U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW FOR THE SALT CREEK TIGER BEETLE *(CICINDELA NEVADICA LINCOLNIANA)* 2016

1. INTRODUCTION

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every five years. Based on the outcome of the 5-year review, we recommend whether the species should: 1) be removed from the list of endangered and threatened species; 2) be changed in status from endangered to threatened; 3) be changed in status from threatened to endangered; or 4) remain unchanged in its current status. If we recommend a change in listing status based on the results of the 5-year review, a separate rulemaking process must be conducted to implement the recommendation.

Figure 1: U*sed with permission from Tony Palmer*

We must use the best scientific and commercial information available when we prepare a 5-year review. We published a Federal Register notice on June 20, 2011, requesting any new information since the last review of the subspecies (76 FR 35906). No comments were received.

This 5-year review was prepared by the Service's Nebraska Ecological Services Field Office with contributions and review by the Regional Office.

2. BACKGROUND ON THE SUBSPECIES' LISTING HISTORY

Scientific and Common Name: Salt Creek tiger beetle (*Cicindela nevadica lincolniana)*

Listing Classification:	Endangered
Listing History:	70 FR 58335, October 6, 2005
Critical Habitat:	72 FR 70716, December 12, 2007 79 FR 26013, May 6, 2014
Other Associated Rules:	None
Recovery Planning:	Recovery Outline for the Salt Creek Tiger Beetle *(Cicindela nevadica lincolniana),* February 2009 Recovery Plan for the Salt Creek Tiger beetle *(Cicindela nevadica lincolniana)* (Notice of Availability published on July 16, 2015 (80 FR 42117)

Lead Agency, Region:	Region 6, Mountain-Prairie Region, U.S. Fish and Wildlife Service
Lead Field Office:	Nebraska Ecological Services Field Office
Contact Information:	Robert R. Harms, U.S. Fish and Wildlife Service Nebraska Ecological Services Field Office, 9325 South Alda Road, Wood River, NE 68883, 308-382-6468, extension 208; Robert_Harms@fws.gov
Cooperating Offices:	None (subspecies is limited to one state)

3. REVIEW OF THE LISTABLE ENTITY

3.1 Taxonomic Information

The Salt Creek tiger beetle is a member of the family Carabidae, subfamily Cicindelinae, 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 subspecies' distinctiveness from other central Great Plains populations of *C. nevadica* was confirmed by Busby (2003).

3.2 Application of the Distinct Population Segments (DPS) Policy

This portion of the 5-year review is not applicable. The DPS policy does not apply because the Salt Creek tiger beetle is not a vertebrate and is listed as endangered rangewide.

4. BASIC SPECIES INFORMATION

4.1 BRIEF SUBSPECIES DESCRIPTION

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

4.2 BASIC LIFE HISTORY AND BIOLOGICAL LIMITING FACTORS

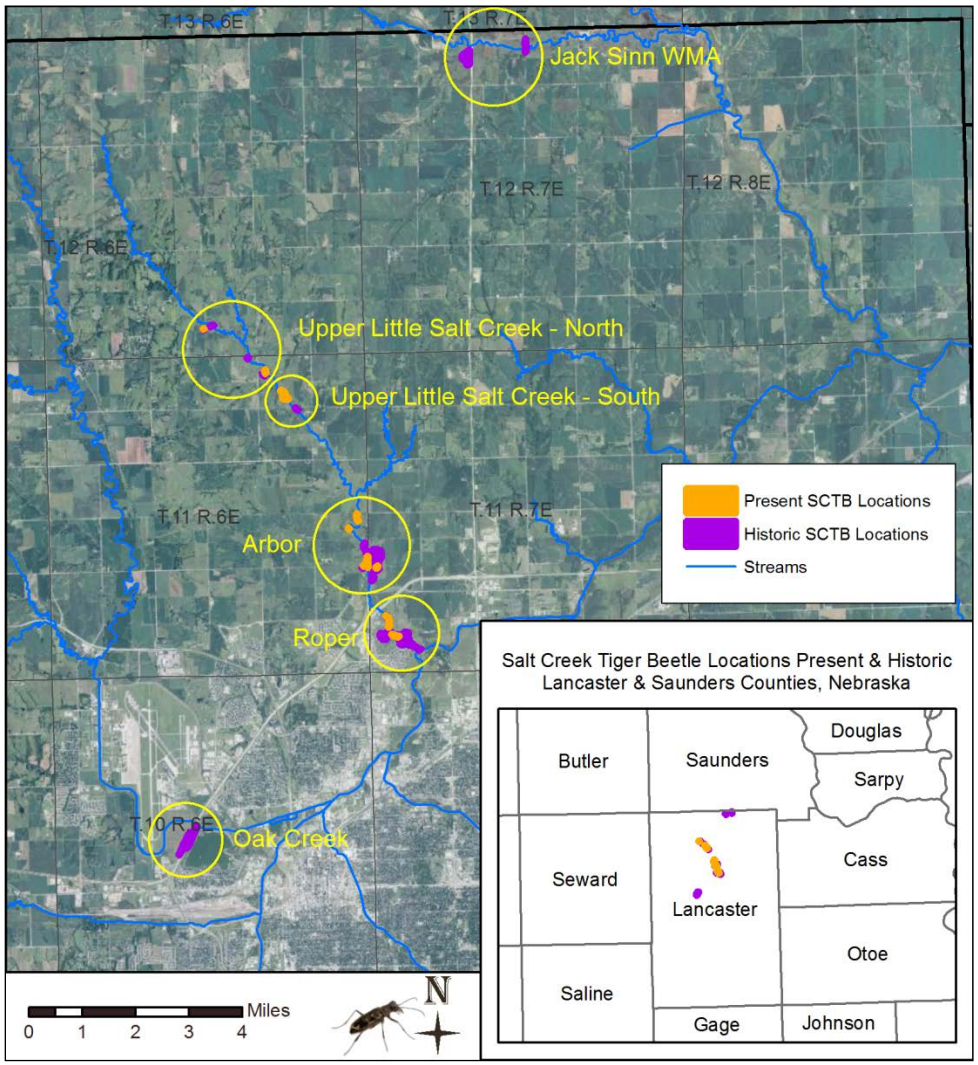
The Salt Creek tiger beetle has very specific habitat requirements and occurs in saline wetlands on exposed saline mud flats or along mud banks of streams and seeps that contain salt deposits and are sparsely vegetated (Carter 1989; Spomer and Higley 1993; LaGrange 1997; Nebraska Game and Parks Commission (NGPC) 1999; Spomer et al. 2004). Larvae have been found only on moist salt flats and salt-encrusted banks of Little Salt Creek in northern Lancaster County (Spomer et al. 2004), Nebraska. Salt Creek tiger beetles require open, barren salt flat areas for construction of larval burrows, thermoregulation, foraging, and for use as dispersal corridors (Spomer and Higley 1993; Higley 2002, pers. comm.; Spomer 2005, pers. comm.). Critical habitat was designated at Rock Creek, Little Salt Creek, Oak Creek, and Haines Branch Units because these areas provide suitable habitat for the Salt Creek tiger beetle (78 FR 33282).

Like many insects, the Salt Creek tiger beetle's close association with specific habitats—salt barrens and stream edges—leaves it particularly vulnerable to habitat destruction and alteration through direct and indirect means (Pyle et al. 1981). Based on metapopulation surveys and a review of U.S.Geological Survey topographic maps showing metapopulation distributions, 99 percent of the remaining Salt Creek tiger beetles are located within a 1.6-kilometer (km) (1 mile) radius of the Interstate 80 and North 27th Street Interchange. Although tiger beetles are mobile and can fly, the lack of suitable habitat and low population numbers have limited recolonization of other suitable habitats on other stream segments.

4.3 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. 2004), only occurring along limited segments of Little Salt Creek and adjacent remnant saline wetlands in Lancaster County, Nebraska (Figure 2). The subspecies was once more widespread and likely occupied suitable habitat throughout the Eastern Nebraska Saline Wetland Complex.

Figure 2. Current and historic distribution of Salt Creek tiger beetles.[1]



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

4.4 METAPOPULATION STATUS

The Salt Creek tiger beetle was known from six metapopulations when surveys began in 1991 (Figure 2). Each Salt Creek tiger beetle metapopulation consists of several spatially separated, interacting populations as defined by Levins

(1969). At present, the subspecies is only known from Little Salt Creek (Figure 2). Half of these metapopulations were thought to have been extirpated since 1991. However, the Upper Little Salt Creek-South metapopulation, 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 (Figure 2). The six Salt Creek tiger beetle metapopulations, including the two that have been extirpated, are described below in order of abundance.

Extant Metapopulations

Little Salt Creek-Arbor Lake Metapopulation: The Little Salt Creek-Arbor Lake Metapopulation contains the largest number of Salt Creek tiger beetles. We believe that this metapopulation has persisted because it consists of several interchanging populations and occurs across a large, relatively intact and restored saline wetland and stream complex. This metapopulation is located approximately 1.6 km (1 mile) north of the Interstate 80 and North 27th Street Interchange at the northern city limits of Lincoln, Nebraska (Figure 2).

Little Salt Creek-Roper Metapopulation: The Little Salt Creek-Roper Metapopulation is the second largest remaining metapopulation of Salt Creek tiger beetles. We believe that this metapopulation is in decline because of the reduction in the number of interchanging populations and habitat degradation. This metapopulation is located immediately south of the Interstate 80 and North 27th Street Interchange, and approximately 1.6 km (1 mile) downstream of the Little Salt Creek-Arbor Lake Metapopulation (Figure 2).

Upper Little Salt Creek-North Metapopulation: The Upper Little Salt Creek-North Metapopulation is the third of four metapopulations of extant Salt Creek tiger beetles. This metapopulation is in decline because of the reduction in the number of interchanging populations and habitat degradation. This metapopulation is located approximately 7.2 km (4.5 miles) upstream from the Little Salt Creek-Arbor Lake Metapopulation, and exists on the saline stream edges of Little Salt Creek and a single salt flat (Figure 2). Recent field work has resulted in the discovery of saline wetlands with what appears to be relatively intact hydrology in this area.

Upper Little Salt Creek-South Metapopulation: The Upper Little Salt Creek-South Metapopulation was thought to have been extirpated since 1995. However, a single population was found at a saline seep located along Little Salt Creek at the Little Salt Creek WMA in 2014. This metapopulation consists of a single population making it at risk to local extirpation. This metapopulation is located approximately 5 km (3 miles) upstream from the Little Salt Creek-Arbor Lake Metapopulation (Figure 2). 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 Metapopulations

Jack Sinn WMA Metapopulation: This extirpated metapopulation consisted of two populations located near Rock Creek in southern Saunders and northern Lancaster Counties, approximately 20 km (10 miles) northeast of the Little Salt Creek-Arbor Lake Metapopulation on property owned by the NGPC (Figure 2). We believe that this metapopulation disappeared due to a reduction in the number of interchanging populations and degradation of habitat along Rock Creek. Salt Creek tiger beetles have not been found at the Jack Sinn WMA since 1998.

Oak Creek Metapopulation: 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 2). Although we do not have historic metapopulation estimates from this site, several museum specimens collected from there suggest that it was once home to a large, sustainable metapopulation of Salt Creek tiger beetles. Currently, all that remains of suitable habitat at Oak Creek 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 mile), southwest of the Interstate 80 and Airport Interchange. No individuals have been found at Oak Creek since 1998. 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 inability to obtain permission to conduct surveys at the site. 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.

5. RECOVERY PROGRESS

A recovery outline was prepared for the Salt Creek tiger beetle. Notice that a draft recovery plan was available for public review was published in the Federal Register on July 16, 2015 (80 FR 42117). The recovery outline and draft recovery plan call for the establishment of multiple, viable Salt Creek tiger beetle metapopulations that persist on conserved habitat with connectivity between populations. Habitat restoration projects as well as reintroduction of Salt Creek tiger beetles are both critical to this effort as are

metapopulation monitoring and evaluation of the effectiveness of habitat restoration projects. Priority actions include rearing and propagation efforts as well as acquisition, restoration, and management of saline wetland and stream habitats. Efforts to conserve and recover the subspecies would begin with four areas previously identified as critical habitat: Rock Creek, Little Salt Creek, Oak Creek, and Haines Branch Units (79 FR 26013).

5.1 RECOVERY ACTIONS

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 and management 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 progress made by the SWCP, City of Lincoln, 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. The SWCP utilizes several strategies, including the purchase of wetlands from willing sellers and the subsequent conversion to conservation easements, which keeps the land in private ownership and protects 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. Tremendous 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 prioritized 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) as the LPSNRD has developed close relationships with private landowners to protect and conserve saline wetlands.

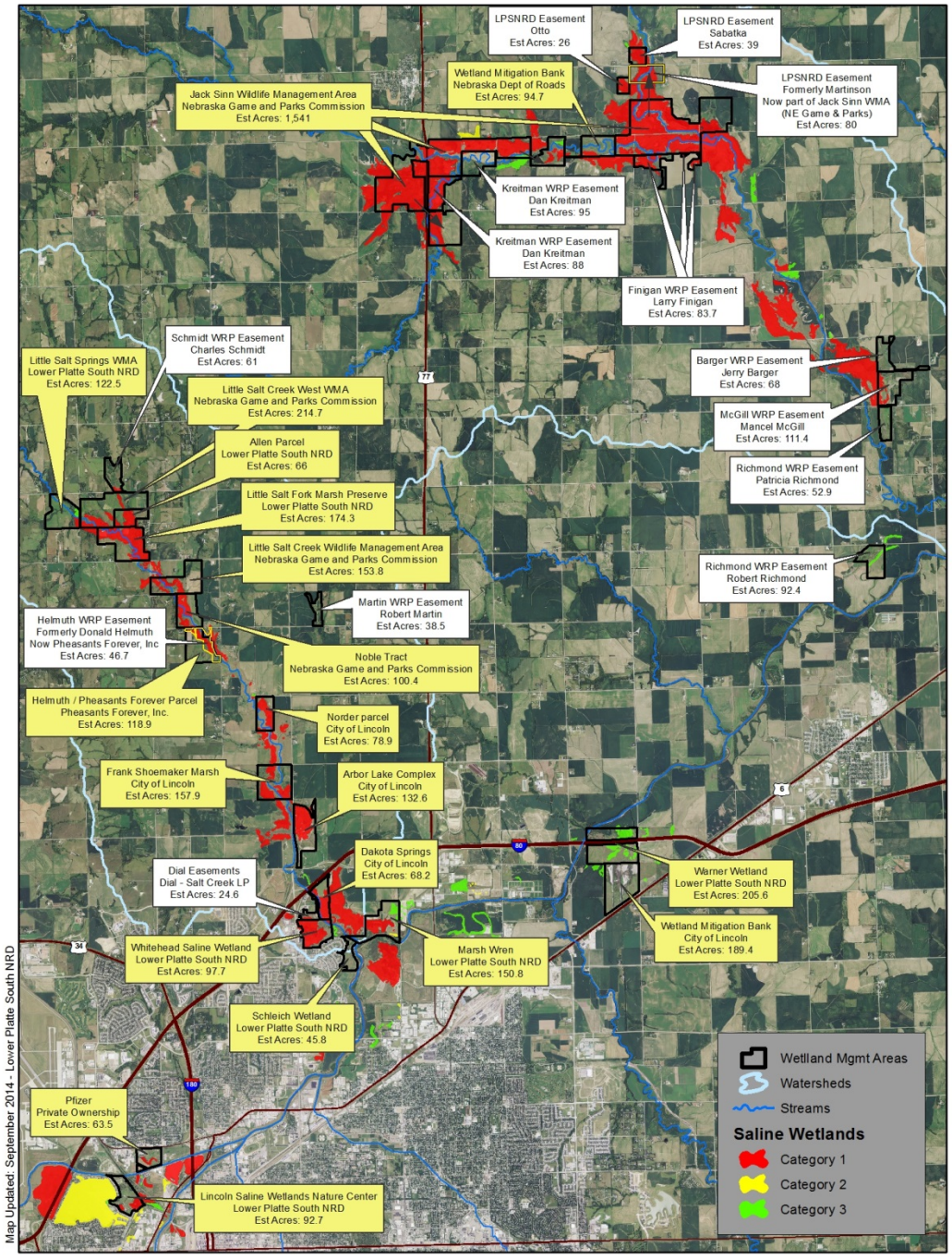
Nebraska Game and Parks Commission: The NGPC owns and manages several WMAs along Little Salt and Rock Creeks that include large blocks of saline wetland habitat (Figure 3). The largest of these saline wetland and stream complexes is the Jack Sinn WMA located along Rock Creek.

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 easements. Significant 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. However, many of these areas still need restoration. Restoration actions include flattening of stream banks to expose saline seeps, installing water control structures, and removing excess sediment. Routine management actions include grazing to control cattails and encourage development of saline wetland vegetation, implementing prescribed burn, and controlling 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.

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

Experimental Rearing, Propagation, and Reintroduction

A partnership including Omaha's Henry Doorly Zoo, Lincoln Children's Zoo, University of Nebraska-Entomology Department, the Master Naturalist Program, the Service, and NGPC, established a captive rearing and reintroduction program for the Salt Creek tiger beetle in 2011; the aim of the program was to begin captive rearing and small-scale experimental Salt Creek tiger beetle reintroduction efforts. Reintroduction has 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. Adults are released back to the wild while larvae are collected and placed in cups 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 cups and reintroduced at various areas with suitable habitat along Little Salt Creek. The 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 are able to lay more eggs in a lab setting. These two factors facilitate the propagation of a significant numbers of Salt Creek tiger beetles in the lab; these beetles can then be used for supplementing small and declining populations, as well as reintroducing individuals at extirpated sites once habitat is restored and appropriate management is implemented in order to maintain suitable conditions.

5.2 DOES THE RECOVERY PLAN NEED TO BE UPDATED?

No. A draft recovery plan for the Salt Creek tiger beetle has recently been completed. A notice of its availability for public review has recently been published in the Federal Register (80 FR 42117). The recovery plan will be finalized in 2016.

6. SUMMARY OF FACTORS AFFECTING THE SUBSPECIES

The Salt Creek tiger beetle was known from six metapopulations when surveys began in 1991 (Figure 2). However, several of these metapopulations 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 the City 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 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 Unit) was once approximately 162 hectares (400 acres) in size, and one of the largest saline wetlands in the area (Cunningham 1985). To accommodate residential and commercial developments, 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 recreation. In 1906, the lake was renamed Capitol Beach. Subsequently, the construction of Interstate 80 northwest of Capitol Beach resulted in the continued filling of saline wetlands. These activities caused the extirpation of the Oak Creek (Capitol Beach) Metapopulation, possibly the largest historic metapopulation of Salt Creek tiger beetles and the location where the subspecies was originally discovered. All that remains is a large saline wetland and associated salt

flat, which appears to provide suitable habitat for the Salt Creek tiger beetle. This property is 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. 99 percent of the remaining Salt Creek tiger beetles are located within a 1.6 km (1 mile) radius of the Interstate 80 and North 27th Street Interchange and ongoing residential and commercial developments. The Little Salt Creek-Roper Metapopulation 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 previously 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 because the overstory shades out open, sunny areas required 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 used by the Salt Creek tiger beetle.

The largest metapopulation of Salt Creek tiger beetles, the Little Salt Creek-Arbor Lake Metapopulation, 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 Metapopulation exhibited a corresponding 55 percent decline 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 Metapopulations. Livestock are attracted to exposed salt and can destroy or substantially degrade salt barren habitats, used by both adult and larval Salt Creek tiger beetle. Livestock trample these areas, 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 Metapopulation occurs along a segment of Little Salt Creek that flows through a pasture; this metapopulation was negatively impacted by cattle grazing as a result (Spomer et al. 2004). 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, which can 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 Metapopulation of Salt Creek tiger beetles in 1998. The larvae were unable to remove the 8 to 10 cm (3 to 4 in) of sediment deposited onto their burrows because they extract excess soil material out and away from their burrow, not inward (Spomer et al. 2004). 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 metapopulation. 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

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

Clean Water Act

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 the City of 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.

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

Small Population Size

Metapopulations 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 metapopulations 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. Insecticides have the potential to harm or kill the Salt Creek tiger beetle and/or reduce the availability of its prey. Research on other 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 also have the potential to enter the creek and impact the Salt Creek tiger beetle and its prey. 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 metapopulations of Salt Creek tiger beetles near the City of Lincoln (Allgeier et al. 2004).

7. SYNTHESIS

The type and level of threats faced by the Salt Creek tiger beetle have varied over time. Our initial concern about wide spread commercial and residential development occurring along Little Salt Creek has declined given that the City of Lincoln is developing to the east and south and not to the north in the Little Salt Creek area. Substantial progress has been made by the SWCP and other entities toward acquisition, restoration, and management of saline wetlands and streams along Little Salt and Rock Creeks; those actions have protected Salt Creek tiger beetle habitat from direct and indirect threats. Progress has been made toward rearing, propagation, and reintroduction with experimental larvae reintroductions occurring at several areas along Little Salt Creek and its associated tributaries. Recent field work in upper reach of Little Salt Creek has resulted in the encouraging discovery of saline wetlands with what appears to be relatively intact hydrology.

Four metapopulations of Salt Creek tiger beetles still remain, but these are all located on Little Salt Creek. Generally, population surveys show a downward trend over time. Existing metapopulations are all located along stream banks in high risk habitat adjacent to Little Salt Creek. This occupied habitat, located within the high banks of Little Salt Creek and a few tributaries, is subject to scouring by flood water. There is also considerable concern that these sites cannot provide sufficient prey for developing larvae.

Saline wetlands, a lower-risk habitat because it is located away from Little Salt Creek in most cases no longer provides suitable habitat for the subspecies; saline wetlands with intact hydrology remain rare.

For these reasons, metapopulations of the Salt Creek tiger beetle remain on the brink of extinction even though progress has been made at achieving recovery priorities including acquisition, restoration and management of saline wetland and stream habitats and rearing, propagation, and reintroduction research involving successful reintroduction of larvae into occupied habitat.

8. RECOMMENDATIONS FOR FUTURE ACTIONS

The following actions should occur over the next 5-years to support the survival and recovery of the Salt Creek tiger beetle:

- Finalize the subspecies' recovery plan.
- Continue acquisition, restoration, and management of saline wetlands and streams in tributaries to Salt Creek. Conduct further research in rearing, propagation, and reintroduction methods including synchronization of wild and captive-reared life cycles.
- Conduct experimental reintroductions in low risk habitats such as saline wetlands located adjacent to Little Salt Creek, Rock Creek, Oak Creek, and Haines Branch Creek.
- Continue metapopulation surveys and habitat monitoring.
- Conduct further research on interactions between habitat and saline ground and surface waters; apply such research to habitat restoration projects.
- Conduct research on the appropriate frequency and intensity of using prescribed grazing as a saline wetland management tool.
- Conduct research on the effect of grazers on a surrogate tiger beetle species.
- Conduct research on the effectiveness and success of reintroduction efforts.

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RESULTS

Classification:

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No revision needed

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APPROVAL

Approved: ELIZA HINES Digitally signed by ELIZA HINES Date: 2016.01.25 10:56:02 -06'00' Date_____

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