,956; and 2003-2004: 8,572) (Appendix C). The 2005 total of 9,563 birds from Cape Girardeau to Vicksburg was higher than any year to date. The grand total from Cape Girardeau to Baton Rouge was slightly lower in 2005 than 2004 (10,960 and 11,239 respectively) due to a lower number of birds counted between Vicksburg and Baton Rouge in 2005 than 2004 (1,622 and 2,087, respectively). This is a dramatic increase from the only other years where surveys were conducted between Vicksburg and Baton Rouge (1994-1995) when an average of only 263 birds was counted.

The count of 172 birds on the Ohio River and at nearby industrial sites in 2005 was above average for the seven years with counts between 1996 and 2004. The count of only 10 birds at Gibson Lake in 2005 was low compared to recent years; however, the 75 birds at Cane Ridge Wildlife Management Area adjacent to Gibson Lake and 14 birds nesting on Wabash River sandbars put the regional total for the Wabash River well within the range of recent numbers for Gibson Lake.

Current monitoring efforts and future considerations

Timing of surveys on the Mississippi River varies annually, and they are scheduled to begin shortly after river levels drop enough to expose sandbars. This can vary between the last week of June and the second week of August. If surveys are done too late in the season, when water levels are low, sandbars become difficult to access by boat and prohibitively large to search. Because of the large distance covered by this survey (>770 RM in 2005), the large size of sandbars (2-4 miles long by 0.75 mile wide), and the large numbers of ILT nesting on the Mississippi River, visits to individual sandbars are brief. Colony counts consist of rapid counts of all flying birds by three or more observers. This pace allows the entire survey to be completed by a single survey crew within 6-8 days. Between 1997 and 2005, colonies along the Mississippi River in Missouri (and the adjacent states of Kentucky and Tennessee) have been counted more intensively by the Missouri Department of Conservation (MDC). MDC counts involve systematic searches and direct counts of all nests in a colony. This level of survey intensity often takes hours to complete a count of a single large colony. Colonies on the Mississippi River are so large that any one portion of the colony is disturbed for only a short amount of time. These intensive counts should be more accurate than the Corps' rapid counts and MDC counts may be used to assess the accuracy of the Corps' rapid surveys in the future.

In previous years, however, MDC counts did not take place at the same time as Corps counts (MDC counts averaged 2 weeks earlier than Corps counts from 1997-2004, ranging from 37 days earlier to 14 days later). In 2005, MDC counts were scheduled for the same week as Corps counts and 10 colonies were counted by both the MDC and the Corps within the same week. Similar comparison counts will be made in future years. With a larger sample size, these comparison counts should be sufficient to describe possible bias in rapid Corps counts. Since the Corps counts only adults that are present at the colony during the colony visit and MDC counts account for birds away from the colony (by counting nests times two) it is suspected that Corps counts may be biased low. Since counts of ILT on the Mississippi River make up such a high proportion of the range-wide total for this population, it is critical that annual counts continue indefinitely, as these counts provide the backbone for long-term analyses of ILT population trends. In addition, since these counts are necessarily rapid, due to the large distance to be covered by a single survey team, the accuracy of these counts should be determined.

Reproductive success is not currently monitored anywhere on the Mississippi River, although several studies have been done in the past (Smith and Renken 1993, Dugger et al. 2000, Dugger et al. 2002, Szell and Woodrey 2003). Additional monitoring of reproductive success on the Mississippi River will be challenging, but it may help to assess whether local population increases are due to local productivity or emigration from adjacent areas. Annual surveys on the Ohio have been conducted since 2000. These surveys involve an initial flight to identify colony locations, followed by single or multiple visits to colonies on the ground between early June and mid-August to document nesting activity and sometimes productivity (Ciuzio et al. 2005). Annual intensive monitoring efforts for productivity and nest fates occur at Gibson Lake. These efforts should continue, and perhaps shift locations, if the breeding distribution of this small population shifts to the newly created habitat at Cane Ridge WMA in subsequent years.

Table 6. 2005 count totals for the Mississippi, Ohio, and Wabash Rivers with comparative historic data from 1986-2004.

Mississippi, Ohio, and Wabash Rivers	2005 survey		Historic data for comparisons						
	# Adults	# Colonies	Mean	SD	low	high	CV	years	missing
Wabash River									
Wabash River, IN	14	1							
Gibson Lake, IN	10	1	41	34	0	110	84	1986-2004	
Cane Ridge WMA, IN	75	1							
Subtotal, Wabash River	99	3	41	34	0	118	84	1986-2004	
Ohio River									
Ohio River, KY-IN-IL	132	5							
Ohio River Industrial Sites (2), KY	40	2							
Subtotal, Ohio River sandbars and industrial sites	172	7	120	56	59	197	47	1996-2004	98,99
Mississippi River									
Mississippi River, Cape Girardeau, MO to Vicksburg, MS	9,338	76	5086	1969	2005	9061	39	1988-2004	93
Mississippi River, Cape Girardeau, MO to Baton Rouge, LA	10,960	87	11239					2004 only	all other years
Subtotal- Mississippi, Ohio, and Wabash Rivers	11,231	97	11425					2004 only	

Arkansas River System

The 2005 survey and ILT distribution

Within the Arkansas River system in 2005, 2,129 adult ILT were counted (Figure 9, Table 7). Nearly half of these birds occurred on the Arkansas River, with major breeding areas on riverine segments below two major dams (Kaw and Keystone) in Oklahoma and along the McClellan-Kerr Navigation System in Arkansas. Other important breeding areas for ILT within the Arkansas River system include sandbars on the Cimarron River

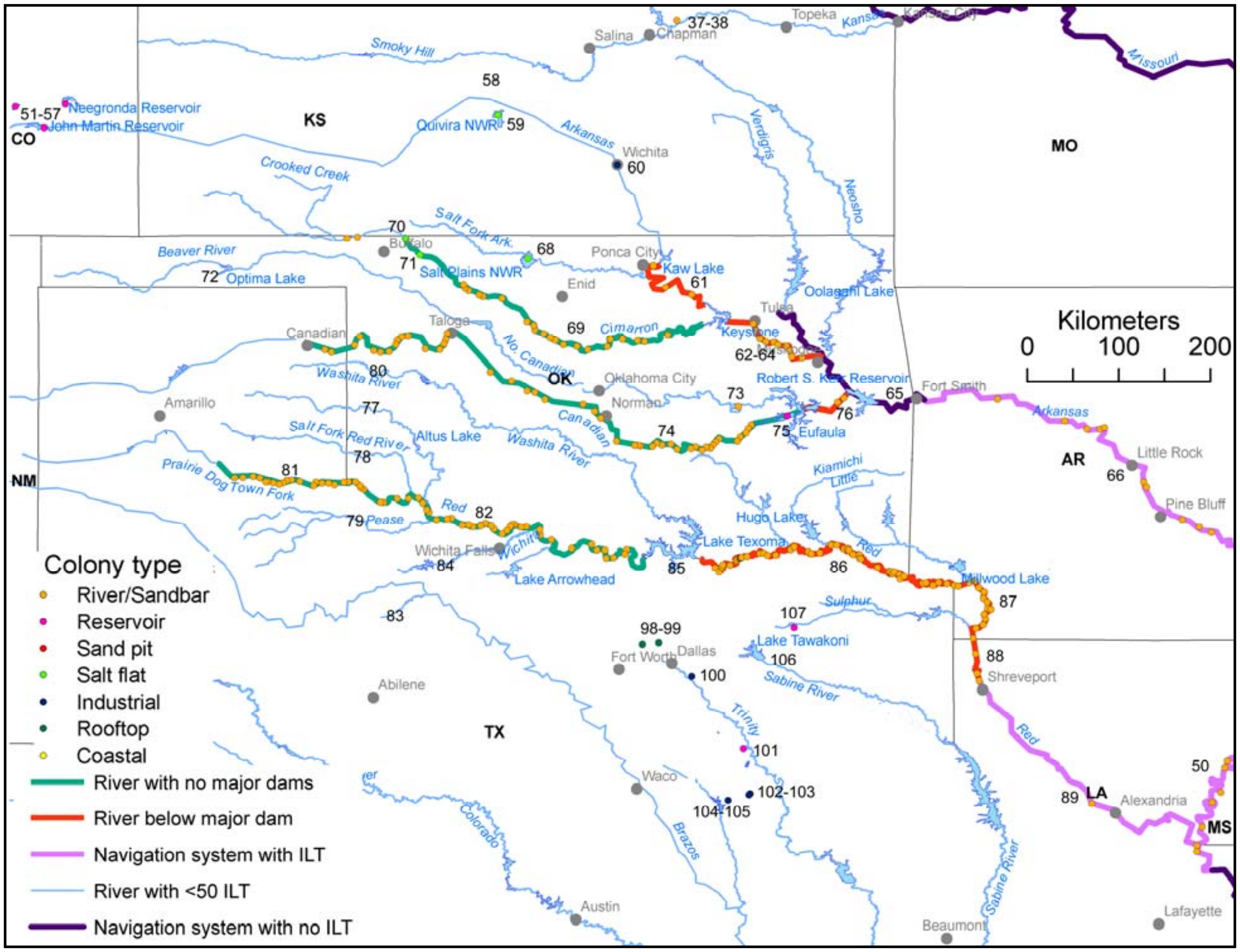

Figure 9. 2005 colony locations for the Arkansas and Red River Systems. Numbers correspond to survey segments in Appendix B.

between Crooked Creek and Keystone Lake (186 ILT at 27 colonies); salt flats adjacent to the Cimarron River in Woods County, OK (242 ILT at two sites) and at Salt Plains National Wildlife Refuge (90 ILT at eight colonies); sandbars on the "Upper" Canadian River above Eufaula Lake (342 ILT at 34 colonies); and riverine areas downstream of Eufaula Dam on the "Lower" Canadian River (118 ILT at two colonies). ILT also nest in small numbers on three reservoirs on the Arkansas River in Colorado, at two sites in Kansas, and in very small numbers on the North Canadian River in Oklahoma. No ILT were recorded at Optima National Wildlife Refuge in Oklahoma at the far western edge of the North Canadian-Beaver River basin and ILT have not bred at Optima since 1992. In 2005, a large colony (130 birds) was detected at the delta of the "Upper" Canadian River at Eufaula Lake. This delta is typically under water for at least part of summer and was exposed only because of abnormally low lake levels during nest initiation in 2005. Similar river/reservoir delta colonies occurred at the mouth of the "Lower" Canadian River (105 ILT) on Robert S. Kerr Lake in 1987 and at a different site at the mouth of the "Upper" Canadian River at Eufaula Lake in 1993 (28 ILT). These types of colony sites are only available periodically during extreme low water and are usually flooded as lake levels rise (Kevin Stubbs, USFWS, Tulsa, Oklahoma, personal communication).

Historic data

Historically, survey coverage within the Arkansas River system has been variable and mostly incomplete. This should be kept in mind when interpreting long-term data. The U.S. Army Corps of Engineers, Tulsa District, has conducted surveys for ILT within the Arkansas River System below three major dams in Oklahoma (Kaw and Keystone on the Arkansas River and Eufaula on the "Lower" Canadian River) since the early 1990s. Typically, two or three surveys are done per season in an attempt to document population size and productivity. Although data are presented in annual reports and have been summarized in the recent Arkansas River Biological Opinion (USFWS 2005a), historic data are difficult to interpret due to different methods used to present data from multiple surveys within the same year (see the methods section for how survey data were treated for this report's presentation of historic data). Historic data from the Arkansas River in Arkansas have been sporadically collected by the Little Rock District of the Corps of Engineers, but these data have not been summarized or interpreted clearly in any written reports. The full 308 RM of the Arkansas River in Arkansas had not been surveyed until 2004 (Erin Knoll and Tom Nupp, Arkansas Tech University, unpublished data). Monitoring was done on the western portion of the Cimarron River (from Crooked Creek to Freedom, OK) in the late 80s and early 90s (Boyd 1994); however, there has been only one complete survey of the Cimarron River from Crooked Creek to Keystone Lake (in 1992) and this survey did not cover adjacent salt flats (Hill 1993). Thus, the 2005 survey represents the first complete survey of ILT nesting areas on, or adjacent to, the Cimarron River. Similarly, part of the "Upper" Canadian River with nesting ILT (from Newcastle to Purcell, OK) was monitored between 1992 and 1998 (Byre 2000); and more lengthy airboat surveys were conducted in several years from starting points near Oklahoma City to Eufaula Lake (Appendix C); however, 2005 represents the first complete survey of all of the areas where ILT breed on the "Upper" Canadian River from Eufaula Lake west to near Canadian, Texas. In fact, 2005 represents the first time where all known breeding areas for ILT within the Arkansas River system were surveyed within the same year.

Table 7. 2005 count totals for the Arkansas River System with comparative historic data from 1986-2004. Totals for the Red River System are presented in Table 7.

Arkansas River System	2005 survey		Historic data for comparisons						
	# Adults	# colonies	Mean	SD	low	high	CV	years	missing
Arkansas River									
"Upper" Arkansas Valley Reservoirs, CO	44	6	42	13	22	66	30	1990-2004	
Quivira NWR, KS	40	2	45	15	17	68	32	1986-2004	92,98,99,01
Arkansas River near Wichita, KS	12	1	9	1	8	10	12	2000-2004	01,02
Arkansas River, Kaw Dam to Keystone Lake, OK	104	3	86	47	19	145	55	2000-2004	
Arkansas River, Keystone Dam to Muskogee, OK	496	16	455	83	355	565	55	2000-2004	Keystone-Zink
Arkansas River- Keystone Dam to Zink Lake, OK	54	1	38					1998 only	
Arkansas River- Zink Island, OK	25	1	51	31	23	93	59	2000-2004	
Arkansas River- Tulsa to Muskogee, OK	417	14	404	79	282	472	19	2000-2004	
Arkansas River, McKlellen-Kerr Arkansas Navigation System, AR	319	11	404					2004 only	
Subtotal, Arkansas River	1,015	39	1416					2004 only	
Salt Fork of the Arkansas River									
Salt Plains NWR, OK	90	8	147	51	82	240	35	1986-2004	88,97-02
Cimarron River									
Cimarron Salt Flats (2), OK	242	2	192	73	86	280	38	1989-1994	91
Little Salt Plains Salt Flats	96	1	78	22	52	110	28	1986-1994	88,91
Cargill Salt Flats, Big Salt Plains	146	1	107	58	14	174	54	1989-1994	91
Cimarron River, OK (Crooked Creek to Keystone Lake)	186	27	415					1992 only	
North Canadian River									
North Canadian River, OK	6	1						no data	
Canadian River									
"Upper" Canadian River, TX-OK (Canadian, TX to Eufaula Lake)	342	46						no data	
"Upper" Canadian River mouth at Eufaula Lake, OK	130	1						no data	
"Lower" Canadian River, east of Eufaula Lake, OK	118	2	81	21	59	107	99	1999-2004	
Subtotal, Arkansas River System	2,129	126						no previous years	

Current monitoring efforts and future considerations

The U.S. Army Corps of Engineers, Tulsa District, has conducted annual monitoring programs on the Arkansas and “Lower” Canadian Rivers in Oklahoma since the early 1990s. These programs conduct three surveys per year to provide data on adult numbers and are used to calculate productivity indices based on the maximum number of young birds observed on any survey divided by the maximum number of adults observed on any of these three surveys (USFWS 2005a). Raw data from these surveys should be entered into a centralized repository to avoid long-term data loss and to aid in future presentations and analyses of historic data. More detailed studies of reproductive success (particularly in relation to factors that cause nest failure such as predation, weather, and flooding) would be particularly instructive for this region, where flooding is hypothesized to be a major cause of nest loss (USFWS 2005a). Existing methods of calculating productivity indices for these rivers probably do not provide accurate measures of reproductive success.

As the Little Rock District of the Corps of Engineers develops an ILT monitoring plan for the McClellan-Kerr Navigation System in response to the recent Arkansas River Biological Opinion (USFWS 2005a), it is critical that, at minimum, the full 308 river miles of the Arkansas River in Arkansas is covered by annual surveys. Long-term data from Corps monitoring programs below dams and on navigation systems alone will be insufficient to monitor long-term regional trends in ILT numbers for the entire Arkansas River system since many ILT are present and not counted each year on the Cimarron and “Upper” Canadian Rivers, upstream of major reservoirs. Since movements among unmonitored rivers and monitored rivers are likely, increased survey effort on the Cimarron and “Upper” Canadian Rivers would be necessary to document regional population trends. Although the 2005 survey represented the first complete survey coverage for the entire Arkansas River system, two major breeding areas (the Cimarron River upstream of Keystone Lake) and the “Upper” Canadian River (upstream of Eufaula Lake) were surveyed by fixed-wing aircraft and aerial counts are probably less accurate than ground-based counts (Boyd 2005). If aerial counts of these areas are to be conducted in the future, more extensive ground-based surveys should be used to ground-truth (and calibrate) aerial count data. More extensive and frequent airboat surveys on these river segments would help to provide more accurate counts of ILT for these two large and important breeding areas.

Red River System

The 2005 survey and ILT distribution

In 2005, 1,821 adult ILT were counted on the Red River (Figure 10, Table 8). ILT breed on virtually the entire Red River from its headwaters at the Prairie Dog Town Fork of the Red River in the Texas panhandle to the J. Bennett Johnston Navigation system in Louisiana (Hervey 2001, Hervey 2002, Aqua-terr 2003, Gulf South Research Corporation 2005). A vast majority of both colonies and birds are on the ~410 RM of the Prairie Dog Town Fork/Red River upstream of Lake Texoma to the west and the ~373 RM of the "Lower" Red River below Denison Dam, but above the J. Bennett Johnston Waterway in Louisiana. A smaller number of ILT (51 birds at 1 colony in 2005) nest on the navigable waterway in Louisiana.

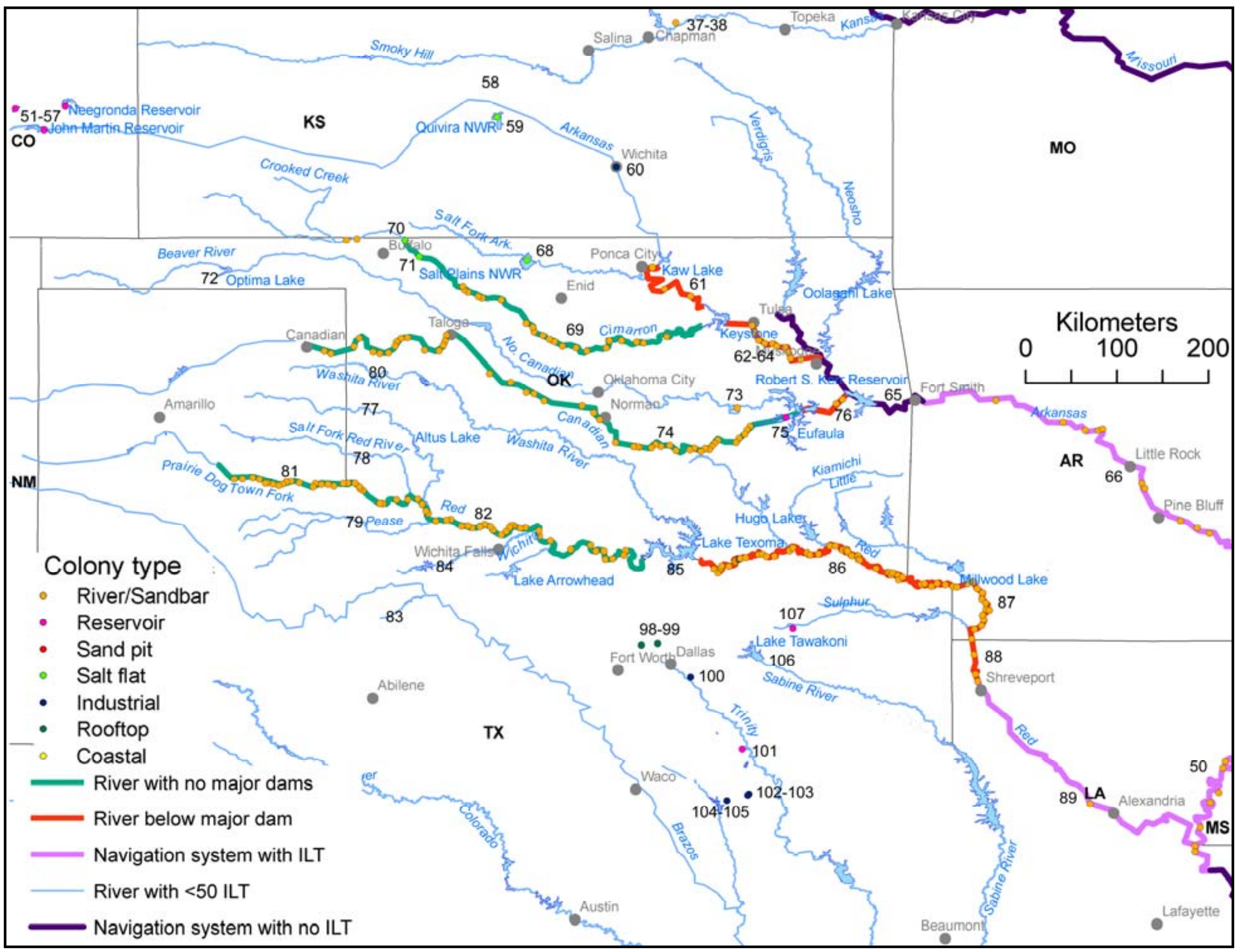

Figure 10. 2005 colony locations for the Arkansas and Red River Systems. Numbers correspond to survey segments in Appendix B.

Table 8. 2005 count totals for the Red River System with comparative historic data from 1986-2004. Totals for the Arkansas River System are presented in Table 7.

Red River System	2005 survey		Historic data for comparisons						
	# Adults	# colonies	Mean	SD	low	high	CV	years	missing
Red River									
"Upper" Red River, west of Lake Texoma, TX-OK	394	57	597					2003 only	
"Lower" Red River, Denison Dam to Red River Navigation System	1,376	66	1136	145	927	1296	13	1999-2004	
"Lower" Red River, Denison Dam to Index, AR	812	48	834	158	631	1013	19	1999-2004	
"Lower" Red River, Index, AR to Red River Navigation System	564	18	301	72	233	441	24	1999-2004	
Red River Navigation System, LA	51	1	88	37	48	135	42	1999-2004	
Subtotal, Red River System	1,821	124	1993					2003 only	

Historic data

Historic survey data for the entire Red River are virtually lacking before 1999, with the exception of a single survey in 1991 from the confluence of the North Fork of the Red River and the Red River to Lake Texoma and then downstream of Denison Dam to Index, AR (Hill 1992). Historic survey data prior to 1999 for the "Lower" Red River below Index, Arkansas, do not exist (Hervey 2001) and the importance of the Red River to the breeding distribution of ILT was virtually unknown when the USFWS recovery plan was written (USFWS 1990). In 2003, the first (and only) nearly complete ground-based survey was conducted on the entire Red River (including the Prairie Dog Town Fork) upstream of Lake Texoma (Aqua-terr 2003). In 2003, only 31 river miles from the Louisiana border to RM 244, 8.5 miles above the head of the J. Bennett Johnston Navigation System, were not surveyed. The 2005 corrected aerial count of 394 birds on the "Upper" Red River above Lake Texoma was lower than the 2003 total of 597 birds from ground-based counts (Aqua-terr 2003). This may be due to the difficulty of counting terns from the air on this stretch of river, which has a large, shallow braided channel, and loose aggregations of terns (Boyd 2005).

Current monitoring efforts and future considerations

2003 and 2005 are the only two years where nearly the entire breeding population of ILT on the Red River has been surveyed (31 RM of the

"Lower" Red River upstream of the navigation system were not surveyed in 2003). Although these areas have been covered by recent surveys, two very important reaches of the Red River are not covered by dedicated annual monitoring efforts: the ~410 RM of the "Upper" Red River above Lake Texoma and 133 RM of the "Lower" Red River in Arkansas and Louisiana between Index, Arkansas and the J. Bennett Johnston Waterway in Louisiana. This part of the "Lower" Red River is between the coverage of long-term monitoring programs of the Corps of Engineers' Tulsa District and the Vicksburg District. Similar to the situation within the Arkansas River system, incomplete survey coverage of the entire Red River makes the interpretation of long-term trends, and the evaluation of the effects of river management, difficult for this region. The "Upper" Red River upstream of Lake Texoma represents the largest breeding area across the entire range of ILT that is not covered by annual survey efforts. If additional aerial surveys of the "Upper" Red River occur in the future, more extensive ground-truthing should occur in conjunction with these surveys to determine their accuracy. Given the large size of the sandy channel of the "Upper" Red River, airboat/ATV surveys following the methods of Aqua-terr (2003) may provide more accurate survey data than aerial counts for this area.

Between 1999 and 2005, survey coverage downstream of Lake Texoma has been nearly complete from Denison Dam to Alexandria, LA, below which there are no tern colonies. However, three independent and uncoordinated survey efforts have contributed to this complete coverage. The area between Denison Dam and Index, AR, is covered by regular monitoring efforts by Gulf South Research Corporation, a contractor for the U.S. Army Corps of Engineers, Tulsa District, using similar methods to the Tulsa district's monitoring program on the Arkansas River in Oklahoma. The U.S. Army Corps of Engineers' Vicksburg District has conducted monitoring using similar protocols on the J. Bennett Johnston Waterway in Louisiana since 1999. The 133 river miles of the "Lower" Red River in Arkansas and Louisiana that are not currently covered by the Tulsa District and Vicksburg District monitoring efforts were surveyed by Hubert Hervey, a private citizen and local tern expert between 1999 and 2002 (Hervey 2002) and in 2003 and 2004 much of this area was surveyed by a graduate student at Arkansas Tech University working on his masters thesis (Luke Meduna, Arkansas Tech University, personal communication). Given the proximity of this stretch of river to many Corps-maintained reservoirs on tributaries to the Red River and the Red River Navigation system, the entire Red

River in Arkansas and Louisiana should be covered by future monitoring efforts to provide adequate data to assess the effects of these projects on ILT. Additional long-term data from this survey segment are particularly important given plans to expand the J. Bennett Johnston Waterway farther upstream (USFWS 2005b).

Rio Grande/Pecos River System

The 2005 survey and ILT distribution

In 2005, 138 ILT were counted at three reservoirs on the Pecos River (Bitter Lake NWR and Brantley Lake State Park in New Mexico and Imperial Reservoir in Texas) and a single reservoir on the Rio Grande (Amistad National Recreation Area) (Figure 11, Table 9). ILT are not known to nest on sandbars on either the Rio Grande or the Pecos River. During the 2005 census, water levels at Falcon Reservoir (a historically important nesting area for ILT on the Rio Grande) were very high during our survey window and all ILT nesting habitat was presumed to be under water (Kay Jenkins, Texas Department of Parks and Wildlife, personal communication). Therefore, surveys of Falcon Reservoir were not conducted. Additional surveys will be necessary to document if (and how many) ILT are still nesting at Falcon Reservoir.

Historic data

Historically, Least Terns have nested at six reservoirs on the Rio Grande/ Pecos River System and a single reservoir (O.C. Fischer) on the nearby North Concho River (Kasner et al. 2005) (Appendix C). Habitat conditions at Lake Casa Blanca on the Rio Grande and O.C. Fischer Reservoir on the North Concho River seem to have declined to where ILT would no longer nest, and no ILT were recorded during the ILT census at both of these locations. The 2005 count of 85 ILT at Amistad Reservoir is below average, compared to counts between 1999 and 2004, which have been variable. Large numbers of terns were counted at Falcon Reservoir in the late 1980s and early 1990s (Appendix C). However, habitat conditions have declined since then (Lee Elliot, The Nature Conservancy, personal communication) and it is unclear how many ILT are still nesting there.

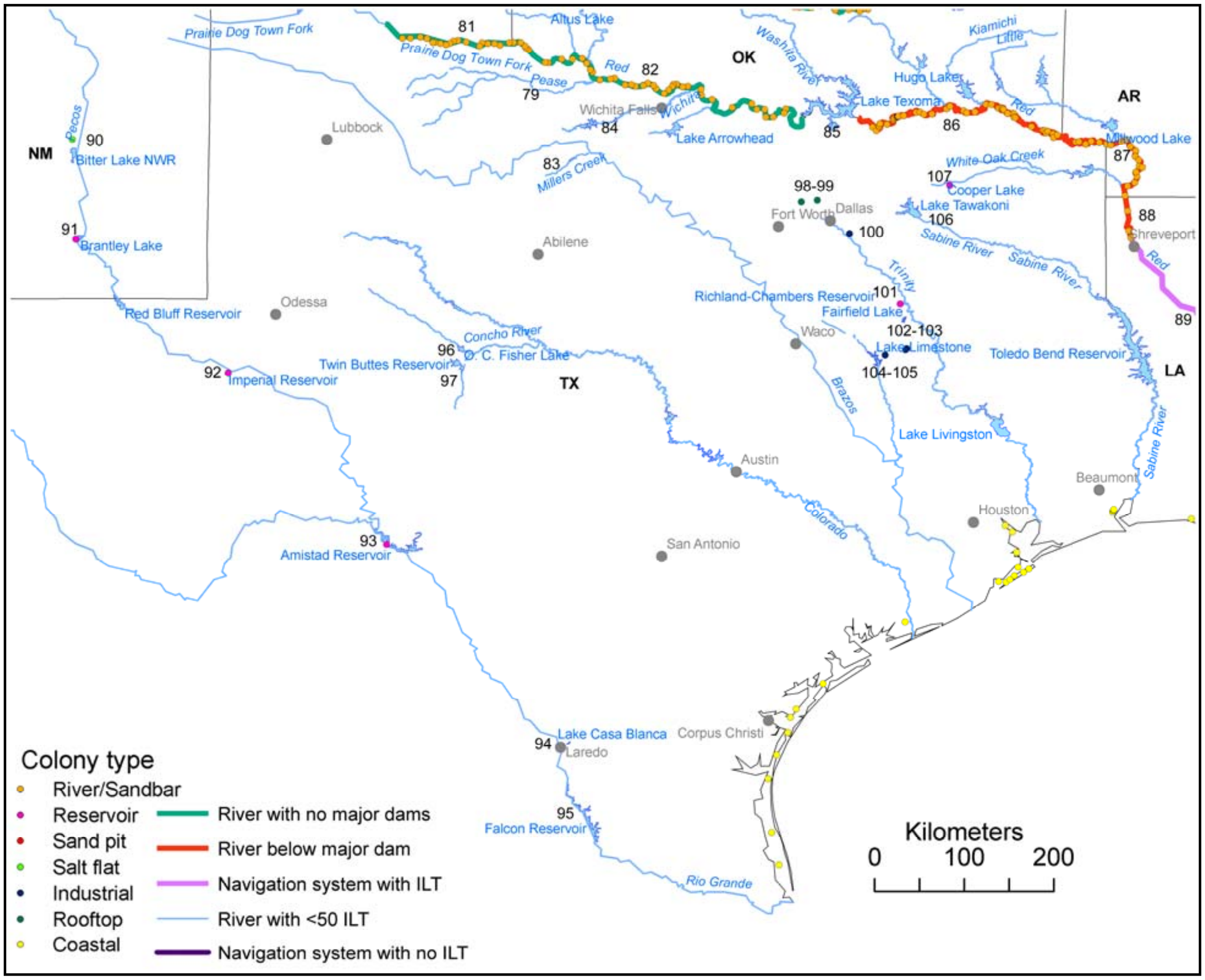

Figure 11. 2005 colony locations for Texas and New Mexico. Numbers correspond to survey segments in Appendix B.

Current monitoring efforts and future considerations

Annual monitoring takes place at the two New Mexico reservoirs, Bitter Lake and Brantley Lake (where terns have been nesting since only 2004), and at Amistad Reservoir, in Texas (since 1999). These surveys may be logistically difficult to complete due to the increased difficulty of crossing the Mexican border (which bisects the reservoir). Future surveys on both Falcon Reservoir and Amistad Reservoir may be more difficult than in the past due to increased concerns over homeland security, as both of these reservoirs include land areas in Texas and in Mexico.

Table 9. 2005 count totals for Texas and New Mexico with comparative historic data from 1986-2004.

Non-coastal Texas and New Mexico	2005 survey		Historic data for comparisons						
	# Adults	# colonies	Mean	SD	low	high	CV	years	missing
Pecos-Rio Grande Rivers									
Bitter Lake NWR	28	1	14	6	6	22	43	1987-2004	
Brantley Lake State Park	11	0						no data	
Imperial Reservoir, TX	14	1	26					1998 only	
Amistad Reservoir, TX	85	2	152	87	11	273	57	1999-2004	
Lake Casa Blanca, TX	0	0	28	19	14	50	69	1987-1989	
Falcon Reservoir, TX	ns		294	206	62	655	70	1988-89, 2000	
Subtotal, Pecos-Rio Grande Rivers	138	4	408	151	234	507	37	1988-1989, 2000	
Trinity River									
North Dallas Rooftops (2)	58	2	61	32	25	84	52	2002-2004	
South Dallas wastewater treatment and gravel pits	28	1	26	7	15	38	29	1992-2004	
Richland-Chambers Reservoir, TX	5	0						no data	
Big Brown Mine	38	2	28	10	14	44	34	1997-2004	
Jewett Mine	50	1	21	21	0	70	99	1994-2004	
Subtotal, Trinity River	179	6	141	15	128	157	11	2002-2004	
East Texas									
Cooper Lake, TX	49	2	22	21	4	50	94	1995-2004	96.01-03
Subtotal, Non-coastal Texas and New Mexico	228	8						no data	

Historic, system-wide survey totals for the Rio Grande/Pecos River systems are not directly comparable among years because of variable survey coverage. The last time that all major reservoirs were surveyed for this system was in 1989, when 482 birds were present. It is unclear whether numbers have really declined from this total to the 138 reported during the 2005 census or if this low number simply reflects the lack of survey data from Falcon Reservoir in 2005.

Trinity River System and East Texas Reservoirs

The 2005 survey and ILT distribution

In 2005, 179 ILT were counted at a number of rooftop, industrial, and reservoir locations near the Trinity River, with more than half of these observations (88) on sand tailings of two lignite mines (Figure 11, Table 9). No ILT nest on sandbars on the Trinity River itself. An additional 49 ILT were recorded at Cooper Lake, a reservoir on White Oak Creek, a tributary of the "Lower" Red River in east Texas that is closer to other Trinity River nesting sites than the Red River.

Historic data

Since the early 1990s, ILT have been documented nesting at a variety of industrial, urban, and reservoir sites in the Trinity River System (Boylan et al. 2004, Kasner et al 2005). Most of these sites were unknown when the ILT recovery plan was written (USFWS 1990). Historic data for these sites have been maintained in a regional database at the USFWS office in Arlington (Omar Bocanegra, USFWS, Arlington, personal communication). All 2005 count totals were similar to recent historic totals.

Current monitoring efforts and future considerations

Annual monitoring occurs at rooftop colonies north of Dallas, the Southside wastewater treatment plant and associated gravel pits, at two mines near the river south of Dallas, and at Cooper Lake reservoir (formerly Jim Chapman reservoir), which is east of the Trinity River. Some ILT have been banded in this region in recent years and reproductive success will be monitored at several sites in the future (Jeannette Boylan, Dallas Zoo, personal communication).

Gulf of Mexico Coast

Recent surveys and Coastal Least Tern distribution

Survey coverage for Least Terns on the Gulf Coast is incomplete, although recent coast-wide surveys have been completed for Louisiana (Zdravkovic 2005) and Mississippi (Dinsmore 2005). Recent survey totals (2003 to 2005) and recent educated guess estimates for numbers of Coastal Least Terns nesting on rooftops have been pooled in Table 10 to provide a minimum estimate of 11,400 to 12,200 Least Terns breeding on the Gulf Coast (from the Texas/Mexico border in the west to the easternmost colonies of the Florida Panhandle in Wakulla County, Florida). Counts from this portion of the Gulf of Mexico coastline are most likely minimum estimates due to incomplete survey coverage, particularly in Texas (Lee Elliot, The Nature Conservancy, Texas; Chuck Hunter, USFWS, Atlanta, personal communications). There is a distributional gap for Least Terns of approximately 200 shoreline miles along the Big Bend region of the west coast of Florida between the Florida Panhandle and colonies in Pinellas County, near Tampa Bay. Along the southwest coast of Florida, there are many rooftop colonies and some beach colonies (Gore et al. in press); however, all of these colonies are not regularly surveyed (Alex Kropp, Florida Fish and Wildlife Conservation Commission, Lakeland, personal communication). If these colonies were included here, population estimates for the Gulf Coast of Mexico coast may be considerably higher.

Historic data

The author has not completed an extensive search for historic Least Tern survey data from the Gulf Coast. Thirty years of survey data from the Texas Colonial Waterbird Census (TCWC) have been summarized recently in McFarlane (2004) and these data are available online at *http://texascoastalprogram.fws.gov*. Aside from 1973, when an abnormally huge Least Tern colony occurred near Galveston Bay, Least Tern counts from the TCWC have been relatively stable, although the distribution of colonies has shifted along the Texas Coast (McFarlane 2004). A coastal waterbird database for the Mississippi coast from 1994 to the present is maintained by the Mississippi Ornithological Society. Extensive studies of coastal Least Terns were done in coastal Mississippi in the mid-1970s to the mid-1980s, when between 8,000 and 12,000 Least Terns (two to three times the numbers reported in recent years) were counted (Jackson and Schardien-Jackson 1985). Least Tern colonies in coastal Florida were counted during a three-year statewide coastal seabird survey between 1998 and 2000. However, the total number of adults at rooftop colonies was not counted during this survey, only the presence of rooftop colonies. An average of 1,544 Least Terns was nesting on Panhandle beaches between 1998 and 2000 (Gore et al. in press). Recent surveys suggest that few Least Terns are nesting on panhandle beaches and most Least Terns on the Florida Panhandle coast are now nesting on rooftops (Patty Kelly, USFWS, Panama City, personal communication).

Current monitoring efforts and future considerations

Only the Texas coast and the coastline of the Florida panhandle are currently covered by extensive survey efforts for Least Terns. Even so, survey coverage of these areas is incomplete due to the difficulty of covering huge stretches of coastline and incomplete survey coverage for rooftop colonies (Lee Elliot, Nature Conservancy, San Antonio; Jeff Gore, Florida Fish and Wildlife Conservation Commission, Panama City, Florida; Allan Mueller, The Nature Conservancy, Arkansas; personal communications). It is unclear how Hurricanes Katrina and Rita have affected Least Tern breeding habitat on the Gulf Coast. Hurricanes can be positive habitat creation events for Least Terns as vegetation is cleared and new early-successional habitat may be created; however, most Least Terns nest on nourished beaches in coastal Mississippi (Dinsmore 2005) and many of these beaches were reduced in size by Hurricane Katrina.

A Least Tern chick that was originally banded on the Texas coast was later found breeding at Quivira National Wildlife Refuge in Kansas (Boyd and Thompson 1985) and Boyd and Sexson (2004) documented ILT dispersal from the Kansas River in Kansas to breeding areas on the Wabash River in Indiana (455 miles) and the Mississippi River in Arkansas (445 miles). Many Coastal Least Tern colonies are within 100 to 400 miles of major ILT breeding populations on the “Lower” Mississippi and “Lower” Red Rivers. Currently, the extent to which Interior and Gulf Coast Least Tern populations are linked is unknown; however, ongoing genetic studies may be able to provide data on rates of exchange among coastal and interior populations (Hope Draheim, Oregon State University, personal communication). If exchange between these populations is common, incomplete survey coverage for the Gulf Coast may make it difficult to interpret population trends for ILT, particularly in the southern portion of their range. Increased survey effort for Least Terns on the Gulf Coast would be very welcome, particularly after such a large habitat change event as the 2005 hurricane season.

Table 10. Recent survey data (and estimates) for Least Tern populations on the Gulf of Mexico.

Gulf of Mexico Coast	Recent Survey Data		
	# Adults	Year	Source
Texas, subtotal	1,538 (min.)	2003	Texas Colonial Waterbird database, unpublished data
Coastal	1,498	2003	Texas Colonial Waterbird database, unpublished data
Rooftop	42	2003	Texas Colonial Waterbird database, unpublished data
Louisiana, subtotal	2,262-2,862	2005	combination of sources below
Coastal	2,062	2005	Zdravkovic (2005)
Rooftop	200-800	guess	Chuck Hunter, USFWS, personal communication
Mississippi, subtotal	4,400-4,600	2004	combination of sources below
Coastal	4,184	2004	Mississippi Coastal Waterbird database, MS Ornithological Society
Rooftop	200-400	guess	Chuck Hunter, USFWS, personal communication
Alabama, subtotal	1,000	guess	Roger Clay, Alabama DCNR, personal communication
Coastal	667	guess	Roger Clay, Alabama DCNR, personal communication
Rooftop	333	guess	Roger Clay, Alabama DCNR, personal communication
Florida panhandle (east to Wakulla Co.)	2,200	2005	unpublished data, Florida Fish and Wildlife Conservation Commission
Coastal	?	2005	unpublished data, Florida Fish and Wildlife Conservation Commission
Rooftop	majority of total	2005	unpublished data, Florida Fish and Wildlife Conservation Commission
Subtotal, Gulf of Mexico coast	11,400-12,200	2003-2005	above sources combined

7 Discussion and Recommendations

Distribution and abundance of Interior Least Tern breeding populations

The 2005 range-wide survey provides the first complete summary of the distribution and abundance of the interior population of the Least Tern, since the ILT was originally listed as endangered 20 years ago (USFWS 1985). The 2005 survey, in conjunction with the summaries of previous Least Tern surveys from both the Interior and the Gulf Coast provided in this report, provides a baseline for future studies of the range-wide distribution and abundance of ILT and the development of a range-wide monitoring program. An important initial requirement for developing an effective range-wide monitoring program for any colonial waterbird is to have sufficient information about the distribution of colonies across the entire range of the study population (Steinkamp et al. 2003). This information has not been available for previous range-wide summaries of the distribution and abundance of ILT (USFWS 1990, Kirsch and Sidle 1999, USFWS 2003, USFWS 2005a). In fact, given the incomplete nature of historic survey data for ILT, the 2005 survey most likely represents the first time that distribution or relative abundance across the entire ILT population has ever been described.

The 2005 count of 17,591 interior Least Terns is considerably higher than the minimum estimate of 11,400-12,200 Least Terns on the Gulf Coast (Texas to the Florida Panhandle) although the Gulf Coast estimate is most likely biased low due to incomplete survey coverage in most states. Recently, estimates for Atlantic Coast Least Tern numbers were included in regional conservation plans of the Waterbird Conservation for the America's partnership (*http://www.waterbirdconservation.org/regional/*). The estimated number of Least Terns in the Northeastern US is 16,018 individuals and the estimate for the southeastern coastal plain is 10,150 pairs (or a minimum of 20,300 individuals). This includes an estimate of 8,000 individuals in Florida. Removing the 2,200 individuals from the Florida Panhandle from this estimate that are accounted for in the Gulf Coast estimate above, produces a final estimate of at least 42,118 individual Least Terns on the Atlantic Coast (Maine to southwest Florida). A statewide count of California Least Terns in 2005 produced an estimate of

6,865-7,341 pairs, or a minimum count of 13,730-14,682 adults (Marschalek 2005). Combining all of these estimates, the minimum number of adult Least Terns present during the breeding season in the United States is somewhere between 84,839 and 86,591. This is considerably higher than the most recent estimate of at least 55,000 Least Terns breeding in the U.S. (Thompson et al. 1997). The discrepancy between these numbers likely reflects the better survey coverage of the data reported in this document, not an actual population increase. This estimate does not include counts of Least Terns in nearby breeding areas in Mexico or the Caribbean that may be part of the same meta-population.

Now that all ILT breeding areas have finally been surveyed, it is still clear that the "Lower" Mississippi River is the most important breeding area for the Interior Least Tern (Kirsch and Sidle 1999) and more than 62 percent of all ILT occur on the "Lower" Mississippi. ILT counts on the Mississippi River increased nearly 500 percent between 1986 and 2005. Most ILT on the Mississippi River nest on sandbars that are created as river sediments settle out within dike fields. Since early in the 20th century, the Corps has constructed over 1 million linear feet of dikes on the Mississippi River (John Rumancik, U.S. Army Engineer District, Memphis, unpublished data). During the time period between 1986 and 2004, when ILT numbers increased on the Mississippi, the pace of dike construction was slowing down (averages of 20,649 feet of dike constructed per year between 1975 and 1984; 18,054 feet/year between 1985 and 1994; and 10,881 feet/year between 1995 and 2004), so increases in ILT numbers on the Mississippi may not be related to increased sandbar habitat availability. The absence of long-term survey or productivity data for other important breeding areas for Least Terns near the Mississippi River (most of the Gulf of Mexico coast; the Red and Arkansas River systems in Oklahoma, Arkansas, and Louisiana) make it impossible to know if the increase of ILT on the Mississippi is due to local population processes or immigration from other breeding areas. It is also possible that at least a portion of count increases on the Mississippi River may be due to increased surveyor efficiency between 1988 and 2005 (Ken Jones, Dyersburg State Community College, personal communication).

In a long-term study of Roseate Tern (*Sternula dougallii*) meta-population dynamics, local population trends were often driven by immigration and emigration (Lebreton et al. 2003). Kirsch and Sidle (1999) proposed that increases on the Mississippi River may be related to high productivity on the Gulf of Mexico coast. However, between the mid-1980s and 2005, Least Tern populations on the coast of Mississippi declined 100 to 200 percent (see Regional Results for the Gulf Coast). Given the current high levels of human disturbance on Gulf Coast beaches, an alternative hypothesis to explain population increases on the Mississippi River may be that adult Least Terns are abandoning the Gulf Coast and emigrating to breed on the Mississippi River. Given the long distances that ILT are known to disperse (Boyd and Sexson 2004), movements among survey segments within the breeding range may occur regularly for ILT and this population may need to be conceptualized as a large meta-population, which may include (to an unknown degree) breeding populations of Least Terns on the Gulf Coast.

Outside of the “Lower” Mississippi River, ILT are most abundant on a number of riverine stretches of the Arkansas and Red River systems. Unfortunately, ILT on many of these river segments have been infrequently surveyed or studied, although this trend may be changing (see Leslie et al. 1997, Urbanic 2003, USFWS 2005a, and Knoll 2006 for the Arkansas River; and Hervey 2001, Aqua-terr 2003, Gulf South Research Corporation 2005, and Meduna 2006 for the Red River). The importance of the Red River to ILT was not known when earlier large-scale summaries of ILT distribution were compiled (USFWS 1990, Kirsch and Sidle 1999). Extensive surveys since 1999 have demonstrated that more ILT breed on the Red River than on any other river other than the Mississippi (USFWS 2005a, USFWS 2005b). Nearly 600 ILT were counted on the “Upper” Red River (including the Prairie Dog Town Fork) upstream of Lake Texoma in 2003 (Aqua-terr 2003). This was the first time this portion of the Red River had ever been completely surveyed and there are no known plans for future regular counts of this important breeding area. ILT are also abundant on the “Lower” Red River below Denison Dam; however, they become uncommon on the Red River Navigation System where many nesting sandbars were inundated during the construction of the navigation system and remaining sandbars are becoming unsuitable for nesting due to vegetative succession (Hervey 2001, USFWS 2005b). Within the Arkansas River system, ILT are abundant below dams on the Arkansas and “Lower” Canadian Rivers and upstream of major reservoirs on the Cimarron and “Upper” Canadian Rivers (USFWS 2005a). Important breeding populations on the Cimarron and “Upper” Canadian are infrequently surveyed. The lack of regular survey efforts on these important rivers for ILT, and of important nearby breeding populations on the Gulf of Mexico, may make it difficult to analyze or interpret long-term population trends for ILT. Although the Missouri and Platte River systems have received extensive monitoring and research attention for many years, survey coverage is still incomplete for these regions and important breeding populations on the Niobrara, Loup, and Elkhorn Rivers are not surveyed annually. Increases in survey coverage for the important breeding areas should be a priority for long-term monitoring of ILT populations.

ILT counts and population trends

Although this survey will provide a foundation to focus future range-wide monitoring efforts for ILT, it is only a starting point. With improved range-wide survey coverage, long-term adult counts should provide a means of tracking shifts in the breeding distribution of ILT over time. However, a frequently cited objective of monitoring efforts is to track long-term population trends. Aside from the need to improve survey coverage, four additional methodological and data management issues remain to be addressed before ILT count data will provide reliable data for analyses of range-wide population trends. First, the target metric for long-term, range-wide population trend analyses should be agreed upon by all surveyors. The total number of adults within the entire survey area during the survey window is reported here. In the future, it may also be useful to summarize results by number of nesting pairs counted during the survey window, if this information is collected by enough survey crews. Second, counts from all survey segments should take place within a narrow survey window to minimize the chance of double-counting as individual birds move among survey segments within the same season. Third, the relative accuracy (direction and magnitude of bias) in count data from different programs should be assessed through the estimation of detection ratios so that local counts can be translated into comparable estimates of population size that include estimates of error. Fourth, count data from individual monitoring programs must be contributed to a central database for long-term data storage (Lott 2006).

Historic ILT count data generally represent one of three different quantities: an “adult census” total, a “maximum seasonal” total, or a “single trip” total. Adult census totals reflect the total number of adult birds counted within a standard survey window (e.g., the last two weeks of June). Although the term “census” is not technically appropriate for many of these counts due to the difficulty of accurately counting all birds and/or visiting all sites within most survey areas, it is retained here to avoid confusion with past studies (Thompson 2002). The "maximum seasonal" total is the number that is reported by monitoring programs that conduct multiple visits across the entire ILT breeding season (with a variable number of visits among programs) and then report the maximum number of adults counted during any one visit as their annual count. Finally, some monitoring programs may conduct only a single count per year and this count may not be scheduled for a specific, date-focused survey window. For example, annual counts on the Mississippi River (and some other areas) are scheduled to correspond with peak incubation, predicted by water levels. The timing of "single trip" counts in other areas may be driven by other logistics, such as availability of boats or personnel.

The maximum number of ILT actually present in any one survey area may occur on different dates in different years in relation to habitat conditions or water levels. Therefore, peak tern numbers do not always coincide with pre-defined survey windows or the dates of single trip surveys. This confounds comparisons of totals among monitoring programs that report different types of annual totals. Many local monitoring programs report maximum seasonal totals because they more effectively document how many birds use a local area (e.g., a colony, a single reservoir, a short stretch of river) within a given season than adult census counts, which frequently underestimate this quantity. However, at regional or larger scales, reporting the maximum seasonal total for different sites when this total occurs on different dates for each site most likely leads to double-counting individuals that move among survey segments within the same season. Thus, regional count totals are inflated if maximum seasonal totals are summed across multiple sites.

At regional or range-wide scales, reporting count totals from ALL survey segments within a narrow survey window probably provides the best means to reduce double-counting. A preferred course of action for historic data summaries would be to report both adult census counts and maximum seasonal totals when both of these numbers are available, since adult census counts minimize double-counting in regional analyses and maximum seasonal totals most effectively document season-long use of an area. Historic ILT annual count data tables frequently report only a single count total for each year for each survey segment. The type of count represented by this total (annual census, maximum seasonal count, or single trip total) is often not reported. This may be one reason for discrepancies among publications in adult count totals as some publications report adult census totals and others report maximum seasonal totals for the same survey area.

For the sake of documenting range-wide population size and trends, holding counts for all survey segments within a pre-specified survey window is probably the best way to minimize the chance of double-counting birds that may move among survey segments within the same breeding season. Timing of this survey window is critical. Ideally, counts should take place when the maximum numbers of adults are incubating eggs. This is the time period where breeding populations are most stable, movements of adults among survey segments are minimal, and counts should be of breeding birds and not migrants. The timing of peak incubation varies among areas and years depending on water levels. There is also variation in timing of peak incubation, up to several weeks, within a stretch of river within a year. Choosing a standard, range-wide survey window for ILT is complicated by the fact that ILT counts on the Mississippi River usually occur later in the season than counts at all other locations. A survey window in mid to late June would capture peak incubation for most population segments in most years. However, sandbars are often not exposed on the Mississippi until mid-July or early August (by which time reproduction on most other rivers is finished). With more than 62 percent of all ILT nesting on the Mississippi River, it may be advisable to conduct adult counts on all locations other than the Mississippi during a standard two-week survey window in late June and to conduct ILT counts on the Mississippi as soon as water levels drop below a threshold that allows for effective surveys. Thus, Mississippi River surveys may coincide with the range-wide survey window in some years, but not others.

For all current and historic ILT annual count data, the accuracy of counts and the direction and magnitude of count bias are unknown. One type of bias that limits comparisons of ILT numbers among monitoring programs is that associated with detection ratios (e.g., the number of birds counted at a site compared to the number of birds that are actually present) (Thompson 2002). An estimation of this ratio is necessary to convert annual counts, which should be currently viewed as indices of the numbers of birds present, to actual estimates of population size (Bart and Earnst 2002). Long-term comparisons of index counts within single monitoring programs may be possible if count methods and survey coverage have not changed dramatically among years. However, regional or range-wide analyses of population trends that do not account for potential bias in different types of count data collection among monitoring programs are likely to provide questionable results (Bart et al. 2004) because differences in survey methods among survey segments can result in count variation that is related to survey methodology, not the underlying population processes that long-term counts are designed to measure (Anderson 2002).

Differences in methods among monitoring programs could be addressed in future surveys through some combination of standardization of methods and/or double-sampling (Thompson 2002). Standardization of methods seems unlikely due to the large existing variation in count methods used among ILT monitoring studies and the wide range of logistical situations confronting ILT surveyors range-wide. Another possibility would be to employ programmatic double-sampling to document the relative bias of individual counts and develop detection ratios that could be used to standardize results among surveyors (Bart and Earnst 2002). In this method, all sites would continue to use the original count protocols that they have used since the beginning of their monitoring programs. This way, future counts from individual programs remain comparable with counts from past years. At a subset of sites from each of these programs, however, much more intensive counts would be conducted that are designed to detect as close to 100 percent of all individuals as possible. A standardized methodology would need to be developed for intensive counts at all sites. Original count methods would not need to be standardized (Bart and Earnst 2002). Next, totals from original counts would be compared with totals from intensive counts to quantify the detection ratio of original counts to intensive counts. This ratio estimator would then be used to correct all original counts for bias. This method corrects equally for bias in individual counts that employ different methods; allowing bias-corrected counts to be summed across multiple sites to create an essentially unbiased estimate of population size for a region. This method has the additional advantage of being able to provide an estimate of count error (Bart and Earnst 2002). Such detection ratios have not been estimated for any of the count methods used by current monitoring programs for ILT.

For Interior Least Terns, as for many other species, poor long-term data storage and management may undermine confidence in analyses of long-term population trends (Bart 2005). Since count data are expensive to collect and cannot be re-collected in retrospect, greater responsibility should be taken to preserve historic and future monitoring data in a central repository to avoid similar problems in the future. In consolidating historic data for this report, it became clear that some regional repositories of historic data, such as those for the Missouri River (at the Omaha District of the U.S. Army Corps of Engineers), the Platte River and tributaries (at the Nebraska Game and Parks Commission [NGPC]), and the Arkansas River system (at the USFWS and U.S. Army Corps of Engineers offices in Tulsa, Oklahoma) need to be proofed and discussed more thoroughly by local experts and data contributors so that inconsistencies may be resolved and consensus may be reached regarding historic data. The summary of historic data presented in this report will undoubtedly be revised in this process, which will make this document inconsistent with future summaries. Therefore, this compilation of historic data (as well as all previous summaries) should not be viewed as definitive, but rather, as a thoroughly researched starting point for more detailed local and regional discussions related to the revision of, and hopefully agreement on, historic data. A worthwhile goal would be to come to consensus on a single version of historic count totals for ILT and then commit these totals to a single centralized database for long-term data storage (see *http://el.erdc.usace.army.mil/leasttern/*).

Adult counts and the conservation status of ILT populations

Although this document focuses exclusively on breeding-season counts of adults, these counts (such as the 2005 range-wide survey) are only one element of an effective monitoring program that is designed to provide information regarding the conservation status of ILT (Lott 2006). Additional studies of demographic rates (such as productivity, survival, or movement rates among breeding areas) will be necessary to model population dynamics or to evaluate the effects of different management scenarios on ILT populations (International Association of Fish and Wildlife Agencies (IAFWA) 2004). Although some ongoing monitoring programs collect information on ILT reproductive success, data collection and analysis methods vary strongly among programs. Further review of demographic data is beyond the scope of this report, but a critical review of data on reproductive success, estimates of survival and movement rates, and approaches to population modeling for ILT will be another necessary step toward the development of a range-wide monitoring program.

Finally, ILT were originally listed as endangered due to concerns about management-related habitat loss and/or degradation on highly regulated rivers of the interior United States (USFWS 1985, 1990). Pressures on these rivers have not decreased since ILT were listed (USFWS 2003, 2005a, 2005b). Therefore, long-term monitoring of ILT populations will need to move beyond simply counting birds to track population trends or collecting demographic data for population modeling (both important tasks that present significant challenges). In order to truly assess the conservation status of ILT (particularly in relation to the effects of management on nesting habitat, numbers, or reproductive success) a monitoring program will need to be developed that is designed to test competing hypotheses about interactions among river management, habitat conditions, and the underlying factors that limit ILT breeding populations (such as the availability of suitable nesting habitat or reproductive failure due to flooding, predation, human disturbance, or other causes).

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Appendix A: Interior Least Tern Working Group and Monitoring Program Mission Statement

The Interior Least Tern (ILT) Working Group (WG) is a multi-agency group that is dedicated to improving the collection, storage, analysis, and dissemination of high-quality monitoring data regarding ILT populations. Representatives of this group come from four U.S. Fish and Wildlife Service regions, eleven U.S. Army Corps of Engineers districts, several U.S. Geological Survey science centers, twelve State wildlife agencies, several universities, and several non-government organizations. A full list of WG members with their affiliations is included below. This working group has received letters of support from the U.S. Fish and Wildlife Service Regional Director for the recovery lead region for Interior Least Tern and the U.S. Army Corps of Engineers Chief of Operations.

The three main guiding principles of this group are 1) inclusiveness; 2) open communication, and 3) dedication to a high standard of scientific credibility. The WG will work together to create a range-wide ILT monitoring program. The goal of this program will be to provide high-quality monitoring data to allow for the accurate assessment of regional and range-wide ILT population numbers and trends. We recognize fully that ILT monitoring takes place at a large number of different scales and locations and for a range of purposes (e.g., minimizing take under the Endangered Species Act [ESA], scientific research, evaluating the effects of a specific management action). Therefore, a range-wide ILT monitoring program will not replace local monitoring programs, but rather incorporate them into a larger-scale effort so that results of local monitoring programs can be better evaluated in a regional or range-wide context.

An ILT Monitoring Program Coordinator will work closely with a ten-member Executive Committee that is composed of WG members to design and implement a range-wide ILT Monitoring Plan (the Plan). There will be mechanisms for incorporating comments from the entire WG throughout this process. Development of the Plan will be an iterative process that will take place over the next few years. The Plan will provide goals and objectives for a range-wide monitoring program and will synthesize all information regarding current and historic range-wide monitoring data collection. This will require the assistance of WG members to connect the Coordinator with all contacts engaged in the collection of monitoring data. A final draft of the Plan (incorporating comments from the entire working group) will receive independent peer review coordinated by the U.S. Monitoring Working Group of the North American Bird Conservation Initiative (NABCI).

A Web-accessible database has been developed to centralize storage of range-wide monitoring program data, greatly improving the availability of data and ease of analyses (*http://el.erdc.usace.army.mil/leasttern/*). This database was designed to meet the needs of diverse monitoring programs and it is hoped that by the 2006 (or 2007 at the latest) breeding season all parties collecting monitoring data for ILT will be contributing their data to this centralized data repository. This database will be designed to store spatially explicit data so that results can be summarized and presented using geographic information systems (GIS).

After the breeding season of 2005, the Coordinator will begin producing annual reports that summarize range-wide monitoring program results. The first of these reports will summarize the results of the first ever range-wide ILT census that was conducted during the 2005 breeding season. More detailed analyses of range-wide status and trends will be performed at five-year intervals. All WG members will have one month to review and provide comments on the annual report and two months to provide comments on five-year synthesis reports. Once these comments have been incorporated, final reports will be produced and provided to the WG for dissemination across networks of contacts with interests in ILT population status and trends. Five-year synthesis reports will also receive independent peer review through NABCI.

Given the strong agency representation of the WG, it is expected that range-wide analyses of ILT monitoring program data will be consulted and that monitoring program data will be available for future agency activities such as 1) revision of the ILT recovery plan if this is necessary; 2) range-wide status assessments for ILT; 3) ESA consultations regarding specific projects; and 4) the preparation of biological assessments and biological opinions.

Interior Least Tern Working Group Member List

Updated September 27, 2006

Total of 91 members representing 11 Corps districts, 4 USFWS regions, 14 state wildlife agencies, 8 academic institutions, 4 USGS science centers, 3 Joint Ventures, and several non-profits.

Executive committee: 11 people

- Carol Aron, USFWS Region 6/South Dakota Game, Fish, and Parks
- Rich Fischer, USACE Engineer Research and Development Center
- Eileen Kirsch (Chair), USGS, Upper Midwest Environmental Sciences Center
- Casey Kruse, USACE Omaha District
- Jane Ledwin, USFWS Region 3 (recovery lead office)
- Lindsey Lewis, USFWS, Region 4, Arkansas
- Casey A. Lott, American Bird Conservancy (ILT monitoring coordinator)
- David Pashley, American Bird Conservancy
- Sandy Stiles, USACE Tulsa
- Kevin Stubbs, USFWS Region 2
- Martha Tacha, USFWS Region 6

Working group: 80 people

- Lindsay Addison, Florida Gulf Coast University
- Stacy Adolf-Whipp, USFWS, Region 6, Arrowwood Wetland District
- Eric Baka, Louisiana Department of Wildlife and Fisheries
- Jonathan Bart, USGS, Snake River Field Station
- Randy Becker, USACE Little Rock District
- Roger Boyd, Baker University
- Jeanette Boylan, Dallas Zoo
- Christopher Brantley, USACE New Orleans District
- John Cannon, USACE St. Louis District
- John Castrale, Indiana Division of Fish and Wildlife
- Lyann Comrack, California Dept. of Fish and Game
- Glenn Covington, USACE Kansas City District
- Mark Czaplewski, Central Platte Natural Resources District
- Clayton Derby, Platte River Cooperative Agreement
- Arnold Dood, Montana Fish, Wildlife, and Parks

- Mark Doles, USACE Fort Worth District
- Hope Draheim, Oregon State University
- Wade Eakle, USACE South Pacific Division
- Aron Flanders, Texas Parks and Wildlife, Cooper Lake
- Jane Fitzgerald, ABC- Central Hardwoods Joint Venture Coordinator
- Greg Garetz, NPS- Amistad National Recreation Area
- Gypsy Gooding, USFWS- North Louisiana Refuges Complex
- Champe Green, USACE Albuquerque District
- Michael Guilfoyle, USACE Engineer Research and Development Center
- Sue Haig, USGS Forest and Rangeland Ecosystem Science Center
- Lou Hanebury, USFWS- Billings Field Office
- Renae Held, University of Nebraska, Lincoln
- Hubert Hervey, Louisiana, LSU, Museum of Life Sciences
- Mark Howery, Oklahoma Department of Wildlife Conservation
- Coral Huber, USACE Omaha District
- John Hughes, USFWS, Canadian, TX Field Office
- Jerry Jackson, Florida Gulf Coast University
- James Jenniges, Nebraska Public Power District
- Ken Jones, Dyersburg State Community College
- Joel Jorgensen, Nebraska Game and Parks Commission
- Andy Kasner, Lamar State University, Texas
- Patty Kelly, USFWS, Panama City, Florida
- Linda LaClaire, USFWS, Region 4
- Gary Lester, Louisiana Natural Heritage Program
- Bob McFarlane, McFarlane and Associates
- Larry Marcy, USACE Vicksburg District
- Daniel Marschalek, California Dept. of Fish and Game
- Lynn Martin, USACE, Institute for Water Resources
- Johnny Mclean, USACE Little Rock District
- Mike Miller, Texas Parks and Wildlife
- Allan Mueller, USFWS, Region 4, Arkansas
- Thomas Nupp, Arkansas Tech University
- Kate O'Brien, USFWS, Rachel Carson National Wildlife Refuge
- David Oliver, USACE Vicksburg District
- Brent Ortego, Texas Parks and Wildlife Department
- Brainard Palmer-Ball, Jr., Kentucky State Nature Preserves Commission
- Greg Pavelka, USACE Omaha District
- Mark Peyton, Nebraska Public Power and Irrigation District
- Rochelle Renken, Missouri Department of Conservation

- Bruce Reid, Audubon Mississippi
- Karen Rowe, Arkansas Game and Fish Commission
- John Rumancik, USACE Memphis District
- Christopher Rustay, Playa Lakes Joint Venture
- Monica Schwalbach, South Dakota Game, Fish, and Parks
- Brad Semel, Illinois Department of Natural Resources
- Terry Shaffer, USGS, Northern Prairies Wildlife Research Center
- Ron Shepperd, USFWS Salt Plains NWR
- Mark Sherfy, USGS, Northern Prairies Wildlife Research Center
- Marsha Sovada, USGS, Northern Prairies Wildlife Research Center
- Maryetta Smith, USACE Mississippi Valley Division
- Jerry Sturdy, USACE Tulsa District
- Martha Tacha, USFWS, Grand Island, NE
- Matt Tanner, HDR Inc.
- Bob Van Hoff, USACE Louisville District
- Bill Vermillion, USFWS, Gulf Coast Joint Venture
- Mike Ward, Illinois Natural History Survey
- Michael Watkins, USACE Kansas City District
- Heather Whitlaw, Texas Parks and Wildlife
- Jim Widlak, USFWS, Tennessee
- Sandy Williams, New Mexico Department of Game and Fish
- Erika Wilson, University of Nebraska, Kearney
- Randy Wilson, USFWS, Lower Mississippi Joint Venture
- Stephen Wilson, National Park Service: Niobrara National Scenic River and Missouri National Recreational River
- Nick Winstead, Mississippi Wildlife, Fisheries, and Parks
- Margo Zdravkovic, National Audubon Society

Appendix B: Complete List of Interior Least Tern Survey Segments

A complete list of survey segments (with corresponding GS#) for the 2005 range-wide survey follows. Bolded entries represent areas where totals for several survey segments were reported together. NS = not surveyed. TB = totaled below, where survey segment total is part of summarized total. RM = river mile(s), SM = shoreline miles, and AC = acres.

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
1		1	Missouri River- Ft. Peck Lake, MT	0	0	Missouri	Reservoir	yes	170	SM	Eastern third of shoreline from Ft. Peck Dam
2		2	Missouri River- Ft. Peck River Reach, MT	34	5	Missouri	River	yes	203	RM	Fort Peck Dam (RM 1771) to Lake Sakakawea (RM 1568)
3		3	Yellowstone River, MT	16	2	Missouri	River	yes	181	RM	Miles City, MT (RM 181) to confluence with Missouri River (RM 0)
4		4	Missouri River- Lake Sakakawea, ND	26	5	Missouri	Reservoir	yes	350	SM	Mouth of Ft. Peck River (RM 1568) to Garrison Dam (RM 1389)
5		5	Missouri River- Garrison River Reach, ND	199	20	Missouri	River	yes	84	RM	Below Garrison Dam (RM 1389) to head of Lake Oahe (~RM 1304)
6		6	Missouri River- Lake Oahe, SD	89	12	Missouri	Reservoir	yes	470	SM	Shoreline from mouth of Garrison River (~RM 1305) to Oahe Dam (RM 1090)
7		7	Cheyenne River, SD	4	1	Missouri	River	yes	100	RM	Confluence with Belle Fourche River to confluence with Missouri River
8		8	Lake Sharp, SD	0	0	Missouri	Reservoir	no	80	RM	To Big Bend Dam
9		9	Lake Francis Case, SD	4	0	Missouri	River	yes	76	SM	White River confluence (RM 956) to Ft. Randall Dam (RM 880)
10		10	Missouri River- Ft. Randall River Reach, SD	76	5	Missouri	River	yes	36	RM	Ft. Randall Dam (RM 880) to confluence with Niobrara River (RM 844)
11		11	Niobrara River, NE (National Scenic River, Norden to HWY 137)	15	2	Missouri	River	yes	40	RM	Norden, NE (RM 120) to HWY 137 bridge (RM 80) north of Newport, NE
11		12	Niobrara River, NE (HWY 137-Spencer Dam)	190	8	Missouri	River	no	40	RM	HWY 137 bridge (RM 80) north of Newport, NE to Spencer Dam (RM 39.4)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
11		13	Niobrara River, NE (Spencer Dam- National Recreational river boundary)	*tb*		Missouri	River	no	19	RM	Spencer Dam (RM 39.4) to National Recreational River boundary (RM 20)
11		14	Niobrara River, NE (National Recreational River unmonitored reach)	*tb*		Missouri	River	no	5	RM	National Recreational River boundary (RM 20) to RM 15
11		15	Niobrara River, NE (National Recreational River monitored reach)	*tb*		Missouri	River	yes	15	RM	RM (15) to confluence with Missouri River
11		**13-15**	**Niobrara River, NE (Spencer Dam- confluence with Missouri River)**	**84**	**5**	Missouri	River	partial	39	RM	Full segment covered only in IPP census years
12		16	Lewis & Clark Lake, SD-NE (Niobrara River delta)	4	1	Missouri	River	yes	18	RM	Niobrara confluence (RM 844) to Charley Creek (RM 826)
13		17	Missouri River- Gavins Point Reach, SD-NE	476	25	Missouri	River	yes	58	RM	Gavins Point Dam (RM 811) to Ponca State Park (RM 753)
14		18	Mid-American Energy Plant near Sioux City, IA	0	0	Missouri	Industrial	no			Fly-ash deposits
15		19	Lake McConaughy, NE	32	4	Platte	Reservoir	yes	39,000	AC	Entire shoreline
16		20	North Platte River Sandpits, NE	0	0	Platte	Sand Pits	yes	1	Pits	One pit at Lewellen, no historic nesting
17		21	South Platte River Sandpits, NE	0	0	Platte	Sand Pits	no	4	Pits	South Platte River from Ogallala to North Platte, NE
18	a	22	“Upper” Platte River (Central Diversion to J-2 return in Lexington, NE)	ns		Platte	River	no	67	RM	Central Diversion in North Platte, NE (RM 314) to J-2 Return in Lexington (RM 247)
18	b	23	"Upper" Platte River Sandpits (North Platte to Lexington, NE)	20	1	Platte	Sand Pits	yes	9	Pits	North Platte, NE to Lexington, NE
19	a	24	"Central" Platte River 1 (J-2 Return to Kearney Canal Diversion, NE)	*tb*		Platte	River	yes	18	RM	J-2 Return at Lexington (RM 247) to Kearney Canal Diversion (RM 229)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
19	a	25	"Central" Platte River 2 (Kearney Canal Diversion to Chapman, NE)	*tb*		Platte	River	yes	72	RM	Kearney Canal Diversion (RM 229) to Chapman, NE (RM 157)
19	a	26	"Central" Platte River 3 (Chapman, NE to Columbus, NE)	*tb*		Platte	River	?	52	RM	Chapman, NE (RM 157) to Columbus, NE (RM 105)
19	a	**24-26**	**"Central" Platte River (J-2 Return near Lexington to Columbus, NE)**	**3**	**0**	Platte	River	partial	142	RM	Lower segment (Chapman to Columbus) has inconsistent coverage
19	b	27	"Central" Platte River Sandpits 1 (Lexington to Chapman, NE)	*tb*		Platte	Sand Pits	yes	17	Pits	Lexington, NE to Chapman, NE
19	b	28	"Central" Platte River Sandpits 2 (Chapman to Columbus, NE)	*tb*		Platte	Sand Pits	yes	2	Pits	Chapman, NE to Columbus, NE
19	b	**27-28**	**"Central" Platte Sandpits (Lexington to Columbus, NE)**	**152**	**9**	Platte	Sand Pits	yes	28	Pits	Lexington, NE to Columbus, NE
20		29	North Loup River Sand Pits	14	2	Platte	Sand Pits	yes	2	Pits	One in Valley County, one in Howard County
21	a	30	Loup River	19	0	Platte	River	no	68	RM	Confluence with Middle Loup near St. Paul, NE to confluence with Missouri
21	b	31	Loup River Sand Pits	54	2	Platte	Sand Pits	yes	2	Pits	Genoa and Columbus
22	a	32	Elkhorn River	ns		Platte	River	no	117	RM	From Norfolk, NE to confluence with Platte
22	b	33	Elkhorn River Sand Pits	74	3	Platte	Sand Pits	yes	3	Pits	From Norfolk, NE to confluence with Platte
23	a	34	“Lower” Platte River (Columbus to confluence with Missouri)	53	2	Platte	River	yes	105	RM	Confluence with Loup River (RM 105) to confluence with Missouri (RM 0)
23	b	35	“Lower” Platte River Sand Pits	328	13	Platte	Sand Pits	yes	22	Pits	Confluence with Loup River (RM 105) to confluence with Missouri (RM 0)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
24		36	Mid-American Energy Plant, Council Bluffs, IA	33	1	Platte	Industrial	yes			Fly-ash deposits
25	a	37	Kansas River, KS	13	1	Kansas	River	yes	171	RM	Confluence with Republican River (RM 170) to Kansas City (RM 15)
25	b	38	Jeffrey Energy Center, KS	32	1	Kansas	Industrial	yes	30	AC	Fly-ash deposits
26	a	39	Wabash River, IL-IN	14	1	Wabash	River	no	82	RM	Shoreline sandbar east of Grayville, IL
26	b	40	Gibson Lake, IN	10	1	Wabash	Industrial	yes			Cooling pond dikes or fly-ash deposits near coal plant
26	c	41	Cane Ridge Wildlife Management Area, IN	75	1	Wabash	Reservoir	yes			2 created islands, just south of Gibson Lake
27	a	42	"Lower" Ohio River Sandbars	132	5	Ohio	River	yes	255	RM	From Cannelton Dam, KY (724) to confluence with Mississippi River (RM 979)
27	b	43	Camp #9 (10m SE of ORM 842.5 at Uniontown, Union Co.)	15	1	Ohio	Industrial	yes			Coal plant slurry pond
27	b	44	Arkema Plant, Marshall Co., KY (near Tennessee River Mile 14.75)	25	1	Ohio	Industrial	yes			Chemical plant impoundment
28		45	Mississippi River (Cape Girardeau, MO- Cairo, IL)	92		Mississippi	River	yes	50	RM	Cape Girardeau, MO (URM 50) to Cairo, IL (RM 954)
28		46	Mississippi River (Cairo, IL-Osceola, AR)	2450		Mississippi	River	yes	154	RM	Cairo, IL (RM 954) to Osceola, AR (RM 790)
28		47	Mississippi River (Osceola, AR-Helena, AR)	1721		Mississippi	River	yes	120	RM	Osceola, AR (RM 790) to Helena, AR (RM 670)
28		48	Mississippi River (Helena, AR-Greenville, MS)	3784		Mississippi	River	yes	140	RM	Helena, AR (RM 670) to Greenville, MS (RM 530)
28		49	Mississippi River (Greenville, MS- Vicksburg, MS)	1291		Mississippi	River	yes	100	RM	Greenville, MS (RM 530) to Vicksburg, MS (RM 430)
28		50	Mississippi River (Vicksburg, MS- Baton Rouge, LA)	1622		Mississippi	River	yes	200	RM	Vicksburg, MS (RM 430) to Baton Rouge, LA (RM 230)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
28		45-50	Mississippi River (Cape Girardeau, MO- Baton Rouge, LA)	10,960	87	Mississippi	River	yes	770	RM	Cape Giraredeau, MO (URM 50) to Baton Rouge, LA (RM 230)
29		51	John Martin Reservoir, CO	30	4	Arkansas	Reservoir	yes	13000	AC	Whole reservoir
29		52	Adobe Creek Reservoir, CO	2	1	Arkansas	Reservoir	yes	4800	AC	Whole reservoir
29		53	Horse Creek Reservoir, CO	0		Arkansas	Reservoir	yes	2810	AC	Whole reservoir
29		54	Neegronda Reservoir, CO	12	1	Arkansas	Reservoir	yes	3200	AC	Whole reservoir
29		55	Neenoshe Reservoir, CO	0		Arkansas	Reservoir	yes	3200	AC	Whole reservoir
29		56	Neesopah Reservoir, CO	0		Arkansas	Reservoir	yes	3750	AC	Whole reservoir
29		57	Neeskah Reservoir, CO	0		Arkansas	Reservoir	yes	2200	AC	Whole reservoir
30		58	Cheyenne Bottoms Wildlife Area, KS	ns		Arkansas	Salt Flat	no			Habitat no longer suitable for ILT nesting
31		59	Quivira NWR, KS	40	2	Arkansas	Salt Flat	yes	1900	AC	Big salt marsh area (1900 acres) is historic nesting site
32		60	Wichita, KS (on Arkansas River)	12	1	Arkansas	Industrial	yes			Small dredged material disposal site 3 miles from Arkansas River
33		61	Arkansas River, OK (Kaw to Keystone)	104	3	Arkansas	River	yes	92	RM	Kaw Dam (RM 654) to head of Keystone Lake (RM 552)
34		62	Arkansas River, OK (Keystone Dam to Zink Lake)	54	1	Arkansas	River	no	17	RM	Keystone Dam (RM 539) to Zink Lake (RM 522)
34		63	Arkansas River, OK (Zink Island in Zink Lake)	25	1	Arkansas	River	yes			Monitored by Tulsa Audubon Society
34		64	Arkansas River, OK (Tulsa to Muskogee)	417	14	Arkansas	River	yes	64	RM	Tulsa, OK (RM 522) to Muskogee, OK (RM 458)
35		65	Arkansas River, OK (McKlellen-Kerr Navigation System)	ns		Arkansas	River	?	??	RM	Robert S. Kerr Dam to AR border
35		66	Arkansas River, AR (McKlellen-Kerr Navigation System)	319	11	Arkansas	River	yes	289	RM	Arkansas border (RM 308) to end of MCKARNS (RM 19)
36		67	Arkansas River, AR below MCKARNS to Mississippi River	ns		Arkansas	River	?	19	RM	End of MCKARNS (RM 19) to Mississippi River (RM 0)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
37		68	Salt Plains NWR, OK	90	8	Salt Fork	Salt Flat	yes	10000	AC	About 80 percent of salt flats searched by ATV
38	a	69	Cimarron River, OK (confluence with Crooked Creek-Keystone Lake)	186	27	Cimarron	River	no	220	RM	Crooked Creek, OK-KS border to head of Keystone Lake
38	b	70	Little Salt Plains, Cimarron River, OK	*tb*		Cimarron	Salt Flat	no	1900	AC	
38	b	71	Big Salt Plains, Cimarron River, OK	*tb*		Cimarron	Salt Flat	no	2400	AC	Salt Flats near Cargill Solar Plant
38	b	**70-71**	**Cimarron Salt Flats, OK**	**242**	**2**	Cimarron	Salt Flat	no	4300	AC	
39		72	Optima Reservoir, OK	0	0	Canadian	Reservoir	no			Habitat no longer suitable for ILT nesting, formerly nested on roads west of reservoir
40		73	North Canadian River, OK	6	1	Canadian	River	no	100	RM	North of Cromwell, OK to head of Eufaula Lake
41		74	“Upper” Canadian River, OK-TX (Canadian, TX to Eufaula Lake)	342	46	Canadian	River	no	300	RM	Canadian, TX to head of Eufaula Lake
42		75	“Upper” Canadian River mouth, OK (at Eufaula Lake)	130	1	Canadian	River	no			Delta colony, only exposed in some years (when reservoir levels are low)
43		76	“Lower” Canadian River, OK (below Eufaula Lake)	118	2	Canadian	River	yes	27	RM	Eufaula Dam to confluence with Arkansas River at Robert S. Kerr reservoir
44		77	North Fork of the “Upper” Red River, OK	0	0	Red	River	no	35	RM	Confluence with Red to U.S. 62 east of Headrick, OK
45		78	Salt Fork of the “Upper” Red River, OK	0	0	Red	River	no	45	RM	Greenbelt Reservoir to U.S. 83 near Lutie, TX
46		79	Pease River, TX	0	0	Red	River	no	50	RM	Confluence with Red to Copper Breaks State Park, north of Cromwell, TX

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
47		80	Washita River, TX-OK	0	0	Red	River	no	90	RM	US 83 south of Canadian, TX to just west of Foss Lake in OK
48		81	Prairie Dog Town Fork of the “Upper” Red River (west of Red and Salt Fork confluence)	*tb*		Red	River	no	135	RM	20 miles west of HWY 70 to confluence with Red River at the Salt Fork of the Red
48		82	“Upper” Red River (PDT fork-confluence of Red with Salt Fork) to head of Lake Texoma	*tb*		Red	River	no	275	RM	Confluence of the PDT fork of the Red River to head of Lake Texoma
48		**81-82**	**“Upper”Red River (including the PDT Fork, OK-TX (west of Lake Texoma)**	**394**	**57**	Red	River	no	410	RM	Combines the PDT fork and the Red River west of Lake Texoma
49		83	Miller's Creek Reservoir, Brazos River, TX	ns		Red	Reservoir	no	4500	AC	Record from Texas Breeding Bird Atlas, no additional data
50		84	Lake Kemp, Wichita River, TX	ns		Red	Reservoir	no	18000	AC	Record from Texas Breeding Bird Atlas, no additional data
51		85	Hagerman NWR, near Lake Texoma, TX	0	0	Red	Industrial	yes			Terns have not nested since 2003
52		86	“Lower” Red River, OK,TX,AR (Denison Dam- Index, Arkansas)	812	48	Red	River	yes	240	RM	Denison Dam (RM 608) to Index, AR (RM 368)
52		87	“Lower” Red River (Index, AR to AR-LA border)	*tb*		Red	River	no	93	RM	Index, AR (RM 368) to AR-LA border (RM 275)
52		88	“Lower” Red River (LA-AR border to Red River Navigation System)	*tb*		Red	River	no	40	RM	AR-LA border (RM 275) to Red River Navigation System (RM 235)
52		**87-88**	**“Lower” Red River between Index, AR and Red River Navigation System)**	**564**	**18**	Red	River	yes	133	RM	Combines AR and LA segments listed below
53		89	Red River Navigation System, LA, Atchafalaya River, LA	51	1	Red	River	yes	235	RM	Red River Navigation System (RM 235) to Atchafalaya River (RM 0)

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
54		90	Bitter Lake NWR, Pecos River, NM	28	1	Pecos-Rio	Salt Flat	yes	120	AC	Nesting on salt-flats
55		91	Brantley Lake, Pecos River, NM	11	0	Pecos-Rio	Reservoir	yes	4000	AC	Nesting on area where vegetation is managed by park
56		92	Imperial Reservoir, Pecos River, TX	14	1	Pecos-Rio	Industrial	yes	1200	AC	Nesting on limestone oil-well pads
57		93	Amistad Reservoir, Rio Grande, TX-MX	85	2	Pecos-Rio	Reservoir	yes	39000	AC	Of 547 miles on U.S. side, 450 are searched (65,000 total acres, 39,000 in US)
58		94	Lake Casa Blanca and nearby gravel pits, Rio Grande, TX	0	0	Pecos-Rio	Reservoir	no	1000	AC	Habitat may no longer be suitable
59		95	Falcon Reservoir, Rio Grande, TX-MX	ns		Pecos-Rio	Reservoir	no	44000	AC	Not well surveyed since 2000 (Mexico portion of reservoir may be inaccessible)
60		96	O.C. Fischer Reservoir, Concho River, TX	0	0	Concho	Reservoir	no	7000	AC	Habitat may no longer be suitable
61		97	Twin Buttes Reservoir, Concho River, TX	0	0	Concho	Reservoir	no	15000	AC	Habitat may no longer be suitable
62		98	Carrollton (Dallas County), Trinity River, TX	40	1	Trinity	Roof	yes			Warehouse rooftops
62		99	Lewisville (Denton County), Trinity River, TX	18	1	Trinity	Roof	yes			Warehouse rooftops
63		100	Southside plant, Dallas, (Dallas County), Trinity River, TX	28	1	Trinity	Industrial	yes			Entire plant
64		101	Richland-Chambers Reservoir, Trinity River, TX	5	0	Trinity	Reservoir	no	44000	AC	Shoreline and Trinity River Authority pump station
65	a	102	Fairfield Lake, Trinity River, TX	ns		Trinity	Reservoir	no	5500	AC	May be terns foraging from colony at Big Brown mine, no confirmed nesting
65	b	103	Big Brown Mine, near Trinity River, TX	38	2	Trinity	Industrial	yes			Newly leveled mine soil and nearby developed water areas

GS #	Hab.	Surv Seg #	Survey segment	# Adults	# Colonies	River	Type	Annual?	Extent	Unit	Area description
66	a	104	Lake Limestone, Navasota River, TX	ns		Trinity	Reservoir	no	33000	AC	May be terns foraging from colony at Jewett mine, no confirmed nesting
66	b	105	Westmoreland Coal, Jewett Mine, near Trinity River, TX	50	1	Trinity	Industrial	yes			Active and inactive mine sites, regraded areas, ponds
67		106	Tawakoni Reservoir, Sabine River, TX	0	0	East Texas	Reservoir	no	40000	AC	Shoreline and nearby limestone quarries
68		107	Cooper Lake, White Oak Creek, TX	49	2	East Texas	Reservoir	yes	20	SM	Terns nesting in 20 shoreline mile area maintained by park
			RANGE-WIDE TOTAL	17,591	489						

Appendix C: Historic Annual Counts for Interior Least Terns by Survey Segment and by Region

A “p” indicates a year where ILT were known to breed in an area, but no count was made. A question mark indicates that historic data should be available, but has not yet been acquired. Please read the “historic data” sections of this report for caveats regarding the interpretation and further distribution of these historic data.

"Upper" Missouri River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Missouri Riv. (Fort Peck Lake), MT		4	3	4	6	10	0	7	9	2	0	0	4	0	4	0	0	2	0	0
Missouri Riv. (Fort Peck River Reach)			18	48	92	66	110	31	58	95	128	162	25	40	33	39	34	38	48	34
Yellowstone Riv. (MT, ND)			12	12	12	16	14	19	40	21	19	19	15	11	21	16	19	18	14	16
Missouri Riv. (Lake Sakakawea), ND			7	15	6	8	29	17	35	7	27	2	23	9	10	34	21	25	16	26
Missouri Riv. (Garrison River Reach)	141	166	125	94	142	146	184	140	209	284	105	41	133	99	99	114	118	128	142	199
Missouri Riv. (Lake Oahe), ND-SD	46	30	88	111	99	171	138	130	168	84	74	101	118	63	91	105	114	86	73	89
Cheyenne Riv., SD	31	54	27	12						54	28		23		6	11		8	3	4
Missouri Riv. (Lake Francis Case)																0	0	6	10	0
Missouri Riv. (Ft. Randall River Reach)	11	32	0	4	26	32	13	38	43	10	2	0	64	124	106	71	84	44	61	76
Niobrara Riv. NE from Norden- Missouri River						291					321					150				289
Niobrara Riv. NE (Norden- HWY 137) National Scenic River						?					?					?	15	12	26	15
Niobrara Riv. NE (HWY 137- Spencer Dam)						?					?					?				190
Niobrara Riv. NE (Spencer Dam- Missouri River)																				84
Niobrara Riv. NE (lower 15 RM of Nat. Rec. River)						?					?					?		40	64	
Missouri Riv. (Lewis and Clark Lake)	14	28	45	29	63	55	29	76	44	16	28	6	118	76	10	46	42	46	13	4
Missouri Riv. (Gavins River Reach)	181	232	252	210	167	193	187	272	211	93	82	115	144	161	206	232	314	366	359	476
Missouri Riv. (Mid-American Energy, Sioux City, IA)	p						p			p	p	p	p							
All Missouri River (Rivers plus Reservoirs)	424	546	538	515	601	681	690	711	777	591	446	427	629	572	559	641	727	741	722	904
Missouri River river segments only	347	458	440	385	490	492	523	557	565	498	345	324	484	500	454	502	592	622	623	789
Missouri River reservoir segments only	46	34	98	130	111	189	167	154	212	93	101	103	145	72	105	139	135	119	99	115
Missouri percent nesting on rivers			82	75	82	72	76	78	73	84	77	76	77	87	81	78	81	84	86	87
"Upper" Missouri River and tributaries			577	539	613	988	704	730	817	666	814	446	667	583	586	818	746	767	739	1213
Platte River System	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Lake McConaughy, NE						16					10					24				32
South Platte River sandpits						0					2					4				ns
Platte River ("Upper") sand pits (North Platte to Lexington)						29					13					5				20
Platte River sand pits (Lexington to Columbus)						158					98					67				152
North Loup River sand pits, NE						ns					ns					ns				14
Loup River (sand pits)						ns					65					46				54
Elkhorn River (sand pits)						30					43					38				74
Platte River ("Lower") sand pits (Columbus- Missouri Riv.), NE						156					127					163				328
Platte River ("Upper") river (North Platte to Lexington)						0					10					10				0
Platte River ("Central") (Lexington to Columbus)						39					36					29				3
Loup River (river)						117					91					51				19

Elkhorn River (river)						ns					43					28				ns
Platte River (“Lower”) river (Columbus- Missouri Riv.), NE						331					163					175				53
Mid-American energy plant, Council Bluffs, IA	28	22	24	9	0	22	9	9	5	4	8	5		p		p		p		33
“Upper”/”Central” Platte river						39					46					39				
“Upper”/”Central” Platte sand pits						187					111					72				
“Upper”/”Central” Platte river and sand pits, NE						226					157					111				175
“Upper”/”Central” percentage on river						17					29					35				2
“Lower” Platte river and sand pits (Columbus- Missouri Riv.), NE						487					290					338				381
“Lower” Platte percentage on river						68					56					52				14
Loup River total						117					156					97				73
Elkhorn River total						30					86					66				74
Platte River System (Platte, Loup, Elkhorn)						898					709					640				782
Kansas River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Kansas River and Jeffrey Energy Center, KS										32	34	25	36	28	26	32	34	38	34	45
Ohio River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Gibson Lake	4	4	0	7	8	12	9	34	30	24	55	65	85	50	70	80	110	45	90	10
Cane Ridge WMA																				75
Wabash River sand bars																				14
“Lower” Ohio River sandbars and industrial sites											138	91			191	197	59	70	96	172
Ohio River System (Ohio and Wabash)											193	156			261	277	169	115	186	271
Mississippi River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Low. Miss. Riv. C. Girardeau, MO- Cairo, IL	90	20	80	49	70	56	19		32	39	89	81	9	28	39	19	35	135	96	92
Low. Miss. Riv. Cairo, IL- Osceola, AR	1015	1202	1003	950	2375	1781	1179		3001	1308	1713	1047	1969	2089	2294	1802	2082	2222	2981	2450
Low. Miss. Riv. Osceola, AR- Helena, AR	383	501	492	391	930	914	734		1856	1269	483	1033	1735	1488	1523	1792	1772	2232	2125	1721
Low. Miss. Riv. Helena, AR- Greenville, MS	700	483	504	222	1316	990	1052		796	723	341	509	1121	1213	1170	1344	1325	2132	2575	3784
Low. Miss. Riv. Greenville, MS- Vicksburg, MS			277	393	347	556	669		765	825	441	758	704	1341	894	1404	588	1361	1284	1291
Low. Miss. Riv. Vicksburg MS- Baton Rouge LA									326	200									2087	1622
Low. Miss Riv (C. Girardeau to Greenville)	2188	2206	2079	1612	4691	3741	2984		5685	3339	2626	2670	4834	4818	5026	4957	5214	6721	7777	8047
Low. Miss Riv (C. Girardeau to Vicksburg)			2356	2005	5038	4297	3653		6450	4164	3067	3428	5538	6159	5920	6361	5802	8082	9061	9338
Mississippi River (C. Girardeau, MO to Baton Rouge, LA)									6776	4364									11239	10960
Arkansas River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
“Upper” Arkansas Reservoirs, CO					30	46	42	32	22	24	64	38	66	50	38	40	38	48	50	44
Quivira National Wildlife Refuge, KS	48	54		46	68	54		48	46	50	66	56	43		24		31	28	17	40
Arkansas River near Wichita, KS															10			8	10	12
Arkansas Riv. OK (Kaw Dam- Keystone Lake, OK)			12		21										19	63	95	107	145	104

Arkansas Riv. OK (Keystone Dam to Muskogee)			148		186	320									355	565	498	462	395	496
Arkansas Riv. OK (Keystone Dam-Tulsa/Zink Lake)														38						54
Arkansas Riv. OK (Zink Island, OK)		20	31	45	44	60	?	?	?	?	?	?	?	?	73	93	42	23	26	25
Arkansas Riv. OK (Tulsa- Muskogee, OK)			117		142	260	220	203	?	?	?	?	?	?	282	472	456	439	369	417
Arkansas Riv., MCKARNS, AR (AR border to RM 19)																			404	319
Arkansas Riv. AR (RM 101-191)																198	264			
Salt Plains National Wildlife Refuge, OK	130	210		220	240	82	136	168	90	116	122							130	118	90
Cimarron River Salt Flats				86	236		186	170	280											
Little Salt Plains Salt Flats, Cimarron River	70	52		72	110		74	62	106											96
Big Salt Plains Salt Flats, Cimarron River				14	126		112	108	174											146
Cimarron River, KS-OK (Crooked Creek to Keystone Lake)				415																186
Cimarron River, OK (Crooked Creek to Freedom (OK)	80	80		64	100		68	56	50											
Cimarron River, OK (Crooked Creek to Cashion, OK)							230													
Optima National Wildlife Refuge, OK	52	60	38	0	0	15	16													0
North Canadian River sandbars, OK																				6
"Upper" Canadian River, TX-OK (Canadian, TX to Eufaula Lake)																				342
"Upper" Canadian River (Union City-Byars, then Saskwa-Eufaula Lake)					174															
"Upper" Canadian River (Norman to Eufaula Lake)							239										286			
"Upper" Canadian River (Newcastle to Purcell)							68	52	78	122	100	110	106							
"Upper" Canadian Riv. Mouth at Eufaula Lake																				130
"Lower" Canadian Riv. OK (Eufala Dam- Arkansas River, OK)			62	7	13		30			54	77	41		106	107	65	71	59	78	118
Arkansas River System																				2129
Red River System	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
"Upper" Red Riv. (Headwaters PDF to Lake Texoma)																		597		394
"Upper" Red Riv. (North Fork/Red confluence to I-35 near Texoma)						146														
Millers Creek Reservoir (Brazos River), TX															p?					
Lake Kemp (Wichita River), TX															p?					
Hagerman NWR (Lake Texoma), TX														p	p	p	p	p		0
"Lower" Red Riv. OK-TX (Denison Dam- Index AR)						187								694	631	893	782	993	1013	812
"Lower" Red River, Index, AR to Red Riv Nav System														233	441	273	280	303	280	564
"Lower" Red Riv Nav System in LA (RM 235) to Alexandria (RM 90)														62	58	123	135	100	48	51
"Lower" Red River (Denison Dam to LA Nav system)														927	1072	1166	1062	1296	1294	1376
Red River (whole system from PDF to LA)																		1993		1821

Rio Grande/Pecos River System	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bitter Lake National Wildlife Refuge NM		6	6	6	6	10	12	14	11	14	14	12	14	14	20	22	22	22	22	28
Brantley Lake State Park, NM																			p	11
Imperial Reservoir (Pecos County), TX													26							14
Rio Grande Riv. Amistad Res., TX	9		14	30										166	273	196	115	150	11	85
Rio Grande Riv. Lake Casa Blanca and gravel pits, TX		14	50	20											0					0
Rio Grande Riv. Falcon Res.(Zapata Co.), TX	150	62	164	426	386			655							214				p	
Rio Grande/Pecos River System Reservoirs			234	482											507					
Colorado River System	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
O.C. Fischer Reservoir (Tom Green County), TX														20						0
Trinity River System	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
North of Dallas rooftops (Dallas Co), TX																	25	75	84	58
Dallas southside wastewater treatment plant							15	24	20	20	27	25	30	34	21	18	38	38	30	28
Richland-Chambers Reservoir, TX																p			p	5
Fairfield Lake (Freestone CO., TX																			p	
Big Brown Mine (Freestone Co.), TX												38	44	32	25	20	24	28	14	38
Lake Limestone, Navasota River, TX																			p	
Jewett Mine (Freestone Co.), TX									10	20	20	20	0	15	12	70	50	16	0	50
Trinity River System urban sites and reservoirs																	137	157	128	179
East Texas Reservoirs	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Tawakoni Reservoir (Rains and Hunt Counties), TX																p				0
Cooper Lake, formerly Jim Chapman Lake (Delta and Hopkins Co.), TX										20		8	4	50	5				45	49
East Texas Reservoirs										20		8	4	50	5				45	49

Appendix D: Sources of Historic Data in Appendix C

Please contact the author of this report for more information or to report an error.

Survey segment	Source
Missouri Riv. (Fort Peck Reservoir), MT	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Missouri Riv. (Fort Peck Reach)	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Yellowstone Riv. (MT, ND)	Atkinson and Dood (2005)
Missouri Riv. (Lake Sakakawea), ND	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Missouri Riv. (Garrison Reach)	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Missouri Riv. (Lake Oahe), ND-SD	Aron (2005), plus Schwalbach (1988) for 1986 and Dirks (1990) for 1988 and 1989
Cheyenne Riv., SD	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Missouri Riv. (Ft. Randall reach)	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Niobrara Riv. NE from Norden- Missouri River	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Niobrara Riv. NE (Norden- HWY 137) National Scenic River	Stephen Wilson, NPS, annual reports
Niobrara Riv. NE (Spencer Dam- Missouri Riv) National Recreation Riv	Stephen Wilson, NPS, annual reports
Missouri Riv. (Lewis and Clark Lake)	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Missouri Riv. (Gavins Reach)	Omaha DMS (maintained by Greg Pavelka, USACE- Omaha District-Yankton, SD
Mid-American Energy Plant. (Sioux City, IA)	Dinsmore et al. (1999) and Dinsmore et al. (2004)
Lake McConaughy, NE	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
South Platte river and sandpits	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Platte River (“Upper”) river (North Platte to Lexington)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Platte River (“Upper”) sand pits (North Platte to Lexington)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Platte River (“Central”) river (Lexington to Columbus)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)

Survey segment	Source
Platte River ("Central") sand pits (Lexington to Columbus)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Platte River ("Lower") river (Columbus-Missouri Riv.), NE	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Platte River ("Lower") sand pits (Columbus- Missouri Riv.), NE	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
North Loup River sand pits, NE	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Loup River (river)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Loup River (sand pits)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Elkhorn River (river)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Elkhorn River (sand pits)	NGPC database (formerly maintained by John Dinan, now Renae Held and Joel Jorgenson)
Mid-American energy plant, Council Bluffs, IA	Dinsmore et al. (1999) and Dinsmore et al. (2004)
Kansas River. And Jeffery Energy Center, KS	R.Boyd, Baker University, KS (unpublished data)
Wabash River, Gibson Lake	J. Castrale, Indiana DNR (unpublished data)
"Lower" Ohio River	B. Palmer-Ball and E. Ciuzio. Kentucky DFWR (unpublished data), Ciuzio et al. (2005)
Low. Miss. Riv. C. Girardeau, MO- Cairo, IL	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
Low. Miss. Riv. Cairo, IL- Osceola, AR	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
Low. Miss. Riv. Osceola, AR- Helena, AR	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
Low. Miss. Riv. Helena, AR- Greenville, MS	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
Low. Miss. Riv. Greenville, MS- Vicksburg, MS	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
Low. Miss. Riv. Vicksburg MS- Baton Rouge LA	Jones (2005), J. Rumancik, USACE, Memphis District (previous reports)
"Upper" Arkansas Reservoirs, CO	D. Nelson, Biological Consultant, Las Animas, CO (unpublished data), Nelson and Green (2003)
Quivira National Wildlife Refuge, KS	Boyd (1993) for 1986-1994, G.P. Meggers, USFWS- Quivira NWR (unpublished data) 1995-2004)
Survey segment	Source
Arkansas River near Wichita, KS	R.Boyd, Baker University, KS (unpublished data)
Arkansas Riv. OK (Kaw Dam- Keystone Lake, OK)	Hill (1993) 1988 and 1990, J.Sturdy. USACE, Tulsa District, or K. Stubbs, USFWS-OK (unpublished data) 2000-2004, USACE (2004) report

Survey segment	Source
Arkansas Riv. OK (Keystone Dam-Tulsa/Zink Lake)	J. Sturdy, USACE, Tulsa District (unpublished data)
Arkansas Riv. OK (Zink Island, OK)	Hill (1993) 1987-1991, K.Stubbs, USFWS-OK (unpublished data) 2000-2004 (USACE 2004) report
Arkansas Riv. OK (Tulsa- Muskogee, OK)	Hill (1993) 1988-1993, K. Stubbs, USFWS-OK (unpublished data), USACE (2004) report
Arkansas Riv. AR (RM 101-191)	Urbanic (2003)
Arkansas Riv. AR (Fort Smith RM 308-Mississippi Riv, RM 0)	E.Knoll and T.Nupp, Arkansas Tech University, (unpublished data)
Salt Plains National Wildlife Refuge, OK	Kirsch and Sidle (1999) 1986-1994, B.Winton, OSU (unpub. data) 1995-1996, R. Sheppard- USFWS- Salt Plains NWR (unpub. data 2003-2004
Cimarron River Salt Flats (Little Salt Plains)	Boyd (1994)
Cimarron River Salt Flats (Cargill, sic Big Salt Plains, Edith SP)	Boyd (1994)
Cimarron River, OK (Crooked Creek to Keystone Lake- no flats)	Hill (1993)
Cimarron River, OK (Crooked Creek to Cashion, OK)	Hill (1993)
Cimarron River, OK (Crooked Creek to Freedom (OK)	Boyd (1994)
Optima National Wildlife Refuge, OK	Boyd (1994)
“Upper” Canadian River (Union City/HWY 81 to Byars, then Saskwa to Eufaula)	Hill (1993)
“Upper” Canadian River (Norman to Eufaula Lake)	Hill (1993) for 1992 and K. Stubbs, USFWS-OK (unpublished data) for 2002
“Upper” Canadian River (Newcastle to Purcell- 32km)	Byer (2000)
“Lower” Canadian Riv. OK (Eufala Dam-Arkansas River, OK)	Hill (1993) for 1988-1990, USFWS (2005) for 1992-2004
“Upper” Red Riv. (Headwaters PDF to Lake Texoma)	Aqua-terr (2003)
“Upper” Red Riv. (North Fork/Red confluence to I-35 bridge west of Lake Texoma)	Hill (1992)
Millers Creek Reservoir, Brazos River, TX	Kasner et al (2005)
Lake Kemp, Wichita River, TX	Kasner et al (2005)
Hagerman NWR (Lake Texoma), TX	requested from Johnny Beall, USFWS- Hagerman NWR
“Lower” Red Riv. OK-TX (Denison Dam-Index AR)	Hill (1992) for 1991, Gulf Coast Research Corporation, Baton Rouge, LA (unpublished data) 1999-2004, RC (2004) report
“Lower” Red River Arkansas (Index, AR, RM 374- Red Riv Nav System RM 235)	H. Hervey, Consultant, Shreveport, LA (unpublished data) 1999-2002, L. Meduna and T. Nupp, ATU (unpublished data) 2003-2004
Red Riv Nav System in LA (RM 235) to Alexandria (RM 90)	W.D. Oliver, USACE- Vicksburg District, (unpublished data)

Survey segment	Source
Bitter Lake National Wildlife Refuge NM	Kirsch and Sidle (1999) for 1987-1990, USFWS (2005) for 1991-1997, 2000-2001, S.O. Williams, NMGF (pers.comm) 1988-1999, 2002-2004
Imperial Reservoir (Pecos County), TX	Kasner et al. (2005)
Rio Grande Riv. Amistad Res. (Val Verde Co.), TX	Kirsch and Sidle (1999) 1986-1990, R. Slade, NPS, Amistad NRA (unpublished data) 1999-2004
Rio Grande Riv. Lake Casa Blanca and Rio Grande Gravel pits (Webb Co.). TX	Kirsch and Sidle (1999)
Rio Grande Riv. Falcon Res.(Zapata Co.), TX	Kirsch and Sidle (1999) 1986-1990, USFWS (2005) 1993 and 2000, Andy Kasner, (pers. comm.) for 2004
O.C. Fischer Reservoir (Tom Green County), TX	Kasner et al. (2005)
North of Dallas rooftops (Dallas Co), TX	O.Bocanegra, USFWS-Arlington (unpublished data)
Dallas southside wastewater treatment plant	O.Bocanegra, USFWS-Arlington (unpublished data)
Richland-Chambers Reservoir (Freestone and Navarro Co.) TX	Kasner et al. (2005), Andy Kasner (pers. comm.) for 2004
Fairfield Lake, TX	Kasner et al. (2005)
Big Brown Mine (Freestone Co.), TX	O.Bocanegra, USFWS-Arlington (unpublished data)
Limestone Lake, TX	Kasner et al (2005)
Jewett Mine (Freestone Co.), TX	T. Rosol. Westmoreland Coal Company, TX (unpublished data)
Tawakoni Reservoir (Rains and Hunt Counties), TX	O.Bocanegra, USFWS-Arlington (unpublished data)
Cooper Lake, formerly Jim Chapman Lake (Delta and Hopkins Co.), TX	O.Bocanegra, USFWS-Arlington (unpublished data)

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14. ABSTRACT
The interior population of the Least Tern (*Sternula antillarum*) was added to the U.S. Fish and Wildlife Service (USFWS) list of threatened and endangered species in 1985 because of suspected low numbers and concerns about breeding season habitat loss or degradation on large interior rivers. Range-wide survey data were incomplete when Interior Least Terns (ILT) were originally listed. Although many ILT counts have been conducted over the past 20 years, regular survey coverage is still incomplete across the large breeding range of ILT, limiting the ability to assess the conservation status or trends for this population. During the last two weeks of June and the first week of July 2005, over 140 participants contributed to the first complete range-wide survey for ILT (see acknowledgments). The primary objectives of this survey were 1) to provide a minimum count of the number of adult ILT occurring in North America during the breeding season, 2) to document the range-wide distribution of nesting colonies, and 3) to describe the types of habitats that are being used for nesting. Survey crews covered ~4,700 river miles, 22 reservoirs, 62 sand pits, 12 industrial sites, 2 rooftop colonies, and over 16,000 acres of salt flats, counting a grand total of 17,591 ILT in association with 489 different colonies. Just over 62 percent of all adult ILT were counted on the "Lower" Mississippi River (10,960 birds on 770+ river miles). Four additional river systems accounted for 33.3 percent of the remaining ILT, with 11.6 percent on the Arkansas River system (including the Canadian
(Continued)

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Interior Least Tern (ILT)

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and Cimarron Rivers and the Salt Fork of the Arkansas River), 10.4 percent on the Red River system, 6.9 percent on the Missouri River system, and 4.4 percent on the Platte River system. Lesser numbers of terns were counted on the Ohio River system (1.0 percent), the Trinity River system in Texas (1.0 percent), the Rio Grande/Pecos River system in New Mexico and Texas (0.8 percent), the Wabash River System (0.6 percent), two reservoirs in East Texas (0.3 percent), and the Kansas River system (0.3 percent). A majority of adult terns were counted on rivers (89.9 percent), with much smaller numbers at sand pits (3.6 percent), reservoirs (2.5 percent), salt flats (2.3 percent), industrial sites (1.4 percent), and rooftops (0.3 percent). This report discusses the results of the 2005 survey at three different spatial scales: 1) the entire breeding range for ILT and adjacent breeding populations on the Gulf Coast; 2) regional analyses by major river systems; and 3) individual survey segments (some of which have been combined into geographic segments comprised of more than 1 similar survey segment). Results of the 2005 survey are also compared with historic survey data from 1986 through 2004. The value of historic data for local, regional, and range-wide analyses of population trends is evaluated in the context of this first complete picture of the breeding distribution of ILT. Recommendations are made to 1) increase annual survey coverage for ILT to include several important breeding areas documented in this report that do not receive regular monitoring attention; 2) conduct additional large-scale surveys (such as the 2005 survey) during a standard survey window for long-term analyses of range-wide population trends; 3) conduct double-sampling to calculate detection ratios that will describe relative bias among survey segments with different survey methods; allowing unbiased estimation of population size and trend; and 4) improve long-term data storage for ILT count data through the development of a centralized data management system. The 2005 range-wide survey was a large collaborative effort that represents a major step forward toward developing the framework for a range-wide ILT monitoring program.