NESTING SUCCESS OF LEAST TERNS ON THE RED RIVER OF LOUISIANA

HUBERT HERVEY
203 Hervey Dairy Road
Stonewall, LA 71078

ABSTRACT

The presence of the endangered Interior Least Tem (*Sterna antillarum athalassos*) as a breeding bird on the Red River in Louisiana was not documented between 1956 and 1996. I located six nesting colonies during 1996 and 1997. The complete failure of some colonies, and limited nesting success for other colonies, was observed in both years. My observations in 1996 and 1997 encouraged me to conduct the present study in 1999. I located nineteen colonies, seven colonies in Louisiana, eleven in Arkansas, and one in Texas. Colonies in Arkansas and Texas were visited only once in order to locate and document their presence. In Louisiana, I visited each colony seven to eight times to determine nesting and fledging success. In these three states, 415 adult Least Terns were located, the 189 birds found in Louisiana are the subject of this study. Nesting success was determined to be lower than required for maintenance of the species. Nesting failure and chick mortality were caused by flash floods from rain run-off, rising river waters, coyotes (*Canis latrans*), human disturbance, cattle, raccoons (*Procyon lotor*), and Fish Crows (*Corvus ossifragus*). Records for river levels and heavy rainfall over a 12-year period are examined. A description is made of each island-nesting site. Recommendations are made regarding safe high temperatures for eggs to remain exposed. A series of locks and dams completed in 1995, adversely affected the quality of the sand islands needed by Least Terns for successful nesting. The length of the Red River covered was 570 km from the Oklahoma - Arkansas border to Lock and Dam 1, which is 71 km (44 mi) from the Mississippi River. The best conditions for nesting Least Terns are in Arkansas and north of Shreveport, LA, where the river retains more of its natural characteristics. The islands in the pool areas, south of Shreveport, are much less suitable for nesting, due to the lack of scouring action by high water. Least Terns abandon these islands as soon as they are overgrown by grasses and trees, black willow (*Salix nigra*), and Eastern cottonwood (*Populus deltoides*). The nesting problems caused by the changes made to the Red River need to be solved soon, while this Least Tern population is still at healthy numbers. Recommendations are made to improve the nesting success of these Least Terns.

INTRODUCTION

There are historic reports of three breeding colonies of the Interior Least Tern (*Sterna antillarum athalassos*) on the Red River in northwestern Louisiana. Horace Jeter (pers. comm.) reported 10 to 15 pairs of Least Terns nesting on a sand island near Sunny Point in the early 1950's. Sunny Point is 8 km (5 mi) south of the Jimmy Davis Bridge (LA Hwy 511) in Bossier Parish. In 1999, Least Terns nested within two miles of that location. Chester Silverton (pers. comm.), a fishing guide on Black Lake, remembers a colony on a large sand island at Mile Marker 108 (MM hereafter), in the Red River, 3.2 km north of Boyce, Rapides Parish, Louisiana, in the 1960's or 1970's. A visit to this island in July 1996 and on 23 June 1999 failed to locate any nesting Least Terns. Terry Davis (pers. comm.) remembers a tern colony in Bossier City, Bossier Parish, during the 1970's, on a fenced-in gravel parking area, south of the intersection of 1-20 and Barksdale Boulevard. This area is now developed and is no longer suitable habitat for nesting Least Terns.

On 7 July 1996, I learned of a Least Tem colony in Red River Parish, at the confluence of Loggy Bayou and the Red River (MM 194). The next day, I counted 60 terns and 20 nests on a sand island. Numerous scrapes indicated other pairs had attempted to nest, were in the process of nest building, or had completed nesting. On 19 July 1996, the island was flooded, and the eggs were destroyed. Only two chicks fledged, representing the entire reproductive effort of 60 birds.

I observed that other northwestern Louisiana colonies suffered failure in 1996 from river flooding. I located six colonies in 1997, all of which had losses from river flooding. The islands on which most colonies nest are only 0.6 - 1.4 m above seasonal river level. The extent of the damage varied with the elevation of the nest area above the usual river stage. River level records were obtained for years since 1988 from the National Weather Service in Shreveport. They reveal that in 10 of these 12 years, the river level was high enough to flood nesting tern colonies, either partly or completely (APPENDIX 1), during nesting season.

I spent four days (21 - 24 June 1999) traveling with U S Army Corps of Engineers biologists, George Chandler and David Oliver. This trip was made to acquaint Corps personnel with methods of locating, counting and monitoring Least Tem colonies. We traveled downstream from MM 240, north to Shreveport to MM 44 at Lock and Dam 1. MM 0 is at the beginning of the navigation channel, where the Red River Waterway meets the Mississippi River Other well-known locations are Alexandria MM90, Coushatta MM178, Lock and Dam 5 MM 200, Port of Shreveport - Bossier MM 212, Shreveport boat launch MM 226, LA Hwy 2 bridge MM 264, Fulton, AR MM 345 and north of Texarkana at U.S. Hwy 71 bridge MM 368. Mr. Chandler and Mr. Oliver were conducting a survey of Least Tern nesting colonies. We surveyed colonies 5, 6, and 7 (FIGURE 1).

In 1999 I obtained a grant from the Louisiana Ornithological Society to study Least Tem colonies on the Red River. I traveled 1,933 km on the Red River spending 143 hours, studying the seven tern colonies in Louisiana to determine the reasons for nesting success and failure. The purpose of this study was to locate all Least Tem colonies on the Red River in Louisiana and Arkansas, and to determine the extent and causes of nesting failures in Louisiana.

METHODS

All MM distances mentioned in the text are taken from the U. S. Army Corps of Engineers 1998 Navigation Maps of the Red River Waterway, and Red River Index of 1996 Mosaics, which extends 161 km into Arkansas. They reveal that straightening the bends has shortened the river by 88.5 km (U. S. Army Corps of Engineers 1996, 1998).

Before entering the nest area of an island, I usually took a temperature reading with an indoor-outdoor thermometer. Temperature readings were needed to assure the safety of eggs and chicks. The presence of a person in the midst of a colony could cause loss of eggs or chicks, due to exposure to high temperatures. Temperature readings were not needed when the birds were not nesting or in early morning when temperatures were lower. The outdoor bulb was placed 1 mm under the sand; the indoor bulb was placed 2 mm above the sand. Thirty-eight temperature readings were recorded. If the air temperature was 37.8° C (100° F) or higher, I immediately left the island. This only happened twice, because temperatures were below normal for our area during most of the study period. There were also times when travel on the river was not possible due to thunderstorms, strong winds, and high water. The river was closed from 2 Jul 1999 to 7 Jul 1999, due to a chemical spill from a railroad tank car in Bossier City.

On each visit to a Least Tern colony, I located and counted all nests. My criterion for giving an island a colony number is that at least one egg has to be laid in a nest by a Least Tern. Nests were located by scanning each island upon approach, noting nest locations. A quick walking search of each island was made, taking record of each nest by number and content. Each nest was marked with a wooden tongue depressor, placed 0.6 meter from the nest, on the side away from the river channel, stating the colony number, nest number, and number of eggs. Some markers were lost due to water, wind, animal, man, or other undetermined factors. All tracks (vehicular, mammal, bird, reptile, turtle, etc.) were observed at each colony and, when followed, were often connected to nest and chick losses.

Boat travel between colonies was time consuming and it was never possible to survey all the Louisiana colonies in one day. All work on each colony site was done expeditiously to reduce stress on adult and young birds.

RESULTS

I found seven nesting Least Tern colonies in Louisiana. Those were all of the Least Tern colonies on the Red River in Louisiana in 1999. The extreme distance between the northernmost and southernmost colonies was 138 km, the greatest distance between colonies was 41 km, the least distance 9 km, ($\bar{x}$ = 19.8 km). Least Terns fledged 49 chicks from 94 pairs. Sizes of colonies ranged from 5-21 pairs ($\bar{x}$ = 13). On the night of 25 and 26 June 1999, up to 13 cm of rain washed eggs out of nests, except for those nests placed on crests so water drained away from them. The river at Fulton, Arkansas, rose from 0.88 m on 28 June 1999 to 2.8 m on 8 July 1999, and nests were flooded. However, some birds in most colonies nested again. First nesting attempts produced 166 eggs in 60 nests in June, an average of 2.8 eggs per nest. Later nests in July produced 56 eggs in 33 nests, an average of 1.7 eggs per nest. The total reproduction effort was 222 eggs in 93 nests, $\bar{x}$ = 2.4 eggs per clutch.

In Arkansas, 11 colonies were located, while covering 185 km of river, for an average of 15 km between colonies. Those were all of the Least Tern colonies on the Red River in Arkansas in 1999. Three trips were made to locate Arkansas colonies, and only one of those was late enough in the year to see fledglings. On 22 July 1999, 22 fledgling Least Terns were in the company of 106 adults at five colony locations between U.S. Hwy 71 and Garland City, Arkansas.

One colony was located in Bowie Co, Texas, MM 374.6, while searching for Arkansas colonies. This colony had 32 adult Least Terns present on 16 June 1999. They had not started to lay eggs as the island had only recently become exposed, but scrapes were observed.

The number of adult Least Terns counted in Arkansas, Texas, and Louisiana totaled 415 and the number of fledglings was 71. No attempts were made to count all the Arkansas or Texas fledglings.

Point source pollution was observed in Louisiana at MM 190 and in Arkansas at MM 373. The source of the pollution in Louisiana was unknown, the pollution in Arkansas was from the paper mill in Ashdown, Arkansas.

After observing Least Tern colonies in 1996 and 1997, I realized the difficulties the birds were having raising a brood successfully. Coyotes (*Canis latrans*), raccoons (*Procyon lotor*), red foxes (*Vulpes fulva*), or gray foxes (*Vrocyon cinereoargenteus*), and Fish Crows (*Corvus ossifragus*), were destroying nests and depredating young birds. Fox depredation was observed once in Arkansas, but foxes are not included in the discussion of causes of observed nest loss, because the nest loss did not occur in Louisiana.

Each island has unique qualities and presents different nesting problems, as presented below. Details on daily observations, including the number of fledglings at each colony, are presented in APPENDIX 2. Colony numbers used below, in FIGURE 1 and APPENDIX 2 are the same.

Colony 1, (MM 270) is near Wardview, Bossier Parish, and 8 km south of Arkansas. It is on a large sand island, with gravel in the riverbed. This successful sand island is a good location for Least Terns to nest. The size given for each island is for a river level of approximately 6ft measured at Fulton, Arkansas. Fulton is used as a reference because it more accurately reflects the river level at five of the seven colonies studied than does the Shreveport gauge. This is because the river is free flowing north of Shreveport and in Arkansas. Only colonies 5 and 6 are in areas where dams control the water level. The pool stage of Lock and Dam 5 (which includes colony 5) extends beyond the other gauging station (KCS RR Bridge) in Shreveport Louisiana. Island size was 1.6 km by 0.64 km.

Colony 2, (MM 257) is near Gilliam, Caddo Parish. Raccoons destroyed several turtle nests and one Least Tern nest here. Tracks and feathers revealed that on a dark night, a coyote caught and ate two adult terns. This island has a good future because it is still building upstream. It is a large island with brush on the south, grass in the middle offering protection to chicks, and sand in the north for nesting. This is excellent nesting habitat. Size was 1.6 km by 0.32 km.

Colony 3, (MM 250) near Belcher, Caddo Parish, is not an island, but an attached sandbar. A small colony completely abandoned this sandbar in 1999 due to four-wheeler destruction of nests. This is not a good location due to the small nesting area and easy access from land. Size was 1.6 km by 0.32 km but, 90% is vegetated.

Colony 4, (MM 244) is Cat Island, Bossier Parish, and had revetment work done in 1996, which disrupted nesting and moved the island south 3.2 km. The terns have been slow to recover from this disruption. Fish Crows depredated a nest here. I don't expect this island to be good habitat for Least Terns in the near future, because the island is small and has no cover (except one large log) in which young birds can hide. Size was 0.8 km by 0.16 km.

Colony 5, (MM 221) is the only colony in the pool part of Lock and Dam 5. This island is adjacent to the Eagle Bend area of Bossier City, Bossier Parish. A Fourth of July fireworks celebration in the midst of the colony could not have been beneficial to the terns, yet more terns fledged here than any other location studied. The river level doesn't fluctuate here as much as it does upstream so this island doesn't receive the beneficial spring flooding, nor scouring to the same extent as the upstream islands; thus it is rapidly growing up in weeds and bushes. It is just ten minutes from boat launches in Shreveport and Bossier City Louisiana, and is popular with people as an overnight visiting, fishing and camping island. Size was 0.48 km by 0.16 km.

Colony 6, (MM 191) is the only colony in the pool area of Lock and Dam 4. It is 3.2 km south of Loggy Bayou, in Red River Parish. The original colony found in l996, which started my interest in Interior Least Terns, was nearby but has been destroyed by the construction of two dikes through the island. It could be reclaimed. Tracks indicated a coyote chased adult terns, leaping at them in an unsuccessful attempt to catch them during daylight hours. Raccoons destroyed one nest. This island is growing up in willows and cottonwoods faster than the American beavers (*Castor canadensis*) can cut them down. The flowing nature of Loggy Bayou gives this colony some of the same advantages found in areas north of Shreveport. Size was 0.8 km by 0.16 km.

Colony 7, (MM 238) is 4.5 km north of 1-220 Bridge near North Highlands in Shreveport. Cattle bed down on it nearly every night, so I call it Cattle Island. Cattle destroyed most nests and squashed three young chicks here. High water can actually work to the advantage of nesting Least Terns, since it prevents cattle from reaching the island. There was no plant growth on this island in 1999. Young terns used several large logs for protection. Cattle Island is large enough to support a Least Tern colony. Size was 0.96 km by 0.16 km.

No Least Tem colonies were found from Colony 6, the southernmost colony down river to Lock and Dam 1, a distance of 233.4 km. Three km south of the U.S. Hwy 84 Bridge at Coushatta, is a small island (MM 176), slightly larger than a football field. Local people play volleyball here, so I call it Volleyball Island. On each of two visits, I observed 13 Least Terns, two nest scrapes and no eggs. These birds were not seen after 22 Jun 99, but Colony 6, located 15 miles upstream, had an increase in tern numbers about the time they left. Fish Crows were present.

Least Terns attempted to nest on 19 of 22 suitable sand islands in Louisiana and Arkansas. The island at Boyce, Rapides Parish, (MM108) and an island near Colony 1 were not used. Another island near Campti, Natchitoches Parish, at MM 157.3 is tall, small, and quite sandy. I don't know why it is not in use unless it is so sandy that the nests would not hold shape under windy conditions. Nesting attempts were made on all other suitable islands. The total nest and nestling losses for 93 nests studied in 1999, show a loss of 73% of the nests and young as detailed in Table 1.

Flash Floods. There is a distinct difference in flash floods and river floods as used in the text. A flash flood is a downpour of rain in a 24 h period, sufficient to move sand, dirt, and eggs. I found that rainfall of over 8 cm in a 24 h period will cause sheet flooding, sanding over, and abandonment of nests. This agrees fully with findings from the Salt Plains National Wildlife Refuge, Oklahoma (Koenen et al. 1996) where similar rainfall losses were reported. In 1999, flash floods caused greater loss than river floods, but this is not usually the case.

River Floods. A river flood is rising river waters sufficient to inundate nests and eggs. The distinction is clear because the river rises several days after a heavy rainfall, or following upstream discharges from dams. Least Tem females abandon flooded nests, but their instinct to brood is so strong that I have seem them attempt to incubate (brood) round shapes of wood and round balls of cattle dung in which scarab beetles (tumblebugs) have laid their eggs.

A total of 68 nests of the 93 studied were destroyed, a 73% nesting failure. Of the unknown causes of failure, I suspect raccoons, Great Blue Herons (*Ardea. herodias*), or Great Egrets (*A. alba*). Raccoons hunt mostly at night, and their damage is difficult to assess. In 1998, Paul Dickson (pers. comm.) saw the tracks of a raccoon that devastated a colony so severely in one night that the terns abandoned the island. This occurred at MM 205, near Clarks Marina, in pool 5, within the study area. Vegetation at this location was too heavy for nesting terns in 1999.

Temperature observations: The air on a sand bar is cooler than the sand, except early in the morning. The 0700 CST temperature of sand and air is usually about the same. Wet sand is cooler than dry sand. Only twice was the air temperature over 37.8°C and those were both at 1300 h on sunny days. The sand was over 37.8° C six times. The sand temperature averaged 2.4° C hotter than the air temperature. All air temperatures over 35.0° C had simultaneous sand temperatures of over 37.8° C (37.8° C - 46.7° C, $\bar{x}$ = 40.9° C). My work suggests that the highest air temperature for unattended eggs to be safe from heat damage is 35.0° C (95° F). The observation of incubating Least Terns returning to the nest one or two minutes after being flushed, is an indication that the temperature has reached borderline high limits. My observation that when the adult returned, it merely shaded the eggs without snuggling down in the nest, shows that it knew the eggs needed shade, not warmth. I recommend that temperature readings should be a routine part of working with Least Tem colonies anytime after 1100 h under northern Louisiana conditions.

Table 1. Nest, nestlings, and adult Least Tern Losses on the Red River in Louisiana in 1999

Cause of Loss	Nests Lost[a]				Percent of Total Nests Lost[b] (n = 93)
	No.	(%)	Young	Adult	
Flash Floods	27	(40)			29
River Floods	21	(31)			23
Coyote	5	(7)		2	5.4
Raccoon	2	(3)[c]			2
Fish Crow	1	(1)[c]			1
Cattle	4	(6)	3		4.2
Human Disturbance	4	(6)			4.2
Unknown	4	(6)		1	4.2
Totals	68	(100)	3	3	73

a. Percentage of loss due to each cause of all nests lost.
b. Percentage of loss due to each cause of all nests found.
c. Minimum numbers – only observed losses (not suspected losses) are included.

DISCUSSION

Endangered species require a higher reproductive rate to rebuild numbers to a sustainable population level than would be required to maintain a population once that sustainable level is reached. The number of fledglings needed to sustain a population of interior Least Terns in Missouri is 0.70 fledged per nesting pair (Kirsh and Sidle 1999a). This study is the nearest one made to our area, so is useful for comparison purposes. The U.S. Fish and Wildlife Service has ordered the U.S. Army Corps of Engineers to achieve this level of fledging success on the Missouri River by decreasing flooding of nests, scheduling water releases from reservoirs to meet Least Tem needs, and reducing depredation and human disturbance (Kirsh and Sidle 1999b).

The total number of pairs of birds in the seven colonies in Louisiana was 94. The number of chicks fledged by these pairs was 49, therefore 0.53 chicks were fledged per adult pair. This rate is evidently inadequate to sustain the local population. The 73% rate of nesting failure reported in this study is substantially higher than the 52 % reported in sandy beach colonies in Connecticut (Brunton 1999), where house cats and Black-crowned Night-Herons (*Nycticorax nycticorax*) were the major causes of nesting failure. No house cats or Black-crowned Night-Herons were seen during the course of my study. The highest June, July, or August counts of Black-crowned Night-Herons carried in the database of The Shreveport Society for Nature Study, Bird Study Group, is 14 on 28 Jul 1992, and 5 on 2 Jun 1996. The location of both these count's was Smithport Lake, DeSoto Parish, 12 km distance from the Red River.

Due to the many factors causing nest failure and reduction of Least Tern fledging success, a decline in the Red River population is to be expected. Replacement birds would have to come from other interior locations, probably the Mississippi River colonies that are increasing in numbers (Smith and Renken 1993). No banded birds were seen in the course of this study, so it is not known if birds from other colonies come to the Louisiana and Arkansas sections of the Red River.

The Red River frequently rises above Least Tem nests, flooding the sand islands and sandbars, partly or completely. From 1988 to 1999, the river rose to levels high enough to inundate nesting colonies in 10 of those 12 years (APPENDIX 1). These records show that only in 1988 and 1998 were the terns able to nest without suffering river floods. My work during 1999 shows that a river level at Fulton AR of 2.4 - 2.7 m

and Shreveport of 2.7 - 3.0 m before 1995 and 4.6 - 4.9 m after 1995 is high enough to cause losses of approximately 30%. I suggest a mandate to the U. S. Army Corps of Engineers to keep the river below those levels in June and July except when public safety and irrigation needs would be affected.

A study of rainfall at Shreveport, Louisiana in amounts over 8 cm from 1988-1999 (U. S. Weather Service records) shows that flash floods caused nest loss in half as many years as river floods (5 vs 10). Rain amounts over 8 cm in 24 hours, during June and July, occurred in five years: 4 Jun 1989 - 8 cm, 27 Jun 1989 - 9 cm, 12 Jul 1994 - 9 cm, 5 Jul 1995 - 12 cm, 1 Jun 1996 - 9 cm, and 25 - 26 Jun 1999 - 14 cm. River flooding occurred in 10 years (APPENDIX 1).

The importance of late nesting becomes apparent when considering the July dates of river floods and flash floods. I saw running young terns (still fuzzy) from the second nesting, as late as 11 Aug 99, at Colony 6.

MANAGEMENT IMPLICATIONS

Any of the following measures that can be implemented will improve the nesting success of the Red River Interior Least Tern colonies. Reduction of human interference with Least Tern colonies would be improved by posting endangered species notices where needed, especially for colonies 5, 6, and 7.The new boat-launch at Louisiana Hwy 2 Bridge will increase travel near colonies 1 and 2. Signs may be needed at these locations. If nesting at failed colony 3 is attempted in the future, it should be posted also. The signs would need regular maintenance. Cattle should be fenced away from colony 7. This could be one of the more productive colonies, if cattle were not allowed on the island.

A suggestion, by both Dr. Laurence M. Hardy and Mr. W. M. Shepherd, to use abandoned barges as artificial nesting platforms has merit. The barges could be anchored at strategic locations with predator cones on the anchor lines. Boarding ladders should be removed. The surface of a Least Tern nesting barge could be covered with sand, with a layer of gravel under the sand, to facilitate drainage of excess rain. Least Tem decoys could be placed in plain sight of passing terns. Decoys have attracted the endangered California Least Tern (*S. a. browni*) to preferred nesting sites (Fancher 1984). Short joints of 4" or 6" PVC pipe could be secured in the sand for young birds to hide from avian predators and get relief from the sun. Additionally chick shelters can be constructed from durable slats around an iron pipe driven into the sand. Chick shelters constructed of used snow fence material have proven effective in protecting chicks from American Kestrels (*Faico sparverius*) and Northern Harriers (*Circus cyaneus*) on Nantucket Island, Massachusetts. (Jenks-Jay 1982). These structures should not be large enough to afford hidden approaches to Fish Crows. Derelict barges might even be obtained from oil companies, and the expense could be written off or applied to mitigation obligations. The most promising locations include Loggy Bayou (MM 194), Clark's Marina Islands (MM 204), 1-220 Bridge (MM 235), and Cat Island (MM 244). The Red River is the perfect locale to try an experiment such as this, because of its width, regularity of barge traffic bringing revetment rock, and the large numbers of Least Terns present.

Two round, concrete, mooring piers are located in the river at Harrahs' Casino (MM 228.5). These piers are tall, flat, solid concrete on top and would make excellent, inexpensive places to try an experiment similar to that suggested with the barges. The presence of Cross Bayou gives this location extra appeal because the change in water clarity, and varying fish forage opportunities, would work to the terns advantage. I saw Least Terns at this location every time I passed it.

Piles of sand were left by a dragline in 1998 as it opened a pathway through the original Loggy Bayou colony site (MM 194) while constructing two dikes. These piles need to be leveled so the terns can return to nest on them. The flattened tops would be higher above river flood level than any other island, thereby providing safe nesting during times of river flooding. Material dredged from the navigational channel along the entire J. Bennett Johnston Waterway could be used to build nesting locations for Least Terns.

Solar-powered electric fences need to be placed perpendicular to the approach route of raccoons and coyotes to halt their depredation, especially at colonies 2 and 6. This measure has proven effective against foxes at Cape Cod National Seashore, MA (Minsky 1980). The same barrier could be used across the dikes at the original Loggy Bayou island (MM194), after it is flattened.

Another problem that will confront Least Terns on the Red River, in the future, is the initiative to extend the lock and dam system through northwestern Louisiana, Arkansas, and into Texas and Oklahoma. A complete study by the U. S. Army Corps of Engineers for an additional system of four locks and dams in Louisiana and Arkansas, was started in 1999. The proposal would bring the Red River under control in all of Arkansas and Louisiana. Following that a new proposal would extend the system to Dennison Dam at Lake Texoma. Records from Oklahoma show Least Terns nesting along the Red River in Bryan, Choctaw, and McCurtain counties; the highest number counted was 85 in 1991, the most fledglings counted were 17 in 1997; and in 1998 four nests were known to fledge 2 birds (Oklahoma Natural Survey 1999). A complete survey of the Oklahoma portion of the Red River would provide information needed to address potential problems connected with the extension of the navigation project into that area. Any such future plans must consider the impact that will be made on Interior Least Tern colonies.

Only two Least Tern colonies (5 and 6), are in the pool areas of the Red River from Lock and Dam 1, MM 44 to Shreveport, MM 235. They will both need annual vegetation control. Chemical weed and brush control is in use on some Mississippi River sand bars and could work here. Cutting with a weed cutter plowing, or disking seems the best way to control vegetation. Colony 5 the most successful colony in 1999, has had its last nesting season at Eagle Bend unless the vegetation is controlled. The river does not flood over the island with enough scouring action to control the vegetation as it would under natural conditions. The above situation is a major reason why the Interior Least Tern is endangered. The Arkansas River has had a navigation channel across the entire state of Arkansas for over 30 years. Least Tern nesting sites were flooded by the series of locks and dams. Very few Least Terns nest now on the Arkansas River (James and Neal 1986). Perhaps we can prevent what has happened to Least Terns on the Arkansas River from happening on the Red River. A program for survival of the species in the local area needs to be formed.

The Red River north of Shreveport will continue to support a Least Tern population, unless the lock and dam system is extended farther upstream. The fisheries population is adequate to meet the terns' needs. The islands come and go, and come again. The terns can accommodate this natural occurrence very well. The fidelity of Least Terns to a certain nest island is transient, but their attachment to a certain short stretch of river is strong (Renken and Smith 1995). If it is determined economically feasible to extend the lock and dam navigation system further into free-flowing river areas of Louisiana, Arkansas, Texas, and Oklahoma, then loss of nesting territory for Least Terns will occur, similar to that documented here. I counted two colonies in 371 km of controlled river, as opposed to 19 colonies in 261 km of flowing, more nearly natural river. An example of a free-flowing river with a high Least Tern nesting success rate exists in the Yellowstone River, Montana, with a 3 year average of 84.2%. This is higher than nesting success on the Missouri River 51%, Platte River 38%, and Mississippi River 60% (Bacon and Rotella 1998). All the studies cited above show nesting success rates considerably higher than I found in 1999 on the Red River of Louisiana with only 27%. Before any further navigation projects are initiated, or dams

constructed, tern survival projects should have been underway and proven to work in the dammed part of the river. Then a recovery program can be put in place.

Although many agencies are connected to the development of the Red River, none has yet come forward to aid the Interior Least Tern colonies in respect to the problems set forth in this paper. The Red River Wetlands Coalition has been involved in educating the public regarding the natural value of the Red River. The Nature Conservancy, The Natural Heritage Foundation, Louisiana Department of Wildlife and Fisheries, and the U. S. Fish and Wildlife Service all need to be involved. Northwestern Louisiana would benefit from a branch office of the U. S. Fish and Wildlife Service. A bill to establish a National Wildlife Refuge along the Red River in northwest Louisiana has been introduced in congress and some lands already acquired. This would bring a unit of the U. S. Fish and Wildlife Service to the area. The Red River Valley Assn. also is involved in the development of the river but could be involved in assisting tern restoration projects, by providing logistic support involving transportation of materiel and equipment where needed. The U. S. Army Corps of Engineers has the final decision on the future of the Red River, depending on congressional approval. The 415 adult Least Terns and the 71 young they raised in 1999 represent an important portion of the total population, nearly 6%, of an endangered subspecies. Management procedures must be set in place soon.

The Least Tern population detailed in this study on the Red River should be the subject of continued studies. The number of terns reported here is higher than any area except the Mississippi and Missouri Rivers. The comparison of nesting success in pooled waters and flowing waters needs further study. Maintaining suitable nesting islands is a needed project. The threat of further navigation projects needs addressing. The Arkansas colonies need a detailed study to be made of their islands, predators, nesting success, and fledging success.

After traveling 1932.8 km on the Red River, and spending 29 days during June, July and August 1999, I have determined that fluctuations in the river level are the main cause of nesting failure of Least Terns over the last twelve years. The flash flood conditions, which were the primary cause of loss in 1999, would be secondary to river flooding in most years. Between 1988 and 1999, ten years had rising river flood conditions and only five years had rain flash flood conditions. Considering the endangered status of Interior Least Terns, all feasible measures suggested here-in need to be put in action, as each would play a part in contributing to the total success of a recovery program.

The Red River water is clean compared to many other American rivers. However, point source pollution was observed in two states. Vigilance needs to be maintained in order to improve and assure water quality.

One adult Least Tern found dead (cause undetermined) was within 2 km of the discharge line at MM 190. Least Terns definitely have a future in the Arkansas and Louisiana sections of the Red River. This future will be very limited if the current lack of management continues. If most of the recommendations proposed in this article are implemented, their future will be considerably brighter. If the economic advancement of the areas involved is the only consideration of those who manage the river, the Red River Interior Least Tern population here will drastically decline.

ADDENDUM

Some new information regarding Least Tern Colony nesting sites was discovered during a two- day trip on the Red River. On 19 Jun 2000, with Army Corps of Engineers personnel, I traveled from Cat Island (MM 244) to Lock and Dam 5. We saw 23 Least Tern adults, all in flight, (apparently searching for nesting locations) or riding on logs. The river was very high, completely over Cat Island, leaving only the log above water at Cattle Island MM 238, and no sandy portions of islands were seen within the area covered. Colony 5 MM 221 is not being used as a nesting location because it is overgrown with brush and weeds. Eight terns were at Cattle Island, and 7 were at Colony 5. All the first nesting attempts were flooded out and the birds were just waiting for the water to recede.

On 20 June 2000 we traveled from Lock and Dam 5 MM 200 to St. Maurice MM 141. The Least Terns were doing better in pools 4 and 3. I found two new colonies, which are numbered LA 8 and LA 9. No terns were seen south of colony LA 9.

Colony 8 is located on 4 very small islands (27 m x 22.5 m largest), at MM 188.8 in Red River Parish. Fifteen Least Terns were present with 3 nests and 1 egg in each nest (3 eggs). Many other scrapes indicate that other birds plan to nest there. This location is 3 miles farther south than the southernmost known nesting location on the Red River {Colony 6 (MM 191)}. This new island was bare of all vegetation and only 1 foot above water level, at the time we visited it, and terns had just started to lay.

Colony 9 is located on a medium sized island (115.2 m x 37.8 m), at MM 157.3. This colony had 30 adult Least Terns at nine nests with 23 eggs. This is the first recorded nesting of Least Terns in Natchitoches Parish and is 34 miles farther south than any documented nesting of Least Terns on the Red River prior to this year. This location, near Campti, LA, is a new island and is bare of all vegetation. This colony had a better location than Colony 8, got an earlier start, and will probably have a more successful nesting season.

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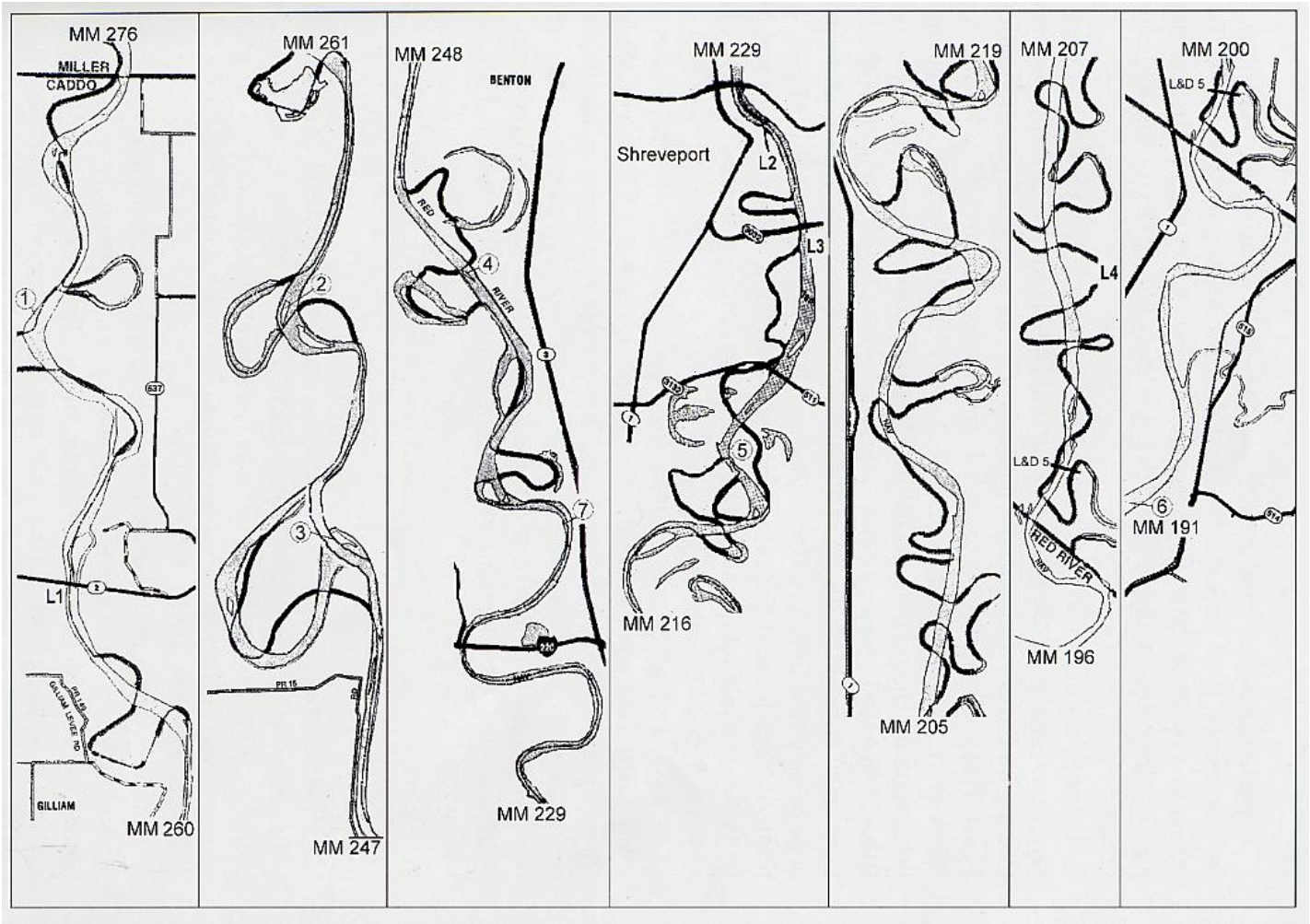
FIGURE 1

Mosaic map of the Red River in Louisiana, from the Arkansas line to a point south of Loggy Bayou, showing seven adjoining sections of river from MM 276 (north) to MM 189 (south). Four boat launches are shown: L-1 - is LA hwy 2 Bridge, launch opened 22 Apr 2000, L-2 is Stoner Ave in Shreveport, L- 3 is Arthur Teague Drive in Bossier City, and L-4 is Clark's Marina near McDade, LA. Three other launches were used but are not in the area covered by the map: Spring Bank Bridge on AR hwy 160, Loggy Bayou Wildlife Management Area east of U. S. hwy 71 in south Bossier Parish, and U. S. 84 Bridge in Coushatta, LA. Eighty-seven miles of river are shown from left to right, north to south, showing all seven LA colonies of Least Terns designated by numbers 1-7 (circled).



APPENDIX 1

Low and High Water Levels for May, June, and July 1988 – 1999, Taken in Shreveport, Louisiana, and Fulton, Arkansas, from US Weather Service, Shreveport Regional Office. The Red River stage at which a majority of Least Tern nests are flooded at Fulton is 2.4 – 2.7 m (8 – 9 ft), and at Shreveport before 1996, is 3.0 – 3.4 m (10 - 11 ft), and after 1995, is 4.9 m (16 ft). All measurements are recorded in feet.

Date		Fulton		Shreveport		Remarks
		Low	High	Low	High	
May	1988	2.9	7.2	4.8	10.0	Probably a good year for terns, as suggested by water levels
Jun	1988	2.4	3.0	3.9	4.8	Good level for nesting
Jul	1988	2.5	5.5	3.9	6.4	Young terns raised
May	1989	4.3	19.4	8.9	21.8	Water too high for tern nesting
Jun	1989	16.0	20.3	17.5	22.8	Water too high for tern nesting
Jul	1989	9.3	15.5	14.3	21.5	None raised
May	1990	20.5	34.3	23.6	34.2	Water too high for tern nesting
Jun	1990	15.3	24.1	19.9	27.1	Water too high for tern nesting
Jul	1990	2.1	15.3	10.4	19.1	A few chicks may have fledged
May	1991	8.4	16.0	13.9	23.8	Water too high for tern nesting
Jun	1991	6.7	14.4	10.2	16.3	Water too high for tern nesting
Jul	1991	2.5	8.9	4.7	12.8	A few chicks may have fledged
May	1992	3.1	11.6	8.4	13.6	None raised
Jun	1992	6.5	17.8	10.4	20.1	None raised
Jul	1992	5.8	15.7	10.2	18.3	None raised
May	1993	10.9	19.1	13.1	22.0	Water too high
Jun	1993	6.7	16.0	10.0	17.9	Water still too high
Jul	1993	2.7	6.6	4.5	10.0	A few chicks may have fledged
May	1994	3.0	14.9	4.7	18.1	None raised, too much fluctuation
Jun	1994	3.0	12.9	4.8	17.0	None raised, fluctuation & flooding
Jul	1994	3.4	11.0	4.7	14.7	None raised
Jan	1995					Lock and Dam 5 was completed
May	1995	6.8	18.7	17.1	25.8	High/steady, new Shreveport level
Jun	1995	12.4	15.1	19.4	21.4	None raised
Jul	1995	3.8	14.1	13.9	19.5	None raised
May	1996	3.6	9.2	14.1	16.1	None raised
Jun	1996	2.5	6.3	14.0	14.7	None raised
Jul	1996	3.2	10.3	13.9	16.5	None raised
May	1997	6.6	13.1	18.3	26.8	Flood water, none raised
Jun	1997	4.9	10.0	16.4	19.3	High water, none raised
Jul	1997	2.9	5.8	14.2	16.6	High water, none raised
May	1998	1.3	5.8	14.3	16.1	Low water, nesting
Jun	1998	0.9	3.9	14.1	16.1	Lower water, nesting success
Jul	1998	0.8	2.1	14.2	14.4	Record hot and dry summer
Aug	1998	0.6	1.9	14.1	14.5	Conditions were good for terns
May	1999	3.1	12.4	15.6	20.0	Water too high early May
Jun	1999	2.2	7.9	15.0	16.8	Flooded in late June
Jul	1999	3.7	9.1	15.5	17.4	Fifty percent of the nests were flooded

APPENDIX 2

Nesting results of Least Terns on seven sand bar islands on the Red River in Louisiana.
MM = Mile Marker on the river
Scrape = a nesting depression scratched out by the hen for possible use
fledged = 3 weeks old, capable of flight

Colony Number	Date	Number					Notes
		Adults	Nests	Scrapes	Eggs	Young	
1-MM 270	Jun 7	28	0	Y	0	0	Pre-laying, Courtship
1-MM 270	Jun14	21	10	Y	28	0	Laying and Incubating
1-MM 270	Jun 29	24	7	Y	0	0	6 Nests flooded
1-MM 270	Jul 9	30	3	Y	5	3	Hatching to 4-10 day age
1-MM 270	Jul 20	20	2	N	2	1	1 new nest
1-MM-270	Jul 31	21	0	N	0	14	14 fledged
2-MM 257	Jun 7	26	8	Y	21	0	Incubating
2-MM 257	Jun 14	42	23	N	64	0	4-wheeler, coyotes, wild pigs rooting
2-MM 257	Jun 29	32	2	--	6	2	20 nests destroyed by flash flood Jun 24-25
2-MM 257	Jul 13	30	4 new	Y	6	1	Coyote tracks, 4-wheeler tracks
2-MM 257	Jul 15	30	1 new	N	2	4	Running young terns
2-MM 257	Jul 21	30	3	N	5	3	3 fledged
2-MM 257	Jul 26	22	0	N	0	5	5 fledged total
2-MM 257	Aug 5	9	0	N	0	0	Migration south started
3-MM 250	Jun 7	10	2	N	6	0	Courtship displays, pair bonding rituals
3-MM 250	Jun 14	10	0	N	0	0	4-wheeler destroyed 2 nests
3-MM 250	Jun 29	6	1	N	3	0	Wild pig tracks, 40 Fish Crow on Island
3-MM 250	Jul 13	0	0	N	0	0	Abandoned by Least Terns
4-MM 244	Jun 7	10	2	Y	6	0	No cover for protection
4-MM 244	Jun 14	8	2	Y	6	0	Incubating
4-MM 244	Jun 21	6	0	N	0	0	Fish crow suspect in nest destruction
4-MM 244	Jun 29	13	2	N	4	0	Eggs washed out by flash flood
4-MM 244	Jul 13	31	2 new	--	2	0	Rebuilding nests
4-MM 244	Jul 15	17	0	N	0	2	Fish Crow destroyed 1 nest
4-MM 244	Jul 26	19	0	N	0	3	3 fledglings
4-MM 244	Aug 5	18	0	N	0	3	3 fledged
5-MM 221	Jun 8	14	7	Y	19	0	Incubating, courting
5-MM 221	Jun 15	20	8	N	20	0	All incubating
5-Mm 221	Jun 21	17	9	N	28	0	All incubating
5-MM 221	Jun 30	18	5	N	15	5	Hatching, incubating
5-MM 221	Jul 8	16	2	N	5	4	Hatching, feeding
5-MM 221	Jul 15	18	0	N	0	6	Feeding, protecting
5-MM 221	Jul 27	14	0	N	0	16	Most successful colony

APPENDIX 2 continued

Colony Number	Date	Number					Notes
		Adults	Nests	Scrapes	Eggs	Young	
5-MM 221	Aug 11	0	0	0	0	0	16 fledged
6-MM 191	Jun 9	26	3	Y	9	0	Pre-nesting, courting
6-MM 191	Jun 15	20	2 new	Y	3	0	2 nests destroyed, coyotes
6-MM 191	Jun 22	32	8	Y	19	0	Tracks Of raccoons, kids, & coyotes
6-MM 191	Jul 2	32	13	N	30	0	River rising fast
6-MM 191	Jul 19	26	12 new	N	24	0	All old nests flooded, no hatching, rebuild
6-MM 191	Jul 27	20	12	N	24	2	2 hatched, beaver tracks
6-MM 191	Aug 2	24	10	N	18	2	Incubating, feeding
6-MM 191	Aug 11	15	0	N	0	6	6 fledged
7-MM 238	Jun 7	8	1	--	0	0	1 nest destroyed by cattle
7-MM 238	Jun 21	10	3	--	8	0	1 nest destroyed by cattle
7-MM 238	Jun 29	17	6	--	15	2	No cattle due to high water
7-MM 238	Jul 8	18	1	--	2	0	4 nests & 3 chicks destroyed by cattle
7-MM 238	Jul 13	12	2	Y	4	0	Adults protecting young
7-MM 238	Jul 15	12	2	N	4	0	Feeding
7-MM 238	Jul 26	12	0	N	0	2	1 nest destroyed by cattle
7-MM 238	Aug 5	3	0	N	0	3	3 fledged