MONTANA
INTERIOR LEAST TERN
MANAGEMENT PLAN

With input from the
Montana Interior Least Tern and
Piping Plover Work Group

APRIL 2006

Montana Fish, Wildlife & Parks

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Front Cover Photograph: Interior least tern (*Sterna antillarum athalassos*). Courtesy: Doug Backlund, Pierre, SD.

EXECUTIVE SUMMARY

The interior population of the least tern (*Sterna antillarum*) is listed as endangered because of perceived low population size and threats to its breeding habitat. Alteration of natural river flow dynamics as well as recreational use of sandbar habitat has had a major impact on the reproductive success of the least tern. Consequently, breeding colonies in the interior U.S. are restricted to less altered river segments where there is still suitable habitat. Within Montana, least terns breed on sand and gravel bars along the Yellowstone River, below Miles City, and on the Missouri River, from below Fort Peck Reservoir to the Montana-North Dakota border. Reservoir shoreline at Fort Peck is also utilized in years when water and habitat conditions are suitable.

As a state, Montana supports one of the smallest populations of interior least terns and results from monitoring efforts over the past 19 years show that the state has met and/or exceeded its specific recovery goal of 50 adult birds. Although the Missouri River has yet to meet its goal of 2,100 birds, the current range-wide census, carried out during the 2005 breeding season, recorded an interior least tern population of 17,587. The peripheral nature of Montana relative to the overall breeding range of interior least terns, coupled with the small population of birds the state supports, make it difficult to ascertain how critical Montana's subpopulation is to overall population recovery. What appears more noteworthy, however, is the potential resource Montana's reaches of the Missouri and Yellowstone rivers may provide to breeding birds during years characterized by abnormal weather and river conditions further south.

This plan recommends specific management and research activities, that we believe are necessary to sustain the population as well as aid long term recovery efforts. The following recommendations are discussed as a multifaceted approach to managing interior least tern breeding habitat and increasing productivity in the State of Montana.

- i. continued annual monitoring of terns coupled with efforts to standardize monitoring and data collection techniques within and between states in the interior U.S.
- ii. management of water flows that restore riverine habitats and their associated ecosystem processes
- iii. management of water flows that reduce the potential for nest inundation
- iv. management of vegetation encroachment to increase nest site availability
- v. preservation and restoration of suitable nesting habitat through protective easements
- vi. investigation of fish prey abundance and foraging success along both the Missouri and Yellowstone rivers
- vii. analysis of the population's likelihood of persistence, using PVAs, coupled with a review of the status of the interior least tern.

ACKNOWLEDGEMENTS

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INTRODUCTION

The smallest and rarest of the five tern species that visit Montana, the interior least tern (*Sterna antillarum*) is listed as endangered because of perceived low population size and threats to its breeding habitat (USFWS 1985, USFWS 1990a, Kirsch and Sidle 1999). Although the least tern has never been commonly found in Montana, it is a common summer visitor throughout the Mississippi Valley drainage, nesting on sand and gravel bars and foraging in the surrounding shallow water habitats.

Alteration of natural river flow dynamics as well as recreational use of sand bar habitat has had a major impact on the reproductive success of the least tern. Since the 1940s, large stretches of the Mississippi River and its tributaries have been channelized and impounded to meet navigation and flood control objectives. This has altered natural flood water regimes and led to a significant decline in the widely braided river channels that provide essential breeding and foraging habitat for these migratory birds.

Three subspecies of least terns are recognized in North America: the eastern or coastal, the California and the interior. Although the American Ornithological Union (1983) officially recognizes these separate subspecies, debate surrounding the validity of the taxa continues. As a result of taxonomic uncertainty, the U.S. Fish and Wildlife Service (USFWS) did not list the subspecies but instead designated the "population of least terns occurring in the interior U.S." as endangered (USFWS 1990a).

The recovery plan for the interior population of least terns describes a number of actions necessary to achieve recovery of the population, which if met, would allow delisting to be considered (USFWS 1990a). Recovery goals in the plan call for essential habitat to be protected and managed and require that 7,000 adult birds be maintained throughout the breeding range on stretches of the Missouri, Mississippi, Ohio, Arkansas, Red and Rio Grande river systems. Within the Missouri River system, the plan specifies that essential habitat be protected, enhanced or restored and that a population level of 2,100 adult birds is maintained for ten years. Montana, which is at the extreme northwestern edge of the population's breeding range, has a specific recovery goal of 50 adults. While critical habitat, as per the Endangered Species Act, has not been designated for this population, the Interior Least Tern Recovery Plan (USFWS 1990a) does recognize riverine sandbars, river channels with appropriate channel widths and flows, and lake shorelines as essential breeding habitat.

The purpose of this plan is to describe the current status of the population as well as the actions necessary to achieve and maintain the recovery goal for interior least terns breeding in the State of Montana. Experts in state, and federal resource agencies, were consulted to determine the status of Montana's current population and habitats as well as the potential for increase. Although Montana supports one of the smallest populations of interior least terns, what appears noteworthy is the potential resource Montana's reaches of the Missouri and Yellowstone rivers may provide to breeding birds during years characterized by abnormal weather and river conditions further south. Least tern numbers, and annual reproductive success, fluctuate widely at the local scale (USFWS 1990a), perhaps as a result of habitat availability along river reaches. Consequently birds may not return to exactly the same locations between breeding seasons (Kirsch and Sidle 1999). In light of the inherent variability in local river conditions and nest site availability, we believe that a five-year trend period will provide flexibility in planning and management, relative to tern dispersal patterns.

The goal of this plan is to manage for and maintain approximately 50 adult birds, on a running five-year average, distributed in appropriate habitats in Montana. This goal will allow Montana to meet the standards of the current recovery plan and also provide additional support for national recovery. Moreover, Montana Fish, Wildlife and Parks (MFWP) recognizes that an integrated multi-agency approach is required to manage this population effectively. As such, the plan attempts to compile into one document the measures required to enhance recovery whether such actions are undertaken by the Department or in collaboration with other agencies and/or tribal authorities. We believe that such an approach will ultimately strengthen the program by building on collaborative management activities already being undertaken.

TAXONOMY AND SYSTEMATICS

Ornithologists have debated the taxonomic classification of the least tern (*Sterna antillarum*) for over a century. First described in North America by Lesson (1847), the least tern was originally accorded species status and assigned the name *Sternula antillarum*. Taxonomic revisions in the early 1900s resulted in these North American birds being consolidated, along with numerous other small tern species, into a new genus, *Sterna* (Hartert 1921, quoted in Massey 1998). During this period of reorganization, the North American birds were downgraded to sub-species status, being considered conspecific with the little terns (*Sterna albifrons*) of the Old World. In 1983, primarily as a result of research into breeding behavior and vocalizations, the American Ornithological Union (AOU) reclassified the least and little terns as separate species - namely *Sterna antillarum* and *Sterna albifrons* (Massey 1976, AOU 1983).

Three subspecies of least terns from North America are recognized by the AOU (1957, 1983). Eastern or coastal least terns (*Sterna antillarum antillarum*) breed along the Atlantic seaboard from Maine to Florida, the Gulf Coast, and Caribbean islands (AOU 1983). California least terns (*Sterna antillarum browni*) are restricted to breeding sites along the Pacific coast from the San Francisco Bay, California to Baja, Mexico. Interior least terns (*Sterna antillarum athalassos*) breed in the Mississippi Valley and have been recorded from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana (Hardy 1957).

There is, however, some question about the validity of the distinction between subspecies (Boyd and Thompson 1985, Thompson et al 1992, Patten and Erickson 1996, Massey 1998). Some ornithologists point out that descriptions are based largely on qualitative assessment with limited statistical analyses of morphological traits (Thompson et al 1992, Patten and Erickson 1996, Thompson et al 1997). Massey (1976) failed to detect any consistent morphometric, behavioral or vocal differences between coastal (*S. a antillarlum*) and California least terns (*S.a. browni*). Likewise, electrophoretic analyses revealed no genetic distinctions between coastal (*S. a antillarum*) and interior least terns (*S.a athalassos*) at four breeding sites on the Texas coast (Thompson et al 1992). In fact, Thompson et al (1992) concluded, "research indicates no practical means for distinguishing among the North American subspecies of least terns".

Lack of observational data during the winter months also raises questions as to whether these populations mix on wintering grounds or migrations routes (Massey 1976, Thompson et al 1992). More recently, however, in contrast to the results of Thompson et al (1992), refined colorimetric analysis of clean museum specimens has detected differences between all three subspecies. Significant seasonal differences, presumably as a result of plumage wear and bleaching, were also noted (Johnson et al 1998).

Moreover, the authors also reported distinctions between central and southern populations along the California coastline, which are all currently included within *S. a. browni* (Johnson et al 1998). Although the AOU (1983) continues to officially recognize three subspecies of least terns in North America, the debate is still largely unresolved within the ornithological arena. Further research utilizing more sensitive genetic and molecular techniques may ultimately resolve this issue.

SPECIES DESCRIPTION

Slender and graceful in flight, with a wingspan of approximately 51 cm (20 inches) and a body length of 21-23 cm (8-9 inches), the least tern is the smallest of the tern species resident in North America (Thompson et al 1997, Sibley 2003). All three subspecies are morphologically similar and are currently distinguished based on geographical separation of breeding areas (Massey 1976, Boyd and Thompson 1985, Whitman 1988, Thompson et al 1992).

During the breeding season adults are characteristically light gray above with an obvious black-capped crown, loral stripe and nape (Figure 1). In distinct contrast to the black cap, the forehead is white and the bill a striking yellow or orange color with a black tip (Thompson et al 1997). The under parts of the bird are white and the legs bright orange to yellow. In flight, the upper wing pattern is diagnostic: the outer two primaries forming a conspicuous black wedge against the slender pale wings (see front cover).

Although the sexes are morphologically alike, subtle differences have been noted during the breeding season. Boyd and Thompson (1985) identified breeding males and females on the basis of foot and bill color: a male's feet and bill being brighter than its mates. Likewise, Olson and Larsson (1995) noted that males have a wider loral stripe compared to females. Despite these differences, the sexes are more reliably distinguished by behavior patterns (Thompson et al 1997).

Figure 1: Interior least terns, *Sterna antillarum athalassos*
Courtesy: USFWS

Basic non-breeding plumage is similar for birds of all ages. The upper body is light gray, the under parts snowy white, and the bill and legs dark in coloration (Massey and Atwood 1978, Thompson et al 1997). Juveniles are darker than adults with buff colored plumage, a dark bill, dark gray eye stripe and dusky brown cap. From a diagnostic perspective, the diminutive size of the least tern coupled with its relatively short deeply forked tail and large bill makes it readily identifiable and unlikely to be confused with other species of terns in North America even when in non-breeding or juvenile plumage.

HISTORICAL AND CURRENT DISTRIBUTION

The least tern is a migratory species that breeds along the Pacific, Atlantic and Gulf coasts as well as the major interior rivers of North America (Figure 2). Historically the interior population bred along the Mississippi, Missouri, Arkansas, Red, Rio Grande and Ohio River systems (AOU 1957, Hardy 1957, Thompson et al 1997, USFWS 2003). Its breeding range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana (USFWS 1990a).

Although the boundaries of the breeding range of least terns in the 1990s were similar to its boundaries a century earlier, the distribution of least terns in the interior of the United States is now much more fragmented than previously reported (National Research Council 2004). Breeding colonies are restricted to less altered river segments where there is still suitable habitat (USFWS 1990a) and reports indicate that they no longer occur on most tributaries of the Lower Mississippi River, including the Ohio River (Sidle et al 1988). Consequently, the interior least tern's breeding range represents remnants of a wider distribution that existed prior to impoundment and channeling of the Mississippi River drainage (Hardy 1957, Sidle et al 1988).

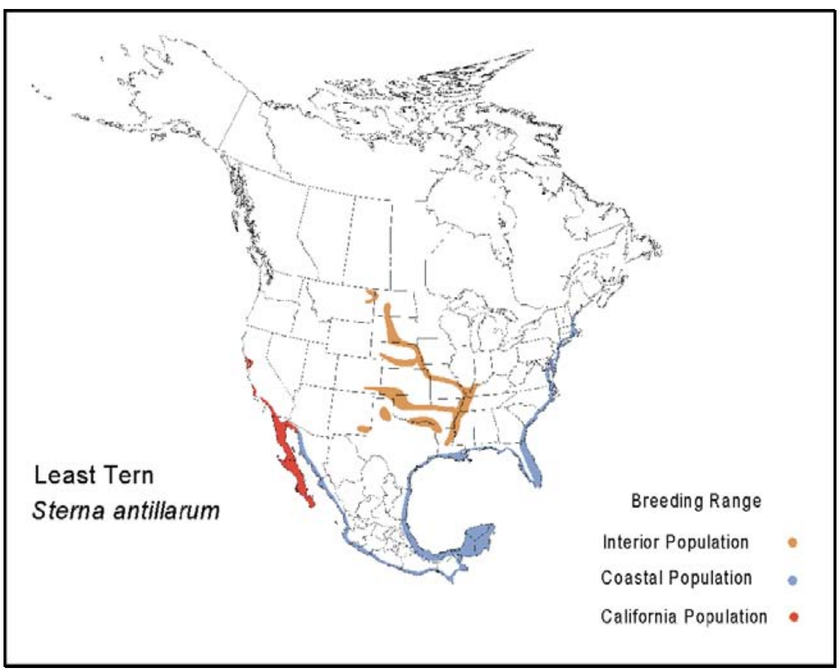

Figure 2: Distribution range of the least tern in North America
Courtesy: Mitchell et al (2000), USACE

Within the Missouri River system, breeding sites occur along the Missouri River and many of its major tributaries in eastern Montana, North Dakota, South Dakota, Nebraska and Kansas (USFWS 1990a). Few historical records of least terns in Montana exist and prior to their listing as endangered in 1985 only two non-breeding records were reported (Skaar et al 1985). Two years later, least terns were documented at Fort Peck Reservoir but the only known nesting attempt failed (Montana Piping Plover Recovery Committee 1988). More recently, interior least terns have been reported in three distinct areas in Montana: the Yellowstone River below Miles City, the eastern end of Fort Peck Reservoir above Fort Peck Dam, and the Missouri River below Fort Peck Dam (Figure 3). Detailed distribution maps compiled from individual breeding observations, gathered between 1988 and 2004, are presented in Figures 4 and 5.

Observational records of transient or migrant birds have also been reported in the southeastern (Lenard et al 2003) and central parts of Montana (Bergeron et al 1992). These are noticeably further west than the majority of confirmed breeding records. Reports of least terns also exist for Phillips County. In June 1997, a least tern was reported at Nelson Reservoir, while an additional two were recorded on Whitewater Lake in northern Phillips County in July 2004 (Fritz Prellwitz pers. comm.). Based on follow-up interviews and reviews of field notes, it is likely that these unconfirmed sightings will be upgraded to confirmed sightings. The 1997 sighting is of interest to breeding distribution patterns as it corresponds with a peak in least tern numbers along the Missouri River in northeast Montana. Although speculative, it is possible that in years characterized by a substantial increase in terns on this section of the Missouri, breeding birds expand their distribution northwestward in search of potential nesting sites (Fritz Prellwitz, pers. comm.).

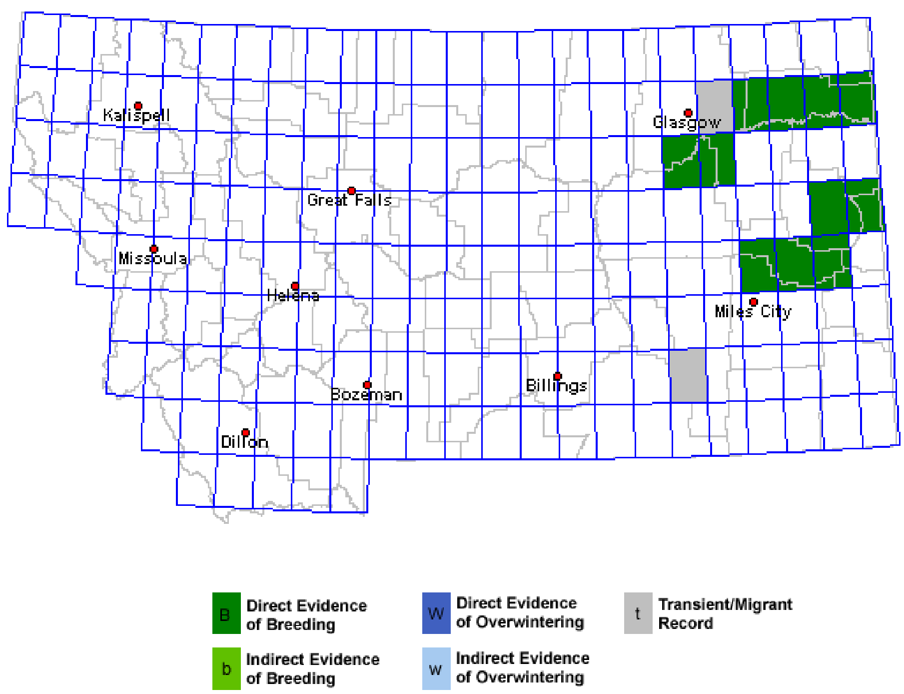

Figure 3: Quarter Latilong Occurrences for Interior Least Terns 1995-present
Courtesy: Montana Bird Distribution Database, Natural Heritage Program (2005).

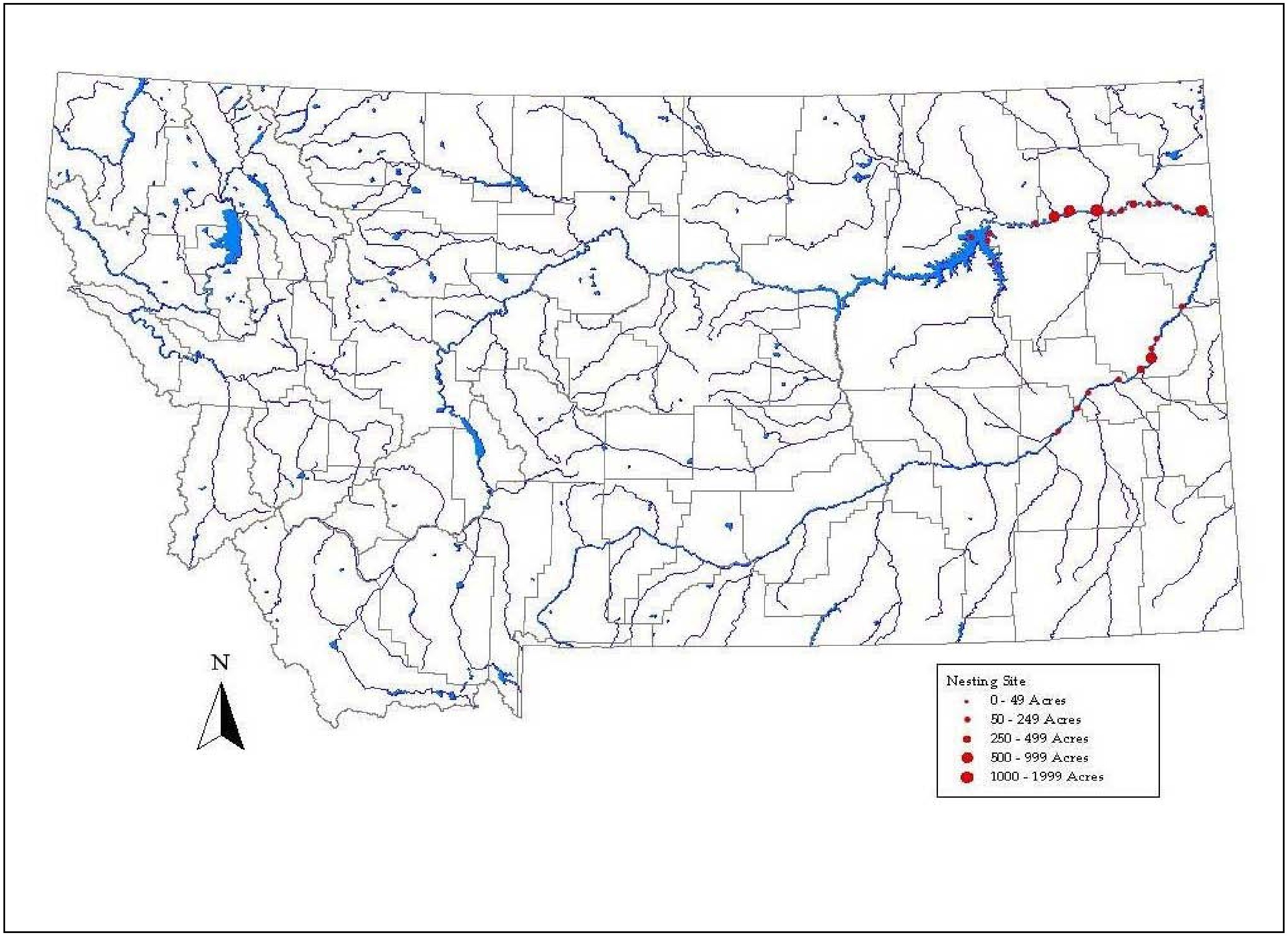

Figure 4: Distribution of interior least terns in Montana, based on 1988-2004 breeding records. Adapted from: Montana Heritage Program.

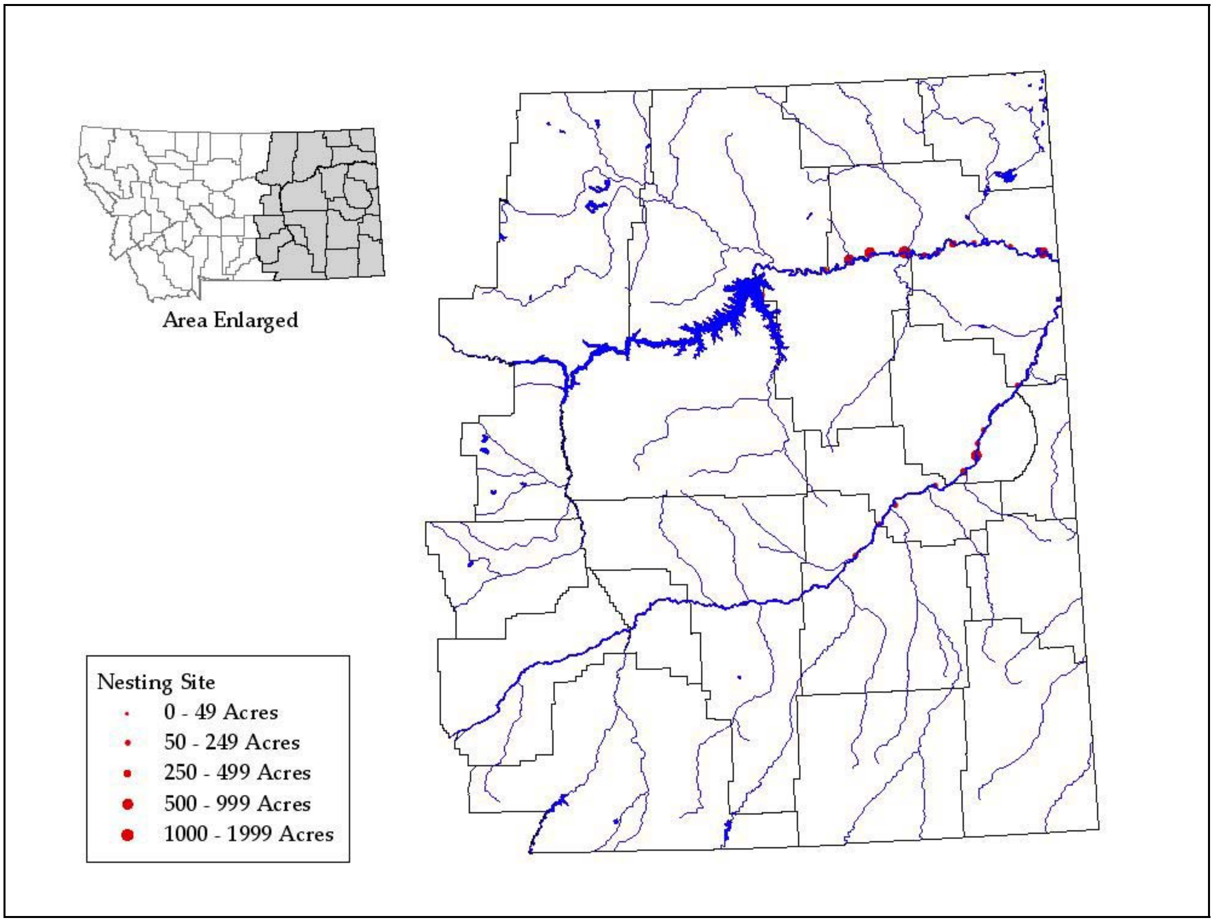

Figure 5: Distribution of interior least terns in northeastern Montana, based on 1988-2004 breeding records. Adapted from: Montana Heritage Program.

Limited banding recoveries make it impossible to specify wintering areas for each subspecies of least tern (Thompson et al 1997). As a result, the precise wintering range of the interior population of least terns remains unknown (USFWS 1990a). As a species, least terns winter primarily in marine coastal areas and have been reported regularly along the Central American coast and the South American coast as far as northern Argentina and southern Brazil (Thompson et al 1997). Many remain in wintering areas throughout their first year (Haverschmidt 1968).

HABITAT REQUIREMENTS

Breeding Season Habitat

Although not the case along the Yellowstone River in Montana, during the breeding season, interior least terns are frequently found in close association with piping plovers (*Charadrius melodus*). As such they are often thought to have similar habitat requirements. Despite similarities in nesting habitat, these closely related species belong to different feeding guilds: piping plovers feed on benthic invertebrates found along the moist sand shoreline while least terns are primarily shallow water piscivores. So, in addition to habitat for nesting and raising young, terns also require suitable adjacent aquatic habitat for foraging.

Breeding terns typically nest on sandbars and sandy islands in the Missouri and Mississippi Rivers and their tributaries (Sidle et al 1988). Gravel pits, river channel environments, and lake and reservoir shorelines are also used for nesting and foraging (USFWS 1990a). Important physical attributes of the nest site include: presence of suitable nesting substrate, lack of vegetative cover, existence of favorable water conditions and proximity to stable food resources (Hardy 1957, Sidle et al 1992, Ziewitz et al 1992, USFWS 2003). Characteristic riverine nesting sites are dry, flat, barren to sparsely, vegetated sections of sand or pebble beach within a wide, unobstructed, river channel (USFWS 1990a). Nests are usually located after the spring and early summer flows recede and dry areas on isolated sandbars are exposed, usually at higher elevations away from the waters edge. The presence of driftwood or other debris on sandy beaches may be important as nests are frequently situated in close vicinity (Smith and Renken 1991).

Figure 6: Typical least tern nesting habitat, Yellowstone River, MT
Courtesy: Lynn Bacon.

Sites with gravel substrate tend to provide the most suitable sites for nesting (Montana Piping Plover Recovery Committee 1994) as sites with excessive silt or clay content can cause eggs to adhere to one another during wet conditions leading to embryo death (Thompson and Slack 1982, Thompson et al 1997). Preferred vegetation cover is low ranging from <10% along the Missouri River in South Dakota (Schwalbach 1988) to 7-18% in Nebraska (Faanes 1983), and if present, is usually located far from the colony. Along the Yellowstone River, Montana (Figure 6), Bacon and Rotella (1998), reported that all nest sites were on bare cobble on the upstream portion of vegetated channel bars. Vegetative cover was, however, low and averaged 2.5%, consisting primarily of cottonwood (*Polpulus deltoids*) and sandbar willow (*Salix exigua*) saplings.

In North Dakota, South Dakota and Nebraska terns occur almost entirely on remnant sandbars along short free-flowing stretches of the Missouri River below most of the mainstem dams (Sidle et al 1988). On the lower Platte River in Nebraska, terns tend to use river sites characterized by relatively wide channels and large midstream sandbars (Kirsch 1996). In Montana, least terns breed on the shorelines and islands of Fort Peck Reservoir and on midstream sandbars of the Missouri River (Figure 7) downstream of the Fort Peck Dam (USFWS 1990b). Most breeding sites on the Yellowstone River occur in a section of the river where channel sinuosity begins to increase and there is a higher incidence of channel bars and overlapping islands surrounded by irregular channel activity (USFWS 2003).

Preferred sandbar habitat has disappeared along many river segments within the Mississippi Valley and as a result least terns have been forced to exploit new areas for nesting (Sidle and Kirsch 1993). Breeding birds now nest on artificially created habitat such as sand and gravel pits and dredge islands created by dredging operations (Sidle and Kirsch 1993, Kirsch 1996, Mallach and Legerg 1999) as well as ash disposal areas of power plants (Johnson 1987). Evidence suggests that terns utilize artificial habitats where natural habitat is limiting, however it is unclear to what extend they have replaced natural habitats or whether reproductive success is similar between habitats (Sidle and Kirsch 1993).

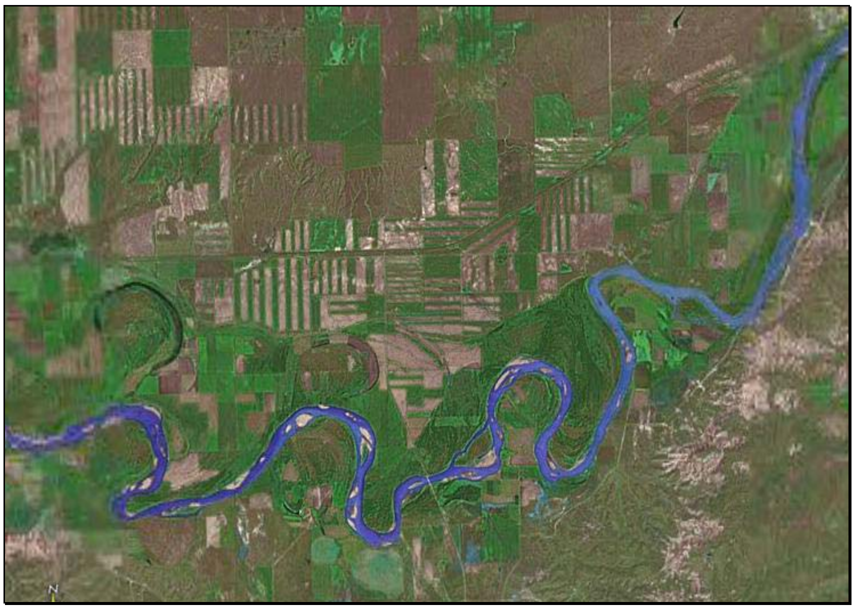

Figure 7: Satellite image of Missouri River, below Fort Peck Reservoir, Montana, showing midstream sandbars.
Courtesy: Google Earth (2005).

As habitat that meets both nesting and foraging requirements is essential, not all riverine areas are suitable. Primary foraging sites during the breeding season are usually limited to the margins of sandbars or potholes, side channels, tributaries and shallow-water habitats adjacent to the main channel. Reel et al (1989) found that nests were often associated with shallow areas of lakes or backwaters that offer an abundant food source. Open river channels with pooled or slow-flowing water less than 15 cm deep offer the most productive foraging. Foraging habitat is usually close to the nest site (Dugger 1997) occurring within 100 m of the colony (Faanes 1983, Thompson et al 1997).

Migratory and Winter Habitats

A dearth of scientific literature exists on the migratory patterns and wintering grounds for this species. As a result, little is known about the habitat requirements of this species during the remainder of the year. It appears likely however, that migrating terns use similar habitat types to those used for foraging and nesting during the breeding season (Whitman 1998). Wintering least terns have been reported in coastal lagoons and mudflats, in bays and estuaries, and inland foraging along shallow lagoons and exposed mudflats (Thompson et al 1997).

LIFE HISTORY AND ECOLOGY

Migration

Interior least terns are migratory, breeding along inland rivers systems in the United States and wintering along the coast in Central and South America (USFWS 1990a). Spring arrival times in the U.S. progress northward with the first birds arriving at breeding grounds in the lower Mississippi from mid April to early May. In the central Mississippi drainage arrival times generally occur from mid May (Tennessee) to late May (Illinois) although birds have been recorded as early as late April (Hardy 1957).

Little is known about the migratory patterns of the interior least tern in Montana. Most observations have been recorded for breeding pairs, with few reported sightings of transient individuals. Spring arrival of the species occurs in mid to late May, with departure in the fall generally occurring by mid-August (Montana Piping Plover Recovery Committee 1997, Lenard et al 2003). Departure from the breeding colony for southern wintering grounds varies according to geographic location and time of nesting. Initial migration from breeding colonies may begin as early as June while northern interior sub-populations may not depart until mid-August (Thompson et al 1997). Stiles (1939) noted that, in some years, river conditions along the Missouri River prevented nesting before the beginning of August and in these areas the young were not able to fly until after late August. In general, regardless of geographic location, most sites have been vacated by early September.

The precise migration route of the interior least tern remains unclear but records suggest that they follow major river basins to the confluence of the Mississippi River and then migrate south to the Gulf of Mexico. The route thereafter remains unknown (Thompson et al 1997).

Reproductive Biology

Least terns spend about 4-5 months at breeding grounds in the United States. Soon after arrival at the breeding site, provided the area is not inundated, adult terns begin a noisy courtship period lasting two to three weeks. Such behavior involves complex aerial courtship displays that culminate in the transfer of fish, on the ground, between two displaying birds. Other courtship displays include posturing, parading, vocalization, copulation and nest scraping (Hardy 1957). Monogamous pair bonds are apparently established for the breeding season and form either on the courting sites far from the colony or at the nest site (Tomkins 1959).

Figure 8: nest scrape with eggs, surrounded by pebbles.

The nest is a shallow scrape or depression (Figure 8) that is often lined with small pebbles and other conspicuous objects such as woody debris or dried plant material (Thompson et al 1997). Although males initiate nest scraping both sexes participate in the nest selection process and females select the shallow scrape that will ultimately become the nest (Hardy 1957). Females initiate egg-laying within two days of nest completion (Thompson et al 1997). Incubation is shared by both parents and lasts for 20-25 days (Massey 1974, Hardy 1957, Thompson et al 1997).

The eggs vary in coloration from pale buff to olive buff and are speckled or streaked with dark purplish-brown to blue-grey markings (Hardy 1957, Whitman 1988). Typical clutch sizes range from 1-3 eggs although interior terns average three egg clutches (Thompson et al 1997). Clutch sizes in the Lower Mississippi valley averaged 2.09-2.48 eggs during the 1986-1989 breeding season (Smith and Renken 1993). Likewise, in Texas, Conway et al (2003) report clutch sizes ranging from 1-3 eggs. While similar clutch sizes, averaging 1.9-2.7 eggs, were reported during the 1995-1997 breeding seasons for the Lower Mississippi River, several clutches of 4-5 eggs were also found. These large clutches, however, represented less than 0.5% of the total nests in any given year (Snell and Woodrey 2003).

Hatching within one day of each other, least tern chicks are able to walk almost immediately (Bent 1921). Chicks initially remain at the nest site with brooding being undertaken by both parents. Within two days of hatching they become highly mobile and leave the nest (Akcakaya et al 2003, Smith and Renken 1993), often taking refuge in nearby vegetation or beside debris (Thompson et al 1997). The period between hatching and fledging averages 20 days, however, juveniles do not become proficient at fishing until after migrating from the breeding grounds in the fall (Hardy 1957, Massey 1974).

Population Biology

Based on banding studies, the average age at which least terns begin breeding is three (Massey and Atwood 1981, Massey et al 1992) but birds as young as two have nested in California, Massachusetts, and the interior U.S. (Massey and Atwood 1981, Boyd 1993). Once nesting is initiated, terns typically attempt to breed every year, producing one brood per season (Thompson et al 1997).

Although natal and juvenile mortality is typical high, least terns tend to be long lived (Hardy 1957). Boyd (1993) recovered two interior least terns in Kansas that were six years old. Other banding studies have recaptured birds as old as 15 and 17 years (Renken and Smith 1995) while record longevity for a least tern banded in Massachusetts and recovered in New Jersey was 24 years and one month (Klimkiewicz and Futcher 1989).

Foraging Ecology and Diet Composition

Although the diet of least terns may include aquatic invertebrates such as crustaceans, mollusks, and annelids, the interior population feeds almost exclusively on fish (Hardy 1957, Atwood and Kelly 1984, Whitman 1988). Fish species captured by least terns tend to be surface schoolers found in shallow water (Wilson et al 1993). Accordingly, shallow water habitats (<1 m deep) are primary forage sites (Hardy 1957, Atwood and Minsky 1983). Inland feeding sites include rivers, streams, marshes, ponds, sand pits and reservoirs (Thompson et al 1997).

Foraging throughout the day, terns search for potential prey while flying or hovering 5-10 meters above the surface of the water (Eriksson 1985). Detected fish are pursued as the bird plunge-dives into the water. As “surface plungers” they utilize the volume of water closest to the surface and as a consequence any decline in density of schooling fish, water transparency, or an increase in aquatic vegetation may negatively impact their foraging ability (Eriksson 1985, Schweitzer and Leslie 1996).

Least terns will forage a considerable distance from nest sites (Atwood and Minsky 1983) with both parents supplying the chicks with food once incubation is complete (Hardy 1957). In general, however, in order to successfully reproduce, productive foraging habitat must be located close to the colony (Dugger 1997) and several studies note that foraging occurs within 100 m (approx 300 ft) of the breeding colony (Thompson et al 1997).

Prey size appears to be the most important factor determining dietary composition. Most fish ingested by adult birds range in size from 2.0-9.0 cm in length with a body depth <1.5 cm (Massey and Atwood 1980, Atwood and Kelly 1984) while chicks <10 days old are fed smaller fish (Atwood and Kelly 1984). Although dropped fish left uneaten at colonies appear to serve as a reliable index of principle species eaten, studies suggests they are inaccurate indicators of prey size consumed; such fish are often too large to be ingested (Atwood and Kelly 1984, Schweitzer and Leslie 1996). Common prey species for terns in the interior U.S. include gizzard shad (*Dorosoma cepedianum*), red shiner (*Cyprinella lutrensis*), river shiner (*Notropis blennius*), creek chub (*Semotilus atromaculatus*), plains minnow (*Hybognathus placitus*) and plains killifish (*Fundulus zebrinus*) (Hardy 1957, Schweitzer and Leslie 1996).

POPULATION STATUS

Population Status in the US

Early 20th century accounts indicate that uncontrolled hunting for the plume industry may well have played a significant role in the first major decline of this species (Bent 1921). Passage of the Migratory Bird Treaty Act in 1918, which prohibited the sale, purchase, taking, or possession of any wild migratory bird, allowed the species to recover in the 1920s and 1930s. This recovery was short lived, however. Beginning in the 1940s, human development pressures and the use of tern nesting beaches for recreation and housing contributed to the subsequent decline. In addition, in the interior U.S., river channelization and levee construction led to the destruction and alteration of natural nesting sandbar habitat (USFWS 1990a).

Breeding surveys conducted by Downing (1980) during the mid 1970s, estimated the interior least tern population at 1,250 birds. Additional census data reported by the USFWS (1985) indicated a population ranging in size from 1,400-1,800. In both cases, the results were based on partial surveys and the true population size was thought to be considerably higher (Kirsch and Sidle 1999). For example, Downing (1980) only surveyed part of the tern's breeding range; North Dakota, South Dakota and Texas were not included.

Data compiled from published and unpublished surveys conducted between 1984 and 1995 suggests that the interior population (n= 8,859) exceeded the outlined total population recovery goal of 7,000 birds in 1995 (Kirsch and Sidle 1999). While population increases during 1984-1986 were most likely a result of greater survey effort, Kirsch and Sidle (1999) report that increases in more recent years were primarily due to large increases in tern numbers along a 901 km (560 mile) stretch of the Lower Mississippi River.

Population increases along the Lower Mississippi during these years were high (60-100%), however, the average number of birds at most breeding sites farther north did not reach recovery levels.

Overall population trends during this time were positive, but this was due in large part to the increases recorded along the Lower Mississippi River (Kirsch and Sidle 1999). Annual increases for the entire interior population were around 9%, however, when data for the Mississippi River were excluded, that number dropped to 2.4% (Kirsch and Sidle 1999). At the scale of drainage basins, increases were noted for the Lower Mississippi (13%), Platte (2.6%) and Missouri (1.8%). Within the Missouri River drainage, although long term trends in least tern numbers were positive, these increases were not found to be statistically significant.

Of particular importance, however, are results from the 2005 range-wide census: a total of 17,587 interior least terns were recorded during the most recent breading season (Casey Lott, pers. comm.). This represents a significant increase in numbers compared to previously reported estimates and is substantially higher than the population size of approximately 7,000 birds required to meet recovery objectives (USFWS 1990a). As was the case when Kirsch and Sidle (1999) reported on published and unpublished surveys conducted between 1984 and 1995, the majority of birds were recorded along the Mississippi River. Within the Missouri River system, 2,040 least terns were counted in 2005 (Casey Lott, pers. comm.). Thus, recovery goals (n=2,100) have not been met for this drainage system.

Population Status in Montana

Population Size

Following their listing in 1985, interior least terns were first recorded in Montana at Fork Peck Reservoir in 1987 (Montana Piping Plover Recovery Committee 1988). Since that time surveys have been conducted on an annual basis in portions of the state believed to correspond to potential breeding habitat. The largest population of interior least terns recorded in Montana occurred during the 1994-1997 breeding seasons and was primarily a result of substantial increases recorded along the Missouri River below Fort Peck Reservoir (Table 1). Surveys conducted along this stretch of river have consistently recorded higher numbers of nesting birds, compared to other areas in Montana, and this section of the Missouri represents approximately 75% of the total Montana population (Figure 9).

Probably the most intensive survey of the Yellowstone River was conducted during the 1994-1996 breeding seasons by Bacon (1997). During this time, the river reach between Miles City and Seven Sisters Recreation Area supported an average of 27 birds (see Table 1). This represents the highest number of terns reported along the Yellowstone River since the birds were federally listed. Since 1997, fewer adult birds have been recorded along this section of the Yellowstone than were recorded during the intensive survey years of 1994 -1996, but numbers between years have remained stable (1997-2005 mean =16.6). While surveys conducted prior to 1994 did not cover the entire reach, the high numbers of terns recorded between 1994-1996, compared to those reported more recently may, as is often the case, be associated with sampling intensity. Without banding, however, it is impossible to calculate survivorship or rate of return.

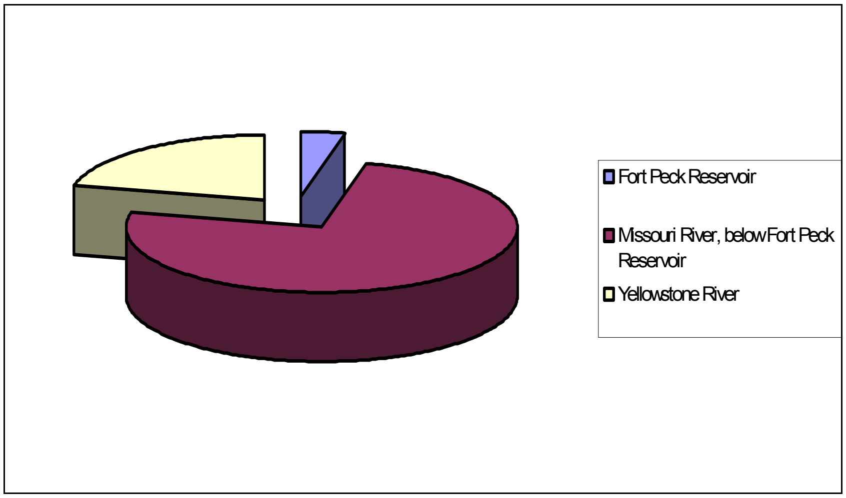

Figure 9: Distribution of adult interior least terns by river reach in Montana, based on combined survey results,1988-2005.

Least tern numbers clearly fluctuate widely at the local scale, perhaps as a result of habitat availability along river reaches. Consequently birds may not return to exactly the same locations between breeding seasons (Kirsch and Sidle 1999). Montana represents the extreme northwestern most breeding range of the interior least tern and this may affect the numbers of birds that ultimately reach the Yellowstone River, Missouri River or Fort Peck Reservoir in any given year (Bacon 1997). Average least tern numbers for the state are lower today than those reported during the 1994-1997 breeding season. This is more than likely a reflection of river conditions along other parts of the Missouri River drainage. During 1997, for example, near record runoff and associated USACE flood control activities along the Missouri, resulted in substantial habitat inundation on Lake Sakakawea and the Missouri River below Garrison Dam (USACE 1997). Sizable decreases in tern numbers were recorded in these regions. In comparison, the largest number of terns (n=162) ever recorded along the Fort Peck river reach of the Missouri occurred in 1997.

Using a ten-year trend average, as set forth in the Interior Least Tern Recovery Plan, Montana has averaged 72.9 birds (ranging from 40-181). Montana has, however, elected to use a five-year running average for trend analysis and management planning. The population over the past five-tear period (2001-2005) has averaged 51.6 birds (ranging from 49-58). Although the Recovery Plan has not been updated in 15 years, survey results support the notion that Montana has met and/or exceeded the recovery goal of 50 birds as set forth in the 1990 document.

Table 1: Estimated numbers of adult interior least terns in Montana based on annual survey results, 1987-2005. Data from USACE, G. Pavelka (pers. comm.), Bacon (1997), MFWP (unpublished data) and Montana Piping Plover Recovery Committee (unpublished data).

Year	Fort Peck Reservoir	Missouri River below Fort Peck Reservoir	Yellowstone River	Total
1987	4	-	-	4
1988	3	18	12	33
1989	4	48	12	64
1990	6	92	12	110
1991	10	66	16	92
1992	0	110	14	124
1993	7	31	19	57
1994	9	48	40	97
1995	2	94	21	117
1996	0	128	19	147
1997	0	162	19	181
1998	4	21	15	40
1999	0	40	11	51
2000	4	27	21	52
2001	0	33	16	49
2002	0	28	19	47
2003	2	38	18	58
2004	0	40	14	54
2005	0	34	16	50
Total	55	1058	314	1427
Mean	2.9	58.8	17.4	75.1
SD	3.2	41.26	6.5	44.08

Productivity and Reproductive Success

In addition to population trend data, reproductive parameters such as nest survival rate, chick production and fledgling success, provide valuable insight into the health and status of a population. Fledgling success (number of young that survive to fledgling age per adult pair) is widely used as an index of reproductive success in avian studies. While this index is frequently determined by dividing the total number of fledglings by the total number of adult pairs surveyed that year (USWFS 2003, Aron 2005), differences in data collection techniques make direct comparisons between sites difficult. This is the case for available fledge ratio data on the Yellowstone and Missouri Rivers in Montana. The Yellowstone River ratios were calculated by dividing the total number of chicks fledged by the number of nests identified. In contrast, the USACE typically utilize number of chicks per pair of adults when calculating fledge ratios along the Missouri River.

In Montana, least tern productivity data gathered along the Yellowstone River between 1994 and 1996 varied greatly among years but was high on average (Bacon and Rotella 1998). Fledge ratios were estimated at 1.4, 0.1 and 0.7 fledglings per nest respectively, with a mean annual estimate of 0.73 fledgling per nest. Along the Missouri River, below Fort Peck Reservoir, the USACE has undertaken least tern productivity monitoring since 1988. Fledge ratios are determined as the number of fledged chicks per pair of adult birds counted during the annual census that year. As data gathered between 1988 and 2001 represented a reach sub-sample (G. Pavelka, pers. comm.), productivity data for the 2002–2005 breeding seasons may provide a more thorough assessment of reproductive success along the Missouri River. During these years, fledge ratios fluctuated between 0.60 and 2.18 fledglings per pair of adult birds with a mean annual estimate of 1.01 (Table 2). The 2005 breeding season was particularly successful, although the late arrival of several birds (after the annual adult census) elevated the fledge ratio. These birds were not included in the annual adult census, but their nests and chicks were. Consequently, at least a portion of the variation is due to inclusion of these late arrivals in the productivity data (G. Pavelka, pers. comm.).

Such data provide a good assessment of productivity during a limited time period, but least terns appear to respond to changes in habitat availability at the landscape level. In light of such variation, survey data gathered prior to 2002, combined with census data from 2002 through 2005, may provide a more accurate reflection of long term variation and trends. Fledge ratios over the past ten years (1996 to 2005) vary from 0 to 2.18 chicks fledged per pair of adult birds. The mean fledge ratio during this time was lower (0.69 fledgling per pair of adult birds) than that (0.94) set forth in the USFWS Biological Opinion (USFWS 2003).

Table 2: Estimates of interior least tern reproduction on the Fort Peck river reach of the Missouri River, 2002-2005. Data from USACE, G. Pavelka, pers. comm.

Year	Adult Census	Nests	Nest Hatching	Nest[a] Success	Eggs	Eggs Hatching	Chicks Fledge	Fledge[b] Ratio
2002	28	22	10	45.5	49	10	10	0.71
2003	38	16	10	50.0	45	8	12	0.63
2004	40	17	16	82.4	33	14	12	0.60
2005	34	26	18	69.2	63	18	37	2.18
Total	140	81	54	66.7	190	50	71	1.01
Mean	35	20.3	13.5		47.5	12.5	17.8	

a = nests per 100 attempts
b = fledged chicks per pair of adult birds (does not include collected fledged)

FACTORS AFFECTING CURRENT POPULATION LEVELS

Habitat degradation and loss, and human-related disturbance, have been identified as the primary agents of decline for interior least terns throughout their breeding range (USFWS 1990a). Increased predation pressures and localized food shortages near breeding colonies also impact terns thereby limiting productivity, survivorship and reproductive success.

Habitat Alteration and Loss

Channelization, bank stabilization, and construction of reservoirs to meet flood control, hydroelectric and navigation objectives have all contributed to the degradation or loss of much of the interior least tern's sandbar nesting habitat (USFWS 1990b). For example, in the Missouri River valley hundreds of kilometers of historic sandbar habitat have been destroyed and the construction of reservoirs (Figure 10) has impounded almost a third of the river, converting essential riverine habitats into lake habitats (USFWS 2003). Likewise, approximately 40% of the historic sandbar habitat has been lost along the Mississippi River and least terns have been eliminated from the upper reaches of the Mississippi and its tributaries (USFWS 1988, Smith and Renken 1993)

In fact, many of the factors affecting interior least tern reproductive success can be traced to degradation of habitat as a result of altered water flow regimes. These are discussed in more detail below.

Water Flow and River Dynamics

Water flow regimes throughout much of the interior U.S. differ greatly from historic regimes. Prior to anthropogenic alteration, the Missouri River was a dynamic constantly changing ecosystem characterized by braided channels, sandbars and natural floodplain communities (USFWS 2003). Typically, the natural hydrologic cycle followed a double peaking regime corresponding with snowmelt and spring rains on the plains in March and April, and snowmelt from the Rockies in June (USACE 1997, USFWS 2003). July was characterized by receding water levels.

Figure 10: Fort Peck Spillway, MT
Courtesy: Airphoto - Jim Wark.

Following this bimodal flood pulse, an extended period of low flow from August through February occurred (Galat and Lipkin 2000). Under such natural river conditions, islands and sandbars were continually reshaped, created and destroyed by the rivers erosion and deposition processes (USFWS 1985). Periodic inundation due to natural water regimes also scoured sandbars and maintained tern nesting habitats that were relatively free of vegetation.

Beginning in the 1930s, impoundment of the Missouri River greatly affected natural hydrologic and geomorphic processes, resulting in altered water quality characteristics downstream. The Missouri Rivers flows below Fort Peck Reservoir are now highly regulated (see Figure 10), with greatly reduced peak flood pulses and generally higher than pre-impoundment base flows (Power and Rychman 2000). In fact, the median high flow was cut in half following the dam's closure (Shields et al 2000).
The result of these changes is an annual hydrograph that exhibits far less variability (National Research Council 2002).

Heese and Mestl (1993) reported that early operations of Fort Peck dam did not appear to affect the hydrograph and define the pre-regulation period for the whole river as 1929-1948. Utilizing these criteria, pre and post regulation hydrographs for the Missouri River, downstream of Fort Peck Dam, illustrate such changes in water flow (Figures 11 and 12).

In addition to alteration of the hydrologic cycle, discharge regulation and storage of flows along the Missouri have interrupted sediment and organic material transport (USFWS 2003), thereby altering many of the dynamic physical processes that maintain this large river ecosystem. Impoundment has contributed to degradation of the remaining sandbar habitat as sediment-poor water erodes islands without corresponding accretion elsewhere (National Research Council 2004). Suppression of high spring flows, due to reservoir storage, has also led to vegetation encroachment and as a result much of the essential sandbar habitat is now unsuitable for nesting terns. Below Garrison Dam, North Dakota, a lack of new alluvial deposits is reportedly leading to a floodplain forest of advanced successional stage (Johnson et al 1976).

By way of contrast, the Yellowstone River exhibits a somewhat natural hydrograph (Figure 13 and 14), although it does have altered flow regimes due to smaller dams in the drainage system. For example, the unregulated Yellowstone River at Sidney has 30% of its run-off controlled by the Yellowtail (on the Bighorn River), and Tongue River dams (Koch et al 1977). In general, however, pre and post regulation hydrographs are similar: both are characterized by obvious spring flood pulses and base flows during the summer months that are markedly lower.

While the Yellowstone River hydrographs provide valuable insight into long range trends, it is difficult to ascertain precise discharge rates and flow regimes during critical nesting periods in any given tern breeding season. As approximately one third of the run-off is controlled by the Yellowtail and Tongue River dams, a smaller sub-set of data were examined more closely. The past five years (2000-2005) were compared to a representative five years period (1945-1950) gathered prior to impoundment of the Tongue (Tongue River Dam completed in 1965) and Big Horn tributaries (Yellowtail Dam completed in 1966). Analysis of both hydrographs reveals that while the timing of spring flood pulses is consistent between post and pre-impoundment periods, the magnitude of these peak flows differ (Figures 15 and 16). During the pre-dam era, maximum stream flow discharge during the spring flood pulse period was consistently higher than today.

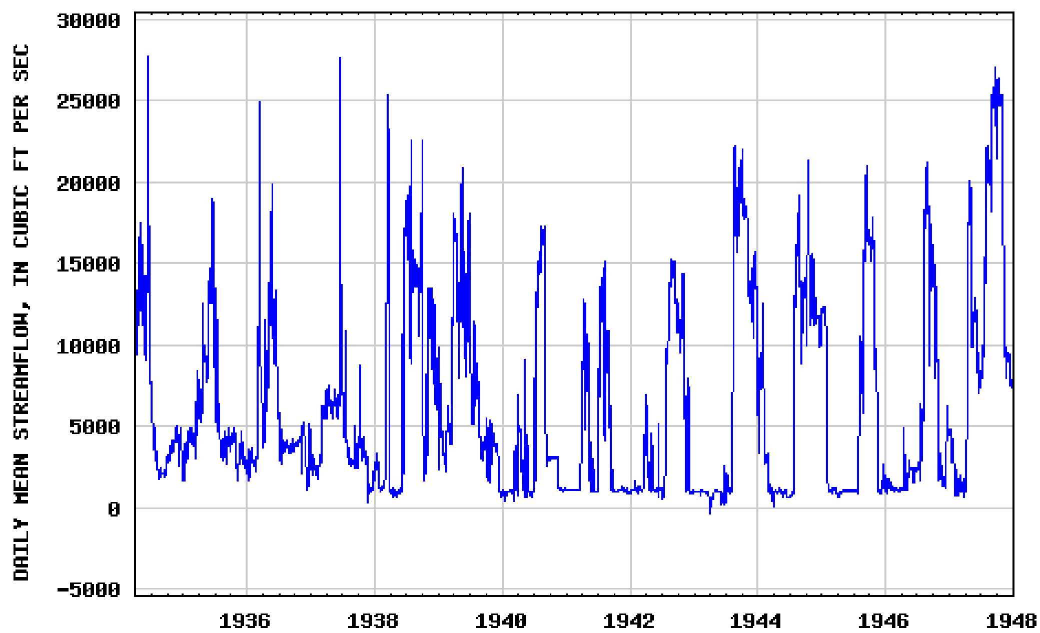

Figure 11: Pre-regulation hydrograph for Missouri River, below Fort Peck Dam, Montana. Data from USGS.

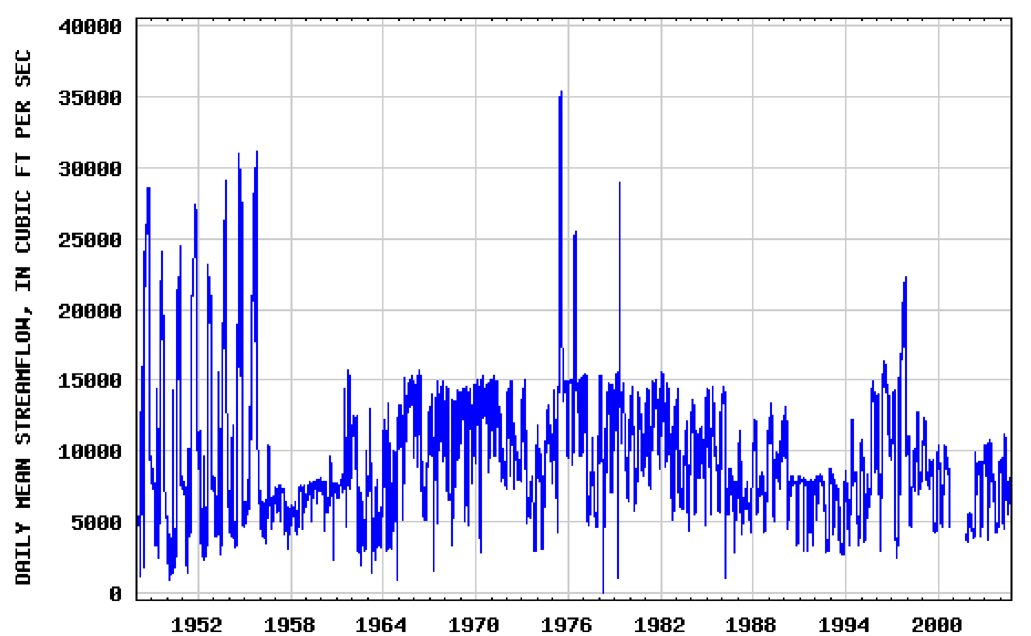

Figure 12: Post-regulation hydrograph of Missouri River, below Fort Peck Dam, Montana. Data from USGS.

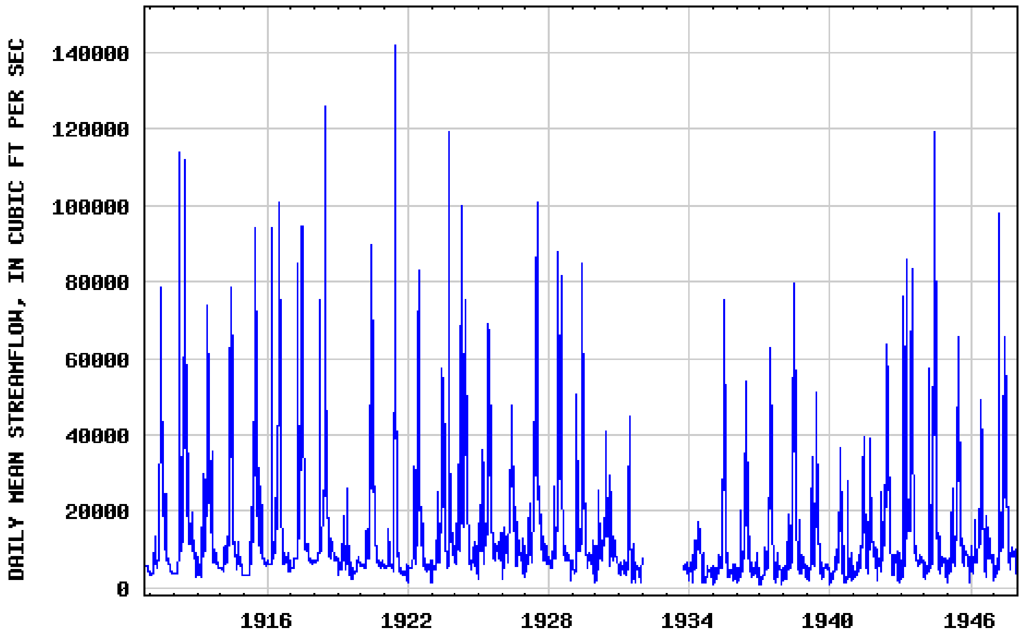

Figure 13: Pre-regulation hydrograph of Yellowstone River near Sidney, Montana. Data from USGS.

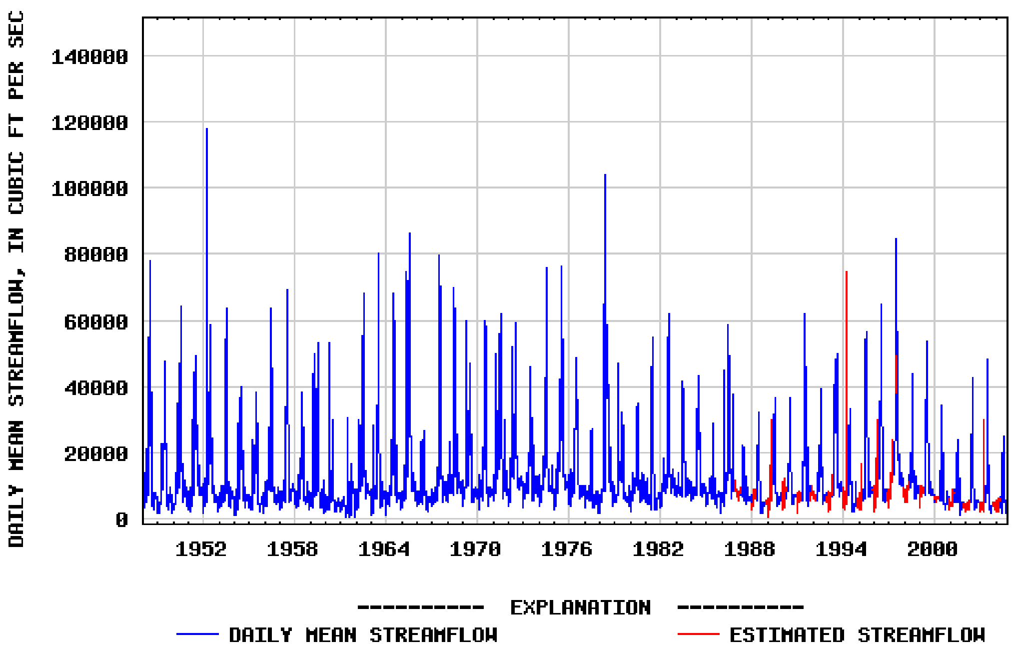

Figure 14: Post-regulation hydrograph of Yellowstone River near Sidney, Montana. Data from USGS.

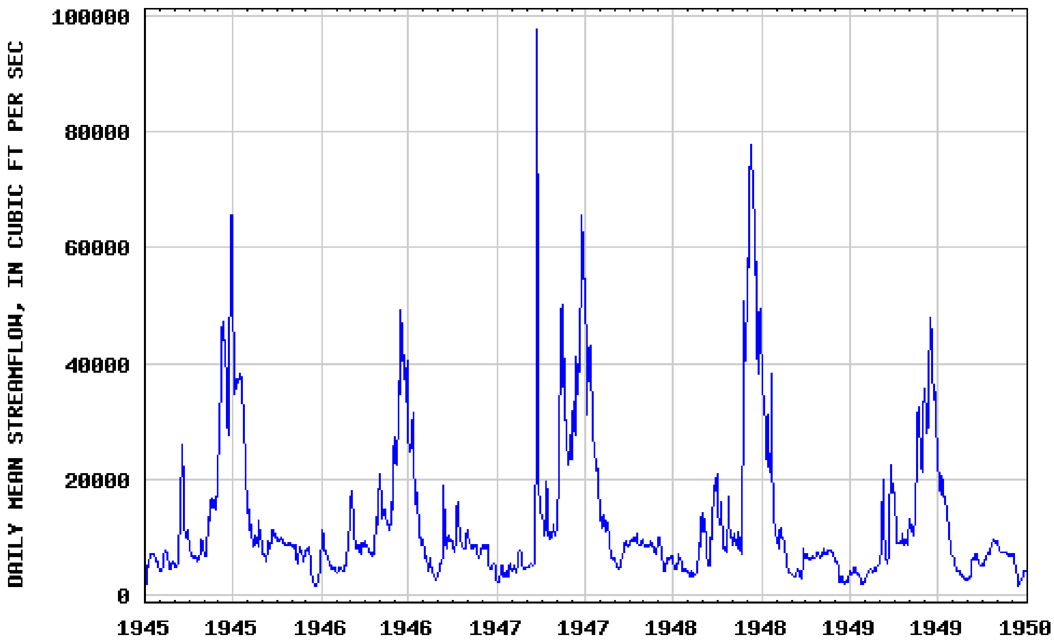

Figure 15: Representative five year, pre-regulation, hydrograph of Yellowstone River near Sidney, Montana. Data from USGS.

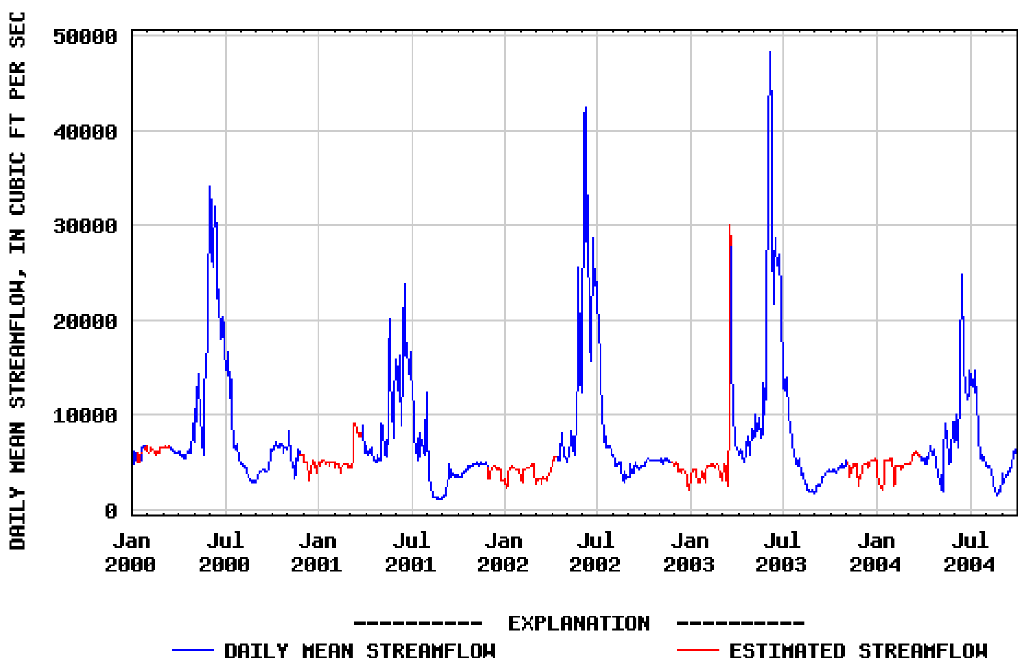

Figure 16: Representative five year post-regulation hydrograph of Yellowstone River near Sidney, Montana. Data from USGS.

Although the period between 2000 and 2004 was characterized by poor rainfall and regional drought (MFWP 2005), of greater significance perhaps, to the river ecosystem is the water diverted from the lower Yellowstone to meet irrigation demands. Six mainstem low-head irrigation diversion dams occur along this river reach (Figure 17). As most irrigation diversions are not measured, data are not available to accurately determine the amount of water consumed by irrigation. About 90%, however, of all water use on the Yellowstone River is for irrigation (White and Bramblett 2001) and the largest diversion dam (Intake Diversion) diverts approximately $38 m^3/s$ (Hiebert et al 2000). In fact, so marked is water withdrawal for agriculture that releases from the Yellowtail reservoir now represent a substantial portion of the Yellowstone's Rivers total flow during summer months and are vital during drought years (MFWP 2005). Furthermore in 2002, irrigation demands on the Tongue River essentially dried up the lower 32 km (20 miles) throughout the irrigation season (May-October): diversions took the entire stream flow resulting in a desiccated lower river (MFWP 2003).

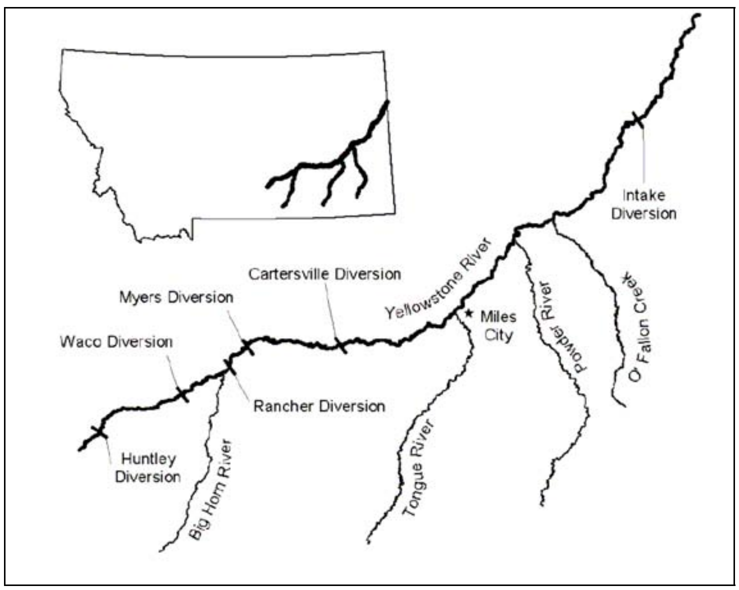

Figure 17: The Yellowstone River, its major tributaries, and diversion dams. Adapted from Jaeger (2005).

A reduction in stream flow, as a result of water diversion, coupled with likely silt build up behind tributary dams on the Bighorn and Tongue rivers raises questions concerning potential cumulative effects of altered erosion and deposition processes that are so vital to the formation and maintenance of sandbar habitat for nesting terns. Such impacts may include a reduction of open bar areas and encroachment of vegetation throughout the impacted reach (Womack and Associates 2001). In summary, although pre and post variation in flood pulse discharge rates exist at the local scale along the Yellowstone, in it's assessment of the Missouri River, the National Research Council (2002) concludes that where the Yellowstone River, with its abundant silt load and naturally varying hydrology, meets the Missouri River near the Montana-North Dakota border, near pre-regulation conditions exist.

Unpredictable water levels (flooding)
Prior to dam construction, water flow patterns along main stem rivers were more predictable. After the spring peaks, river flows normally declined affording least terns the opportunity to nest as water levels receded and sandbars became available (Hardy 1957). In fact, field research suggests that along the lower Mississippi River, least tern reproduction coincides with water flow reduction following spring floods (Tibbs and Galat 1998, Dugger et al 2002), Moreover, the majority of sand bars and islands used by terns for nesting in the lower Mississippi River typically remain exposed for at least 100 consecutive days from mid-May to late August (Smith and Renken 1991), indicating the importance of protracted low river stages in summer (Tibbs and Galat 1998).

Today rivers are managed for flood control, navigation and hydroelectric power. As a result, inappropriately timed water releases may cause periodic inundation of sandbars, which can prove lethal to interior least terns if water discharge takes place during nesting or prior to fledging. For example, tern egg (nest inundation) and chick (stranding) losses below dams may occur after water held back to minimize flooding downstream is subsequently released (USFWS 2003). In fact, sustained reservoir releases during the naturally low-water season cause protracted flooding of about two-thirds of the Missouri River and may be as damaging a disturbance to the river biota as reduction of the annual June flood pulse (Galat and Lipkin 2000).

In Montana, while the Yellowstone River remains largely unregulated (Bacon and Rotella 1998), the Missouri River is subject to USACE water level regulation policies. Accordingly, lower lying nest sites along the Missouri River, below Fort Peck Reservoir, may be subject to rapid flooding and inundation. Due to substantial water diversion for agriculture purposes, normal operational releases from the Yellowtail and Tongue River dams are unlikely to pose such a threat to tern nests along the lower Yellowstone.

Food Availability
Least terns feed on "surface schooling" prey (fish) species found in shallow water habitats (Hardy 1957, Atwood and Minskey 1983, Wilson et al 1993). Dam and reservoir construction has converted shallow riverine and floodplain aquatic habitats, into deep water habitats. Modifications to free-flowing reaches for bank stabilization and commercial navigation have also resulted in a significant loss of river shoreline and shallow, slow velocity habitats, thereby reducing suitable foraging habitat (USFWS 2003).

Several researchers have studied the relationship between river hydrology, fisheries productivity and reproductive success of least terns (Dugger 1997, Tibbs and Galat 1998, Dugger et al 2002). Along the Lower Mississippi River tern reproductive success was highest during years with the lowest July water levels. It is hypothesized that low water levels later in the nesting season increase fish prey availability by concentrating small fish in shallow water habitats and backwater areas, thereby increasing both foraging efficiency and food availability during chick rearing (Dugger et al 2002). In a conceptual model integrating the abiotic factors of hydrology and sand island area to least tern reproduction and fish availability in the lower Mississippi River, Tibbs and Galat (1998) suggest that forage availability and least tern reproduction is strongly regulated by river stage. Consequently, alteration of the natural flow regime may significantly impact reproductive success. Moreover, the ensuing release of water from mainstem dams during summer months, may further impact food availability and reproductive success.

Suitable water conditions are also required for successful fish reproduction and so, in addition to the hydrograph and appropriate foraging habitat, favorable water temperatures must exist for fish reproduction. According to the USFWS Biological Opinion (USFWS 2003), unsuitable water temperatures as a result of current flow regimes below main stem dams such as Fort Peck, Montana, are likely to negatively impact spawning by native fish and limit food supplies for least terns.

In Montana, although terns are recorded annually along the Missouri River, very few have been recorded west of Wolf Point (approximately 112 km/70 miles east of Fort Peck Dam). While tern nesting habitat availability is poor along this stretch, so too is prey species abundance: very few minnows and other small forage species have been sampled along this stretch (Dave Fuller, pers. comm). Unfavorable water temperature conditions, coupled with a lack of shallow river channels and backwaters may prevent fish as well as terns from successfully breeding along this reach below Fort Peck Dam. Interestingly, research conducted by MFWP biologists between April and November 2004, revealed that average daily water temperature below Fort Peck was significantly lower (12.3 ^{0}C) than that recorded upstream of the dam (17.6 ^{0}C) (Figure 18). More importantly, maximum water temperature (attained during summer months) was suppressed 10.4 ^{0}C. Mean daily water temperature did warm longitudinally from below Fort Peck Dam to the lowermost Nohly site (15.8 ^{0}C), but mean daily water temperature at Nohly was significantly less than above the dam (D. Fuller, pers. comm.). As a consequence, the thermal impacts of cold hypolimnetic releases from Fort Peck Dam remained evident 280 km (174 rm) downstream from Fort Peck Dam. In fact, natural water temperatures were only restored where the Missouri River met the Yellowstone River at the Montana-North Dakota border.

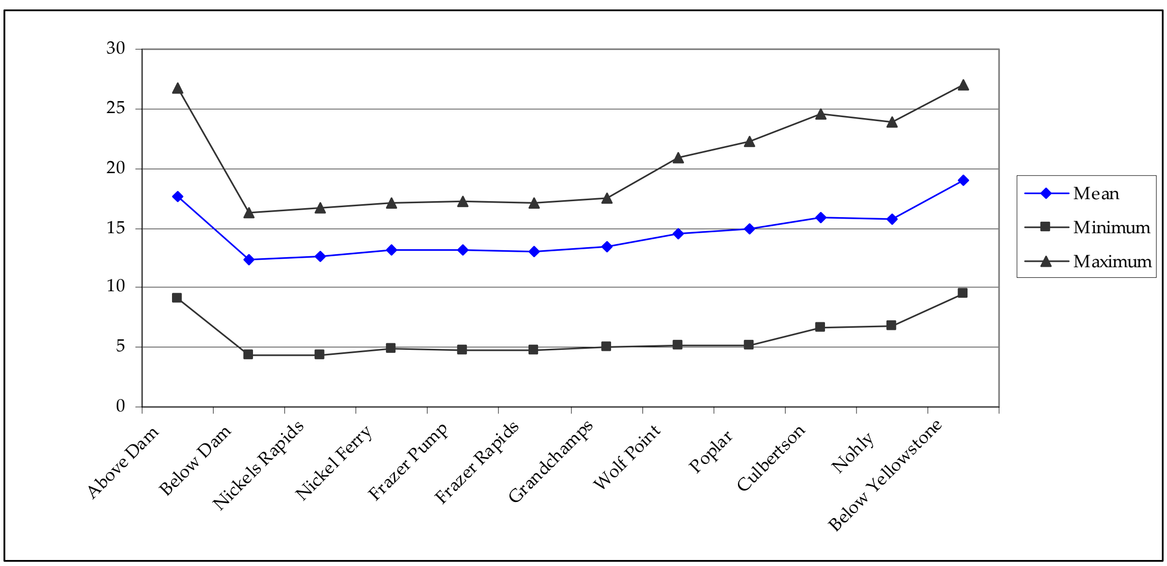

Figure 18: Mean daily water temperature (^{0}C) for Missouri River mainstem locations in 2004. Data from MFWP, D. Fuller pers. comm.

Along the Yellowstone River, least tern forage species availability appears to be good (D. Fuller, pers. comm.) but reduced stream flows as a result of water demands for agriculture have affected the fish assemblage (White and Bramblett 1993). By the mid-1970s water depletions and diversions had decreased the Yellowstone River's flows by approximately 24% from historical levels, and additional depletions have been allowed since that time (Power et al 2000). Low stream levels can detrimentally affect forage species abundance by stranding eggs, limiting downstream transport of larvae and reducing available habitat for adult fish. Likewise at low flows, backwater and side-channel nursery areas are eliminated (MFWP 2005). In fact, in its Annual Drought Summary for 2004, MFWP (2005) concludes that habitat limitation combined with irrigation demand on the little remaining water equates to poor fisheries health. Although speculative, there is a potential, therefore, that interior least tern prey abundance along the lower Yellowstone River could be impacted by stream flow reduction due to irrigation diversions particularly during drought years such as those that characterized the region from 2000-2004.

Predation

While terns have evolved with predation pressures and some loss due to predation is expected even in unaltered systems, management operations may exacerbate the situation (USFWS 1990b). In addition to direct flooding of nests, river level fluctuations also influence the degree of predation a colony site experiences (Szell and Woodrey 2003). While nest sites on channel sandbars that remain isolated from the main shoreline are less susceptible to mammalian predators, studies conducted by Schulenberg and Schulenberg (1982) report that flooding of river sandbars during the nesting season increases the incidence of predation. Rising water levels shrinks the limited available habitat leaving chicks and eggs more vulnerable to predators.

Burger (1984) suggests that habitat loss appears to cause a decrease in the number of nesting colonies but an increase in colony size. This trend towards large colonies is potentially detrimental to overall productivity of the species as large colonies may be more vulnerable to predation (Burger 1984, Brunton 1997) as well as stochastic events. Research conducted along the shorelines of Connecticut appears to supports this hypothesis. In 1988, the colony under study failed, with less than 0.08 chicks fledged per pair, as a result of intense predation by black crowned night herons (Brunton 1997).

Along the Missouri River in South Dakota, predation was reported as the leading cause of nest and chick loss (Kruse et al 2001). Primary nest predators identified included American crow (*Corvus corvus*), raccoon (*Procyon lotor*) and mink (*Mustela vison*), while American kestrel (*Falco sparverius*) and great horned owls (*Bubo virginianus*) were responsible for the majority of chick losses. The authors suggest that the high predation rates observed were a direct result of sandbar habitat deterioration and the resulting increase in predator foraging efficiency (Kruse et al 2001).

Species that nest along shorelines may also be exposed to a variety of predators whose populations are affected by humans. Dogs, cats, rats and raccoons all have the potential to affect reproductive success (Burger et al 1994).

Human Disturbance
Human disturbance, both direct and inadvertent, continues to pose a problem in many areas. The presence of people, pets or vehicles in the vicinity of nest sites may result in nest abandonment or the unintended crushing of nests (Thompson et al 1997). In addition, breeding birds may be reluctant to return to the nest, leaving eggs and/or chicks vulnerable to temperature fluctuations. Vehicular and other recreational activities are widespread along the Platte, Missouri and Mississippi rivers and such activities occur predominantly on the barren islands favored by terns (USFWS 1985). Likewise, all terrain vehicle (ATV) disturbances pose a threat and have the potential to impact tern reproduction. In areas where river levels are low, ATV's can gain access to islands and in some instances this has reportedly led to chick and adult mortalities (Smith and Renken 1993).

As birds nesting in areas frequented by humans often suffer from disturbance, management activities also pose a potential threat. For example, weed control activities on sandbars or along stretches of shorelines could result in disturbance if undertaken during critical nesting periods.

Infectious Disease
Population impacts as a result of disease are most likely to have deleterious effects on small populations with limited distributions. Diseases, such as West Nile Virus (WNV) and Avian Influenza, have the potential to impact least tern populations. While no known least terns have reportedly tested positive for WNV, other related species have (USGS 2003). A dead piping plover, located on Lewis and Clark Lake, South Dakota, tested positive for WNV in 2003 (Aron 2005).

In mid-June 2001, the U. S. Fish and Wildlife Service reported the mortality of endangered California least tern chicks in several nesting colonies along the southern California coast. By late June, the mortality had increased to nearly 400 chicks. Tern biologists suggested the chick mortality could be due to infectious disease, predation, starvation due to food scarcity, disturbance by predators, or intoxication by naturally occurring marine biotoxins. The only significant finding in two chicks submitted to the National Wildlife Health Center was emaciation (USGS 2001), although tests are still ongoing.

In addition, the first isolation of influenza virus from wild birds was reported in 1961 from common terns (*Sterna hirundo*) in South Africa (Becker 1966), although the virus responsible for these tern deaths (H5N3 HPAI) did not persist in wild bird populations. While a highly pathogenic H5N1 AI epizootic may transiently impact the local population of interior least terns, based on our current knowledge of the disease, it is unlikely to affect long-term viability (Mark Atkinson, pers. comm.). Furthermore, Montana represents the northwestern limit of the population's breeding range and as such, it is unlikely that interior least terns in Montana would come into close contact with more northerly infected migrant species.

Pollution and Environmental Contaminants
Least terns feed at upper trophic levels and as a consequence may be susceptible to the effects of bioaccumulation from contaminants such as organochlorine pesticides, heavy metals and polychlorinated biphenyls (PCBs). This has the potential to negatively affect egg production, chick survival and overall

reproductive success (Ohlendorf et al 1986, Hothern and Powell 2000) but little is known about the impacts in this species (Thompson et al 1997, Mierzykowski and Carr 2004).

Mercury residues have been recorded in interior least terns from the Cheyenne River system while DDE (organochlorine metabolite of DDT) and PCBs have been reported in both coastal subspecies (USFWS 1983, Whitman 1988, USFWS 2003). Elevated concentrations of organochlorine pesticides and heavy metals have also been detected in coastal least tern eggs and chicks. Although declines in reproductive success due to elevated DDE levels have been noted in the literature (Nisbet and Reynolds 1984), other studies reported normal chick growth rates and reproductive success at colonies with elevated levels of organochlorines (Custer et al 1986, Mierzykowski and Carr 2004).

Pollutants entering river systems as a result of coal bed methane development also have the potential to degrade water quality and fish habitat. This could negatively affect small fish populations upon which least terns depend.

Nesting and Reproductive Success

Fledgling success is difficult to establish for colonial nesting waterbirds such as least terns (Erwin and Custer 1982, Massey and Atwood 1981, Smith and Renken 1993), however, a thorough knowledge and understanding of reproductive success is critical if conservation efforts aimed at increasing or stabilizing the interior least tern population are to be met. Many factors highlighted in the preceding sections, such as habitat loss and degradation, altered water flow regimes, predation, and human disturbance, affect least tern nesting and reproductive success (USFWS 1990b, USFWS 2003). More specifically, data suggests that reproductive success of interior least terns is highly variable among sites and years and appears to be influenced primarily by annual hydrologic patterns (water-flow regimes) in combination with predation pressures (Smith and Renken 1993, Szell and Woodrey 2003, National Research Council 2004).

Several analyses of least terns have been undertaken to determine the fledge ratio required to maintain or increase the population. Criteria for fledgling success established for least tern populations in California consider 1.0-1.5 fledglings per nesting pair as good, 0.5-1.0 fledgling per nesting pair as moderate and 0-0.5 fledgling per nesting pair as poor (Massey and Atwood 1981). Similar indices are reported by Thompson (1982) and Hill (1985) who propose 0.5 fledglings per adult (or 1.0 fledgling/pair) and 0.5 fledgling per female respectively as a production level necessary for population stability. Kirsch and Sidle (1999), however, suggest a much more conservative estimate (0.51 fledglings/pair) necessary for population maintenance. In its Biological Opinion for the Missouri River mainstem reservoir system, the USFWS established an annual fledge ratio goal of 0.94 fledglings per pair of breeding adults and directed the USACE to maintain this fledge ratio for all areas (USFWS 2003).

Although not referred to as frequently in the published literature, clutch size is also an important component of reproductive fitness because it directly affects reproductive success in any breeding season. The availability and quality of food can affect clutch size (Burger et al 1994) and differences in both, preceding the egg laying period, may be a proximate cue by which birds reduce their clutch size (Murray 1985). Thus, regional differences in clutch size may reflect differences in food availability (Burger et al

1994). Given that water temperature affects environmental cues for fish reproduction (USFWS 2003), and much of the shallow water foraging habitat for least terns has been lost or altered (USFWS 1990b), it is possible that clutch size, and hence reproductive success, of interior least terns could be affected by foraging success and prey availability.

Factors Affecting Interior Least Tern Productivity in Montana

Along the Missouri River, productivity monitoring conducted between 1993 and 2005 identified 214 nest sites, of which 134 hatched. Of the remaining nests (n=80) the outcome of nearly 50% could not be determined (Table 3). From a conservation perspective, this is potentially problematic: this category accounts for the single largest number of potential nest failures.

Excluding nests that were abandoned (n=14) or whose fate was unclear (n=38), weather (hail, rain and wind storms) accounted for the highest number of known nest failures. While flooding led to the destruction of only three nests, fluctuations in water releases may be additive to extreme weather problems. Of those nests destroyed by rising water, however, none could be directly attributed to USACE operations (G. Pavelka, pers. comm.). Predation caused 10% of nest failures. Unlike many areas in the Mississippi River drainage, livestock and human disturbance does not appear to be a major threat along the Missouri River below Fort Peck Reservoir.

Table 3: Causes of least tern nest failures along the Missouri River, below Fort Peck Dam, during USACE monitoring period 1993-2005. Data from USACE, G. Pavelka, pers. comm.

Cause	**Flood**	**Weather**	**Predation**	**Bank Erosion**	**Human Disturbance & Livestock**	**Unknown****	**Abandoned**
Number of Nests Destroyed	3	13	8	4	0	38	14
As a % of nests that failed to hatch	3.8%	16.3%	10%	5%	0%	47.5%	17.5%
As a %of all nests identified	1.4%	6.1%	3.7%	1.9%	0%	17.8%	6.5%

* Number of nests reported include those of known and unknown outcome.

** Nests designated unknown include (i) destroyed nests (fate undetermined) and (ii) nest sites previously recorded but no visible sign (egg fragments, predator tracks etc.) present at subsequent visitation.

Annual least tern surveys have been conducted along the Yellowstone River since the late 1980s but productivity monitoring data have not been gathered consistently. In most instances, only breeding adults and nest sites were recorded. Between 1994 and 1996 mean nest success along the river was 84% (Bacon 1997, Bacon and Rotella 1998). Unlike results from other studies of interior least terns, predation and human disturbance did not have strong negative effects on reproduction, and it is likely that the relative seclusion of the channel bars used for nesting, coupled with the limited number of river access sites decreased the probability of human disturbance (Bacon and Rotella 1998). During the study period, the largest causes of mortality along this unregulated section of the Yellowstone River were probably weather related (Figure 19).

Fledge ratios within the State of Montana fluctuate substantially between years and river reaches. Productivity data, gathered during three consecutive years for the Yellowstone population, show a mean fledge ratio of 0.73 fledgling per nest (Bacon and Rotella 1998). Fort Peck Reservoir has never supported a large number of least terns and productivity along its shoreline, and on islands, is generally poor to non-existent in most years.

Figure 19: Weather killed chicks, Yellowstone River, Montana.
Courtesy: Lynn Bacon.

Along the Fort Peck river reach of the Missouri, the average fledge ratio, based on data gathered over the past 10 years (1996-2005), is lower (0.69 fledglings/pair of adult birds) than that called for in the USFWS 2003 Biological Opinion (0.94 fledglings/pair of adult birds). More recent fledge ratios are higher: the current three year running average (2003-2005) for this stretch of the Missouri is 1.09 (see Table 2). These data are promising, however, they represent a limited number of monitoring years and noticeable variability between years does exist.

CONSERVATION AND MANAGEMENT CONSIDERATIONS

As a state, Montana supports one of the smallest populations of interior least terns and results from monitoring efforts show that the state has met and/or exceeded its specific recovery goal of 50 adult birds. Although the Missouri River has yet to meet its goal of 2,100 birds, the current range-wide census carried out during the 2005 breeding season recorded an interior least tern population of 17,587 (Casey Lott, pers. comm.). The peripheral nature of Montana relative to the overall breeding range of interior least terns, coupled with the small population of birds the state supports, make it difficult to ascertain how critical Montana's subpopulation (0.28% based on 2005 census data) is to overall population recovery.

In light of this relatively small breeding population, what appears more noteworthy is the potential resource Montana's reaches of the Missouri and Yellowstone rivers may provide to breeding birds during years characterized by abnormal weather and river conditions further south. In order to support national recovery objectives, essential habitat has to be maintained and restored throughout the birds breeding range. The value of maintaining such habitat in Montana was highlighted during the 1997 breeding season when inundation of primary breeding areas further south resulted in a substantial increase in the number of breeding birds recorded along waterways in the eastern part of the state. Without such habitat, terns migrating northward in search of suitable nesting sites may have failed to secure nest sites. The precise role Montana's essential habitat had on preventing large scale reproductive failure is, however, impossible to ascertain as no orchestrated range-wide breeding census was conducted in 1997. Many of the following management recommendations focus, therefore, on the necessary actions needed to maintain and/or restore essential breeding and foraging habitat. In addition, habitat specific productivity enhancement strategies, aimed at increasing reproductive success, are proposed.

General Management Concerns and Recommended Actions

1. <u>Standardization of monitoring techniques and data collection</u>

Least tern monitoring and breeding surveys within any given state or river reach are often conducted by numerous state agencies as well the USACE, and each utilize different monitoring protocols. A lack of standardized monitoring techniques, coupled with varying amounts of coordination between agencies makes it difficult to interpret the range-wide population status of the interior least tern (Guilfoyle et al 2004). Although fiscal restraints often determine the type and frequency of survey conducted, standardized procedures for data collection may ultimately increase the accuracy and efficiency with which data are gathered and allow for comparisons between regions. In addition, accumulated observational data of interior least terns needs to be entered into a centralized regional database at the end of each field season. Such a database would ensure that critical data is maintained and accessible to managers while implementing recovery efforts.

To adequately estimate population size and distribution, efforts should be made to coordinate with USACE, state agencies, and other regional biologists so that surveys are conducted during a narrow time frame (i.e. a two-week period) during the breeding season. Where possible, data gathered using standardized data forms and survey methods should be used e.g. how birds should be quantified (number of pairs, nests, or individual birds). In addition, a coordinated range-wide census should be conducted every five years, while established monitoring programs within the State of Montana should continue on an annual basis.

MFWP and BLM should continue to conduct annual surveys along the Yellowstone River. Monitoring efforts along the Missouri are conducted by the USACE and will continue on an annual basis (USFWS 2003). Consideration should be given to incorporating MFWP personnel currently operating along the Missouri River into surveys along this river reach. Such coordination will reduce duplication of effort and result in a more cost effective and efficient way of gathering and disseminating necessary data.

2. Managing water flow regime to simulate the natural hydrograph

Ecologically based water flow management regimes often conflict with USACE management objectives (i.e. navigation, flood control, hydropower etc.), however, managed flooding along major rivers and their tributaries to mimic a more natural hydrograph should be considered. Naturalized flows would clearly help restore aquatic habitats and their associated ecosystem processes, thereby lessening the negative effects associated with reduced annual flood pulses, and increased water discharges during the tern nesting season.

Moreover, supporting data shows that high flows associated with naturally occurring high-water years (e.g. 1995 through 1997) created significant amounts of sandbar complexes and shallow water habitats necessary for tern nesting and foraging (USFWS 2003). For example, in the Gavin's Point reach of the Missouri suitable tern nesting habitat increased 13-fold between 1996 and 1998 (USFWS 2003). Continual habitat loss due to erosion and vegetation growth would consequently be reduced by restoring a more natural water regime that included a substantial spring pulse.

3. Preventing or reducing inundation of nests

Efforts should continue to be made to reduce untimely discharges of accumulated spring water from reservoirs during critical nesting periods. Moreover, as discharge volumes from mainstem dams are often calculated with little room for error, weather conditions should continue to be monitored downstream and appropriate flood control actions taken to prevent the inundation of nests due to increased wave and wind action. Similarly, storm drainage discharges from tributaries feeding into mainstem river reaches should also be monitored to reduce the cumulative effects of high water levels, tributary inflow and wave action.

4. Vegetation encroachment

Vegetation cover at potential nest sites should ideally be no greater than 10% (Schwalbach 1988) and initiatives to reduce vegetation encroachment should be undertaken prior to the arrival of terns. Water flow regimes that scour sandbars and islands may not be required on an annual basis but periodic "flood pulse" discharges should be undertaken to reduce vegetation encroachment. In addition, manually clearing sites should be evaluated as a possible management tool. If effective, breeding sites utilized in recent years could be maintained by clearing excessive vegetation prior to tern arrival in the spring. This could be undertaken either by physically removing vegetation or spraying with herbicides. However, based on USACE experience in 2005, remaining dead vegetation provides extensive predator perch sites and if vegetation is sprayed the capacity needs to exist to adequately remove it (Karen Kreil, pers. comm.).

5. <u>Forage Availability</u>

Research linking variables such as water flow, forage availability and tern reproduction suggest that alteration of the historic flow regimes along mainstem rivers may significantly impact tern reproductive success (Tibbs and Galat 1998). The USFWS (2003) also recognizes that unsuitable water temperatures below dams, such as Fort Peck, negatively impact food supplies for least terns. In light of this, water flow regimes along the Missouri River should be managed to enhance fish reproduction (i.e. spawning and recruitment).

Higher spring flows, coupled with warmer water releases are needed. It is recommended that powerhouse and spillway releases be adjusted through August to ensure suitable water temperatures (at least 18 ^{0}C at Wolf Point, MT) for development and survival of native riverine fish eggs, fry, and juveniles. As sustained drought periods, such as characterized the region in 2000 through 2004, may result in lower water levels at Fort Peck Reservoir, spillway releases are not always an option. Likewise, warmer waters downstream of the dam are ideally required throughout the summer months when flows need to be reduced. Researching the feasibility of drawing water for the powerhouse from the warmer upper layers of the lake could be investigated.

In addition to managing water temperatures and flood pulses, biological studies aimed at determining fish prey abundance and foraging success of least terns along the Missouri and Yellowstone Rivers are warranted.

6. <u>Preservation and restoration of suitable habitat in areas not currently utilized</u>

Clearly, suitable nesting habitat needs to be preserved throughout the interior least tern's breeding range, not only to maintain the current range, but also to provide habitat when other areas are unavailable due to flooding (Kirsch and Sidle 1999). Such a strategy may ultimately reduce the risk of nest failure in any given breeding season. Directing habitat funding to maintain or secure easements along sections of river with consistent tern activity is also recommended. River reaches not included in annual surveys may also provide additional potential tern nesting habitat. If funding is available, surveys should be undertaken to identify and assess potential breeding sites.

7. <u>Enhancing nesting habitat to increase available nest sites along any given reach</u>

Habitat loss has been shown to cause a decrease in the number of nesting colonies but an increase in colony size. As large colonies may be more vulnerable to predation, efforts to increase the number of potential nest sites along river reaches may reduce vulnerability to predation. During annual surveys, identification of sandbars with likely nesting habitat along reaches should be recorded. If suitable foraging habitat exists within the immediate vicinity, habitat enhancement may be as simple as initiating vegetation removal to create potential nesting habitat.

8. <u>Predator management</u>

While predation has been reported as a leading cause of chick and adult mortality in parts of the interior U.S., at this time it does not appear to significantly impact least terns nesting in Montana. Predator management should therefore be undertaken on a site by site basis when appropriate. Suggested methods for ground predators include elimination or, relocation using live traps. Strobe lights have been used in other areas for nocturnal avian predators (G. Pavelka, pers. comm.) and are an option if warranted.

9. Human Disturbance

At this time, human disturbance does not appear to dramatically impact tern reproductive success along either the Missouri River, below Fort Peck Reservoir, or the Yellowstone River, in Montana. Systematic surveys of human activity should, however, be conducted to assess the level of activity that is occurring as well as the extent to which identified disturbances could potentially impact nest sites. If disturbance levels increase, to the point that they impact productivity, appropriate action should be taken.

Although the posting of signs at river access points and on nesting sandbars is an accepted technique, this has the potential to exacerbate problems in areas where people are hostile to endangered species protection. Likewise strict enforcement may be impractical due to fiscal constraints. Consultation with regional biologists and law enforcement officials will most likely prove more valuable in determining the appropriate action at a site should disturbance become a problem. For example, one-on-one contact with sport fishermen or recreational boaters at river access sites may be more effective. In addition, communication with relevant state and federal agencies should be undertaken to ensure that weed control and vegetation removal exercises are undertaken prior to the nesting season.

10. Updating the Interior Least Tern Recovery Plan

Finally, the interior least tern recovery plan, produced in 1990, is in need of revision. In order to be considered for removal from the endangered species list, the recovery plan set a quantifiable goal (e.g. recovery objective): the population of interior least terns had to increase to 7,000 birds and be maintained for 10 years (USFWS 1990). Although specific distribution targets for breeding birds have not been met for all areas (i.e. Missouri River System), data compiled from surveys conducted between 1984 and 1995 (Kirsch and Sidle 1999) coupled with the most recent range-wide census conducted in 2005 (Casey Lott, pers. comm.) indicate that the interior least tern population has likely met the overall recovery objective: both studies reported greater than 7,000 birds.

Given that the original recovery goals were based largely on population size, it would be useful if the USFWS developed population models that predict the probability of persistence for interior least terns. Based on this information, the interior least tern recovery plan could be reviewed and updated. When undertaken, it is recommended that state agencies currently involved in least tern conservation be active participants in the decision making process. A working group including representatives from, but not limited to, the USFWS, USACE, USGS, state agencies, tribal authorities and universities would provide a more inclusive forum for discussing and evaluating interior least tern management and requirements at a variety of scales. Such involvement would likely strengthen the plan, and provide a working document specific to local and regional programs that is incorporated into a larger scale national recovery effort.

Site Specific Recommendations within Montana

Factors affecting interior least tern habitat suitability, reproductive success and productivity vary by area and recommendations for each are discussed in more detail below.

Missouri River and Fort Peck Reservoir

Water level management, coupled with the ensuing variation in suitable habitat availability, is the key determinant of interior least tern presence and productivity, and the USACE is strongly urged to restore the river to a more natural flow regime. Criteria for improved spring flows and warm water releases from Fort Peck have been jointly developed by numerous federal and state agencies, including the USACE, and are laid out in the USFWS Biological Opinion (2003). Regional drought conditions delayed implementation, however, it is hoped that the USACE will carry out these recommendations as soon as reservoir elevation and runoff criteria can be met.

Artificial flooding via high dam releases from Fort Peck Dam will likely scour vegetation from existing sandbars, but may not bring suspended and bed-load sediment from upstream. In order to assess habitat availability under different operational scenarios, monitoring reproductive success and mapping essential least tern breeding habitat should continue. Such evaluations will hopefully provide estimates of current levels of productivity as well as the potential for population change under differing water management regimes.

<u>Fort Peck Reservoir</u>

Fort Peck Reservoir is at the northwestern limit of the interior least tern's breeding range and contains little suitable habitat for breeding terns (USFWS 2003). During years of poor habitat conditions further south, a handful of tern nests have been recorded along the lower portion of the reservoir. This area has been surveyed since 1987 however the greatest number of nests located in the past decade is two: two nest sites were recorded in 1998 and 2000. Breeding habitat is widely scattered across beaches along the eastern part of Fort Peck Reservoir and the relative abundance of suitable habitat varies annually with the amount of water captured in the reservoir during the spring runoff (USFWS 2003).

Given the poor record of breeding activity and reproductive success along this impounded stretch of the Missouri River, conservation efforts may be better focused on areas below the dam as well as along the Yellowstone River. That being said, the reservoir provides critical habitat for other listed species, such as the piping plover. Estimating the amount of potential habitat available to least terns as well as specific enhancement actions would provide valuable information to mangers and could be undertaken in conjunction with habitat assessment surveys for piping plovers.

If tern nest sites are identified along the reservoir shoreline, monitoring should be undertaken and action taken when necessary to reduce potential human related impacts. Interpretive signage and education of the general public may prove more effective than restrictive signage and enforcement. Regional biologists and law enforcement officials, familiar with least tern biology, could determine the appropriate action should disturbance become a problem.

Missouri River, below Fort Peck Reservoir.

This reach also lies within the northwestern fringes of the least terns breeding range and has been surveyed annually since 1988. Populations of terns fluctuate depending on habitat conditions elsewhere in their summer range and consequently this section of river can be an important nesting area. It is recommended that the Missouri River, below Fort Peck Reservoir, continue to be actively managed for terns as it may provide a potentially useful resource in years when habitat is unavailable in other parts of the populations breeding range.

Managing flooding along the Fort Peck river reach of the Missouri to mimic a more natural hydrograph should be the primary management objective. Incorporating a naturalized flow regime would clearly help restore essential habitat as well as the dynamic hydrologic and ecological processes that maintain them. Short term habitat enhancement, through vegetation removal, should also be considered at sites known to support least terns. In addition, efforts should continue to reduce untimely discharges of accumulated spring water from Fort Peck Reservoir during critical nesting periods.

The effects of cold hypolimnetic releases on forage availability for interior least terns should be investigated more thoroughly. If results indicate that productivity is being negatively impacted, warm water releases will need to be considered. As mentioned in the preceding section, researching the feasibility of drawing water for the powerhouse from the upper layers of the reservoir should be investigated.

Predation rates do not appear to be high along this river reach, but monitoring should continue. As predator pressure will likely be site specific, management techniques should be determined based on the specific situation.

Human and livestock disturbance does not appear to be negatively impacting reproductive success along the Missouri River in Montana at this time but human use monitoring should be conducted. If disturbance patterns change, interpretive signage and education of the general public may prove more effective than restrictive signage and enforcement. Regional biologists and law enforcement officials, familiar with least tern biology, could determine site appropriate action.

Yellowstone River

Although differences in productivity data collection techniques between the Yellowstone and Missouri rivers preclude direct comparisons, data (Bacon and Rotella 1998) indicate that the Yellowstone River can support a small productive population of least terns. Furthermore, tern nesting sites appear to be widely distributed along this reach (Montana Piping Plover and Interior Least Tern Work Group, pers. comm.) limiting the potential for catastrophic losses due to predation or human induced disturbance.

It is recommended that annual surveys be continued and that periodic (5-year) productivity data, utilizing standardized protocols, be gathered if financial resources permit. Productivity monitoring might include data similar to that gathered by the USACE. Identification of nests, number of eggs, fate of clutch, and number of chicks fledged would all provide valuable productivity data for this river.

Although human disturbance does not appear to be limiting reproductive success at this time, human use monitoring should be conducted. If disturbance patterns change, interpretive signage and education of the general public may prove more effective than restrictive signage and enforcement. Regional biologists and law enforcement officials, familiar with least tern biology, could determine site appropriate action.

Greater understanding of the potential impacts water diversion canals and tributary dams have on relatively unregulated river systems such as the Yellowstone is required. Research focused on describing and quantifying vegetation growth patterns, sandbar alteration, and river channel characteristics would provide valuable insight into the sustainability of this river reach relative to least tern reproduction.

Future Research

1. As Montana's breeding population of interior least terns currently represents a fraction (0.28%) of the total number surveyed in 2005, updated information regarding the importance of small populations to long term population recovery would be useful. It is currently impossible to determine how important geographic areas that consistently support low numbers of interior least terns (i.e. low abundance) are to aiding national and regional recovery efforts. Analysis of regional monitoring data as well as investigations into large scale population dynamics would best be undertaken by the recently established Interior Least Tern Monitoring Working Group. Dissemination of findings to states that are actively involved in managing least terns would provide useful information for planning.

2. Areas that consistently support small numbers of least terns may be critical to recovery efforts. Banding studies along the Yellowstone River would provide valuable information on survival and return rates for adult birds utilizing this river reach.

3. To gain insights into possible links between prey availability, water flow regimes and reproductive success, research focused on least tern foraging ecology below Fort Peck Reservoir would be valuable. It may also be worthwhile if such research compared the largely unregulated Yellowstone with the highly regulated Missouri river systems.

4. Greater understanding of the potential impacts water diversion canals and tributary dams have on relatively unregulated river systems such as the Yellowstone are required. Research focused on describing and qualifying vegetation growth patterns, reduced sandbar formation, sandbar alteration, and river channel characteristics would provide valuable insight into the long term sustainability of this river reach relative to interior least tern reproduction.

5. Although fledgling success is widely used as an index of reproductive success in avian studies, survival of the young after fledging is rarely estimated (Keedwell 2003). As mortality may be significant during this period, telemetry studies aimed at determining mortality rates in the post-fledging period would provide more precise information on the productivity of terns in both the Missouri and Yellowstone River systems. This would also provide more accurate data on juvenile survival that could be used for population modeling.

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APPENDIX 1

MONTANA INTERIOR LEAST TERN AND PIPING PLOVER WORK GROUP CONTACTS

Name	Affiliation
Dan Casey	American Bird Conservancy
Gayle Skunkcap, Director	Blackfeet Tribe
Bobby Baker	BLM
David Waller	BLM
Fritz Prellwitz	BLM-Malta Field Station
John Carlson	BLM-Glasgow Field Station
Justin Kucera	BOR
Sue Camp	BOR
Paul Backlund	BOR-Canyon Ferry
Steve Morehouse	BOR-Dillon
Blaskovich, Rick	BOR-Montana Area Office
Stan Huhtala	BOR-Tiber Dam
Dan Spencer	Bureau of Indian Affairs
Robbie Magnun, Director	Fort Peck Assiniboine & Sioux Tribes
Debbie Madison	Fort Peck Tribes
Jim Thompson	Milk River Alliance
Monty Sullins	Montana Dept. of Agriculture
Arnold Dood	Montana Fish, Wildlife and Parks
Shirley Atkinson	Montana Fish, Wildlife and Parks
Brian Martin	Nature Conservancy
Wayne Harris	Saskatchewan Environment
Casey Kruse	US Army Corps of Engineers
Darin McMurry	US Army Corps of Engineers
Greg Pavelka	US Army Corps of Engineers
Vanessa Fields	US FWS-Benton Lake NWR
Lou Hanebury	USFWS (working group coordinator)
Jane Roybal	USFWS
Karen Kreil	USFWS-Bismarck
Kathy Tribby	USFWS-Bowdoin NWR
Glenn Guenther	USFWS-CMR
Everett Russell	USFWS-CMR
Lori Nordstrom	USFWS-ES
Bob Murphy, T&E Specialist	USFWS-Lost Wood NWR
Beth Madden	USFWS-Medicine Lake NWR
Mike Rabenberg	USFWS-Medicine Lake NWR
Tim Connolly	USFWS-Medicine Lake NWR
Chuck Carlson	n/a

APPENDIX 2

DATASHEET FOR INTERIOR LEAST TERN BREEDING BIRD SURVEY

INTERIOR LEAST TERN
ANNUAL BREEDING BIRD SURVEY DATASHEET

Date: ____________________ Observers: ______________________________________

River Reach: ____

Site Description: ____

GPS Location: N ____________________________ E ______________________________

Number of terns observed: 1 2 3 4 5 >5 (specify #) _________

Activity		Habitat Description		Vegetation	
Flying	_____	Sandbar	______	None	______
Loafing	_____	Gravelbar	______	>10%	______
Breeding	_____	Riverbank	______	10-14%	______
Nesting	_____	Reservoir	______	15-20%	______
Foraging	_____	Other	______	>20%	______
Other	_____				

Plant species present: ____

Other animal species present: ____

Remarks: ____

____

____

APPENDIX 3

LIST OF ACRONYMS

AOU	American Ornithological Union
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
MFWP	Montana Fish, Wildlife and Parks
USACE	United States Army Corp of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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