

**Kansas River
Interior Least Tern and Piping Plover
Productivity Report**

February 2006

**Prepared by:
U.S. Army Corps of Engineers
Kansas City District
760 Federal Building
Kansas City, Missouri**

EXECUTIVE SUMMARY

The USFWS issued a Biological Opinion (BiOp) on November 30, 2000 titled: *Operation of the Missouri River Main Stem System Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System*. The BiOp included a jeopardy finding for the federally endangered interior least tern (*Sterna antillarum*) and piping plover (*Charadrius melodus*). An element of the Reasonable and Prudent Alternative (RPA) for the two species stated “to facilitate decision making on Kansas River terns and plovers, the Corps shall collect and evaluate productivity, habitat, and other pertinent data to identify whether the Kansas River provides a source or sink for least terns and piping plovers.” An amendment to the BiOp issued in December of 2003 did not change this element of the RPA. However, the USFWS sent a letter on June 26, 2006 to provide additional guidance on the BiOp. They stated that an analysis and report of the reproductive output of nesting least terns and piping plovers, as monitored from 2000 to 2005, would fulfill the intent of the BiOp. This report provides that requested evaluation.

Piping plovers and least terns nesting on the Kansas River produced only 0.2 percent of the Missouri River Basin’s (basin) piping plover fledglings and 1.4 percent of the basin’s least tern fledglings, from 2000 to 2005. This low level of productivity on the Kansas River contributed little to the overall basin population recovery of the species.

Also, the sand bars created by the record flood of 1993 and used as nesting habitat by the piping plover and least terns along the Kansas River have had an increase in revegetation by woody plants. This deterioration of nesting habitat will likely make nesting success on the Kansas River more difficult in the future.

An analysis of Kansas River lake operations since 1998 through 2005 indicates that approximately seven of 177 tern and plover nests likely benefited from our Actual Operations versus the Water Control Manual operation. Also, these seven nests only fledged 8 to 11 chicks out of the total of 67 chicks fledged on the Kansas River from 1998 to 2005 and were only 0.2 to 0.3 percent of the basin wide number of least tern fledglings from 1998 to 2005.

The Corps recognizes that protecting listed species under the Endangered Species Act (ESA) is important, along with the importance of other project purposes of our Kansas River tributary lakes. We also recognize the minimal impact our Kansas River tributary lake operation has on the total least tern and piping plover populations throughout the Missouri River basin. Further, Kansas River tributary lake operation has also had minimal impact the past seven years on least tern and piping plover populations on the Kansas River.

Based on the results of this study, the Corps recommends: 1) operating within the reasonable flexibility of the Corps Water Control Manuals; and, 2) standardizing our bird monitoring with a: a) spring distribution survey, b) mid-season adult census and nesting survey for occupied sites, and c) productivity survey timed to coincide with the expected fledging peak. Also, prior to and after any release that may impact eggs and or chicks; we will monitor the nesting colonies to document take. Further, the Corps will continue to coordinate Kansas River reservoir operations with the ACT using a Missouri River Basin-wide focus and in accordance with the 2003 Amendment to the BiOp.

INTRODUCTION

The U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion (BiOp) on November 30, 2000 titled: *Operation of the Missouri River Main Stem System Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* (USFWS 2000). The BiOp included a jeopardy finding for the federally endangered interior least tern (*Sterna antillarum*) and piping plover (*Charadrius melodus*). In the BiOp, an element of the Reasonable and Prudent Alternative (RPA) contained stated “to facilitate decision making on Kansas River terns and plovers, the Corps shall collect and evaluate productivity, habitat, and other pertinent data to identify whether the Kansas River provides a source or sink for least terns and piping plovers.” An amendment to the BiOp issued in December of 2003 did not change this element of the RPA (USFWS 2003). However, the USFWS sent a letter on June 26, 2006 to provide additional guidance on the BiOp. They stated that an analysis and report of the reproductive output of nesting least terns and piping plovers, as monitored from 2000 to 2005, would fulfill the intent of the BiOp. This report provides that requested evaluation.

The large and prolonged record flood flows of 1993 scoured a number of sandbars in the Kansas River of vegetative cover. In 1996, the interior least tern and piping plover were discovered nesting on several recently scoured sand bars in Wabaunsee County between the cities of Manhattan and Wamego. This was the first documented account of piping plovers nesting in Kansas, and the first account of least terns nesting on the Kansas River.

In 1998 the Corps initiated formal consultation on the operation of the Kansas and Missouri River reservoirs with the USFWS under Section 7 of the Endangered Species Act (ESA). This consultation resulted in the RPA previously mentioned as part of the November 30, 2000 BiOp. During the nesting season, the Corps coordinates extensively with the USFWS to minimize impacts to downstream nests. The number of least terns and piping plovers nesting on the Kansas River is relatively small; however, Section 7 and 9 of the ESA still requires protection for all individuals of listed species.

LEAST TERN AND PIPING PLOVER NEST MONITORING

The least tern breeds along coastal beaches of the Atlantic, Gulf of Mexico, and California as well as on sandbars, dredge spoil and alkaline flats associated with interior rivers. In the past the Interior subspecies (*S.a. athalassos*) was restricted to the Rio Grande, Red, Arkansas, Missouri and Mississippi Rivers and some of their tributaries from Texas northward to the upper reaches of the Missouri River in North Dakota and Montana (Thompson et al., 1997).

Until recently, the piping plover nested on open beaches along the Atlantic coast as well as sandbars along rivers and lakeshores from the Platte River in Nebraska, northward into Canada and several locations around the Great Lakes (Haig, 1992).

Primarily due to habitat loss and human disturbance, both species have received federal protection under the ESA. The California and Interior populations of the least tern were

designated as endangered in 1980 and 1985, respectively (Thompson et al., 1997). Also, in 1985 the piping plover was designated as endangered around the Great Lakes and Canada and threatened throughout the rest of its range in the United States (Haig, 1992).

In 1994, a population of least terns was observed nesting near the Kansas River on fly-ash spoil piles at Jeffrey Energy Center in northeastern Kansas. Record high water events on the Kansas River in 1993 and 1995 resulted in many newly scoured sandbars on the Kansas River. The first documented nesting of least terns and piping plovers on the Kansas River was in 1996 and 1997 (Busby et al., 1997). This was the first nesting of the piping plover ever recorded in Kansas and the first time the least tern was known to nest along the Kansas River.

Beginning in 1998, Dr. Roger L. Boyd of Baker University was contracted to monitor the least tern and piping plover nests on the Kansas River during the breeding season and determine productivity. Funding for the 1998 study was provided by the USFWS and, since 1999, has been provided by the Corps. More intensive nest monitoring was initiated in 2000 with annual reports summarizing yearly nesting activity. The monitoring objectives were:

- Determine nest initiation timing and examine what factors may influence nest initiation along the Kansas River.
- Determine nest locations and elevation in relation to current water flow.
- Since 2003, survey the Jeffrey Energy Center for nesting terns and plovers.
- Once nests were initiated, determine estimated fledging date.
- Determine total number of active breeding pairs along the river (and since 2003, at Jeffrey Energy Center).
- Whenever appropriate, capture and band adult terns in order to facilitate re-sightings (to facilitate recaptures elsewhere in the system, assist in determining fledging success, and aid in determining whether the Kansas River is a source or sink for the population).
- When possible, capture and band juvenile terns (U. S. Geological Survey bands only).
- Determine fledging success and calculate fledging ratio for the season.

STUDY METHODS

Annual airboat surveys in late April and early May were used to locate active nest sites on the Kansas River. The elevation of each nest was surveyed using a construction level on a tripod and a measuring rod. This elevation was then converted to a gage elevation on the nearest USGS stream gage which then was used to monitor the approximate river elevation at the nest by checking the gage reading on the internet. Latitude and longitude coordinates were taken for

each nest using a portable global positioning system. Nest survey data was e-mailed to the Corps and the USFWS to aid in lake operations immediately after each survey.

If necessary, egg flotation was used to determine age of incubation (Hayes and LaCroy 1971) and the date of hatching and fledging was estimated for each nest. For least tern nests, 21 days was used to estimate both hatching and fledging times (Thompson et al. 1997). For piping plovers, 28 days incubation (beginning with the third egg) and approximately 28 days for fledging was used (Haig, 1992). If necessary, the estimated fledging date was adjusted once the eggs hatched.

Periodically from May through August, USFWS and Corps personnel conducted airboat surveys for additional nesting locations. These surveys were critical to the overall monitoring process and the most effective mechanism of surveying the river due to limited number of access points and shallow water depth.

After nests were located, disturbance of the nesting colony was minimized whenever possible by observing from a distance the presence of incubating birds and juveniles. During the third week of incubation, an effort was made to capture incubating adult terns for the purpose of banding or determining when and where they had been previously banded. Capture on the nest was done using a radio controlled bail trap. When an adult was not captured, an effort was made to determine whether those adult least terns were banded or not.

Captured adult terns were banded with a U.S. Geological Survey band on the left leg and a yellow color band on the right leg. Both bands were placed on the lower metatarsus. Each nesting season, efforts were made to observe each nesting pair to determine if they were banded. Often the incubating adult would simply land on the nest without any opportunity to observe its legs for bands. When the adults did land close to the nest, it was difficult to observe their legs for bands due to their very short size and the inability to get a clear view.

Due to high incidence of predation during the 2002 nesting season, nest exclosures were used to reduce the chance of predation. The use of nest exclosures is consistent with Reasonable and Prudent Measure (RPM) #6 from the 2000 BiOp. This RPM states that “the Corps shall implement aversive actions to reduce predation on least tern and piping plover nests, chicks, and adults” and “the following management actions shall be taken to implement this RPM. The Corps shall implement all available predator management techniques to support tern and plover productivity, including, but not limited to nesting exclosures, trapping, and strobe light systems.” Exclosures were constructed based on designs used on the upper Missouri River (C. Kruse, pers. com.) for both piping plovers and least terns and were constructed of weld-wire with 4 x 9 cm (1.5x3.5”) openings (USACE 2003). Nest exclosures were buried into the ground 5-10 cm and anchored into the ground with rebar 25 cm long.

Once the eggs hatched, the juvenile terns were banded with a USFWS band on the left leg. No color band was applied to the juveniles. They were banded as shortly after hatching as they could be located. None of the piping plover chicks were banded as our contractor did not have a banding permit for this species.

RESULTS

Nest monitoring was initiated in 1998 to determine general productivity by the terns and plovers nesting on the Kansas River. More intensive nest monitoring was initiated in 2000 and included annual reports summarizing the nesting activity for that year. There were twelve locations along the Kansas River between the cities of Manhattan and Lawrence where terns and plovers nested from 1996 to 2005 (Figure 1). The following is a summary of nesting data as presented in the annual reports from 2000 through 2005. Based on banding observations, it is known that least terns move regularly between the Kansas River and the Jeffrey Energy Center, especially during high water events on the Kansas River during the nesting season. Data on nesting at the Jeffrey Energy Center is presented separately but is not included in the discussion section as they reflect management actions, or lack thereof, taken at this site rather than on the Kansas River.

Nesting Habitat

All of the nesting sites previously used along the Kansas River have followed a typical successional process after the unusually high scouring flows of 1993 and 1995. This consists of larger islands and sandbars becoming stabilized with woody vegetation and smaller islands and sandbars becoming lower as they are increasingly over-topped by high-flow events (Keenlyne 1993, Kirsch and Lingle 1993, Latka et al. 1993, Sidle et al. 1993). This phenomenon has been documented at the Belvue site in a series of pictures taken during the years of the survey (USACE 2004).

Figure two compares the amount of woody debris at the nesting colony site on three different dates. In June 2004 there were many large debris piles covering much of the sandbar. The middle panorama photo shows what the Belvue nesting site looked like just prior to high flows that occurred on the Kansas River in the early summer of 2005. The bottom image shows how the high flows in early June 2005 removed much of the woody debris except to the southwest. However, there is still significant invasion of willows and cottonwoods on the northern and eastern edges of the sandbar.

Piping Plover Nesting

Since 1998, the Kansas River has had a total of 21 nesting pairs of piping plovers (Table 1) with an average of two to three pairs annually. These birds have fledged 20 juveniles for a weighted fledge ratio of 0.95 fledglings (1998 to 2005).

Since 2000 (when more intensive monitoring was initiated on the Kansas River), 23 piping plover nests were observed including renests by a couple of pairs which lost their initial nests. These 23 nests produced a total of 80 eggs, of which 38 hatched for a success rate of 48% (Table 1). Of all nests; 48% hatched, 22% were destroyed by predators, 13% were flooded by uncontrollable river flows, 9% were abandoned, 4% (one) was taken by lake releases, and 4% (one) had an unknown fate (Table 2).

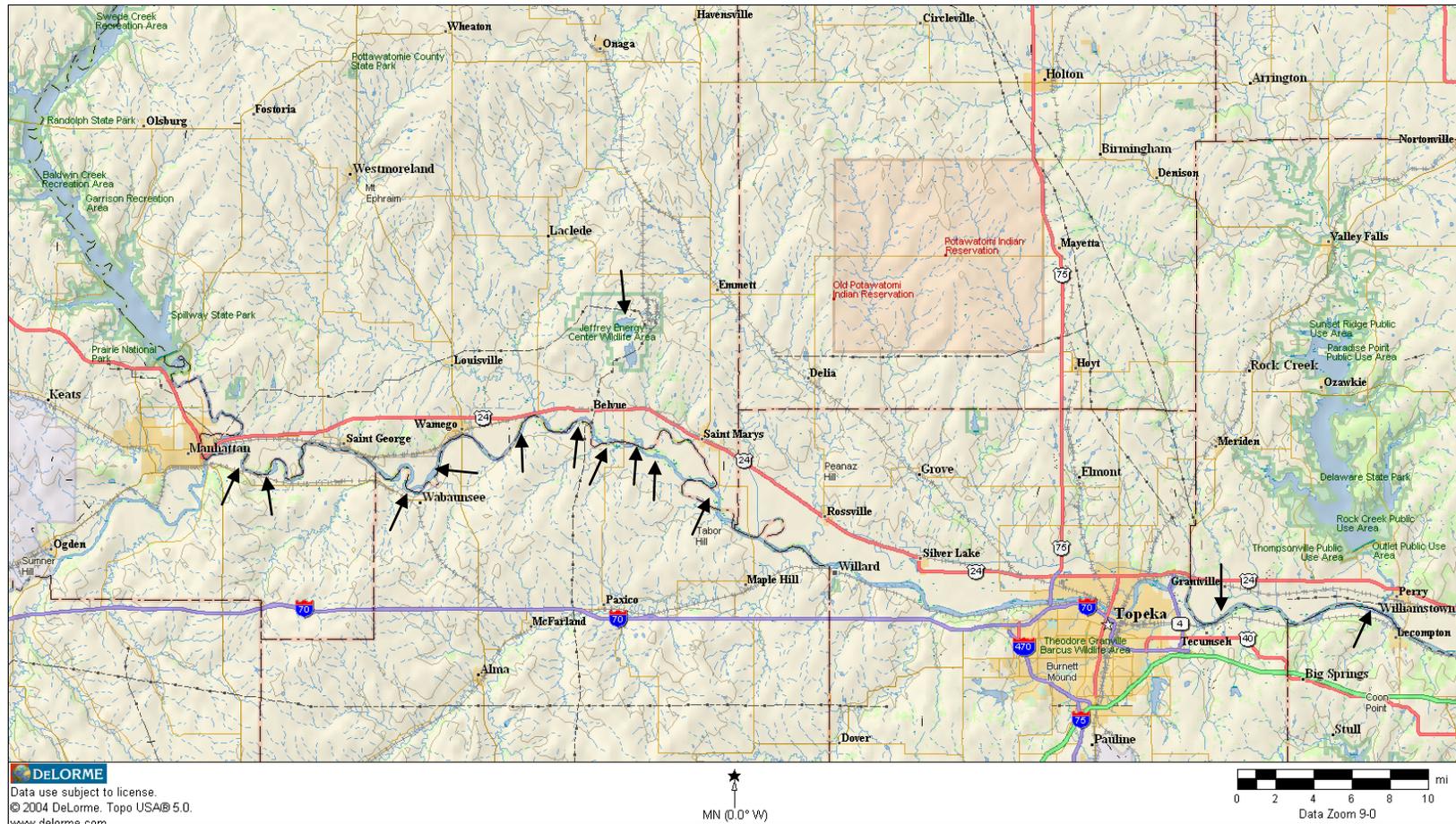


Figure 1. Map showing the locations (black arrows) of documented nesting locations of least terns and piping plovers on the Kansas River from 1996 to 2005. From left to right the locations are: Battery Bar, Swamp Angel, Wabaunsee, Wabaunsee Annex, Vermillion, Jeffrey Intake, Paxico Bridge West, Belvue, Belvue Annex, St. Marys, Frank's Island, and Lecompton. The location northwest of St. Marys and west of Emmett is Jeffrey Energy Center.



Figure 2. Successional changes of Belvue Colony site between 2004 and 2005. The amount of logs and debris increased during the 2004. The July image shows the absence of these log piles after the high water event in early June 2005. Invasion of willows and cottonwoods continues to be a concern.

Table 1. Piping Plover Population Survey & Productivity Monitoring for the Kansas River.

YEAR	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
1998	3						6	2.00
1999	2						0	0.00
2000	2	2	2	100	7	7	6	3.00
2001	2	3	1	33	9	4	0	0.00
2002	3	4	2	50	14	4	4	1.33
2003	4	6	1	17	23	3	0	0.00
2004	2	3	2	67	10	8	3	1.50
2005	3	5	3	60	17	12	1	0.33
TOTALS	21	23	11		80	38	20	

Interior Least Tern Nesting

From 1998 to 2005, the Kansas River had 99 nesting pairs of least terns (Table 3) with an annual average of 12 pairs. These birds have fledged 47 juveniles with a weighted fledge ratio of 0.47 fledglings/pair.

From 2000 to 2005, least terns on the Kansas River had 154 nests, including renesting by some pairs which lost their initial nests. Of these nests, 21% hatched, 28% were destroyed by predators, 28% were flooded by uncontrollable river flows, 17% were abandoned, 5% were lost to the weather, and one nest (1%) was destroyed by humans (Table 4). These nests produced a total of 352 eggs, of which only 75 (21%) hatched (Table 3).

Banding and Recaptures

Banding was done to facilitate recaptures elsewhere in the system and to assist in determining fledging success.

None of the piping plover chicks were banded as our contractor does not have a banding permit for this species. However, a previously banded piping plover was apparently observed nesting on the Kansas River for three consecutive nesting seasons (2003– 2005). With permission from the USFWS, this bird was captured and identified in 2003. This plover was from an egg salvaged from Lewis & Clark Lake in 2001 and hatched and raised at the Gavins Point captive rearing facility. The chick was banded and, after fledging, was released on August 6, 2001 on Lewis & Clark Lake. The banded plover was not caught and identified in 2004 or 2005; but, based on field observations, was thought to be the same bird identified nesting on the Kansas River in 2003.

Juvenile least terns were first banded near the Kansas River at the Jeffrey Energy Center in 1995 and 1996 before any birds were banded along the Kansas River. Since 1995, there have been 146 juveniles and 57 adults banded along the river, including the Jeffrey Energy Center. There have been 37 recaptures during this time which included 16 different adults, six different juveniles, and three foreign birds. Several birds have been recaptured more than once. Figure three illustrates the time distribution of these recaptured individuals, excluding foreign birds. With 28 percent (16 of 57) of the banded adults having been recaptured in later nesting seasons between 1995 and 2005, it appears that least terns on the Kansas River have relatively strong site tenacity, especially to historical sites of successful nesting (Boyd 1993, Thompson et al. 1997, USACE 2005). Four of the sixteen adult recaptures were recaptured twice during the study. Welty (1975) refers to bird species with nesting site tenacity based on recapture rates ranging from 7 to 83 percent. Also, of six juveniles recaptured, four were males and two were females. This supports previous research that indicates female birds tend to disperse and males tend to show more homing behavior (Boyd 1962, Greenwood 1980, Lenington and Mace 1975, Wilcox 1959). However, this is a very small sample and the results should not be considered conclusive.

Table 2. Piping Plover Nest Losses 2000 – 2005.

YEAR	UNCONTROLLED FLOODING	LAKE RELEASES	WEATHER	DEPREDATED	HUMAN DISTURBED	ABANDONED	UNKNOWN	TOTAL
2000								0
2001	1	1						2
2002				1			1	2
2003	2			2		1		5
2004				1				1
2005				1		1		2
TOTAL	3	1		5		2	1	12

Table 3. Least Tern Population Survey & Productivity Monitoring for the Kansas River.

YEAR	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
1998	18						14	0.78
1999	7						0	0.00
2000	11	23	12	52	58	30	15	1.36
2001	6	7	2	29	15	5	3	0.50
2002	17	39	4	10	87	10	7	0.41
2003	19	36	7	19	80	17	5	0.26
2004	16	31	2	6	75	4	0	0.00
2005	5	18	5	28	37	9	3	0.60
TOTALS	99	154	32		352	75	47	

Table 4. Least Tern Nest Losses on the Kansas River 2000 – 2005.

YEAR	UNCONTROLLED FLOODING	WEATHER	DEPREDATED	HUMAN DISTURBED	ABANDONED	TOTAL
2000	5	2	3		1	11
2001	3	1	1			5
2002	1	3	26	1	4	35
2003	9	1	10		9	29
2004	19				10	29
2005	6	1	3		3	13
TOTAL	43	8	43	1	27	122

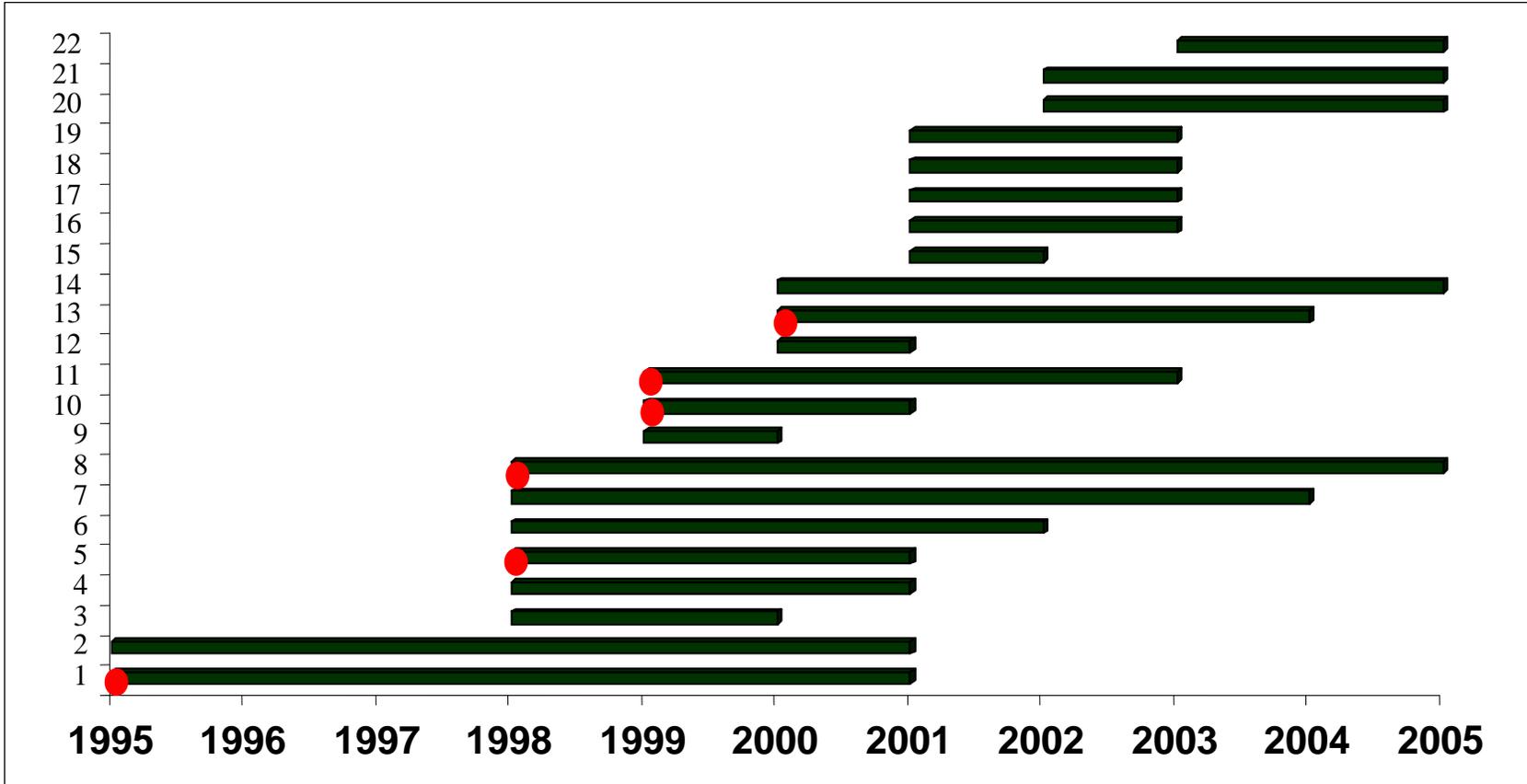


Figure 3. The dates that 22 different least terns were recaptured. The left end of the bar is when the bird was originally banded. The right end of the bar is the year it was last captured. The illustration does not indicate intermediate dates that the bird may have also been captured. The red circles indicate birds that were originally banded as juveniles.

There are a number of factors that prevent the recapture of all adults present in the breeding population at a nesting colony. Therefore, the numbers of recaptured banded birds does not accurately reflect the number of birds occurring within the population. These factors include:

- Once captured as an adult, they recognize the trap and tend to avoid it.
- If they are paired up with an unbanded bird, the unbanded bird will readily come to the trap. If the unbanded bird is captured, its banded mate will often not come back to the nest.
- If the nest was lost prior to the third week of nesting, which is when all trapping and banding took place.
- The later in the nesting season that the birds nest, the urge to incubate is less tenacious and trapping increases the risk of nest abandonment.

During 2005, there were 17 nests where the birds were observed well enough to determine if they were banded and whether or not they had a color band. At seven of these nests, only one bird from the pair were observed well enough to determine if they were color banded. Six of these birds were color banded and one was not. At the other ten nests, both nesting adults were observed. Sixteen of these birds were color banded and only four were not. The observations of both nesting adults at these ten nests would indicate that as much as 80% of the population may be color banded.

Jeffrey Energy Center Nesting

From 2003 to 2005, the Jeffrey Energy Center had 20 nesting pairs of least terns that fledged seven juveniles. The weighted fledge ratio for the years 2003 to 2005 was 0.35 fledglings/pair (Table 5). The Jeffrey Energy Center had 23 least tern nests, including renesting by some pairs which lost their initial nests. Of these nests; 57% hatched, 30% were destroyed by predators, 9% were lost to the weather, and one nest (4%) was abandoned (Figure 4 and Table 6). These nests produced a total of 51 eggs, of which 27 hatched (53%). No piping plovers have been observed nesting at the Jeffrey Energy Center.

DISCUSSION

Nesting Habitat

Historically, the least tern and piping plover were not known to nest on the Kansas River. Records do exist of nesting terns on some of the larger tributaries in the western part of the basin (BiOp 2000). The first records of nesting least terns and piping plovers on the main stem Kansas River occurred in 1996 near Wabaunsee. Their occurrence was believed to be due to available suitable habitat resulting from record floods in 1993 and 1995, and because other habitats were unavailable during nest initiation due to prolonged flooding on the Missouri, Platte, and lower Mississippi Rivers (BiOp 2000). Since then, nesting terns and plovers have returned every year.

Table 5. Least Tern Population Survey & Productivity Monitoring at Jeffery Energy Center

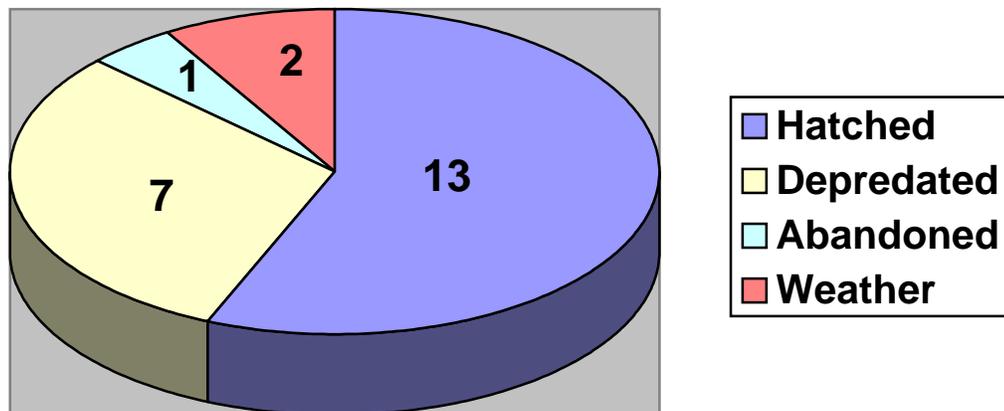
YEAR	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
2003	3	3	3	100	7	6	2	0.66
2004	1	1	1	100	2	2	0	0.00
2005	16	19	9	47	42	19	5	0.26
TOTALS	20	23	13	57	51	27	7	

Table 6. Least Tern Nest Losses at Jeffery Energy Center 2003 – 2005.

YEAR	WEATHER	DEPREDATED	ABANDONED	TOTAL
2003				0
2004				0
2005	2	7	1	10
TOTAL	2	7	1	10

**Figure 4. TERN NESTING TOTAL
JEFFERY ENERGY CENTER**

2003 - 2005 Tern Nesting, N = 23



Because the population of nesting least terns and piping plovers on the Kansas River is small, it is difficult to determine the potential importance of the river to the interior least tern and piping plover.

Early in 2005, the nesting habitat on the Kansas River did not appear to be very good after the recent below normal runoff in the basin, especially the sandbar at the main nesting colony near Belvue (USACE 2005). There were many large piles of logs and debris on this sandbar (Figure 2). Also, all previously observed nesting sites were now completely vegetated or eliminated (USACE 2005). However, a high water event from June 4 - 16, 2005 washed away nearly all of the woody debris at the Belvue site. This event peaked at 17.6 feet and a flow of 56,400 cubic feet per second at the NR Belvue river gauge and was the fifth highest flow recorded for this gage since 1983. This river discharge inundated the highest part of the sandbar with nearly five feet of water (USACE 2005). During this 12 day period of inundation of the nesting colony sandbar, the bulk of the Kansas River nesting least tern population appeared to relocate to the Jeffrey Energy Center. After the high river discharge, three least tern nests were recorded at three new nesting locations.

Overall, nesting habitat has declined on the Kansas River since the record flood in 1993. Nesting habitat has improved somewhat from 2004 to 2005 with the high flows of 2005 which washed away much of the woody debris at the Belvue sandbar. However, the invasion of woody vegetation on the sandbar does not appear to have stabilized. All nesting sites along the Kansas River have experienced the typical successional process that follows periodic high scouring flows in rivers, such as in 1993 and 1995. This process is altered on the Kansas River due to the regulated flows from tributary lake operation which reduces sandbar scouring and development.

Nest Fate

Data on piping plover nest hatching success since 2000 (when more intensive monitoring was initiated) are presented in Figure five. There have been 23 piping plover nests of which 48% hatched at least one egg, 22% were lost to predators, and 13% were lost to uncontrollable river flows. One nest with a single egg was taken by lake operation. Figures six and seven show annual nest hatching success and annual nest fate, respectively, for piping plovers on the Kansas River.

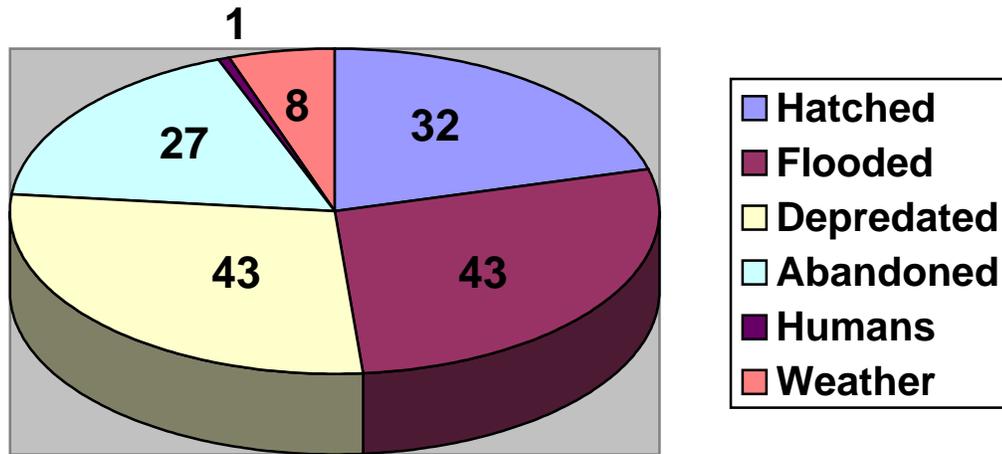
For least terns, there have been 154 least tern nests of which 21% hatched at least one egg, 28% were lost to predators, 28% were lost to uncontrollable river flows, 17% were abandoned (often as a result of near flooding events), 5% were lost to the weather, and one nest (1%) was destroyed by humans (Figure 5 and Table 7). Figures six and eight show annual nest hatching success and annual nest fate, respectively for least terns on the Kansas River.

Nesting Success

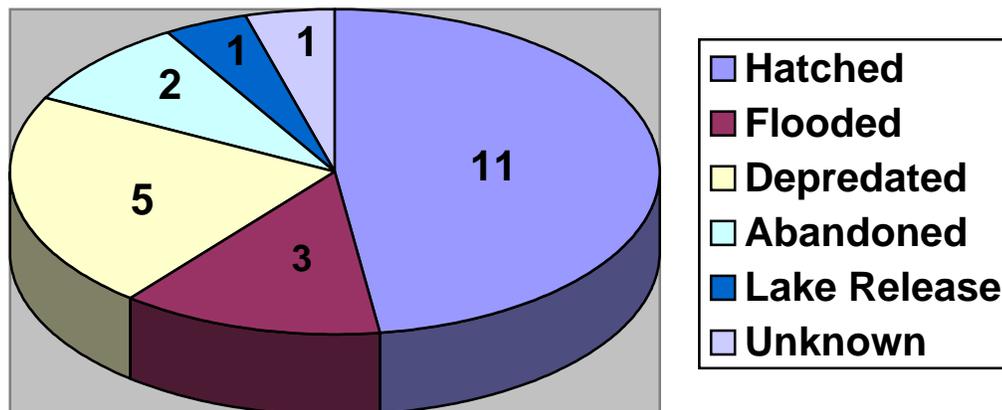
The piping plover and least tern are both species that utilize ephemeral habitats throughout their nesting season and are susceptible to frequent nest destruction and, consequently, large population fluctuations (USFWS 2000). The reproductive success and productivity of both species are usually reported by fledge ratios (number of flighted chicks per breeding pair).

Figure 5. TERN and PLOVER NESTING TOTAL

2000 - 2005 Tern Nesting, N = 154



2000 - 2005 Plover Nesting, N = 23



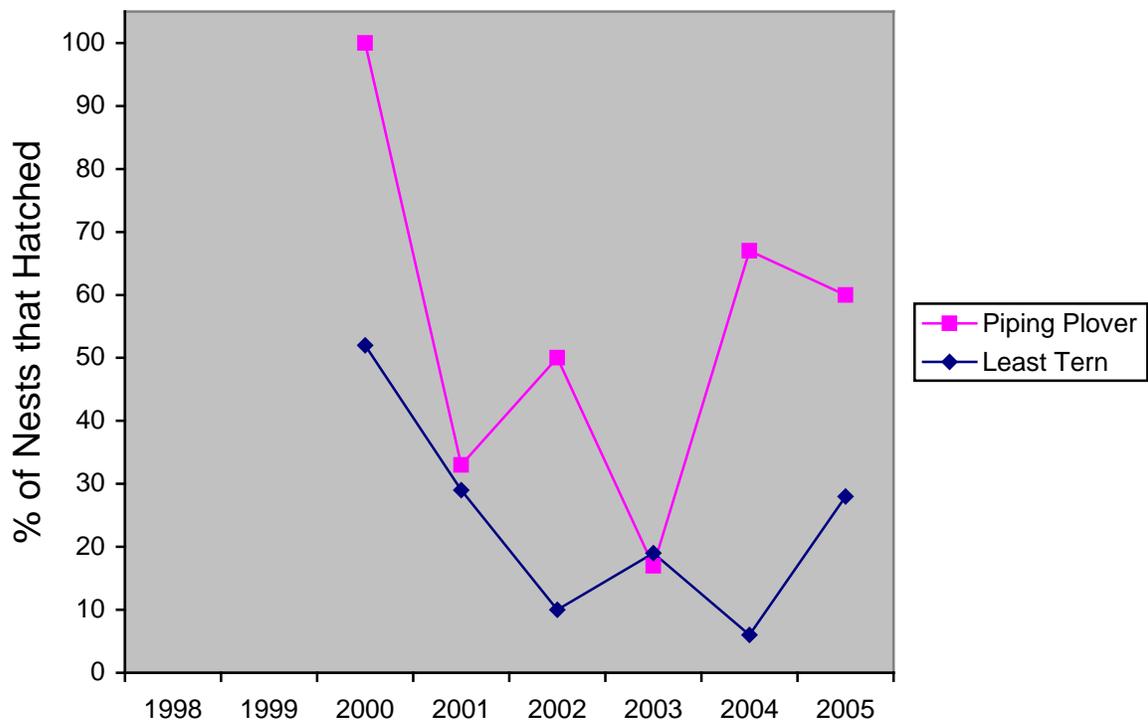
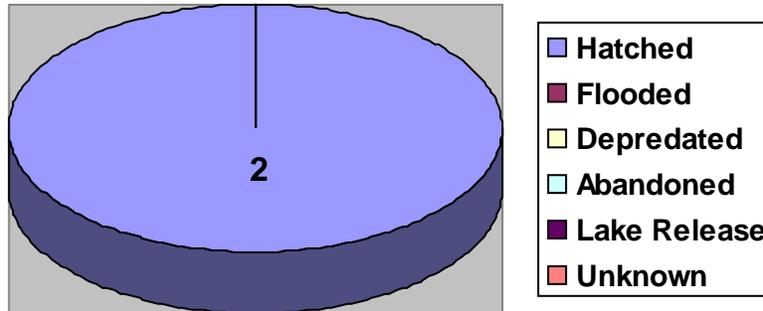


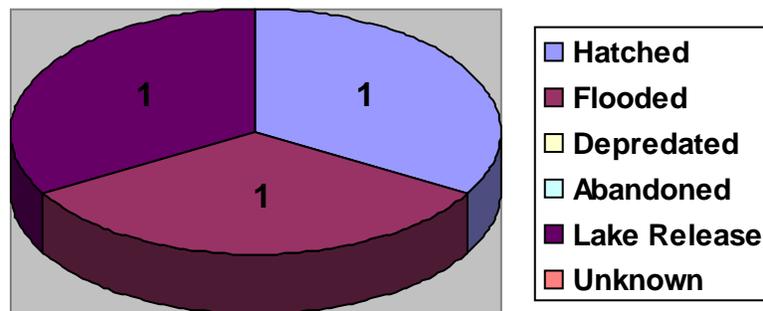
Figure 6. Nest Hatching Success, by Species, on the Kansas River from 2000 through 2005.

FIGURE 7. PIPING PLOVER NESTING

2000 Nesting



2001 Nesting



2002 Nesting

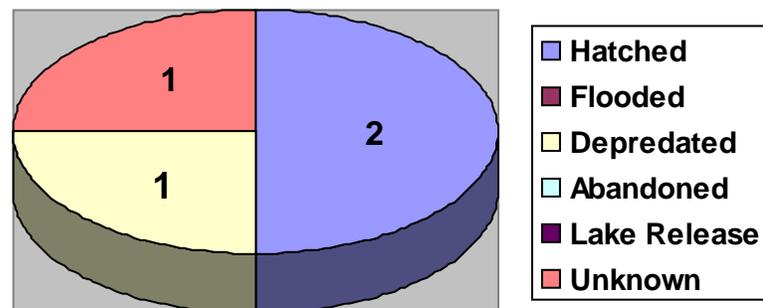
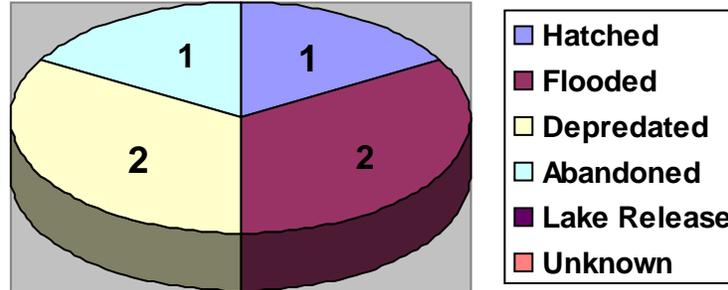
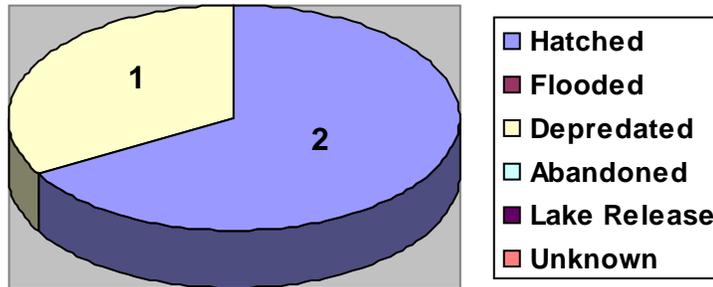


FIGURE 7 (Cont). PIPING PLOVER NESTING

2003 Nesting



2004 Nesting



2005 Nesting

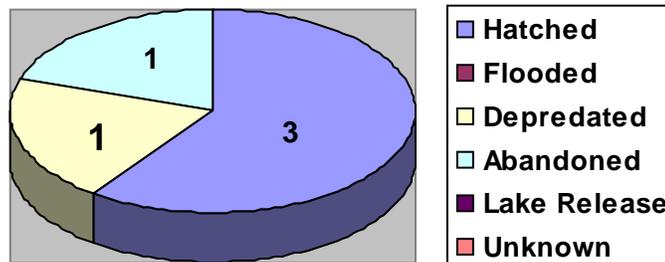
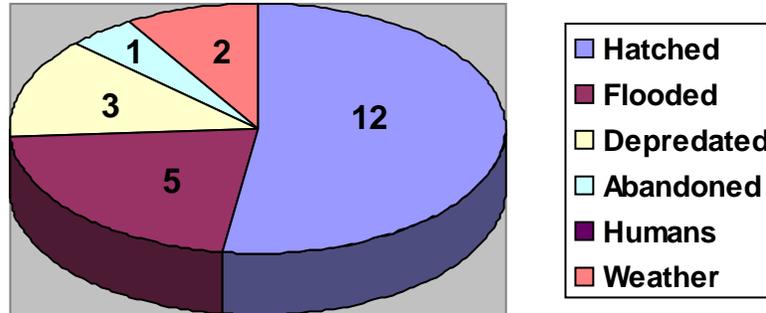


Table 7. Least Tern Nest Losses on the Kansas River 2000 – 2005.

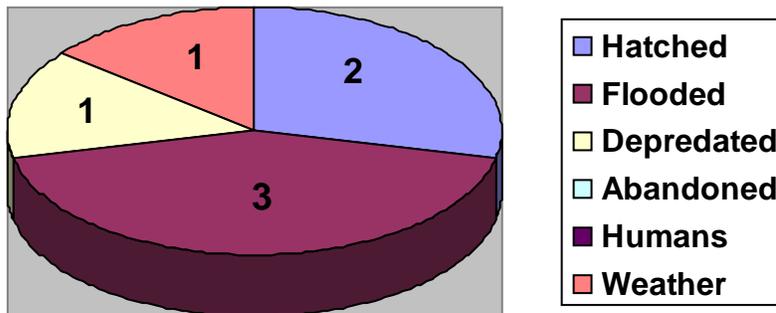
YEAR	UNCONTROLLED FLOODING	WEATHER	DEPREDATED	HUMAN DISTURBED	ABANDONED	TOTAL
2000	5	2	3		1	11
2001	3	1	1			5
2002	1	3	26	1	4	35
2003	9	1	10		9	29
2004	19				10	29
2005	6	1	3		3	13
TOTAL	43	8	43	1	27	122

Figure 8. LEAST TERN NESTING

2000 Nesting



2001 Nesting



2002 Nesting

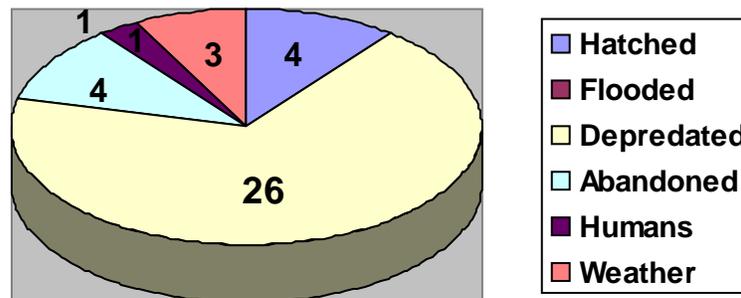
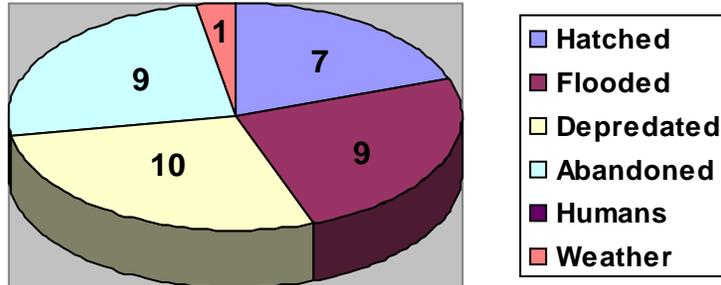
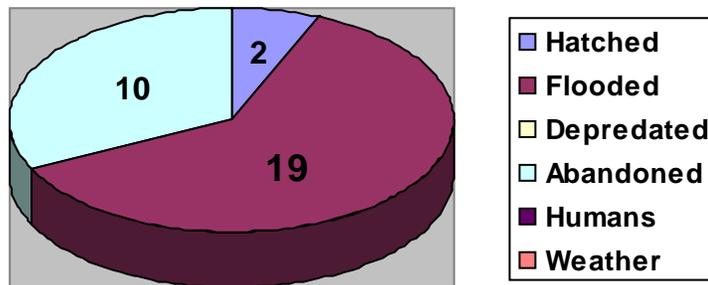


Figure 8 (Cont). LEAST TERN NESTING

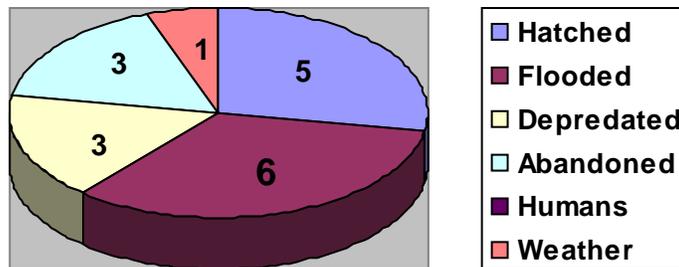
2003 Nesting



2004 Nesting



2005 Nesting



Studies by Boyd (1990) along the Cimarron River in Kansas and Oklahoma calculated an average of 0.51 fledglings/pair in ten least tern nesting colonies. The average for 11 years at Quivira NWR was 0.47 fledglings/pair (Boyd 1993). Three studies reported by Thompson et al. (1997) ranged from 0.59 fledglings/pair on the Gulf of Mexico coast to 0.47 fledglings/pair on the Platte River in Nebraska. These studies indicate that other locations appear to be maintaining stable least tern populations with less than the required 0.94 fledglings/pair (per the 2003 amendment to the 2000 USFWS BiOp). Reproductive success on the Kansas River for both species seems to be within the average estimates for other populations that have been studied.

The 2000 BiOp states that fledging success is variable across the least tern's range. In many local areas, Kirsch (1996) found fledging success to be below a very conservative 0.51 fledglings/pair thought to be required for population maintenance. Both Kirsch (1992) and Smith and Renken (1993) found great variation of fledging success among sites and years to be typical for this species.

Both species appear to experience highly variable success from year to year. This variability in success appears to be a part of the nesting and reproductive strategy for both species (Thompson et al. 1997 and Haig 1992).

Figure nine presents the annual fledge ratio of piping plovers and least terns from 1998 (when monitoring began) through the 2005 breeding season. Figure ten presents the annual fledge ratio of least terns from 1998 (when monitoring began) through the 2005 breeding season. Over the past eight years, the weighted fledge ratio along the Kansas River has been 0.95 fledglings/pair for piping plovers (Table 1) and 0.47 fledglings/pair for least terns (Table 3). However, given such a small population of terns and plovers a small variation in fledging success in any year can significantly change the ratio.

Piping Plover Nesting Success

Nesting data shows that the number of piping plover nesting pairs has been very consistent, averaging two to three pairs per year (Figure 11). From 1998 to 2005, twenty piping plovers fledged on the Kansas River with an average of 2.5 fledglings per year and a range from zero to six (Figure 12).

Interior Least Terns Nesting Success

The number of least tern nesting pairs has been more variable than the piping plover. While averaging 12.4 pairs per year, the range has been from a low of five in 2005 to a high of 19 in 2003. The number of nesting pairs increased from 1999 to 2004, but decreased in 2005 to only five pairs (Figure 11). From 1998 to 2005, 47 least terns fledged on the Kansas River. The number of least tern fledglings has averaged 5.9 per year, ranging from zero to 15. The number of least tern fledglings decreased from a high of 15 in 2000 to a low of zero in 2004. There was a small increase to three fledglings in 2005 (Figure 12).

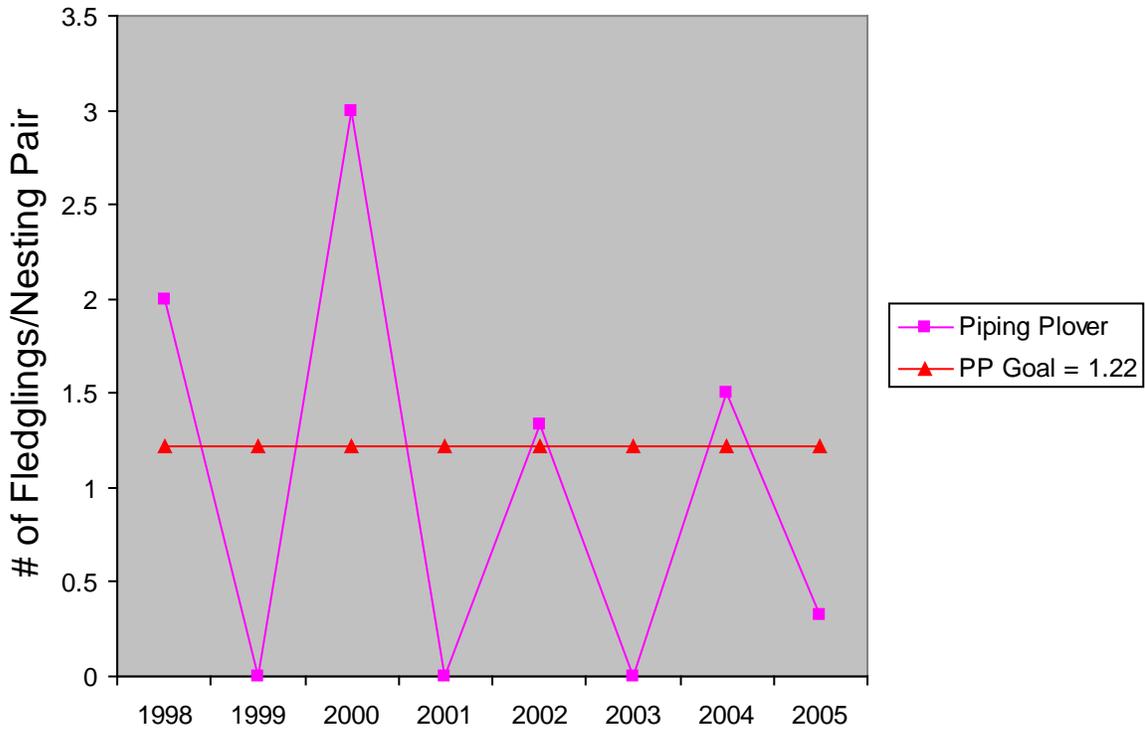


Figure 9. Piping Plover Fledge Ratios on the Kansas River from 1998 through 2005.

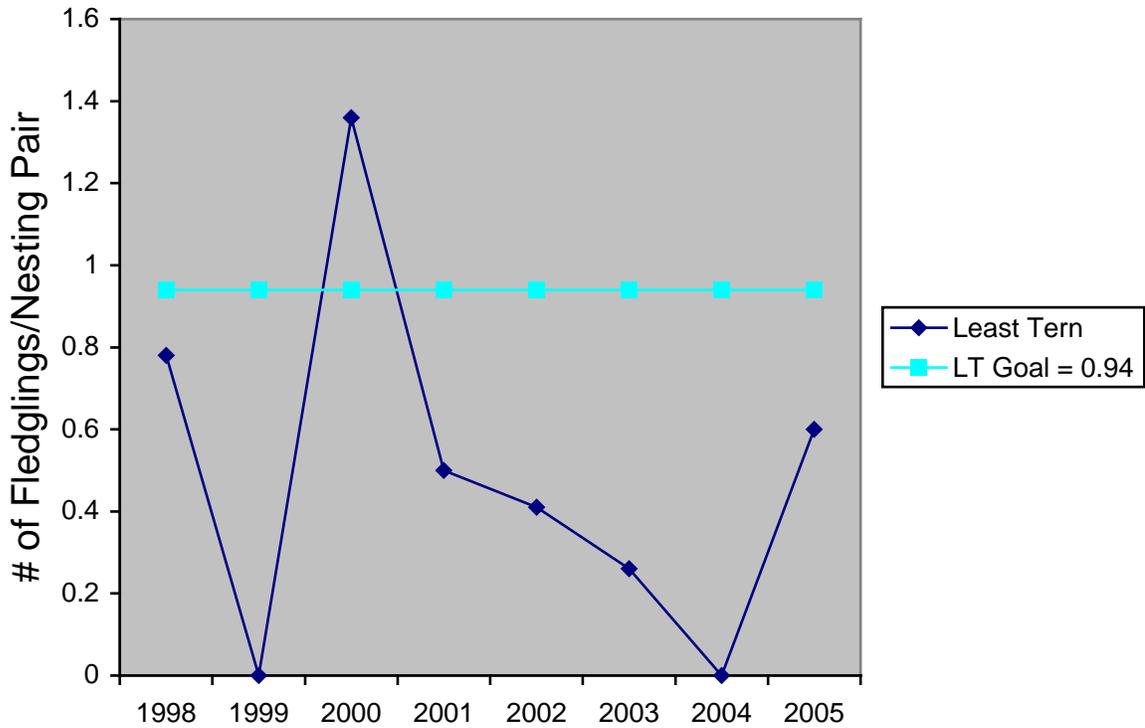


Figure 10. Least Tern Fledge Ratios on the Kansas River from 1998 through 2005.

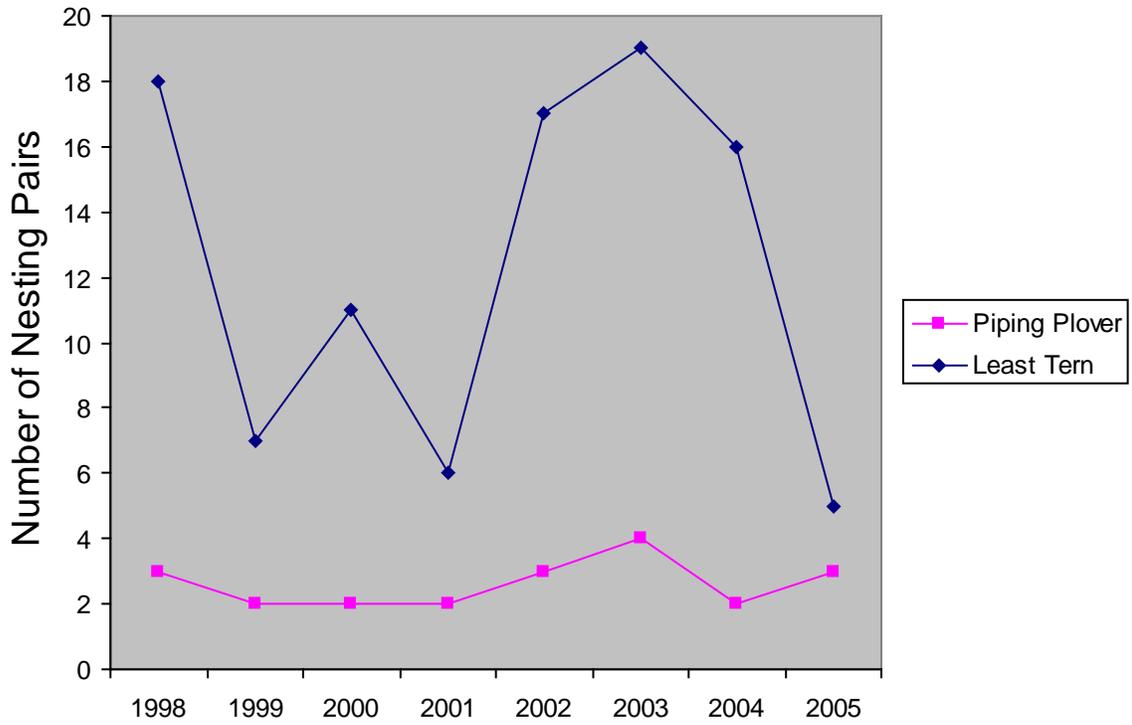


Figure 11. Number of Nesting Pairs, by Species, on the Kansas River from 1998 through 2005.

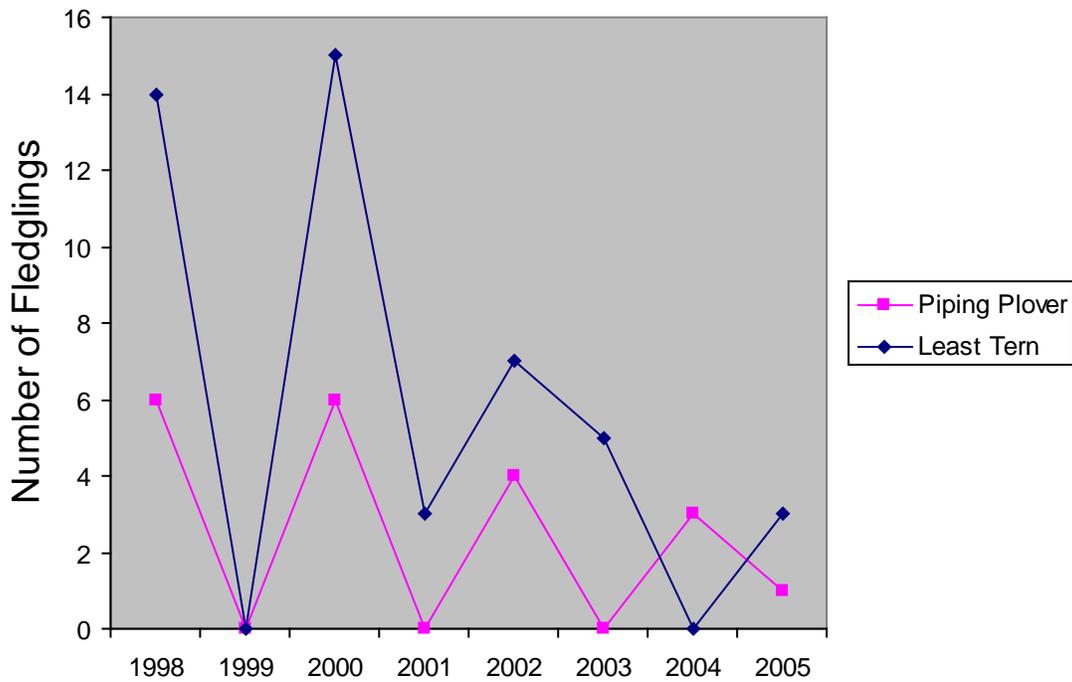


Figure 12. Number of Fledglings, by Species, on the Kansas River from 1998 through 2005.

Regional Productivity

Tables 8 - 13 present data on piping plover productivity from throughout the Missouri River basin for 2000 – 2005. Annual piping plover nests on the Kansas River made up only 0.4 to 0.9 percent of all nests documented within the basin. The weighted average for this period was only 0.6 percent (Table 14). From 2000 to 2005, the annual number of piping plover fledglings from the Kansas River ranged from zero to 0.9 percent, with a weighted average of only 0.2 percent of those documented within the basin (Table 14).

Tables 15 - 20 present data on least tern productivity from throughout the Missouri River basin for the years 2000 – 2005. For least tern nesting, the Kansas River annually made up only 1.9 to 7.2 percent of all least tern nests documented within the basin and the weighted average was only 5.0 percent, for this period (Table 21). The number of least tern fledglings annually from the Kansas River ranged from only zero to 4.1 percent with a weighted average of only 1.4 percent of those documented within the Missouri River basin from 2000 to 2005 (Table 21).

Table 8. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2000.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	1	1	1	100	4	3	2	2.00
MO River below Fort Peck	2	2	0	0	8	0	0	0.00
Lake Sakakawea	139	115	106	92	362	311	223	1.61
MO River below Garrison Dam	49	47	33	70	162	110	70	1.43
Lake Oahe	69	70	50	71	224	147	102	1.48
MO River below Fort Randall Dam	31	40	19	48	126	65	27	0.87
Lewis and Clark Lake	14	20	10	50	75	38	7	0.50
MO River below Gavins Point Dam	93	125	87	70	460	321	206	2.22
Kansas River	2	2	2	100	7	7	6	3.00
TOTALS	400	422	308	73	1428	1002	643	1.61

Table 9. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2001.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	2	2	1	50	7	2	2	1.00
MO River below Fort Peck	1	2	2	100	7	7	2	2.00
Lake Sakakawea	212	187	169	90	615	520	265	1.25
MO River below Garrison Dam	81	89	59	66	325	223	119	1.47
Lake Oahe	86	111	61	55	387	211	125	1.45
MO River below Fort Randall Dam	19	26	11	42	82	40	14	0.74
Lewis and Clark Lake	17	18	13	72	65	43	12	0.71
MO River below Gavins Point Dam	109	114	96	84	429	358	201	1.84
Kansas River	2	3	1	33	9	4	0	0.00
TOTALS	529	552	413	75	1926	1408	740	1.40

Table 10. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2002.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	1	1	1	100	3	3	2	2.00
MO River below Fort Peck	1	1	0	0	4	0	0	0.00
Lake Sakakawea	235	218	193	89	775	628	388	165
MO River below Garrison Dam	59	88	55	63	296	197	121	2.05
Lake Oahe	102	100	85	85	369	299	218	2.14
MO River below Fort Randall Dam	17	31	8	26	91	28	18	1.06
Lewis and Clark Lake	22	24	17	71	88	53	37	1.68
MO River below Gavins Point Dam	130	161	126	78	588	464	288	2.22
Kansas River	3	4	2	50	14	4	4	1.33
TOTALS	570	628	487	78	2228	1676	1076	1.89

Table 11. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2003.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	9	7	3	43	20	9	3	0.33
MO River below Fort Peck	3	3	2	67	12	8	8	2.67
Lake Sakakawea	264	235	193	82	856	669	279	1.06
MO River below Garrison Dam	74	84	61	73	310	226	124	1.67
Lake Oahe	150	161	130	81	608	472	285	1.90
MO River below Fort Randall Dam	19	22	14	64	78	53	27	1.42
Lewis and Clark Lake	7	9	5	56	33	18	11	1.57
MO River below Gavins Point Dam	143	175	121	69	658	442	277	1.94
Kansas River	4	6	1	17	23	3	0	0.00
TOTALS	673	702	530	75	2598	1900	1014	1.51

Table 12. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2004.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	4	4	4	100	14	14	10	2.50
MO River below Fort Peck	0	0	0	0	0	0	0	0.00
Lake Sakakawea	369	329	280	86	1204	967	552	1.50
MO River below Garrison Dam	82	86	68	82	318	250	95	1.16
Lake Oahe	186	213	169	83	775	583	262	1.41
MO River below Fort Randall Dam	21	23	16	70	76	58	15	0.71
Lewis and Clark Lake	0	4	0	0	16	0	0	0.00
MO River below Gavins Point Dam	131	167	102	62	565	362	245	1.87
Kansas River	2	3	2	67	10	8	3	1.50
TOTALS	795	829	641	77	2978	2242	1182	1.49

Table 13. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2005.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	13	11	7	64	36	20	14	1.08
MO River below Fort Peck	1	1	1	100	4	4	4	4.00
Lake Sakakawea	373	326	235	72	1159	745	333	0.89
MO River below Garrison Dam	110	115	75	65	420	271	91	0.83
Lake Oahe	182	220	144	66	798	482	220	1.21
MO River below Fort Randall Dam	21	23	17	74	88	65	17	0.81
Lewis and Clark Lake	12	9	2	22	28	8	2	0.17
MO River below Gavins Point Dam	170	222	153	69	784	528	335	1.97
Kansas River	3	5	3	60	17	12	1	0.33
TOTALS	885	932	637	68	3334	2135	1017	1.15

Table 14. Piping Plover Population Survey & Productivity Monitoring for the Missouri River Basin 2000 - 2005.

RIVER REACH	NESTS	PERCENT OF BASIN NESTS	TOTAL FLEDGE	PERCENT OF BASIN FLEDGLINGS
Fort Peck Lake	26	0.6	33	0.6
MO River below Fort Peck	9	0.2	14	0.2
Lake Sakakawea	1410	34.7	2040	36.0
MO River below Garrison Dam	509	12.5	620	10.9
Lake Oahe	875	21.5	1212	21.4
MO River below Fort Randall Dam	165	4.1	118	2.1
Lewis and Clark Lake	84	2.1	69	1.2
MO River below Gavins Point Dam	964	23.7	1552	27.4
Kansas River	23	0.6	14	0.2
TOTALS	4065		5672	

Table 15. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2000.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	2	2	1	50	3	2	1	0.50
MO River below Fort Peck	13	7	1	14	8	2	2	0.15
Lake Sakakawea	5	3	1	33	6	1	1	0.20
MO River below Garrison Dam	53	57	49	86	153	128	54	1.02
Lake Oahe	42	49	34	69	122	86	43	1.02
MO River below Fort Randall Dam	53	72	52	72	176	132	67	1.26
Lewis and Clark Lake	13	44	15	34	114	44	5	0.38
MO River below Gavins Point Dam	103	149	123	83	388	318	177	1.72
Kansas River	11	23	12	52	58	30	15	1.36
TOTALS	295	406	288	71	1028	743	365	1.24

Table 16. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2001.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	0	0	0	0	0	0	0	0.00
MO River below Fort Peck	19	20	13	65	42	25	20	1.05
Lake Sakakawea	17	19	14	74	38	25	13	0.76
MO River below Garrison Dam	63	55	48	87	144	122	79	1.25
Lake Oahe	47	66	42	64	155	104	63	1.34
MO River below Fort Randall Dam	35	58	30	52	143	80	5	0.14
Lewis and Clark Lake	29	33	17	52	83	45	34	1.17
MO River below Gavins Point Dam	116	116	104	90	309	269	127	1.09
Kansas River	6	7	2	29	15	5	3	0.50
TOTALS	332	374	270	72	929	675	344	1.04

Table 17. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2002.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	0	0	0	0	0	0	0	0.00
MO River below Fort Peck	17	23	10	43	50	24	10	0.59
Lake Sakakawea	11	17	12	71	38	25	9	0.82
MO River below Garrison Dam	63	77	64	83	186	161	115	1.83
Lake Oahe	53	58	42	72	146	102	70	1.32
MO River below Fort Randall Dam	42	71	25	35	161	63	30	0.71
Lewis and Clark Lake	23	37	13	35	87	35	24	1.04
MO River below Gavins Point Dam	157	216	157	73	538	409	207	1.32
Kansas River	17	39	4	10	87	10	7	0.41
TOTALS	383	538	327	61	1293	829	472	1.23

Table 18. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2003.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	1	1	0	0	3	0	0	0.00
MO River below Fort Peck	19	19	10	53	50	26	12	0.63
Lake Sakakawea	12	15	13	87	34	27	7	0.58
MO River below Garrison Dam	72	92	63	68	218	143	92	1.28
Lake Oahe	35	51	35	69	116	78	42	1.20
Lake Francis Case	3	5	5	100	13	13	9	3.00
MO River below Fort Randall Dam	22	46	27	59	89	69	14	0.64
Lewis and Clark Lake	23	41	13	32	91	32	9	0.39
MO River below Gavins Point Dam	183	247	178	72	624	460	138	0.75
Kansas River	19	36	7	19	80	17	5	0.26
TOTALS	389	553	351	63	1318	865	328	0.84

Table 19. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2004.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	0	0	0	0	0	0	0	0.00
MO River below Fort Peck	24	22	16	84	46	33	12	0.50
Lake Sakakawea	8	7	7	100	17	14	7	0.88
MO River below Garrison Dam	71	73	62	89	163	141	80	1.13
Lake Oahe	36	51	40	85	124	92	46	1.28
Lake Francis Case	5	16	1	6	32	2	0	0.00
MO River below Fort Randall Dam	31	51	21	45	109	48	13	0.42
Lewis and Clark Lake	6	0	0	0	0	0	0	0.00
MO River below Gavins Point Dam	180	280	169	63	662	422	186	1.03
Kansas River	16	31	2	6	75	4	0	0.00
TOTALS	377	531	318	60	1228	756	344	0.91

Table 20. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2005.

RIVER REACH	NESTING PAIRS	NESTS	NEST HATCHED	NEST SUCCESS (Percent)	EGGS	EGGS HATCHED	TOTAL FLEDGE	FLEDGE RATIO
Fort Peck Lake	0	0	0	0	0	0	0	0.00
MO River below Fort Peck	17	26	18	69	63	43	37	2.18
Lake Sakakawea	13	17	10	59	39	20	4	0.31
MO River below Garrison Dam	79	85	60	71	211	131	57	0.72
Lake Oahe	65	79	52	66	185	124	57	0.88
Lake Francis Case	2	4	2	50	6	3	3	1.50
MO River below Fort Randall Dam	38	63	35	56	135	76	18	0.47
Lewis and Clark Lake	2	21	0	0	31	0	0	0.00
MO River below Gavins Point Dam	238	354	195	55	862	464	318	1.34
Kansas River	5	18	5	28	37	9	3	0.60
TOTALS	459	667	377	57	1569	870	497	1.08

Table 21. Least Tern Population Survey & Productivity Monitoring for the Missouri River Basin 2000 - 2005.

RIVER REACH	NESTS	PERCENT OF BASIN NESTS	TOTAL FLEDGE	PERCENT OF BASIN FLEDGLINGS
Fort Peck Lake	3	0.1	1	0.1
MO River below Fort Peck	117	3.8	93	4.0
Lake Sakakawea	78	2.6	41	1.7
MO River below Garrison Dam	439	14.3	477	20.3
Lake Oahe	354	11.5	321	13.6
Lake Francis Case	25	0.8	12	0.5
MO River below Fort Randall Dam	361	11.8	147	6.2
Lewis and Clark Lake	176	5.7	72	3.1
MO River below Gavins Point Dam	1362	44.4	1153	49.1
Kansas River	154	5.0	33	1.4
TOTALS	3069		2350	

HYDROLOGICAL ANALYSIS OF RECENT LAKE OPERATIONS FOR INTERIOR LEAST TERN AND PIPING PLOVER

Since 1998, during the nesting season for the terns and plovers, lake operations upstream of the potential nesting sites have been modified from what is specified in the Water Control Manual to minimize impacts to listed species. In general, the modified lake operations have involved reducing target stages on the Kansas River to avoid flooding existing nests. During the nesting season, the Corps has coordinated extensively with the USFWS to minimize adverse impacts. Weekly field observations are made of nest sites and a river elevation at Wamego is established that provides the best potential to provide protection for the nests. No water is intentionally released from upstream Corps lakes which would increase river stages above that established Wamego elevation. During the past eight years, releases from Corps lakes have been reduced when a rise occurs in the uncontrollable baseflow of the Kansas River upstream of the nesting colonies. The USFWS is also consulted after any uncontrollable high flows occur on the river that flood nests and prior to resuming normal lake operations.

Appendix A contains a hydrological analysis of the recent lake operations for the interior least tern and piping plover. The Water Management Branch used available hourly data (1985 to 2005) to investigate the hydrologic conditions near the Wamego gage on the Kansas River and review the effectiveness of special lake operations to protect nesting birds from 1998 through 2005.

For the evaluation, the “actual operation” has been the recent operation of Tuttle Creek since 1998 to protect downstream nesting. One alternative, storing all inflow into Tuttle Creek (“No TUCR Release”) is impractical. Storing all inflows to Tuttle Creek in 1993 filled the flood control pool and filled the surcharge pool such that water overtops the spillway gates. This alternative provides useful information regarding the nature of uncontrollable flow in the Kansas River, but should not be considered a reasonable operation alternative.

Operating strictly in accordance with the Water Control Manuals (“WCM Operation”) was the second mode of operation investigated. While WCM operation gives a good indication of lake operation without downstream nesting, it does not include all the other variables and extenuating circumstances determining lake operation. For example, any special operation required for reasons such as construction are not included. In addition, the WCM does not incorporate operation flexibility and judgment that can be used to maximize the benefits derived from the lake project, particularly in the lower portion of the flood control zone.

Operations Results

For each year a determination was made whether a six-week period occurred with a stable or declining river stage. This was used as the measure of acceptable nesting habitat. Also examined was the number of instances when the Wamego stage with no Tuttle Creek release increased due to uncontrollable events. In summary:

Two years in eight, both “WCM Operation” and “Actual Operation” provided acceptable nesting habitat (2002 & 2005).

Four years in eight “Actual Operation” provided generally more acceptable nesting habitat while “WCM Operation” did not (1998, 2000, 2001, & 2003). Furthermore, in 2001, both “WCM Operation” and “No TUCR Release” failed to provide acceptable nesting habitat.

Only one year in eight did “No TUCR Release” provide acceptable nesting habitat while both “WCM Operations” and “Actual Operations” failed to provide acceptable nesting habitat (2004)

In 1999, no method of operation was able to provide acceptable nesting habitat.

In the four years that “Actual Operation” appeared to provide more acceptable nesting habitat than the “WCM Operation”, a relatively few number of nests may actually have benefited. On June 29, 1998 one least tern nest with three eggs was in jeopardy if the river rose more than a foot before hatching. The 1998 hydrograph (Appendix A) shows a crest 1.5 feet higher with the “WCM Operation” versus the “Actual Operation.” This nest may have been impacted with the “WCM Operation” versus “Actual Operation.”

In 2000, there was one least tern nest initiated on July 14 at an estimated elevation of 8.1 feet (per Belvue Bridge gage). The 2000 hydrograph (Appendix A) shows that the river would have been approximately a foot higher with the “WCM Operation” versus the “Actual Operation” on July 14. This nest may or may not have been initiated with the “WCM Operation” versus “Actual Operation.” This nest did fledge two chicks.

In 2001, there was one least tern nest initiated on July 12 or 13 that was two feet above the river when the Belvue Bridge gage was at 7.0 ft. The 2001 hydrograph (Appendix A) shows that with the “WCM Operation” the river would have been approximately one foot higher when the nest was initiated and would have crested 1.5 feet higher on July 27 than the “Actual Operation.” This nest may have been impacted with the “WCM Operation” versus “Actual Operation.” This nest did fledge two chicks.

In 2003, three or four least tern nests were likely protected with our “Actual Operation.” There was one nest at Vermillion that was initiated on June 1 at an elevation of 5.86 on the Wamego gage. There was another nest at elevation 935.04 at the Belvue colony that was initiated on May 30. The 2003 hydrograph (Appendix A) shows that with the “WCM Operation” the river would have crested 1.5 feet higher on June 14 and then approximately three feet higher on July 1 when compared with the “Actual Operation.” These two nests were likely protected by the “Actual Operation” versus the “WCM Operation.” At the Belvue colony, additional nests were initiated at elevation 933.75 on July 3 and at elevation 932.12 on July 4. The nest initiated on July 4 was raised on July 9 to protect it from high water. The 2003 hydrograph (Appendix A) shows that the river would have been approximately one to 1.5 feet higher with the “WCM Operation” versus the “Actual Operation” when these nests were initiated. These nests may or may not have been

initiated with the “WCM Operation” versus “Actual Operation.” These nests did fledge four chicks.

It appears that only 7 nests out of 177 total nests (4%) on the Kansas River from 1998 to 2005 may have been protected to some extent by our “Actual Operation” versus the “WCM Operation”. These 7 nests also fledged only 8 to 11 chicks out of the total of 67 least tern and piping plover chicks fledged (12-16%) on the Kansas River from 1998 to 2005 and were only 0.2 to 0.3 percent of the basin wide number of least tern fledglings from 1998 to 2005. What nesting would have actually occurred with the “WCM Operation”, and how successful it would have been, is not known.

Inflows to Tuttle Creek coincident with the study period (1998 to 2005) were compared with historical averages for each month. Over the course of the study period, inflows were significantly below average. Therefore, Tuttle Creek operations (1998 to 2005) in conjunction with reduced inflows could raise false expectations of the Corps’ ability to provide/ensure nesting habitat.

CONCLUSIONS

Based on the analysis and the above discussion of the data collected in the past seven years, the following are the key findings:

Piping Plovers and Interior Least Tern Productivity

The annual productivity of piping plovers on the Kansas River from 2000 to 2005 was very minor for the Missouri River basin comprising only 0.6 percent of the basin’s nests and only 0.2 percent of the basin’s fledglings. In addition, the annual productivity of least terns on the Kansas River was also a very minor component of overall productivity for the Missouri River basin from 2000 to 2005 comprising only 5.0 percent of the basin’s nests and only 1.4 percent of the fledglings.

Nesting Habitat

The sand bars used by the terns and plovers on the Kansas River for nesting have experienced the typical successional process which follows periodic high scouring flows on rivers, such as occurred in 1993 and 1995. Overall nesting habitat has declined on the Kansas River since the record flood in 1993. Nesting habitat has improved somewhat from 2004 to 2005 with the high flows of 2005 which washed away much of the woody debris at the Belvue sandbar. However, the invasion of woody vegetation on this sandbar does not appear to have stabilized and will continue to limit the amount of available nesting habitat (USACE 2005). The nesting habitat that resulted from the 1993 flood will not occur again till another record flood of similar magnitude occurs. This process is also affected on the Kansas River by the regulated flows from tributary lake operations reducing seasonal sandbar scouring and development. It is this ephemeral

sandbar habitat resulting from dynamic river processes that the least tern and piping plover desires for nesting habitat (USFWS 2000).

Hydrologic Effects

Modifying lake operations protected only a few nests out of the total nests on the Kansas River from 1998 to 2005 based on the operations hydrologic analyses contained in Appendix A. Only seven out of 177 nests (4%) from 1998 to 2005 likely benefited from the Corps' "Actual Operation" versus "WCM Operation" operation. In addition, these seven nests fledged only eight to eleven chicks out of 67 chicks fledged on the Kansas River from 1998 to 2005 and only 0.2 to 0.3 percent of the basin wide number of least tern fledglings from 1998 to 2005.

RECOMMENDATIONS

The Corps recognizes that protecting listed species under the ESA is important, along with the importance of other project purposes of our Kansas River tributary lakes. We also recognize the minimal impact our Kansas River tributary lake operation has on the total least tern and piping plover populations throughout the Missouri River basin. Further, Kansas River tributary lake operation has also had minimal impact the past seven years on least tern and piping plover populations on the Kansas River.

Based on the results of this study, the Corps recommends: 1) operating within the reasonable flexibility of the Corps Water Control Manuals; and, 2) standardizing our bird monitoring with a: a) spring distribution survey, b) mid-season adult census and nesting survey for occupied sites, and c) productivity survey timed to coincide with the expected fledging peak. Also, prior to and after any release that may impact eggs and or chicks; we will monitor the nesting colonies to document take. Further, the Corps will continue to coordinate Kansas River reservoir operations with the ACT using a Missouri River Basin-wide focus and in accordance with the 2003 Amendment to the BiOp.

LITERATURE CITED

- Boyd, H. 1962. Mortality and fertility of European charadrii. *Ibis* 104:368-387.
- Boyd, Roger L. 1990. Habitat management and population ecology studies of the Least Tern in Kansas and Oklahoma. Kansas Department of Wildlife and Parks. Nongame Wildlife Project Report.
- Boyd, Roger L. 1993. Site Tenacity, philopatry, longevity, and population trends of Least Terns in Kansas and northwestern Oklahoma. Pp 196-205 *in Proc. Missouri River and its tributaries: Piping Plover and Least Tern Symp.* (K. F. Higgins and M. R. Rashier, eds.) South Dakota State Univ., Brookings, SD.
- Busby, William H., Daniel W. Mulhern, P. Gregory Kramos, and David A. Rintoul. 1997. Nesting Piping Plover and Least Tern on the Kansas River. *The Prairie Naturalist*. 29:257-262.
- Greenwood, P. J. 1980. Mating systems, philopatry and dispersal in birds and mammals. *Anim. Behav.* 28:1140-1162.
- Haig, S. M. 1992. Piping Plover. *In The Birds of North America*, No. 2 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academia of Natural Sciences; Washington, DC: The American Ornithologists' Union.
- Hayes, Helen and Mary LeCroy. 1971. Field criteria for determining incubation stage in eggs of the Common Tern. *Wilson Bulletin*, 83:425-429.
- Keenlyne, Kent D. 1993. Historical Overview of the Upper Missouri River and its Tributaries. Pp 1-6 *in Proc. Missouri River and its tributaries: Piping Plover and Least Tern Symp.* (K. F. Higgins and M. R. Rashier, eds.) South Dakota State Univ., Brookings, SD.
- Kirsch, E. M. 1992. Habitat selection and productivity of least terns (*Sterna antillarum*) on the lower Platte River, Nebraska. Ph.D. Thesis, University of Montana, Missoula. 119pp.
- Kirsch, E. M. 1996. Habitat selection and productivity of least terns on the Lower Platte River, Nebraska. *Wildlife Monographs* 132:1-48.
- Kirsch, E.M. and G.R. Lingle 1993. Habitat use and nesting success of least terns along the Platte River, Nebraska. Pp 73-74 *in Proc. Missouri River and its tributaries: Piping Plover and Least Tern Symp.* (K. F. Higgins and M. R. Rashier, eds.) South Dakota State Univ., Brookings, SD.
- Latka, R.J., D.C. Latka, and R.S. Nebel. 1993. Island clearing and habitat improvement for Least Tern and Piping Plover nesting habitat along the Missouri River main-stem system, 1987-1992. Pp 97-102 *in Proc. Missouri River and its tributaries: Piping Plover and Least Tern Symp.* (K. F. Higgins and M. R. Rashier, eds.) South Dakota State Univ., Brookings, SD

Lenington, S. and T. Mace. 1975. Mate fidelity and nesting site tenacity in the Killdeer. *Auk* 92:149-151.

Rimmer, David W., and Robert D. Deblinger. 1992. Use of Fencing to Limit Terrestrial Predator Movements into Least Tern Colonies. *Colonial Waterbirds* 15:226-229.

Sidle, J.G., D.E. Carlson, E.M. Kirsch, and J.J. Dinan. 1993. Least Tern and Piping Plover mortality and habitat creation due to flooding. Pp 68 *in* Proc. Missouri River and its tributaries: Piping Plover and Least Tern Symp. (K. F. Higgins and M. R. Rashier, eds.) South Dakota State Univ., Brookings, SD.

Smith, J. W., and R. B. Renken. 1993. Reproductive success of least terns (*Sterna antillarum*) in the Mississippi River Valley. *Colonial Waterbirds* 16:39-44.

Thompson, Bruce C., Jerome A. Jackson, Joanna Burger, Laura A. Hill, Eileen M. Kirsch, and Jonathan L. Atwood. 1997. Least Tern. *In* The Birds of North America, No. 290 (A. Poole and F. Gill, Eds.). Philadelphia: The Academia of Natural Sciences; Washington, DC: The American Ornithologists' Union.

U. S. Army Corps of Engineers. 2000. Final Report on least tern (*Sterna antillarum*) and piping plover (*Charadrius melodus*) surveys along the Kansas River. Report prepared by Dr. Roger L. Boyd and Norma Gallegos. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U. S. Army Corps of Engineers. 2001. Least tern and piping plover surveys on the Kansas River, 2001 breeding season. Report prepared by Dr. Roger L. Boyd. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U. S. Army Corps of Engineers. 2002. Least tern and piping plover surveys on the Kansas River, 2002 breeding season. Report prepared by Dr. Roger L. Boyd and Natasha Thomas. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U. S. Army Corps of Engineers. 2003. Least tern and piping plover surveys on the Kansas River, 2003 breeding season. Report prepared by Dr. Roger L. Boyd and Matthew Sexson. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U. S. Army Corps of Engineers. 2004. Least tern and piping plover surveys on the Kansas River, 2004 breeding season. Report prepared by Dr. Roger L. Boyd and Jason Patty. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U. S. Army Corps of Engineers. 2005. Least tern and piping plover surveys on the Kansas River, 2005 breeding season. Report prepared by Dr. Roger L. Boyd and Jordan Olsen. Baker University Biology Department, Baldwin City, KS. Report prepared for the Kansas City District, U. S. Army Corps of Engineers, Kansas City, MO.

U.S. Fish and Wildlife Service. 2000. Biological opinion on the operation of the Missouri River main stem system reservoir system, operation and maintenance of the Missouri River Bank Stabilization and Navigation Project, and operation of the Kansas River reservoir system. U.S. Fish and Wildlife Service, Region 6, Denver, Colorado, and Region 3, Fort Snelling, Minnesota.

U.S. Fish and Wildlife Service. 2003. 2003 Amendment to the 2000 Biological Opinion on the operation of the Missouri River main stem system reservoir system, operation and maintenance of the Missouri River Bank Stabilization and Navigation Project, and operation of the Kansas River reservoir system. U.S. Fish and Wildlife Service, Region 6, Denver, Colorado, and Region 3, Fort Snelling, Minnesota.

Welty, J. C. 1975. *The Life of Birds*. W. B. Saunders Company. 2nd edition. 623pp.

Wilcox, L. 1959. A twenty year banding study of the Piping Plover. *Auk* 76:129-152.