APPENDIX J

SUMMARY OF STUDY RESULTS RELATED TO THE INTERIOR LEAST TERN AND PIPING PLOVER

THE SUMMARY OF STUDY RESULTS RELATED TO THE INTERIOR LEAST TERN AND PIPING PLOVER IS CURRENTLY UNAVAILABLE BUT WILL BE PROVIDED PRIOR TO THE UPDATED STUDY RESULTS MEETING.

Loup River Hydroelectric Project
FERC Project No. 1256

Summary of Study Results Related to the Interior Least Tern and Piping Plover

Loup Power District
Hydro Project

August 26, 2011

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Loup River Hydroelectric Project
FERC Project No. 1256

Summary of Study Results Related to the Interior Least Tern and Piping Plover

August 26, 2011

Prepared by:
Loup Power District
2404 15th Street
Columbus, NE 68602

With assistance by:
HDR Engineering, Inc.
8404 Indian Hills Drive
Omaha, NE 68114

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SUMMARY OF STUDY RESULTS RELATED TO THE INTERIOR LEAST TERN AND PIPING PLOVER

Loup River Public Power District (Loup Power District or the District) has conducted a series of studies, the results of which have been filed with the Federal Energy Regulatory Commission (FERC), as part of relicensing the Loup River Hydroelectric Project (FERC Project No. 1256 or the Project). Several of these studies examined potential Project effects related to threatened and endangered species known to use the Loup and lower Platte rivers. Following publication of the District's Second Initial Study Report, FERC requested a summary that synthesizes the results of Studies 1.0 (Sedimentation), 2.0 (Hydrocycling), and 5.0 (Flow Depletion and Flow Diversion) to discuss how the results of these studies have the potential to collectively impact the presence, absence, and/or nesting success of interior least terns and piping plovers (FERC, April 8, 2011). Therefore, this report was prepared to summarize study results. This report includes a brief description of the species and their habitat use within the study area, a summary of individual study results, and a discussion of potential Project effects on habitat and, by extension, interior least terns and piping plovers related to all study results.

1. SPECIES BACKGROUND

The biology, life history, habitat, and range of the interior least tern (*Sternula antillarum athalassos*) and piping plover (*Charadrius melodus*) are briefly summarized below. These Federally listed species are known to occur within and near the Project Boundary.

1.1 Interior Least Tern

The interior least tern was Federally listed as endangered on May 28, 1985 (50 Federal Register [FR] 21784-21792). On April 22, 2008, the U.S. Fish and Wildlife Service (USFWS) initiated a 5-year review of this species (73 FR 21643-21645). The 5-year review for this species is ongoing, and no report has been published to date. No critical habitat has been designated for the interior least tern.

1.1.1 Species Description

Interior least tern on nest. Photo courtesy of U.S. Fish and Wildlife Service.

Least terns (all currently recognized subspecies/populations) are the smallest members of the subfamily Sterninae and family Laridae of the order Charadriiformes. Adults measure approximately 8 to 9.5 inches long, with a 20-inch wingspan. The birds have a black cap, a white forehead, grayish back and dorsal wing surfaces, and a dark-tipped bill (Thompson et al., 1997).

The interior least tern is a migratory species, breeding along large rivers within the interior of the United States. They typically begin arriving in Nebraska in early May to mid-June and spend approximately 4 to 5 months at their breeding sites (Faanes, 1983; USFWS, September 1990).

Interior least terns nest in shallow depressions with small stones, twigs, or other debris nearby. Interior least terns nest in colonies, or terneries, and nests can be as close as just a few feet apart or widely scattered up to hundreds of feet. Egg-laying typically begins in late May, with the female laying one to three eggs in a nest (Thompson et al., 1997; USFWS, September 1990; Szell and Woodrey, 2003). Incubation typically lasts 17 to 28 days (Thompson et al., 1997; USFWS, September 1990).

Interior least tern chicks are able to walk upon hatching, but are brooded for approximately 1 week and fledged after 3 weeks, although parental care continues until fall migration (USFWS, September 1990). Departure from colonies by both adults and fledglings varies, but is usually complete by early September.

Interior least terns are opportunistic feeders and feed on a variety of small fishes found in the shallow waters of rivers, streams, and lakes. Adult terns usually consume fish longer than 1.6 inches and bring smaller fish to the nest for the chicks (Mitchell, March 1998). Interior least terns are categorized as surface plungers because they search for prey while flying or hovering above the surface of the water and plunge into the water to capture detected prey (Mitchell, March 1998).

1.1.2 Habitat and Range

Interior least terns winter in South America, where little is known about their wintering habits and habitats, and they reproduce in the summer months in North America. Historically, the interior least tern’s breeding range extended from Montana to Texas and from southern Indiana to New Mexico, and this breeding range has not changed. This species breeds, nests, and forages along the Missouri, Mississippi, Arkansas, Ohio, Red, and Rio Grande river systems (USFWS, September 1990).

Lott conducted the first range-wide census of the interior least tern in 2005 and found that the lower Mississippi River is the most important breeding area for this species, with approximately 62.3 percent of all interior least terns surveyed occurring on the lower Mississippi (Lott, November 2006). Four additional river systems accounted for 33.3 percent of the remaining interior least terns. The overall results of the census are as follows:

- Lower Mississippi River system – 62.3 percent
- Arkansas River system – 11.6 percent
- Red River system – 10.4 percent

- Missouri River system – 6.9 percent
- Platte River system – 4.4 percent

Less than 5 percent of the population was counted on the Ohio River system, the Trinity River system in Texas, the Rio Grande/Pecos River system in New Mexico and Texas, the Wabash River system, two reservoirs in east Texas, and the Kansas River system.

Many of the river systems known to be used by interior least terns, including some of the most populated such as the Missouri, Red, and Arkansas, have power or flood control facilities that practice hydrocycling operations or the manipulation of flows in a way that mimics hydrocycling.

Meandering rivers with broad flat floodplains, high sedimentation rates, and slow currents resulting in the formation of sandbars and shallow water areas offer the most suitable habitat for nesting and feeding (Whitman, 1988, as cited in Lott, November 2006). Typical riverine nesting habitat for interior least terns is unvegetated or sparsely vegetated sand and gravel bars within a wide unobstructed river channel (USFWS, September 1990). The Platte River in Nebraska contains habitat that is consistent with these typical riverine nesting conditions.

An important factor for nest site selection of interior least terns is continuous exposure of the site above water for at least 100 days during the nesting period from mid-May to early August (Smith and Renken, 1993). Sandbar habitats used by interior least terns are ephemeral (Kirsch, 1996; Thompson et al., 1997); thus, interior least tern nests are susceptible to loss of nests, eggs, or chicks caused by high water events. Nesting is usually initiated during high-flow periods, causing interior least terns to nest on higher areas of sandbars. In some areas, sand/gravel pits and lakeshore housing developments may provide the most suitable nesting habitat available when the interior least terns arrive in the spring (Lingle, 1988, as cited in Nebraska Game and Parks Commission [NGPC], December 2008). These sand-pit lakes are often found in close proximity to the river.

Another important factor for nesting habitat for interior least terns is lack of vegetation at the nest site. Suitable nesting areas often contain little vegetation (less than 25 percent) (Ziewitz et al., 1992), and the vegetation that is present is typically less than 3.9 inches tall (Dirks et al., 1993). Wilson et al. (1993) and Dirks et al. (1993) found that nesting interior least terns on sand pits preferred areas of less than 10 percent vegetative cover. Smith and Renken (1993) found that a common feature of nesting habitat is the presence of large amounts of sticks, twigs, and bark (driftwood) deposited by receding river levels near nesting colonies.

Nesting sites on river sandbars are often found within relatively wide channels with a large area of dry, sparsely vegetated sand (Kirsch, 1996). Nest sites in the lower Platte River had an average of 3.58 acres of dry, sparsely vegetated sand (Ziewitz et al., 1992). Ziewitz et al. (1992) also found that birds nested in areas where the channel was wider with a greater area of sandbars. That study recommended that sandbars be at least 3.58 acres in size and be 2.99 feet above river level for maximum flooding protection and at a minimum 1.48 feet in height. In a preliminary study, Brown and Jorgensen (2008) looked at river nesting habitat used by interior least terns in the lower Platte River in Nebraska. They found that the average sandbar area used was 12.18 acres. The average elevation of sandbars selected by interior least terns for nesting was 2.29 feet above the surface of the water.

Nesting areas at sand-pit sites have been characterized by expansive areas of sand with large areas of surface water (Kirsch, 1996). When Kirsch (1996) examined interior least tern preference of habitat between river sandbar habitat and man-made sand-pit habitat, four out of five criteria for judging habitat preference suggested that interior least terns did not prefer one habitat over the other. The results of that study suggested that bare sand and proximity to other important resources may be enough for interior least terns to colonize a site. Sidle and Kirsch (1993) found classified suitable sand pits on the Platte River as ranging in size from 1.48 to 196.70 acres. The sand and gravel areas of these sites ranged from 0.49 to 92.17 acres, and the surface area of water ranged from 0.99 to 149.75 acres. The Project's North and South Sand Management Areas, near the Diversion Weir on the Loup River, were considered as one site during that study, and this area was the largest site reviewed at 496.79 acres, with 425.50 acres of sand and gravel and 70.67 acres of water.

1.1.3 Threats to the Species

A 5-year review to determine the magnitude of threats to the interior least tern is currently being conducted and has not yet been completed (73 FR 21643-21645). The following threats to this species are listed in the current USFWS interior least tern recovery plan (USFWS, September 1990):

- Habitat alteration and destruction – specifically along the Missouri, Arkansas, and Red river systems, due to flow regulation
- Human disturbance – specifically due to recreational and commercial development activity

1.2 Piping Plover

Piping plover on nest with eggs. Photo courtesy of the Tern and Plover Conservation Partnership.

The Northern Great Plains population of piping plovers was Federally listed as threatened on December 11, 1985 (50 FR 50726-50733). On September 30, 2008, USFWS initiated a 5-year review of this species (73 FR 56860-56862). The results of the 5-year review were published by USFWS on September 29, 2009. The review concluded that no change is warranted in the listing status of the piping plover and that the species should remain listed as endangered in the watershed of the Great Lakes and listed as threatened in the remainder of the species' range (USFWS, September 2009). Critical habitat was designated for this species on September 11, 2002 (67 FR 57637-57717), but this designation in the State of Nebraska was vacated by the U.S. District Court on October 13, 2005. No critical habitat is currently designated in Nebraska for the piping plover.

1.2.1 Species Description

The piping plover is a small sand-colored, migratory shorebird with a short, stout bill, pale underparts, and orange legs. Both sexes are sand-colored. During the breeding season, adults acquire single black forehead and breast bands, and orange bills (USFWS, 1988).

The piping plover is a migratory species, breeding along large rivers within the interior of the United States and Canada, and along the Atlantic coast. Piping plovers typically begin arriving in Nebraska in late April and early May and spend approximately 3 to 4 months at their breeding sites (Sharpe et al., 2001). Once the birds arrive, the males begin establishing territories with aerial displays and calls (Aron, 2005).

Piping plover nests are shallow depressions frequently lined with small pebbles or shell fragments (Cairns, 1982; USFWS, 1988). Egg-laying typically begins in mid-May, with females usually laying three to five eggs (USFWS, November 30, 2000; Aron, 2005). Incubation lasts approximately 28 days (Wilcox, April 1959; Cairns, 1982; Haig and Oring, 1988a, as cited in NGPC, December 2008).

Piping plover chicks are precocial, leaving the nest almost immediately. The chicks begin foraging and feeding themselves within a few hours of hatching and leaving the nest (Cairns, 1982). Fledging typically occurs approximately 28 days after hatching. Departure from nesting areas by both adults and fledglings varies, but is usually complete by early August (Cairns, 1982; Prindiville Gaines and Ryan, 1988).

Piping plovers forage visually for invertebrates in shallow water and associated moist substrates (Cuthbert et al., 1999; Whyte, 1985, as cited in NGPC, December 2008). Along the Platte River, piping plovers primarily feed on beetles and small soft-bodied invertebrates from the waterline. In addition, they opportunistically take prey from drier sites at sand pits (Lingle, 1988, as cited in NGPC, December 2008).

1.2.2 Habitat and Range

Piping plovers winter along the southern Atlantic coast in the U.S., the Gulf of Mexico coast in the U.S. and Mexico, and the Caribbean islands. Reproduction occurs in the summer months in the northern U.S. and Canada. The piping plover breeding range includes the Northern Great Plains from Alberta to Manitoba and south to Nebraska; the Great Lakes beaches; and Atlantic coastal beaches from Newfoundland to North Carolina. The most recently published results of the International Piping Plover Breeding Census (2006) indicated that over half of these birds were found in the U.S. and Canada Northern Great Plains and Prairie Canada regions (Elliott-Smith et al., 2009).

Piping plovers are relatively short-distance migrants that spend up to 70 percent of their annual cycle on wintering areas. During the nonbreeding period (approximately early September to early April), piping plovers use beaches, sandflats, and dunes along the Gulf of Mexico coastal beaches, adjacent off-shore islands (Haig and Oring, 1985), and the southern Atlantic coast (Nicholls and Baldassarre, 1990). Spoil piles in the Intercoastal Waterway are also used. Despite their broad winter distribution, more than 50 percent of the piping plovers counted during the 2006 winter census (the most recent for which data have been published) occurred along the Texas coast (Elliott-Smith et al., 2009).

Piping plovers nest on open to sparsely vegetated sand and gravel beaches along the Atlantic coast, the Great Lakes, and throughout the Great Plains of North America (Cairns, 1982; Prindiville Gaines and Ryan, 1988; Haig, 1992). In north-central North America, piping plovers nest on barren sand and gravel shores and islands of rivers and lakes in the Great Plains (USFWS, 1988).

Piping plovers nesting on the Missouri, Platte, Niobrara, Yellowstone, and other Great Plains rivers use beaches and dry, barren sandbars in wide open channel beds (Kirsch, 1996; USFWS, 1988). Suitable nesting areas often contain minimal vegetative cover of less than 25 percent (Ziewitz et al., 1992). The optimum range for vegetative cover on nesting habitat has been estimated at 0 to 10 percent (Armbuster, 1986, as cited in NGPC, December 2008). Piping plovers often express a strong preference for nests to be initiated near objects, such as driftwood, stones, or plant debris (Haig, 1992).

Sandbar area and height are important factors in nesting habitat selection. Faanes (1983) studied Platte River sandbars occupied by nesting piping plovers and found that the sandbars with active nests averaged approximately 3.89 acres. Piping plover nests averaged 52 feet from the water's edge, with the average height above the river level measuring 0.66 foot (it should be noted that all of the nests studied were inundated by rain events). Ziewitz et al. (1992) found similar results with nest site sandbars on the lower Platte River averaging 3.58 acres. Nests on the central Platte River were initiated at lower elevations (an average of 1.28 feet) than nests on the lower Platte River (1.61 feet) (Ziewitz et al., 1992). Recommendations based on that study suggest that sandbars should be at least 3.58 acres in size and greater than 1.48 feet in height to be suitable for piping plover nesting.

Along with interior least terns, piping plovers will use man-made habitats such as sand and gravel mine pits and lakeshore housing developments. These sandy lake shores provide a barren to sparsely vegetated substrate suitable for nesting habitat (Sidle, 1993).

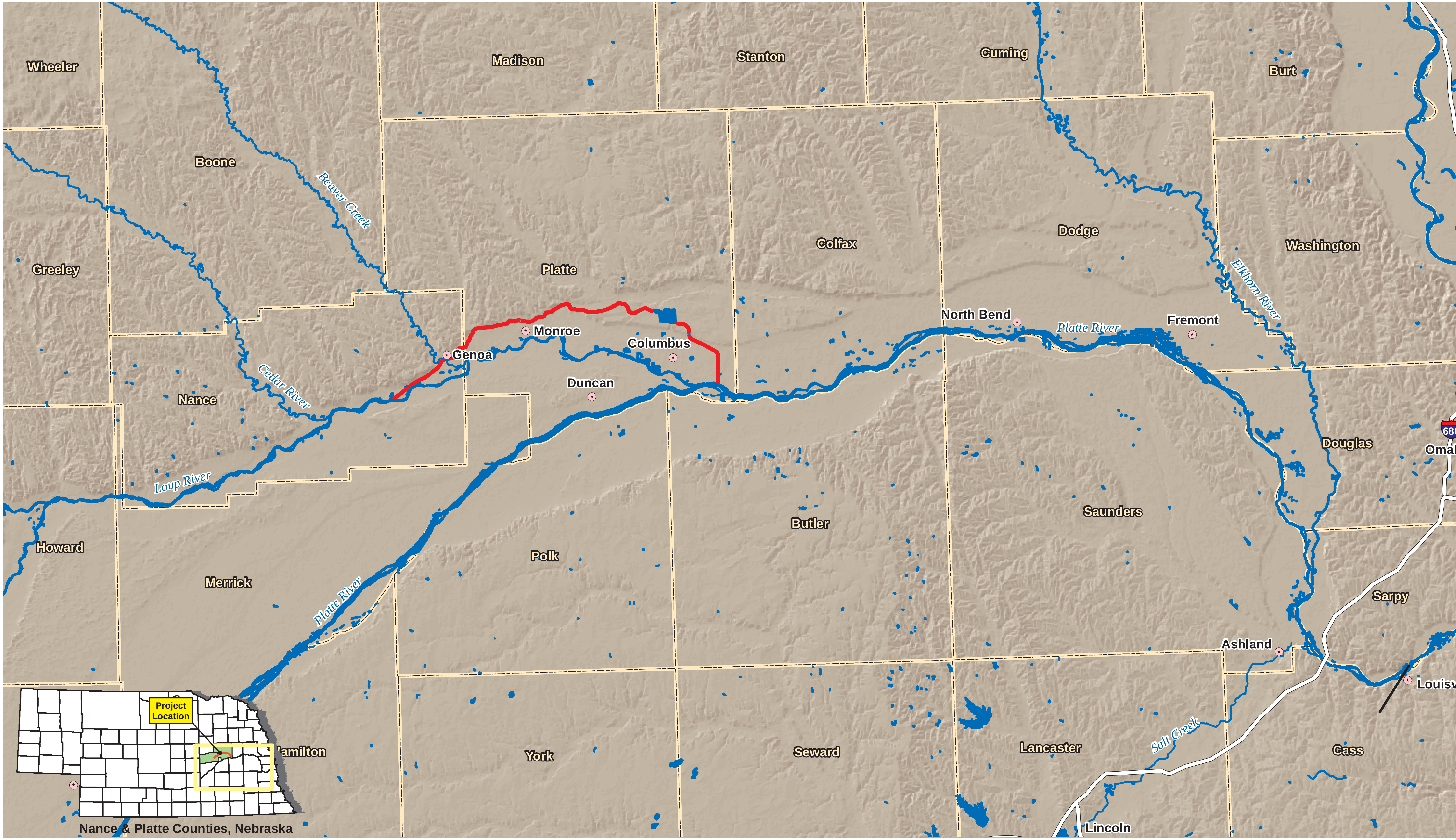
1.2.3 Threats to the Species

The following threats to the piping plover are discussed in the 5-year review conducted by USFWS (September 2009) and were classified as major threats to the species based on criteria within the review:

- Destruction of wintering habitat due to human development
- Reservoirs, channelization of rivers, and flow modification
- Predation
- Human disturbance, specifically due to recreational activity
- Vegetation encroachment

2. STUDY AREA

The Project is located in Nance and Platte counties, Nebraska, which is in the Great Plains physiographic province (Flowerday, Kuzelka, and Pederson, 1998). The study area for consideration of potential Project effects on threatened or endangered species includes the Loup River bypass reach (from the Diversion Weir to the confluence with the Platte River), and the lower Platte River (see Figure 2-1). The Loup and lower Platte rivers are part of the larger Platte River Basin (see Figure 2-2).



N

8 4 0 8
Miles

Source: Streams/Waterbodies, 2000 Tiger Files

Legend
- City
- Interstate
- Stream/River
- Loup Power Canal
- Waterbody
- County

Loup Power District Hydro Project

Study Area

Loup River Hydroelectric Project
FERC Project No. 1256
Updated Study Report

DATE
Aug. 26, 2011

FIGURE
2-1

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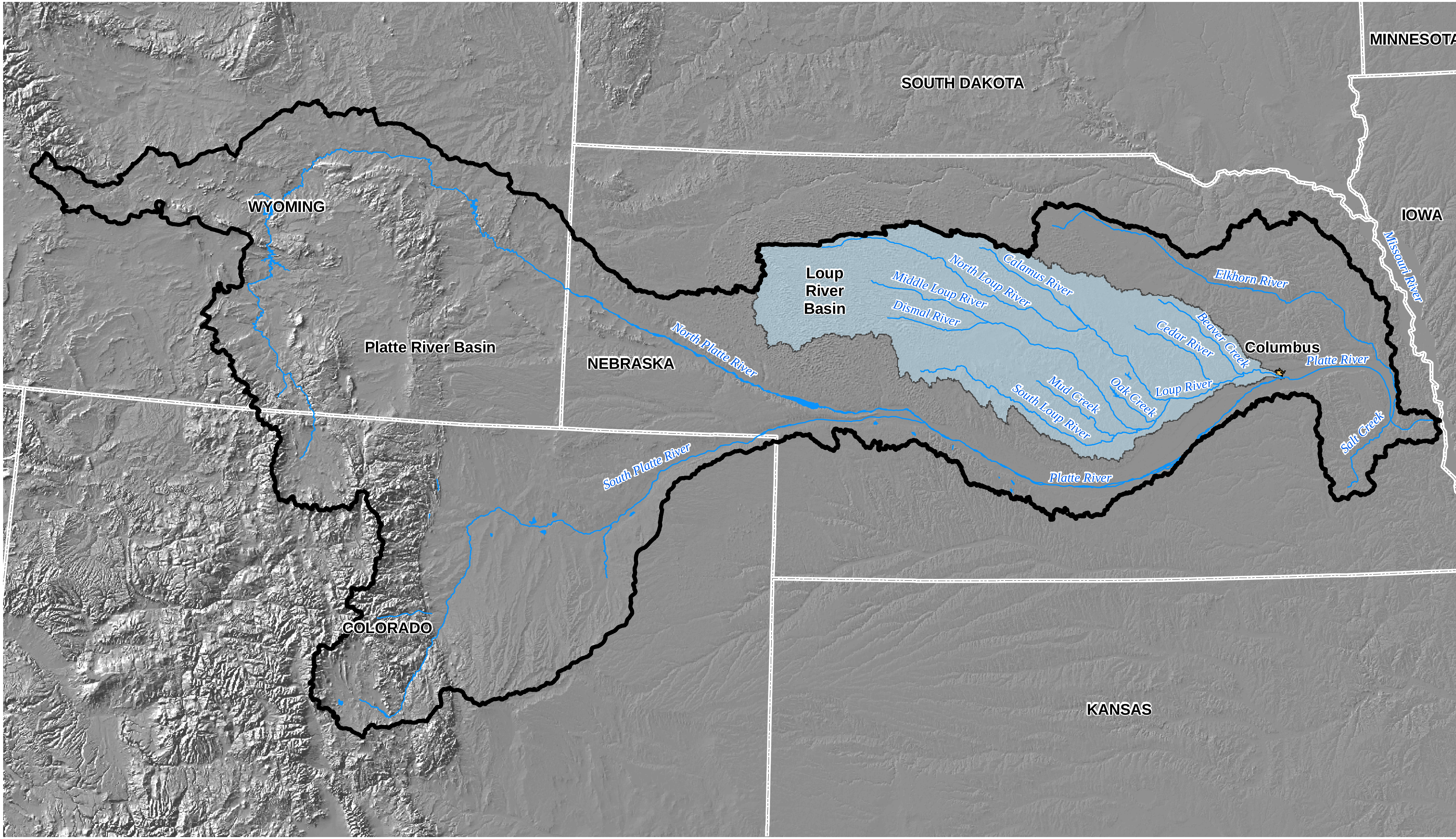

45 22.5 0 45
Miles

Source: Platte River Basin, River, National Hydrography Dataset: U.S. Geological Survey

Legend
- Platte River Basin
- River

Platte and Loup River Basins

Loup River Hydroelectric Project
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Updated Study Report

DATE
Aug. 26, 2011

FIGURE
2-2

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2.1 Loup and Lower Platte Rivers

Both the Loup and Platte rivers are considered braided rivers; therefore, sediment transport is an important factor in retaining their natural characteristics (Donofrio, 1982). A braided river is defined as a river channel in which water flows around deposited bars and islands. It has been shown that, for a given discharge, braided channels slope more steeply than meandering channels. Braiding occurs when the discharge fluctuates frequently, when the river cannot carry its full sediment load, where the river is wide and shallow, where banks may be easily eroded, and where there is copious bedload. The position of the bars is changeable; sediment may be entrained by scour at channel junctions and then be re-deposited down-channel as flows diverge again and new channels are cut by overbank flooding (Mayhew, 2004). The braiding in the channel allows for the development of emergent sandbar habitat.

The Loup River Basin encompasses approximately 15,200 square miles of central Nebraska, accounting for nearly one-fifth of the state's total land area (Nebraska Department of Environmental Quality [NDEQ], December 2005). The Loup River Basin originates in Sheridan County, Nebraska, and flows approximately 260 miles to Platte County and its confluence with the Platte River, near the City of Columbus, Nebraska (NDNR, 1975, as cited in NDEQ, December 2005). The ecoregions of the Loup River Basin are the Nebraska Sandhills and the Central Great Plains (Chapman et al., 2001, as cited in NDEQ, December 2005). Several large tributaries flow into the Loup River, including the Middle and North Loup rivers and Cedar Creek. The Project diverts water from the Loup River at a point about 6 miles southwest of Genoa, Nebraska, into the 35-mile-long Loup Power Canal. The diverted water flows into the Platte River 3 miles southeast of Columbus, approximately 2 miles downstream of the confluence of the Loup and Platte rivers.

In the Loup River Basin, nearly all soils are highly erodible when deprived of vegetative cover. Because of the highly erodible nature of the soils, nearly all streams carry heavy loads of sediment, which allows for the deposition of sediment and the formation of sandbars (Bliss and Schainost, October 1973).

The South Loup, Middle Loup, and North Loup rivers derive their flow from groundwater discharge out of the southern Sandhills and provide a significant source of summer flow to the Loup and lower Platte rivers (Schneider et al., August 2005). The South, Middle, and North Loup rivers in these reaches are medium-sized rivers with broad, braided, somewhat shallow channels. The river channels have many open sandbars and wooded islands (Schneider et al., August 2005). General habitat parameter characteristics of the Loup River are typical of rivers found in similar agriculturally impacted areas of Great Plains grassland ecosystems, tending to be relatively shallow, primarily sandy bottoms, and exhibiting low current velocities that are impacted by strong rain events (NGPC, 1997, as cited in U.S. Department of the Interior, Bureau of Reclamation [USBR], September 2002).

The lower Platte River begins at the Platte River's confluence with the Loup River in Platte County and continues eastward to its confluence with the Missouri River in Sarpy County, Nebraska.[1] This portion of the Platte River receives water from the Loup and Elkhorn rivers and has fairly stable flow. The lower Platte River is a mid-size, shallow, braided river. Sandbars and wooded islands are common within the channel. The width in some downstream areas of the lower Platte River has remained relatively constant, with approximately 90 percent of the historical width remaining (Eschner et al., 1983, as cited in NGPC, December 2008). Much of the stream banks are wooded, with cottonwood and eastern red cedar as the dominant species. Commercial sand pits are common along the river and have provided non-river habitat for a variety of species, including interior least terns and piping plovers. Most of the river floodplain is now cropland, though there are scattered wet meadows and marshes (Schneider et al., August 2005).

Flow in the Platte River is seasonally influenced. Flows are relatively high in the spring and early summer due to snow melt and weather events, and flows are low during the late summer and early fall due to irrigation and infrequent rainfall. The lower Platte River retains many of the important flow characteristics of its historic natural hydrograph. The variable timing of water inputs from upstream sources provides base flow throughout much of the year. The channel of the lower Platte River still contains a wide range of habitats, from large sandbars to woody islands to shallow sandbars and swift channels (Parham, 2007). The combinations of ample sediment supplies and steady flows maintain the braided morphology and alternatively create transverse bars and then dissect the macroforms into braids, lending support to the development and maintenance of habitat potentially used by interior least terns and piping plovers.

Specialized habitats such as backwaters, sloughs, side channels, shoreline, and deep water habitats along the edges of sandbars and river banks are examples of the diverse habitat types that occur along the Platte River (NGPC, December 2008). These instream features provide year-round habitat for numerous species of plants, invertebrates, mammals, birds, amphibians, fish, and reptiles. The presence of this variety of habitat types is a reflection of the highly dynamic geomorphology of the Platte River system.

2.2 Available Habitat within Study Area and Species Use

Very limited information exists regarding the historic use of the Loup and lower Platte rivers by interior least terns and piping plovers prior to the 1980s. Although there are a few references to these species in historical journals dating back to the

[1] The lower Platte River is defined in several different ways by various resource agencies; for the purposes of the Loup River Hydroelectric Project relicensing, the lower Platte River is defined as the reach from the confluence with the Loup River down to the confluence with the Missouri River.

early 1800s, the little information that does exist does not describe much about the exact location of the sightings, nesting on- or off-river, or the historic density of these birds on the Loup and lower Platte rivers. Furthermore, it does not provide information on the type, density, physical aspects, or other characteristics of the sandbars and channel systems or on the "value" of the habitat during times of use.

Within the study area, interior least terns and piping plovers currently use the Loup River, the lower Platte River, and adjacent sand pits for nesting, breeding, and feeding from May to August. Interior least terns typically use the same habitat for nesting and nest in the same areas as piping plovers; therefore, interior least terns and piping plovers are considered nesting associates.

2.2.1 Loup River Use

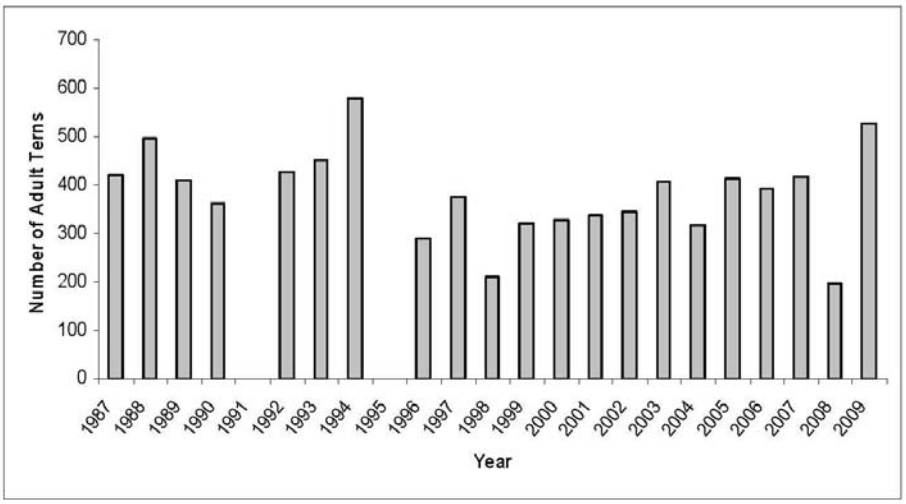
In the Loup River system, breeding interior least terns and piping plovers occur as far west as Valley and Howard counties, Nebraska (Sharpe et al., 2001). Currently, interior least tern and piping plover use of the Loup River in relation to use of other Nebraska rivers is minimal. For example, during the 2005 range-wide census of interior least terns, only 7 percent of the total number of interior least tern adults counted in Nebraska were recorded on the Loup River (Lott, November 2006). During the 2006 International Piping Plover Census, only 2 percent of the total number of piping plover adults counted in Nebraska were recorded on the Loup River system (Elliott-Smith et al., 2009). Based on nest counts from 1983 to 2006, obtained from the NGPC Nongame Bird Program's Nebraska Least Tern and Piping Plover database, relatively few interior least terns and piping plovers have been recorded nesting on the Loup River (NGPC, 2009). On average, 10 interior least tern and 4 piping plover nests are recorded along the entire 69-mile stretch of the Loup River in a year. Most recorded nesting along the Loup River system occurs at off-river sites.

The largest colony of nesting interior least terns and piping plovers along the Loup River is located within the Project Boundary on the North Sand Management Area. This site is where sand dredged from the adjacent Settling Basin is stockpiled, creating a large sandy area with adjacent wetted areas. Interior least terns and piping plovers also use other sand and gravel pits and lakeshore housing developments along the Loup and North Loup rivers (NGPC, February 23, 2009). However, very little data have been gathered on the Loup and North Loup rivers because the Loup River system has rarely had large numbers of interior least terns and piping plovers and therefore has not been surveyed regularly. Sand and gravel mines and housing developments adjacent to the Loup River system were last surveyed by NGPC and the Tern and Plover Conservation Partnership in 2010. The Loup River was last surveyed for interior least terns and piping plovers by USFWS in 2010. Prior to these most recent surveys, the Loup River system was surveyed for interior least terns in 2005 during a range-wide survey (Lott, November 2006) and for piping plovers in 2006 for the International Piping Plover Census (Elliott-Smith et al., 2009).

2.2.2 Lower Platte River Use

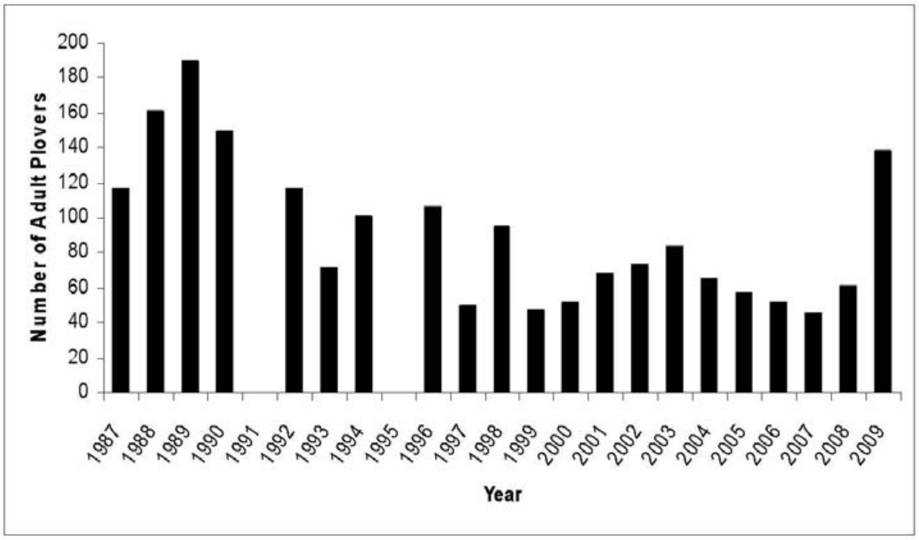
Interior least terns are routinely seen on the lower Platte River. A review of adult count survey information from 1987 to 2009 indicates that interior least tern numbers have remained relatively stable along the lower Platte River during this period, as shown in Figure 2-3 (Brown and Jorgensen, 2009). These numbers include both on-river and off-river sites along the lower Platte River.

Piping plovers are also routinely seen on the lower Platte River. A review of adult count survey information from 1987 to 2009 indicates a slight decline in piping plover numbers along the lower Platte River during this period; however, after 2009 monitoring efforts, the numbers spiked in 2009, as shown in Figure 2-4 (Brown and Jorgensen, 2009). These numbers include both on-river and off-river sites along the lower Platte River.



Note: No data are included for 1991 and 1995 because those surveys were not conducted during the standardized June summer survey window.

Figure 2-3. Total Number of Adult Interior Least Terns Recorded During the Lower Platte River Mid-Summer Survey, 1987 – 2009



Note: No data are included for 1991 and 1995 because those surveys were not conducted during the standardized June summer survey window.

Figure 2-4. Total Number of Adult Piping Plovers Recorded During the Lower Platte River Mid-Summer Survey, 1987 – 2009

3. SUMMARY OF STUDIES

As part of the relicensing effort for the Project, several studies were conducted to investigate potential Project effects, including any that might be related to interior least tern and piping plover habitat. The studies conducted included sedimentation, hydrocycling, and flow depletion and flow diversion. These studies and their results are summarized in Sections 3.1, 3.2, and 3.3, respectively.

3.1 Sedimentation

The Loup and Platte rivers both carry a large sediment load. When water is diverted from the Loup River, it enters the 2-mile-long Settling Basin. The Settling Basin is designed for low velocity to allow heavier sediment materials to settle out of the water before it enters the Upper Power Canal. A Sluice Gate Structure adjacent to the Diversion Weir is operated periodically to mobilize and remove accumulated sediment from in front of the Intake Gate Structure. This process conveys sediment into the Loup River bypass reach. As documented in the Pre-Application Document, a Hydraulic Dredge removes approximately 2 million tons of sediment from the Settling Basin annually (Loup Power District, October 16, 2008).

During project scoping, agency comments were received that stated that Project operations, such as the removal of sediment through Project dredging at the Settling Basin, may affect the morphology of both rivers, which may affect sandbar development and, by extension, may affect interior least tern and piping plover habitat. To address this issue, the District conducted a sedimentation study. This study was detailed in the District's Revised Study Plan, dated July 27, 2009, and the results of this study are presented in the Updated Study Report, Appendix A. The study area and study sites for the sedimentation study are shown in Figure 3-1. The goal of the sedimentation study and a summary of the results related to interior least terns and piping plovers are provided below.

3.1.1 Goal of Study

The goal of the sedimentation study was to determine the effect, if any, that Project operations have on stream morphology and sediment transport in the Loup River bypass reach and in the lower Platte River because stream morphology relates directly to habitat, and habitat may determine species abundance and success. In addition, the study compared the availability of sandbar nesting habitat for interior least terns and piping plovers to their respective populations.

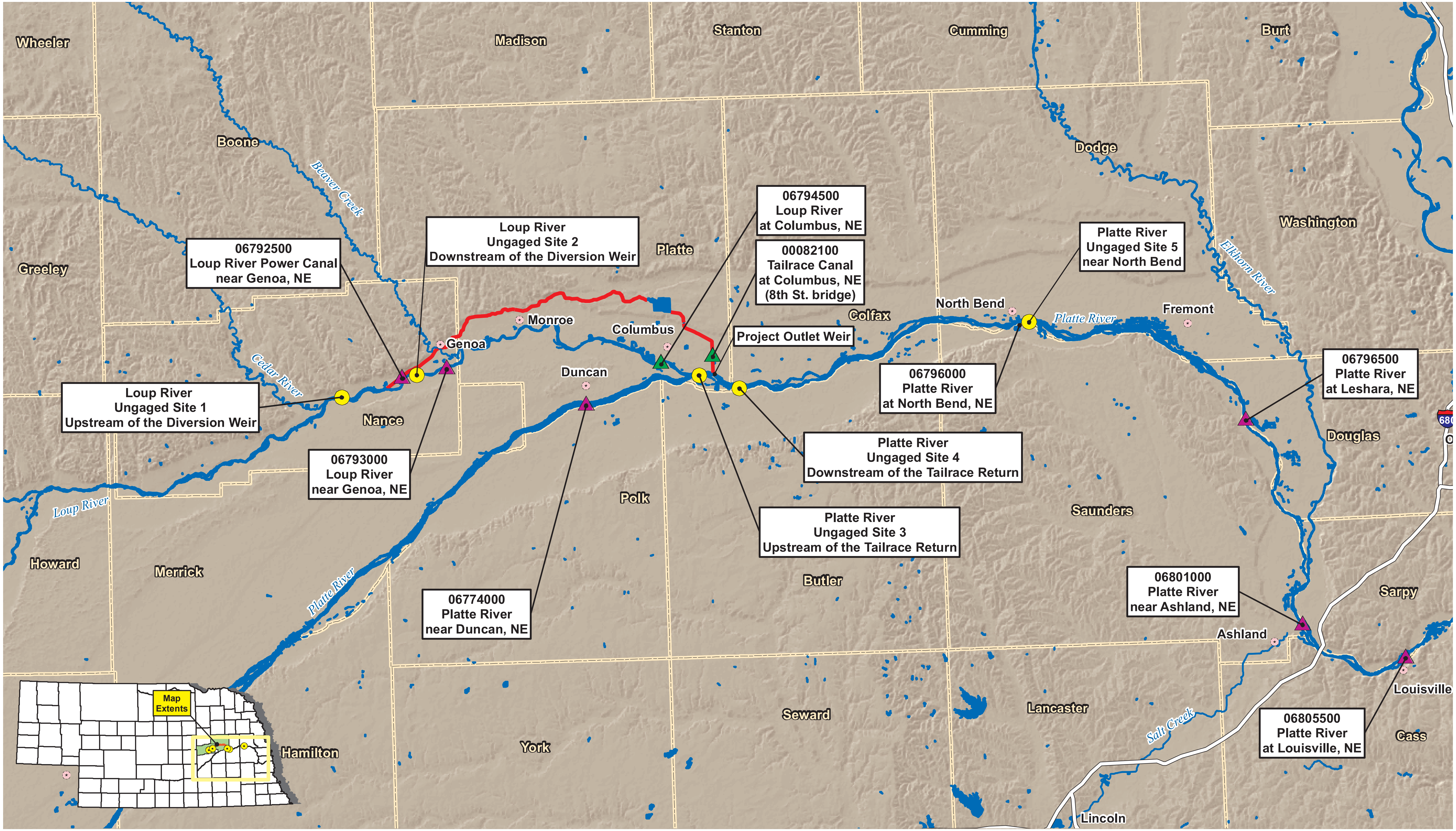
3.1.2 Summary of Results

The body of literature cited and the supplemental analyses at the gaged and ungaged sites demonstrate that the Loup River bypass reach and the lower Platte River are in regime and are seated well within regime zones considered as braided streams. Further, the analyses and other supporting literature cited clearly indicate that both the Loup River bypass reach and the lower Platte River at all locations studied are clearly in regime, not supply limited, and not aggrading or degrading, with no indications of channel geometry characteristic (width and depth) changes over time.

Objective 1: To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.

The sedimentation study, including the collection and analysis of data at both gaged and ungaged sites, supports the conclusion that the sediment availability and yield throughout the study area by far exceed the capacity of the flow to transport sediment as well as greatly exceed the actual measured amounts of suspended sediment being transported. The results of the collection and analysis of data at both gaged and ungaged sites show that both the Loup River bypass reach and the lower Platte River at all locations studied are clearly not supply limited.

Effective discharge and other sediment transport and hydraulic geometry calculations, combined with river regime theory, show that the channel geometries are "in regime" with the long-term flows shaping them. The current channel hydraulic geometries match the width, depth, and velocity calculations for flow rates matching the effective and dominant discharge rates. Nothing appears to be constraining either the Loup or the Platte River from maintaining the braided river hydraulic geometry associated with the effective discharges.



Source: Stream Gage, Nebraska Department of Natural Resources; Streams/Waterbodies, 2000 Tiger Files

Legend

- City
- NDNR Gaging Station
- USGS Gaging Station
- Ungaged Study Sites
- Interstate
- Stream/River
- Loup Power Canal
- Waterbody
- County

Loup Power District Hydro Project

Sedimentation Study Sites

Loup River Hydroelectric Project
FERC Project No. 1256
Study 1.0 - Sedimentation

DATE
August 26, 2011

FIGURE
3-1

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Cross-section data at the ungaged sites reveal that the braided channel geometry of both rivers is not only widely diverse over a few hundred feet of length, but highly subject to dramatic changes over a few months' time. The cross sections both upstream and downstream of the Tailrace Return exhibited similar cross-section changes. Any measured or calculated adjustment in geometry cannot be readily attributed to any other cause than the natural dynamics of a braided river.

The literature review, sediment transport calculations, specific gage analysis, and regime analysis indicate that short-term fluctuations in the morphology of the Loup River bypass reach and lower Platte River are not transitioning to another form, thus affirming that the rivers are currently in dynamic equilibrium. The combinations of slopes, sediment sizes, and effective discharges at all of the gaged and ungaged sites result in all locations being well within braided river morphologies, with none being near any thresholds of transitioning to another morphology.

Objective 2: To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.

Existing literature, including Platte River studies by the U.S. Army Corps of Engineers (USACE), USBR, and the U.S. Geological Survey (USGS); calculations of effective discharges; regime analyses; literature on the channels' profiles; and physical observations indicate that the Loup River bypass reach and the lower Platte River are not experiencing aggradation or degradation. Instead, these analyses, particularly the bed gradation studies by others and the effective discharge and regime analyses, clearly indicate that both the Loup and lower Platte rivers are well within parameters establishing them as dynamically stable, non-aggrading and non-degrading, braided rivers.

Objective 3: To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by the Nebraska Game and Parks Commission [NGPC]) and productivity measures.

The initial statistical analysis of interior least tern and piping plover data by hydrologic river segment yielded results of no significant relationship between interior least tern and piping plover nest counts and sediment transport indicators. No evidence from this analysis was discovered that would suggest that a relationship exists between nest counts and sediment transport indicators or hydrologic parameters.

Supplemental statistical analysis of interior least tern data by river mile for RM 102 to RM 72 used binary logistic regression, multiple linear regression, nonparametric methods, and one-way ANOVA to evaluate if the hydrologic variables could explain nest count numbers and may be an influencing factor in nesting of interior least terns on the lower Platte River. The results of these analyses are as follows:

- Nest counts were weakly associated with number of data collection visits per year, but strongly associated with interior least tern adult counts, which were also weakly associated with number of data collection visits.
- No association was detected between summed nest counts and river mile, which indicates that variability in nest counts is not associated with proximity to the Tailrace Return.
- A period of relatively high nest counts from 1987 to 1995 was followed by a period of lower but also static nest counts from 1995 to 2008 between RM 102 and RM 72; this dichotomy is not associated with Project operations.
- Binary logistic regression analysis failed to detect a measurable relationship between presence or absence of interior least tern nests and ranked calendar year, river mile, peak mean daily flow, percent diverted flow, or any combination of these variables.
- Nonparametric correlation studies suggested annual percent diverted flow as a weak but statistically significant predictor of nest counts summed by river mile. This relationship was demonstrated to be spurious following more thorough examination of results of multiple linear regression analyses.
- One-way ANOVA determined that changes in peak mean daily flow between years in relation to nest counts is statistically significant, providing evidence in support of the theory that high flows followed by low flows may be beneficial for interior least tern nesting. However, effect of flow on nest frequency is difficult to gauge from the current data because of extreme variability in the frequency and locations of annual nest counts.
- One-way ANOVA also determined that changes in flow between river miles is not statistically significant in relation to nest counts.

3.2 Hydrocycling

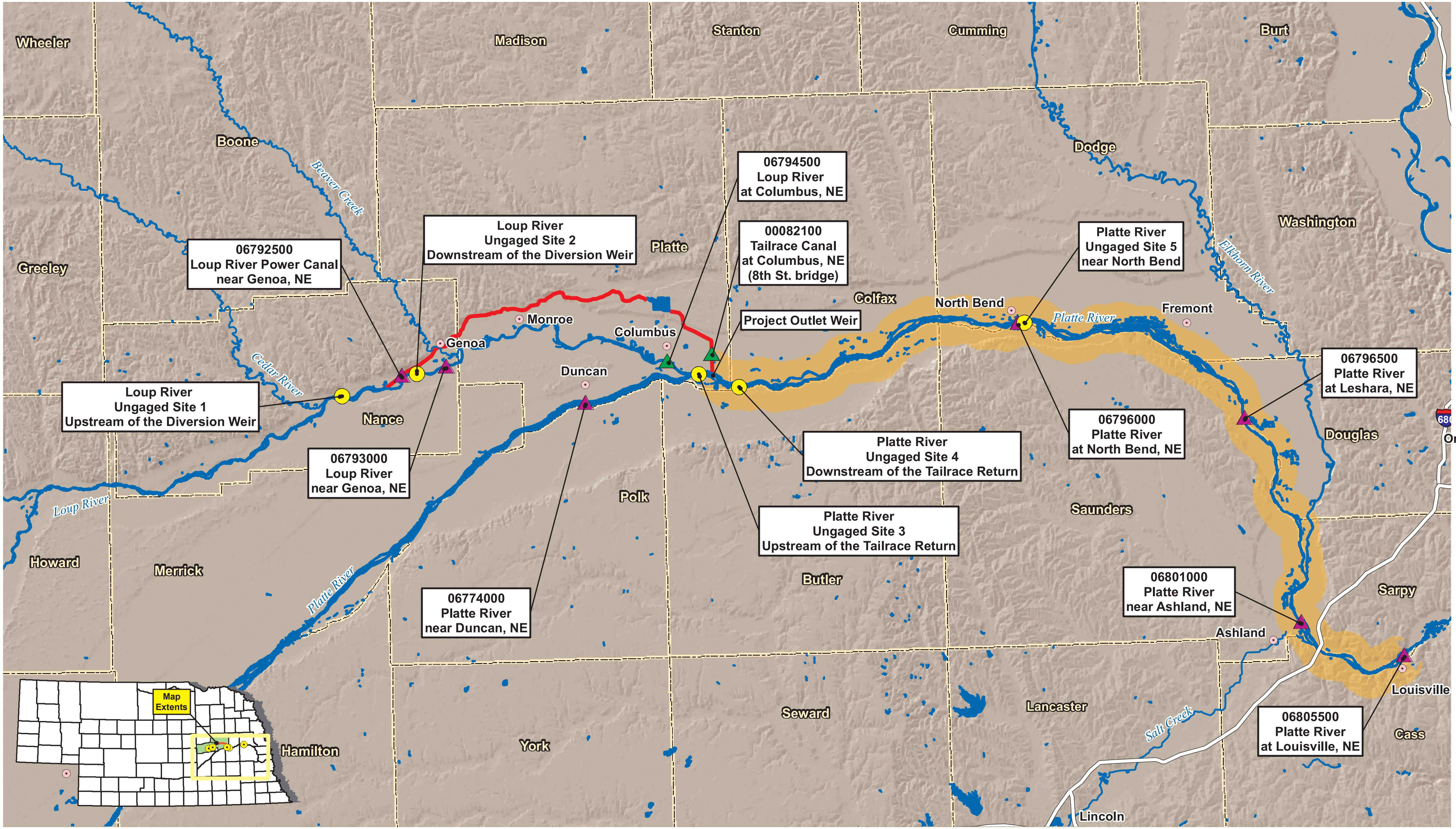
Upstream of the regulating reservoirs, the Loup Power Canal and the Monroe Powerhouse operate in a run-of-river mode with no storage capacity. Average daily flow in this reach is 1,610 cubic feet per second (cfs). Maximum flow in the canal is limited to 3,500 cfs by both water rights and hydraulic capacity. The interconnected regulating reservoirs, Lake Babcock and Lake North, accumulate water and build head during a portion of each day. Accumulated water is then released through the Columbus Powerhouse to produce energy during high-demand periods of the day as directed by NPPD, the exclusive purchaser of Project power. This sub-daily regulation at the Columbus Powerhouse is called hydrocycling.

Except during brief ramp-up and ramp-down periods, operating discharge from the Columbus Powerhouse ranges from a minimum of about 1,000 cfs with one turbine operating to a high of about 4,800 cfs with all three turbines operating at high efficiency settings. Water discharged from the Columbus Powerhouse flows down the 5-mile-long Tailrace Canal and enters the Platte River at the Outlet Weir. This weir is located approximately 2 miles downstream of the confluence of the Loup River bypass reach and the Platte River. Tailrace Canal flow is recorded at the Nebraska Department of Natural Resources (NDNR) gage at the 8th Street bridge in Columbus. Including local inflows unrelated to the Project (primarily inflows from the Lost Creek Flood Control Channel), Tailrace Canal discharge to the Platte River ranges from less than 100 cfs to over 6,300 cfs.

During project scoping, agency comments were received that stated that hydrocycling of Project flows entering the lower Platte River may affect riverine morphology, thereby affecting habitat, including habitat used by interior least terns and piping plovers. These possible effects are derived from the sub-daily variability, rate of change, and proportion of hydrocycling flows relative to flows already in the Platte River. To address this issue, the District conducted a hydrocycling study. This study was detailed in the District’s Revised Study Plan, dated July 27, 2009, and the results of this study are presented in the Updated Study Report, Appendix B. The study area for the hydrocycling study focused on the lower Platte River from the Tailrace Return to the confluence with the Missouri River, as shown in Figure 3-2. The goal of the hydrocycling study and a summary of the results related to interior least terns and piping plovers are provided below.

3.2.1 Goal of Study

The goal of the hydrocycling study was to determine if Project hydrocycling operations benefit or adversely affect the habitat used by interior least terns, piping plovers, and pallid sturgeon in the lower Platte River. The physical effects of hydrocycling (current operations) were quantified and compared to an alternative condition (run-of-river operations). Run-of-river operations are defined as simulated conditions that would exist without regulation for hydrocycling.



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Source: Stream Gage, Nebraska Department of Natural Resources; Streams/Waterbodies, 2000 Tiger Files

Legend

- City
- NDNR Gaging Station
- USGS Gaging Station and/or Study Site
- Ungaged Study Sites
- Interstate
- Stream/River
- Loup Power Canal
- Waterbody
- County
- Potentially Affected Reach of the Lower Platte River

Loup Power District Hydro Project

Hydrocycling Study Sites

Loup River Hydroelectric Project
FERC Project No. 1256
Study 2.0 - Hydrocycling

DATE
August 26, 2011

FIGURE
3-2

3.2.2 Summary of Results

Objective 1: To compare the sub-daily Project hydrocycling operation values (maximum and minimum flow and stage) to daily values (mean flow and stage). In addition to same-day comparisons, periods of weeks, months, and specific seasons of interest to protected species will be evaluated to characterize the relative degrees of variance between hydrocycling (current operations) and run-of-river operations in the study area.

Hydrographs and water surface elevation graphs were plotted annually and seasonally for selected years with wet, dry, and normal hydrologic flow classifications. The effects of hydrocycling on the hydrograph are immediately apparent for the 2006 dry year. The difference between the maximum and minimum daily flows for current operations is larger than the difference between the maximum and minimum daily flows for run-of-river operations. These differences are reduced for the wet and normal years for 2008 and 2009, respectively. The average annual difference in water surface elevation between current operations and run-of-river operations is typically less than 1 foot. The natural seasonal flow variability is equal to or greater than the daily flow variability during operations unaffected by high flows.

Objective 2: To determine the potential for nest inundation due to both hydrocycling (current operations) and run-of-river operations.

The pre-nesting season benchmark flow for piping plovers was exceeded more often under run-of-river operations than under current operations for all years evaluated (2003 to 2009). For interior least terns, the benchmark exceedances were equal under both operating scenarios. For all exceedances for both species, there were no instances where current operations exceeded the benchmark flow, while run-of-river operations did not exceed the benchmark flow.

The pre-nesting season benchmark flows for both interior least terns and piping plovers for current operations ranged from 7,860 to 26,500 cfs, with an average benchmark flow of 13,716 cfs. The pre-nesting season benchmark flows for both species for run-of-river operations ranged from 5,910 to 25,900 cfs, with an average of 12,686 cfs. In general, the difference between pre-nesting season benchmark flows for current operations is, on average, 8.1 percent higher than that of run-of-river operations.

The nesting season peak maximum daily flow for both interior least terns and piping plovers for current operations ranged from 4,100 to 39,986 cfs, with an average peak flow of 18,985 cfs. The nesting season peak maximum daily flow for both species for run-of-river operations ranged from 3,213 to 35,533 cfs, with an average of 17,788 cfs. The nesting season peak maximum daily flow rate for current operations is, on average, 6.7 percent higher than that of run-of-river operations.

When evaluating the number of exceedances of the pre-nesting season benchmark (peak) flow, it was found that, for interior least terns, on average, the benchmark flow was exceeded 3.9 times per event under both current operations and run-of-river operations. For piping plovers, on average, the benchmark flow was exceeded 3.0 times per event for current operations and 3.1 times per event for run-of-river operations. Run-of-river operations had more distinct events for piping plovers that exceeded the pre-nesting season benchmark than current operations in 2003.

Objective 3: To assess effects, if any, of hydrocycling (current operations) and run-of-river operations on sediment transport parameters and channel morphology.

Dominant and effective discharges and total sediment transport at capacity were calculated for ungaged Sites 3, 4, and 5 as well as the USGS gage at North Bend. These values were calculated for the selected wet, dry, and normal years as well as the entire period from 2003 to 2009 using synthetic current operations and run-of-river operations sub-daily flows.

The results show that the run-of-river operations would transport less sediment, assuming all sediment is transported at capacity. The effective discharges for current operations are larger than the effective discharges for run-of-river operations. The dominant discharges are only slightly larger for current operations, by about 100 cfs. These differences in dominant and effective discharges would likely result in the channel area being smaller under run-of-river operations.

The results of the sediment transport modeling show that under each operating scenario, the system is transporting sediment at capacity. Because the system is flow limited and not supply limited, no degradation occurs under current operations.

Objective 4: To identify material differences between hydrocycling (current operations) and run-of-river operations in potential effects on habitat of the interior least tern, piping plover, and pallid sturgeon.

Comparison to Other Rivers

A review and comparison of habitat parameters, species counts, hydrocycling operations, and potential effects on interior least terns and piping plovers was conducted. Almost all other river reaches identified as important to interior least terns and piping plovers, based on population numbers, included large-scale dams and reservoirs with limited flow releases. Project operations are different from a large-scale dam in several ways. The Project includes a smaller degree of daily hydrocycling and no cold water releases. In addition, during times of high flow, these flows are bypassed and the Project does not divert water. Although daily hydrocycling occurs on most of these other rivers, limited information was found regarding the potential effect of this practice on the birds and their associated habitat.

In these other river reaches, large releases to relieve flooding or reach navigation targets appear to have a measurable effect on interior least terns and piping plovers and their respective habitat. The Project does not release water for flooding or navigation and does not have the capability to retain water for a prolonged period, such as these other dams do. Most other dams reviewed have large storage reservoirs and are able to release large quantities of water to meet electric generation or navigational needs, whereas the Project differs from a traditional dam in that it has no significant dam structure, no instream reservoir, and no project spillway. The Project's regulating reservoirs (Lake Babcock and Lake North) are used to provide capacity to pond water during low electrical demand hours of the day and release water during the high electrical demand hours of the day. During low electrical demand hours, flow through the Columbus Powerhouse normally drops to zero to maximize ponding. Maximum releases are 4,800 cfs during hours of peak electrical demand. Therefore, it is difficult to compare the Project's operations and habitat on the lower Platte River to these other, larger structures and the habitat that exists downstream on these larger rivers.

While studies in other rivers have not been conducted for the direct purpose of determining the effects of daily hydrocycling on interior least terns and piping plovers, changes in operations at Fort Randall Dam in accordance with conditions set forth in the USFWS amended Biological Opinion (December 16, 2003) have shown that releasing at higher rates prior to the nesting season and during the early nesting season has encouraged the birds to nest at a higher elevation and prevented nest losses due to hydrocycling. Additionally, a study conducted by Leslie et al. (2000) on the effects of hydropower and flood-control operations of the Keystone Dam on the Arkansas River on interior least tern populations found that daily hydropower operations were not affecting the birds; however, subjecting nesting habitat to periodic high river flows prior to the nesting season could be beneficial because availability and quality of the habitat increased with flooding and population numbers expanded in a year following the flood. Because the Project does not have control over stopping or allowing large flood flows to affect the lower Platte River, the Project's effects from daily hydrocycling on sandbar formation are minor when compared to the effects from large flood flows.

HEC-RAS Model Results

The results of the one-dimensional (1-D) HEC-RAS model were used to determine variations in potential nesting habitat under current operations and run-of-river operations for the selected wet, dry, and normal years based on a maximum daily flow at both Sites 4 and 5 for low-, medium-, and high-flow conditions. Site 3 was used as a control and compared to Site 4 under current operations in order to note any differences. The following summarizes the results of this analysis:

- Site 3:
  - The average channel width (as measured from bank to bank) showed very little change between the June and September cross sections (1,071 and 1,077 feet, respectively).
  - The percentage of exposed channel width decreased from dry to wet years. This is to be expected because it is a property of rigid-boundary hydraulics for the exposed channel width in any irregular boundary channel to decrease with rising stages.
  - When compared to Site 4, Site 3 exhibited, on average, a higher percentage of exposed channel width during the dry year, but less exposed channel width than Site 4 during the normal and wet years, under current operations. When comparing Site 3 to Site 4 under run-of-river operations, in the dry year, both sites exhibit a similar percentage of exposed channel width; however, in the normal and wet years, Site 4 has a higher percentage of exposed channel width than Site 3 under run-of-river operations.
- Site 4:
  - The average channel width was relatively constant for both the June and September cross sections (1,726 and 1,723 feet, respectively).
  - The percentage of exposed channel width generally decreased from the dry year (2006) to normal year (2009) to wet year (2008) for both June and September cross sections for both current operations and run-of-river operations.
  - The percentage of exposed channel width generally decreased from low- to medium- to high-flow conditions. This would be expected, given that channels will show a decrease in exposed channel width for higher discharge rates and wetter conditions.
  - The run-of-river operations generally had a higher percentage of exposed channel width than exhibited under current operations, and the June cross sections yielded a higher percentage of exposed channel width than did the September cross section (with the exception of the medium-flow condition for the normal year [2009]).

- Site 5:
  - The average channel width was relatively constant for both the June and September cross sections (1,610 and 1,604 feet, respectively); however, when compared to Site 4, the channel begins to narrow in this area (1,600 feet at Site 5 compared to 1,700 feet at Site 4).
  - The percentage of exposed channel width was greatest under the dry year (2006) and decreased under the normal (2009) and wet (2008) years, respectively, under both current operations and run-of-river operations.
  - The run-of-river operations generally had a higher percentage of exposed channel width than exhibited under current operations.

No consistent trend in percentage of exposed channel width is evident between Sites 4 and 5. At all sites, there is generally a higher percentage of exposed channel width under run-of-river operations than under current operations. The cause of this decrease in exposed channel width under current operations is likely that the duration of higher-than-average flows during days with hydrocycling compared to the duration on the same days of lower-than-average flows resulted in an accumulation of time when higher overall water levels prevailed, thereby causing overall reduced exposed widths, which would always be true for a rigid-boundary channel.

3.3 Flow Depletion and Flow Diversion

The Project diverts water from the Loup River and routes it through the 35-mile-long Loup Power Canal, which empties into the Platte River near Columbus. The Project includes various hydraulic structures, two powerhouses, and two regulating reservoirs. The portion of the Loup River from the Diversion Weir to the confluence with the Platte River is referred to as the Loup River bypass reach. The Project is able to divert up to 3,500 cfs of water. This is the capacity of the Loup Power Canal as well as the maximum allowed by the District's water right.

During project scoping, agency comments were received that stated that diminished natural flows in the Loup River bypass reach related to Project operations may affect riverine habitat distribution, including interior least tern and piping plover habitat. In addition, these agencies have expressed concern that depletions attributed to the Loup Power Canal, regulating reservoirs, and irrigation activities may result in flow depletion in the lower Platte River. To address this issue, the District conducted a flow depletion and flow diversion study. For the purposes of this study, flow depletion is defined as Project-related water lost to consumptive use (that is, evaporation and evapotranspiration). All other water that is seeped to the groundwater is not technically lost because this area is hydraulically connected and any water that is not lost to the atmosphere will eventually return to the lower Platte River system. That is, the specific flow may be time lagged but is not lost.

This study was detailed in the District's Revised Study Plan, dated July 27, 2009, and the results of this study are presented in the District's Second Initial Study Report, dated February 11, 2011. The study area for the flow depletion and flow diversion study includes the Loup River from the Diversion Weir to the confluence with the Platte River and continues along the Platte river to the confluence with Tailrace Return, as shown in Figure 3-3. The goal of the flow depletion and flow diversion study and a summary of the results related to interior least terns and piping plovers are provided below.

3.3.1 Goal of Study

The goals of the flow depletion and flow diversion study were to determine if Project operations result in flow depletion on the lower Platte River and to what extent the magnitude, frequency, duration, and timing of flows affect the Loup River bypass reach. The results were used to determine if Project operations (current operations) relative to flow depletion and flow diversion adversely affect the habitat used by interior least tern and piping plover populations, the fisheries, and the riverine habitat in the Loup River bypass reach and the lower Platte River compared to an alternative condition (the no diversion condition). No diversion was defined as no water being diverted into the Project but does not represent a case of Project decommissioning.

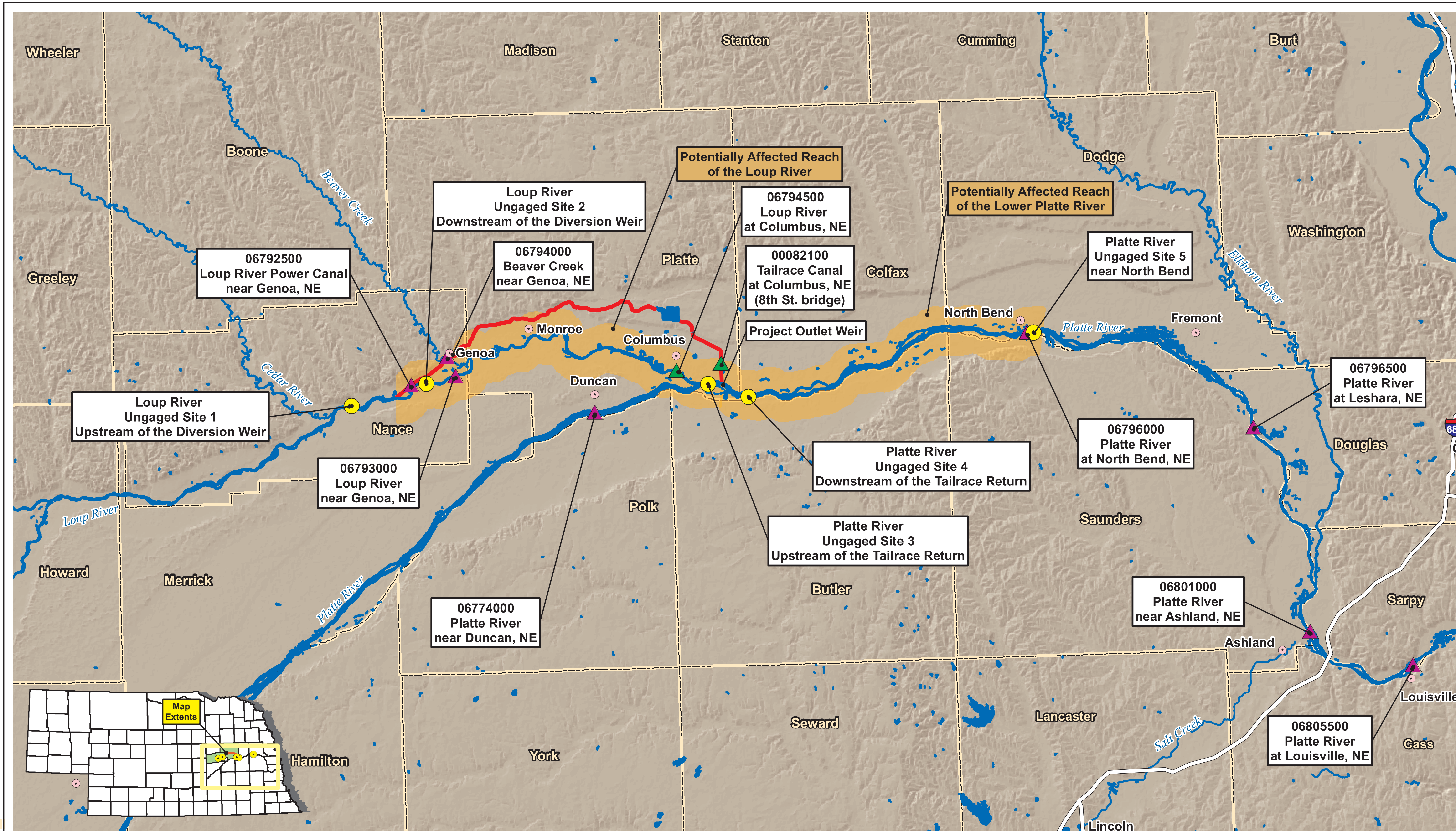
3.3.2 Summary of Results

Objective 1: To determine the net consumptive losses associated with Project operations compared to the no diversion condition.

The consumptive loss analysis shows that flow depletions under current operations are less than would occur under the no diversion condition. Therefore, it is concluded that Project operations do not adversely impact fisheries and aquatic habitat relative to flow depletions.

Objective 2: To use current and historic USGS gage rating curves to evaluate change in stage in the Loup River bypass reach during Project operations and compare against hydrographs of a no diversion condition.

The increase in flow in the Loup River bypass reach between current operations and the no diversion condition results in an increase in stage, which is to be expected. In general, the magnitude of the stage change decreases for higher flows. In addition, both the flow and associated stage change are greater under a dry year classification than a wet year classification.



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Source: Stream Gage, Nebraska Department of Natural Resources; Streams/Waterbodies, 2000 Tiger Files

Legend

- City
- NDNR Gaging Station
- USGS Gaging Station and/or Study Site
- Ungaged Study Sites
- Interstate
- Stream/River
- Loup Power Canal
- Waterbody
- County
- Potentially Affected Reach

Loup Power District Hydro Project

Flow Depletion and Flow Diversion Study Sites

Loup River Hydroelectric Project
FERC Project No. 1256
Study 5.0 - Flow Depletion and Flow Diversion

DATE
Feb. 11, 2011

FIGURE
3-3

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Objective 3: To evaluate historic flow trends on the Loup and Platte rivers since Project inception.

The long-term historic trends indicate that annual Platte River flows upstream (at Duncan) and downstream (at North Bend and Louisville) of the Loup River confluence have been well-documented as increasing throughout the period that the Project has been in operation. As shown in two USGS reports (Ginting, Zelt, and Linard, 2008; Dietsch, Godberson, and Steele, 2009) and additional analyses by the District, no adverse flow impacts of Project operations are evident. Although flows are highly fluctuating and cyclic, this natural positive long-term trend in flows is statistically significant and, according to USGS, is attributed largely to natural climatic cycling. The positive trend should be neither credited to nor charged against the Project because the Project does not impact flows at Duncan, yet the same trends identified at Duncan also occur downstream.

Objective 4: To determine the extent of interior least tern and piping plover nesting on the Loup River above and below the Diversion Weir.

The comparison of nesting occurrences of interior least terns and piping plovers above and below the Diversion Weir yielded inconclusive results. Because of the small sample size and limited dataset, it was concluded that data were insufficient to accurately determine if there is a significant difference between nesting occurrences above and below the Diversion Weir.

However, the aerial imagery review of interior least tern and piping plover habitat parameters above and below the Diversion Weir yielded detectable differences in the measured parameters (number of sandbars, channel widths, average size of the sandbars, and location of sandbars). On average, there are more sandbars per river mile above the Diversion Weir, but these sandbars are smaller than sandbars below the Diversion Weir. The channel widths (high bank to high bank) are wider above the Diversion Weir and become approximately 400 feet narrower below the Diversion Weir. In general, there is a higher percentage of vegetation on sandbars located below the Diversion Weir, although all average vegetation percentages were less than 21 percent and within the range of acceptable vegetation percentages for nesting interior least terns and piping plovers.

Sandbars below the Diversion Weir, likely due to their larger size, also had a higher percentage of bare sand and a larger bare sand area than sandbars above the Diversion Weir. Most sandbars located below the Diversion Weir are point bars and located along the riverbanks, while, on average, a greater percentage of mid-channel bars exist above the Diversion Weir.

The comparison above and below the Diversion Weir under current operations and the no diversion condition using the 1-D HEC-RAS model determined that, on average and as expected, the percentage of exposed channel width was generally greater under current operations below the Diversion Weir during all flows and all years. The percentage of exposed channel width above the Diversion Weir ranged from 38 percent of the channel width under low flows in a dry year to 2 percent of the channel width under high flows in a wet year. The percentage of exposed channel width below the Diversion Weir under current operations ranged from 87 percent of the channel width under low flows in a dry year to 10 percent of the channel width under high flows in a wet year. Below the Diversion Weir under the no diversion condition, the percentage of exposed channel width was similar to percentages above the Diversion Weir and ranged from 26 percent of the channel width under low flows in a dry year to 3 percent of the channel width under normal and high flows in a wet year.

4. SUMMARY OF STUDY RESULTS RELATED TO SPECIES

During preparation of the Pre-Application Document, the District coordinated with resource agencies, and the agencies identified the following potential effects that the Project might have on interior least terns and piping plovers:

- Habitat may decrease in suitability due to material changes in the Loup and lower Platter rivers' sediment transport regime.
- Habitat diversity, connectivity, and suitability may be diminished in the lower Platte River due to erosion of sandbars by Project hydrocycling operations.
- Project hydrocycling operations may cause inundation of interior least tern and piping plover nests on the lower Platte River.
- Habitat connectivity and suitability may be diminished in the Loup River bypass reach due to diversion of flows.

The District conducted the sedimentation, hydrocycling, and flow depletion and flow diversion studies to address potential Project effects on interior least terns, piping plovers, and their associated habitat.

Conclusions

Separately, the results of the sedimentation, hydrocycling, and flow depletion and flow diversion studies provide useful insights into the state of the rivers' morphology. However, when all of the District's analyses from the sedimentation, hydrocycling, and flow depletion and flow diversion studies are compiled, they culminate in a complete body of evidence that consistently demonstrates the following:

- The supply of sediment by far exceeds the rivers' capacity to transport sediment (that is, the Loup River bypass reach and lower Platte River are not supply limited). Continued hydraulic dredging from the Loup Power Canal, in the District's proposal to continue existing operating conditions, would not affect this relationship. Therefore, the sediment that the Loup River bypass reach and lower Platte River transport and use in the formation of sandbars, which serve as nesting habitat, would be unaffected by the District's proposed operating scenario (that is, current operations).

- Both the Loup River bypass reach and lower Platte River are in dynamic equilibrium and are well-seated in the braided morphology regime for flow hydrographs of all operating scenarios. Because the Project's sediment removal operations have no effect on the braided channel morphology, which creates habitat that may be used by interior least terns and piping plovers, it is reasonable to say that the Project's sediment removal operations have no effect on any habitat associated with the braided regime. Because no trend toward a different morphology is occurring or will occur under the District's proposed operating scenario (that is, current operations), the proposed Project would not impact morphology, habitat, or its suitability for interior least terns and piping plovers.
- The differences in flow (and stage) between current operations and run-of-river operations diminish downstream of the Project with increased flow, and it becomes more difficult to separate the singular effect of hydrocycling. This is due to many factors, including tributary inflow and water management actions upstream in the Platte River Basin.
- Project hydrocycling operations result in higher flows and stage on a daily basis than a run-of-river scenario; however, a comparison of benchmark flows for run-of-river operations and current operations indicated that exceedances of the benchmark flows are a result of natural high flow events. All benchmark exceedances under current operations were due to high flow events that also caused benchmark exceedances under run-of-river operations.
- Daily fluctuations in stage due to hydrocycling affect available nesting habitat in the form of increasing the wetted fringe of a sandbar. This effect is greatest when upstream Platte River flows are the lowest. As a result, this effect is expected to be the most evident nearest the Tailrace return.
- Nest location on the lower Platte River is influenced by several factors, such as availability of sandbars, vegetation on sandbars, location of predators, recreational disturbance, and past and current flow conditions. However, statistical analysis indicated that river mile location was not a factor in explaining nest count variance. Therefore, while the effects of hydrocycling relative to flow and stage would be expected to be the greatest nearest the Tailrace Return, the available nest count data do not indicate that proximity to the Tailrace Return is a factor in the overall distribution of nest locations.
- The statistical studies have demonstrated substantial variability in nesting numbers and locations throughout the 24 years that nesting data have been

collected. However, during that same time period, Project operations have been unchanged; therefore, it is determined that variability in nesting numbers on the lower Platte River are likely caused by a combination of factors such as suitable habitat, mid-summer flooding, recreational disturbance, predation, nesting success in other locations, and threats in the wintering locations.

- There are some differences in channel geometry (width, depth, etc) below the Diversion Weir as compared to above the Diversion Weir. There is not enough bird use data on the Loup River to ascertain that the differences in physical characteristics above and below the Diversion Weir impact use by interior least terns or piping plovers. Due to the limited use of the Loup River both above and below the Diversion Weir by the species, it is not possible to determine that a change in Project operations would result in increased use of the Loup River bypass reach by interior least terns or piping plovers.
- The District's studies demonstrate that no morphological changes have occurred in the 25-year study period (1985 to 2009), which includes nearly the entire current license period (1982 to 2014). The literature review, sediment transport calculations, specific gage analysis, and regime analysis all show that the Loup River bypass reach and the lower Platte River are both in dynamic equilibrium and well-seated in the braided river regime. This would not change under the District's proposal to continue existing operating conditions. Because there is no trend toward a change in morphology, the proposed relicensing of the Project would not impact morphology or instream habitat suitability.

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