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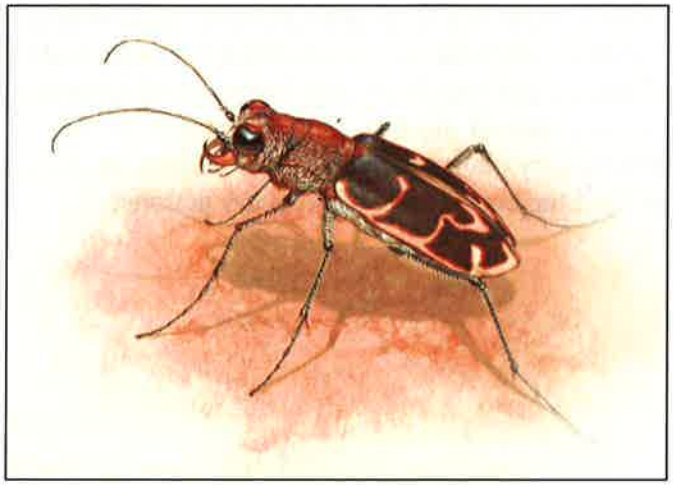
RECOVERY PLAN FOR THE SALT CREEK TIGER BEETLE
(Cicindela nevadica lincolniana)



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EXECUTIVE SUMMARY

Current Species Status: The Salt Creek tiger beetle *(Cicindela nevadica lincolniana)* was listed as a federally endangered subspecies on November 7, 2005 (70 FR 58335, October 6, 2005). On May 6, 2014 (79 FR 26013), we published a revised final rule designating approximately 1,110 acres (449 hectares) of critical habitat for the Salt Creek tiger beetle in Lancaster and Saunders Counties in Nebraska. The Salt Creek tiger beetle has a recovery priority number of 6C, which means it is a subspecies that faces a high level of threat, including conflict with development activities; a priority number of 6C also indicates it has a low potential for recovery. The Salt Creek tiger beetle has one of the most restricted ranges of any insect in the United States and is currently limited to segments of Little Salt Creek and adjacent remnant saline wetlands in northern Lancaster County, Nebraska.

Habitat Requirements and Limiting Factors: The Salt Creek tiger beetle requires open, barren saline mud flats and mud banks of streams with saline seeps for constructing larval burrows, thermoregulation (ability of an organism to regulate its body temperature using internal and external mechanisms), foraging, and using them for dispersal corridors. The species is adapted to highly saline conditions and brief periods of flooding.

The primary threat to this species is loss and degradation of saline wetland and stream habitats due to commercial, residential, and agricultural developments. Construction of levees, reservoirs, and additional channelization of Salt Creek resulted in the degradation and loss of saline wetlands and seeps and entrenchment of its associated tributaries (i.e., Rock, Little Salt, Oak, and Haines Branch Creeks). Contamination, artificial lights, floods, and drought can also have a negative impact on this insect. The Salt Creek tiger beetle is currently found on only one stream segment (Little Salt Creek), which makes it subject to high extinction risk should a catastrophic event occur.

Recovery Strategy: Our recovery strategy is to establish metapopulations in multiple recovery areas. Recovery areas were identified based on site inspections, soil surveys (including the presence of saline soils), and restoration feasibility. Accomplishing this strategy requires acquisition of land or conservation easements, focused habitat restoration and management projects, and reintroductions.

Recovery Goals, Objectives, and Criteria: The goal of our recovery plan is to recover the Salt Creek tiger beetle such that it no longer meets the Endangered Species Act's (Act) definition of threatened and can be removed from the Federal List of Endangered and Threatened Wildlife. Downlisting from endangered to threatened and delisting of the Salt Creek tiger beetle should be considered when the threats have been removed or reduced as indicated by the following:

- Criterion (downlisting) – The criterion for downlisting is: a) establishment of three metapopulations of Salt Creek tiger beetles with populations each numbering between 500 to 1,000 individuals to ensure population viability; b) establishment of these three metapopulations in three recovery areas; and c) no net loss of saline wetlands and streams and their associated functions in Rock, Little Salt, Oak, and Haines Branch Creeks and their floodplains.

- Criterion (delisting) – In addition to the downlisting criterion, the criterion for delisting is the establishment of three additional metapopulations (for a total of six metapopulations) of Salt Creek tiger beetles with populations each numbering between 500 to 1,000 individuals to ensure population viability with a distribution spanning at least four recovery areas.

The recovery criteria listed above are based on addressing threats to the Salt Creek tiger beetle. Cumulatively, these address the five listing factors (A-E) identified in section 4(a) (1) of the Act that were considered when the Salt Creek tiger beetle was listed in 2005. We estimate recovery will take 30 years including 20 years to achieve the goals and a minimum of 10 years to maintain viable populations and suitable habitat for the subspecies. This ten year period will demonstrate that the threats of habitat loss and degradation (Factor A), overutilization through collection of individuals for insect collections (Factor B), predation and parasitism by other insects (Factor C), the inadequacy of regulatory mechanisms (Factor D), and catastrophic events such as floods and drought (Factor E) have been managed and reduced such that delisting of the Salt Creek tiger beetle is merited.

Actions Needed:

1.0 Recovery Area Protection
2.0 Recovery Area Restoration and Management
3.0 Salt Creek Tiger Beetle Rearing, Propagation, and Reintroduction
4.0 Population and Recovery Area Monitoring
5.0 Outreach and Education
6.0 Post-delisting Monitoring

Total Estimated Cost of Recovery by Recovery Action Priority:

Table 1. Estimated Cost of Recovery by Recovery Action Priority

Years	Priority[1] 1(a) Actions	Priority 1(b) Actions	Priority 2 Actions	Priority 3 Actions	Total Cost/Year
1 and 2	1,835	46	4	0	1,885
3 and 4	2,038	16	4	0	2,058
5 and 6	2,156	48	4	0	2,208
7 and 8	2,161	18	4	0	2,183
9 and 10	3,155	50	4	0	3,209
11 to 15	5,284	102	16	0	5,402
Downlist Cost					**16,945**[2]
15 to 30	13,389	408	16	25	13,838
Total Recovery Cost	**$30,018**	**$688**	**$52**	**$25**	**$30,783**

[1]dollars are shown in 1,000s
[2]Cost to downlist in 15 years

Date of Recovery: If recovery actions are fully funded and carried out as outlined in this plan, criteria for downlisting could be met within 15 years and the subspecies could be delisted in approximately 30 years.

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ACRONYMS

The following acronyms are used in this recovery plan:

Act	Endangered Species Act
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DPS	Distinct Population Segment
km	Kilometer
LPSNRD	Lower Platte South Natural Resources District
mi	Mile
NESCA	Nongame and Endangered Species Conservation Act
NGPC	Nebraska Game and Parks Commission
NRCS	Natural Resources Conservation Service
NRD	Natural Resources District
UNL	University of Nebraska at Lincoln
WMA	Wildlife Management Area
WRP	Wetland Reserve Program
Service	U.S. Fish and Wildlife Service
SWCP	Saline Wetlands Conservation Partnership

1 BACKGROUND

1.1 Introduction

The purpose of this recovery plan is to guide implementation of recovery actions to achieve the goal of recovering and delisting the Salt Creek tiger beetle. Section 4(f) of the Endangered Species Act (Act) requires development and implementation of recovery plans for the conservation and survival of endangered and threatened species. This recovery plan includes objective, measurable criteria that, when met, will allow the species or populations to be removed from the Federal List of Threatened and Endangered Species. Section 4(f) of the Act also requires that recovery plans include site-specific management actions necessary to achieve these criteria as well as provide time and cost estimates.

Recovery plans are not regulatory documents; instead, they are intended to provide guidance to the U.S. Fish and Wildlife Service (Service), states, and other partners on both methods of avoiding and minimizing threats to listed species as well as criteria that may be used to determine when recovery is achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without all criteria being fully met. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may judge that the threats have been minimized sufficiently and the species is robust enough to reclassify it from endangered to threatened or to delist. In other cases, recovery opportunities may have been identified that were not known at the time the recovery plan was finalized. These opportunities may be used instead of methods identified in the recovery plan. Likewise, new information on the species may be learned that was not known at the time the recovery plan was finalized. This new information may change the extent that criteria need to be met for recognizing recovery of the species. Recovery of a species is a dynamic process requiring monitoring, assessment, and a feedback loop that allows adjustments to be made as needed; if new or unexpected information is found, adjustments or may not fully follow the guidance provided in a recovery plan.

Status of the Species

We listed the Salt Creek tiger beetle *(Cicindela nevadica lincolniana)* as a federally endangered subspecies on November 7, 2005 (70 FR 58335, October 6, 2005). On May 6, 2014 (79 FR 26013), we published a revised final rule designating approximately 1,110 acres (449 hectares) of critical habitat for the Salt Creek tiger beetle in Lancaster and Saunders Counties in Nebraska. The Nebraska Game and Parks Commission (NGPC) listed the Salt Creek tiger beetle as endangered under the State's Nongame and Endangered Species Conservation Act (NESCA) in March 2001. The Salt Creek tiger beetle has one of the most restricted ranges of any insect in the United States and is currently limited to segments of Little Salt Creek and adjacent remnant saline wetlands in northern Lancaster County, Nebraska.

Recovery Priority Number with Rationale

Table 2. Recovery Priority Table

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	**6C**
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

The current recovery priority number for the Salt Creek tiger beetle was recently revised to 6C. This ranking indicates that: a) the Salt Creek tiger beetle is a subspecies of *Cicindela nevadica*, but it is not a distinct population segment (DPS); b) it faces a high degree of threat; c) it has a low potential for recovery; and d) it is in conflict with development activities or other forms of economic activities. The high degree of threat is linked to species biological constraints such as: 1) reduced number of individuals and abundance and distribution of populations; 2) reduced genetic diversity due to limited number of individuals; 3) inability of the subspecies to colonize and persist in unoccupied areas lacking suitable habitat or in high risk habitat; and 4) excessive freshwater intrusion and sedimentation, overgrazing, stream entrenchment, and saline wetland and stream loss and degradation. A number of these threats are related to development or economic activities. The low potential for recovery is based on the difficulty in achieving conservation through habitat protection and management techniques and ability to successfully reintroduce the subspecies following captive rearing. This recovery priority number will be reviewed during the recovery planning process.

1.2 Species Description and Taxonomy

The Salt Creek tiger beetle is a member of the family Cicindelidae, genus *Cicindela*. Eighty-five species and more than 200 subspecies of tiger beetles in the genus Cicindela are known from the United States (Boyd et al. 1982, Freitag 1999). The Salt Creek tiger beetle was originally described by Casey (1916) as a separate species, *C. lincolniana*. Willis (1967) identified *C. n. lincolniana* as a subspecies of *C. nevadica* which evolved from *C. n. knausii.* This sub-species' distinctiveness from other central Great Plains populations of *C. nevadica* was confirmed by Busby (2003).

The Salt Creek tiger beetle is metallic brown to dark olive green above, with a metallic dark green underside, and measures 1.3 centimeters (0.5 inch) in total length. The elytra (wing covers) are metallic brown or dark olive green, and the head and pronotum (thorax) are dark brown (Carter 1989). It is distinguished from other tiger beetles by its distinctive form and the color pattern on its dorsal and ventral surfaces.

1.3 Population Trends and Distribution

The Salt Creek tiger beetle has one of the most restricted ranges of any insect in the United States (Spomer and Higley 1993; Spomer et al. 2004a), now only occurring along limited segments of Little Salt Creek and adjacent remnant saline wetlands in Lancaster County,

Nebraska. The Salt Creek tiger beetle was known from six populations when surveys began in 1991 (Figure 1; Appendix A). These populations were located on Rock and Oak Creeks, but now the subspecies is only known from Little Salt Creek (Figure 1). Half of these populations were thought to have been extirpated since 1991. However, the Upper Little Salt Creek-South population, thought to be extirpated since 1995, was re-discovered along the banks of Little Salt Creek at the Little Salt Creek Wildlife Management Area (WMA) in 2014. The six Salt Creek tiger beetle populations, including the two that have been extirpated, are described below in order of abundance.

Extant Populations

Little Salt Creek-Arbor Lake Population: The Little Salt Creek-Arbor Lake Population contains the largest number of Salt Creek tiger beetles (Appendix A). We believe that this metapopulation has persisted because it consists of several interchanging subpopulations and occurs across a large, relatively intact and restored saline wetland and stream complex. The Little Salt Creek-Arbor Lake Population is located approximately 1.6 kilometer (km) (1 mile [mi]) north of the Interstate 80 and North 27th Street Interchange at the northern city limits of Lincoln, Nebraska (Figure 1).

Little Salt Creek-Roper Population: The Little Salt Creek-Roper Population is the second largest remaining population of Salt Creek tiger beetles (Appendix A). We believe that this metapopulation is in decline because of the reduction in the number of interchanging subpopulations and habitat degradation. This population is located immediately south of the Interstate 80 and North 27th Street Interchange, and approximately 1.6 km (1 mi) downstream of the Little Salt Creek-Arbor Lake Population (Figure 1).

Upper Little Salt Creek-North Population: The Upper Little Salt Creek-North Population is the third of four populations of extant Salt Creek tiger beetles (Appendix A). This metapopulation is in decline because of the reduction in the number of interchanging subpopulations and habitat degradation. This population is located approximately 7.2 km (4.5 mi) upstream from the Little Salt Creek-Arbor Lake Population, and exists on the saline stream edges of Little Salt Creek and a single salt flat (Figure 1). This population is comprised of four sites along Little Salt Creek that were surveyed from 1991 to 2014.

Upper Little Salt Creek-South Population: The Upper Little Salt Creek-South Population was thought to have been extirpated since 1995 (Appendix A). However, a population was found using saline seeps along Little Salt Creek at the Little Salt Creek WMA in 2014. This metapopulation consists of a single subpopulation making it at risk to local extirpation. This population is located approximately 5 km (3 mi) upstream from the Little Salt Creek-Arbor Lake Population (Figure 1). Degraded and non-functioning saline wetlands exist adjacent to Little Salt Creek. Although this site was once devoid of vegetation, saline stream edge habitats here are now vegetated. Entrenchment of Little Salt Creek, over covering of saline seeps, and drainage of saline wetlands have resulted in the loss of suitable habitat.

Presumed Extirpated Populations

Jack Sinn WMA Population: This extirpated population consisted of two sites located near Rock Creek in southern Saunders and northern Lancaster Counties, approximately 20 km (10 mi) northeast of the Little Salt Creek-Arbor Lake Population on property owned by the NGPC (Figure 1). We believe that this metapopulation disappeared due to a reduction in the number of interchanging subpopulations and degradation of habitat along Rock Creek. Salt Creek tiger beetles have not been found at the Jack Sinn WMA since 1998 (Appendix A).

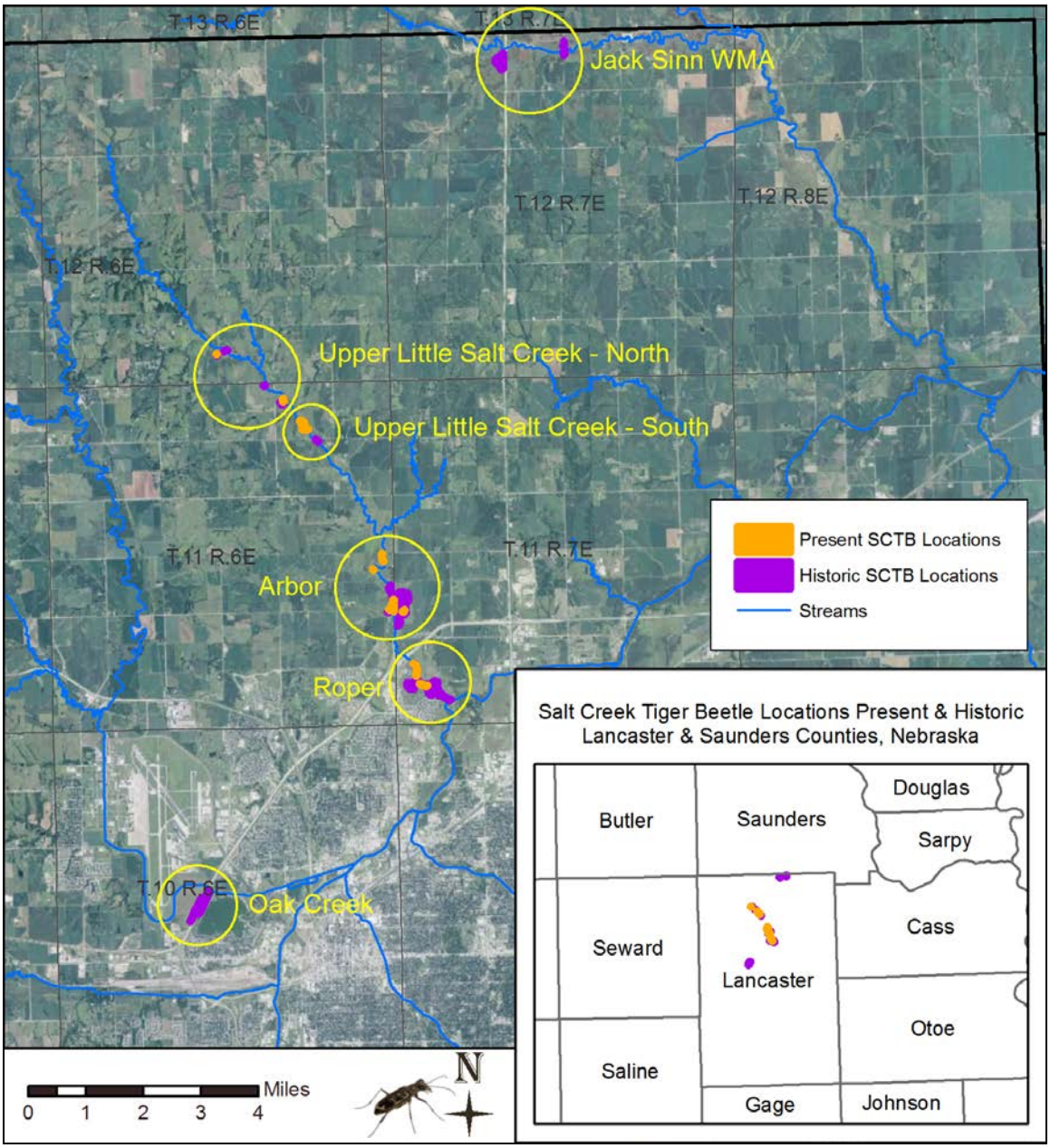
Oak Creek Population: Oak Creek and its associated saline wetlands, locally referred to as Capitol Beach, were historically one of the largest saline wetland tracts in eastern Nebraska, with a size of approximately 162 hectares (400 acres) (Cunningham 1985) (Figure 1). Although we do not have historic population estimates from this site, records suggest that it was once home to a large, sustainable population of Salt Creek tiger beetles. All that remains of suitable habitat at Oak Creek now is a large saline wetland located within the boundaries of the Lincoln Municipal Airport. Oak Creek is a 10 to 20 meter-wide (40 to 50 foot-wide) drainage that parallels Interstate 80 for approximately 0.8 km (0.5 mi), southwest of the Interstate 80 and Airport Interchange. No individuals have been found at Oak Creek since 1998 (Appendix A) (Spomer et al. 2002 and 2004a and b; Allgeier et al. 2003). Although this metapopulation is presumed extirpated, a large saline wetland on property owned by the Lincoln Municipal Airport has not been surveyed for over fifteen years due to lack of permission for access. Thus, it is possible that the Salt Creek tiger beetle is present at the saline wetland located on the Lincoln Municipal Airport property given the presence of suitable habitat and observations of other conspecific tiger beetles adjacent to the site.

1.4 Life History/Ecology

Breeding

The Salt Creek tiger beetle is believed to have a two-year life cycle in the wild, not uncommon for tiger beetles (Allgeier et al. 2004; Spomer et al. 2004a). Wild adults are first observed as early as mid-May or as late as mid-June. Their numbers peak about two-weeks after the first individuals appear and begin to feed and mate. After mating, the male rides atop the female to prevent her from re-mating (a phenomenon known as mate-guarding). Females deposit their eggs on barren salt flats of saline wetlands, along sloping banks of streams in areas where the salt layer is exposed in the soil horizon, or along saline stream edges that are found in close association with water, near a seep. We believe that wild female Salt Creek tiger beetles lay approximately 50 eggs at night in the wild (Farrar 2003). Following mating and egg-laying, wild adult populations begin to die in late-July and August likely due to high summer temperatures (Spomer et al. 2004a).

Figure 1. Historic and Current Populations of Salt Creek Tiger Beetles[1]



[1]Map must be viewed in color to differentiate between present and historic Salt Creek tiger beetle locations.

Spomer and Higley (1993) and Spomer et al. (2004a) describe the life cycle of the Salt Creek tiger beetle in detail through egg, larval, and adult stages as follows. Eggs hatch approximately two weeks after being laid by the female. After the eggs hatch, the young larva digs a burrow and uses its head to scoop out soil. The larva takes these small mud clods to the burrow entrance and flips them outside the hole. The larva will plug its burrow and retreat inside during periods of high water, very hot weather, or very dry conditions. As the larva grows, it molts to a larger instar (a life stage between molts), enlarging and lengthening its burrow. Typically, a Salt Creek tiger beetle larva will remain active until cold weather (late October-early November), at which time it plugs its burrow and hibernates. The Salt Creek tiger beetle has three instars. It probably overwinters the first and second years as a second and third instar, respectively, then pupates in May and emerges as an adult. Before pupation, the larva seals its burrow entrance and digs a side chamber about 5 to 8 centimeters (2 to 3 inches) below the soil surface. After the adult emerges from the pupa, it remains in the chamber until its cuticle hardens, then leaves the burrow to feed and mate.

Feeding

Larval tiger beetles ambush prey passing near the burrow entrance. Once it has captured its prey, the larval tiger beetle pulls it into the burrow with the aid of two pairs of hooks on the abdomen. These hooks also function to prevent the larva from being pulled from its burrow by larger prey or predators. Adult Salt Creek tiger beetles prey on other insects on sandbars, mid-stream gravel areas, and salt flats.

Habitat

The entire life cycle of the Salt Creek tiger beetle occurs in saline wetlands, on exposed saline mud flats or along mud banks of streams and seeps that contain salt deposits and are sparsely vegetated (Carter 1989; Spomer and Higley 1993; LaGrange 1997; Spomer et al. 2004a). Larvae have been found only on moist salt flats and salt-encrusted banks of Little Salt Creek in northern Lancaster County (Spomer et al. 2004a). Salt Creek tiger beetles require open, barren salt flat areas for construction of larval burrows, thermoregulation, foraging, and as dispersal corridors (Spomer and Higley 1993; Higley 2002, pers. comm.; Spomer 2005, pers. comm.).

2 Critical Habitat

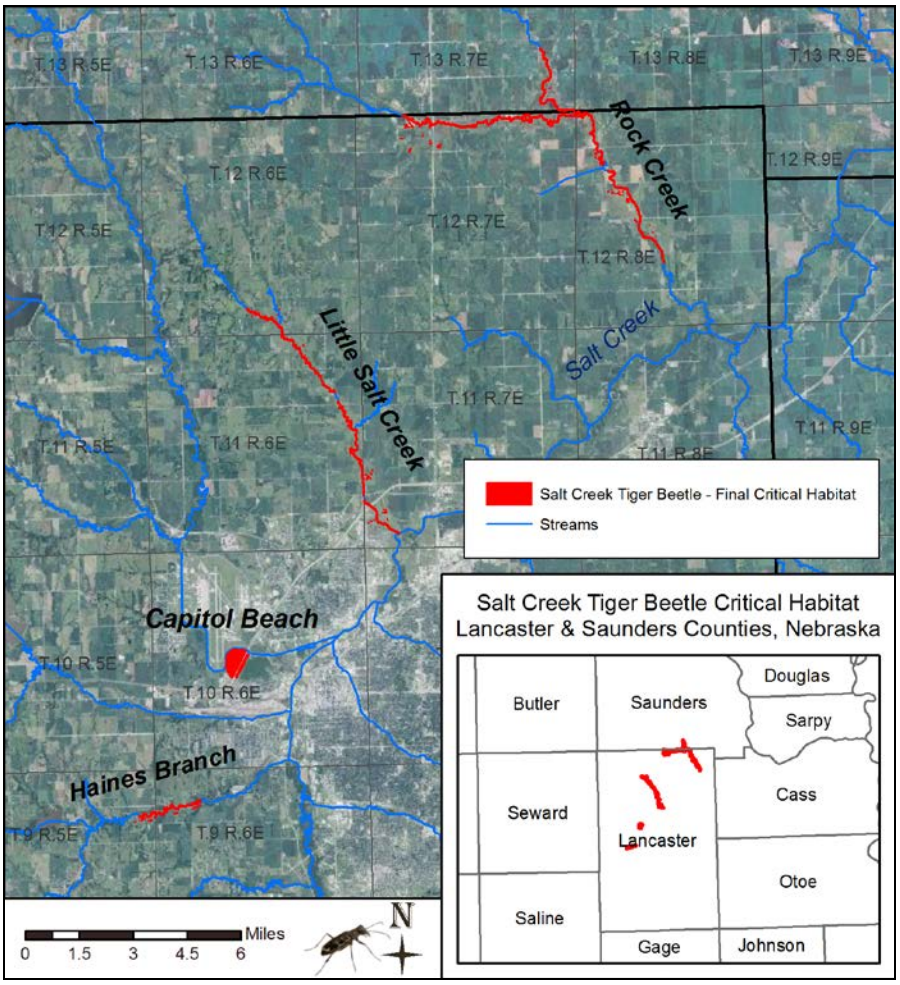
Critical habitat was designated for the Salt Creek tiger beetle on May 6, 2014 (79 FR 26013). The 1,110 acre (449 hectare) designation includes saline seeps along Rock, Little Salt, Oak, and Haines Branch Creeks (Figure 2). A 42 meter (137-foot) dispersal distance was extended outward on either side of these creeks to provide the Salt Creek tiger beetle with access to saline wetland and seeps located in the floodplains of Rock, Little Salt, Oak, and Haines Branch Creeks. In some instances, large saline wetlands were also included if they were near one of the aforementioned streams and provided suitable habitat for the Salt Creek tiger beetle (e.g., saline wetland located on Lincoln Municipal Airport property). Rock, Little Salt, Oak, and Haines Branch Creeks were selected as critical habitat because we were familiar with these areas and their ability to provide the primary constituent elements to the Salt Creek tiger beetle.

We determined that the primary constituent elements specific to the Salt Creek tiger beetle are saline barrens and seeps found within saline wetland habitat in Little Salt, Rock, Oak, and Haines Branch Creeks. Two habitat types within suitable wetlands are required by the Salt Creek tiger beetle:

- Exposed mudflats associated with saline wetlands or the exposed banks and islands of streams and seeps that contain adequate soil moisture and soil salinity are essential core habitats. These habitats support egg-laying and foraging requirements.
- Vegetated wetlands adjacent to core habitats that provide shade for subspecies thermoregulation, support a source of prey for adults and larval forms of Salt Creek tiger beetles, and protect core habitats.

Our recovery approach is to establish six metapopulations of Salt Creek tiger beetles at Rock, Little Salt, Oak, and Haines Branch Creeks. Although these creeks provide the best opportunity for recovery of the subspecies, it is possible that these areas may not be able to support six viable metapopulations due to past alterations to habitat and hydrology. Under these circumstances, we believe that other habitat shown as recovery areas on Figure 4 (Ashland, Lower Salt Creek, Roca, Upper Salt Creek, and Hickman Recovery Areas) but not designated as critical habitat may be important for the recovery of the Salt Creek tiger beetle. These areas have the potential to provide alternative reintroduction and recovery sites.

Figure 2. Salt Creek Tiger Beetle Critical Habitat[1]



[1]Map must be viewed in color to identify designated critical habitat.

2.1 Threats

The Salt Creek tiger beetle was known from six populations when surveys began in 1991 (Figure 1; Appendix A). These populations were located on Rock, Little Salt, and Oak Creeks (Figure 1). However, several of these populations are presumed to be extirpated (since 1991) due to the threats outlined below, the most significant threat being Listing Factor A, the destruction, modification, or curtailment of habitat. Below is a summary of the most significant threats to the Salt Creek tiger beetle and its saline wetland and stream habitats. A detailed discussion about the threats to Salt Creek tiger beetle can be found in the final rule to list the subspecies as federally endangered (70 FR 58335, October 6, 2005).

Listing Factor A – the present or threatened destruction, modification, or curtailment of habitat or range

Commercial and Residential Developments

Commercial and residential developments pose a significant threat to the saline wetlands of eastern Nebraska as well as plant and animal species that depend upon these habitats (Gilbert and Stutheit 1994; Ratcliffe and Spomer 2002). From the 1930s to the 1950s, saline wetlands were destroyed for the development of Lincoln (Farrar and Gersib 1991). In the 1960s, construction of Interstate 80, through the heart of the remaining Salt Creek tiger beetle habitat, resulted in additional filling, dredging, diking, draining, and diversion (Farrar and Gersib 1991). Most of the remaining habitat now is composed of small habitat complexes (i.e., less than 0.04 hectare (0.09 acre)) that are unlikely to provide all of the necessary life history requirements that the Salt Creek tiger beetle needs to survive without restoration. This spatial dispersion also reduces the connectivity between populations thereby eliminating genetic interchange and the ability to repopulate after catastrophic events (Murphy et al. 1990; Fahrig and Merriam 1994; Ruggerio et al. 1994; Noss 2002).

An example of development prompted by growth of the City of Lincoln is the conversion of Salt Basin to Capitol Beach at the turn of the 20th century. Salt Basin (now known as Capitol Beach and included in the Oak Creek Recovery Area) was once approximately 162 hectares (400 acres) in size, and one of the largest saline wetlands in the area (Cunningham 1985). To accommodate the residential and commercial developments there, saline wetlands and associated streams at Capitol Beach were ditched, drained, and filled (Murphy 1992; Rus et al. 2003). In 1895, Salt Lake was diked and Oak Creek was diverted to create a permanent lake for recreational purposes. In 1906, the lake was renamed Capitol Beach. Construction of Interstate 80 northwest of Capitol Beach resulted in the continued filling of saline wetlands. These activities caused the extirpation of the Capitol Beach Population, possibly the largest historic population of Salt Creek tiger beetles and the location of the type locality for the subspecies. All that remains is a large saline wetland and associated salt flat which appears to provide suitable habitat for the Salt Creek tiger beetle on property owned by the Lincoln Municipal Airport.

Construction of the North 27th Street interchange along Interstate 80 facilitated the conversion of a large grassland and saline wetland and stream complex to extensive commercial and residential developments. Ninety-nine percent of the remaining Salt Creek tiger beetles are located within a 1.6 km (1 mi) radius of the Interstate 80 and North 27th Street Interchange and ongoing residential and commercial developments. The Little Salt Creek-Roper Population of Salt Creek tiger beetles in the area of Interstate 80 and the North 27th Street interchange is nearly surrounded by commercial and residential developments.

Freshwater runoff from commercial and residential developments dilutes salinity. Reduced salinity concentrations on barren salt flats and along saline stream edges has encouraged the invasion of vegetation such as cattail (*Typha angustifolia*) and reed canary grass *(Phalaris arundinacea*) into habitats used by the Salt Creek tiger beetle. These plants, ordinarily unable to tolerate high salinity, are aggressive invaders that convert sunny, barren salt flats into habitat that is dominated by herbaceous overstory. The resulting vegetated habitat then becomes unsuitable for use by the Salt Creek tiger beetle. The overstory shades out open, sunny areas required by the Salt Creek tiger beetle to thermoregulate, forage, and lay eggs (Fritz 2001, pers. comm.).

Increased vegetative encroachment is the primary factor attributed to the extirpation of several populations of other *Cicindela* species (e.g., *C. abdominalis* and *C. debilis*) (Knisley and Hill 1992), and was one of the main threats to *C. ohlone* (66 FR 50340). A species-specific preference for salt and soil moisture is likely important for habitat partitioning and reduction in competition between the Salt Creek tiger beetle and other cogener species of tiger beetles that live in saline wetlands (Allgeier et al. 2004).

Stream Channelization, Bank Stabilization, and Incisement

Channelization of Salt Creek from Lincoln to Ashland, Nebraska was done to control flooding and protect infrastructure (Farrar and Gersib 1991; Murphy 1992). In the 1950s, a flood control plan was developed and implemented to reduce the frequency of flooding. The flood control plan resulted in the construction of levees and reservoirs and additional channelization of Salt Creek (Murphy 1992). Channelization of Salt Creek encouraged tributary streams (e.g., Little Salt, Oak, Rock, and Haines Branch Creeks) to head-cut, carving deeper into their beds to adjust to the change in stream bed gradient. This resulted in the gradual lowering of the water table and drainage of adjacent saline wetlands that are important to the Salt Creek tiger beetle (Wingfield et al. 1992). The on-going long-term effects of these past channelization projects continue to cause saline ground water to be intercepted and directed into streams. This has reduced the flow of saline water to surface seeps and caused the loss and degradation of saline wetlands and salt flats required by the Salt Creek tiger beetle.

The largest population of Salt Creek tiger beetles, the Little Salt Creek-Arbor Lake Population, was significantly impacted by a stream channelization and bank stabilization project along Little Salt Creek (Spomer and Higley 1993; Farrar 2003). In an attempt to control erosion and bank sloughing and to prepare for the widening of North 27th Street, a portion of Little Salt Creek was straightened, and its banks were armored with rock riprap. These actions destroyed about half of the remaining prime habitats for the Salt Creek tiger beetle along Little Salt Creek (Spomer and Higley 1993; Farrar 2003). The Little Salt Creek-Arbor Lake Population exhibited a corresponding 55 percent decline (see Appendix A) after the project was completed (Spomer and Higley 1993).

Agricultural Development

Agricultural practices can threaten Salt Creek tiger beetle habitat, especially in the rural Upper Little Salt Creek-North, Upper Little Salt Creek-South, and Little Salt Creek-Arbor Lake Populations. Livestock are attracted to exposed salt. Livestock can destroy or substantially degrade salt barren habitats for adult and larval forms of the Salt Creek tiger beetle through trampling, which can destroy larval burrows and the larvae that inhabit them (Spomer et al. 2001). Cattle grazing also can compact soil and modify soil hydrology, gradually drying out a site and making it unsuitable for adults and larvae (which prefer moist, muddy sites with encrusted salt on soil surfaces). For example, the Upper Little Salt Creek-North Population occurs along a segment of Little Salt Creek that flows through a pasture; this population was negatively impacted by cattle grazing as a result (Spomer et al. 2004a). However, grazing has always been associated with saline wetlands and is undoubtedly an important component of their management. Grazing can be an effective land management tool to control encroachment of aggressive vegetation when done at appropriate stocking rates and times and with use of exclosures to prevent damage to salt barrens and seeps along stream banks. Historically, large herds of bison *(Bison bison)*, pronghorn *(Antilocapra americana)*, and elk *(Cervus canadensis)*

were known to spend a considerable amount of time grazing in the saline wetlands. It is relatively common to find bones of these large herbivores along Little Salt Creek.

Cultivation poses a threat to Salt Creek tiger beetle habitats generally through indirect means. Cultivation can increase sediment erosion and result in the introduction of pesticides into adjacent saline wetlands especially in the absence of a grass buffer. Adverse impacts can also occur if winter and spring thaws wash sediment from cultivated land and either cover larval burrows with a thick layer of sediment or encourage vegetative encroachment of saline stream edges through sediment accumulation. Flooding and over covering by sediment originating from cultivated areas is likely to have caused the extirpation of the Jack Sinn WMA Population of Salt Creek tiger beetles in 1998. The larvae were unable to remove the 8 to 10 centimeters (3 to 4 inches) of sediment deposited onto their burrows because they extract excess soil material out and away from their burrow, not inward (Spomer et al. 2004a). The flood also changed the vegetation of the area; before the flood, there were large areas of saline wetlands and salt flats present. After the flood, a thick herbaceous overstory composed of reed canarygrass and cattails infested the area, making it unsuitable for the Salt Creek tiger beetle.

Listing Factor B – Overutilization for commercial, recreational, scientific, or educational purposes

Tiger beetles (genus *Cicindela*) are one of the most sought after genera of beetles by amateur collectors because of their unique metallic colors and patterns as well as their fascinating habits. However, we do not have any information that suggests that over collection of adult Salt Creek tiger beetles is a factor contributing to its decline.

Listing Factor C – Disease or predation

Predators and parasitoids evolved in conjunction with the Salt Creek tiger beetle and would not normally pose a severe threat to the survival of a healthy and viable population. In light of the subspecies current small population size and limited distribution, predation and parasitism may be a significant source of mortality and be an issue of concern for the subspecies (Higley 2002, pers. comm.). This issue was likely not a meaningful contributor to historical declines.

Listing Factor D – The inadequacy of existing regulatory mechanisms

<u>Clean Water Act</u>
The U.S. Army Corps of Engineers (Corps) regulates the placement of fill materials into wetlands, streams, rivers, and other water features under section 404 of the Clean Water Act (CWA). Placement of fill into these water features requires a permit from the Corps. Stream channelization and bank stabilization projects on Salt Creek have caused channel entrenchment and the gradual drainage of adjacent saline wetlands over time in several tributaries. These activities are not regulated by the Corps because the CWA does not regulate wetland drainage resulting from channel entrenchment or construction of drainage ditches. Additionally, the CWA also does not apply to runoff of sediment originating from upland sources. The effects of these activities, which are not regulated, could have substantial adverse impacts on saline wetlands and associated streams used by larval and adult Salt Creek tiger beetles.

State Implemented Regulatory Mechanisms

Under section 401 of the CWA, the Nebraska Department of Environmental Quality issues a Water Quality Certification that Nebraska State Water Quality Standards have been met whenever a permit is issued by the Corps. However, the Nebraska Department of Environmental Quality can only take an enforcement action after an impact to a wetland has occurred. Water Quality Standards are not aligned with quantitative biological criteria, and thus, projects may still meet certification standards but have negative impacts on saline wetlands and associated streams that provide habitats needed to meet life requirements of both larval and adult Salt Creek tiger beetles.

Local Conservation Planning

In a joint effort to plan long-term development projects for Lincoln and Lancaster County, city and county officials approved the 2002 Lincoln and Lancaster County Comprehensive Plan (City of Lincoln/Lancaster County 2002). Since then, the Comprehensive Plan has been updated. The LPlan2040 was adopted in October 2011, and has been updated with amendments through 2014 (City of Lincoln/Lancaster County 2011). The Comprehensive Plan is a good guide for the growth and development of Lincoln and Lancaster County but can provide no assurances for the protection and habitat for the Salt Creek tiger beetle beyond the elected terms of the officials instrumental in its development.

Conclusion

The Act is the primary tool that we use to protect federally listed endangered species like the Salt Creek tiger beetle. Protections conveyed by the CWA, Nebraska Water Quality Certification, and comprehensive planning efforts are helpful but in the absence of federal listing would not contribute to the ultimate goal of recovering the Salt Creek tiger beetle.

Factor E – Other natural or manmade factors affecting its continued existence

Small Population Size

Populations of Salt Creek tiger beetles are isolated, small, and vulnerable to extinction by chance demographic events, disease, inbreeding, or other events such as changing water levels, succession of wetland vegetation, and habitat destruction (Murphy et al. 1990, Ruggerio et al. 1994, Gibbs 1993). Murphy et al. (1990) and Gilpin (1987) recognized a direct association between increased extinction rates of a species and reduced habitat areas, distances between populations, and small population size. The negative effects of habitat fragmentation and loss on the total number of individuals within a population include the loss of genetic diversity (Lacy 1987).

Climate and Weather Events

The remaining populations of Salt Creek tiger beetles are highly susceptible to extinction as a result of weather events. Such events may include: a) heavy rain storms and severe flooding that drown and scour larvae away, dilute salinity, and result in sediment deposition and b) drought, which can dry out seeps and saline wetlands making them unsuitable as habitat and modify the diversity and abundance of prey. Climate change may also affect the Salt Creek tiger beetle if predictions about loss of wetlands and gradual warming in the Midwest occur. In such an instance, we could reasonably expect to see a loss of saline wetland habitat for the Salt Creek tiger beetle which could cause potentially significant issues for the subspecies.

Pesticides

Corn, soybean, pasture, and sorghum fields dominate the Little Salt Creek watershed and are potential sources of pesticide exposure to Salt Creek tiger beetles and their habitat. Insecticides that enter occupied habitats of the Salt Creek tiger beetle through runoff have the potential for direct and indirect impacts through reduction of prey availability. No studies have evaluated pesticide exposure and adverse effects to Salt Creek tiger beetles; however, research on ground beetles (*Carabidae*) indicates that pesticide exposure may place adult Salt Creek tiger beetles at risk from decreased survival and reproduction (Mullin et al. 2010; Pisa et al. 2014). Insecticides applied annually to lawns and landscaping in residential and commercial developments near Little Salt Creek have the potential to enter the creek and impact the Salt Creek tiger beetle and its prey base. Salt Creek tiger beetles also may be exposed to pesticides applied to control mosquitoes, grasshoppers, and pests in residential yards and gardens.

Artificial Lights

Artificial lights that have proliferated due to commercial and residential developments along streets and highways in Lincoln, particularly mercury vapor lamps, may also contribute to population losses of the Salt Creek tiger beetle because such lights have been implicated in population losses of nocturnal insects elsewhere (Pyle et al. 1981). Allgeier et al. (2003) found that Salt Creek tiger beetles were attracted to artificial lights in the following order of preference: a) black light; b) mercury vapor; c) incandescent; d) fluorescent; and e) sodium vapor. Because female Salt Creek tiger beetles lay eggs at night, artificial light sources may reduce reproduction (Allgeier et al. 2003) by drawing females away from suitable breeding habitat. Movement away from habitat to lighted areas, such as areas surrounding major transportation routes (e.g., Interstate 80) and associated residential and commercial developments, may increase energy expenditure, reduce reproductive success, and ultimately impact the survival of the two largest populations of Salt Creek tiger beetles near the City of Lincoln (Allgeier et al. 2004).

Electric insect light traps likely pose a threat to the Salt Creek tiger beetle especially given the residential development near the Little Salt Creek-Roper Population. It is likely that such traps are present at residences that border the saline wetland and stream complex that provides habitat for the Little Salt Creek-Roper Population.

Conclusion

Direct and indirect loss of saline wetland and stream habitats prior to, and following listing in 2005, remains the greatest threat to the Salt Creek tiger beetle. Of these threats, indirect loss, likely poses a greater risk than direct loss through filling activities post-listing, due to the increase regulatory oversight that has been applied through administration of section 404 of the CWA. However, the on-going, long-term effects of past channelization projects continue to cause the loss and degradation of saline wetlands and salt flats required by the Salt Creek tiger beetle. The comprehensive plan has regulated development in the Little Salt Creek area and has helped guide proposed commercial and residential developments away from Salt Creek tiger beetle habitat.

Impacts caused by weather events such as drought and excessive rainfall and flooding have significantly impacted the Salt Creek tiger beetle. Drought has been shown to play a role in the

reduction of populations through desiccation of saline wetlands and seeps along streams, making them unsuitable for egg laying and larval use. Excessive rainfall has caused scouring of larval habitat along streams, bank sloughing and over covering of larval habitat, and excessive flooding of saline wetlands over long periods of time which likely affects the Salt Creek tiger beetle.

Artificial lights attract the Salt Creek tiger beetle away from habitat subjecting it to risk from predation and unnecessary energy expenditure. Additionally, parasitism and predation may be a concern given the small number of populations and small population sizes. Pesticide application likely has had a negative impact on the Salt Creek tiger beetle. We have no information that would support the conclusion that over collecting of individuals has had a negative impact on the Salt Creek tiger beetle.

2.2 Conservation Efforts

The Saline Wetlands Conservation Partnership (SWCP), City of Lincoln, Lower Platte South Natural Resources District (LPSNRD), NGPC, and the Natural Resources Conservation Service (NRCS) have made protection of saline wetlands in eastern Nebraska a priority and have been extremely effective in the implementation of conservation projects. The focus of these efforts has been along Little Salt and Rock Creeks, but there have also been conservation efforts along Oak Creek as well. We expect the efforts of the SWCP, LPSNRD, NGPC, and NRCS to continue into the future.

Saline Wetlands Conservation Partnership: The SWCP is a partnership between the City of Lincoln, Lancaster County, LPSNRD, The Nature Conservancy, and NGPC. An Implementation Plan for the Conservation of Nebraska's Eastern Saline Wetlands guides the SWCP and provides a holistic watershed approach designed to preserve both wetlands and their surrounding watersheds. Plan implementation involves local, state, and federal agencies working in concert with private individuals and organizations to develop additional strategies and programs that encourage saline wetland conservation. The SWCP utilizes several strategies, from the purchase of wetlands from willing sellers to conservation easements and keeping the land in private ownership but protecting it in perpetuity (Figure 3). Funding for the SWCP has been provided through Nebraska Environmental Trust grants and state and federal funding programs including several Non-traditional Section 6 grants obtained by the NGPC and used for land acquisition. Other partners have contributed to the conservation of saline wetland and steam complexes along Little Salt and Rock Creeks including the Cooper Foundation, The Nature Conservancy, Ducks Unlimited, Service, U.S. Environmental Protection Agency, Nebraska Department of Environmental Quality, Home Builders Association of Lincoln, Nebraska Wildlife Federation, Waschiska Audubon, Hugo and Thelma Aspegren Trust, Nebraska Sierra Club, Pheasants Forever, Conservation Alliance of the Great Plains, and several private landowners.

City of Lincoln: The City of Lincoln has been instrumental in the acquisition, restoration, and management of saline wetland and stream complexes in Lancaster County. A tremendous amount of progress has been made along Little Salt Creek (Figure 3). The City of Lincoln has been especially effective at developing innovative restoration projects including creation of barren salt flats and bank pull backs which have benefited the Salt Creek tiger beetle.

Lower Platte South Natural Resources District: The LPSNRD has made a priority the acquisition, restoration, and management of saline wetland and stream complexes in Lancaster County. A considerable amount of progress has been made along Little Salt Creek (Figure 3). The LPSNRD has been effective at developing close relationships with private landowners to protect and conserve saline wetlands.

Nebraska Game and Parks Commission: The NGPC owns and manages several WMAs along Little Salt and Rock Creeks that include large blocks of saline wetland habitat (Figure 3). The largest of these saline wetland and stream complexes is the Jack Sinn WMA located along Rock Creek.

Natural Resources Conservation Service: The NRCS has spent a considerable amount of time working with private landowners to enroll saline wetland and stream complexes into Wetland Reserve Program (WRP) easements. A significant amount of progress has been made along Rock Creek (Figure 3).

Land Management

Many saline wetlands and stream complexes shown in Figure 3 are restored and managed to encourage development of a healthy saline system. Many of these areas still need restoration. Restoration actions include flattening of stream banks to expose saline seeps, installation of water control structures, and removal of excess sediment. Routine management actions include grazing to control cattails and encourage development of saline wetland vegetation, prescribed burns, and control of noxious weeds, aggressive native plants, and woody vegetation. A high diversity, native seed mix has been planted at many of these areas to restore native vegetation. As a result of these restoration and management actions, several of the areas shown on Figure 3 have been used as experimental Salt Creek tiger beetle reintroduction sites.

Experimental Rearing, Propagation, and Reintroduction

A partnership including the Henry Doorly Zoo, Lincoln Children's Zoo, University of Nebraska, Entomology Department, Master Naturalist Program, Service, and NGPC established a Captive Rearing and Reintroduction Program for the Salt Creek tiger beetle in 2011 to begin captive rearing and small-scale experimental Salt Creek tiger beetle reintroduction efforts. Reintroduction efforts have occurred since 2011 at several locations along Little Salt Creek.

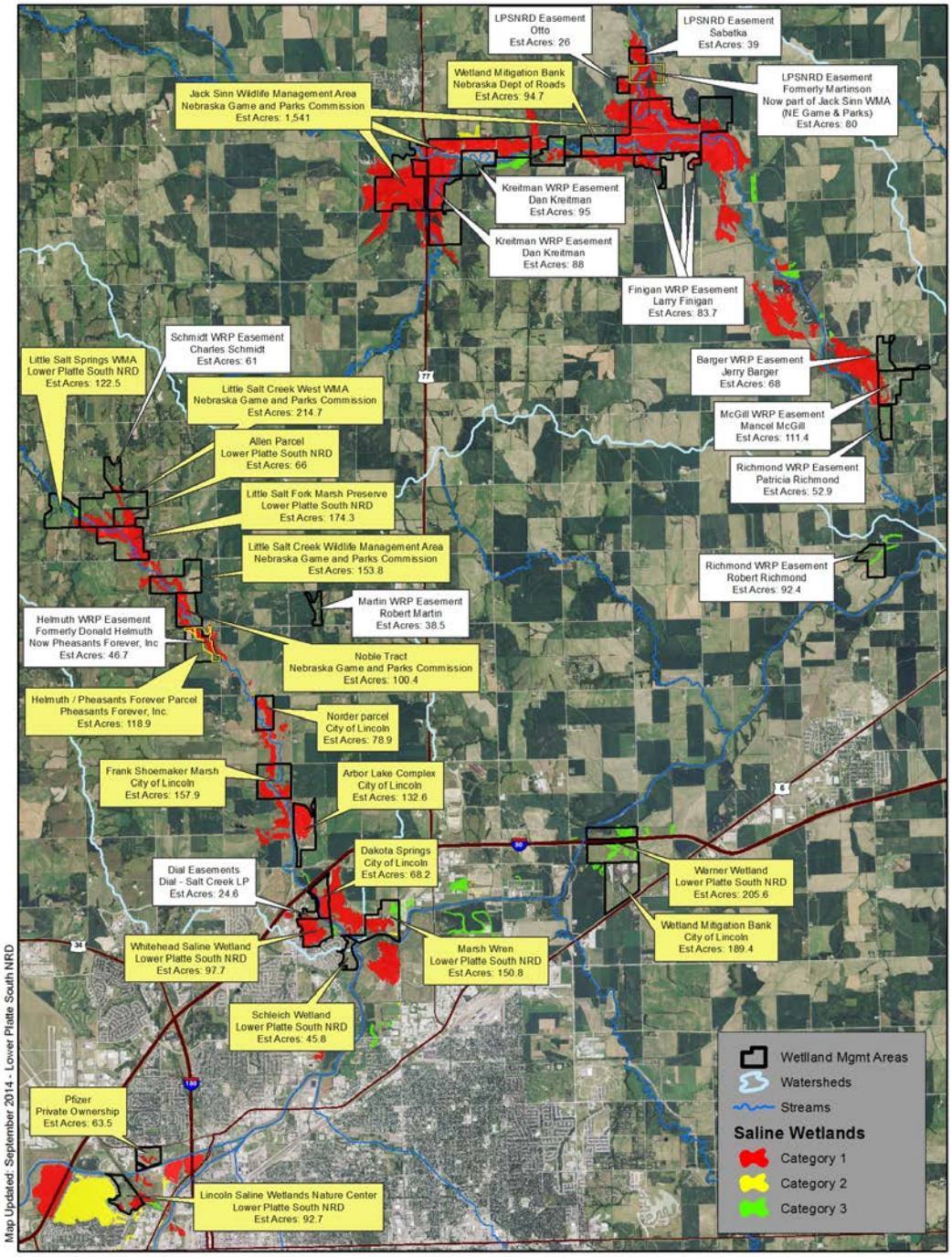
Male and female pairs are collected in early-June, immediately after they emerge from their burrows. Pairs are placed in individual rearing containers with a 50 percent sand and 50 percent loam substrate at the Henry Doorly Zoo. A 0.5 molar solution of sodium chloride is sprayed on the substrate to simulate saline egg-laying conditions. Following mating, the female lays eggs and in approximately 2-3 weeks, the larvae hatch. Larvae are collected and placed in tubes and fed fruit flies and crickets until late fall at the Lincoln Children's Zoo, Henry Doorly Zoo, and University of Nebraska-Entomology Department. Larvae are induced to enter a diapause state in late-fall in rearing chambers through reduction in temperature, light, and feeding frequency. In April, temperature and light are increased to simulate spring conditions to bring larvae out of diapause. Larvae are then removed from tubes and reintroduced at various areas with suitable habitat along Little Salt Creek. Master Naturalists, a group of citizen volunteers organized through the University of Nebraska, monitor the larvae, soil temperature, and moisture at reintroduction sites throughout the year and assist the zoos with care of larvae. Although the Salt

Creek tiger beetle is believed to have a two-year life cycle in the wild, the life cycle can be reduced to a single year under lab conditions when food is regularly provided and temperature, humidity, and substrate conditions are kept at preferred levels. Female Salt Creek tiger beetles lay approximately 50 eggs at night in the wild (Farrar 2003), but they can lay more eggs in a lab setting. These two factors offer the potential to propagate significant numbers of Salt Creek tiger beetles for use in supplementing small and declining populations and to reintroduce individuals at extirpated sites once habitat is restored and appropriate management is implemented to maintain suitable habitat.

2.3 Biological Constraints and Needs

The Captive Rearing and Reintroduction Program for the Salt Creek tiger beetle has been successful at rearing and reintroducing Salt Creek tiger beetle larvae. However, more research is needed to determine the success of adult emergence following larval reintroductions. Thus far, reintroductions have been in areas that already have a wild population of Salt Creek tiger beetles, making it difficult to discern between wild and zoo-raised adults. Additionally, monitoring reintroduced larvae and subsequent emergence of adults involves placement of enclosures around reintroduction sites. Enclosures would limit the ability of a newly emerged Salt Creek tiger beetle to obtain prey and water, which could result in mortality. Additional research is also needed to ensure development synchronization of wild and zoo-reared Salt Creek tiger beetles. Determining the success of actual reintroduction efforts and developmental synchrony is critical to determine the success and net benefit of experimental reintroductions and long term viability of reintroduction efforts.

Figure 3. Saline Wetland and Stream Complexes along Little Salt, Rock, and Oak Creeks[1]



(From Saline Wetlands Conservation Partnership, 2013 Progress Report)

[1]Map must be viewed in color to identify Saline Wetland and Stream Complexes

3 RECOVERY

The following section presents a strategy to recover the Salt Creek tiger beetle, including objective and measurable recovery criteria, which will be used to achieve downlisting and delisting as required under section 4 of the Act. The Recovery Plan also addresses the five statutory listing/recovery factors (section 4(a)(1) of the Act) to demonstrate how the recovery criteria and actions will lead to removal of the Salt Creek tiger beetle from the list of Threatened and Endangered Species.

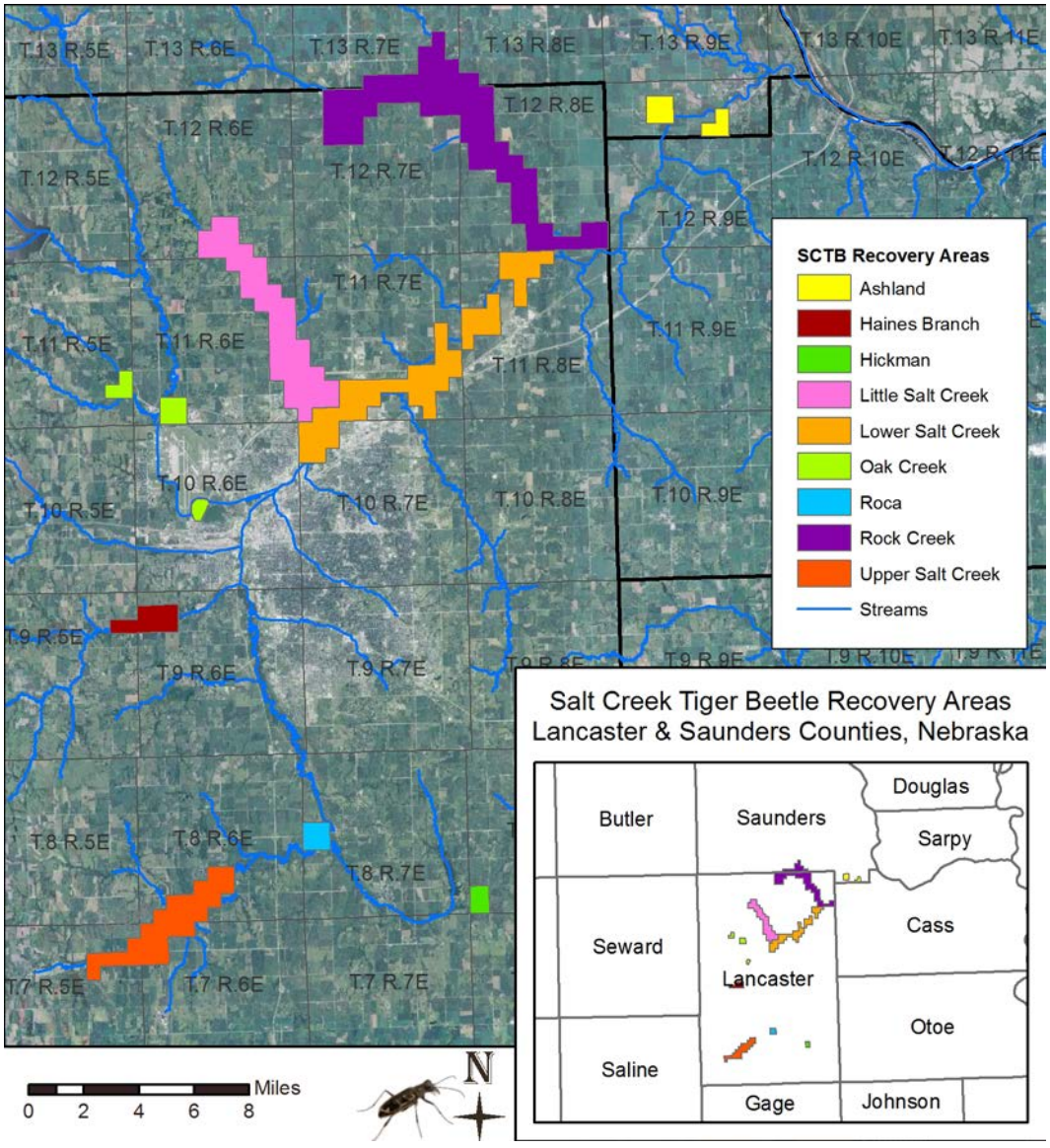
3.1 Recovery Strategy

Our recovery strategy is to establish a minimum of six self-sustaining metapopulations numbering between 500-1,000 individuals in four separate recovery areas. Multiple stream segments are required because they provide a buffer against risk that a catastrophic event may extirpate a single metapopulation that is located on a single stream. Metapopulations which by definition, contain multiple subpopulations of Salt Creek tiger beetles, tend to remain present over time and not suffer local extirpation (e.g., Little Salt Creek-Arbor Lake population). Other metapopulations that contain two or less subpopulations have disappeared entirely (e.g., Capitol Beach, Jack Sinn WMA populations).

Our recovery strategy includes establishment of metapopulations in multiple stream segments along Rock, Little Salt Creek, Oak, and Haines Branch Creeks. These sites are seen as having the highest probability of being successful and are currently envisioned as our highest priority reintroduction and recovery sites. However, it is possible that these recovery areas may not succeed as envisioned or that other opportunities may be worth pursuing as recovery efforts progress. Therefore, this plan also identifies alternative potential recovery areas that may be appropriate to consider including Ashland, Lower Salt Creek, Roca, Upper Salt Creek, and Hickman. These alternative units are not currently seen as essential to the conservation of the species, but could (depending on a number of variables) play a role in the path to recovery. Figure 4 illustrates all of these potential recovery areas.

Recovery areas provide suitable habitat or have a high potential to provide suitable habitat for the Salt Creek tiger beetle. Recovery areas were identified based on site inspections, soil surveys (including the presence of saline soils), and restoration feasibility. Currently, all populations have fallen below a viable population size of 500-1,000 individuals. Land protection (through acquisition or easements), habitat restoration and management for the benefit of the Salt Creek tiger beetle, and reintroduction efforts are anticipated to be necessary to increase population sizes to within a range of 500-1,000 individuals.

Figure 4. Potential Salt Creek Tiger Beetle Recovery Areas[1]



[1]Map must be viewed in color to identify recovery areas.

3.2 Goals, Objectives, and Criteria

Recovery Goal
The ultimate goal of the recovery plan is to recover the Salt Creek tiger beetle so that it no longer meets the Act's definition of threatened and can be removed from the Federal List of Endangered and Threatened Wildlife (i.e., delisted). An intermediate goal is to improve the species viability which no longer faces a high near-term risk of extinction (no longer "in danger of extinction") and can be reclassified to threatened.

Objective
Our recovery objectives are to: a) establish self-sustaining metapopulations (comprised of multiple subpopulations); b) establish these metapopulations on multiple stream segments located in the recovery areas shown on Figure 4; and c) reduce or eliminate threats to the subspecies, especially those related to Risk Factor A (see Section 2.1).

Downlisting Criteria
Criterion for downlisting includes: a) establishment of three metapopulations of Salt Creek tiger beetles with populations each numbering between 500-1,000 individuals to ensure population viability; b) establishment of these three metapopulations in three recovery areas; and c) no net loss of saline wetlands and streams and their associated functions in the Rock, Little Salt Creek, Oak, and Haines Branch Creeks and floodplains.

Delisting Criteria
In addition to the downlisting criterion, the criterion for delisting includes the establishment of three additional metapopulations (for a total of six metapopulations) of Salt Creek tiger beetles with populations each numbering between 500-1,000 individuals with a minimum 10 year average of at least 750 individuals to ensure population viability with a distribution spanning at least four recovery areas.

Rationale

The risk of local extirpations of Salt Creek tiger beetle metapopulations is high given the low number of individuals, habitat specificity of the subspecies, and isolated nature of the metapopulations resulting in little opportunity for dispersal among metapopulations. Given these circumstances, it is difficult to conduct a robust population viability analysis to determine what a viable population should be to inform our downlisting and delisting criteria.

As an alternative to a population viability analysis, we analyzed 24 years of Salt Creek tiger beetle survey data (See Appendix A). All surveys were conducted using the same methods and surveys were done at the same time of year. Our data analysis showed that two populations (Little Salt Creek-Arbor and Little Salt Creek-Roper) have consistently supported the Salt Creek tiger beetle over 24 years of species surveys. Of these, the Little Salt Creek-Roper appears to be in decline ranging from 258 individuals surveyed in 2002 to just 2 individuals surveyed in 2014. The Little Salt Creek-Arbor Population, however, ranged from 583 individuals in 2013 to 62 individuals in 1993. Throughout the 24 years of surveys, this population appears to have

remained relatively stable with a high population exceeding 500 individuals in 2003 (i.e., 583) compared to the Little Salt Creek-Roper Population that peaked at 258 individuals.

Based on the high degree of risk of local extirpation and an analysis of survey data from the Little Salt Creek-Arbor Lake Population, we concluded that a viable metapopulation (consisting of multiple subpopulations) should range at least between 500-1,000 individuals. Surveys to demonstrate that this criteria has been met would be done annually in late May-early June when adults are present. To address the variability of populations from year to year due to climatic variation, reproductive success, and observation conditions, a minimum average of at least 750 individuals would be required over a ten-year period.

Multiple metapopulations are necessary to adequately minimize the risk of extinction. We based our determination that six metapopulations are necessary based on the historical distribution of the Salt Creek tiger beetle. Survey results show that the Salt Creek tiger beetle was known from at most six metapopulations in 1991. We lack survey data to establish that the subspecies was known from additional locations, although it is possible that it was elsewhere but was not surveyed to establish its presence. Other potential recovery areas that are not currently envisioned as essential the conservation of the species are identified for planning purposes. Although these areas are not seen as priority areas for recovery at this time or as having the highest probability of being successful, these alternative recovery areas do appear to provide suitable habitat and could (depending on a number of variables) be targeted for future reintroduction efforts. Identifying these alternative areas gives us flexibility to be nimble and adjust recovery efforts as the situation dictates which in turn may help maximize our chance of achieving recovery.

The Salt Creek tiger beetle has a two-year life cycle. Suitable conditions (e.g., habitat suitability, adequate hydrology, food availability) during larval development influence the ability of adults to reproduce once they emerge in the second year. Additionally, populations of insects, including the Salt Creek tiger beetle are naturally cyclic over time and the range of population size may be considerable on a yearly basis due to climatic variation, reproductive success, and observation conditions. As such, we will consider downlisting and ultimately delisting of the Salt Creek tiger beetle after an even cycle of ten years has passed and the threats of habitat loss and degradation (Listing Factor A) have been managed and reduced. The criteria for management and reduction of habitat loss and degradation is no net loss of saline wetlands and streams and their associated functions in the Rock, Little Salt Creek, Oak, and Haines Branch Creeks and floodplains. We have no information to support over collection (Listing Factor B) as being a threat to the Salt Creek tiger beetle. We believe that larger populations of 500-1,000 individuals comprising six metapopulations on at least four recovery areas will sufficiently reduce the threats from disease and predation (Listing Factor C) and portions of Listing Factor E including the small population sizes and catastrophic events such as floods and drought that can extirpate a single population.

3.3 Narrative of Recovery Actions

The following recovery actions represent a step-downed approach to our Recovery Plan for the Salt Creek tiger beetle. These items are discrete, specific actions and are listed in the Implementation Schedule and Cost Estimates in section 3.4 with associated time and cost

estimates, and potential partners and responsible parties.

The saline wetland habitat required by the Salt Creek tiger beetle is a very unique and limited resource that is highly vulnerable to degradation from impacts that affect saline groundwater supplies to the saline seeps and wetlands. In order to ensure the long-term viability of the Salt Creek tiger beetle, the sites occupied by the six metapopulations necessary to meet delisting criteria should have permanent acquisition or long-term conservation agreements that will protect both the saline wetlands and saline groundwater and maintain suitable habitat for the Salt Creek tiger beetle. The protection of recovery areas should include the implementation of management plans and practices with the viability of the Salt Creek tiger beetle as a main objective.

1.0 Recovery Area Protection

1.1 Protection of the majority of recovery areas that count towards the demographic criterion above (from Figure 4) through purchase by fee title, perpetual conservation easements, enrollment in WRP, and establishment of buffers. To protect the Salt Creek tiger beetle, a considerable amount of land has been acquired and conservation easements have been put in place on Little Salt Creek (Figure 3). However, there are still gaps between areas that have easements or have been purchased. Purchase of these lands would ensure protection of the entire Little Salt Creek corridor. A significant amount of land has been purchased by the NGPC along Rock Creek; another significant area of land has been enrolled in the WRP by the NRCS. However, there are also gaps between these lands that pose a risk to the Salt Creek tiger beetle and purchase of these lands would ensure protection of the entire Rock Creek corridor. Buffers should be established between commercial, residential, and agricultural developed areas to protect recovery areas. Purchase of lands, establishment of perpetual easements, and enrollment in the WRP should be done on the Haines Branch and Oak Creek drainages and other saline wetland and stream complexes shown as recovery areas (Figure 4) to ensure protection of these entire drainages and provide duplication of important saline wetland and stream habitats. Buffers should also be established between commercial, residential, and agricultural developed areas and recovery areas.

1.2 Protection of Recovery Areas through Land Use Planning. The Service has worked with representatives of Lancaster and Saunders Counties and the City of Lincoln Planning Department to provide technical assistance in land use planning in the Rock, Little Salt, Oak, and Haines Branch Creek drainages and other potential recovery areas shown in Figure 4. The evaluation of potential conflicts between land development and identified recovery areas is needed to determine the feasibility of habitat restoration and Salt Creek tiger beetle reintroduction efforts. Some proposed recovery areas include areas of current and proposed urbanization. Urban development will present a unique challenge as reintroduction would subject the Salt Creek tiger beetle to potential urban impacts such as lighting and runoff. It will also create new subspecies locations, which will impact development and planning decisions for local communities. These recovery areas will require additional cooperation so land use planning decisions best benefit all parties and mitigate

potential impacts. Urban and future urban reintroduction sites should be treated as a second level of opportunity after more rural sites have been fully explored.

2.0 Recovery Areas Restoration and Management

2.1 Restoration. Conduct saline wetland stream restoration projects on Rock, Little Salt, Oak, and Haines Branch Creeks and other saline wetland stream complexes in other identified recovery areas shown in Figure 4 for the benefit of the Salt Creek tiger beetle. Potential restoration projects include, but are not limited to: a) removal of excess sediment; b) restoration of wetland hydrology through installation of water control structures; c) restoration of saline seeps through bank pull-backs; d) restoration of stream bank benches; and e) management of saline groundwater. Restoration activities will provide additional suitable habitat into which existing Salt Creek tiger beetle populations can expand and areas where the Salt Creek tiger beetle would be reintroduced.

2.2 Management. Conduct land management activities at saline wetlands and streams at Rock, Little Salt, Oak, and Haines Branch Creeks and other saline wetland stream complexes in other identified recovery areas shown in Figure 4 for the benefit of the Salt Creek tiger beetle. The main objective of management activities should be the long-term viability of the Salt Creek tiger beetle through the optimization of suitable saline habitat. Such actions would include, but not be limited to saline groundwater management (e.g., use control of invasive weeds, prescribed grazing, prescribed burns, and water level management.

2.3 Research.

2.3.1 Conduct research on surface and groundwater roles in saline wetland and stream restoration and management. This information will be used to restore saline hydrology to salt barrens and seeps by using groundwater and surface water sources. Information needs include: a) groundwater movement to the surface; b) groundwater interaction with surface hydrology and fresh groundwater; c) channel entrenchment and impediments to upward movement of saline groundwater; and d) maintenance of soil salinity and moisture regimes.

2.3.2 Conduct research on the appropriate frequency and intensity of using prescribed grazing as a saline wetland management tool.

2.3.3 Conduct research on the effect of grazers on a surrogate tiger beetle species.

3.0 Salt Creek Tiger Beetle Rearing, Propagation, and Reintroduction

3.1 Refine and implement propagation and rearing

3.1.1 Conduct experimental propagation and rearing techniques. Experimental propagation and rearing of Salt Creek tiger beetles involves collection of

male and female pairs for breeding and care for larvae in the lab under variable substrate and salinity replications. Larvae would be translocated to larval habitat at identified recovery areas. Salt Creek tiger beetles would be reintroduced in occupied (Little Salt Creek) and unoccupied (Rock, Oak, and Haines Branch) recovery areas. Experimental efforts are underway by the Entomology Department of the University of Nebraska at Lincoln (UNL), Lincoln Children's Zoo, and Henry Doorly Zoo.

3.1.2 Assess success of adult emergence from reintroduced larvae.

3.1.3 Synchronize wild and captive-reared life cycles.

3.1.4 Determine the best method for reintroducing captive-reared Salt Creek tiger beetles into the wild. Methods to be considered and evaluated include the use of second or third instar larvae, fall or spring reintroduction of larvae, or the release of adult Salt Creek tiger beetles.

3.1.5 Evaluate success of survival by reintroducing Salt Creek tiger beetles in unoccupied recovery areas.

3.2 Determine the microhabitat characteristics of larval habitat located at saline stream and wetland habitats. Collection of data from remote sensing units is underway at several locations to determine soil moisture, temperature, and range. This information will be used to identify suitable reintroduction sites for the Salt Creek tiger beetle.

3.3 Implement large-scale propagation and reintroduction efforts to restore populations of the Salt Creek tiger beetle at identified occupied and unoccupied recovery areas Reintroductions are to be made at sites with existing and/or restored suitable habitat with priority on sites with permanent protection or long-term conservation agreements where management practices for the Salt Creek tiger beetle are the main objective. Priority reintroduction sites are to include areas acquired with funding from Section 6 grants for the recovery and conservation of the Salt Creek tiger beetle.

4.0 Population and Recovery Area Monitoring

4.1 Monitor populations and population size. Annual surveys for the Salt Creek tiger beetle will be conducted to track population status and trends.

4.2 Monitor restoration and management actions to restore habitat at recovery areas. Evaluate success of habitat restoration and management practices to restore suitable Salt Creek tiger beetle habitat.

5.0 Outreach and Education

5.1 Educate the public about the Salt Creek tiger beetle and its habitat. Education will include development of various forms of outreach materials including, but not limited

to handouts, clothing, and video footage. Local zoos, Service, NGPC, City of Lincoln, LPSNRD, SWCP, UNL, the Master Naturalist Program, and others would provide outreach about the conservation of saline wetlands and streams and Salt Creek tiger beetle.

5.2 Provide instruction and information to the public. Programs will be developed to educate all ages of people about saline wetlands and stream habitats and the importance of these habitats for the Salt Creek tiger beetle and humans alike. Information can be disseminated through websites, brochures, signs, workshops, classes, videos, and other avenues of public outreach.

6.0 Post-delisting Monitoring

Section 4(g) (1) of the Act requires that the Service monitor the status of all recovered species for at least five years following delisting. The Service's post-delisting monitoring guidance calls for development of a plan well ahead of delisting, using the methodology for years prior to delisting and using the data as supporting information in the delisting. In keeping with this mandate and monitoring guidance, a pre and post-delisting monitoring plan will be developed by the Service in cooperation with the NGPC, Federal agencies, academic institutions, and other appropriate entities. The post-delisting plan would continue following delisting for a period established by the plan (with a statutory minimum of 5 years). This plan will outline indicators that will be used to assess the status of the delisted species (considering population numbers and threat monitoring), develop monitoring protocols for those indicators, and evaluate factors that may trigger consideration for relisting.

6.1 Develop a post-delisting monitoring plan

6.2 Implement the post-delisting monitoring plan

3.4 Implementation Schedule and Cost Estimates

The implementation schedule (Table 3) follows the outline in Section 2.3 and estimates costs for implementing this recovery plan. It is a guide for meeting the objectives discussed in this section. This schedule indicates action priorities, action numbers, action descriptions, action duration, potential partners, and estimated costs. When these actions are completed, the objectives of this plan should be achieved. The Service has identified agencies and other potential partners to help implement the recovery of the Salt Creek tiger beetle. This plan does not commit any partners to actually carry out a particular recovery action or expend funds. Likewise, this schedule does not preclude or limit other agencies or parties from participating in the recovery program.

The estimated cost of recovery, according to each priority, is provided below. The implementation schedule contains the estimated monetary needs for all parties involved in recovery. Estimated funds for agencies include only project specific contracts and staff or operations costs in excess of base budgets. They do not include budgeted amounts that support ongoing agency staff responsibilities.

We estimate progress to the point of reclassification to threatened will take 15 years and cost $16,945,000. We estimate achieving full recovery will take 30 years and cost $30,783,000. Some additional costs will continue after delisting via required management; these costs are additional and not included in the above estimates as the Act requires time and costs estimates to delisting and the intermediate goals of reclassification to threatened.

The term "continuous" is used to denote actions that are expected to require constant attention throughout the recovery process and have an indefinite duration.

Priorities in column one of the following Implementation and Cost Schedule are assigned using the following guidelines:

Priority 1 (a) – An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 1 (b) – An action that by itself will not prevent extinction, but is needed to carry out a Priority 1 (a) action.

Priority 2 – An action necessary to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3 – All other actions necessary to meet the recovery objectives.

Actions and action numbers are taken from the Recovery Action Narrative.

Table 3. Implementation and Cost Schedule

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties[1]	FWS Lead?	Total Cost ($1,000s)	FY[2] 1-2	FY 3-4	FY 5-6	FY 7-8	FY 9-10	FY 11-15	FY 15-30
1(a)	1.1	Purchase or otherwise implement other measures (e.g., conservation Easements; Wetland Reserve Program to protect recovery areas	30	NGPC, NRCS, LPSNRD, City	No	15568	830	904	986	1078	2078	2769	6923
1(a)	1.2	Landuse planning	30	Service, City, and NGPC	No	0	0	0	0	0	0	0	0
1(a)	2.1	Restoration	30	NGPC, LPSNRD, City	No	9900	760	770	780	790	800	1714	4286
1(a)	2.2	Management	30	NGPC, LPSNRD, City	No	3098	130	156	182	208	233	625	1564
1(b)	2.3.1	Surface and Groundwater Research	30	UNL, LPSNRD, City NGPC, Service	No	150	10	0	10	0	10	20	100
1(b)	2.3.2	Prescribed Grazing Research	30	UNL, LPSNRD, City NGPC, Service	No	150	10	0	10	0	10	20	100
1(b)	2.3.3	Prescribed Grazing and Tiger Beetle effects Research	30	UNL, LPSNRD, City NGPC, Service	No	150	10	0	10	0	10	20	100
1(a)	3.1.1	Experimental Propagation and Reintroduction	5	Service, NGPC, UNL, HDZ, LCZ, MN, City, LPSNRD	Yes	30	30	0	0	0	0	0	0
1(a)	3.1.2	Adult Emergence Study	2	Service, NGPC, UNL, HDZ, LCZ, MN	No	82	41	41	0	0	0	0	0
1(a)	3.1.3	Wild and Captive-Reared Synchrony Study	2	Service, NGPC, UNL, HDZ, LCZ, MN	No	82	0	41	41	0	0	0	0
1(a)	3.1.4	Reintroduction Study	2	Service, NGPC, UNL, HDZ, LCZ, MN	No	82	0	0	41	41	0	0	0

Table 3. Implementation and Cost Schedule Continued

Priority Number	Action Number	Action Description	Action Duration	Responsible Parties[1]	FWS Lead?	Total Cost ($1,000s)	FY[2] 1-2	FY 3-4	FY 5-6	FY 7-8	FY 9-10	FY 11-15	FY 15-30
1(a)	3.1.5	Adult Survival Study	2	Service, NGPC, UNL, HDZ, LCZ, MN	No	82	0	41	41	0	0	0	0
1(a)	3.2	Microhabitat Study	2	Service, NGPC, UNL, HDZ, LCZ, MN	No	82	0	41	41	0	0	0	0
1(a)	3.3	Full Scale Propagation and Reintroduction	25	Service, NGPC, UNL, HDZ, LCZ, MN, City, LPSNRD	Yes	1012	44	44	44	44	44	176	616
1(b)	4.1	Monitor populations	30	UNL,MN,NGPC,	No	119	8	8	9	9	10	21	54
1(b)	4.2	Monitor recovery areas	30	MN, NGPC, UNL	No	119	8	8	9	9	10	21	54
2	5.1	Public Outreach	30	Service, UNL, NGPC, City, LPSNRD, MN	No	26	2	2	2	2	2	8	8
2	5.2	Public Education	30	Service, UNL, NGPC, City, LPSNRD, MN	No	26	2	2	2	2	2	8	8
3	6.1	Develop a Post-delisting Monitoring Plan	5	Service	Yes	5	0	0	0	0	0	0	5
3	6.2	Implement a Post-delisting Monitoring Plan	5	Service	Yes	20	0	0	0	0	0	0	25

[1]The following acronyms used in Table 3 are as follows: Saline Wetlands Conservation Partnership (SWCP), U.S. Fish and Wildlife Service (Service), Nebraska Game and Parks Commission (NGPC), University of Nebraska at Lincoln (UNL), Lower Platte South Natural Resources District (LPSNRD), Henry Doorly Zoo (HDZ), Lincoln Children's Zoo (LCZ), City of Lincoln (City), and Master Naturalist Program (MN).
[2]All costs by FY are in thousands of dollars, estimated in 2015 and not adjusted for inflation for future years.

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APPENDIX A

Population survey results from 1991 through 2014 ("-" indicates no surveys for that population that year).

YEAR	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14
Little Salt Creek-Arbor Lake Population	171	94	62	376	459	437	406	254	208	225	434	511	583	392	115	345	197	109	148	169	234	319	327	104
Little Salt Creek-Roper Population	-	-	-	54	161	151	144	45	55	80	85	258	162	154	22	97	32	17	21	16	66	47	11	2
Upper Little Salt Creek-North Population	24	32	48	35	14	41	0	4	8	4	0	8	0	12	16	97	33	39	25	20	18	8	27	19
Upper Little Salt Creek-South Population	7	5	4	8	3	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0	18
Jack Sinn WMA Population	15	11	1	0	0	1	-	1	0	-	0	0	0	0	-	-	-	-	-	-	-	-	0	0
Oak Creek Population	12	8	-	-	0	-	-	4	0	-	0	0	0	0	-	-	-	-	-	-	-	-	0	0
TOTALS	**229**	**150**	**115**	**473**	**637**	**630**	**550**	**308**	**271**	**309**	**519**	**777**	**745**	**558**	**153**	**539**	**262**	**165**	**194**	**205**	**318**	**374**	**365**	**143**