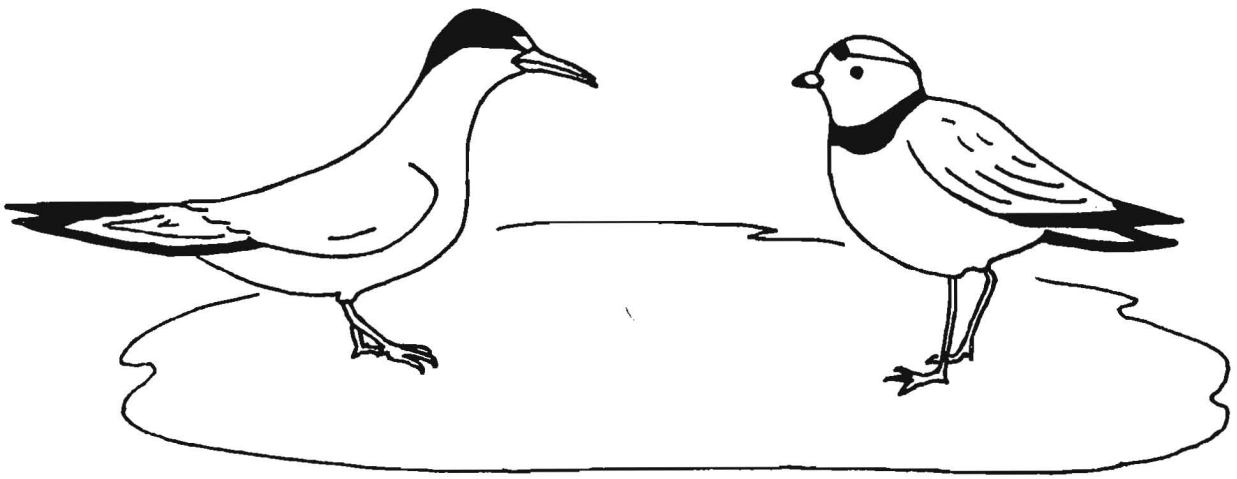
Mark Czaplewski

STATUS OF THE INTERIOR LEAST TERN AND PIPING PLOVER IN NEBRASKA



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

STATUS OF THE INTERIOR LEAST TERN AND PIPING PLOVER IN NEBRASKA (PERIOD OF RECORD THROUGH 1986)

Prepared for

Interstate Task Force on Endangered Species

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Nebraska Water Resources Association
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September 1988

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EXECUTIVE SUMMARY

This report provides a contemporary assessment of the status of the endangered interior least tern and the threatened piping plover in Nebraska to serve as a basis for species and resource management decisions. Information collected during recent systematic surveys along major rivers of the state (i.e., the Platte, Missouri, and Niobrara) through the 1986 breeding season has been summarized from agency progress reports and other documents, and presented in context with historical sighting records and published literature. Because of concerted regulatory attention and concern associated with proposed water resource applications involving the Platte River, additional focus has been placed on evaluating the species' use of this system in light of habitat changes that have occurred to date. Following is a synopsis of key information.

NESTING HABITS

Interior least terns and piping plovers are primarily colonial nesters and in Nebraska they frequently occur in heterogeneous colonies. They typically construct their nests (shallow, bowl-shaped depressions) on the surface of relatively open sandbars, beaches, or spoil deposits near standing or flowing water bodies. Utilization of specific sites for nesting appears to be dependent on sufficient water in the vicinity of the site to support a readily available source of aquatic food items (i.e., small fish for terns, and aquatic invertebrates for plovers). In Nebraska, the breeding season for both species is essentially the same, extending from approximately May through late August, although plovers may arrive at breeding areas several weeks in advance of terns (Faanes 1983). Upon completion of the breeding season, the birds return to wintering grounds along the Gulf of Mexico (plovers), and the coast of Central America eastward along the northern coast of South America (terns).

HISTORICAL SIGHTINGS

Because region-wide censuses of interior least tern populations were not conducted until 1975, the status of this species was uncertain prior to that time (Erwin 1984). Moreover, although Russel (1983) referred to the northern plains population of the piping plover as "healthy", there has been a general lack of quantitative survey data until recent years. The occasional, qualitative observations that comprised the historical sightings records for Nebraska, prior to the onset of systematic censusing, led to conflicting impressions regarding the species' status in the state. Normalized analyses of non-systematic sightings data, however, reflect trends of stability or increase in reported occurrence since 1945. In addition, the known geographical distribution of both species in Nebraska has increased over time as more counties have reported sightings. Since the late 1800's least terns and piping plovers have been observed in 54 (58 percent) and 32 (34 percent) of Nebraska's 93 counties, respectively. For both species, the number of counties reporting sightings has more than doubled since 1945 and, in most cases, counties of record border or include portions of major rivers in the state. Although, to some extent, these distribution trends may be related to an increase in observers, they do not suggest greater localization or rarity of the species over time.

SYSTEMATIC SURVEYS

Recent systematic surveys conducted along Nebraska's rivers have 1) documented substantially larger least tern breeding populations than were observed or estimated during the initial census in 1975 (Downing 1980); and 2) established the fact that Nebraska is a major stronghold for this species. In 1986, 438 adult least terns were censused along the Platte River and 181 adults were censused along the Missouri River from Gavins Point Dam to Ponca, Nebraska. Although the Niobrara River was not surveyed in 1986, 174 birds were censused along this river in 1985. Assuming stable abundance along the Niobrara from 1985 to 1986, these census results reflect a total of 793 adult least terns as of the 1986 breeding season. This compares with a total of 200 adults observed (and 400 adults estimated) by Downing based on his 1975 survey of these same three river areas.

Other least tern breeding populations have also been discovered in recent years in areas not surveyed by Downing. For example, an aerial inventory of the Loup rivers in 1985 yielded 56 adult terns which, considering that aerial surveys typically census only about half of the birds present, suggests a population of twice that size. In addition, 25 adult least terns were censused in 1986 along the Missouri River between Fort Randall Dam and Lewis and Clark Lake upstream of the Gavins Point Dam to Ponca reach. Thus, systematic survey results through 1986 indicate a total statewide population of approximately 900 birds. Because these surveys did not include all potential or known nesting habitat within the state, this statewide estimate should be considered conservative.

In view of the fact that Downing's 1975 inventory served as a primary basis for the Service's proposed rule to list the interior least tern as endangered (reference 49FR 22444-22447), the results of recent systematic surveys in Nebraska are particularly noteworthy. Although Downing (1980) believed the 80 least terns observed along the Platte River in 1975 were more birds than the habitat seemed capable of supporting, census results recorded in 1986 (438 birds) represent more than a five-fold increase. Similarly, given that the population observed along the Missouri River below Gavins Point Dam was more than five times larger in 1986 than in 1975 (181 versus 35 birds), it is also apparent that Downing substantially underestimated the habitat potential of this river segment. It deserves particular emphasis that the 619 least terns censused only along the Platte River and the Missouri River below Gavins Point Dam in 1986 represents more birds than the total number (616) actually seen by Downing during his entire survey of the greater part of the species' breeding range (which included 11 rivers of the Mississippi/Missouri River drainage, plus national wildlife refuges in three U.S. Fish and Wildlife Service regions).

As in 1975 (Downing 1980), flood conditions following the nest initiation period were also observed on the Platte and Missouri rivers in 1986 (NGPC 1986, Schwalbach et al. 1986) when least tern breeding populations censused on both rivers were substantially larger. Fewer birds have been inventoried during other survey years when lower flow conditions have prevailed and habitat was apparently more abundant. It may be that abnormally wet conditions in 1986 broadly reduced the amount of habitat throughout the species' breeding range, resulting in greater utilization of those nesting areas that were available. In any case, the more than five-fold increase in the size of least tern breeding populations censused along the Platte and Missouri rivers in 1986

versus 1975 is in clear contrast to Downing's (1980) prediction that, without active habitat protection and enhancement, "[a]lmost complete loss of these populations may occur in a few years."

Since the initiation of systematic surveys along Nebraska rivers, the discernible trend during years of similar survey coverage and effort has been one of increasing rather than decreasing populations. These increases may reflect 1) the improved ability of investigators to locate nesting colonies (resulting from greater experience and knowledge of the species' behavior and nesting habits); 2) distributional shifts, or immigration of adult birds from other nesting areas within the breeding range; 3) true population increases; or 4) a combination of all factors. Regardless of which factors apply, recent survey results attest to the fact that habitat along these rivers can support considerably larger least tern breeding populations than was previously thought to be the case.

More recently, systematic surveys along the Platte, Missouri, and Niobrara rivers have been expanded to include the collection of more complete census data on piping plovers. However, because expanded survey emphasis was not initiated concurrently among all rivers, insufficient data presently exists to evaluate trends in the statewide population over time. Nonetheless, as in the case of the interior least tern, results clearly indicate that Nebraska's piping plover population is substantially larger than earlier believed, and that the state is an important stronghold for this species as well. In 1986, the following numbers of adult piping plovers were censused along various rivers in the state: 164 along the Platte; 172 along the Missouri below Gavins Point Dam; and 11 along the Missouri below Fort Randall Dam. Although the Niobrara River was not surveyed in 1986, 100 birds were censused along this river in 1985. Assuming stable abundance along the Niobrara from 1985 to 1986, these census results reflect a total statewide population of approximately 450 adult piping plovers as of the 1986 breeding season. Since recent systematic surveys have not inventoried all potential or known nesting habitat within the state, this estimate should be considered conservative.

By way of comparison, the statewide population of approximately 450 piping plovers, as determined from systematic surveys through 1986, is about nine times larger than estimated in 1983 (Haig 1985) before comprehensive census information was available for major breeding areas in the state. Based on a review of the species' status reported by Haig (1985), the present breeding population in Nebraska exceeds that of all other states in the nation, and is second only to Saskatchewan among the Canadian provinces.

SHIFTS IN COLONY LOCATIONS

Interior least terns and piping plovers exhibit an opportunistic nest site selection strategy that provides resiliency in responding to temporal and spatial changes in the availability of suitable habitat. Systematic surveys along Nebraska rivers provide clear documentation that both species make frequent changes in nesting colony locations. By nature, riverine sandbars are ephemeral and go through natural successional cycles of formation, shifting and/or stabilization, and vegetation development. In addition, water-level fluctuation, as affected by the high variability in runoff and precipitation characteristic of the region, may reduce or enhance the availability of riverine or interior wetland habitat either broadly or locally from one year to

the next. Nesting habitat associated with off-river sandpits (e.g., along the Platte and Loup rivers) is also transient. With the passage of time, sandpit spoil piles become overgrown with vegetation or are leveled to develop housing or recreation areas. Consequently, a given site may be suitable for nesting one year but absent or unsuitable the next. Such changes do not necessarily represent permanent losses of habitat inasmuch as suitable habitat may be forming elsewhere. As Erwin (1984) pointed out, the propensity of least terns to relocate their colonies within and between years makes breeding populations appear unstable, but it may be this tendency that enables the species to persist despite the hazards of flooding and other disturbances. This remark is equally applicable to piping plovers.

If suitable habitat is not available at a previously used nesting site when breeding birds arrive, they may select alternate sites (Wycoff 1960) or delay nesting until sandbars or beach areas become exposed (Hardy 1957). Some researchers (e.g., Renaud et al. 1979) have also noted that piping plovers may shift their nesting locations from year to year for unknown reasons apparently not related to changing habitat conditions. If selected sites become unsuitable during the nesting season (due to flooding, human disturbance, or other factors), nest relocation or renesting may occur. Late nesting and/or renesting, however, may have a lower likelihood of success because of the time budget required (Schulenberg et al. 1980, Wingfield 1982).

The inherent ability of least terns and piping plovers to adjust to temporal differences in local habitat availability is further exemplified by shifts in the utilization of riverine sandbar and off-river sandpit habitat along the Platte River. During recent years (1985 and 1986), sandpit spoil piles near the Platte have provided habitat for nearly half the breeding birds of both species that nest along this river. When flood conditions reduce the amount of mid-stream sandbar habitat, sandpits near the river assume even greater importance to the extent that during years of extreme and prolonged high flows (as in 1983 and 1984) they provide the only nesting habitat available. These findings document the fact that sand and gravel mining along the Platte River has created important supplemental nesting habitat for least terns and piping plovers.

Least terns that nest at sandpits adjacent to the Platte River forage primarily in shallow areas of the river to obtain food (i.e., small fish). Foraging is apparently more limited on sandpits themselves because the steeper side-slopes and general lack of shallow water areas characteristic of these sites are less conducive to the capture of fish prey items. Thus, even during years when mid-stream sandbars are inundated during the breeding season, the river continues to play an important role as a foraging area for nearby least tern colonies. In contrast, piping plovers feed mainly on aquatic invertebrates and can presumably satisfy their dietary requirements by foraging along shoreline margins associated with either riverine or sandpit habitat.

COLONY SPATIAL CHARACTERISTICS

Available data (though limited) do not indicate greater crowding at colonies during years when high flows in the Platte River restricted nesting activity to off-river sandpits. Measurements of area per colony, area per nest, and inter-nest distances recorded at one river colony in 1985, when moderate flows prevailed during the breeding season, fell within the range of values measured

at 11 sandpits in 1984 when riverine habitat was unavailable because of high water levels. Additional measurements of colony spatial characteristics during years of contrasting flow conditions would facilitate further evaluation of this matter.

Certain parameters such as area per colony, nest elevation above water level, and nest-to-water distances are subject to change during the breeding season with fluctuations in river stage. All of these parameters vary inversely with river stage and, in general, decreasing stage conditions are more favorable to tern and plover colonies. Increases in area per colony resulting from stage decreases tend to reduce the potential for predation, whereas associated increases in nest elevation and nest-to-water distances reduce potential disturbances from wave action or subsequent rises in water levels (Schwalbach et al. 1986). Stage increases cause reverse effects and, in the event of large increases, complete inundation of nesting areas can occur.

Although several researchers (Ducey 1981b, Faanes 1983) have reported that piping plovers tend to nest closer to the water surface elevation than least terns at sandbar colonies along the Platte River, marked differences in nest elevation between species were not apparent at Missouri River colonies in 1986.

PRODUCTION

Production data for least tern breeding populations in Nebraska indicate considerable variability from year to year and from location to location. Along the Platte River, production rates reported at sandpit colonies in 1984 and 1986 (0.42 and 0.38 fledglings/nesting pair, respectively) were twice as high as reported at river sandbar colonies in 1986 (0.19 fledglings/nesting pair). Moreover, of four Platte River sandbar and two sandpit colonies monitored in 1982 (Ducey 1982), highest production occurred at a sandpit where the owner took an active interest in protecting the nesting birds. The 30 adult terns (15 breeding pairs) observed at this site produced a minimum of 10 fledglings, reflecting a minimum fledging rate/nesting pair of 0.67. Within the Gavins Point Dam to Ponca reach of the Missouri River, fledging rates/nesting pair ranged from 0.60 to 0.16 over the 3 years of record (1982, 1983, and 1986), indicating nearly a four-fold difference between the highest and lowest production years (1982 versus 1986). For the Missouri River reach between Fort Randall Dam and Lewis and Clark Lake, production results in 1986 reflected a fledging rate/nesting pair of 0.50. Production rates have not been determined for breeding populations along the Niobrara or Loup rivers.

The low production rates reported at Platte River sandbar colonies and at nesting sites along the Gavins Point Dam to Ponca reach of the Missouri River in 1986 were affected primarily by flooding conditions that occurred after nest establishment. Along the Platte River, flooding was the most frequent known cause of direct loss of eggs during the 1986 breeding season, and losses of chicks to flooding were either observed or highly suspected at most sandbar colonies that year (NGPC 1986). Similarly, all Missouri River colonies showed signs of water disturbance (flooding or wave action) at some time during the 1986 nesting season; nest scrape dampness was also evident at most sites and may have contributed to low production (Schwalbach et al. 1986).

The overall rate of production necessary to achieve growth in the interior least tern population is uncertain. However, in light of the species'

vulnerable habit of nesting on low river bars and other land surfaces exposed to the rigors of the plains climate (rainstorms, wind storms, hail, floods, and intense heat), low production is undoubtedly a regular occurrence. As reported by McNicholl (1975), nesting in widely fluctuating habitats requires flexibility in selecting nest sites, but unstable or immediately stable habitat may not prove successful every year. Hardy (1957) commented that sudden rises of water sufficient to inundate tern colonies are particularly likely in streams traversing the plains region, and in many colonies (especially those on low bars) floods take a heavy toll. He further stated that the "extremely high mortality" of young least terns up to the flying stage is compensated by low mortality in adults.

For California least terns, Atwood and Massey (1981) indicated that a production rate of 1.0-1.5 fledglings/nesting pair is considered good success, 0.50-1.0/pair is moderate, and 0-0.5/pair is poor. For Atlantic Coast least terns, on the other hand, Burger (1984) considered colonies producing more than 0.5 fledglings/nesting pair as successful, and those producing 0.25-0.49 fledglings/pair as moderately successful. Burger additionally reported that reproductive success for least tern colonies in New Jersey averaged 0.48 fledglings/nesting pair (range: 0.2 to 0.8 fledglings/pair) over the 5-year period 1978-1982 during which time the number of breeding birds increased significantly. Ultimately, however, determination of whether a given production rate results in population increase or decrease is dependent on the level of production necessary to maintain a stable or self-sustaining population (where mortality in the breeding stock is balanced by production). Because of more rapid population turnover, short-lived species require higher production rates to maintain their populations. Consequently, the long life span of the least tern (one banded bird lived to be 21 years old [Wingfield 1982]) is of definite survival importance. Based on a 10-year breeding span for adult least terns (Wingfield 1982), and assuming 33 percent mortality from fledgling stage to reproductive maturity at age 2, the mean annual production rate required to maintain a self-sustaining population would be 0.30 fledglings/nesting pair.

Maintenance of a self-sustaining production rate of 0.30 fledglings/nesting pair would, in effect, require that each pair of adult least terns in the population produce three fledglings any time during their 10-year breeding span. Lower production one year could be offset by higher production the next, or higher production at one nesting area could compensate for lower production at another. Within this context, cumulative production rates above 0.30 fledglings/nesting pair would affect population growth, whereas lower rates would affect population decline. If subsequent information indicates the average number of breeding years per adult is less than or greater than 10, or that juvenile mortality is less than or greater than 33 percent, then a higher or lower production rate would be necessary to achieve a self-sustaining population.

Production data for piping plovers, which in Nebraska utilize the same types of nesting habitat as least terns, also reflect considerable variability between years and from one location to the next. Along the Platte River, production rates reported at sandpit colonies in 1984 (1.80 fledglings/nesting pair) were substantially higher than those reported at sandpit or river sandbar colonies in 1986 (0.27 and 0.23 fledglings/nesting pair, respectively). Along the Missouri River, approximately 0.24 piping plover young per nesting pair were

fledged below Gavins Point Dam in 1983, whereas fledging rates/nesting pair were 0.05 and 0.20 below Gavins Point Dam and Fort Randall Dam, respectively, in 1986.

Flooding resulting from high flows subsequent to the next initiation period appeared to be the main cause of low production at piping plover colonies located on sandbars along the Platte River in 1986 and along the Missouri River in 1983 and 1986. The higher production rate of 1.8 fledglings/nesting pair determined at sandpit colonies adjacent to the Platte River in 1984 compares favorably with rates reported for colonies along the Atlantic Coast: at one area in Nova Scotia, piping plovers nesting on an isolated, rarely visited beach fledged 1.3 to 2.1 young per pair, whereas birds nesting on a recreational beach at another site fledged 0.7 to 1.1 young per pair (Cairns 1977, 1982). The reason for the lower production rates at sandpit colonies along the Platte River in 1986 versus 1984 is not known.

Because piping plovers occupy the same types of nesting habitat as least terns (low river bars, beaches, and other exposed land surfaces), they, too, are subject to high temporal and spatial variability in production rates, as influenced by the occurrence of floods, storms, and other disturbance factors. Like least terns, piping plovers are advantaged by a long life span: one banded bird lived to be 14 years old (Wilcox 1962) and, in general, adult males and females may live as long as 10 and 11 years, respectively (Dinsmore 1984). As a result, the species is able to cope with periodic bouts of low productivity. However, the population as a whole cannot be sustained or augmented, unless occurrences of reproductive failure are balanced or augmented by occurrences of reproductive success.

As has been noted by the Nebraska Game and Parks Commission (NGPC 1984 and 1986) production rates reported for least tern and piping plover breeding populations should be viewed with caution because 1) the mobility and dispersal of young birds from their nests soon after hatching makes it difficult to monitor development through to fledging (age at first flight); and 2) lack of nesting synchrony among and between colonies results in young reaching fledging age at different times. Based on similar observations during studies of least tern colonies along the Texas coast, Thompson and Slack (1984) determined that single counts of fledglings substantially underestimate cumulative production among colonies. Instead, they concluded that multiple counts timed with the breeding chronology for colonies within the survey area, and corrected for juvenile departure, are required to achieve more realistic estimates of survival to fledging. They stated that empirical verification at other nesting areas was warranted.

To more effectively monitor the health and status of least tern and piping plover populations in Nebraska (and elsewhere within the species' breeding ranges), priority should be placed on the collection of accurate production data in accordance with the procedures recommended by Thompson and Slack (1984), and in consort with regular censusing and management initiatives.

FACTORS AFFECTING PRE-FLEDGLING MORTALITY

Available data and observations recorded during systematic surveys indicate that main sources of pre-fledgling mortality at least tern and piping plover colonies along Nebraska rivers include flooding, human disturbance, and

predation. Periodic high flows impact production at riverine sandbar sites on a frequent basis and appear to be the greatest single factor affecting nesting success. Depending on timing, flood events can impact tern and plover nesting activity in two ways. First, the occurrence of high water levels during the nest selection period causes the reduction of exposed sandbar nesting habitat, to the extent that under extreme and prolonged conditions (as occurred on the Platte River in 1983 and 1984) virtually all riverine sandbars may be inundated throughout the breeding season. Second, the occurrence of high flows after nest establishment can result in substantial mortality (and in some cases complete loss) of eggs and young at sandbar colonies.

Flooding is not typically a major source of mortality at off-river sandpits which provide nesting habitat for a significant portion of the Platte River breeding populations. The greater stability of water-level conditions characteristic of these sites appears to be the reason that highest reported production rates to date have occurred at sandpits, as opposed to riverine sandbar sites, along the Platte River.

Human activities in the vicinity of tern and plover nesting areas pose a regular threat to nesting success at riverine colonies along the Platte and Missouri rivers, and at off-river sandpits adjacent to the Platte. Such activities likely have a proportionately greater impact on production when favorable water level conditions exist throughout the breeding season. Nesting colonies on the Niobrara River are probably less affected by human disturbances because 1) unlike the Platte and Missouri, this river is relatively far removed from major urban centers; and 2) access to the river channel is limited in areas where tern and plover colonies occur.

Sandbars along the Platte and Missouri rivers support a variety of human recreational uses in summer including hiking, picnicking, camping, fishing, sunbathing, driftwood collection, nature exploration and fireworks displays. Among the human activities encountered at sandpits, the use of recreational vehicles is of particular concern. These disturbances may prevent nesting at an otherwise suitable site, or cause abandonment and/or direct mortality of eggs and young after nests have been established. Nest abandonment at least tern colonies can also be caused by factors other than disturbances. Based on extensive observations of the Bell Island colony on the Ohio River, Hardy (1957) reported that adult least terns often deserted remaining eggs once the first hatched chicks left the nest.

Predation at tern and plover colonies along Nebraska rivers is affected by a variety of birds, reptiles, and terrestrial mammals; however it is not known whether any one of these groups has a more pronounced impact on nesting mortality than the others. Water surrounding riverine sandbar colonies may discourage access by terrestrial predators to some extent, but it does not deter predation by avian species or most reptiles (snakes and turtles). Although it has been suggested that greater losses from predation may occur at off-river sandpits, recent monitoring of colonies along the Platte River has not revealed major differences in predation-caused mortality, or the kinds of predators present, at sandpit versus riverine sandbar colonies. In this regard, Hardy (1957) noted that many successful least tern colonies have been reported at locations that are not completely surrounded by water barriers. Similarly, piping plovers in the northern prairie region are known to often nest along the shores of alkali lakes (Ryan and Prindiville 1984) at sites that

are not bordered by water on all sides. Studies by other researchers (e.g., Schulenberg and Schulenberg 1982) have found that flooding, which primarily affects colonies on river sandbars as opposed to off-river sandpits, can actually increase the incidence of predation. As rising water levels cause adult birds to abandon their nests, the unprotected eggs and chicks become more vulnerable to predation.

HABITAT USE CONSIDERATIONS RELATIVE TO THE CENTRAL PLATTE RIVER

Three lines of evidence support the conclusion that the central Platte River from Overton to Grand Island, Nebraska (commonly referred to as the Big Bend reach), did not play a significant role in the maintenance of least tern or piping plover populations prior to the activation of upstream water projects in 1941 (i.e., Kingsley Dam and the Tri County Canal system). First, peak flows historically occurred during the species' nest selection and/or nest initiation period (i.e., early May-early June). Given the original pattern of high flows from mountain snowmelt commencing in late April or early May and peaking in June, it follows that during most years potentially suitable sandbar habitat would have been largely inundated at the time of arrival and nest selection. Nests initiated before the period of peak flow, in years of delayed snowpack thaw, would have been subject to flooding. Second, extended no-flow episodes occurred during the nesting season. The historical tendency of the central Platte reach to go dry during summer months was not conducive to successful nesting. Dry riverbed conditions would have eliminated adjacent feeding areas and exposed nest sites to predation. Third, despite regular observations of least terns and piping plovers in Nebraska since the turn of the century, historical sighting records contain no reference to the occurrence of these species along the Platte River from east of the confluence of the North and South Platte rivers to the Loup fork until after 1941. It therefore seems more than coincidental that the first record of least terns nesting along the central Platte was in 1942 near Lexington--the very year perennial flow was established in this reach by water project operation--and that the first report of piping plovers in this same area was in 1950.

These considerations instead indicate that regular use of the Platte River above the Loup confluence (and including the Big Bend reach) by least terns and piping plovers is a recent phenomenon occasioned by the onset of permanent, moderate flow conditions resulting from water project operation. Water storage along the Platte has reduced dramatic, natural water-level changes from floods or droughts that historically acted to limit utilization and/or nesting success through inundation of potential or active nest sites, elimination of adjacent food supplies, and exposure of nest sites to predation. Paradoxically, the progressive shift to perennial flow that created suitable nesting habitat for these species has sustained the growth and perpetuation of woody vegetation. Optimum conditions (in terms of the maximum quantity and quality of suitable riverine habitat) should therefore be viewed as transitory, though the future situation appears more favorable than the past. In addition, sand and gravel operations near the river have also created substantial additional nesting habitat which has been used extensively by these species. As previously noted, these sites are particularly important during years when high river flows limit or preclude the use of mid-stream sandbars (e.g., 1983 and 1984). Because sandpit colonies are less susceptible to flooding (a dominant source of mortality at sandbar colonies), they have significant potential for successful production, especially if active steps can be taken to control human

disturbance and predation. This has been demonstrated in a specific case where a sandpit owner took interest in observing and protecting least terns (Ducey 1982).

Thus, perceptions that water projects and other human developments have been wholly detrimental to populations of least terns and piping plovers along the Platte River are not supported by existing information. Neither historical sighting records nor more recent systematic surveys provide evidence that breeding populations of least terns or piping plovers have declined along the Big Bend reach, the Platte River in general, or within the state. Rather, current information indicates that habitat along the Platte and other rivers in Nebraska can support far more birds than was previously thought to be the case. It should be recognized, too, that some aspects of past man-induced change have benefited terns and plovers, exemplifying the fact that progress in meeting human needs, and those of wildlife, need not be mutually exclusive.

1. INTRODUCTION

1.1 OVERVIEW

1.1.1 Interior Least Tern

The least tern (Sterna antillarum) is the smallest species of tern (subfamily Sterninae). Individuals measure 20-22 cm long and have a wingspread of 50 cm. Three subspecies of least tern are found in the United States: 1) the eastern least tern (Sterna antillarum antillarum) which breeds along the Atlantic and Gulf coasts and in the Bahamas and Caribbean Islands; 2) the California least tern (Sterna antillarum browni) which breeds along the Pacific Coast from central California southward; and 3) the interior least tern (Sterna antillarum athalassos) which breeds primarily in the Great Plains region and along the Mississippi and Ohio rivers (Figure 1-1).

Historically, the breeding range of the interior least tern included central North Dakota, South Dakota, Nebraska, eastern Colorado, Iowa, Kansas, Missouri, Illinois, Indiana, Oklahoma, Arkansas, Tennessee, Kentucky, eastern New Mexico, Texas, Louisiana, and Mississippi (American Ornithologists' Union 1957). Major river systems within this range are the Mississippi, Ohio, Missouri, Arkansas, Red, and Colorado (in Texas). Although the specific wintering range for the interior population has not been determined, least terns are found in winter from the northern coast of South America westward along the coast of Central America (reference 49 FR 22444).

Within its breeding range, the interior least tern commonly nests along major rivers with braided channels (Hardy 1957, Downing 1980). Nesting success in riverine settings is largely dependent on 1) the availability of bare or nearly bare alluvial islands or sandbars that provide suitable nesting substrate; 2) favorable water levels that preclude nest inundation and serve as a barrier to terrestrial predators; and 3) a nearby food source (typically small fish). Nonriverine nesting habitats include salt flats, salt marshes, sandy beaches at off-river sandpits, dredged sand piles, and mud or sand flats at the upper reaches of reservoirs (Ducey 1981a).

Though interior least terns usually nest in colonies, Johnsgard (1979a) noted that "[s]olitary nesting is frequent in the Great Plains". Breeding colonies are usually small (up to 20 nests) with the nests spaced far apart. The nest is a simple unlined scrape containing 2 to 4 (usually 2 or 3) spotted buffy eggs. Egg laying and incubation occur from late May to about mid-July depending on geographical location and habitat availability. The incubation period is approximately 20 days, and the chicks fledge approximately 20 days after hatching. Fall departure from nesting areas usually takes place from August, in the northern portions of the breeding range, until October in the south (Hardy 1957, Johnsgard 1979a, Erwin 1984).

1.1.2 Piping Plover

The piping plover (Charadrius melodus) is a small shorebird endemic to central and eastern North America. Never abundant (Lambert and Ratcliff 1981), the species breeds discontinuously throughout its range in suitable habitat including: sandy beaches along the Atlantic Coast and inland lakes; bare areas on dredge piles and natural alluvial islands in rivers; salt-encrusted, bare or

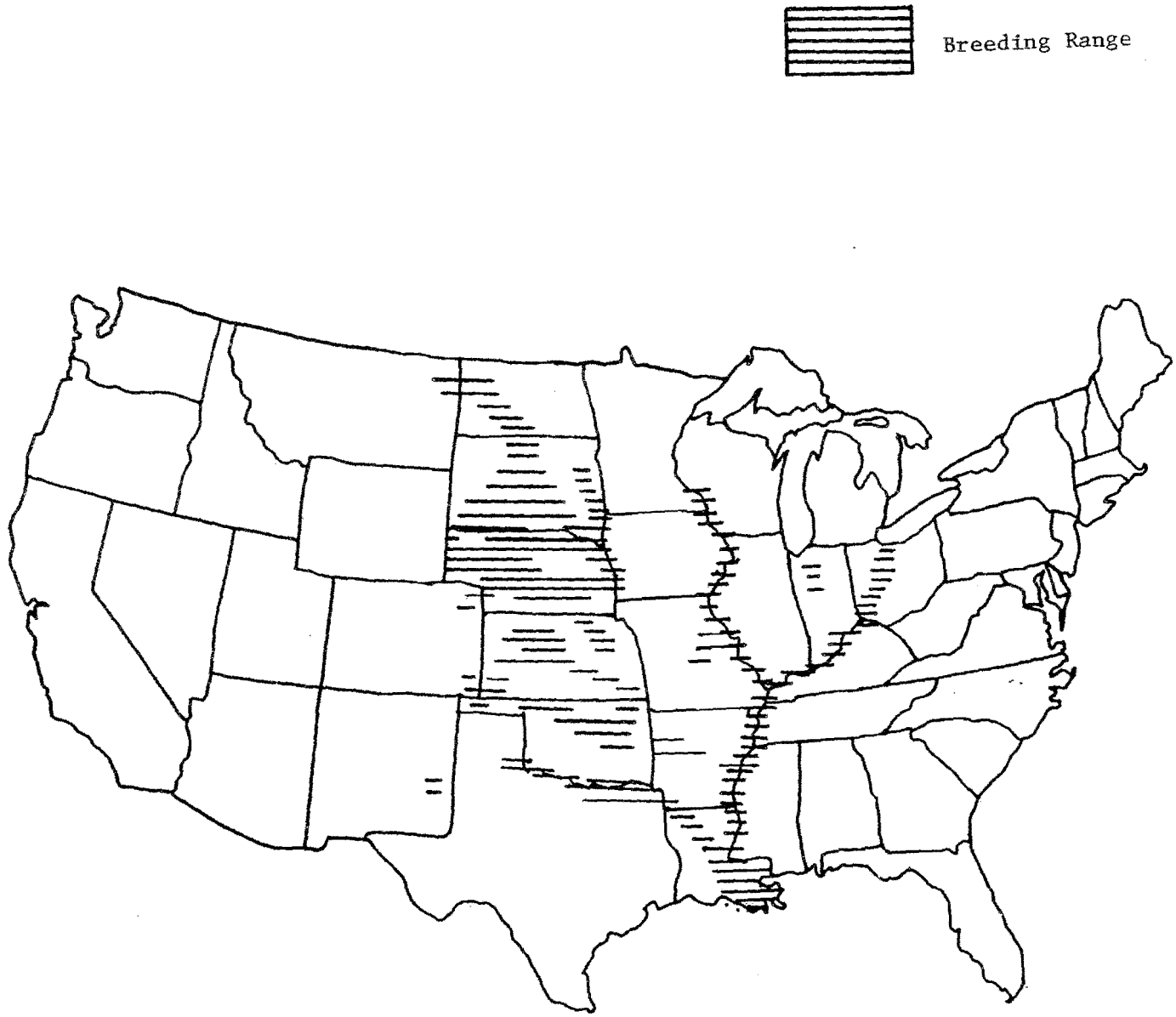


Figure 1-1 Geographical range of the interior least tern in the United States (adapted from Erwin 1984).

sparsely vegetated shores of sand, gravel, or pebbly mud on interior alkali lakes and subsaline semipermanent ponds and lakes; and man-made reservoirs (Stewart 1975; Renaud et al. 1979; Cairns 1982). Nests are shallow, scraped depressions in the substrate and may be lined with shell fragments or pebbles (Dinsmore 1984).

Three geographically distinct breeding populations exist for the species (Dinsmore 1984; Figure 1-2): 1) the Atlantic Coast population (Canadian maritime provinces and Atlantic Coast states from Newfoundland to North Carolina); 2) the Great Lakes population (Great Lakes states and Ontario); and 3) the northern plains population (Alberta to Manitoba; and Montana to Nebraska, with occasional rare breeding in Iowa). Among these three breeding populations, two subspecies are recognized. The Atlantic Coast population comprises the subspecies Charadrius melodus melodus. Birds from this population winter on the Atlantic Coast from South Carolina to Florida with scattered records occurring along the Gulf Coast and throughout the Bahamas and Greater Antilles (American Ornithologists' Union 1983). The Great Lakes and northern plains populations belong to the subspecies C. m. circumcinctus. These populations winter on coastal beaches of the Gulf of Mexico (American Ornithologists' Union 1957).

The northern plains breeding population of the piping plover utilizes a variety of nesting habitats including: bare areas on dredge piles and natural alluvial islands in rivers; bare or sparsely vegetated shorelines of alkali lakes and sloughs; subsaline, semipermanent ponds and lakes; and man-made reservoirs (Stewart 1975; Renaud et al. 1979). Ryan and Prindiville (1984) reported that in the northern prairie region, the species typically nests in greatest densities along the shores of alkali lakes. Saline wetlands in North Dakota and the bordering Canadian province of Saskatchewan "probably support the highest numbers and densities of plovers in North America" (reference 49 FR 44713). Although Russell (1983) referred to the northern plains population as "healthy", there has been a general lack of systematic survey data for this breeding population until recently and little comparative information exists for assessing trends in numerical status. Accordingly, Dinsmore (1984) noted that:

> "Monitoring is especially needed on the Great Plains because little is known about this population and it is the largest population. Because piping plovers breed in limited, fairly well-defined areas, it should be possible to obtain close to complete population counts."

In a recent proposal submitted to the U.S. Fish and Wildlife Service, Ryan and Prindiville (1984) also pointed out: "Whereas information on breeding biology, behavior, and habitat use exists for the Atlantic Coast, virtually no quantitative data on productivity or habitat requirements are available for the northern Great Plains population".

1.2 REGULATORY STATUS

On December 30, 1982, the U.S. Fish and Wildlife Service, in a notice of review addressing vertebrate wildlife taxa being considered for listing as endangered or threatened species (reference 47 FR 58454-58460), assigned the interior least tern and the piping plover to "Category 2" which was defined as follows:

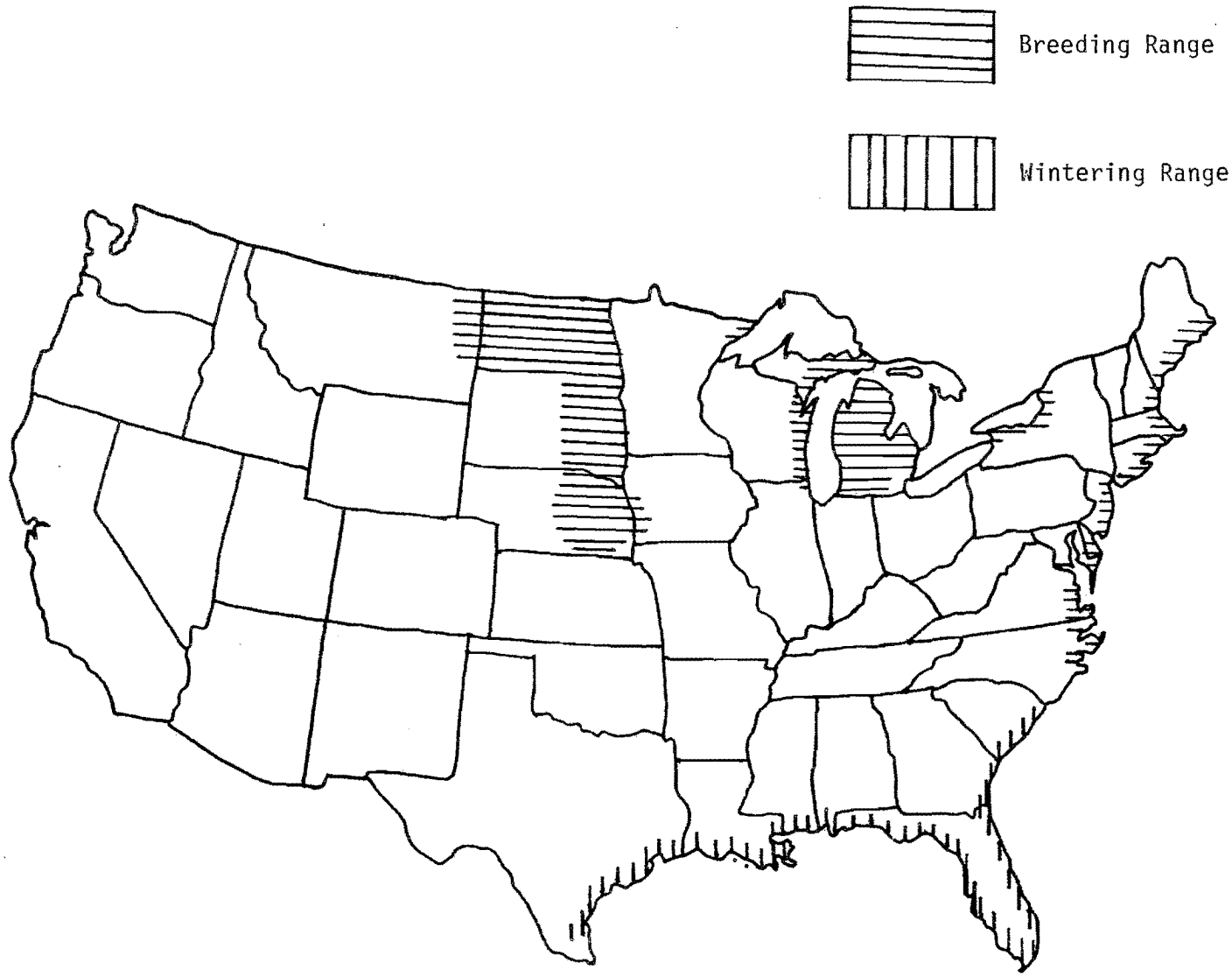


Figure 1-2 Geographical range of the piping plover in the United States (adapted from Dinsmore 1984).

> "Category 2 comprises taxa for which information now in possession of the Service indicates that proposing to list the species as Endangered or Threatened is possibly appropriate, but for which substantial data are not currently available to biologically support a proposed rule. Further biological research and field study will usually be necessary to ascertain the status of the taxa in this category, and it is likely that some of the taxa will not warrant listing."

On May 29, 1984, a year and a half after the publication of this notice of review, the Service issued a proposed rule to list the interior least tern as endangered under authority contained in the Endangered Species Act as amended (reference 49 FR 22444-22447). On May 28, 1985 the Service designated the interior least tern as endangered, effective June 27, 1985 (reference 50 FR 21784-21792).

Similarly, on November 8, 1984, less than 2 years after the publication of the notice of review, the Service issued a proposed rule to list various U.S. populations of the piping plover as endangered or threatened under authority contained in the Endangered Species Act as amended (reference 49 FR 44712-44715). The Service recognized the distinct geographical separation between the three plover breeding populations and chose to apply separate consideration to each. Specifically, the proposed rule recommended endangered status for the Great Lakes population, and threatened status for the Atlantic Coast and northern plains populations as well as the wintering range. On December 11, 1985, these status recommendations were adopted by the Service in a final rule effective January 10, 1986 (reference 50 FR 50726-50734).

1.3 SCOPE OF REPORT

This report provides a contemporary assessment of the status of the interior least tern and piping plover in Nebraska to serve as a basis for resource management decisions. The information synthesized for each species (Chapters 2 and 3) includes historical sighting records as well as systematic survey data through 1986 for major rivers in the state. In addition to summarizing available information, original analyses and interpretations of existing data are presented which offer insights relevant to species and habitat management applications. Main topics of discussion include census results, distribution, colony spatial characteristics, production, and factors affecting mortality. In light of recent concerns associated with proposed water developments involving the Platte River, the past-to-present use of this system by interior least terns and piping plovers is evaluated based on trends in habitat change that have occurred to date (Chapter 4).

2. INTERIOR LEAST TERN

Two categories of information are available on the distribution and abundance of interior least terns in Nebraska. The first category consists of published records of occurrence in specific counties or cities as well as notes on the species' general distribution or relative abundance (e.g., common, uncommon, rare) in the state. Few notes are available for years prior to 1900, but since then records on least terns and other species have been reported in various publications. This category of information, which currently appears in the Nebraska Bird Review, is useful for determining the species' reported distribution or occurrence over time, but is not adequate for quantifying historical or recent abundance. The second category consists of data collected during recent systematic surveys of specific rivers or sections of rivers in Nebraska. The results of these surveys provide information on both the abundance and distribution of interior least terns for the areas surveyed.

2.1 HISTORICAL SIGHTINGS

The proposed rule to list the interior least tern as endangered (reference 49 FR 22444-22447) noted "[i]n Nebraska, [least tern] breeding locations have been located on the Platte River in recent years as a result of intensive searches." Earlier in the proposed rule, however, it is stated that: "Historical trends of the interior least tern population are poorly known. No reliable estimates of original numbers are available."

Records on the historical distribution and occurrence of the interior least tern in Nebraska (1804-1975) have recently been compiled by Ducey (1985) and reflect a breeding range that "included the entire stretch of the Missouri River along the state's eastern boundary, the Platte River (including portions of the North and South Platte rivers), the Middle Loup River, and about 75 miles along the lower portion of the Niobrara River." According to Ducey, the first sightings of the species in present-day Nebraska were made in 1804 by the Lewis and Clark expedition which was traveling up the Missouri River to explore the Louisiana territory. The journals of Lewis and Clark refer to the least tern as a frequently observed aquatic bird; several downy chicks were captured in the vicinity of current Washington County, and the species was more plentiful in this area than below the confluence with the Platte River (in Ducey 1985). Shortly after the turn of the century, Tout (1902) reported observing least tern nesting activity on the banks of a large wetland basin near York, Nebraska, in 1896 and 1897, and Wolcott (1909) listed the species' distribution in the state as "confined to the Missouri River and prairie regions, except as they straggle out of the fringe of trees and shrubbery along the rivers into the plains, or across to the lakes and marshes of the sand-hills."

Later references convey conflicting impressions regarding the least tern's status in Nebraska, which perhaps is not surprising considering the fact that prior to 1975 observation efforts in the state were irregular and non-systematic. Wycoff (1960), for example, mentioned a 1949 letter in which Chandler S. Robbins, a biologist with the U.S. Fish and Wildlife Service, commented that "we have very few definite nesting localities on record" for the least tern in Nebraska. Less than 10 years later, Hardy (1957), who conducted an extensive literature review on the species, reported that the least tern was "common and widely distributed" in the state. Hardy also mentioned that least

terns were shot at a fish hatchery near North Platte, Nebraska, "because they feed on the small fish in rearing ponds." (Note: This hatchery, which is owned and operated by the Nebraska Game and Parks Commission, is still in use.) More recently, Johnsgard (1979b) noted that least terns "breed locally and probably irregularly in suitable habitats in the Platte and Niobrara valleys [and that the species is] rare and probably declining in the state" (no basis was given for this opinion).

Additional insights concerning the least tern's historical distribution in the state can be gleaned from the species' presence or absence on spring or fall county migration lists and/or inclusion on county nesting surveys. In contrast to the quantitative census data collected during recent systematic surveys (Section 2.2), this type of information is primarily qualitative in nature. Most records indicate the occurrence of least terns within a county, but not the number of birds or number of sightings, and in many cases the exact sighting location within the county is not specified. Based on these records, least terns have been reported in 54 of the 93 counties in Nebraska (Table 2-1). In recent years, counties of occurrence have included Sioux in the northwest, Dixon in the northeast, Johnson in the southeast, and Chase in the southwest, indicating that interior least terns potentially range throughout the state. Only five counties with reported occurrences prior to 1940 have not reported least terns since 1940; these counties are Burt, Dakota, Nemaha, Richardson, and Thurston, all of which border the Missouri River. Conversely, there are 33 counties for which the only reported sightings have occurred after 1940 (Table 2-1).

To gain perspective on the statewide occurrence of least terns over time, historical sightings records through 1984 were compiled. Consecutive volumes from Proceedings of the Nebraska Ornithologists Union (1900-1915), the Wilson Bulletin (1915-1933), and the Nebraska Bird Review (1933-1984) served as primary information sources (Table 2-1). The most comparable data were documentation of presence or absence during spring or fall migration (non-systematic) surveys, which have been conducted for various counties since the early 1930's. These data were used to calculate, for 5-year intervals, the mean number of counties in which least terns were sighted. Because the number of counties participating in spring or fall surveys has fluctuated over time, the results were normalized to account for differences in survey effort. In addition, sighting records since 1905 were used to construct statewide distribution maps depicting the sighting frequency for each county over incremental 20-year time periods.

The occurrence of interior least terns (expressed as the mean number of Nebraska counties reporting the species on spring and/or fall [non-systematic] surveys over a 5-year period) has increased slightly since the early 1930's (Figure 2-1A). Because least tern occurrence may be related to the number of Nebraska counties submitting survey results, the influence of effort was investigated (where effort refers to the number of counties participating in spring and/or fall surveys). As shown in Figure 2-1A, survey participation (on a county level) peaked during the late 1950's in Nebraska, and a noticeable peak in tern occurrence is also discernible at that time. On an annual basis, the total number of counties involved in surveys and the total number of counties reporting least terns were significantly correlated ($P > 0.01$, $r=0.64$, $n=50$). Thus, reported least tern occurrence appears to be related to the

TABLE 2-1 LEAST TERN SIGHTING OCCURRENCE BY COUNTY IN NEBRASKA, 1804-1984*

County	Total	Year(s) of Occurrence: Spring/Fall Surveys	Year(s) of Occurrence: Nest Sighting
Adams	6	1930, 1935, 1939, 1948, 1957, 1963	
Antelope	2	1955, 1958	
Boyd	5	1934, 1938	1955, 1980, 1983
Brown	1		1982
Buffalo	2		1982, 1983
Burt	1		1937
Butler	1		1983
Cass	17	1943, 1951, 1956, 1958, 1959, 1961-1968, 1971, 1981	1981-1983
Cedar	5		1960, 1969, 1980, 1982, 1983
Chase	1	1982**	
Cherry	1	1980	
Colfax	2	1955-1956**	
Dakota	1		1920
Dawes	2	1937, 1973	
Dawson	14	1950, 1951, 1953-1956	1948, 1949, 1952, 1957-1959, 1969, 1983
Dixon	5	1954	1866, 1980, 1982, 1983
Dodge	2		1982, 1983
Douglas	34	1928, 1937, 1940-1944, 1947, 1953-1958, 1960, 1963, 1964, 1968, 1969, 1971, 1972, 1975-1983	1893, 1896, 1929, 1930, 1981-1983
Gage	2	1961, 1966	
Garden	1	1978	
Garfield	1	1960	
Hall	7	1953, 1954, 1957, 1959, 1973, 1984	1983
Hamilton	6	1955-1958, 1963, 1965	1955
Harlan	1	1964	
Holt	8	1938, 1979**	1902, 1955, 1977, 1980, 1982, 1983
Howard	4	1955**, 1973, 1984	1955, 1983
Jefferson	2	1937, 1946	
Johnson	1	1982**	
Kearney	1	1960	
Keith	9	1947-1951, 1953-1955, 1977**	1948
Keya Paha	4	1956, 1979**	1982, 1983
Knox	14	1902**, 1975, 1979**	1959-1962, 1969, 1972-1974, 1980, 1982, 1983
Lancaster	24	1913, 1925, 1926, 1950-1953, 1957, 1962, 1963, 1966, 1969-1975, 1979, 1980, 1982	1920, 1922, 1983
Logan	4	1935, 1936, 1944, 1948	
Lincoln	21	1935, 1938, 1941, 1944, 1947-1950, 1955, 1959, 1961, 1965, 1967, 1969-1971	1926-1930
McPherson	1	1982**	
Merrick	2		1982, 1983
Nance	1	1983**	1983
Nemaha	1		1896
Perkins	1	1974	
Platte	19	1937, 1951-1959, 1961-1969	1941
Polk	1		1983
Richardson	1	1939	
Rock	1		1977
Saline	1	1954	
Sarpy	15	1943, 1964, 1968, 1969, 1971, 1972, 1975-1983	1982, 1983
Saunders	8	1956, 1978-1984	1980-1983
Scottsbluff	2	1933**, 1957	
Sioux	1	1973	
Thayer	2	1953, 1959	
Thurston	3	1935-1937	
Washington	17	1970, 1971, 1982	1804, 1960, 1961, 1963-1970, 1972-1975
Webster	1	1957	
York	3	1896**, 1897**, 1966	1896**, 1897**

Sources: 1900-1915: Proceedings from the Nebraska Ornithologists Union, 1915-1933: Wilson Bulletin, 1933-1984: Nebraska Bird Review, 1804-1975: Ducey (1985).
* 1984 nesting survey results not included.
** Specific sighting record.

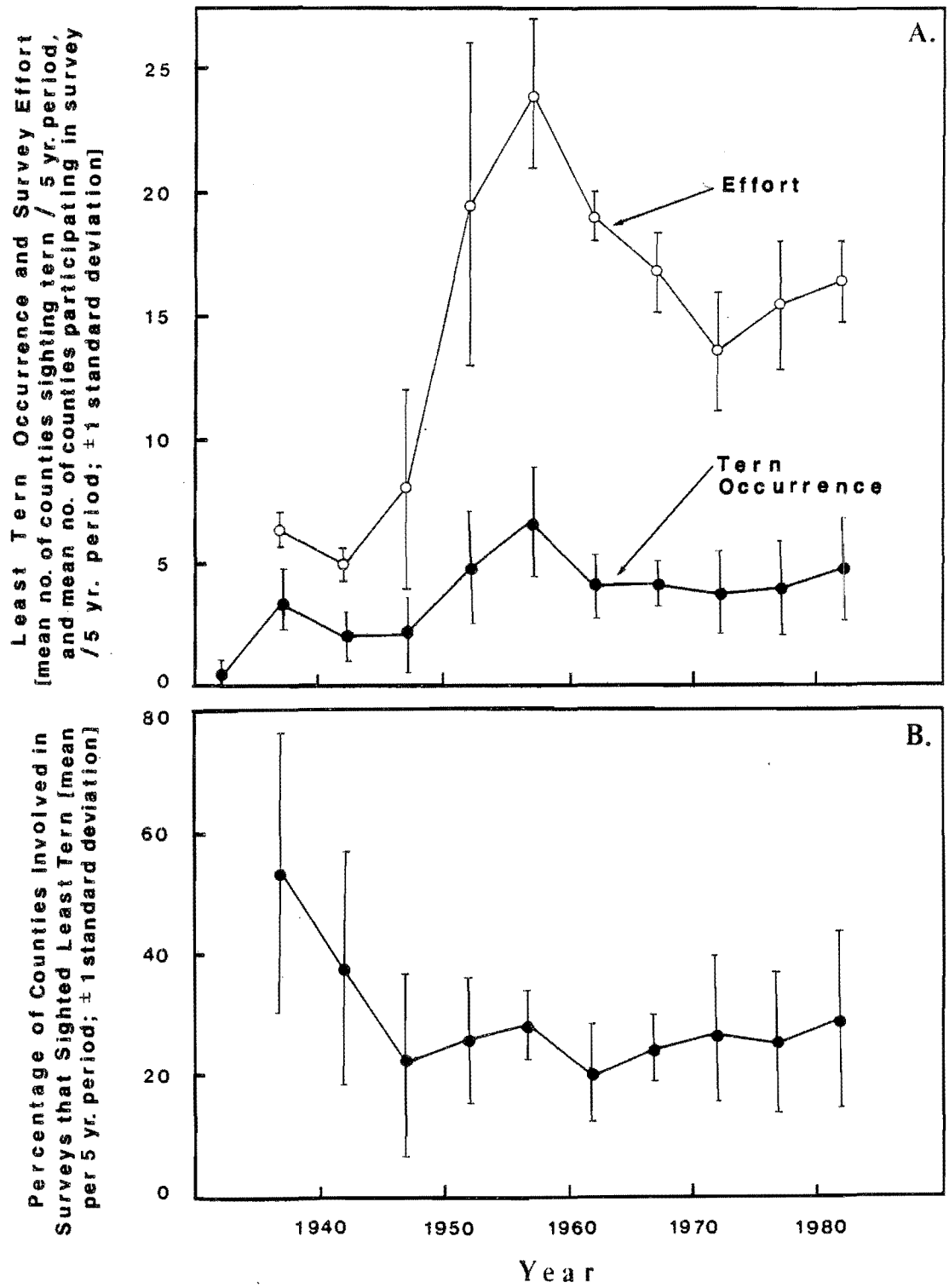


Figure 2-1. A. Reported interior least tern occurrence and associated survey effort, and B. normalized least tern occurrence in Nebraska.

amount of observation effort, and conclusions regarding population increases or decreases based on occurrence alone may be misleading.

Normalizing least tern occurrence to account for survey effort (by determining the percentage of counties involved in surveys that recorded sightings) indicated that between 21 and 54 percent of participating counties reported the species (Figure 2-1B; mean per 5-year period) from 1935 to 1984. The higher percentage of counties reporting the species in the late 1930's and early 1940's represents a disproportionately high sighting frequency associated with limited effort (only 6.4 and 5.0 counties, respectively, participated in surveys during these early years; mean per 5-year period). Since this time, however, the percentage of participating counties reporting least tern sightings has remained relatively stable over the period of record (Figure 2-1B).

It is important to note that the spring and fall migration surveys provide considerably less than statewide coverage. During the late 1950's when participation peaked, the maximum number of counties reporting survey results included only 27 of the 93 counties in Nebraska. Even for those participating counties, much of the survey effort often appeared to be localized, usually relatively near population centers. Thus, in most years more than two-thirds of the state was not surveyed for least tern and other species, resulting in a rather incomplete picture of tern distribution and occurrence in the state.

The distribution of reported least tern sightings in Nebraska (based on the number of years terns were sighted per county, including presence on spring and/or fall observation lists and nesting surveys, over 20-year periods) has increased over time (Figure 2-2, Table 2-1). Prior to 1900, 6 percent of Nebraska's 93 counties reported least tern sightings, whereas during subsequent 20-year periods the percent of counties reporting the species was as follows: 1905 to 1924, 2 percent; 1925 to 1944, 17 percent; 1945 to 1964, 34 percent; and 1965 to 1984, 40 percent. Although, to some extent, these distribution trends may be attributable to increasing numbers of observers, they do not reflect a pattern of decline or increased localization in recent years. Increases in the distribution of reported least tern sightings are particularly evident along the Niobrara River and the central portion of the Platte River beginning in the mid-1940's (Figure 2-2).

2.2 SYSTEMATIC SURVEYS

In recent years, breeding populations of the interior least tern in Nebraska have been surveyed systematically by low altitude aerial flyovers and/or ground surveys along major rivers. These surveys have provided quantitative census data on breeding populations along various rivers or river reaches, and have included the collection of information on colony distribution, nest characteristics, productivity, and factors affecting mortality. The first systematic survey of least terns in Nebraska was conducted in 1975 by Downing, who included the Republican, Platte, Niobrara, and Missouri rivers in his 15-day ground and aerial inventory of the species' known breeding areas (Downing 1980). Annual surveys by the Nebraska Game and Parks Commission (NGPC) were initiated in 1978 for the Niobrara and Missouri (Gavins Point Dam to Ponca, Nebraska) rivers, and in 1982 for the Platte River. In addition, other researchers surveyed the central Platte River and portions of the Loup River in 1979 (Faanes 1983), and the lower Platte River in 1981 (Ducey 1981b).

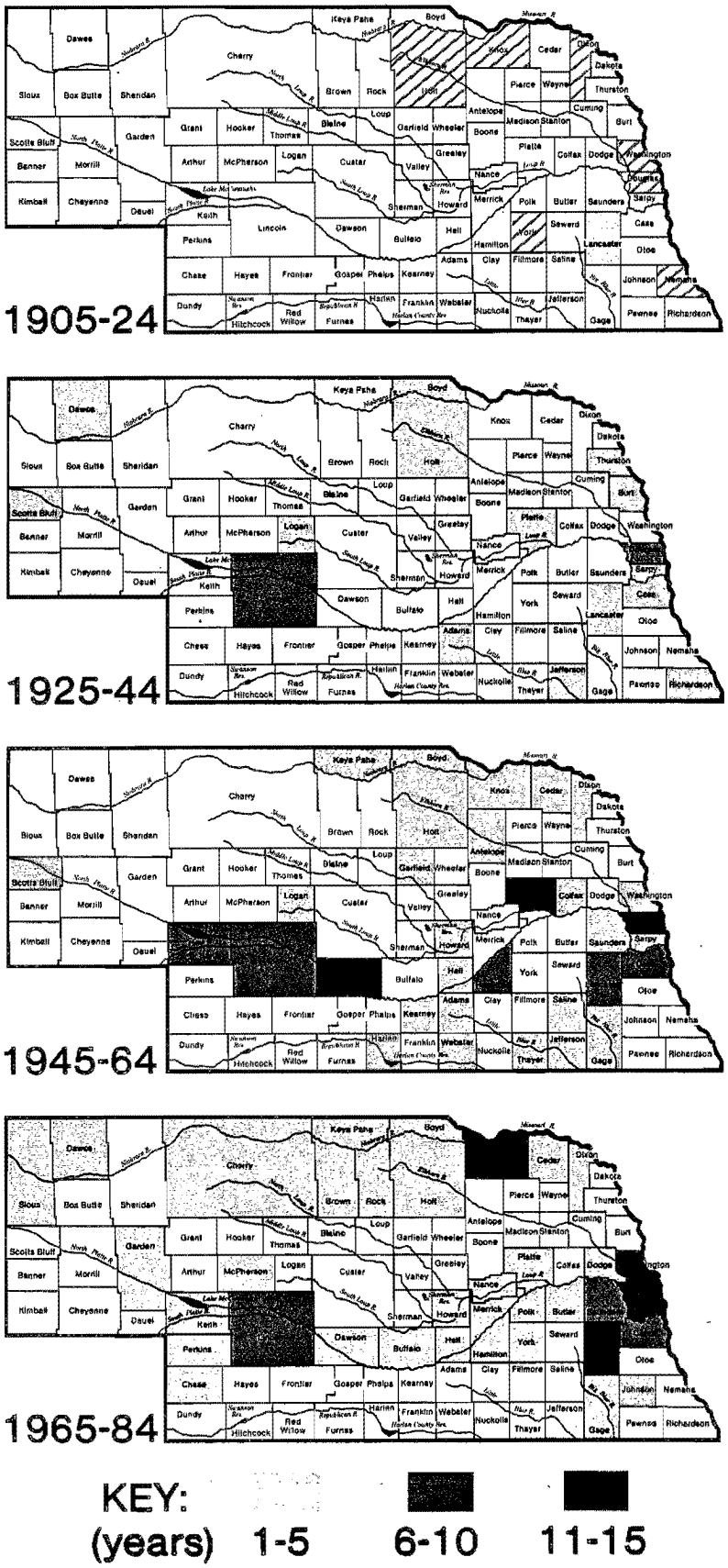


Figure 2-2. Historical distribution of reported least tern sightings in Nebraska. Shading reflects the number of years terns were sighted per county during 20-year periods from 1905 to 1984 (inclusive). Diagonal shading indicates sightings prior to 1905.

NGPC also surveyed portions of the Loup rivers in 1983-1986, the Missouri River reach between Fort Randall Dam and Lewis and Clark Lake in 1982-1985, and the lower Elkhorn River in 1985-1986. Surveys by the South Dakota Department of Game, Fish and Parks (in cooperation with the U.S. Fish and Wildlife Service) were also conducted in 1986 along the northeastern border of Nebraska from Fort Randall Dam to Lewis and Clark Lake, and from Gavins Point Dam to Ponca, Nebraska (Schwalbach et al. 1986, 1988).

Although differences in survey coverage and effort limit year-to-year comparisons to some extent, the results of these systematic surveys have provided valuable new information on the species' nesting behavior and factors affecting reproductive success. Moreover, given that census results from Downing's initial inventory in 1975 were cited as a principal basis for proposing endangered status for the interior least tern (reference 49 FR 22444-22447), recent systematic surveys serve to document the species' population status along Nebraska's rivers more than a decade later.

2.2.1 Platte River

2.2.1.1 Census Results and Distribution

Census data on adult interior least terns recorded along the Platte River during the period 1975-1986 are shown in Table 2-2; additional site-specific data for the 1981-1986 surveys are presented in Appendix Table A-1, and information on survey coverage and effort for all years is presented in Appendices B-1 and C-1. During the initial survey of the Platte in 1975, Downing (1980) estimated a population of 150 least terns based on 80 birds seen (Table 2-2), however he did not provide specific information on colony locations. He noted that the birds were widely scattered at the time of the survey due to flooding, and that a sand and gravel industry had created additional nesting and feeding habitat near the river. Downing (1980) further commented that the least terns observed on the Platte River were probably remnants of previously larger populations, because there were "presently more birds than the habitat seems capable of supporting." He expressed belief that the Platte River population may experience almost complete loss in a few years unless sandbar and sand-and-gravel pit habitat along the river was kept free of vegetation, and protected from human disturbance and predators (Downing 1980).

Following Downing's initial inventory of the Platte River interior least tern population in 1975, partial surveys were conducted along two different segments of the river in 1979 and 1981 (Table 2-2). During 1979, ground surveys along the central Platte reach from Grand Island to Lexington yielded a minimum population of 19 breeding pairs (38 adult terns); 17 pairs were reported at 2 riverine sites (Faanes 1983) and 2 additional pairs were located at sandpits near the river (C. Faanes, USFWS, personal communications). Two years later in 1981, Ducey (1981b) observed 65 adult least terns at four river sites (no sandpits were surveyed) in the lower Platte reach from Schramm Park State Recreation Area to Leshara. Interestingly, on the basis of the 1979 survey results, Faanes (1983) concluded that: "The least tern population along the Central Platte River appears to be in danger of further decline." This conclusion was apparently based on the reduced number of terns censused in 1979, as compared to the initial 1975 survey (38 versus 80 birds). However, it did not take into account the fact that the survey area in 1979 was considerably smaller; i.e., the initial 1975 survey was conducted along the

TABLE 2-2 SUMMARY OF INTERIOR LEAST TERN BREEDING POPULATIONS ALONG THE PLATTE RIVER, 1975-1986

River Section		Adult Terns Censused								
		1975[a]	1979	1980	1981	1982	1983	1984	1985	1986
Plattsmouth to Columbus (110 RM)	-R	UNK	NS	NS	65	40	0	0	107	214
	-P	UNK	NS	NS	NS	38	179	188-194	35	90
Columbus to Grand Island (70 RM)	-R	UNK	NS	NS	NS	22	0	0	0	0
	-P	UNK	NS	NS	NS	24	28	12	16	20
Grand Island to Lexington (80 RM)	-R	UNK	34	NS	NS	38	0	0[b]	40[c]	20
	-P	UNK	4	NS	NS	NS	39	26-30	58	78
Lexington to North Platte (60 RM)	-R	UNK	NS	NS	NS	0	0	0	0	0
	-P	UNK	NS	NS	NS	NS	0	0	0	16
Total		**80/150**	**38**		**65**	**162**	**246**	**226-236**	**256**	**438**
No. Birds (% total) - River		UNK	34 (89%)	NS	65	100 (62%)	0 (0%)	0 (0%)	147 (57%)	234 (53%)
No. Birds (% total) - Sandpits		UNK	4 (11%)	NS	NS	62 (38%)	246 (100%)	226-236 (100%)	109 (43%)	204 (47%)
No. Colonies Located - All Habitat[d]		**UNK**	**4**		**4**	**13**	**18**	**12**[b]	**25**[c]	**24**
No. Colonies - River		UNK	2 (50%)	NS	4	9 (69%)	0 (0%)	0 (0%)	15 (60%)	9 (38%)
No. Colonies - Sandpits		UNK	2 (50%)	NS	NS	4 (31%)	18 (100%)	12 (100%)	10 (40%)	15 (62%)
Avg. Adult Terns/Colony-All Habitat		**UNK**	**9.5**	**NS**	**16.3**	**12.5**	**13.7**	**18.8-19.7**	**10.2**	**18.3**
Avg. Adult Terns/Colony - River		UNK	17.0		16.3	11.1	0	0	9.8	26.0
Avg. Adult Terns/Colony - Sandpits		UNK	2.0		NS	15.5	13.7	18.8-19.7	10.9	13.6

Sources: 1975 data from Downing (1980); 1979 data from Faanes (1983) and C. Faanes (personal communications, 18 August 1987); 1981 data from Ducey (1981b); 1982-1986 data from Table I, Platte River Interior Least Tern and Piping Plover Nesting Survey, 1986, prepared by the Nebraska Game and Parks Commission. Detailed census data for the 1981-1986 surveys are presented in Appendix Table A-1.

Notes: RM = river miles; R = river P = sandpits; UNK = unknown; NS = not surveyed.

(a) During this initial survey of the Platte River interior least tern population, Downing (1980) observed 80 birds and estimated a population of 150. However, information on colony locations, or the number and size of colonies involved, was not reported.

(b) One colony of 6 birds was observed on the river in late summer of 1984 and may have been a renesting effort. This colony and the birds associated with it were not included in totals to avoid possible duplication.

(c) Two additional colonies of 14 and 8 birds, respectively, were observed on the river in late summer of 1985 and may have been renesting efforts. These colonies and the birds associated with them were not included in totals to avoid possible duplication.

(d) The following numbers of sandpits were surveyed during various years: 2 in 1979; 4 in 1982; 21 in 1983; 24 in 1984; 26 in 1985; and 28 in 1986.

entire length of the Platte (approximately 260 river miles), whereas the 1979 survey included only the 80 mile segment of the river from Grand Island to Lexington.

Since 1982, interior least tern surveys along the Platte River have been conducted annually by the Nebraska Game and Parks Commission (NGPC). The results of these surveys reflect a steady increase in population size from 162 adult terns in 1982 to 438 adults in 1986 (Table 2-2). In the interest of proper interpretation, it is important to point out that annual survey coverage and effort have varied (Appendix B-1), and undoubtedly account for some of this increase. This is particularly true with regard to the 52 percent increase in the number of adult terns that occurred from 1982 to 1983 (162 versus 246 birds), despite the fact that during this latter year unusually high flows precluded use of river sandbars and restricted nesting entirely to off-river sandpits (NGPC 1983a). Both aerial surveys and ground checks were made along the Platte from North Platte to Plattsmouth in 1982 and 1983. However, because of the high flows in 1983, survey efforts were expanded to include 21 off-river sandpits (only 4 sandpits were surveyed in 1982).

Although the number of survey trips varied between years from 1983 through 1986, survey coverage remained relatively consistent (Appendix B-1); i.e., during each of these years the full length of the Platte River from North Platte to Plattsmouth was surveyed and similar emphasis was placed on monitoring off-river sandpit habitat (21 sandpits were surveyed in 1983, 24 in 1984, 26 in 1985, and 28 in 1986). Census results for these years reflect apparent stability in the Platte River least tern population from 1983-1985 (averaging approximately 244 adult birds annually), followed by a dramatic increase to 438 adult birds in 1986 (Table 2-2). The number of least terns censused in 1986 was 71 percent higher than the previous year and represented the largest breeding population censused up to that time.

Regardless of factors influencing year-to-year differences in census results, data gathered during systematic surveys over the 1975-1986 period of record (Table 2-2) do not reflect a decline in least tern occurrence along the Platte River. Rather, recent survey data indicate that habitat on and along the Platte River is capable of supporting a much larger breeding population of least terns than was thought to be the case following the initial 1975 survey. This is underscored by the fact that the 438 adult least terns censused along the Platte River in 1986 represents more than a 5-fold increase in the number of birds observed (and a 192 percent increase in the number of birds estimated) by Downing in 1975. Downing's (1980) underestimate of the capacity of the system to support breeding terns was likely affected by 1) the occurrence of flood conditions in the Platte River at the time of his survey, which would limit availability of potential sandbar nesting habitat; and 2), lack of awareness of the extent to which off-river sandpits were used for nesting.

2.2.1.1.1 Shifts in Colony Locations

Changes in the distribution of least tern breeding colonies along the Platte River as determined from systematic survey data (Table 2-2) document the importance of habitat provided by off-river sandpits (particularly during years when flow conditions limit or preclude the use of river sandbars), and attest to the species' inherent ability to adjust to differences in local habitat availability from year to year. Due to high spring and summer flows in the

Platte River during 1983 and 1984, caused primarily by heavy runoff from two consecutive winters of record snowpack accumulation in the Rocky Mountains, riverine habitat was inundated throughout much of the least tern breeding season in these years. As a result, nesting was confined almost entirely to sandpits adjacent to the river, with the exception of a few colonies established on river sandbars in late summer (one in 1983 and two in 1984) which may have been renesting attempts (NGPC 1983a, 1984).

In 1985 and 1986, moderate flow conditions early in the breeding season again permitted nesting on sandbars in the river (Table 2-2). Despite the record use of river sandbar habitat during these years (147 adult terns in 1985, and 234 adult terns in 1986), an additional 109 and 204 birds (43 and 47 percent of the 1985 and 1986 breeding populations, respectively) were censused at sandpits adjacent to the river. Moreover, 12 of the 15 colonies observed on riverine habitat in 1985 were using different sandbar sites than in 1982, the previous year that habitat on the river was available during the late May-early June nest initiation period (NGPC 1985). Similarly, 10 sandbar colony sites used in 1985 were not used in 1986; four of these sites were found to be unsuitable for nesting because of high water levels (NGPC 1986). In 1986, tern colonies were also found for the first time at sandpits along the Lexington to North Platte portion of the river.

Thus, systematic survey data clearly document that least terns make frequent changes in nesting colony locations. By nature, riverine sandbars are ephemeral and go through natural successional cycles of formation, shifting, and/or stabilization and vegetation development. Habitat associated with off-river sandpits is also transient. With the passage of time sandpit spoil piles become overgrown with vegetation or are leveled to develop housing or recreation areas, while fresh spoil deposits at active pits provide new nesting habitat. Consequently, a given site may be suitable for tern nesting one year, but absent or unsuitable the next. Such changes do not necessarily represent permanent losses of nesting habitat inasmuch as suitable habitat may be forming somewhere else.

Annual fluctuations in river flow also tend to increase or decrease the total amount of habitat available along the Platte from one year to the next, which may result in increased localization or dispersion of the breeding population during a given year. When flood conditions reduce the availability of mid-stream sandbars, sandpits adjacent to the river assume greater importance to the extent that during years of extreme and prolonged high flows (as in 1983 and 1984) they provide the only nesting habitat along the river. In any case, the least tern's flexible nest site selection strategy provides resiliency in reacting to annual variations in habitat distribution such that the species' existence is not dependent on the continued availability of specific nesting locations.

2.2.1.1.2 Spatial Occurrence

During years of comparable survey coverage (1983 through 1986) the lower third of the river from Plattsmouth to Columbus has consistently supported the majority of least terns in the Platte River breeding population (Table 2-2). This was true during years when high flows restricted nesting to off-river sandpits (1983 and 1984), as well as during years when riverine sandbar habitat was available (1985 and 1986). Specifically, 73 percent of the breeding

population occurred along the Plattsmouth to Columbus reach in 1983, 82 percent in 1984, 55 percent in 1985, and 69 percent in 1986.

In addition, most of the census increase between 1985 and 1986 occurred along the lower Platte River. Of the additional 182 least terns censused in 1986, 162 (89 percent) were observed along the Plattsmouth to Columbus reach. The remaining increase was contributed by 4 additional birds censused along the Columbus to Grand Island reach, and the occurrence of 16 birds along the Lexington to North Platte reach (the first sightings of least terns along this portion of the river since systematic surveys were initiated). Although the number of least terns censused along the Grand Island to Lexington reach in 1985 (98 birds) was more than double that observed during any previous survey year, no increase in this component of the population occurred in 1986 (i.e., 98 birds were again observed along this reach in 1986).

2.2.1.1.3 Sandbar Versus Sandpit Use

During 1985 and 1986, riverine sandbars as well as off-river sandpits were available as nesting habitat for the Platte River least tern population, and the proportion of breeding birds using these two habitat types was similar (Table 2-2). Of the 256 adult terns censused in 1985, 57 percent were found on sandbars, whereas 43 percent were found on sandpits. In 1986, 53 percent of the 438 adult terns censused were observed on sandbars, whereas 47 percent were observed on sandpits. What is particularly noteworthy, however, is that despite the fact that the number of least terns surveyed on river sandbars increased by 87 birds in 1986 (a 59 percent increase over the 1985 utilization), higher flows early in the nesting season that year apparently reduced the availability of riverine sandbar habitat. This is based on the observation that four of the river sandbars used as nesting sites in 1985 were unsuitable for use in 1986 because of high river flows (NGPC 1986). The fact that more birds apparently used a lesser amount of available riverine habitat in 1986 supports the conclusion that there was adequate riverine habitat to accommodate greater nesting utilization in 1985 if, in fact, least terns truly prefer this type of habitat. The underlying implication is that the species' selection of nesting sites is not motivated by a strong preference for sandbar as opposed to sandpit habitat. Schulenberg and Schulenberg (1982) similarly reported that successful nesting at a recently constructed oil well pad in Kansas "demonstrated that if offered alternative sites, Least Terns will accept them." (Note: Among the eight least tern colonies surveyed in Kansas in 1982, the highest production rate was observed at this site.)

Further resolution of this issue could be accomplished through evaluation of aerial photographs of the Platte River (if available) to quantify and compare the amount of riverine sandbar habitat at the beginning of the 1985 and 1986 nesting seasons.

2.2.1.2 Colony Spatial Characteristics

Available data (though limited) do not indicate greater crowding at least tern colonies during years when high river flows restricted nesting activity almost entirely to off-river sandpits, than during other years when riverine habitat was available as well. These contrasting conditions occurred during 1984 and 1985, respectively. Though the number of breeding birds censused along the Platte River was closely similar during these two years (226-236 birds in 1984

versus 256 birds in 1985), the distribution of the 1985 population was characterized by more colonies, with fewer birds per colony, reflecting greater dispersal of adult birds in apparent response to the added availability of riverine sandbar habitat that year (Table 2-2). Nevertheless, measurements of area per colony, area per nest, and inter-nest distances recorded at one river colony in 1985, fell within the range of values measured at 11 sandpits in 1984 (Table 2-3) when riverine habitat was unavailable due to high water levels.

TABLE 2-3 SPATIAL CHARACTERISTICS OF LEAST TERN/PIPING PLOVER COLONY SITES ALONG THE PLATTE RIVER, 1984-1985

Parameter	1984 11 Sandpit Colonies (125 tern nests and 16 plover nests)	1985 1 River Colony (8 tern nests and 1 plover nest)
Area per colony (acres)[a]	0.09 - 4.9 ($\bar{x}$=1.13)	0.8
Area per nest (sq. ft.)[a]	627 - 10,850 ($\bar{x}$=3,402)	3,929
Inter-nest distance -- least tern (ft.)[b]	6.1 - 240.0 ($\bar{x}$=50.0)	28.0 - 108.0 ($\bar{x}$=52.3)

Source: NGPC (1984, 1985).

(a) The stated values for area per colony and area per nest apply to both least terns and piping plovers.

(b) The distance from each least tern nest to the nearest neighboring least tern nest.

Nest height above water level measured for the eight least tern nests at the river colony site in 1985 (NGPC 1985) ranged from 13.2 to 30.7 inches (33.5 to 77.8 cm) and averaged 23.2 inches (58.8 cm). Faanes (1983), in contrast, reported a mean nest height above river stage of only 13.0 inches (33.0 cm) based on a sample of nine least tern nests located at riverine sites in 1979. It is not known in either case whether the measurements were made at the time of nest initiation.

Plans to measure spatial characteristics at additional sandbar colony sites in 1986 were not completed because of the occurrence of flood conditions following nest establishment (NGPC 1986).

2.2.1.3 Foraging

Data relating to least tern foraging habits and prey utilization were gathered during the 1985 and 1986 surveys. Studies conducted in 1985 indicated that the Platte River serves as the primary food source for least terns that utilize adjacent sandpits for nesting (NGPC 1985). Based on least tern foraging observations recorded at a sandpit colony in 1985, 17 of 20 successful catches of fish by adult birds were made at riverine sites, whereas the remaining three catches were from the sandpit. Observations recorded at other sandpit colonies that year indicated all foraging activity occurred at adjacent Platte River sites. Least terns were observed to take fish at locations where water depth ranged from 1.2 to 12 inches (3.0 to 30.5 cm). At 23 sites where successful

catches occurred, water depth averaged 4 inches (10.2 cm) and velocity averaged 0.9 ft./sec. The three fish species that occurred in greatest abundance in samples collected at these sites were the sand shiner (50.5 percent), red shiner (19.7 percent) and bigmouth shiner (14.2 percent).

During the 1986 survey, 34 fish representing 10 species were found in or near tern colonies and were probably dropped by least terns (NGPC 1986; Table 2-4). In most cases, these fish were apparently too large to be consumed by the birds. Studies conducted by Atwood and Kelly (1984) indicated that morphological characteristics of unsuitable prey specimens included preopercular or fin spines, maximum body depth of approximately 1.5 cm or greater, and body length exceeding approximately 5 cm. Based on these criteria, the length and/or body depth of most fish found in or near least tern colonies along the Platte River in 1986 would have resulted in their unsuitability as food items.

TABLE 2-4 NUMBER OF FISH FOUND AT LEAST TERN COLONIES ALONG THE PLATTE RIVER, 1986

Species	Colony Type	
	Sandbar	Sandpit
River carpsucker (Carpiodes carpio)	2	1
Red shiner (Notropis lutrensis)	3	0
Sand shiner (Notropis stramineus)	1	1
Fathead minnow (Pimephales promelas)	0	2
Minnow (Hybognathus sp.)	1	0
Yellow perch (Perca flavescens)	0	1
Freshwater drum (Aplodinotus grunniens)	2	0
White crappie (Pomoxis annularis)	1	4
Largemouth bass (Micropterus salmoides)	0	6
Gizzard shad (Dorosoma cepedianum	7	2
Totals	17	17

Source: NGPC 1986.

Two regurgitated least tern pellets were also found at two colony sites along the Platte River in 1986, one at a sandbar and one at a sandpit colony (NGPC 1986). Both pellets contained gizzard shad that were within the suitable size range for prey items (i.e., less than 1.5 cm in body depth, and less than 5 cm in body length). Mean body depth for the eight gizzard shad removed from the two pellets was 0.9 cm and the body depth of all specimens was well below 1.5 cm. Mean body length for the eight fish (five specimens were missing heads) was 3.3 cm; average body length for the three whole fish was 3.9 cm.

These data indicate that a variety of fish species, within defined size limits, serve as potential food items for the Platte River least tern population. Although riverine habitat supplies all of the species' basic needs, the requirements of least terns that nest at sandpits are still dependent, in part, upon the river: sandpit spoil piles provide suitable nesting substrate, whereas the river provides shallow water areas where small fish can readily be obtained for food. Foraging is apparently more limited on the sandpits themselves because their characteristically steeper side-slopes and general

lack of shallow water areas are less conducive to the capture of fish prey items (NGPC 1982a). Consequently, even during years when mid-stream sandbars are inundated during the least tern breeding season, the river continues to play an important role as the principal food source for the population.

2.2.1.4 Production

Production data relative to the Platte River least tern breeding population were gathered at 12 sandpit colonies in 1984 (NGPC 1984), and at 10 sandpit and 6 river sandbar colonies in 1986 (NGPC 1986). As shown in Table 2-5, mean clutch size and hatching rate were higher at the sandbar colonies, whereas overall production was twice as high at the sandpit colonies based on fledging rates/nesting pair. Specifically, fledging rates/nesting pair were 0.42 and 0.38 at sandpit colonies in 1984 and 1986, respectively, as compared to 0.19 at sandbar colonies in 1986. A lower survival rate from hatching to fledging appeared to be a main contributing factor to reduced production at the sandbar colonies; i.e., survival rates from hatching to fledging were more than three times higher at the sandpit colonies (0.39-0.50 in 1984, and 0.38 in 1986) than at the sandbar colonies (0.11 in 1986).

TABLE 2-5 SUMMARY OF LEAST TERN PRODUCTION AT COLONY SITES ALONG THE PLATTE RIVER, 1984 AND 1986

	1984	1986	
	12 Sandpit Colonies	10 Sandpit Colonies	6 Sandbar Colonies
No. of nesting pairs	113-118	69	107
No. of nests	149	113	147
No. of eggs laid	319	282	392
Mean clutch size	2.14	2.50	2.67
No. of eggs with known outcome	275	187	317
No. of eggs hatched*	109	68	187
Hatching rate	0.34	0.24	0.48
No. of fledged young	43-54	26	20
Survival rate from hatching to fledging	0.39-0.50	0.38	0.11
Fledging rate/nest	0.32	0.23	0.14
Fledging rate/nesting pair	0.42	0.38	0.19

Source: NGPC (1984, 1986).

* Data for number of eggs hatched applies to eggs with known outcomes.

The lower survival rate from hatching to fledging noted at river sandbar colonies in 1986 was probably affected significantly by flooding which occurred after the main nest initiation period. Losses of chicks due to flooding were observed, or highly suspected, at all but two sandbar colonies during that year (NGPC 1986). Continued collection of production data is needed to determine the extent to which fledging rates at sandbar colonies are increased during years when stable or declining flow conditions persist after nest initiation.

Because of the interior least tern's vulnerable, ground level nesting habit, it is implicit that the species has had to historically contend with highly variable and periodically low production rates, subject to the timing and magnitude of floods, storms, and other climatic factors. However, the rate of fledgling production necessary to achieve population growth (or successful reproduction) remains uncertain. For California least terns, Atwood and Massey (1981) indicated that a production rate of 1.0-1.5 fledglings/nesting pair is considered good success, 0.5-1.0/pair is moderate, and 0-0.5/pair is poor. For Atlantic Coast least terns, Burger (1984) considered colonies producing more than 0.5 fledglings/nesting pair as successful, and those producing 0.25-0.49 fledglings/pair as moderately successful. Burger further reported that reproductive success for least tern colonies in New Jersey averaged 0.48 fledglings/nesting pair (range: 0.2 to 0.8 fledglings/pair) over the 5-year period 1978-1982 during which time the number of breeding birds increased significantly with advancing years. Using Atwood and Massey's criteria all production results shown in Table 2-5 would be considered poor. Using Burger's criteria, the production results recorded at Platte River sandbar colonies in 1986 would also be considered poor, but production results at off-river sandpit colonies in 1984 and 1986 would be considered moderately successful.

Determination of whether a given production rate results in population increase or decline is ultimately dependent on the level of production necessary to maintain a stable or self-sustaining population (where mortality in the breeding stock is balanced by production). Because of more rapid population turnover, short-lived species require higher production rates to maintain their populations than long-lived species. Consequently, in light of its precarious nesting habits, the long life span of the interior least tern is of definite survival importance. In this regard, Wingfield (1982) reported that one banded least tern lived to be 21 years old. More generally, however, "[j]uveniles join the reproducing ranks at age two and are likely to live 10 more seasons" (Wingfield 1982). Assuming a 33 percent mortality rate for juvenile terns (i.e., fledgling stage to reproductive maturity at 2 years) and an average of 10 breeding seasons per bird thereafter, the mean annual production necessary to maintain a self-sustaining population would be 0.30 fledglings/nesting pair. This production rate extended over a 10-year breeding span would allow each pair of adult birds to replace themselves during their lifetime. By comparison, a species with the same rate of juvenile mortality that breeds for an average of only two seasons would have to sustain an annual production rate of 1.50 fledglings/nesting pair to maintain a self-sustaining population.

In effect, a self-sustaining production rate of 0.30 fledglings/nesting pair would require that each pair of adult terns in the population produce three fledglings any time during their 10-year breeding span. Sustained mean annual production rates above or below 0.30 fledglings/nesting pair would result in population increase or decrease, respectively. For the population as a whole, lower production one year could be offset by higher production the next or, similarly, higher production at one location could compensate for lower production at another. Within this context, the mean production of approximately 0.40 fledglings/nesting pair observed at sandpits adjacent to the Platte River in 1984 and 1986 (Table 2-5), if sustained, would be expected to promote population growth. Conversely, the lower production rate of 0.19 fledglings/nesting pair for Platte River sandbars in 1986, if sustained over time, would affect population decline.

If new information indicates the average number of breeding years per bird is less than or greater than 10, or that juvenile mortality is less than or greater than 33 percent, then higher or lower production rates would be necessary to maintain a stable population. For example, at the assumed juvenile mortality rate of 33 percent, mean annual production rates of 0.38 and 0.25 fledglings/nesting pair would be necessary to maintain a self-sustaining population if the average number of breeding years per bird were 8 or 12 years, respectively. Alternatively, if an average 10-year breeding span per bird is representative of the population, mean annual production rates of 0.27 and 0.40 fledglings/nesting pair would be necessary to maintain a self-sustaining population at juvenile mortality rates of 25 and 50 percent, respectively.

As a final point, the Nebraska Game and Parks Commission (NGPC 1984, 1986) qualified that fledging rates reported for Platte River least tern colonies in 1984 and 1986 should be viewed with caution because 1) the mobility and dispersal of young birds from their nests shortly after hatching makes it difficult to monitor development through to fledging (age at first flight), and 2) lack of nesting synchrony among and between colonies results in young reaching fledging age at different times. Thompson and Slack (1984) made similar observations during studies of least tern colonies along the Texas coast and noted that juveniles departed the colonies soon after fledging; 45 percent of the juveniles were not seen at their natal colonies more than 2 weeks after fledging and 86 percent were not seen after 3 weeks. As a result, these authors concluded that single counts of fledged juveniles substantially underestimate cumulative production. They determined that multiple counts timed with the breeding chronology for colonies within the survey area, and corrected for juvenile departure, are required to achieve more realistic estimates of survival to fledging.

2.2.1.5 Sources of Mortality at Nesting Colonies

Sources of mortality to eggs of least terns at nesting colonies along the Platte River were monitored during the 1984 and 1986 surveys (NGPC 1984, 1986). Because high river flows inundated potential sandbar nesting sites during the primary nest initiation period in 1984, monitoring was limited to sandpit colonies. In 1986, however, causes of mortality were assessed at both sandpit and river sandbar colonies. Results of these studies indicate that flooding, human disturbance, and predation are among the most frequent causes of direct loss of eggs at colonies along the Platte River.

As shown in Table 2-6, flooding that followed the 1986 nest initiation period was a primary cause of egg mortality at river sandbar colonies, accounting for 74 percent of the eggs lost at these sites. Other factors affecting egg mortality at sandbar sites included losses due to predation (8 percent), losses resulted from nest abandonment for undetermined reasons (14 percent), and losses due to miscellaneous other factors such as weather, unknown causes, etc. (4 percent).

TABLE 2-6 CAUSES OF EGG LOSS AT LEAST TERN COLONIES ALONG THE PLATTE RIVER, 1984 AND 1986

	1984	1986	
	12 Sandpit Colonies	10 Sandpit Colonies	6 Sandbar Colonies
No. of eggs laid	319	282	392
No. of eggs with known outcome	275 (86%)	187 (66%)	317 (81%)
No. of eggs hatched	109 (34%)	68 (24%)	187 (48%)
No. of eggs lost	166 (52%)	119 (42%)	130 (33%)
Lost due to predation	17 (10%)*	14 (12%)*	11 (8%)*
Lost due to human disturbance	28 (17%)*	8 (7%)*	0 (0%)*
Lost due to abandonment for undetermined reasons	96 (58%)*	11 (9%)*	18 (14%)*
Lost due to flooding	0 (0%)*	9 (7%)*	96 (74%)*
Lost due to other factors (weather, unknown causes, etc.)	25 (15%)*	77 (65%)*	5 (4%)*

Source: NGPC (1984, 1986).

* Percent of eggs lost.

Because of the greater stability of water level conditions that exists at off-river sandpits, flooding is not a major source of mortality at these sites. No loss of eggs due to flooding was observed at sandpit colonies in 1984, though flooding was responsible for nine (7 percent) of the eggs lost at sandpit colonies in 1986 (Table 2-6). Loss of these eggs occurred when Platte River overflow entered a pit near the river and flooded three nests (NGPC 1986). Of the direct sources of mortality identified at sandpit colonies, human disturbance and predation accounted for 17 percent and 10 percent of the eggs lost in 1984, and 7 percent and 12 percent of the eggs lost in 1986. In addition, it is likely that disturbances from human activities as well as predators contributed to egg mortality at sandpit colonies due to nest abandonment for undetermined reasons and/or miscellaneous unknown causes, which together accounted for 73 percent of the eggs lost in 1984 and 74 percent of the eggs lost in 1986. It should be noted, however, that nest abandonment can also be caused by other factors. Based on extensive observations of the Bell Island colony on the Ohio River, Hardy (1957) reported that adult least terns often deserted remaining eggs when the first hatched chicks left the nest.

> "When the first young is hatched, the parents instinctively switch from incubation to brooding and feeding...Least tern chicks began to wander from the nest by the second day after hatching and usually did not return thereafter...[0]nce the interest of the adults in the chicks had been aroused, they neglected any remaining eggs and never resumed incubation once the first born chicks had deserted the scrape." (Hardy 1957)

The following information is relevant to achieving a more complete understanding of the effects of flooding, human disturbance, and predation on the reproductive success of the Platte River least tern population.

1) Flooding: Over the 1975-1986 period of record, flood events have been observed on the Platte River during 5 of the 8 years that least tern nesting surveys have been conducted (survey years included 1975, 1979, and 1981-1986). Such events, depending on timing, can affect tern breeding populations in two ways. First, the occurrence of high flows during the nest selection period causes the reduction or elimination of potential nesting habitat on riverine sandbars. This condition was documented during the 1983 and 1984 breeding seasons when extensive and prolonged flooding inundated mid-stream sandbars and restricted all initial nesting activity to off-river sandpits (NGPC 1983a, 1984). Second, the occurrence of high flows after nest establishment can result in substantial mortality of eggs and young at sandbar colonies. This situation was documented during the 1979 and 1986 breeding season (Faanes 1983 and NGPC 1986, respectively), and probably occurred during the 1975 breeding season as well (Downing 1980).

   As stated previously, flooding after nest establishment accounted for 74 percent of the eggs lost at sandbar colonies in 1986; flood mortality to pre-fledgling chicks was also observed or highly suspected at 7 of the 9 sandbar sites used for nesting that year (NGPC 1986). Based on survey efforts conducted along the Grand Island to Lexington reach of the Platte River in 1979, Faanes (1983) reported that all least tern (and piping plover) nests, both hatched and active, were inundated by rising water caused by late snowmelt in the Rocky Mountains combined with heavy rainfall in western Nebraska. A review of USGS flow data for the Platte River, recorded at the Grand Island gage, indicates that mean daily flow increased from 1,810 cfs on 20 June 1979 to 3,000 cfs on 21 June 1979, the date on which all nests in the central Platte reach were reported to be inundated. In contrast, on 21 May 1979 when first nest initiation by least tern was observed (Faanes 1983), the mean daily flow at Grand Island was 911 cfs.

   Downing (1980) similarly reported that the Platte River breeding population was widely scattered due to flooding during the initial survey conducted in late June 1975. These observations are consistent with USGS gaging records which reflect a flood event occurring at that time; i.e., records for the Grand Island gage indicate an increase in mean daily flows from 950 cfs on 16 June 1975 to a peak for the month of 5,300 cfs on 23 June 1975. By comparison, mean daily Platte River flows at Grand Island during the mid-May to early June nest initiation period (approximately 16 May-7 June) ranged from 388 to 919 cfs. Considering that the timing of the 1975 flood event was similar to that observed in 1979, and that the corresponding discharge was even higher, it is likely that most tern and plover nests on sandbar habitat were also inundated in 1975.

2) Human Disturbance: Human activities in the vicinity of least tern nesting areas pose a regular threat to breeding success at both riverine and sandpit colonies. Human disturbance may prevent use of an otherwise suitable site, or cause abandonment and/or direct mortality of eggs and young after nests have been established. Although no mortality of eggs or young due to human disturbance was reported at sandbars on the Platte River in 1986 (NGPC 1986; Table 2-6), Wingfield (1982) commented that open, riverine sandbars are

inviting for summer recreational activities such as picnicking, sunbathing, firework displays, driftwood collection, etc. During the initial survey of the Platte River breeding population in 1975, Downing (1980) observed vehicle tracks (presumably from motorcycles, dune buggies, or all-terrain vehicles) on "almost every bar that remained above water." Ducey (1981b) similarly reported human activities in the vicinity of most riverine colonies he surveyed, including swimming, campfires, wading in the river hiking on the sandbars, as well as limited vehicular disturbance; heavy recreational use at one site apparently caused adult terns to abandon their nests.

Although human disturbance at a given sandbar colony may be a problem one year and not the next, the frequency of disturbance at mid-stream sandbars is undoubtedly greater at locations where bridge-crossings or nearby roads provide ready access to the river channel. Ducey (1981b), for example, observed a thriving, successful least tern colony at a sandbar on the lower Platte River near Schramm Park State Recreation Area in 1981. One year later, however, fewer breeding birds and complete nesting failure occurred at this colony (Ducey 1982). Easy access to the river in the vicinity of this site was provided by a gravel road that runs along the north bank of the river. Although signs of human activity on this sandbar were noted in 1981, the effects of human disturbance were apparently more disruptive to the nesting birds in 1982. During this latter year, Ducey (1982) commented that "[e]mpty beer cans and bottles, a salad dressing bottle, and other discarded refuse were evident on the sandbar", and that "[r]efuse and a partially burned tree snag were present on 28 July right near where nests had been found on the first visit." Conversely, least terns nested successfully at river sandbars near the Two Rivers State Recreation Area (SRA) in 1982 but not in 1981 (Ducey 1981b, 1982). Ducey reported that heavy human use (e.g., wading in the river, hiking on the sandbars, and limited vehicular disturbance) were apparent at this site in 1981, resulting from visitors to the Two Rivers SRA. Because a portion of this site is owned by the Nebraska Game and Parks Commission, and since access is through state lands, he recommended that nesting success could be improved by limiting human activity in the immediate vicinity of the colony during years when breeding birds are present (Ducey 1982).

Least tern colonies located at sandpits adjacent to the Platte River are also subject to human disturbance. As previously noted, human disturbance accounted for 17 percent and 7 percent of the direct losses of eggs observed at sandpit colonies in 1984 and 1986, respectively (Table 2-6). Among the human activities encountered at sandpits, the use of recreational vehicles appears to be particularly destructive to least tern eggs and pre-fledgling chicks. Such vehicles were responsible for most of the egg and chick mortality resulting from human disturbance at sandpit colonies in 1984 (NGPC 1984). During ground surveys conducted at 18 sandpit colonies in 1983, disturbances from recreational activities including the use of three-wheeled vehicles were observed at four colonies, and leveling of spoil piles for house construction caused complete nesting failure at two colonies (NGPC 1983a). Other disturbances included the occurrence of livestock (an indirect human influence) at one colony, and daily work activities associated with sand-and-gravel mining operations at three colonies. It was noted that such work activities occur at all active sand and gravel pits,

but that the resultant effect on colony nesting success would probably be minimal (NGPC 1983a).

At sandpits, which unlike riverine sandbars are typically not subject to flooding, cooperation from sandpit owners and work crews to minimize disturbances to active colonies can be highly beneficial to nesting success. Ducey (1982) reported the following case in point:

> "The current owner of this sand pit [i.e., Wolf Pit located east of Morse Bluff in Saunders County, NE] showed an intense interest in the breeding terns. Not only did he enjoy observing the birds but he worked at reducing chances of predation by selectively removing bullsnakes that were observed near the colony. This interest also helped reduce human disturbance by limiting access during the breeding season. Activities associated with the transportation of sand seemed to have minimal effect, if any, on nesting birds. One tern nest within 5 m of a road was kept under observation by Mr. Edwards [the owner]. The incubating adult did not leave the scrape even as large trucks carrying sand would drive by. This nest eventually successfully fledged 3 young."

It is significant to note that of the four riverine and two sandpit colonies monitored by Ducey in 1982, highest production occurred at Wolf Pit. The 30 adult terns (15 breeding pairs) observed at this site produced a minimum of 10 fledglings (Ducey 1982), reflecting a minimum fledging rate/nesting pair of 0.67. This rate of production was 60 and 76 percent higher than that observed at Platte River sandpit colonies in 1984 and 1986, respectively, and 253 percent higher than that observed at riverine colonies in 1986 (Table 2-5).

3) Predation: Though least tern colonies on both sandpits and river sandbars are subject to predation, it has been suggested that greater losses from this source of mortality may occur at sandpits (NGPC 1982a, 1983a; Ducey 1982). Unlike river sandbars, sandpit nesting sites are typically not completely surrounded by water and, thus, provide easier access to terrestrial predators. Monitoring of least tern colonies in recent years, however, has not revealed large differences in predation-caused mortality at sandpit versus sandbar colonies; i.e., predation accounted for 10 and 12 percent of direct egg losses at sandpit colonies during 1984 and 1986, respectively, as compared to 8 percent of direct egg losses at river sandbar colonies in 1986 (Table 2-6). Moreover, recent monitoring efforts indicate that both sandpit and sandbar colonies are vulnerable to a similar array of predator species (NGPC 1984, 1986). Predators of least tern eggs or chicks at sandpit colonies, either directly observed or indicated from tracks or other sign, included snakes, turtles, great blue herons, great horned owls, red-winged blackbirds, American kestrels, raccoons, skunks, dogs, and coyotes. Observed or suspected predators at sandbar colonies included snakes, great blue herons, crows, red-winged blackbirds, dogs, and coyotes. Though predation is clearly affected by a variety of birds, reptiles, and terrestrial mammals, it is not known whether any one group has a more pronounced impact on nesting mortality than the others. Water surrounding

sandbars may discourage access by terrestrial predators but it does not deter predation by avian species, or most reptiles (snakes and turtles).

It deserves emphasis that water barriers around the perimeter of nesting colonies are not an absolute prerequisite to site use or to successful production. Hardy (1957) stated that "published accounts and personal communications indicate that many successful terneries are located where such barriers of water are absent." In addition, flooding along the Platte, which primarily affects sandbar as opposed to sandpit colonies, may actually increase the incidence of predation. As reported by Schulenberg and Schulenberg (1982), more instances of predation occurred at a colony site in Kansas following flooding. As increased water levels caused breeding terns to abandon their eggs, scavenging and predation at still active nests increased. Burger and Lesser (1979), similarly reported increased predation in common tern (Sterna hirundo) colonies partially destroyed by flooding and suggested that sufficient numbers may be required for successful mobbing of predators.

2.2.2 Missouri River

2.2.2.1 Census Results and Distribution

Ducey (1985) noted that interior least terns were frequently observed along the Missouri River during the Lewis and Clark expedition in the early 1800's. The journals of this expedition indicate that the species was collected on 5 August 1804 in the vicinity of what is now Washington County, Nebraska, and that it was more plentiful in this area than on the river below the Platte confluence. However, over the period 1923-1976 modifications resulting from the Missouri River Bank Stabilization and Navigation Project eliminated sandbar habitat along the stretch of the river from Ponca, Nebraska, downstream to Kansas City, Missouri. The construction of Gavins Point Dam and Lewis and Clark Lake in the 1950's also resulted in the inundation of additional river habitat above Yankton, South Dakota (Ducey 1985). As a consequence of these changes, least tern habitat on the Missouri River bordering eastern Nebraska is restricted to two unchannelized segments of the river: 1) the 53-mile reach from Gavins Point Dam to Ponca, Nebraska; and 2) the approximately 40-mile reach from the vicinity of Fort Randall Dam to Lewis and Clark Lake. Systematic surveys conducted in recent years provide continuing documentation of least tern breeding populations along both river segments.

2.2.2.1.1 Gavins Point Dam to Ponca, Nebraska

Census data on adult interior least terns recorded along the 53-mile reach of the Missouri River below Gavins Point Dam during the period 1975-1986 are shown in Table 2-7; additional site-specific data for the 1978-1986 surveys are presented in Appendix Table A-2, and information on survey coverage and effort for all years is presented in Appendices B-2 and C-2. During the initial systematic survey conducted along this reach in 1975, Downing (1980) estimated a population of 100 least terns based on 35 birds actually seen. The Missouri was at "semi-flood stage" during the time of this survey and the 35 terns observed were distributed in five small colonies. With regard to the future outlook for these colonies, Downing (1980) commented that four of the five would disappear soon because of vegetative encroachment at the nesting sites. As in the case of the Platte River, he suggested that Missouri River least

terns were probably remnants of a previously larger population because more birds were observed than the habitat seemed capable of supporting. He further stated that almost complete loss of this population may occur in a few years unless habitat was maintained free of vegetation and protected from human disturbance and predation.

During 1978-1986, systematic surveys to census least terns were conducted annually along the Gavins Point Dam to Ponca reach of the Missouri River by the Nebraska Game and Parks Commission. A separate survey was also conducted along this reach in 1986 by the South Dakota Department of Game, Fish and Parks in cooperation with the U.S. Fish and Wildlife Service. Although the same portion of the river has been inventoried each year (reflecting consistency in survey coverage), year-to-year differences in survey effort have occurred (Appendix B-2). In particular, an aerial census was conducted in 1978, whereas the 1979-1986 census estimates were based on counts of adult least terns (and/or nests) recorded during boat and ground surveys. During the latter period, the number of ground surveys varied; i.e., one ground survey was made in 1979 and 1980, two ground surveys were made in 1984 and 1985, three ground surveys were made in 1981, 1982, and 1986, and eight to nine ground surveys were made at each colony location in 1983. In an apparent effort to achieve greater standardization of the survey data, however, census estimates for a given year were based only on the results of one survey trip (Appendix B-2). Because separate survey efforts were conducted by different research teams in 1986, two sets of census data are available for that year (Appendix Table A-2).

As shown in Table 2-7, annual censuses conducted along the Gavins Point Dam to Ponca reach of the Missouri River from 1978 through 1986 have consistently yielded more least terns than were observed or estimated during the initial survey in 1975. The lowest population count during this period was recorded in 1978 (102 birds), the only year that census results were determined by aerial survey. It is important to point out, in this regard, that aerial surveys normally underestimate the number of birds present. The Nebraska Game and Parks Commission's annual progress report on the 1978 least tern surveys (NGPC 1978) reported that aerial surveys conducted by Downing usually accounted for 50 percent of the total number of birds found during subsequent ground searches. Assuming this ratio generally holds true, the 1978 least tern population within the Gavins Point Dam to Ponca reach may have actually approached 200 birds (NGPC 1978).

Though census data since 1978 reflect year-to-year fluctuations as well as spatial distribution shifts in the least tern population below Gavins Point Dam, a declining trend is not apparent (Table 2-7). Instead, ground surveys conducted along this reach from 1979 through 1986 have indicated increased utilization and greater population stability in recent years: the mean population size during the most recent 4-year period 1983-1986 ($\bar{x}$ = 196; SD $\pm$21) was 31 percent higher than during the preceding 4-year period 1979-1982 ($\bar{x}$ = 150; SD $\pm$40). These differences cannot be explained by variability in effort between years; i.e., more birds were not found during years when more ground surveys were conducted. Although eight to nine visits per colony were made during the 1983 breeding season, the population size that year (188 birds) was 20 percent lower than in 1984 (227 birds) when only two ground surveys were made. Similarly, the population size was considerably higher in 1979 and 1980 (176 and 193 birds, respectively) when one ground survey was conducted per

TABLE 2-7 SUMMARY OF INTERIOR LEAST TERN BREEDING POPULATIONS ON THE MISSOURI RIVER FROM YANKTON, SD (GAVINS POINT DAM) TO PONCA, NE, 1975-1986

River Section	River Miles	Number of Adult Terns Censused									
		1975(a)	1978	1979	1980	1981	1982	1983	1984	1985	1986
RM807 to RM797	10	UNK	6	32	55	22	44	69	68	40	40
RM797 to RM787	10	UNK	35	16	38	17	26	3	36	34	14
RM787 to RM777	10	UNK	30	40	33	20	12	14	20	46	43
RM777 to RM767	10	UNK	9	44	34	29	14	16	47	22	32
RM767 to RM754	13	UNK	22	44	33	30	18	86	56	45	52
Total	53	35/100	102	176	193	118	114	188	227	187	181
No. of Colonies Located		5	8	13	11	16	14	12	19	18	16(b)
Avg. Adult Terns/Colony		7.0	12.8	13.5	17.5	7.4	8.1	15.7	11.9	10.4	11.3

Sources: 1975 data from Downing (1980); 1978-1982 from Table 1, Missouri River Interior Least Tern Nesting Survey, 1982 prepared by the Nebraska Game and Parks Commission (NGPC); 1983-1985 data from tabular survey results submitted by NGPC to the Nebraska Department of Water Resources (4 February 1987); 1986 data from Schwalbach et al. (1988). Detailed census data for the 1978-1986 surveys are presented in Appendix Table A-2.

Notes: UNK = Unknown.

(a) During this initial survey to inventory interior least terns along this portion of the Missouri River, Downing (1980) observed 35 birds (in 5 small colonies) and estimated a population of 100; however, information on colony locations was not reported.

(b) Reflects number of colonies observed during 1986 census period when maximum number of adult least terns were counted. Least terns were observed at a total of 22 different sites during all census periods in 1986.

year, than in 1981 and 1982 (118 and 114 birds, respectively) when three ground surveys were conducted during the breeding season.

Considering Downing's (1980) prediction of an imminent decline in the Missouri River least tern population, it deserves emphasis that the 181 least terns censused along the Gavins Point Dam to Ponca reach in 1986 represents more than a 5-fold increase in the number of birds observed, and an 81 percent increase in the number of birds estimated, by Downing during the 1975 survey; moreover 16 tern colonies were observed in 1986 versus 5 in 1975 (Table 2-7). It is also noteworthy that record high water levels in 1986 limited the amount of habitat available along this reach throughout most of the May-August breeding season (Schwalbach et al. 1986); during normal or low flow years, by comparison, more sandbar and beach habitat would be exposed. Nonetheless, during other survey years when habitat was apparently more abundant, fewer birds were observed. In 1981, for example, only 118 least terns were inventoried along this reach (35 percent fewer birds than were censused in 1986) even though observations that year did not indicate abnormally high water levels during the nesting season (NGPC 1981a). In summarizing the results of the 1981 Missouri River least tern survey, the Nebraska Game and Parks Commission commented that vegetation development on riverine sandbars was progressing, but that vegetation encroachment was not necessarily becoming a limiting factor to this population; in a number of instances, open sandy beaches, which presumably would meet tern nesting requirements, were found to be uninhabited (NGPC 1981a). One can only speculate that abnormally wet conditions in 1986 may have broadly reduced potential habitat throughout the species' breeding range, resulting in greater utilization of those sites that were available. Conversely, broader dispersal of least terns throughout the breeding range may occur during normal or dry years when more potential habitat is available.

As a final point, it should be noted that census results from the two separate surveys conducted in 1986 reflect marked disparity in the size of the tern population below Gavins Point Dam. Specifically, 133 least terns were censused during 4-5 June 1986 by the Nebraska Game and Parks Commission, whereas 181 least terns (an increase of 36 percent) were censused during June through early July 1986 in a cooperative survey conducted by the State of South Dakota and the U.S. Fish and Wildlife Service (Appendix Table A-2). Such differences may have been influenced by the timing of the survey efforts and by flow conditions that resulted in an increase in available nesting habitat as the breeding season progressed. Hardy (1957) reported that if nesting bars are immersed when terns arrive, the breeding cycle is delayed until water levels subside and sandbars become exposed. Accordingly, flows below Gavins Point Dam peaked early in the 1986 breeding season (late May), declined with some fluctuation through June and early July, and then remained relatively stable through August (Schwalbach et al. 1986). As flows decreased, additional nesting habitat would have become available, allowing utilization by more birds. This may explain why the cooperative survey by the State of South Dakota and U.S. Fish and Wildlife Service, which extended later into the breeding season, censused a larger least tern population.

2.2.2.1.2 Fort Randall Dam to Lewis and Clark Lake

In 1982, systematic survey efforts to inventory least tern breeding populations along the Missouri River were expanded to include the reach from below Fort

Randall Dam to Lewis and Clark Lake. The Nebraska Game and Parks Commission surveyed this portion of the river from 1982 through 1985, whereas the 1986 survey was conducted by the South Dakota Department of Game, Fish and Parks in cooperation with the U.S. Fish and Wildlife Service. Downing's 1975 survey did not include this section of the Missouri.

As shown in Table 2-8, the number of adult least terns censused in this reach of the Missouri River from 1982 through 1986 has varied from 0 to 34 birds. Variability in population size between years was likely affected, to some extent, by differences in survey methods. That is, more least terns were inventoried in 1983 and 1986 when counts were recorded during boat and ground searches, than in other years when counts were determined by aerial survey. As stated previously, aerial surveys may underestimate the number of birds present by as much as 50 percent (NGPC 1978).

Schwalbach et al. (1986) reported that near record inflows to the Missouri River limited habitat availability below the Fort Randall and Gavins Point dams in 1986; during normal or low flow years, more habitat would be available allowing greater dispersal of the population.

TABLE 2-8 SUMMARY OF INTERIOR LEAST TERN BREEDING POPULATIONS ON THE MISSOURI RIVER BETWEEN FORT RANDALL DAM AND LEWIS AND CLARK LAKE, 1982-1986

	1982	1983	1984	1985	1986
No. of Adult Terns Censused[(a)]	0	34	12	15	25
No. of Colonies Located	0	3	1	3	2[(b)]

Sources: 1982-1985 data from Nebraska Game and Parks Commission survey notes and tabular results submitted to the Nebraska Department of Water Resources on 4 February 1987; 1986 data from Schwalbach et al. (1988).

(a) Aerial surveys only were conducted in 1982, 1984, and 1985, whereas aerial and ground surveys were conducted in 1983 and 1986 (see Appendices B-3 and C-3).

(b) Reflects number of colonies observed during 1986 census period when maximum number of adult least terns were counted. Least terns were observed at a total of 3 different sites during all census periods in 1986.

2.2.2.2 Colony Spatial Characteristics

Selected habitat parameters were measured at Missouri River least tern colonies below Gavins Point Dam and Fort Randall Dam in 1986 (Schwalbach et al. 1986, 1988). Mean values for nesting habitat size, nest elevation above water level, and nest-to-water distance for both reaches are presented in Table 2-9.

TABLE 2-9 SPATIAL CHARACTERISTICS OF LEAST TERN COLONY SITES ON THE MISSOURI RIVER, 1986

Parameter	Below Gavins Point N	$\bar{x}$	(s.e.)	Below Fort Randall N	$\bar{x}$	(s.e.)
Nesting habitat size (acres)[a]	12	7.56	(2.17)	3	10.87	(7.63)
Mean nest elevation above water level (inches)[b]	29	7.56	(0.72)	11	9.36	(2.04)
Mean nest-to-water distance (feet)	39	20.14	(2.21)	22	6.19	(0.61)

Source: Schwalbach et al. (1988).
Note: N = sample size; $\bar{x}$ = mean; s.e. = standard error.

(a) The stated values for nesting habitat size apply to both least terns and piping plovers which commonly nest in sympatric colonies along the Missouri River.

(b) Nest elevations were corrected to dates of nest initiation (Schwalbach et al. 1988).

Because of the near record inflows to the Missouri River that occurred throughout most of the 1986 breeding season (Schwalbach et al. 1986), it is expected that the mean values for the parameters listed in Table 2-9 may be greater during normal or low flow years when more sandbar or beach habitat is exposed. All of the listed parameters vary inversely with river stage and, in general, decreasing stage conditions are more favorable to least tern colonies. As noted by Schwalbach et al. (1986), increases in nesting habitat size resulting from stage decreases tend to reduce the potential for predation, whereas increases in nest elevation and nest-to-water distances reduce potential disturbance from water level fluctuations or wave action. Stage increases cause reverse effects and, in the event of large increases, complete inundation of nesting areas can occur.

2.2.2.3 Production

Available production data for Missouri River least tern breeding populations indicate considerable variability in reproductive success from year to year (Table 2-10). Within the Gavins Point Dam to Ponca reach, fledging rates/nesting pair ranged from 0.60 to 0.16 over the 3 years of record (1982, 1983, and 1986), reflecting nearly a four-fold difference between the highest and lowest production years (1982 versus 1986). For the Fort Randall Dam to Lewis and Clark Lake reach, production results in 1986 indicated a fledging rate/nesting pair of 0.50.

TABLE 2-10 SUMMARY OF LEAST TERN PRODUCTION ALONG THE MISSOURI RIVER, 1982-1983 AND 1986

	Below Gavins Point Dam			Below Fort Randall Dam
	1982	1983	1986	1986
No. of nesting pairs[a]	57	94	90	12
No. of fledged young	34	40[b]	14	6
Fledging rate/nesting pair	0.60	0.43	0.16	0.50

Sources: 1982 data from Missouri River Interior Least Tern Nesting Survey, 1982 prepared by the Nebraska Game and Parks Commission (NGPC 1982b); 1983 data from tabular survey results submitted by NGPC to the Nebraska Department of Water Resources (4 February 1987) and Ducey (1984); 1986 data from Schwalbach et al. (1988).

(a) Maximum number of nesting pairs based on number of adult birds censused (see Tables 2-7 and 2-8).

(b) Ducey (1984) reported that 47 young were counted along this reach of the river in 1983 but that only 40 had reached flight stage by the time higher flows began to inundate colony sites. The remaining seven young were presumably lost due to flooding.

In light of the interior least tern's habit of nesting on low river bars and other land surfaces exposed to the rigors of the plains climate (rainstorms, windstorms, hail, floods, and intense heat), low production rates have undoubtedly been a regular occurrence throughout the existence of the subspecies. Hardy (1957) stated that sudden rises of water sufficient to inundate tern colonies are particularly likely in streams traversing the plains region and in many colonies (especially those on low bars) floods take a heavy toll. He explained, however, that the "extremely high" mortality of young least terns up to the flying stage is balanced (or compensated) by low mortality in adults.

Moreover, the long life span of the least tern enables it to persist at production rates that would be inadequate to sustain short-lived species. As stated previously (see Section 2.2.1.4), Wingfield (1982) noted that one banded least tern lived to be 21 years of age, and that, in general, "[j]uveniles join the reproductive ranks at age two and are likely to live for 10 more seasons." Allowing for an average 10-year breeding span, and assuming 33 percent mortality from fledgling stage to reproductive maturity at age 2, the mean annual production rate required to maintain a self sustaining population would be 0.30 fledgling/nesting pair. This production rate would enable each pair of adult terns to replace themselves during their lifetime.

During 1986, the combined production rate of 0.20 fledglings/nesting pair for the Missouri River least tern populations below Gavins Point and Fort Randall dams (Table 2-10) was well below a threshold rate of 0.30. Nonetheless, this low production rate would result in declining population only if sustained over time. In reality, however, annual production rates are highly variable, as influenced by year-to-year differences in water level conditions, climate, and other factors. Consequently, low production in some years can be offset by higher production during other years when habitat conditions are more

favorable. Over the 3-year period of record (Table 2-10), combined, production for the Missouri River populations has, in fact, yielded 0.37 fledglings/nesting pair which, based on the considerations stated previously, may be slightly above a self-sustaining rate. Based on Atwood and Massey's (1981) criteria for California least terns, a production rate of 0.37 fledglings/nesting pair would be considered poor success, whereas based on Burger's (1984) criteria for Atlantic Coast least terns, this rate would be considered moderately successful (see Section 2.2.1.4). In any case, to the extent that management initiatives can be applied to minimize the causes and occurrences of low productivity years, growth of the Missouri River populations would seem clearly attainable.

It is also important to point out that several Nebraska Game and Parks Commission progress reports on Missouri River least tern surveys (NGPC 1980a, 1981a) noted a lack of syncrony in nest initiation both within and between colonies. For this reason, and because juveniles were found to depart from their natal colonies soon after fledging, Thompson and Slack (1984) determined that single counts of least tern fledglings substantially underestimate cumulative production. Instead, they concluded that multiple counts timed with the breeding chronology for colonies within the survey area, and corrected for juvenile departure, are required to achieve more realistic estimates of survival to fledging. Although Thompson and Slack's findings applied specifically to least tern colonies along the Texas coast, they stated that empirical verification at other nesting areas was warranted.

2.2.2.4 Sources of Mortality at Nesting Colonies

Direct sources of mortality at Missouri River least tern colonies have not been quantified, however, observations made during systematic surveys indicate that pre-fledgling mortality is affected by the same principal factors described for the Platte River population (see Section 2.2.1.5); i.e., flooding, human disturbance, and predation. Though the impacts of flooding are undoubtedly overriding during some years, the effects of human disturbance and predation are probably more pronounced during years when water level conditions are relatively stable. The following information provides additional perspective.

1) Flooding: During the 1986 breeding season when pre-fledgling mortality was particularly high (Table 2-10), flows below Gavins Point Dam peaked in late May but remained relatively high, with some fluctuation, thereafter (Schwalbach et al. 1986). Fluctuating high flows similarly occurred throughout the breeding season in the reach below Fort Randall Dam. As noted by Schwalbach et al. (1986) these flow conditions reduced the availability of suitable habitat and were a main contributor to the high number of abandoned nests, numerous renesting attempts, and low fledgling rates observed at Missouri River colonies in 1986. Many sandbar sites used by least terns were less than 18 inches (45.7 cm) above water, and all colony sites below Gavins Point and Fort Randall dams had signs of water disturbance at some time during the breeding season. Nest scrape dampness was also apparent at most sites and may have added to low productivity (Schwalbach et al. 1986).

   Although near record level inflows and above normal discharges from Gavins Point and Fort Randall dams were clearly a predominant factor in the high mortality recorded at Missouri River least tern colonies in 1986, available

information indicates that periodic high flows impact production at these colonies, to some degree, on a frequent basis. The following observations apply to other survey years:

- 1975 - During the initial survey conducted in late June of this year, the Missouri River was at "semi-flood stage" and few adult terns or colonies were observed (Downing 1980). Water levels obviously limited the amount of suitable habitat available at the time of this survey; however, if the onset of high flows followed the peak period of nest initiation, which usually occurs from mid-May to early June, substantial mortality of eggs from nest inundation or wave action would have been likely.

- 1979 - When the Missouri River population was inventoried in mid-July, a majority of sandbars were found to be wet and packed due to recent high flows and "not yet ideal as nesting substrate" (NGPC 1979). Though survey efforts were conducted well after the typical nest initiation period (mid-May to early June), all colonies were in the nest building or egg laying stage and may have been renesting attempts. As stated previously (see Section 2.2.1.5), all least tern nests on the central Platte River were inundated in late June 1979 by high water levels caused by regional storms and late snowmelt in the Rocky Mountains. It is probable that these same conditions would have resulted in increased inflows to the Missouri River during the 1979 breeding season.

- 1980 - The Nebraska Game and Parks Commission's annual report for the 1980 Missouri River least tern survey, states that river levels appeared higher than during the 2 previous years (NGPC 1980a). Four of 11 colonies surveyed in mid-July were seriously affected by flooding: two were above water at the time of the survey but had experienced recent flooding, and two were under water resulting in complete nesting failure. Nest initiation did not appear to be synchronized between or within colonies indicating the possible influence of fluctuating water levels on habitat availability and renesting activity. Hardy (1957) reported that breeding is delayed if nesting sandbars are immersed when terns arrive, and that the bars are utilized as soon as they become exposed. Depending on elevation and river stage, different bars would become exposed at different times.

- 1981 - Though observations during the three survey periods in 1981 did not indicate substantial water level changes, one colony site that had been under water during the first two surveys was exposed and supported least tern nesting activity during the third survey (NGPC 1981a). Again, little synchronization of nesting activity was observed between and within colonies.

- 1982 - The Nebraska Game and Parks Commission's annual report for the 1982 Missouri River least tern survey (NGPC 1982b), noted that discharges from Gavins Point Dam were 22,000 cfs early in the nesting season (1 June 1982). Flows increased to 30,000 cfs towards the end of June and then remained relatively stable through at least the first 2 weeks in July. Of the 10 active colonies located during the first survey on 22-23 June 1982, seven appeared to be threatened by rising water levels: "All but the highest bars were very damp and water had begun to seep into the nests on the lowest bars." During the second survey on 7-8 July 1982, 15

abandoned least tern nests (37 percent of the 40 active nests located during the first survey) were found to have been silted in by rising water levels or had eggs washed away from the nest scrape. The small clutch size in 57 percent of the 28 active nests located during the second survey indicated probable renesting attempts. The Nebraska Game and Parks Commission concluded that "if releases from Gavins Point Dam would have remained under 27,000 cfs during the critical nesting period [15 May-15 July], the least terns could have attained their optimum reproductive potential" (NGPC 1982b). Nevertheless, a production rate of 0.60 fledglings/nesting pair was recorded in 1982 -- a rate approximately 4 times higher than observed in 1986 (Table 2-10).

- 1983 - Out of a possible 94 nesting pairs (based on 188 adult birds censused; Table 2-7), Ducey (1984) reported that 40 young had reached flight stage by the time higher water flows began to inundate colony sites late in the nesting season. An additional seven young were presumably lost due to the effects of flooding. The resultant production rate of 0.43 fledglings/nesting pair in 1983 was intermediate to those observed in 1982 and 1986 (Table 2-10), and above the estimated threshold rate of 0.30 (see Section 2.2.2.3).

- 1984-1985 - Although only tabular census data are available for systematic surveys conducted during these two years, flooding impacts may have occurred in 1984. Runoff from heavy snowpack accumulation in the Rocky Mountains, undoubtedly resulted in high inflows to the Missouri River during the least tern breeding season that year (as in 1983). On the tributary Platte River, high water levels in 1984 completely inundated riverine sandbar habitat throughout most of the least tern breeding season.

2) Human Disturbance: Sandbars along the Missouri River that provide nesting habitat for least terns are also used for human recreation in the summer. Human activities observed in the vicinity of least tern colonies along the Missouri have included boating, hiking, picnicking, camping, fishing, sunbathing, driftwood collection, nature exploration, and fireworks displays (NGPC 1980a, 1981a; Schwalbach et al. 1986). The incidence of such activities seems to increase as warming water temperatures attract more recreational users to the river. In 1981 and 1982, human activity on river sandbars appeared minimal early in the nesting season; however, following the July 4th weekend, nearly every bar used by nesting terns showed evidence of human use (NGPC 1981a, 1982b).

Thus, although human activities probably have little effect on nest initiation at Missouri River sandbars, increased recreational use of these sites after nests have been established may result in direct mortality from nest abandonment or eggs being crushed underfoot. Two cases of complete colony abandonment associated with human disturbance were noted during the 1981 survey (NGPC 1981a), and in 1986 spent fireworks were found in one abandoned nest (Schwalbach et al. 1986). Least terns appear to be relatively unaffected by human disturbances outside of their nesting colonies; e.g., boating, or varied activities along the river banks (NGPC 1980a, 1981a).

3) Predation: Predators can affect nest abandonment as well as direct mortality of least tern eggs and chicks. In surveying colonies located on sandbars along the Missouri River (and at one parking lot at Gavins Point Dam), as well as beach and parking lot areas on Oahe Reservoir and the Cheyenne River in South Dakota, Schwalbach et al. (1986) noted possible egg loss due to predation at five sites. Potential predators observed on or near nesting areas included mammals (coyote, raccoon, and opossum), reptiles (prairie rattlesnake), and birds (northern harrier, red-tailed hawk, and great blue heron). Because virtually all colonies along the Missouri River below Gavins Point and Fort Randall dams are located on sandbars in the channel, predation at these sites is probably limited primarily to birds and aquatic reptiles (turtles and snakes). Exceptions may occur at bars located near shore.

   As stated previously (see Section 2.2.1.5), the disruption of nesting activities by flooding may increase the vulnerability of least tern eggs and young to predation.

2.2.3 Niobrara River

2.2.3.1 Census Results and Distribution

Census data on adult interior least terns recorded along the Niobrara River from 1975-1985 are shown in Table 2-11 (the Niobrara was not surveyed in 1986); additional site-specific data for the 1978-1985 surveys are presented in Appendix Table A-3, and information on survey coverage and effort for all years is presented in Appendices B-4 and C-4. During the initial systematic survey of the Niobrara River in 1975, Downing (1980) observed 85 least terns and estimated a population of 150 birds. Based on his inventory of nesting populations on major rivers throughout the breeding range, he described the Niobrara as the only river visited where tern habitat was not being seriously threatened. He noted, however, that only the lower 100 miles of the river appeared to provide suitable tern habitat because of natural narrowing of the channel in upper reaches (Downing 1980).

During the period 1978-1985, interior least tern surveys were conducted annually by the Nebraska Game and Parks Commission along the lower portion of the Niobrara from near Valentine (or Norden) downstream to the river mouth at Niobrara. Effort was similar from year to year consisting of an aerial survey to locate the colonies and ground surveys to record population counts (Appendix B-4). The primary exception was that two complete ground surveys were made by airboat in 1985, whereas only one ground survey was conducted during other years.

As shown in Table 2-11, the number of least terns censused on the Niobrara River from 1978-1985 has fluctuated between years but a declining trend is not apparent. Rather, the mean population size during the most recent 4-year period 1982-1985 ($\bar{x}$ = 123; SD ±35) was 60 percent higher than during the preceding 4-year period 1978-1981 ($\bar{x}$ = 77; SD ±31), indicating increased utilization of the Niobrara by breeding least terns. The record population of 174 adult terns censused on the river in 1985, represents more than a 2-fold increase in the number of birds observed, and a 16 percent increase in the number of birds estimated, by Downing (1980) during his initial survey in 1975. Whether the 1985 survey results were influenced by a more intensive survey effort that year (i.e., two ground surveys instead of one) is not known.

TABLE 2-11 SUMMARY OF INTERIOR LEAST TERN BREEDING POPULATIONS ON THE NIOBRARA RIVER, 1975-1985

River Section	Approx. River Miles	Number of Adult Terns Censused								
		1975[a]	1978	1979	1980	1981	1982	1983	1984	1985
Niobrara Park to Spencer Dam	40	UNK	23	35	46	4	34	47	32	58
Spencer Dam to County Line	35	UNK	6	12	50	86	28	79	47	92
County Line to Chimney Creek	40	UNK	11	7	20	7	25	9	16	24
Total	115	**85/150**	**40**	**54[b]**	**116**	**97**	**87**	**135[c]**	**95**	**174**
No. of Colonies Located		**6[d]**	**5**	**4**	**10**	**9**	**8**	**8[c]**	**8**	**14**
Avg. Adult Terns/Colony		**14.2**	**8.0**	**13.5**	**11.6**	**10.8**	**10.9**	**16.9**	**11.9**	**12.4**

Sources: 1975 data from Downing (1980); 1978-1985 data from tabular survey results submitted by the Nebraska Game and Parks Commission to the Nebraska Department of Water Resources (4 February 1987). Detailed census data for the 1978-1985 surveys are presented in Appendix Table A-3.

Notes: UNK = Unknown.

(a) During this initial survey of the Niobrara River interior least tern population, Downing (1980) observed 85 birds and estimated a population of 150; however, information on colony locations was not reported.

(b) Seventeen additional least terns were observed in 1979 but were not associated with specific colony sites.

(c) One additional colony of 7 birds was located by Nature Conservancy personnel in 1983 approximately 3 weeks after surveys conducted by the Nebraska Game and Parks Commission. This colony and the birds associated with it were not included in totals to avoid possible duplication.

(d) Downing (1980) reported that "at least six colonies" were observed on the Niobrara River in 1975.

2.2.3.2 Shifts in Nesting Colony Locations

Shifts in least tern colony locations, as affected by year-to-year variability in habitat conditions, have occurred frequently on the Niobrara River (Appendix Table A-3). In 1979, for example, only one of four colonies was found at a previously documented site (NGPC 1979). In addition, though similar numbers of colonies were located in 1980 and 1981 (10 in 1980 versus 9 in 1981), only 5 colony sites were active during both years; three of the 1981 colonies were in new locations with the remaining colony occurring at a location active in 1979 (NGPC 1981b). Seven of the eight colonies observed in 1982 occurred in new locations ranging up to 5 miles from previously documented sites, whereas the remaining colony was located at a site that was previously used in 1980 (NGPC 1982c). Similarly, only two of 14 colony sites located in 1985 (when the largest population of record was censused on the Niobrara) were active the previous year; six of the 1985 colony sites occurred at completely new locations and 5 others occurred at locations where use had been documented 2 or more years before (Appendix Table A-3).

McNicholl (1975) theorized that strong site tenacity would be disadvantageous to birds like terns that nest in highly fluctuating habitats influenced by the dynamics of flooding, vegetation encroachment, and other factors. The propensity of least terns to relocate their colonies within and between years may, in fact, be a behavioral adaptation that allows the species to persist despite the unstable, ephemeral nature of the nesting habitat it selects (Erwin 1984).

2.2.3.3 Sources of Mortality at Nesting Colonies

As stated previously, Downing (1980) reported that the Niobrara was the only river within the least tern's breeding range where habitat was not being seriously threatened. Though specific data on fledgling production and sources of mortality to least tern eggs and young are not available for the Niobrara River population, observations recorded during annual surveys by the Nebraska Game and Parks Commission provide insights relative to factors affecting productivity.

Like the more heavily developed Platte and Missouri rivers, the Niobrara is subject to periodic flood events and water-level fluctuations that affect year-to-year differences in habitat availability and nesting success. Based on the Nebraska Game and Parks Commission's initial survey of the Niobrara River least tern population in 1978, it was reported that:

> "Even under natural conditions, tern nesting habitat seems temporary in nature. Sandbars free of vegetation are often low enough in elevation that frequent high water flows pack the sand. Scrapes would be difficult to construct in this situation." (NGPC 1978)

Similar conditions (i.e., wet, packed sandbars "not yet ideal as nesting substrate") were also observed during ground surveys conducted along the Niobrara River on 9 July 1979 when only two nests containing eggs were found for 27 possible nesting pairs (NGPC 1979). About 2 weeks earlier (21 June 1979), all least tern nests on the central Platte River to the south were inundated by high flows due in part to heavy rainfall in western Nebraska

(see Section 2.2.1.5). In 1980, fluctuating water levels were noted to have impacted two least tern colonies along the Niobrara River, and a lack of nesting synchronization was observed at active colonies suggesting the possible influence of water-level fluctuations on habitat availability (NGPC 1980b). Additionally, the Nebraska Game and Parks Commission's annual report for the 1982 Niobrara River least tern survey (NGPC 1982c) indicated that higher than expected river levels during spring and early summer may have "masked the availability of newly developed sandbars"; nesting activity in 1982 was approximately 2 weeks behind that observed in previous years, and evidence of possible flooding and renesting activity was noted at two colony sites (NGPC 1982c). Habitat also appeared to be limited by river stage conditions in 1983 (NGPC 1983b).

As a general premise, least tern colonies on the Niobrara River are probably less affected by human disturbances than those along the Platte and Missouri Rivers (see Sections 2.2.1.5 and 2.2.2.4). Although the Niobrara River supports a variety of recreational uses (e.g., canoeing, rafting, fishing, swimming, and hiking), it is relatively far removed from major urban centers in the state, and access is limited by the fact that roads do not closely parallel the channel downstream from Valentine where least tern colonies occur. The Nebraska Game and Parks Commission's annual report for the 1980 Niobrara River least tern survey (NGPC 1980b) noted that "[r]ecreational activities seemed to have a minimal impact on colonies", and annual reports for the 1982 and 1983 surveys (NGPC 1982c, 1983b) commented that disturbance factors (e.g., human and/or livestock) did not have a significant adverse effect on colony nesting success.

Because nesting sandbars on the Niobrara River are mostly of the mid-channel variety (Downing 1980), predation of least tern eggs and chicks is probably limited primarily to avian or aquatic species (i.e., birds, snakes, and turtles). Possible predators in these groups would include those described for the Platte and Missouri rivers (see Sections 2.2.1.5 and 2.2.2.4). Whether or not predation is a significant source of mortality to least tern colonies on the Niobrara River, however, is not known.

Based on the above considerations, it is likely that the reproductive success of the Niobrara River least tern population is largely dependent on flow conditions during the nesting season. Periodic floods or high flow events can reduce habitat availability and/or cause substantial mortality to eggs and young. Consequently, highest productivity would be expected during years when moderate to low flows prevail during the breeding season. Although predation is undoubtedly a factor affecting productivity, it probably does not rival the impact of water-level fluctuations.

2.2.4 Other Nesting Locations

Though efforts to systematically inventory least tern populations in Nebraska have focused on major rivers (i.e., the Platte, Missouri, and Niobrara), incidental surveys have also been conducted in recent years along the Loup and Elkhorn rivers which are tributary to the Platte (Figure 2-2). Nesting activity has been observed along both of these streams, however, the extent of use is uncertain owing to variability in survey efforts, coverage and timing (Appendices B-5 and C-5, B-6 and C-6).

Downing (1980) observed during his 1975 survey that: "The several branches of the Loup River we crossed (did not fly) looked promising and may have supported additional [least terns]." Breeding populations were later documented along the Loup system during surveys conducted in 1979, 1983, 1985 and 1986 (Table 2-12).

TABLE 2-12 SUMMARY OF INTERIOR LEAST TERN BREEDING POPULATIONS ALONG THE LOUP RIVERS, 1979-1986(a)

	1979	1983	1985	1986
No. of Adult Terns Censused	20[b] (G)	43 (A&G)	56 (A)	12 (A)
Survey Dates	mid-July	13 July	26 July	2 June

Sources: 1979 data from Faanes (1983); 1983 data from Nebraska Game and Parks Commission 1983 Platte River Interior Least Tern Nesting Survey (NGPC 1983a); 1985 and 1986 data from NGPC notes on survey dates and coverage (Appendix C-5).

Note: G = ground survey; A = aerial survey.

(a) Survey coverage and effort for each year are summarized in Appendices B-5 and C-5.

(b) A minimum of 20 breeding adults were indicated based on 10 least tern nests observed by Faanes (1983); survey area was not specified.

That habitat along the Loup rivers and adjacent sandpits is capable of supporting a relatively large least tern breeding population during some years, is indicated by the fact that 56 terns (at 15 locations) were observed along this system in 1985 by aerial survey. As has been reported by the Nebraska Game and Parks Commission (NGPC 1985), aerial surveys normally underestimate the number of birds present. Downing, for example, found that aerial surveys usually accounted for 50 percent of the total number of terns found during subsequent ground checks (NGPC 1978). Similarly, ground checks yielded approximately twice as many adult terns as were recorded during aerial counts (124 versus 63 birds) at seven Niobrara River colony sites inventoried by both survey methods in 1983 (NGPC 1983b). Assuming the same ratio generally holds true, the Loup River breeding population may have actually exceeded 100 birds in 1985. Moreover, the reduced number of birds censused in 1986 (Table 2-12) was likely affected, to some extent, by the earlier timing of the survey that year (2 June) than in 1985 (26 July). In this regard, the Nebraska Game and Parks Commission suggested that the relatively low numbers of adult terns observed on the Niobrara River during a June survey in 1978 may have been partially attributable to "the early stage in the nesting cycle, when both members of breeding pairs are not always closely associated with the immediate vicinity of the colony" (NGPC 1978). As a result, it was recommended that future studies be delayed until mid-July. In any event, it is apparent that additional field surveys, and greater consistency of effort between years, are necessary to more accurately assess the potential of habitat along the Loup River system for supporting least tern nesting and production.

To date, survey efforts along the Elkhorn River in eastern Nebraska have been preliminary in nature (Appendix B-6). Two adult terns were observed at an

off-river sandpit near the town of Pilger in 1985, but none were observed during an aerial survey of the Elkhorn (from the mouth of the river to Norfolk) and a ground check at the Pilger sandpit in 1986 (Appendix C-6). Again, these survey efforts were conducted relatively early in the breeding season (22 June in 1985, and 3 and 6 June in 1986) when adult birds are not always in close proximity to the colony site. Additional surveys conducted later in the breeding season are needed to better evaluate habitat use along this system.

Regular, systematic least tern surveys to date have been limited to major rivers in the state (i.e., the Platte, Missouri, and Niobrara) which undoubtedly support the largest breeding populations. However, it is important to point out that Nebraska contains more miles of rivers than any other state in the nation. Most are sandy, alluvial streams and any that contain suitable sandbar habitat during the nesting season may be utilized by this species. In addition, least terns have been reported to nest at non-riverine, wetland basins within the state. As stated previously (see Section 2.1), Wolcott (1909) listed the species' distribution as including the lakes and marshes of the sandhills region in northcentral and northwestern Nebraska, and Ducey (1985) cited records of terns nesting at wetland basins near York and Lincoln. In 1983, nesting was also reported in Lancaster County which encompasses the city of Lincoln (Table 2-1). Thus, it is apparent that other suitable least tern nesting habitat exists within the state exclusive of the major rivers that have received primary survey emphasis in recent years.

2.3 STATEWIDE POPULATION STATUS

Erwin (1984) noted that Nebraska was a stronghold for least tern nesting activity. This is substantiated by systematic surveys along major rivers in the state (i.e., the Platte, Missouri, and Niobrara) which, in recent years, have documented substantially larger numbers of breeding birds than were observed or estimated during the initial census in 1975 (Downing 1980; Table 2-13). During years of similar survey coverage and effort, the discernible trend in population size along each of these rivers has been one of increase rather than decrease. These increases may reflect 1) the improved ability of investigators to locate nesting colonies (resulting from greater experience and knowledge of the species' behavior and nesting habits); 2) distributional shifts, or immigration of adult birds from other nesting areas within the breeding range; 3) true population increases; or 4) a combination of all factors. Regardless, recent census results confirm the fact that habitat along these rivers can support considerably larger least tern breeding populations than was previously thought to be the case. In addition, as survey efforts have been expanded to include new areas, more birds have been found. An aerial inventory along the Loup rivers in 1985 yielded 56 adult terns which, in light of the fact that aerial surveys typically census only about half of the birds present, suggests a population of up to twice that size. Other breeding populations have been discovered in recent years along portions of the Missouri River not surveyed by Downing in 1975; i.e., between Fort Randall Dam and Lewis and Clark Lake along the northeastern border of Nebraska (25 birds in 1986; Schwalbach et al. 1988), and between Garrison Dam and Lake Oahe in North Dakota (130 birds in 1985; Dryer and Dryer 1985).

Considering that Downing's 1975 inventory served as a primary basis for the Service's proposed rule to list the interior least tern as endangered (reference 49 FR 22444-22447), the results of recent systematic surveys in

Nebraska are highly noteworthy. As shown in Table 2-13, least tern breeding populations censused along the Platte, Missouri, and Niobrara rivers in recent years have, in all cases, exceeded the number of birds observed or estimated by Downing. Although Downing (1980) believed the 80 least terns observed along the Platte River in 1975 were more birds than the habitat seemed capable of supporting, census results in 1986 (438 birds) represent more than a five-fold increase. Furthermore, given that the population observed along the Missouri River below Gavins Point Dam was more than five times larger in 1986 than in 1975 (181 versus 35 birds), it is apparent that Downing also underestimated the habitat potential of this river segment. It deserves particular emphasis, too, that the total of 619 least terns censused along the Platte River and the Missouri River below Gavins Point Dam in 1986 represents more birds than the number (616) actually seen by Downing during his entire survey of the greater part of the species' breeding range (which included 11 rivers of the Mississippi/Missouri River drainage, plus national wildlife refuges in three U.S. Fish and Wildlife Service regions). Finally, given that recent systematic surveys in Nebraska have not included all potential or known nesting habitat within the state (see Section 2.2.4), the current population summary presented in Table 2-13 should be considered conservative.

TABLE 2-13 RECENT LEAST TERN BREEDING POPULATIONS CENSUSED ALONG NEBRASKA RIVERS AS COMPARED TO DOWNING'S 1975 SURVEY RESULTS

Location	1975 Birds Observed	1975 Birds Estimated	Recent Census Results Birds Observed[a]	(Year)	Increase Over Birds Observed/Estimated in 1975
. Platte River (confluence of North and South Platte rivers to mouth)	80	150	438	(1986)	448%/192%
. Missouri River (between Gavins Point Dam and Ponca, NE)	35	100	181	(1986)	417%/81%
. Missouri River (between Fort Randall Dam and Lewis and Clark Lake)	NS	NS	25	(1986)	--
. Niobrara River	85	150	174	(1985)[b]	105%/16%
. Loup and Middle Loup rivers	NS	NS	56	(1985)[c]	--

Sources: Data for the Platte, Niobrara, and Loup rivers are from the Nebraska Game and Parks Commission (see Tables 2-2, 2-11, and 2-12, respectively); data for the Missouri River are from Schwalbach et al. (1988) (see Tables 2-7 and 2-8).

(a) Census results for the Platte, Missouri, and Niobrara rivers are based on aerial and ground surveys; census results for the Loup rivers are based on an aerial survey only. (Note: Aerial surveys typically underestimate the number of least terns present [NGPC 1985] and have been reported to yield only about 50 percent of the total number of birds enumerated during subsequent ground checks [NGPC 1978, 1983b]).

(b) The Niobrara River least tern breeding population was not censused in 1986.

(c) Although fewer adult least terns were censused along the Loup rivers by aerial flyover in 1986 (12 birds), this may have resulted from the earlier timing of this survey (2 June) when both members of breeding pairs are not always closely associated with the immediate vicinity of colony sites (see Section 2.2.4). Thus, the results of the 1985 aerial survey, which was conducted in late July, are considered more representative of the number of adult least terns that can be supported by habitat along the Loup rivers. Also, because aerial surveys account for only about half the terns found during subsequent ground checks (see first footnote, above), the Loup River breeding population may actually have exceeded 100 birds in 1985.

3. PIPING PLOVER

As was the case with the interior least tern (Chapter 2), two categories of information are available for the piping plover in Nebraska. Again, the first category consists of published records of occurrence in specific counties or cities, as well as notes on the species' general distribution or relative abundance (e.g., common, uncommon, rare) in the state. This category of information, which currently appears in the Nebraska Bird Review, is useful for determining the species' reported distribution or occurrence over time, but it is inadequate for quantifying historical or recent abundance. The second category consists of information gathered during recent systematic surveys of specific rivers or sections of rivers in Nebraska. Because least terns and piping plovers utilize the same types of nesting habitat, the presence of plovers at or near tern colonies has often been recorded during these surveys. However, the degree of detail varies not only between surveys but also among survey sites. In some instances, adult piping plovers and/or nests were counted, but in other cases occurrence was only subjectively described (e.g., numerous or present). These inconsistencies limit the usefulness of earlier survey data for quantifying piping plover populations.

3.1 HISTORICAL SIGHTINGS

The proposed rule to list various populations of the piping plover as threatened or endangered (reference 49 FR 44712-44715) estimated 100-300 pairs of piping plovers for Nebraska; however, no perspective was provided with regard to the species' historical occurrence or status in the state. Although historical data for the plover are limited, early records of sightings in the state do exist. Hunter (1900) mentioned that the piping plover was "rare" around Lincoln, while in Cherry County he referred to them as "common" (Hunter 1901). In 1901, Brunner et al. (in Moser 1942) listed the species as "a fairly common migrant, breeds along the lakes in the sandhill region, along the Niobrara River in northern Nebraska, on the Loup at Dannebrog, along the Platte, and perhaps on any of the rivers of the state where are the sand-bars on which it nests." Wolcott (1909) listed the piping plover as a spring and fall migrant that breeds in the state, and Moser (1942) commented that over its entire range the species is very selective about nesting areas, which in the Missouri River valley included scattered spots in central and eastern Nebraska. Moser also reported observations of piping plover nesting activity in the Omaha area during the early 1940's (10 adult birds were seen in 1940, 18 in 1941, and 10 in 1942), and mentioned eight museum specimens that had been collected at Capitol Beach in Lincoln. Tout (1951) referred to the piping plover as a "common summer resident and breeder during some years" around Lincoln County in western Nebraska, and the Nebraska Bird Review (1955) listed the species as "fairly common" around the city of Lincoln in eastern Nebraska. Rouche (1979) noted that:

> "There are several older nesting records for the Niobrara, North and South Platte, Loup, and Missouri rivers, but most of the recent records seem to be for the Missouri River from Douglas to Washington counties, and Lake McConaughy, Keith County, where it probably nests."

Later Johnsgard (1981) stated: "The interior race circumcinctus is probably especially in need of protection. It is still locally common in North Dakota...but it has become extremely local in Nebraska."

Additional insights on the piping plover's historical distribution within the state can be determined from the species' presence or absence on spring or fall county migration lists and/or inclusion on county nesting surveys. In contrast to the quantitative census data collected during recent systematic surveys (Section 3.2), this type of information is primarily qualitative in nature. Most records indicate the occurrence of piping plovers within a county, but not the number of birds or number of sightings, and oftentimes the exact sighting location(s) within the county is not specified. Based on these records, piping plovers have been reported in 32 of the 93 counties in Nebraska (Table 3-1). Six counties with reported occurrence prior to 1940 have not reported piping plovers since 1940; these counties include Cherry, Dakota, Garden, Jefferson, Keya Paha, and Platte. Conversely, there are 21 counties for which the only reported sightings have occurred after 1940. In most cases, counties of record border or include portions of major rivers (i.e., the Platte, Missouri, and Niobrara).

To gain perspective on the statewide occurrence of the piping plover over time, historical sightings records through 1984 were compiled. Consecutive volumes from Proceedings of the Nebraska Ornithologists Union (1900-1915), the Wilson Bulletin (1915-1933), and the Nebraska Bird Review (1933-1984) served as the primary data sources (Table 3-1). The most comparable data were documentation of presence or absence during spring or fall migration (non-systematic) surveys, which have been conducted for various counties since the early 1930's. These data were used to calculate, for 5-year intervals, the mean number of counties in which piping plovers were sighted. Because the number of counties participating in spring and fall surveys has fluctuated over time, the results were normalized to account for differences in survey effort. In addition, sighting records since 1905 were used to construct statewide distribution maps depicting the sighting frequency for each county over incremental 20-year time periods.

The occurrence of piping plovers (reported as the mean number of Nebraska counties reporting the species on spring and/or fall [non-systematic] surveys per year over a 5-year period) has remained fairly constant since the early 1930's (Figure 3-1A). Because piping plover occurrence may be related to the number of Nebraska counties submitting survey results, the influence of effort was investigated (where effort refers to the number of counties participating in spring and/or fall surveys). Though survey participation (on a county level) peaked during the late 1950's in Nebraska, there was no comparable peak in piping plover occurrence at this time (Figure 3-1A). On an annual basis, no significant correlation was found between the total number of counties involved in spring and/or fall surveys and the total number of counties in which piping plovers were sighted ($P > 0.05$, $r=0.18$, $n=50$). This suggests that piping plover occurrence was independent of the effort involved, and that the statewide population has remained relatively stable over time.

Normalizing piping plover occurrence to account for survey effort (by determining the percentage of counties involved in surveys that reported the species) demonstrated that between 2 and 34 percent of the counties recorded piping plover from 1935 to 1984 (Figure 3-1B; mean per 5 year period). Lows occurred during the late 1940's and early 1960's, whereas the higher percentage of counties reporting the species in the late 1930's and early 1940's represents a disproportionately high sighting frequency due to limited effort (only 6.4 and 5.0 counties [mean per 5-year period] participated in surveys during these early years). Based on this analysis, the percentage of participating counties that reported piping plover sightings has increased since 1945 (Figure 3-1B).

TABLE 3-1 PIPING PLOVER SIGHTING OCCURRENCE BY COUNTY IN NEBRASKA, 1804-1984*

County	Total	Year(s) of Occurrence	
		Spring/Fall Surveys	Nest Sighting
Adams	5	1933, 1936, 1954, 1956, 1967	
Boyd	2		1982, 1983
Brown	1		1982
Buffalo	2	1957	1983
Butler	1		1983
Cass	7	1944, 1953, 1967, 1968, 1981	1944, 1969, 1981, 1983
Cedar	2		1982, 1983
Cherry	2	1900**, 1902**	
Dakota	1		1866** (2 nests)
Dawson	8	1950-1952, 1954-1956	1979, 1983
Dixon	1		1983
Douglas	17	1940-1944, 1955, 1956, 1968, 1971, 1976-1983	1940-1943, 1981
Gage	1	1967	
Garden	1	1938	
Garfield	1	1960	
Hall	4	1954, 1959	1982, 1983
Holt	4		1977, 1980, 1982, 1983
Howard	4	1900**, 1984	1899**, 1900**, 1983
Jefferson	1	1923	
Keith	3	1958, 1964	1979
Keya Paha	1		1902**
Knox	1	1983	1983
Lancaster	20	1900**, 1913**, 1917**, 1922**, 1925**, 1932, 1954, 1956, 1963, 1966-1972, 1974-1977	
Logan	2	1935, 1944	
Lincoln	12	1933-1935, 1937-1939, 1944, 1947, 1950, 1965, 1967, 1969	
Nance	1	1983	1983
Platte	1	1939	
Rock	1		1977
Sarpy	3	1982, 1983	1981
Saunders	5	1980-1982, 1984	1982, 1983
Washington	3	1971, 1982	1966
York	1	1966	

Sources: 1900-1915: Proceedings from the Nebraska Ornithologists Union; 1915-1933: Wilson Bulletin; 1933-1984: Nebraska Bird Review. Records of several early sightings were also reported by Moser (1942).

* 1984 nesting survey results not included.
** Specific sighting record.

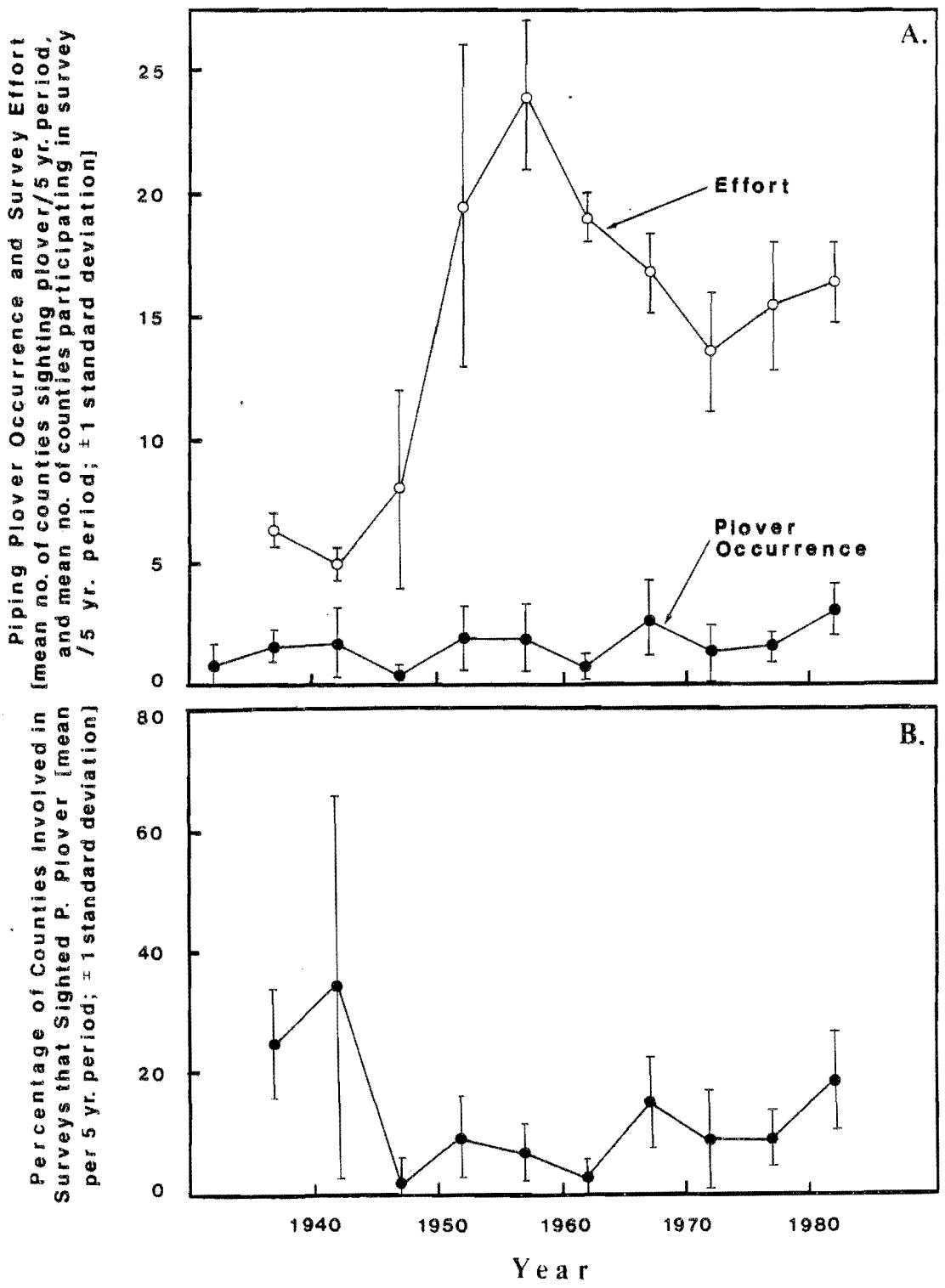


Figure 3-1. A. Reported piping plover occurrence and associated survey effort, and B. normalized piping plover occurrence in Nebraska.

As was noted for the least tern (Section 2.1), the spring and fall migration surveys provide considerably less than full statewide coverage. Even during the late 1950's when participation peaked, the maximum number of counties reporting survey results included only 27 of the 93 counties in Nebraska. Among participating counties, much of the survey effort often appeared to be localized, usually occurring in the vicinity of population centers. Thus, more than two-thirds of the state was not surveyed during most years, resulting in a rather incomplete historical picture of piping plover occurrence in Nebraska.

The geographic distribution of reported piping plover sightings in Nebraska (based on the number of years plover were sighted per county, including presence on spring and/or fall observation lists and nesting surveys, over consecutive 20-year periods) has increased with advancing years (Figure 3-2, Table 3-1). By 1924, piping plovers had been reported in only 6 percent of Nebraska's 93 counties. During subsequent 20-year periods, percentages of counties reporting the species were as follows: 1925 to 1944, 9 percent; 1945 to 1964, 11 percent; and 1964 to 1984, 26 percent. Although to some extent these distributional trends may be attributable to increasing numbers of observers, they do not indicate increased localization in the statewide occurrence of the species. Rather, they reflect an increase in the distribution of reported piping plover sightings over time, particularly along the central reach of the Platte River beginning in the mid-1940's and along the Niobrara River beginning in the mid-1960's (Figure 3-2).

3.2 SYSTEMATIC SURVEYS

The nesting habits of the piping plover are similar to those of the least tern (Sections 1.1.1 and 1.1.2) and in Nebraska the two species frequently occur in heterogeneous colonies or groups, with nests either separated (Hardy 1957) or intermixed (Ducey 1981b) at the same sites. As a result, systematic surveys by the Nebraska Game and Parks Commission, which were initially directed towards inventorying least tern breeding populations along major rivers in the state (i.e., the Platte, Missouri, and Niobrara), have often noted the presence of piping plovers. However, with increasing concerns regarding the status of this species -- culminating in the U.S. Fish and Wildlife Service's determination of 11 December 1985 to list the northern plains population as threatened and other populations as endangered -- the focus of these surveys has been expanded to include the collection of more complete census data on piping plovers. This expanded survey emphasis was implemented sequentially, first along the Missouri River in 1983, and then along the Platte and Niobrara rivers in 1984 and 1985, respectively (J. Dinan, Nebraska Game and Parks Commission, personal communications). Limited additional census data is also available for the Platte River based on partial surveys conducted in 1979 (Faanes 1983) and 1981 (Ducey 1981b). Although piping plover nesting activity has been observed along the Loup and Elkhorn rivers during reconnaissance surveys by the Nebraska Game and Parks Commission (NGPC 1983a; Appendix C-6), population counts for these rivers had not been recorded as of the end of the 1986 breeding season.

Thus, from the standpoint of assessing the piping plover's status in Nebraska, available systematic survey data are limited in two important ways. First, efforts to comprehensively inventory the species have commenced recently and, as a result, relatively few years of annual census data exist for major riverine breeding areas in the state. Second, because expanded survey emphasis to include the piping plover was not initiated concurrently among these rivers,

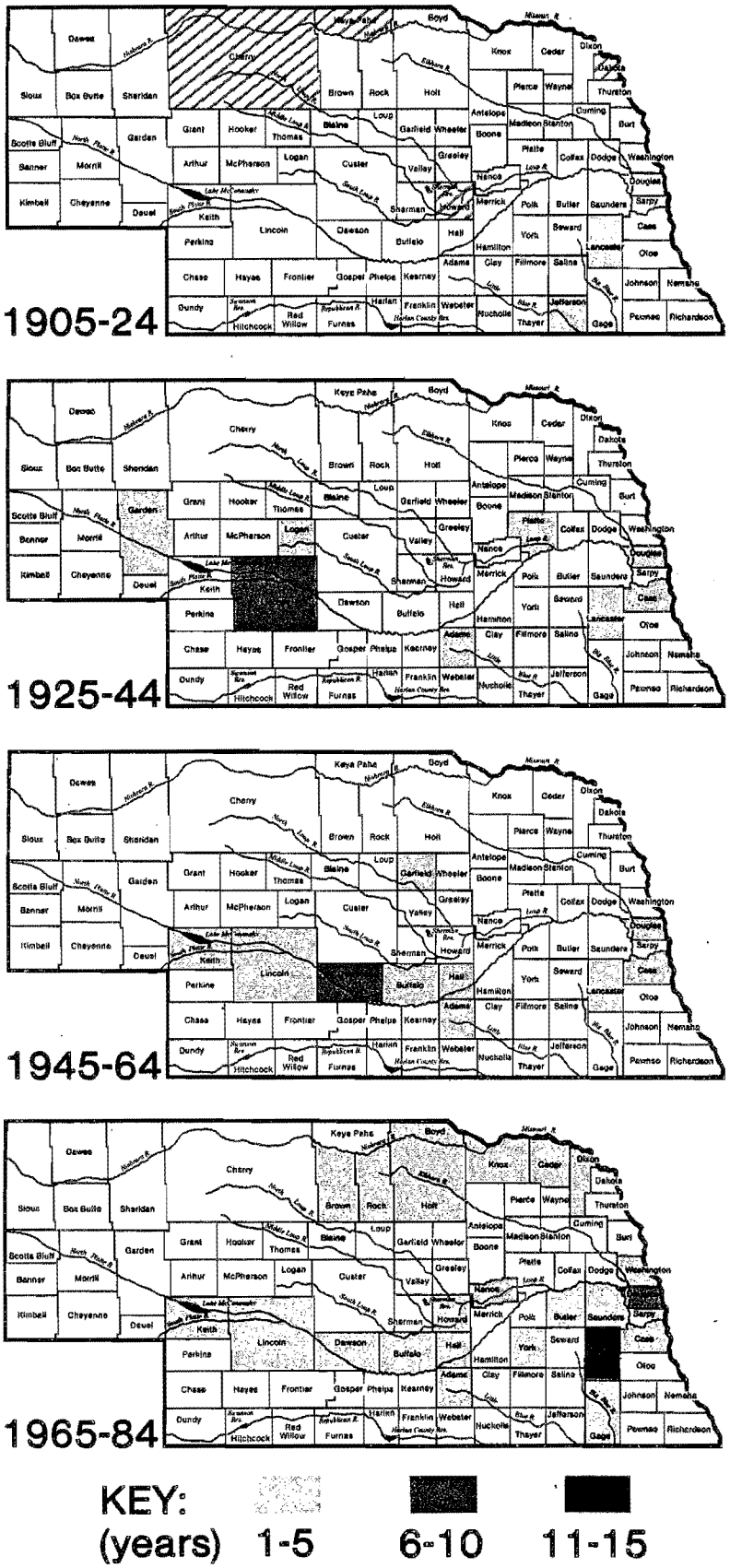


Figure 3-2. Historical distribution of reported piping plover sightings in Nebraska. Shading reflects the number of years plovers were sighted per county during 20-year periods from 1905 to 1984 (inclusive). Diagonal shading indicates sightings prior to 1905.

the data are insufficient for evaluating changes or trends in the statewide population over time.

It also deserves emphasis that recent systematic surveys along the Platte and Niobrara rivers may have underestimated piping plover occurrence. Surveys along these rivers usually commence with aerial reconnaissance flights during which least tern activity is noted and marked on a map (piping plovers are virtually impossible to see during these overflights [NGPC 1985]). Ground surveys are then conducted at the mapped locations to count the numbers of least terns and piping plovers present and to check on nesting status. Consequently, to the extent that the two species do not nest sympatrically or within visual proximity of one another, some piping plovers are likely to be missed. Data presented by Faanes (1983), for instance, indicates that terns and plovers occurred sympatrically at two out of four (50 percent) of the riverine nesting sites found during a thorough ground survey conducted along the Lexington to Grand Island reach of the Platte River in 1979; 16 out of 40 (40 percent) of the piping plover breeding pairs censused at these sites occurred in colonies that did not include least terns. During survey efforts conducted along the Missouri River system in 1986, 59 percent of all least tern and/or piping plover nesting sites (i.e., 24 of 41 sites) were found to be occupied by both species (Schwalbach et al. 1988). Moreover, during some surveys (e.g., the 1985 Platte River survey) not all least tern colonies located from the air were subsequently ground checked. If piping plovers were present at these colonies, it would not have been possible to detect and count them.

Despite these limitations, census data collected during recent systematic surveys provide essential benchmarks for evaluating future changes in the piping plover's statewide population structure. In addition, valuable new information has been obtained on the species' nesting habits, production rates, and factors affecting reproductive success.

3.2.1 Platte River

3.2.1.1 Census Results and Distribution

Census data on adult piping plovers recorded along the Platte River during the period 1979-1986 are shown in Table 3-2; additional site-specific data for the years 1981-1986 are presented in Appendix Table A-1, and information on survey coverage and effort is presented in Appendices B-1 and C-1. Earliest efforts to obtain census information on the Platte River breeding population consisted of partial surveys along two different segments of the river in 1979 and 1981 (Table 3-2). During 1979, ground surveys conducted along the central Platte River from Grand Island to Lexington yielded a minimum breeding population of 80 piping plovers based on 40 nests located at four riverine sites (Faanes 1983). Two sandpits near the river were also visited during this survey, but no piping plover adults or nests were observed (C. Faanes, U.S. Fish and Wildlife Service, personal communications). In 1981, Ducey (1981b) observed 46 adult piping plovers at four river sites (no sandpits were surveyed) along the lower Platte River from Schramm Park State Recreation Area to Leshara.

During systematic surveys conducted by the Nebraska Game and Parks Commission to inventory the Platte River least tern population, piping plover adults and/or nests were noted incidentally at four sites in 1982 and at nine sites in

TABLE 3-2 SUMMARY OF PIPING PLOVER BREEDING POPULATIONS ON THE PLATTE RIVER, 1979-1986

River Section		Adult Plovers Censused						
		1979	1981	1982	1983	1984	1985	1986
Plattsmouth to Columbus (110 RM)	-R	NS	46	NC	NC	0	9	44
	-P	NS	NS	NC	NC	48	26	24
Columbus to Grand Island (70 RM)	-R	NS	NS	NC	NC	0	0	0
	-P	NS	NS	NC	NC	6	5	4
Grand Island to Lexington (80 RM)	-R	80	NS	NS	NC	0	24	38
	-P	0	NS	NC	NC	8	4	48
Lexington to North Platte (60 RM)	-R	NS	NS	NS	NC	0	0	0
	-P	NS	NS	NS	NC	0	0	6
Total		80	46			62	68	164
No. Birds (% total) - River		80 (100%)	46			0	33 (49%)	82 (50%)
No. Birds (% total) - Sandpits		0 (0%)	NS			62 (100%)	35 (51%)	82 (50%)
No. Colonies Located - All Habitat		4	4	4	9	12	13	28
No. Colonies - River		4 (100%)	4	2 (50%)	0	0	7 (54%)	11 (39%)
No. Colonies - Sandpits		0	NS	2 (50%)	9 (100%)	12 (100%)	6 (46%)	17 (61%)
Avg. Adult Plovers/Colony - All Habitat		20	11.5	-	-	5.2	5.2	5.8
Avg. Adult Plovers/Colony - River		20	11.5	-	-	-	4.7	7.5
Avg. Adult Plovers/Colony - Sandpits		-	NS	-	-	5.2	5.8	4.8

Sources: 1979 data from Faanes (1983) and C. Faanes (personal communications, 18 August 1987); 1981 data from Ducey (1981b); 1982-1985 data from Nebraska Game and Parks Commission (NGPC) annual report on the Platte River Interior Least Tern and Piping Plover Nesting Survey, 1986. Detailed data for the 1981-1986 surveys are presented in Appendix Table A-1.

Notes: RM = river miles.
R = river.
P = sandpits.
NS = Not surveyed.
NC = Not censused; piping plover adults and/or nests were noted in association with least tern colonies, but population size was not reported.

1983 (Table 3-2). In 1984, when efforts were first made to estimate or count the number of adult piping plovers present in the vicinity of least tern colonies, a total of 62 adults was censused at 12 sites. Because of high flow conditions that year, riverine habitat was unavailable throughout much of the breeding season and nesting was confined to sandpits adjacent to the river. Although similar census results were obtained in 1985 (68 adult plovers at 13 sites), it was noted that the total population was probably underestimated because not all sites were ground checked (NGPC 1985). Over the 1979-1986 period of record, the largest piping plover breeding population along the Platte River was recorded in 1986 when 164 adults were inventoried at 28 sites (Table 3-2). The 1986 survey results reflected a 141 percent increase in the number of birds and a 115 percent increase in the number of nesting sites found in 1985. The larger population censused in 1986 as compared to the previous year resulted primarily from an increase of 58 birds (207 percent) along the Grand Island to Lexington reach and an increase of 33 birds (94 percent) along the Plattsmouth to Columbus reach. Of the additional birds censused along the former reach in 1986, 44 (76 percent) occurred at sandpit sites, whereas the larger number of birds censused along the latter reach was due entirely to increased occurrence at riverine sandbar sites (Table 3-2).

3.2.1.1.1 Spatial Occurrence

Piping plovers, like least terns (see Section 2.2.1.1.2), have occurred in greatest numbers along two segments of the Platte River: the 110 mile lower reach from Plattsmouth to Columbus, and the 80 mile central reach from Grand Island to Lexington (Table 3-2). However, year-to-year variability is apparent in the numbers of birds inventoried within and between these reaches. Specifically, piping plovers censused in the Plattsmouth to Columbus reach accounted for 77 percent of the Platte River breeding population in 1984, 51 percent in 1985, and 41 percent in 1986. Habitat along the Grand Island to Lexington reach, by comparison, supported 13 percent of the Platte River population in 1984, 41 percent in 1985, and 52 percent in 1986. The distribution of birds utilizing riverine sandbars versus off-river sandpits within these reaches has also varied between years (Table 3-2).

3.2.1.2.2 Sandbar Versus Sandpit Use

In contrast to 1984 when high river flows restricted all nesting to sandpits adjacent to the river, lower flow conditions in 1985 and 1986 resulted in the availability of nesting habitat at both riverine and sandpit sites. During these years, nesting activity along the Platte River was almost equally split between these two habitat types: i.e., in 1985, the proportion of the piping plover breeding population censused on riverine and sandpit habitat was 49 versus 51 percent, whereas in 1986 a 50/50 distribution occurred.

The important role of sandpits along the Platte River in providing nesting habitat for piping plovers, underscores the fact that this species commonly colonizes habitat that is not completely surrounded by a water barrier. For instance, Ryan and Prindiville (1984) reported that in the northern prairie region, the species typically nests in greatest densities along the shorelines of alkali lakes. Piping plovers are also known to nest on bare areas of dredge piles and the shores of man-made reservoirs (Switzer 1979, Renaud et al. 1979). Dinsmore (1984) commented that some piping plovers nest on sandbars in rivers "although such areas are subject to rapid flooding and vegetation change."

Distributional shifts in piping plover nesting activity between sandpit and sandbar habitat along the Platte River, as affected by year-to-year variability in river flow, support the conclusion of Haig (1985) and other researchers that local occurrence within the species' northern plains breeding range may be strongly influenced by annual water-level fluctuations. Based on surveys conducted on alkali lakes in North Dakota, Prindiville and Ryan (1984) similarly commented that no single wetland should be expected to support plovers every year because of annual variations in water level. Accordingly, the U.S. Fish and Wildlife Service's proposed rule for the piping plover (reference 49FR 44712-44715) concluded that determination of critical habitat would not be prudent for this species because of the often ephemeral nature of nesting habitat.

Several researchers have also noted that local distribution may shift unpredictably from year to year for unknown reasons apparently not related to changing habitat conditions. Renaud et al. (1979), for example, reported that piping plovers were "very common breeders" along a specific Saskatchewan lakeshore area in 1975, but were absent in this same area during subsequent investigations in 1976 and 1978; during all three of these years the species was present in "good number" at another beach location on the same lake. Another lake was used by a pair of piping plovers during only 2 years (1972 and 1978) from 1968 to 1978 even though the lake contained some water during the May and June nesting season in all years. In view of the tendency for piping plovers to shift their nesting sites as a result of changing water-level conditions or other factors, Haig (1985) cautioned that census data for any one year is not sufficient to estimate average numbers in a given area.

3.2.1.2 Colony Spatial Characteristics

Only limited data is presently available on the spatial characteristics of piping plover colonies along the Platte River. Measurements recorded in 1984 at seven sandpit colonies containing nests of both least terns and piping plovers (NGPC 1984), indicated colony areas ranging from 0.09 to 5 acres ($\bar{x}$ = 1.48 acres); area per nest, calculated by dividing the colony area by the total number of least tern and piping plover nests within that area, ranged from 627 to 10,850 sq. ft. ($\bar{x}$ = 4,291 sq. ft.). The distance from each piping plover nest to the nearest neighboring plover nest at these seven colonies ranged from 36.4 to 378.5 feet ($\bar{x}$ = 153.6 feet) (NGPC 1984). Plans to take comparable measurements at Platte River sandbar colonies in 1986 were not completed because of the occurrence of flood conditions following nest establishment (NGPC 1986).

Measurements of nest height above river stage recorded at sandbar colonies along the central Platte River in 1979 (Faanes 1983) indicated that piping plovers tend to nest closer to the water surface elevation than least terns: mean nest height above river stage was 13 inches (33.0 cm) for a sample of nine least tern nests versus 7.7 inches (19.6 cm) for a sample of 14 piping plover nests. Based on observations along the lower Platte River in 1981, Ducey (1981b) similarly reported that piping plovers nest on sandbar habitat closer to the water level of the river. Marked differences in nest elevation between species were not apparent at Missouri River colonies surveyed in 1986, however (see Section 3.2.2.2).

3.2.1.3 Foraging

Currier et al. (1985) reported that piping plovers feed mainly on aquatic invertebrates such as insects, insect larvae, and snails. They obtain food items by picking and gleaning the substrate along shoreline margins or by probing below the substrate surface. Thus, although least terns that nest at off-river sandpits along the Platte River are reliant upon shallow areas of the river for obtaining their food items (small fish; see Section 2.2.1.2), piping plovers can presumably satisfy their dietary requirements by foraging along shoreline margins associated with both riverine and sandpit habitat.

3.2.1.4 Production

Production data relative to the Platte River piping plover population were gathered at 12 sandpit colonies in 1984 (NGPC 1984), and at 10 sandpit and 6 riverine sandbar colonies in 1986 (NGPC 1986). As shown in Table 3-3, substantially higher production in terms of fledging rates/nesting pair was recorded at the sandpit colonies monitored in 1984. Specifically, fledging rates/nesting pair were 1.80 at sandpit colonies in 1984 versus 0.27 and 0.23 at sandpit and sandbar colonies, respectively, in 1986.

TABLE 3-3 SUMMARY OF PIPING PLOVER PRODUCTION AT COLONY SITES ALONG THE PLATTE RIVER, 1984 AND 1986

	1984	1986	
	12 Sandpit Colonies	10 Sandpit Colonies	6 Sandbar Colonies
No. of nesting pairs	31	15	22
No. of nests	33	17	36
No. of eggs laid	132	62	136
Mean clutch size	4.0	3.9	3.8
No. of eggs with known outcome	122	40	104
No. of eggs hatched*	81	11	54
Hatching rate	0.61	0.18	0.40
No. of fledged young	56	4	5
Survival rate from hatching to fledging	0.69	0.36	0.09
Fledging rate/nest	1.70	0.23	0.14
Fledging rate/nesting pair	1.80	0.27	0.23

Source: NGPC (1984, 1986).
* Data for number of eggs hatched applies to eggs with known outcomes.

As qualified by the Nebraska Game and Parks Commission (NGPC 1984, 1986), fledging rates should be viewed with caution because 1) the mobility and dispersal of piping plover chicks from their nests shortly after hatching makes it extremely difficult to monitor development through to fledging (age at first flight), and 2) lack of nesting synchrony among and between colonies results in young reaching fledging age at different times. For these same reasons, Thompson and Slack (1984) determined from studies of colony tenure by recently fledged least terns that single counts of fledged juveniles substantially underestimate cumulative production. They stated that multiple counts timed

with the breeding chronology for colonies within the survey area, and corrected for juvenile departure, are required to achieve more realistic estimates of survival to fledging.

The higher production rates recorded at sandpit colonies along the Platte River in 1984 were associated with a hatching rate of 0.61 and a survival rate from hatching to fledging of 0.69 (Table 3-3). In contrast, during 1986 the hatching rates at sandpits and sandbar colonies were 0.18 and 0.40, respectively, and survival rates from hatching to fledging were 0.36 and 0.09, respectively. Thus, in 1986, low hatching rates (egg mortality) were a particular problem at sandpit colonies, whereas low survival rates from hatching to fledging (chick mortality) were a particular problem at sandbar colonies. Flooding subsequent to the nest initiation period appeared to be the primary cause of low production at sandbar colonies in 1986; however, the reason for the lower production rates at sandpit colonies in 1986, as compared to 1984, is not known (see Section 3.2.1.5 which follows).

The higher production rate of 1.8 fledglings/nesting pair determined at piping plover nest sites on sandpits adjacent to the Platte River in 1984 (Table 3-3) compares favorably with rates reported for colonies along the Atlantic Coast. At one area in Nova Scotia, piping plovers nesting on an isolated, rarely visited beach fledged 1.3 to 2.1 young per pair, whereas birds nesting on a recreational beach at another site fledged 0.7 to 1.1 young per pair (Cairns 1977, 1982). As with the interior least tern (see Section 2.2.1.4), the piping plover's vulnerable habit of nesting on low river bars and other land surfaces exposed to the rigors of the plains climate (rainstorms, wind storms, hail, floods, and intense heat) makes it susceptible to marked fluctuations in nesting success from year to year and from one location to the next. Like least terns, however, piping plovers are advantaged by a long life span: one banded bird lived to be 14 years old (Wilcox 1962) and, in general, adult males and females may live as long as 10 and 11 years, respectively (Dinsmore 1984). As a result, the species is undoubtedly able to cope with periodic bouts of low productivity, so long as widespread reproductive failure does not occur on a near constant basis.

Continued collection of production data is needed to determine the extent to which fledgling production rates at Platte River sandbar colonies are improved during years when stable or declining flow conditions persist after nest initiation.

3.2.1.5 Sources of Mortality at Nesting Colonies

Sources of mortality to piping plover eggs at nesting colonies along the Platte River were monitored during the 1984 and 1986 breeding seasons (NGPC 1984, 1986). Because high river flows inundated potential sandbar nesting sites during most of the 1984 season, monitoring that year was limited to sandpit colonies. In 1986, however, causes of mortality were assessed at both sandpit and river sandbar colonies.

Flooding that followed the 1986 nest initiation period was a primary cause of egg mortality at river sandbar colonies. Flooding accounted for 76 percent of the piping plover eggs lost at these colonies (Table 3-4), and losses of chicks (both least terns and piping plover) resulting from flooding were observed or highly suspected at most sandbar colonies (NGPC 1986). Other sources of egg loss at riverine sandbar sites included losses due to nest abandonment for undetermined reasons (22 percent), and losses resulting from miscellaneous other factors such as weather, unknown causes, etc. (2 percent).

TABLE 3-4 CAUSES OF PIPING PLOVER EGG LOSS AT NESTING COLONIES ALONG THE PLATTE RIVER, 1984 AND 1986

	1984	1986	
	12 Sandpit Colonies	10 Sandpit Colonies	6 Sandbar Colonies
No. of eggs laid	132	62	136
No. of eggs with known outcome	122 (92%)	40 (65%)	104 (76%)
No. of eggs hatched	81 (61%)	11 (18%)	54 (40%)
No. of eggs lost	41 (31%)	29 (47%)	50 (37%)
Lost due to predation	1 (2%)*	0 (0%)*	0 (0%)*
Lost due to human disturbance	14 (34%)*	0 (0%)*	0 (0%)*
Lost due to abandonment for undetermined reasons	18 (44%)*	4 (14%)*	11 (22%)*
Lost due to flooding	0 (0%)*	8 (28%)*	38 (76%)*
Lost due to other factors (weather, unknown causes, etc.)	8 (20%)*	17 (59%)*	1 (2%)*

Source: NGPC (1984, 1986).

* Percent of eggs lost.

Loss of piping plover eggs and chicks due to flooding is not as great a problem at off-river sandpits because of 1) greater water-level stability at these sites, and 2) the fact that sandpit spoil piles used for nesting tend to be more highly elevated above the water surface than sandbars, thus providing a greater buffer against water-level rises. However, runoff from heavy rains can cause the washout of nests at sandpits (as well as sandbars), and flooding at one sandpit in 1986 was caused by overflow from the Platte River entering the pit area (NGPC 1986). No loss of eggs due to flooding was observed at sandpit colonies in 1984, but the loss of eight eggs (28 percent) occurred as a result of flooding in 1986 (Table 3-4).

Among the other sources of direct mortality identified at sandpit colonies, predation and human disturbance accounted for 2 percent and 34 percent, respectively, of piping plover eggs lost in 1984, though no loss of eggs from these factors was recorded in 1986 (Table 3-4). It is likely, however, that disturbances from human activities as well as predation contributed to egg mortality at sandpit colonies listed under the categories of 1) abandonment for undetermined reasons; and 2) other factors (e.g., weather, unknown causes, etc.). Together these two categories accounted for 64 percent of the eggs lost at sandpit colonies in 1984, and 73 percent of the eggs lost at sandpit colonies in 1986 (Table 3-4).

Because least terns and piping plovers use the same types of habitat along the Platte River, often occurring together in sympatric colonies, their year-to-year nesting success is affected by common sources of mortality. Consequently, the effects of flooding, human disturbance, and predation on least tern colonies, as discussed in Section 2.2.1.5, also apply to piping plovers.

3.2.2 Missouri River

3.2.2.1 Census Results and Distribution

As noted in Section 2.2.2.1, modifications resulting from the Missouri River Bank Stabilization and Navigation Project over the period 1923-1976 have eliminated sandbar habitat along the river from Ponca, Nebraska to Kansas City, Missouri. Moreover, the construction of Gavins Point Dam and Lewis and Clark Lake in the 1950's inundated additional river habitat above Yankton, South Dakota (Ducey 1985). As a result, piping plover and least tern habitat on the Missouri River bordering eastern Nebraska is presently restricted to two unchannelized segments of the river: 1) the 53-mile reach from Gavins Point Dam to Ponca, Nebraska; and 2) the approximately 40-mile reach from the vicinity of Fort Randall Dam to Lewis and Clark Lake. Systematic surveys in recent years have documented the occurrence of piping plover breeding populations along both river segments.

3.2.2.1.1 Gavins Point Dam to Ponca, Nebraska

Census data on adult piping plovers recorded along the Missouri River below Gavins Point Dam during the period 1979-1986 are shown in Table 3-5; additional site-specific data are presented in Appendix Table A-2, and information on survey coverage and effort is presented in Appendices B-2 and C-2. During the 1983-1986 period when counts of adult piping plovers were recorded for this entire reach (Table 3-5), population size has averaged 160 birds (SD $\pm$ 51). Year-to-year shifts in the distribution of the breeding population are clearly apparent between specific river sections and colony sites within this reach (Table 3-5; Appendix Table A-2), probably influenced in part by local differences in habitat availability and suitability between years (as affected by water level variations and other factors), and the ephemeral nature of nesting habitat.

Except for the low count of 88 birds inventoried in 1984, the piping plover population in the Gavins Point Dam to Ponca reach has been relatively stable (Table 3-5); during the other 3 years of record (1983, 1985, and 1986), the number of birds inventoried has ranged from 172 to 206 ($\bar{x}$ = 184; SD $\pm$ 19). The reason for the low population count in 1984 is not known. However, in view of the record number of least terns censused along this same reach in 1984 (see Table 2-7), it is unlikely that reduced habitat availability was a causative factor. In contrast, 172 adult piping plover were censused below Gavins Point Dam in 1986, a year when near record inflows to the Missouri River throughout most of the nesting season resulted in limited availability of suitable nesting habitat (Schwalbach et al. 1986, 1988).

As in the case of the least tern (see Section 2.2.2.1.1), disparity in the size of the piping plover breeding population recorded below Gavins Point Dam in 1986 is reflected in the census results from two separate surveys conducted that year. Specifically, 70 piping plovers were censused during 4-5 June 1986 by the Nebraska Game and Parks Commission, whereas 172 piping plovers (an increase of 146 percent) were censused during June through early July 1986 in a cooperative survey conducted by the State of South Dakota and the U.S. Fish and Wildlife Service (Appendix Table A-2). As mentioned for the least tern, differences in census counts may have been influenced by the timing of the

TABLE 3-5 SUMMARY OF PIPING PLOVER BREEDING POPULATIONS ON THE MISSOURI RIVER FROM YANKTON, SD (GAVINS POINT DAM) TO PONCA, NE, 1979-1986

River Section	River Miles	Adult Plovers Censused							
		1979	1980	1981	1982	1983	1984	1985	1986
RM807 to RM797	10	6[a]	NC	NC	NC	76	32	72	36
RM797 to RM787	10	NS	NC	NC	NC	8	14	34	18
RM787 to RM777	10	NS	NC	NC	NC	22	8	30	32
RM777 to RM767	10	NS	NC	NC	NC	24	8	11	30
RM767 to RM754	13	NS	NC	NC	NC	76	26	27	56
Total	53	6	–	–	–	206	88	174	172
No. Colonies Located		1	10	6	16	12	13	22	18[b]
Avg. Adult Plovers/Colony		6.0	–	–	–	17.2	6.8	7.9	9.6

Sources: 1980-1982 data from Nebraska Game and Parks Commission (NGPC) annual reports on the Missouri River Interior Least Tern Nesting Survey for 1980, 1981, and 1982; 1983-1985 data from tabular survey results submitted by NGPC to the Nebraska Department of Water Resources (4 February 1987); 1986 data from Schwalbach et al. (1988). Detailed data for the 1979-1985 surveys are presented in Appendix Table A-2.

Notes: NS = Not surveyed.
NC = Not censused; piping plover adults and/or nests were noted in association with least tern colonies, but numbers of birds were not reported.

(a) Reflects number of adults observed incidentally at one location. Piping plovers were not surveyed at other Missouri River locations in 1979.

(b) Reflects number of colonies observed during 1986 census period when maximum number of adult piping plovers were counted. Piping plovers were observed at a total of 23 different sites during all census periods in 1986.

survey efforts and flow conditions that resulted in increased habitat availability as the breeding season progressed. Based on data presented by Schwalbach et al. (1986), flows below Gavins Point Dam peaked early in the 1986 breeding season (late May), declined with some fluctuation through June and early July, and then remained relatively stable through August. As flows decreased, additional nesting habitat would have become available, allowing utilization by more birds. This may explain why the cooperative survey by the State of South Dakota and U.S. Fish and Wildlife Service, which extended later into the breeding season, censused a substantially larger piping plover population.

3.2.2.1.2 Fort Randall Dam to Lewis and Clark Lake

In recent years, ground (boat) surveys have also documented the occurrence of piping plover nesting colonies in the reach of the Missouri River between Fort Randall Dam and Lewis and Clark Lake along the northeast border of Nebraska: 20 adult birds in three colonies were observed in 1983; and 11 adults in two colonies were observed in 1986 (Table 3-6). Schwalbach et al. (1986) reported that near record inflows to the Missouri River in 1986 limited habitat availability that year.

TABLE 3-6 SUMMARY OF PIPING PLOVER BREEDING POPULATIONS ON THE MISSOURI RIVER BETWEEN FORT RANDALL DAM AND LEWIS AND CLARK LAKE, 1982-1986

	1982	1983	1984	1985	1986
No. of Adult Plovers Censused*	--	20	--	--	11
No. of Colonies Located	--	3	--	--	2

Sources: 1982-1985 data from Nebraska Game and Parks Commission survey notes and tabular results submitted to the Nebraska Department of Water Resources on 4 February 1987; 1986 data from Schwalbach et al. (1988).

* Aerial surveys only were conducted in 1982, 1984, and 1985, whereas aerial and ground surveys were conducted in 1983 and 1986 (see Appendices B-3 and C-3). Aerial surveys are effective for detecting least tern colonies, but piping plovers are virtually impossible to see during such surveys (NGPC 1985).

3.2.2.2 Colony Spatial Characteristics

Selected habitat parameters were measured at Missouri River piping plover colonies below Gavins Point Dam and Fort Randall Dam in 1986 (Schwalbach et al. 1986, 1988). Mean values for nesting habitat size, nest elevation above water level, and nest-to-water distance for both reaches are presented in Table 3-7.

TABLE 3-7 SPATIAL CHARACTERISTICS OF PIPING PLOVER COLONY SITES ON THE MISSOURI RIVER, 1986

Parameter	Below Gavins Point Dam			Below Fort Randall Dam		
	N	$\bar{x}$	(s.e.)	N	$\bar{x}$	(s.e.)
Nesting habitat size (acres)[a]	12	7.56	(2.17)	3	10.87	(7.63)
Mean nest elevation above water level (inches)[b]	12	7.68	(1.20)	1	17.52	
Mean nest-to-water distance (feet)	16	20.36	(3.58)	6	5.84	(1.59)

Source: Schwalbach et al. (1988).

Note: N = sample size; $\bar{x}$ = mean; s.e. = standard error.

(a) The stated values for nesting habitat size apply to both least terns and piping plovers which commonly nest in sympatric colonies along the Missouri River.

(b) Nest elevations were corrected to dates of nest initiation (Schwalbach et al. 1988).

As pointed out by Schwalbach et al. (1986), the 1986 breeding season was characterized by near record inflows to the Missouri River and high water conditions below the Gavins Point and Fort Randall dams limited habitat availability and suitability. Consequently, it is expected that the mean values for parameters listed in Table 3-7 may be greater during normal or low flow years when more sandbar or beach habitat is exposed. All of the listed parameters vary inversely with river stage and, in general, decreasing stage conditions are more favorable to piping plover (and least tern) colonies. Increases in nesting habitat size resulting from stage decreases tend to reduce the potential for predation, whereas increases in nest elevation and nest-to-water distances reduce potential disturbance from water level fluctuations or wave action (Schwalbach et al. 1986). Stage increases cause reverse effects and, in the event of large increases, complete inundation of nesting areas can occur.

Though several researchers (Ducey 1981b, Faanes 1983) have reported that piping plovers tend to nest closer to the water surface elevation than least terns at sandbars along the Platte River (see Section 3.2.1.2), marked differences in nest elevation between species were not apparent at Missouri River colonies in 1986. Below Gavins Point Dam, mean nest elevation above river stage was 7.56 inches (19.20 cm) for a sample of 29 least tern nests versus 7.68 inches (19.51 cm) for a sample of 12 piping plover nests (Tables 2-9 and 3-7, respectively). Limited sample size precluded meaningful comparison of nest elevation between species in the Fort Randall reach (i.e., elevation above water level was recorded for only one piping plover nest in this reach in 1986).

3.2.2.3 Production

Production data for piping plover breeding populations along the Missouri River indicate that approximately 0.24 young per nesting pair were fledged below Gavins Point Dam in 1983, whereas fledging rates/nesting pair were 0.05 and 0.20 below Gavins Point Dam and Fort Randall Dam, respectively, in 1986 (Table 3-8).

TABLE 3-8 SUMMARY OF PIPING PLOVER PRODUCTION ALONG THE MISSOURI RIVER, 1983 AND 1986

	Below Gavins Point Dam		Below Fort Randall Dam
	1983	1986	1986
No. of nesting pairs[a]	103	86	5
No. of fledged young	25[b]	4	1
Fledging rate/nesting pair	0.24	0.05	0.20

Sources: 1983 data from tabular survey results submitted by the Nebraska Game and Parks Commission to the Nebraska Department of Water Resources (4 February 1987) and Ducey (1984); 1986 data from Schwalbach et al. (1988).

(a) Maximum number of nesting pairs based on number of adult birds censused (see Tables 3-5 and 3-6).

(b) Ducey (1984) reported that of 68 young counted along this reach of the river in 1983, 25 could have reached flight stage. A total of 41 young were known to have been washed from nesting areas by high water flows.

These production rates are substantially lower than rates reported for piping plover colonies along the Atlantic Coast. For example, at one area in Nova Scotia, piping plovers nesting on an isolated, rarely visited beach fledged 1.3 to 2.1 young per pair, whereas birds nesting on a recreational beach at another site fledged 0.7 to 1.1 young per pair (Cairns 1977, 1982).

The reason for the low production rates along the Missouri River during the 1983 and 1986 breeding seasons appears to be associated with the occurrence of high flows following nest establishment. In 1983, Ducey (1984) counted 68 piping plover young in the Gavins Point Dam to Ponca reach, but noted that 41 were known to have been washed from nesting sites by high flows (33 young were lost from three sites alone). At other colonies no young were produced because nests were flooded before the eggs had hatched. In 1986, Schwalbach et al. (1986) similarly reported that all nesting sites below the Gavins Point and Fort Randall dams had signs of water disturbance (flooding or wave action) at some time during the summer; nest scrape dampness was also evident at most sites and may have contributed to low production.

Since piping plovers, like least terns, nest on beaches, low river bars and other exposed land surfaces, they are subject to high variability in production rates from year to year and location to location as influenced by the occurrence of floods, storms, and other disturbance factors. Although the species' relatively long life span (Wilcox 1962, Dinsmore 1984) enables it to cope with periodic bouts of low productivity, the population as a whole cannot be sustained or augmented if occurrences of reproductive failure are not balanced or exceeded by occurrences of reproductive success. Thus, continued collection of production data along the Missouri River and elsewhere within the piping plover's breeding range is essential to monitoring the success of management actions designed to protect and enhance the well-being of the species.

3.2.2.4 Sources of Mortality at Nesting Colonies

Because the breeding season of the piping plover is essentially the same as that of the interior least tern, and because both species use the same types of nesting habitat along the Missouri River (often occurring in sympatric colonies), factors affecting pre-fledgling mortality of least terns also apply to piping plovers (see Section 2.2.2.4).

3.2.3 Niobrara River

3.2.3.1 Census Results and Distribution

Census data on adult piping plovers recorded along the Niobrara River during the period 1978-1985 are shown in Table 3-9 (the Niobrara was not surveyed in 1986); additional site-specific data are presented in Appendix Table A-3, and information on survey coverage and effort is presented in Appendices B-4 and C-4. Though piping plover breeding populations along the Niobrara River have been regularly documented during systematic surveys by the Nebraska Game and Parks Commission (Table 3-9), the primary focus of surveys from 1978 through 1984 was to inventory interior least terns. During these years, counts of adult piping plovers were made on an incidental basis and should not be viewed as complete or appropriate for comparisons between years. As stated previously, survey emphasis for the Niobrara River was expanded to include the collection of more complete census data on piping plover in 1985 (J. Dinan, Nebraska Game and Parks Commission, personal communications). Thus, the 100 piping plovers inventoried in 1985 represents the first definitive census estimate for the Niobrara River.

Of the 11 rivers of the Mississippi/Missouri River drainage, surveyed in 1975 by Downing (1980), the Niobrara was described as the only river where least tern (and piping plover) habitat was not being seriously threatened. Only the lower 100 miles of the river appeared to provide suitable habitat because of natural narrowing of the channel in upper reaches.

3.2.3.2 Sources of Mortality at Nesting Colonies

Although specific data on fledgling production and sources of mortality to piping plover eggs and young are not available for the Niobrara River population, observations recorded during annual surveys by the Nebraska Game and Parks Commission provide insights on factors affecting nesting success relevant to piping plovers as well as least terns (see Section 2.2.3.3).

3.2.4 Other Nesting Locations

To date, systematic surveys to quantitatively inventory piping plover breeding populations have focused on the state's major rivers (i.e., the Platte, Missouri, and Niobrara). However, it is important to note that piping plover nesting activity has also been documented in recent years during incidental surveys along the Loup (NGPC 1983a) and Elkhorn (Appendix C-6) rivers, though adult birds were not censused. Moreover, piping plovers in the northern plains population are known to use non-riverine wetlands (e.g., the shores of alkali lakes, ponds, and man-made reservoirs), and in Nebraska breeding has been previously reported along the lakes of the sandhills region in the northcentral portion of the state and at other off-river sites that have not been

TABLE 3-9 SUMMARY OF PIPING PLOVER BREEDING POPULATIONS ON THE NIOBRARA RIVER, 1979-1985

River Section	Approx. River Miles	Adult Plovers Censused							
		1978	1979	1980*	1981	1982	1983	1984	1985
Niobrara Park to Spencer Dam	40	11	NS	NS	0	4	20-22	8	32
Spencer Dam to County Line	35	13	NS	NS	10	0	61	24	52
County Line to Chimney Creek	40	10	NS	NS	82	8	6	6	16
Total	115	34	–	–	92	12	87-89	38	100
No. Colonies Located		3	–	–	6	2	8	6	14
Avg. Adult Plovers/Colony		11.3	–	–	15.3	6.0	10.9-11.1	6.3	7.1

Sources: 1978-1985 data from tabular survey results submitted by the Nebraska Game and Parks Commission to the Nebraska Department of Water Resources (4 February 1987). Detailed data for the 1978-1985 surveys are provided in Appendix A-3.

Notes: NS = Not surveyed.

* Piping plovers were generally not surveyed on the Niobrara River in 1980, however nesting was noted in association with one least tern colony.

systematically surveyed (see Section 3.1). It is therefore apparent that additional suitable habitat, as well as nesting colonies, occur within the state exclusive of the major rivers that have received primary survey emphasis. It bears attention, however, that the presence of suitable habitat in and of itself does not assure utilization by breeding birds. In this regard, Haig (1985) has made the relevant observation that "there appears to be quite a bit of suitable habitat in prairie areas, yet [piping plovers] are only sporadically distributed." Thus, accurate population estimates for a given region require thorough censusing of all suitable habitat within that region, rather than extrapolations derived from limited or partial surveys.

3.3 STATEWIDE POPULATION STATUS

Because recent efforts to comprehensively census piping plovers were not initiated concurrently for the Platte, Missouri, and Niobrara rivers, insufficient data presently exists to evaluate trends in the statewide population over time. Nevertheless, systematic surveys conducted along these rivers in recent years clearly indicate 1) that Nebraska's piping plover population is substantially larger than was thought to be the case only a few years ago (Table 3-10); and 2) that Nebraska is an important stronghold for the species. Specifically, census results through 1986 (assuming stable abundance along the Niobrara River from 1985 to 1986) reflect a statewide population approximately nine times larger than estimated in 1983 (Haig 1985); i.e., approximately 450 birds versus 50 birds. Compared to available data reported by Haig (1985), the present Nebraska population exceeds that of any other state in the nation, and is second only to Saskatchewan among the Canadian provinces. Furthermore, because recent systematic surveys have not inventoried all potential or known nesting habitat within the state (see Section 3.2.4), the current population summary presented in Table 3-10 should be considered conservative.

TABLE 3-10 RECENT CENSUS RESULTS FOR PIPING PLOVER BREEDING POPULATIONS ALONG NEBRASKA RIVERS AS COMPARED TO 1983 STATEWIDE ESTIMATE

Location	1983 Statewide Estimate	Recent Census Results Birds Observed (Year)
° Platte River (Plattsmouth to North Platte, NE)	50 birds (20 pairs)	164 (1986)
° Missouri River (Gavins Point Dam to Ponca, NE)		172 (1986)
° Missouri River (Fort Randall Dam to Lewis and Clark Lake)		11 (1986)
° Niobrara River		100 (1985)[a]
° Loup Rivers		PPN[b] (1983)
° Elkhorn Rivers		PPN[c] (1986)

Sources: The 1983 statewide estimate for Nebraska was presented in Haig (1985) with the notation "USFWS, Jamestown (in NE Workshop)"; 1986 data for the Platte River and 1985 data for the Niobrara River are from tabular data or annual progress reports prepared by the Nebraska Game and Parks Commission (see Tables 3-2 and 3-9, respectively); 1986 data for the Missouri River are from Schwalbach et al. (1988) (see Tables 3-5 and 3-6); 1983 data for the Loup Rivers are from NGPC (1983a); and 1986 data for the Elkhorn River are from Appendix C-6 (this report).

Notes: PPN = Piping plover adults and/or nesting activity were observed but counts of adult birds were not made.

(a) The Niobrara River piping plover breeding population was not censused in 1986.

(b) Adults were present at one off-river sandpit, and a nest containing three eggs and one downy chick was observed at another sandpit site; however, adult birds were not censused (NGPC 1983a).

(c) Three plover nests with four eggs each were observed at one off-river sandpit; however, adult birds were not censused (see Appendix C-6).

4. HABITAT USE CONSIDERATIONS RELATIVE TO THE CENTRAL PLATTE RIVER

4.1 NATURAL INTERMITTENCY OF THE CENTRAL PLATTE REACH

In recent years, proposed water projects have stirred considerable controversy with regard to potential effects on wildlife habitat along the 70-mile central portion of the Platte River from Overton to Grand Island, Nebraska, commonly referred to as the Big Bend reach. This controversy has led to much conflicting information about the original character of the river and factors that have influenced subsequent change (Lewis 1988). The development of effective resource and species management strategies for this system will ultimately depend on careful separation of facts from misconceptions, and a thorough weighing of the evidence.

Though the historical record has recently been contested (VanDerwalker 1988), the fact remains that explorer accounts and descriptions of early travelers on the Great Plains have led to the overwhelming consensus among researchers that the Platte River would often cease to flow during the dry season in portions of channel extending from the mouth of the Loup River to the confluence of the North and South Platte rivers. In other words, under natural conditions, this section of the river (which includes the Big Bend reach) tended to be intermittent. The following documentation applies:

- Walter Prescott Webb, in his classic historical/environmental thesis entitled "The Great Plains" (1931), written before the Great Drought of the 1930's, stated:

  > "A stream can be perennial in an arid region only if it lies below the water plane. If, like the Platte, it lies above the water plane, it contributes to ground water **but goes dry inevitably in time of drought; it is intermittent** [emphasis added]." (Webb 1931)

- The Nebraska Natural Resources Commission, in Chapter 2 (Flow Characteristics of Nebraska Streams) of its "Policy Issue Study on Instream Flows" (1982), reported:

  > "**Under natural conditions** [emphasis added], the reach from the confluence of the North Platte and South Platte rivers to the mouth of the Loup River probably was subject to long no-flow periods..." (NNRC 1982)

- Based on an extensive evaluation of historical accounts relative to the presettlement channel and flow characteristics of the Platte River system, Eschner et al. (1983), in a research report prepared for the U.S. Geological Survey, concluded:

  > "Above the confluence with the Loup, the Platte was an intermittent river. It carried little water during the late summer and dried up completely in some years." (Eschner et al. 1983)

- In a special publication entitled "Nebraska Rivers", published by the Nebraska Game and Parks Commission, Cunningham (1983) provided the following synopsis of the Platte's predevelopment flow characteristics:

  > "Old records indicate that in early spring, before snow melt, the river flow was low and occasionally ceased altogether in some reaches. Snow melt at the mountain headwaters then brought on a period of high flow beginning in April or May, reaching a peak in June, and usually receding in July..."
  >
  > Then, in late summer and early fall, depending on rainfall and on groundwater seepage into the river, the Platte might flow continuously, **but in many years would go completely dry in long stretches upstream from the mouth of the Loup** [emphasis added]." (Cunningham 1983)

- In an article published in "Sierra", a bulletin of the Sierra Club, Martha Gilliland, an associate professor in the department of civil engineering at the University of Nebraska at Omaha, presented the following synopsis of historical accounts:

  > "Summer viewers saw 'nothing but a flat expanse of sand, stretching from a mile and a half to three miles in width, and at many points not a drop of water is to be seen; at some points a silver thread, winding along the wilderness of sand, may be discovered, but it is not until the Loup Fork empties its waters into the Platte that it assumes the appearance of a river.' These accounts portray a river that flooded in spring and early summer, that was intermittent in late summer and early fall upstream of its confluence with the Loup River, and that was essentially devoid of trees along its banks." (Gilliland 1984)

- In a compilation of folklore emanating from the frontier history of the Plains, Welsch (1982) noted that the Platte was humorously referred to as an "upside down" river - "sand on the top, water underneath". Clearly, this label conveys a river that regularly went dry, rather than one that always (or nearly always) contained water. It is consistent with historical accounts that describe having to dig down in the sandy bed of the river to obtain water (e.g., Ware 1911).

Thus, the natural tendency for the central Platte River to go dry during late summer and fall months has been the common conclusion of historians, researchers employed by federal and state agencies, and professionals writing for environmental organizations. It is also embedded in the folklore of the Plains. Moreover, the intermittent nature of the Platte was not unique among Plains rivers. Rather, this same feature was characteristic of the predevelopment flow regime of many of the major rivers that traverse the physical and climatic environs of the Great Plains region. Flow-cessation and dry riverbed conditions during the summer-fall period have also been documented for the predevelopment channels of other semi-arid rivers that transect the Great Plains from west to east; e.g., the Republican (Greeley 1860), Arkansas (Jackson 1966), the Cimmaron (McLaughlin 1947), and Red (Webb 1931). In describing the flow patterns of Great Plains rivers which, like the Platte,

carry snowmelt runoff from the Rocky Mountains eastward to the southerly flowing Missouri-Mississippi system, the historian Webb (1931) presented the following general characteristics:

"1. The mountainous region west of the Great Plains supplies moisture, as rain or snow, much of which must eventually find its way eastward toward the Mississippi.
2. Within the mountains the grades are steep, and the streams run strong and 'carry through'. They are loaded with silt and debris, weathered away and washed down from the mountains.
3. Once the streams pass beyond the mountain boundaries into the arid land, **they dwindle, fail and deposit their load** [emphasis added]. Their failure is due to rapid evaporation into the dry air, to absorption into the dry, porous earth, and to lack of local precipitation and augmentation from tributaries." (Webb 1931)

Unfortunately, misunderstandings about the Platte and other Plains rivers have perpetuated because, in many cases, man-induced change -- stemming from the pressing needs for water in a semi-arid environment -- predated thorough scientific study. As a result, the original character of these rivers has often been assumed to be similar to that of rivers in the more humid eastern portion of the country (e.g., year-round rather than intermittent flows) where settlement occurred much earlier and time has facilitated the accumulation of a more extensive base of knowledge. Nevertheless, such misunderstandings are nothing new. In Mari Sandoz's historical book "The Buffalo Hunters" (1954), the following humorous but relevant account is given of the assignment of Generals Hancock and Custer to the Plains in the 1860's to engage Indian parties that were striking back against the slaughter of their buffalo and the settlement of their land:

> "To stop their raids, Hancock and Custer took the field in April 1867 ostensibly to meet with the Indians in a peace council, but they had fourteen hundred men, including artillery and with pontoons, evidently to ford Kansas rivers far beyond the peace grounds. Old-timers at Ft. Larned had laughed to see the expedition go out. 'Looks like Hancock'd know them western rivers is mostly sandbars from when he was fightin' old Santy Ana,' one of them said.
>
> 'Oh, them pontoons'll come in handy in the cactus, an' 'll shure kill a lot of Indians laughin'." (Sandoz 1954)

4.2 THE PROCESS OF CHANGE AND ITS EFFECT ON LEAST TERN AND PIPING PLOVER HABITAT

That the tendency for the reach of the Platte River above the Loup confluence to go dry during summer and fall months continued well beyond the turn of the century is documented by discontinuous gaging records for the period 1894-1914 (Bentall 1982) and continuous recording of river flow after that time (Nebraska Natural Resources Commission Data Bank). These records show that episodes of no flow in the Platte were not restricted to years of below average precipitation but were certainly prolonged by them, particularly when such years occurred in succession during major drought periods (e.g., the 1890's and 1930's). These conditions changed following the completion of Kingsley Dam and

the Tri-County Canal system in 1941, at which time the release of water and return flows during the irrigation season effectively converted the central reach of the Platte River, between Overton and Grand Island, from an intermittent to perennial stream (Smith 1984, Lewis 1984).

However, as documented by graphical analyses of no-flow occurrence prepared by the University of Nebraska Conservation and Survey Division (Bentall 1975), as well as flow duration curves prepared by the U.S. Geological Survey (Kircher and Karlinger 1983), the shift to perennial flow was not contemporaneous throughout the entire reach. Rather, it occurred first at Overton soon after the Kingsley Dam/Tri-County Canal system was activated and progressed farther downstream over time with the gradual buildup of the groundwater table on the south side of the river (Johnson and Pederson 1983) as influenced by recharge from the Tri-County Canal. The following documentation is also relevant:

- "The Overton station had no flow at times in 1919, 1922, 1925, 1927-28, and 1930-41. In 1941 the Tri-County Canal system began routing water back into the Platte River about 11 km upstream from the Overton gaging station, and since then the Platte at Overton has always had some flow.

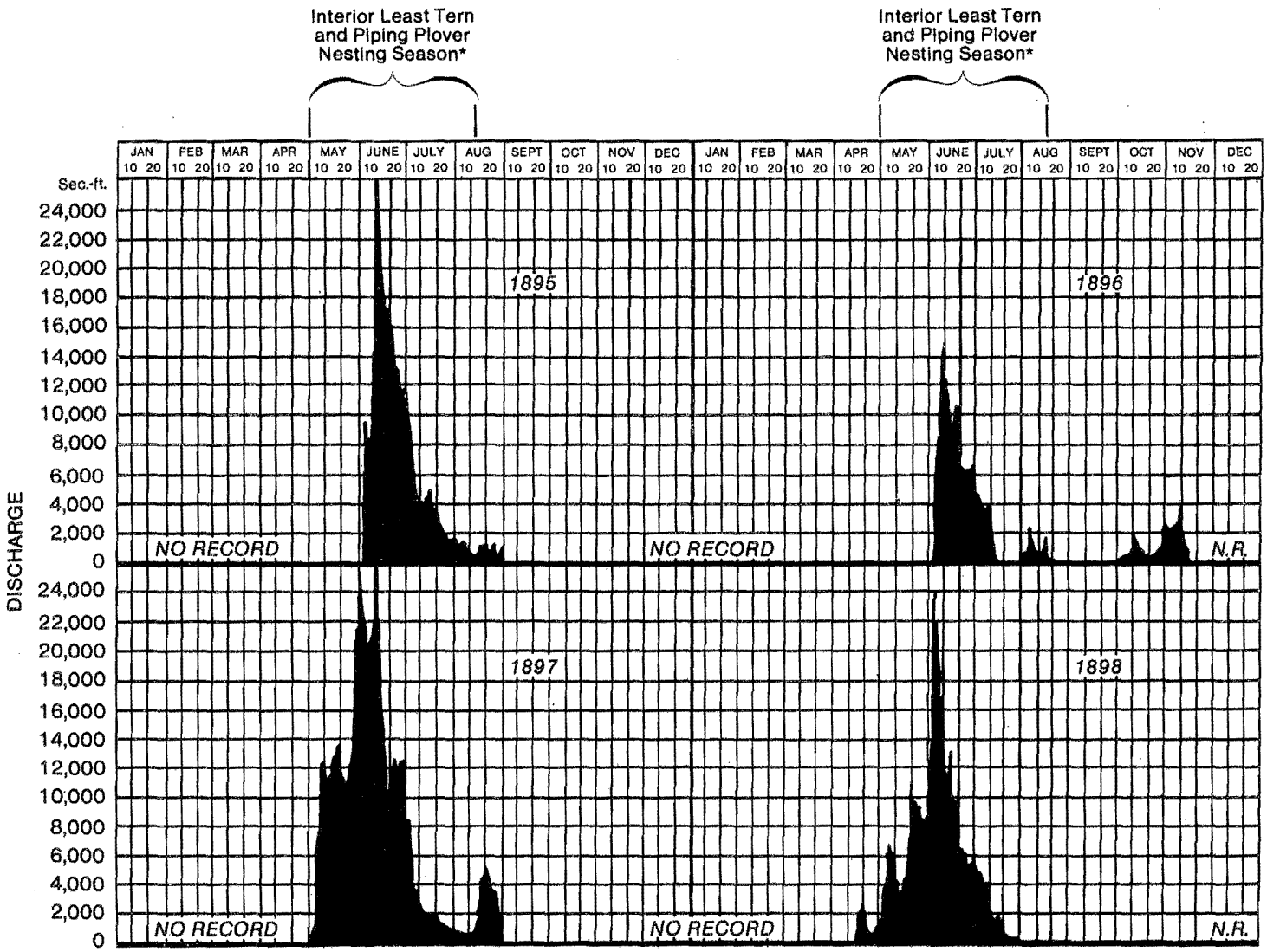
  The Odessa and Grand Island stations do have some rather dry years, at times. For these stations, the meager data... indicate fewer days of no flow after 1941 than before, with Grand Island [located farthest downstream] usually having more such days than Odessa." (Williams 1978)

- "The flow records that exist from the late 1800's indicate that the Platte River of the 1800's was largely intermittent, experiencing both great floods and periods of no flow. **Development of irrigation provided a source of water during the late summer season in the form of return flow and thereby served to make the river flow less seasonal** [emphasis added]." (Eschner 1981)

- "Under natural conditions, the reach [of the Platte River] from the confluence of the North Platte and South Platte rivers to the mouth of the Loup River probably was subject to long no-flow periods, but now the no-flow segments are limited to the downstream half of the reach. **These changes in the river's flow regime are the combined results of the water-storage features and the water-use developments in the Platte's drainage area** [emphasis added]." (NNRC 1982)

In light of the preceding information it appears unlikely that the reach of the Platte River above the Loup confluence could have been important in any significant way to the historical maintenance of least tern or piping plover populations. There are two reasons for this:

1) High flows historically occurred during the primary nest selection/nest initiation period (mid-May to early June; Figure 4-1). Given the pattern of high flows commencing in late April or early May and peaking in June, it is expected that most potentially suitable sandbar habitat would have been inundated during the time of typical nest selection in Nebraska. Nests



* The time-frame of a typical least tern nesting season along the Platte River is based on Wingfield (1982). Studies in North Dakota by Prindiville and Ryan (1984) indicate a concurrent nesting season for piping plover, though sighting dates reported by Moser (1942) and Faanes (1983) reflect slightly earlier arrival in Nebraska.

Figure 4-1. Nesting season of interior least tern and piping plover in relation to earliest U.S. Geological Survey discharge records available for the Platte River at Columbus (recorded just upstream of the Loup confluence), 1895-1898, showing the timing of peak snow-pack runoff flows.

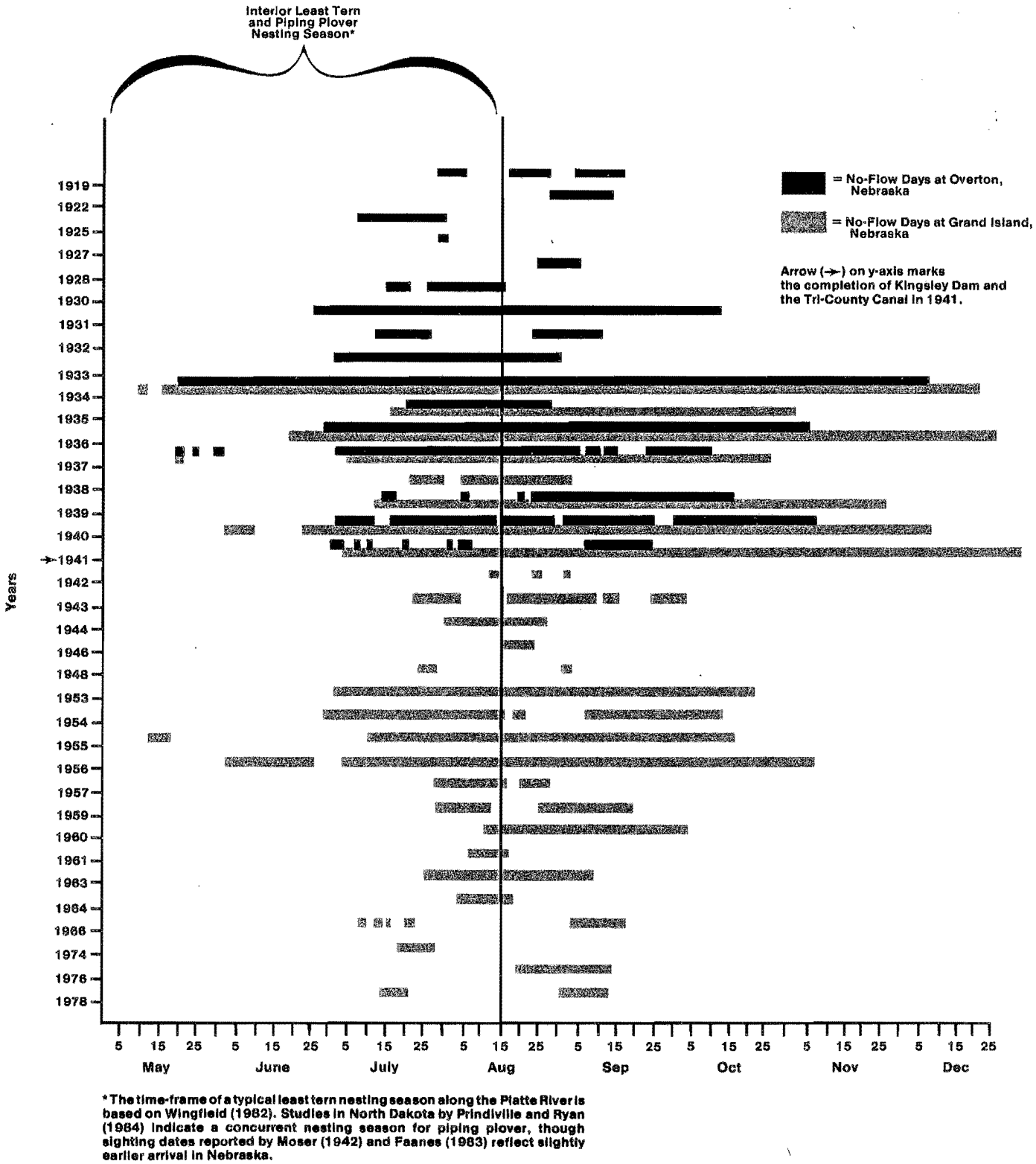
initiated prior to the period of peak flow, in years of delayed snow-pack thaw, would have been subject to flooding.

2) Extended no-flow episodes periodically occurred during major portions of the nesting season (Figure 4-2). As Faanes (1983) stated: "A continuous water flow that serves as a mammalian predator barrier and supplies a stable source of food items [for nesting least terns and piping plovers] is probably essential." Dinsmore (1984) similarly pointed out that "loss of water in a basin would mean the loss of the food base for piping plovers and their probable abandonment of the area." This latter consideration is relevant to least terns as well.

Instead, it appears more likely that significant nesting utilization of the Platte River above the Loup is a recent phenomenon associated with the alteration of flow patterns affected by water storage and development projects. These projects not only tempered peak flows during the species nest selection and initiation period, but affected the progressive eastward extension of continuous flow which assured food availability and greater security during the nesting season. This conclusion is supported by the fact that historical records reflect an absence of sightings of terns and plovers along the upper and central portions of the Platte (from just east of the confluence of the North and South Platte rivers to the mouth of the Loup) until after 1941 (see Figures 2-2 and 3-2).

It is therefore apparent that water development along the Platte River system has reduced the incidence and magnitude of extreme, natural river-stage fluctuations including 1) floods that would cause the inundation of nesting habitat and direct mortality to eggs and young; and 2) drought-induced no-flow events that would result in the elimination of adjacent food supplies and the increased risk of predation. Though the progressive shift to perennial flow provided substantial habitat along the central Platte River for nesting least terns and piping plovers by creating a reliable water supply during the summer nesting season, this change in flow pattern also facilitated the growth of woody vegetation in an area where precipitation alone is inadequate to sustain forest development (Webb 1931, Droze 1977). This cause-and-effect relationship is supported by a substantial body of evidence (e.g., Albertson and Weaver 1945, Eschner et al. 1983, EA 1983, Smith 1984, Lewis 1984), and was vividly described by Wycoff (1960) based on direct observations of the central Platte channel near Lexington, Nebraska during a 17-year period in the 1940's and 1950's.

> "During the year which followed the building of the dams in the hills along the south side of the Platte River, thus insuring a more continuous flow of water, the sandy river bed became covered with sprouting cottonwoods, willows, and many acres of cockleburs and sweet clover...Then by 1945 the lakes along the south side of the Platte River were filling, thus making the continuous flow of water in the river a certainty. This brought about a change in the river bed, because the water not only supplies vegetation with the necessary nourishment, but also brought many seeds, especially with the high water." (Wycoff 1960)



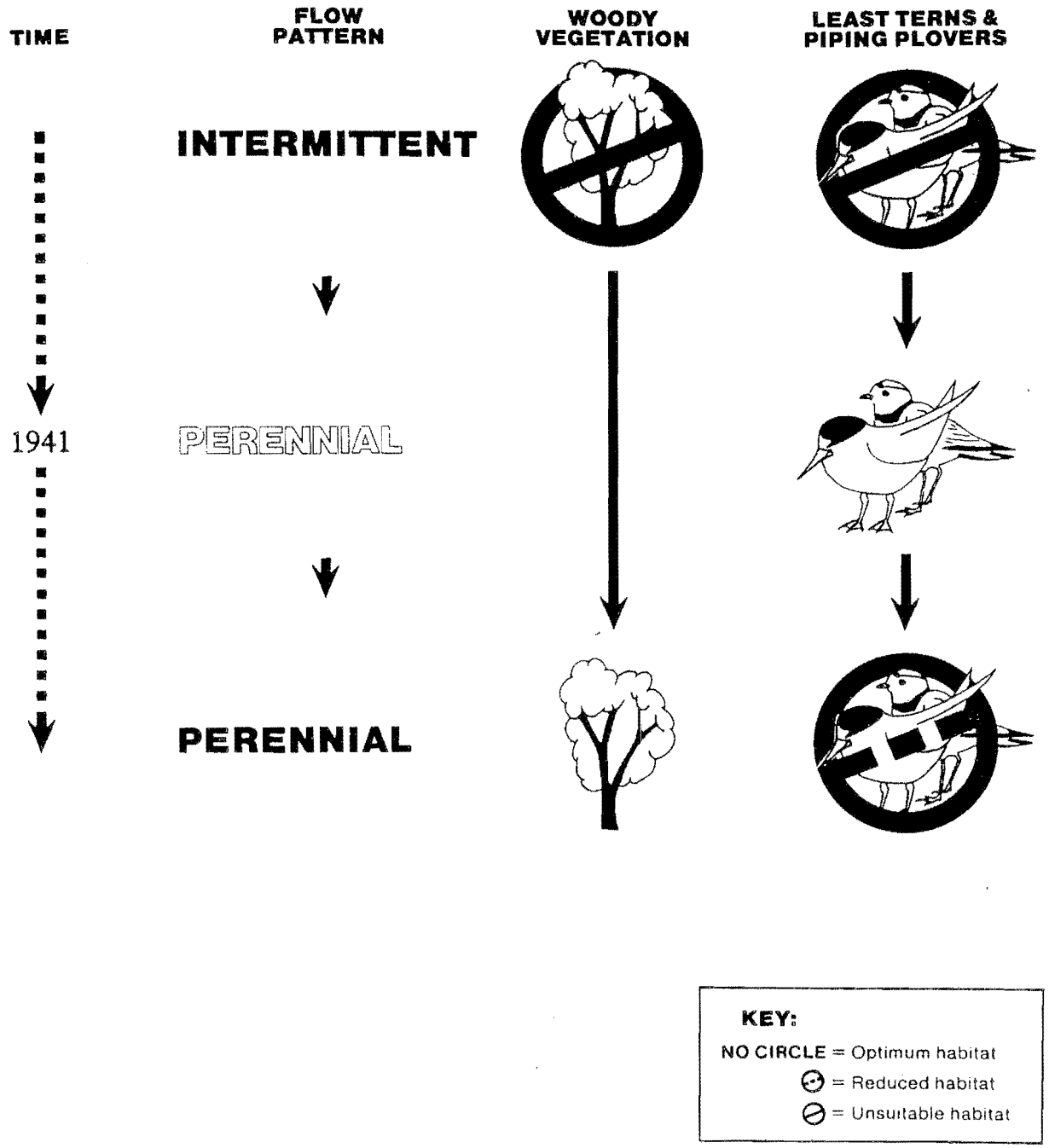
*The time-frame of a typical least tern nesting season along the Platte River is based on Wingfield (1982). Studies in North Dakota by Prindiville and Ryan (1984) indicate a concurrent nesting season for piping plover, though sighting dates reported by Moser (1942) and Faanes (1983) reflect slightly earlier arrival in Nebraska.

Figure 4-2. Nesting season of interior least tern and piping plover in relation to the historical periodicity of no-flow days recorded for the Platte River at Overton and Grand Island, Nebraska.

As the development of woody vegetation has continued, it has tended to reduce the amount of suitable, mid-channel sandbar habitat that was available to terns and plovers at the time the change in flow pattern initially occurred in the central Platte reach (Figure 4-3). Despite such reductions, however, the situation is better now than earlier when more extreme flow variability during the breeding season would have substantially diminished habitat suitability and production potential along this portion of the river. Coincident with changes in riverine habitat that have occurred since 1941, the extraction of sand for commercial use has resulted in the proliferation of sandpit lakes and open spoil piles adjacent to the river that provide considerable additional nesting habitat for terns and plovers (see Tables 2-2 and 3-2, respectively). These sites assume particular importance during years when high river flows limit or preclude the use of mid-stream sandbars (e.g., 1983 and 1984). Moreover, because sandpit colonies are less susceptible to flooding (a dominant source of mortality at sandbar colonies), they have significant potential for successful production, particularly if active steps can be taken to control human disturbance and predation. This has been demonstrated in a specific case where a sandpit owner took interest in observing and protecting nesting least terns (Ducey 1982).

Thus, perceptions that water projects and other human developments have been wholly detrimental to populations of least terns and piping plovers along the Platte River are not supported by existing information. Neither the historical sightings record (Sections 2.1 and 3.1) nor more recent systematic surveys (Sections 2.2 and 3.2) provide evidence that breeding populations of least terns or piping plovers have declined along the Big Bend reach, the Platte River in general, or within the state. Rather, current information indicates that habitat along the Platte and other rivers in the state can support far more birds than was previously thought to be the case (Sections 2.3 and 3.3)...and establishes the fact that Nebraska is presently a stronghold for both species.

Figure 4-3. Interior least tern and piping plover habitat availability along the central Platte River, in relation to changing flow and vegetation growth patterns.



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APPENDIX A

SYSTEMATIC SURVEY CENSUS RESULTS FOR INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATIONS ALONG THE PLATTE RIVER (1981-1986), MISSOURI RIVER (1978-1986), AND NIOBRARA RIVER (1978-1985) IN NEBRASKA

TABLE A-1 SUMMARY OF LEAST TERN (LT) AND PIPING PLOVER (PP) BREEDING POPULATIONS ON THE PLATTE RIVER, 1981-1986

Colony Name	Adults Censused[a]											
	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP
	1986		1985		1984		1983		1982		1981	
Plattsmouth to Columbus Stretch												
1. 73-75 (R)	0	(0)	4*	(0)[b]	0	(0)	0	(0)	0	(0)	-	(-)
2. Collum (R)	20	(4)	10*	(2)[b]	0	(0)	0	(0)	0	(0)	-	(-)
3. Collum (P)	0	(0)	0	(0)	0	(0)	8	(0)	-	(-)	-	(-)
4. Cedar Creek (R)	0	(0)	14	(4)	0	(0)	0	(0)	8	(0)	-	(-)
5. Cedar Creek (P)	0	(0)	0	(0)	10	(6)	20	(PPN)	-	(-)	-	(-)
6. South Bend (P)	0	(0)	0	(0)	4-6	(2)	-	(-)	-	(-)	-	(-)
7. Schramm (R)	0	(0)	8	(0)	0	(0)	0	(0)	10	(0)	30	(6)
8. I-80 (P)	0	(0)	0	(0)	0	(0)	7	(PP)	0	(0)	-	(-)
9. I-80 (R)	0	(0)	3	(0)	0	(0)	0	(0)	0	(0)	-	(-)
10. Camp Ashland (R)	66	(12)	0	(0)	0	(0)	0	(0)	0	(0)	-	(-)
11. Western South (P)	4	(4)	8	(12)	44	(12)	62	(PPN)	-	(-)	-	(-)
12. Thomas Lake (P)	0	(4)	10	(12)	18	(2)	14	(0)	-	(-)	-	(-)
13. Western North (P)	16	(4)	0	(0)	14	(4)	10	(PPN)	-	(-)	-	(-)
14. Two Rivers (R)	30	(12)	0	(0)	0	(0)	0	(0)	12	(PP)	11-12	(35)
15. West Gretna (R)	0	(0)	12*	(-)	0	(0)	0	(0)	0	(0)	-	(-)
16. Hartford Valley (P)	10	(4)	9	(0)	30-34	(4)	12	(0)	-	(-)	-	(-)
17. Valley (R)	0	(0)	3*	(0)	0	(0)	0	(0)	-	(-)	5	(3)
18. Leshara (R)	0	(0)	0	(0)	0	(0)	0	(0)	10	(PP)	18	(2)
19. Hartford Fremont (P)	6	(2)	0	(0)	16	(8)	-	(-)	-	(-)	-	(-)
20. Ames (P)	0	(0)	0	(0)	0	(0)	8	(PP)	8	(PP)	-	(-)
21. Cedar Bluff (R)	30	(4)	0	(0)	0	(0)	0	(0)	0	(0)	-	(-)
22. Morse Bluff (R)	0	(0)	14	(0)	0	(0)	0	(0)	0	(0)	-	(-)
23. Morse Bluff (P)	0	(0)	2	(0)	24	(2)	14	(0)	30	(PPN)	-	(-)
24. Skull Creek (R)	0	(0)	12*	(-)	0	(0)	0	(0)	0	(0)	-	(-)
25. Linwood (R)	14	(8)	7*	(-)	0	(0)	0	(0)	0	(0)	-	(-)
26. Schuyler (R)	54	(4)	10	(1)	0	(0)	0	(0)	0	(0)	-	(-)
27. Bellwood (R)	0	(0)	10	(2)	0	(0)	0	(0)	0	(0)	-	(-)
28. Bellwood Sec. 13 (P)	18	(0)	6	(2)	28	(8)	14	(0)	-	(-)	-	(-)
29. Brandenburg (P)	0	(0)	0	(0)	0	(0)	10	(PPN)	-	(-)	-	(-)
30. Columbus (P)	36	(6)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
Columbus to Grand Island Stretch												
31. Silver Creek Bridge	0	(0)	0	(0)	0	(0)	0	(0)	8	(0)	-	(-)
32. Silver Creek East (R)	0	(0)	0	(0)	0	(0)	0	(0)	14	(0)	-	(-)
33. Silver Creek (P)	0	(0)	0	(0)	0	(0)	2*	(-)	-	(-)	-	(-)
34. Clarks Bridge (P)	0	(0)	0	(0)	0	(0)	0	(0)	6*	(-)	-	(-)
35. Clarks (P)	0	(0)	0	(0)	0	(0)	12	(0)	-	(-)	-	(-)
36. Merrick County (P)	14	(2)	6	(2)	12	(6)	8	(0)	-	(-)	-	(-)
37. Central City Bridge (P)	6	(2)	10	(3)	0	(0)	6	(0)	18	(0)	-	(-)

Table A-1 (cont.)

Colony Name	Adults Censused											
	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP
	1986		1985		1984		1983		1982		1981	
Grand Island to Lexington Stretch												
38. Crystal Lake (P)	4	(8)	–	(–)	–	(–)	–	(–)	–	(–)	–	(–)
39. Doniphan (P)	0	(2)	0	(0)	10	(4)	–	(–)	–	(–)	–	(–)
40. Mormon Island (R)	0	(0)	14[c]	(0)	0	(0)	0	(0)	0	(0)	–	(–)
41. Shumaker Wild Rose (P)	8	(16)	16	(4)	16–20	(4)	20	(PPN)	–	(–)	–	(–)
42. Shumaker (R)	10	(16)	8	(12)	6[c]	(0)	0	(0)	0	(0)	–	(–)
43. Gibbon Bridge (R)	0	(0)	0	(0)	0	(0)	0	(0)	6	(0)	–	(–)
44. Minden Bridge (R)	2	(4)	12	(6)	0	(0)	0	(0)	16	(0)	–	(–)
45. Kearney (P)	18	(2)	0	(0)	0	(0)	8	(PPN)	–	(–)	–	(–)
46. Kearney Bridge East (R)	0	(2)	0	(0)	0	(0)	0	(0)	16	(0)	–	(–)
47. Kearney Bridge West (R)	8	(12)	8[c]	(0)	0	(0)	0	(0)	0	(0)	–	(–)
48. Sandy Channels (P)	40	(14)	20	(0)	–	(–)	–	(–)	–	(–)	–	(–)
49. Overton-Potters (P)	0	(2)	22	(0)	0	(0)	11	(PPN)	–	(–)	–	(–)
50. Jeffrey Island (R)	0	(4)	20	(6)	0	(0)	0	(0)	0	(–)	–	(–)
51. Lexington (P)	8	(4)	0	(0)	0	(0)	0	(0)	–	(–)	–	(–)
Lexington to North Platte Stretch												
52. Kirkpatricks (P)	8	(2)	0	(0)	0	(0)	0	(0)	–	(–)	–	(–)
53. Albrechts (P)	8	(4)	0	(0)	0	(0)	0	(0)	–	(–)	–	(–)
Total	438	(164)	256	(68)	226–236	(62)	246		162		64–65	(46)

Sources: 1981 data from Ducey (1981b); 1982–1986 data from Table I, Platte River Interior Least Tern and Piping Plover Nesting Survey, 1986, prepared by the Nebraska Game and Parks Commission.

Notes: PPN = Piping plovers occurred at colony, nesting was documented.
PP = Piping plovers occurred at colony but numbers or status was not determined.
R = River
P = Sandpit
– = Indicates no survey made

(a) Numbers reflect adults and/or active nests (multiplied by 2) observed during ground surveys unless marked with an asterisk (*) to indicate the use of aerial counts at locations where ground checks were not conducted.

(b) Although least terns were observed at this site during an aerial survey, 2 piping plover were observed during a subsequent ground check.

(c) Since these colonies were established late in the summer, they may represent renesting attempts. Numbers of birds were not included in total to avoid possible duplication.

TABLE A-2 SUMMARY OF LEAST TERN (LT) AND PIPING PLOVER (PP) BREEDING POPULATIONS ON THE MISSOURI RIVER FROM YANKTON, SD (GAVINS POINT DAM) TO PONCA, NE, 1978-1986

River Mile	Colony Name[a]	Adults Censused																	
		LT	PP (NGPC)[b]	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP	LT	PP
		1986		1985		1984		1983		1982		1981		1980		1979		1978	
807.0	First Bend	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	2	(PP)	-	(-)	6	(-)	6	(-)
804.5	Sunken Bar	9	(12)	14	(14)	16	(4)	0	(0)	22	(PPN)	0	(-)	-	(-)	-	(-)	-	(-)
803.8	Lower Sunken Bar	0	(2)	0	(5)	18	(12)	24	(24)	12	(PPN)	5	(0)	-	(-)	-	(-)	-	(-)
803.0	*	8	(4)	3	(8)	0	(0)	0	(0)										
801.9	James River (Upper)*	10	(11)	14	(12)	12	(8)	0	(0)										
801.0	James River	0	(0)	0	(2)	0	(0)	13	(28)	10	(PPN)	15	(PPN)	55	(PP)	22	(6)	-	(-)
800.6	James River (Lower)*	0	(2)	8	(18)	18	(8)	0	(0)										
799.5	St. Helena N.W.	0	(0)	0	(0)	0	(0)	0	(0)	0	(-)	0	(-)	-	(-)	4	(-)	-	(-)
799.0	*	0	(0)	0	(5)	0	(0)	0	(0)										
798.0	St. Helena	1	(3)	1	(8)	4	(0)	32	(24)	0	(-)	-	(-)	-	(-)	-	(-)	-	(-)
796.6	St. Helena Is. West	0	(0)	22	(24)	16	(8)	3	(8)	0	(-)	0	(-)	-	(-)	2	(-)	-	(-)
794.4	St. Helena Cemetery	0	(0)	5	(3)	4	(2)	0	(0)	0	(-)	4	(0)	8	(PP)	-	(-)	-	(-)
791.8	St. Helena Is. #3	0	(0)	0	(2)	0	(0)	0	(0)	0	(-)	3	(PP)	10	(PP)	-	(-)	-	(-)
790.0	*	0	(0)	0	(2)	0	(0)	0	(0)										
790.5	Bow Creek	0	(0)	7	(3)	0	(0)	0	(0)	22	(PPN)	0	(-)	-	(-)	-	(-)	-	(-)
788.6	St. Helena Is. East	0	(0)	0	(0)	16	(4)	0	(0)	4	(PPN)	10	OPP)	20	(PP)	14	(-)	35[c]	(-)
785.0	*	0	(0)	1	(0)	0	(0)	0	(0)										
783.4	Goat Island *	12	(8)	0	(0)	0	(0)	0	(0)										
781.2	Goat Island *	5	(2)	3	(4)	0	(0)	0	(0)										
781.0	*	0	(0)	2	(5)	0	(0)	0	(0)										
780.2	Clay Co. Park	0	(0)	0	(0)	0	(0)	0	(0)	4	(PPN)	4	(0)	-	(-)	35	(-)	20	(-)
778.6	Dixon Co., N.W.	0	(0)	0	(0)	0	(0)	0	(0)	2	(PPN)	0	(-)	11	(PP)	5	(-)	10	(-)
778.2	Ames Creek	16	(8)	40	(21)	20	(8)	14	(22)	6	(PPN)	16	(0)	22	(PP)	-	(-)	-	(-)
776.4	Mulberry Bend	0	(0)	0	(0)	3	(0)	0	(0)	8	(PPN)	4	(0)	-	(-)	-	(-)	-	(-)
774.5	Hourglass	0	(0)	0	(0)	4	(0)	6	(12)	2	(PPN)	4	(0)	32	(PP)	30	(-)	9	(-)
771.7	Vermillion River	0	(0)	0	(0)	2	(0)	2	(4)	2	(PPN)	12	(0)	-	(-)	-	(-)	-	(-)
770.5	Turkey Creek Loup	20	(6)	22	(7)	22	(4)	8	(8)	0	(PPN)	7	(0)	-	(-)	14	(-)	-	(-)
770.1	Turkey Creek Loup B*	12	(4)	0	(4)	0	(0)	0	(0)										
768.6	Rattlesnake Hill	0	(0)	0	(0)	16	(4)	0	(0)	2	(PPN)	2	(PPN)	2	(-)	-	(-)	-	(-)
767.0	Newcastle North	0	(0)	14	(14)	3	(0)	32	(22)	0	(-)	-	(-)	-	(-)	10	(-)	-	(-)
764.8	Newcastle South	10	(4)	3	(0)	3	(0)	0	(0)	0	(-)	12	(PPN)	11	(PP)	2	(-)	10	(-)
762.5	Ionia Bend *	18	(2)	4	(7)	6	(2)	11	(12)										
761.3	Dixon Co. N.E.	0	(0)	0	(0)	0	(0)	0	(0)	0	(PPN)	0	(-)	7	(PP)	2	(-)	-	(-)
759.7	Elk Point *	0	(0)	16	(8)	14	(16)	22	(26)										
757.0	North Ponca Bend	12	(2)	8	(8)	30	(8)	21	(16)	4	(PPN)	12	(0)	15	(PP)	30	(-)	12	(-)
754.0	Ponca Bark	0	(0)	0	(0)	0	(-)	0	(-)	14	(PPN)	6	(0)	-	(-)	-	(-)	-	(-)
Totals		133	(70)	187	(174)	227	(88)	188	(206)	114		118		193		176		102	

TABLE A-2 (cont.)

River Mile	Site ID	Adults Censused LT 1986	Adults Censused PP (SDDGFP)[b]
804.0	11001	8	(9)
803.2	11002	6	(4)
801.6	11003	6	(8)
801.0	11004	0	(0)
801.0	11013	0	(0)
800.9	11005	18	(13)
798.0	11006	2	(2)
796.4		11	(13)
789.5		3	(5)
783.4		0	(0)
782.6	11010	10	(10)
781.3	11011	13	(8)
778.5	11012	20	(14)
776.8		6	(8)
773.8	11014	0	(0)
770.5		4	(10)
770.0	11009	22	(12)
767.0		0	(2)
766.0	11008	22	(14)
764.8		0	(0)
762.5		0	(0)
758.5		10	(6)
757.0		0	(4)
755.3	11007	20	(30)
Totals		181	172

Sources: 1978-1982 least tern data and 1980-1982 piping plover data from Nebraska Game and Parks Commission annual reports on the Missouri River Interior Least Tern Survey, 1978-1982; 1979 piping plover data from NGPC (J. Dinan, personal communications, 24 August 1987); 1983-1986 data from tabular survey results submitted by NGPC to the Nebraska Department of Water Resources (4 February 1987), and Schwalbach et al. (1988).

Notes: PPN = Piping plovers occurred at colony, nesting was documented.
PP = Piping plovers occurred at colony, but numbers or status not determined.
– = Location was not surveyed.

(a) Blanks occur in cases where colony sites are unnamed. Colony sites marked with an asterisk (*) either did not exist or did not contain birds prior to 1983 (J. Dinan, personal communications).

(b) In 1986, separate censusing of the interior least tern and piping plover populations on the Missouri River was conducted by the Nebraska Game and Parks Commission (NGPC) and the South Dakota Department of Game, Fish and Parks (SDDGFP) in conjunction with the U.S. Fish and Wildlife Service. Results of both censuses are presented.

(c) Includes two distinct colonies in close proximity.

TABLE A-3 SUMMARY OF LEAST TERN (LT) AND PIPING PLOVER (PP) BREEDING POPULATIONS ON THE NIOBRARA RIVER, 1978-1985

Colony Name	Adults Censused[a] LT 1985	PP 1985	LT 1984	PP 1984	LT 1983	PP 1983	LT 1982	PP 1982	LT 1981	PP 1981	LT 1980	PP 1980	LT 1979	PP 1979	LT 1978	PP 1978
Chimney Creek to County Line																
1. Chimney Creek	0	(0)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	7*	(-)	0	(-)
2. Meadville Crossing	0	(0)	0	(-)	7[b]	(6)	25	(8+)	0	(-)	0	(-)	0	(-)	0	(-)
3. Prosser Creek	0	(0)	6*	(-)	9*	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
4. Old Cuba Bridge	0	(0)	10	(6)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
5. Cuba II	8	(6)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
6. Rock Creek	16	(10)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
7. Keya Paha II	0	(0)	0	(-)	0	(-)	0	(-)	7	(10)	20	(-)	0	(-)	11	(10)
County Line to Spencer Dam																
8. County Line	0	(0)	0	(-)	0	(-)	0	(-)	2	(15)	12	(PPN)	0	(-)	0	(-)
9. West Clay Creek	0	(0)	0	(-)	0	(-)	0	(-)	5*	(-)	0	(-)	0	(-)	0	(-)
10. Clay Creek III	0	(0)	0	(-)	25	(16+)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
11. Clay Creek-Valley View	0	(0)	0	(-)	0	(-)	0	(-)	27	(25)	0	(-)	0	(-)	0	(-)
12. Keya Paha I	21	(7)	0	(-)	0	(-)	0	(-)	12	(12)	0	(-)	12*	(-)	0	(0)
13. Bottleneck II	3	(4)	0	(-)	18	(12+)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
14. Bottleneck	0	(0)	0	(-)	0	(-)	0	(-)	0	(-)	18	(-)	0	(-)	0	(-)
15. Keya Paha Bend	0	(0)	0	(-)	0	(-)	0	(-)	15	(20)	0	(-)	0	(-)	0	(-)
16. Keya Paha Bend East	0	(0)	0	(-)	0	(-)	7*	(-)	0	(-)	0	(-)	0	(-)	0	(-)
17. Sandy Creek	0	(0)	0	(-)	14	(15)	8*	(-)	0	(-)	0	(-)	0	(-)	0	(-)
18. Sandy Creek II	10	(5)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
19. Butte II	0	(0)	26	(10)	0	(-)	0	(-)	0	(-)	12	(-)	0	(-)	0	(-)
20. Butte	14	(6)	9	(8)	22	(18+)	0	(-)	0	(-)	0	(-)	0	(-)	6	(13)
21. Roundbarn	10	(8)	0	(-)	0	(-)	9	(0)	0	(-)	0	(-)	0	(-)	0	(-)
22. Turkey Creek West	3	(2)	0	(-)	0	(-)	4	(0)	0	(-)	0	(-)	0	(-)	0	(-)
23. Turkey Creek	5	(4)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
24. West Spencer	0	(0)	12	(6)	0	(-)	0	(-)	25	(10)	6	(-)	0	(-)	0	(-)
25. Spencer	26	(16)	0	(-)	0	(-)	0	(-)	0	(-)	2	(-)	0	(-)	0	(-)
Spencer Dam to Niobrara Park																
26. Redbird	0	(0)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	25	(-)	12	(0)
27. East Redbird	0	(0)	0	(-)	0	(-)	0	(-)	2	(0)	14	(-)	0	(-)	0	(-)
28. West Redbird	0	(0)	0	(-)	9	(4+)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
29. Redbird Bridge	0	(0)	0	(-)	0	(-)	6	(4)	0	(-)	0	(-)	0	(-)	0	(-)
30. West Graham Ranch	5	(3)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
31. Graham Ranch	0	(0)	10	(2)	20	(8+)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
32. Bigline	16	(7)	0	(-)	0	(-)	8	(0)	0	(-)	10	(-)	0	(-)	0	(-)
33. Verdel	16	(12)	0	(-)	0	(-)	0	(-)	2	(0)	2	(-)	10*	(-)	5	(0)
34. Pishelville	0	(0)	0	(-)	0	(-)	0	(-)	0	(-)	20	(-)	0	(-)	0	(-)
35. Pishelville East	0	(0)	18	(6+)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
36. Schindler Creek	21	(10)	4*	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)
37. Niobrara	0	(0)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	0	(-)	6	(11)
38. Niobrara Park	0	(0)	0	(-)	18	(8-10)	20	(-)	0	(-)	0	(-)	0	(-)	0	(-)
Totals	174	(100)	95	(38)	135	(87-89)	87	(12)	97	(92)	116		54[c]		40	(34)

Source: Nebraska Game and Parks Commission; tabular data submitted to the Nebraska Department of Water Resources on February 4, 1987.

Notes: PPN = Piping plovers occurred at colony, nesting was documented.
PP = Piping plovers occurred at colony, but numbers or status not determined.
\- = Location was not surveyed.
\+ = Estimated population obtained by multiplying number of nests by 2.

(a) Numbers reflect adults censused during ground survey unless subscripted with an asterisk (*) to indicate the use of aerial counts at locations where ground checks were not conducted.

(b) This colony was located by Nature Conservancy personnel approximately 3 weeks after NGPC surveys. These 7 adult terns were not included in the total to avoid possible duplication.

(c) Seventeen additional least terns were observed on the Niobrara River in 1979 but were not associated with colony sites.

APPENDIX B

SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON NEBRASKA RIVERS, 1975-1986

NOTE: SEE APPENDIX C FOR ADDITIONAL INFORMATION ON NEBRASKA GAME AND PARKS COMMISSION SURVEY DATES AND COVERAGE

APPENDIX B-1. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE PLATTE RIVER, 1975-1986

1975 - Aerial and ground survey conducted in late June along entire river (North Platte to Plattsmouth) to document least tern occurrence. Adult birds were censused but colony locations were not specified. Survey efforts did not include observations of piping plovers. Source: Downing (1980).

1979 - Ground surveys conducted from 19 May - 26 June along central Platte River (Lexington to Grand Island, including 2 off-river sandpits). Adults of both species were censused based on nest counts and colony locations were mapped; each nest was visited 5 to 7 times during the study period. Source: Faanes (1983).

1981 - Ground surveys conducted from 6 June - 22 July in sections of the lower Platte River (Leshara to Schramm Park State Recreation Area). Adults of both species were enumerated and colony locations were recorded; 1 to 4 visits were made to each colony or nesting site. Source: Ducey (1981b).

1982 - Aerial survey conducted on 28-29 June and ground checks made between 30 June and 2 July. Area surveyed included entire river (North Platte to Plattsmouth) plus 4 off-river sandpits. Adult least terns were enumerated and colony locations were recorded. Piping plover were not censused, however the presence of adults or nests of this species was noted at least tern colony sites. Source: Nebraska Game and Parks Commission (NGPC) 1982 Platte River Least Tern Survey.

1983 - Aerial survey conducted along Grand Island to Plattsmouth reach on 5 July and along North Platte to Grand Island reach on 8 July; ground checks made between 6 and 12 July. Area survey included 21 off-river sandpits. Adult least terns were enumerated and the colony locations were recorded; 1 visit was made to each colony site. Piping plover were not censused, however the presence of adults or nests of this species was noted at least tern colony sites. Source: NGPC 1983 Platte River Interior Least Tern Nesting Survey.

1984 - Aerial surveys conducted on 13 June and 3 August, and ground checks made from 24 May until sites were no longer occupied. Area surveyed included entire river (North Platte to Plattsmouth) plus 24 off-river sandpits. Adults of both species were enumerated and colony locations were recorded; 7 to 14 visits were made to each colony site. Source: NGPC 1984 Interior Least Tern and Piping Plover Nesting Survey.

1985 - Aerial surveys conducted on 11 June and 17 June, and ground checks made between 12 June and 31 July. Area surveyed included entire river (North Platte to Plattsmouth) plus 26 off-river sandpits. Adults of both species were enumerated and colony locations were recorded; 1 visit was made to most sites. Source: NGPC 1985 Platte River Interior Least Tern and Piping Plover Nesting Survey.

1986 - Aerial survey conducted along Lexington to Plattsmouth reach on 2-3 June, along North Platte to Lexington reach on 6 June, and along South Platte River from Big Springs to North Platte on 6 June; ground checks made from 13 May until sites were no longer occupied. Area surveyed included 28 off-river sandpits. Adults of both species were enumerated and colony locations were recorded. Colonies on river sandbars were visited every 2 to 3 days, and colonies on sandpits were usually visited every 10 to 20 days. Colony sites between Lexington and Grand Island were monitored by the Platte River Whooping Crane Habitat Maintenance Trust. Source: NGPC 1986 Platte River Interior Least Tern and Piping Plover Nesting Survey.

APPENDIX B-2. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE MISSOURI RIVER FROM GAVINS POINT DAM TO PONCA, NEBRASKA, 1975-1986

1975 - Aerial and ground survey conducted in late June from Yankton, South Dakota to Sioux City, Iowa to document least tern occurrence. Adult birds were censused but colony locations were not specified. Survey efforts did not include observations of piping plovers. Source: Downing (1980).

1978 - Aerial survey conducted on 27 June from Gavins Point Dam (near Yankton, SD) to Ponca State Park, NE. No ground checks were made. Adult least terns were enumerated and colony locations were recorded. Piping plovers were not censused. Source: Nebraska Game and Parks Commission (NGPC) report Breeding Status of the Interior Least Tern (Sterna albifrons athalassos) in Nebraska, plus NGPC notes on survey dates and coverage (Appendix C).

1979 - Survey conducted by boat on 10-11 July from Yankton, SD to Ponca State Park, NE. Adult least terns were enumerated and colony locations were recorded. The number of adult piping plovers were recorded incidentally at one site, but this species was not surveyed at other locations. Source: NGPC 1979 Interior Least Tern Breeding Survey, plus NGPC notes on survey dates and coverage (Appendix C).

1980 - Aerial survey conducted on 25 June and ground checks made by boat during the week of 13 July from Yankton, SD (Gavins Point Dam) to Ponca State Park, NE. Adult least terns were enumerated and colony locations were recorded. Piping plover were not censused but species' use was noted at least tern colony sites. Source: Nebraska Game and Parks Commission (NGPC) 1980 Interior Least Tern Survey.

1981 - Three surveys conducted from Yankton, SD to Ponca State Park, NE; survey dates were 28-29 May, 18-21 June, and 9-10 July. On the first and third surveys, observers ran the river by boat and ground searches were made at locations where least tern colonies were sighted. During the second survey, an observer examined colonies from a distance with a spotting scope and then followed up with a ground search. Adult least terns were enumerated based on counts obtained during the first survey (28-29 May), and colony locations were recorded. Piping plover were not censused, however the presence of adults and/or nests of this species was noted at least tern colony sites. Source: NGPC 1981 Missouri River Interior Least Tern Nesting Survey.

1982 - Three surveys were conducted from Yankton, SD to Ponca State Park, NE; survey dates were 22-23 June, 7-8 July, and 27-28 July. During each survey, observers ran the river by boat and ground searches were made at locations where least tern colonies were sighted. Adult least terns were enumerated based on counts obtained during the first survey (22-23 June), and colony locations were recorded. Piping plover adults were not censused, however active nests of this species were enumerated at least tern colony sites. Source: NGPC 1982 Missouri River Interior Least Tern Nesting Survey.

1983 - Eight to nine ground surveys were made from 24 May to 27 July at colonies located between Yankton, SD and Ponca State Park, NE. Adults of both species were censused and colony locations were recorded. Colony population sizes were based on the 14-16 June survey and were determined from the number of adults observed or the number of nests multiplied by two (whichever was greater). Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1984 - Two ground surveys conducted from Yankton, SD to Ponca State Park, NE by boat; survey dates were 13-15 June and 9-10 July. Adults of both species were censused and colony locations were recorded. Colony population sizes were based on the 13-15 June survey and were determined from the number of adults observed or the number of nests multiplied by two (whichever was greater). Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1985 - Two ground surveys conducted from Yankton, SD to Ponca State Park, NE by boat; survey dates were 19-21 June and 16-17 July. Adults of both species were censused and colony locations were recorded. Colony population sizes were based on the 19-21 June survey and were determined from the number of adults observed or the number of nests multiplied by two (whichever was greater). Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1986 - Separate surveys were conducted by NGPC, and the South Dakota Department of Game, Fish and Parks (in cooperation with US FWS). Survey efforts were as follows:

- NGPC conducted one complete ground survey from Yankton, SD to Ponca State Park, NE by boat on 4-5 June. Adults of both species were censused and colony locations were recorded. Colony population sizes were determined from the number of adults observed or the number of nests multiplied by two (whichever was greater). Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

- The South Dakota Department of Game, Fish and Parks (in conjunction with US FWS) conducted an aerial survey from Yankton, SD to Ponca State Park, NE on 27-28 May to locate colonies and potential nesting habitat. Population censuses were subsequently conducted from early June to early July via boat surveys. Adults of both species were enumerated and colony locations were recorded. All active nesting areas were visited a minimum of three times, at approximately 18 day intervals, to estimate population size and production. Population size of least terns and piping plovers was determined as the maximum number of adults of each species counted during any single census period wherein all active sites were visited sequentially to quantify the total numbers of birds present in the survey area. Source: Schwalbach et al. (1986, 1988).

APPENDIX B-3. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE UPPER MISSOURI RIVER BETWEEN FORT RANDALL DAM AND LEWIS AND CLARK LAKE, 1982-1986

1982 - Aerial survey conducted on 2 July but ground checks were not made. No least terns were observed, and piping plovers were not inventoried because of difficulty in spotting this species from the air. Source: Nebraska Game and Parks Commission (NGPC) notes on survey dates and coverage (Appendix C).

1983 - Aerial survey conducted on 21 June and ground checks were made on 21 June, 11 July, and 25 July. Adults of both species were censused and colony locations were reported. Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1984 - Aerial survey conducted on 19 June but ground checks were not made. Adult least terns were censused and colony locations were reported. Piping plovers were not inventoried because of difficulty in spotting this species from the air. Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1985 - Aerial survey conducted on 30 May but ground checks were not made. Adult least terns were censused and colony locations were reported. Piping plovers were not inventoried because of difficulty in spotting this species from the air. Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1986 - Aerial survey conducted on 27-28 May by South Dakota Department of Game, Fish and Parks (in cooperation with US FWS) to locate colonies and potential nesting habitat. Population censuses were subsequently conducted from early June to early July via boat surveys. Adults of both species were enumerated and colony locations were recorded. All active nesting areas were visited a minimum of three times, at approximately 18 day intervals, to estimate population size and production. Population size of least terns and piping plovers was determined as the maximum number of adults of each species counted during any single census period wherein all active sites were visited sequentially to quantify the total numbers of birds present in the survey area. Source: Schwalbach et al. (1986, 1988).

APPENDIX B-4. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE NIOBRARA RIVER, 1975-1986

1975 - Aerial and ground survey conducted in late June along entire river to document least tern occurrence. Adult birds were censused but colony locations were not specified. Survey efforts did not include observations of piping plovers. Source: Downing (1980).

1978 - Aerial survey conducted on 26 June, and ground checks made on 28-29 June, from Valentine to Niobrara. Adult least terns were enumerated and colony locations were recorded. Counts or estimates of adult piping plovers were recorded during ground checks at least tern colony sites. Source: Nebraska Game and Parks Commission (NGPC) report Breeding Status of the Interior Least Tern (Sterna albifrons athalassos) in Nebraska, plus NGPC notes on survey dates and coverage (Appendix C).

1979 - Ground survey of 1978 colony sites conducted on 17 July, and aerial survey conducted from Norden to Niobrara on 26 July. Adult least terns were enumerated and colony locations were recorded. Surveys did not include censusing of piping plover. Source: NGPC 1979 Interior Least Tern Breeding Survey, plus NGPC notes on survey dates and coverage (Appendix C).

1980 - Aerial survey conducted on 24 June, and ground checks made on 13 and 14 July, from Norden to Niobrara. Adult least terns were enumerated and colony locations were recorded. Piping plover occurrence and nesting were noted incidentally at one site, but this species was not surveyed at other locations. Source: NGPC 1980 Niobrara River Least Tern Survey.

1981 - Aerial survey conducted on 1 July and 5 July, and ground checks made on 6-7 July, from Valentine to Niobrara. Adult least terns were enumerated and colony locations were recorded. Counts or estimates of adult piping plovers were recorded during ground checks at least tern colony sites. Source: NGPC 1981 Niobrara River Interior Least Tern Nesting Survey.

1982 - Aerial survey conducted on 1-2 July, and ground checks made on 13-14 July, from Rocky Ford (southeast of Norden) to Niobrara. Adult least terns were enumerated and colony locations were reported. Counts or estimates of adult piping plovers were recorded during ground checks at most least tern colony sites. Source: NGPC 1982 Niobrara River Interior Least Tern Nesting Survey.

1983 - Aerial survey conducted on 20-21 June, and ground checks made on 21-22 June, from Valentine to Niobrara. Adult least terns were enumerated and colony locations were reported. Counts or estimates of adult piping plovers were recorded during ground checks at least tern colony sites. Source: NGPC 1983 Niobrara River Interior Least Tern Nesting Survey.

1984 - Aerial survey conducted on 19 June, and ground checks made on 20-22 June, from Valentine to Niobrara. Adult least terns were enumerated and colony locations were reported. Counts or estimates of adult piping plovers were recorded during ground checks at least tern colony sites. Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1985 - Aerial survey conducted on 30 May, and two complete ground surveys made by airboat on 4-6 June and 23-25 July, from Valentine to Niobrara. Adults of both species were enumerated and colony locations were reported. Source: NGPC preliminary data submitted to Nebraska Department of Water Resources (4 February 1987).

1986 - No survey conducted.

APPENDIX B-5. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE LOUP RIVERS, 1979-1986

1979 - Reconnaissance ground survey conducted along portions of the Loup River system in Howard County during the period late June through mid-July. Least tern nests were observed and enumerated, but the locations of nest sites were not reported. Piping plover occurrence was not noted. Source: Faanes (1983).

1983 - Aerial survey conducted on 5 July along Loup River from Columbus to St. Paul (including one off-river sandpit), and on 8 July along North Loup River from Ord to St. Paul and Middle Loup River from Milburn to St. Paul; ground checks were made on 13 July. Adult least terns were enumerated and the presence of piping plover adults (or nests) was noted. Locations of colonies and/or nesting sites were recorded. Source: Nebraska Game and Parks Commission (NGPC) 1983 Platte River Interior Least Tern Nesting Survey, plus NGPC notes on survey dates and coverage (Appendix C-5).

1985 - Aerial survey conducted on 26 July along the Middle Loup and Loup rivers from Sargent to Columbus; ground checks were not made. A total of 56 least terns were observed at 15 locations, however the size and location of specific colonies were not reported. Piping plovers were not censused because of difficulty in spotting this species from the air. Source: NGPC notes on survey dates and coverage (Appendix C-5).

1986 - Aerial survey conducted on 2 June along the Middle Loup and Loup rivers from Sargent to Columbus; ground checks were not made. A total of 12 terns were observed at 9 locations, however the size and location of specific colonies were not reported. Piping plovers were not censused because of difficulty in spotting this species from the air. Source: NGPC notes on survey dates and coverage (Appendix C-5).

APPENDIX B-6. SUMMARY OF EFFORT ASSOCIATED WITH INTERIOR LEAST TERN AND PIPING PLOVER BREEDING POPULATION SURVEYS ON THE ELKHORN RIVER, 1985-1986

1985 - Ground survey conducted on 22 June at sandpit adjacent to the river near Pilger, NE. Two adult least terns observed (1 incubating). Source: Nebraska Game and Parks Commission (NGPC) notes on survey dates and coverage (Appendix C-6).

1986 - Aerial survey of river and adjacent sandpits conducted on 3 June from Norfolk, NE to confluence of Elkhorn and Platte rivers; ground survey conducted at sandpit near Pilger, NE on 6 June. Three piping plover nests observed. Source: NGPC notes on survey dates and coverage (Appendix C-6).

APPENDIX C

DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ON NEBRASKA RIVERS CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1977-1986

APPENDIX C-1. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE PLATTE RIVER CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1981-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1981		6/6 to 7/14	Fremont to Two Rivers & I-80 to South Bend	Several colony checks by Ducey
1982	6/28,29		N. Platte-Plattsmouth	G.W. & Spoering/Cub
		6/30-7/2	All colonies	4 of 13 sites at pits
1983	7/5		Grand Is.-Plattesmouth	Dinan-flew river and pits
	7/8		N. Platte-Grand Is.	G.W. & Spoering/Cub-Flew river and pits
		7/6-13	All colonies	18 sites at pits-Dinan, Carlson, G.W.
1984	6/13		N. Platte-Plattsmouth	G.W. with Bob Ritter (Wilson Flying Ser)./180-6.5 Hr. Flew sandpits only
		5/25-7/31	12 colonies	Checks every 3-7 days by Sally Gaines
	8/3		N. Platte-Plattsmouth	G.W. & Spoering/Cub-8+ Hr., River only
1985	6/17		N. Platte-Plattsmouth	G.W. with Al Nemans (Wilson's) Archer II-8 Hr. Flew river & pits active in '84
		(?)	All colonies	Periodic checks by Dinan & summer aide
	7/26		Grand Is.-Lexington	Photo flight
		7/9-11	Jeffrey Is. & Sandy Channel	Food habits sampling-G.W., Dinan, Madsen, Bureau aides
		7/31	Jeffrey Is.	Food habits sampling-Dinan, G.W., Fisheries aide
1986	6/2,3		Lexington-Plattsmouth	G.W. & Lyons (Dept. Aeronautics)/172-6 hr., river & pits
	6/6		Lexington-Big Springs	G.W. & Allen (Wilson's)/172-3½ hr., river & pits
	6/17		Plattsmouth-Lexington	G.W. & George Land (B. Bow)/172-5 hr., Vertical photos with belly camera
		6/5	N. Platte-Keystone (N. Platte River) & N. Platte-Big Springs (S. Platte River)	G.W. checks from bridges for birds and habitat
		6/7	All colonies	Periodic visits by Ilene Kirsch, Dinan, G.W.

Note: Other recent records by Downing (1975), USFWS-Platte River Ecology Study (1978-80), Lingle (Trust) since 1980 and Ducey.

* Source: Nebraska Game and Parks Commission.

APPENDIX C-2. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE MISSOURI RIVER FROM GAVINS POINT DAM TO PONCA, NEBRASKA CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1978-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1978	6/27		Gavins Pt.-Ponca	Spoering/Citabra
1979		7/10,11	Yankton-Ponca	20′ Monarch boat, with Trindle, Stewart, Luce
	7/27		Yankton-Ponca	Photo flight with Spoering
1980	6/25		Yankton-Ponca	Spoering/Cub
		7/16,17	Yankton-Ponca	20′ Monarch boat, with Trindle, Stewawrt, Wellstead
1981		5/27,28	Yankton-Ponca	By boat with Trindle, Carlson, & 4th Observer
		6/18-21	Colony checks	Carlson from bank & boat
		7/9,10	Yankton-Ponca	5 observers
1982		6/22,23	Yankton-Ponca	By boat-includes Carlson, Dinan
		7/7,8	Yankton-Ponca	By boat-includes Carlson, Dinan
		7/27,28	Yankton-Ponca	By boat-includes Carlson, Dinan
1983		5/18 to 6/14	Old colony locations	Spot checks
		6/14-16	Yankton-Ponca	By boat-Dinan, Carlson, Andelt & Ducey Surveyed elevations, nest distances & vegetation transects
		6/28,29	Yankton-Ponca	Select colonies-Ducey via boat
		7/12,13	Yankton-Ponca	Select colonies-Ducey via boat
		7/18,19	Yankton-Ponca	Select colonies-Ducey via boat
	(?)		All colonies	Photo-vegetation flight
1984		6/13-15	Yankton-Ponca	
1985		6/19-21	Yankton-Ponca	Dinan, Carlson by airboat and boat (marginal results)
		7/16,17	Yankton-Ponca	Dinan, G.W., George VanDel boat (good results)
1986		6/4-6	Yankton-Ponca	Dinan, Corps, S. Dakota pers. boat survey

Note: All surveys prior to 6/81 trip included G. Wingfield as an investigator.
* Source: Nebraska Game and Parks Commission.

APPENDIX C-3. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE UPPER MISSOURI RIVER BETWEEN FORT RANDALL DAM AND LEWIS AND CLARK LAKE CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1982-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1982	7/2		Gross, NE to Lewis & Clark	G.W. & Spoering/Cub - no terns observed
1983	6/21		Gross-Lewis & Clark	G.W. & Spoering/Cub
		6/21	"Niobrara Old Town Colony"	
		7/11	Gross to Niobrara	2 colones by Ducey
1984	6/19		Gross to Lewis & Clark	G.W. & Kilmer/150 1 colony-"Bazille Cr." - 12 birds
1985	5/30		Gross to Lewis & Clark	G.W. & Kilmer/150 - 3 colonies
1986		No survey by NGPC (South Dakota coverage)		

* Source: Nebraska Game and Parks Commission.

APPENDIX C-4. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE NIOBRARA RIVER CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1977-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1977		(?)	Butte & Newport	Lock checking '75 locations
1978	6/26		Valentine-Niobrara	Spoering flew Citabra
		6/28,29	All colonies	
1979		7/17	Bassett-Niobrara	Checked '78 locations
	7/26		Nordon-Niobrara	Spoering/Citabra
1980	6/24		Nordon-Niobrara	Spoering/Cub
		7/13,14**	All colonies	Jim Ducey-Investigator
1981	7/1,5		Valentine-Niobrara	Spoering/Cub
		7/6,7	All colonies	With Jon Farrar
1982	7/1,2		Rocky Ford-Niobrara	Spoering/Cub
		7/13,14	All colonies	
1983	6/20,21		Valentine-Niobrara	Spoering/Cub
		6/21,22	Colony checks	
1984	6/19		Valentine-Niobrara	Bob Kilmer/150-3.5 hr.
		6/20-22	All colonies	With Vodehnal
1985	5/30		Valentine-Niobrara	Bob Kilmer/150-3.9 hr. (75-80 mph, 50-100' Alt.)
		6/4-6	Nordon-Niobrara	Airboat-Ralston & Dinan
		6/26		Airboat Cancelled
		7/23-25	Springview-Niobrara	Airboat-Roberts & Dinan
1986		No survey		

* Source: Nebraska Game and Parks Commission.
** All surveys except this one included G. Wingfield as investigator.

APPENDIX C-5. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE LOUP RIVERS CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1983-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1983	7/5		St. Paul to Columbus	Dinan-colony at Fullerton pit
	7/8		Milburn to St. Paul & Ord to St. Paul	G.W. & Spoering/Cub
		7/13	All colonies	G.W. & Dinan
1985	7/26		Sargent to Columbus	G.W. & Chuck (Wilson's)/172-5 hr., 15 locations with 56 terns
1986	6/2		Sargent to Columbus	G.W. & (Dept. Aviation)/172-2½ hr., 9 locations with 12 terns, 250', 80 kts.

* Source: Nebraska Game and Parks Commission.
Note: Other recent records by G. Busch (Bureau) in 1979, Lingle & Vanderwalker (Trust) since 1982.

APPENDIX C-6. DATES AND COVERAGE ASSOCIATED WITH INTERIOR LEAST TERN/PIPING PLOVER SURVEYS ALONG THE ELKHORN RIVER CONDUCTED BY NEBRASKA GAME AND PARKS COMMISSION PERSONNEL, 1985-1986*

Year	Date(s) Aerial	Date(s) Ground	Coverage	Comments
1985		6/22	Pilger-Sandpit	2 adult terns-1 incubating
1986	6/3		mouth-Norfolk	G.W. & Lyons (Dept. Aero.)/172-2¼ hr., river & pits
		6/6	Pilger-Sandpit	3 plover nests with 4 eggs each

* Source: Nebraska Game and Parks Commission.