Cool Water Stream Management Plan
Nebraska Game and Parks Commission
2016 – 2020

This Page Intentionally Left Blank

Contents

Acronyms

ASMP	Ambient Stream Monitoring Program
BMP(s)	Best Management Practice(s)
BRMP	Basin Rotation Monitoring Program
BUL(s)	Biologically Unique Landscape(s)
CRP	Conservation Reserve Program
CWA	Clean Water Act
E&T	Endangered and Threatened
EPA	Environmental Protection Agency
ESA	Endangered Species Act
GIS	Geographic Information System
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NESCA	Nebraska Nongame and Endangered Species Conservation Act
NET	Nebraska Environmental Trust
NGPC	Nebraska Game and Parks Commission
NNLP	Nebraska Natural Legacy Project
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRD(s)	Natural Resources District(s)
OFW	Open Fields and Waters Program
PAPR	Private Access Permission Required
PRBE	Platte River Basin Environments
PRRIP	Platte River Recovery Implementation Program
RSD-Q	Relative Stock Density of Quality Length
SBMP	Stream Biological Monitoring Program
SFH	State Fish Hatchery
SP	State Park
SRA	State Recreation Area
SWU	Surface Water Unit
TMDL(s)	Total Maximum Daily Load(s)
TU	Trout Unlimited
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VHS	Viral Hemorrhagic Septicemia
WMA	Wildlife Management Area

List of Figures

List of Tables

List of Photographs

Cool Water Streams Initiative Development Team

Alicia Hardin – Co-Chair, NGPC Wildlife Division*

Mark Porath – Co-Chair, NGPC Fisheries Division*

Michelle Stryker – Facilitator, NGPC Planning and Programming Division

Frank Albrecht, NGPC Planning and Programming Division

Jeff Blaser, NGPC Wildlife Division*

Zac Brashears, NGPC Fisheries Division*

Andy Glidden, NGPC Fisheries Division*

Jeremy Hammen, NDEQ Water Management Division*

Al Hanson, NGPC Fisheries Division*

Michelle Koch, NGPC Planning and Programming Division

Greg Michl, NDEQ Water Management Division

Ritch Nelson, NRCS Ecological Sciences Division*

Brett Roberg, NGPC Fisheries Division*

Joe Rydell, NGPC Fisheries Division*

Steve Schainost, NGPC Wildlife Division*

Trisha Schlake, NGPC Information Technology Division

Rick Schneider, NGPC Wildlife Division

Jeff Schuckman, NGPC Fisheries Division*

Dave Schumacher, NDEQ Water Management Division

Matt Steffl, NGPC Wildlife Division*

Elbert Traylor, NDEQ Water Management Division

Bill Vodehnal, NGPC Wildlife Division*

Scott Wessel, NGPC Wildlife Division*

**Member of the Stream Team*

Introduction

Purpose

The purpose of the Cool Water Stream Management Plan is to identify goals for stewardship of cool water stream resources in Nebraska, and to develop specific, attainable and measurable action items for Nebraska Game and Parks Commission (NGPC) staff to implement to achieve the vision.

NGPC is the primary agency entrusted with conserving and managing the state's fish, wildlife, and parklands. This plan provides NGPC fisheries and wildlife staff with goals and objectives designed to protect and maintain Nebraska's cool water streams, provide angling opportunities, promote recovery of at-risk species, and increase the public's awareness and appreciation of these resources. This plan includes an existing inventory of public and private cool water resources, the current status of the resources, and the threats to the resources. It concludes with recommendations and management strategies which will be implemented by NGPC in collaboration with partners identified in the plan.

The conservation and enhancement of Nebraska's cool water streams will continue to evolve as NGPC moves forward to meet the challenges of the future. As such, the plan is dynamic, and will be modified as the need for revision arises. This five-year plan (2016-2020) focuses on specific issues that were identified and prioritized during its development. Significant progress in addressing these issues will demonstrate sufficient effort is being directed to the stewardship of our cool water stream resources. Program evaluation will include annual progress reports, and an overall plan review and update will be conducted in 2020.

Vision Statement for Nebraska Cool Water Streams

Cool water streams in Nebraska will support productive and sustainable populations of cool water aquatic life, have healthy riparian zones and clean water, and contribute to watershed stability.

Supporting the Nebraska Natural Legacy Project

The Nebraska Cool Water Stream Management Plan complements the Nebraska Natural Legacy Project (NNLP) and will aid with its implementation. The NNLP is Nebraska's State Wildlife Action Plan. The NNLP is part of a nationwide effort to address the needs of declining wildlife populations. It is Nebraska's blueprint for conserving the state's flora, fauna and natural habitats through proactive conservation actions. It identifies more than 700 "at-risk" species and natural communities in Nebraska (Schneider et al. 2011).

In order to prioritize which species and communities to focus scarce resources on, the NNLP Science Team developed lists of Tier I and Tier II at-risk species and communities. Tier I species and communities include those which are globally or nationally at-risk, state or federally listed as endangered or threatened, candidates for listing or proposed for listing. The Tier II list contains those species and communities which are at-risk within Nebraska while apparently doing well in other parts of their range.

The NNLP also identifies priority landscapes which, if managed properly, would conserve the majority of Nebraska's biological diversity. These landscapes, known as Biologically Unique Landscapes (BULs), were selected based on known occurrences of at-risk species and natural communities. In addition to at-risk species, these landscapes support a broad array of common species. Twenty-five BULs contain cool water streams used by at-risk species. Therefore, it is imperative for those implementing the NNLP and the Cool Water Stream Plan to collaborate on common goals and objectives, and to ensure efficient delivery.

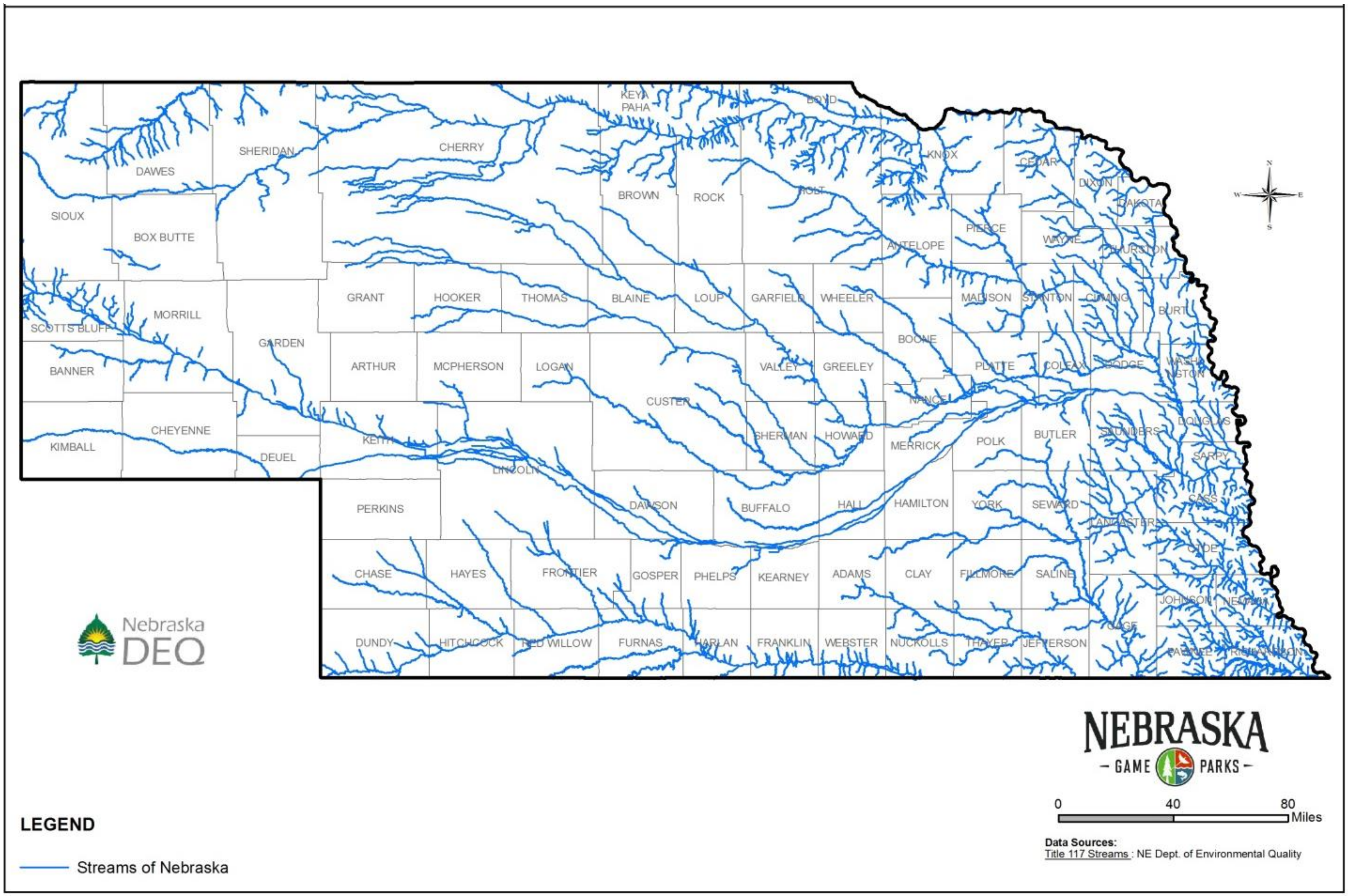
Defining Cool Water Streams in Nebraska

Extent of the Resource

Nebraska has over 16,000 miles (25,750 km) of flowing water (Figure 1), comprised of approximately 2,100 different rivers, streams or creeks. Approximately 98 percent of Nebraska's stream miles are located on private property. Cool water streams account for less than 28 percent of all stream miles in Nebraska, but they are still a tremendous resource, often overlooked by many. Nebraska's cool water streams were originally pristine, meandering channels, but since European settlement, many have been manipulated, altered and degraded. Good land stewardship has preserved the relatively pristine condition of some stream reaches, which provide habitat for a variety of aquatic organisms, including native and at-risk species. However, these habitats remain extremely vulnerable to climatic changes, and are continually threatened by human disturbance as land and water use patterns change over time.

Certain aquatic communities depend on cold or cool water thermal conditions found in such streams. These communities are comprised of fish, macroinvertebrates (aquatic insects) and aquatic plants whose survival depend on healthy habitat conditions both within the stream and its associated riparian corridor. The Nebraska Department of Environmental Quality (NDEQ) defines these communities based on nine fish species [e.g., rainbow trout (*Oncorhynchus*

Figure 1: Nebraska Streams



mykiss) and longnose sucker (*Catastomus catastomus*)], 39 groups of insects [e.g., stoneflies (order Plecoptera) and mayflies (order Ephemeroptera)], and nine aquatic plants [e.g., water cress (*Nasturtium sp.*) and horned pondweed (*Zannichellia palustris*)]. At this time, the classification of these communities does not include mussels and riparian plant species, which may also depend on the health of these unique stream resources in Nebraska.

Stream Classifications

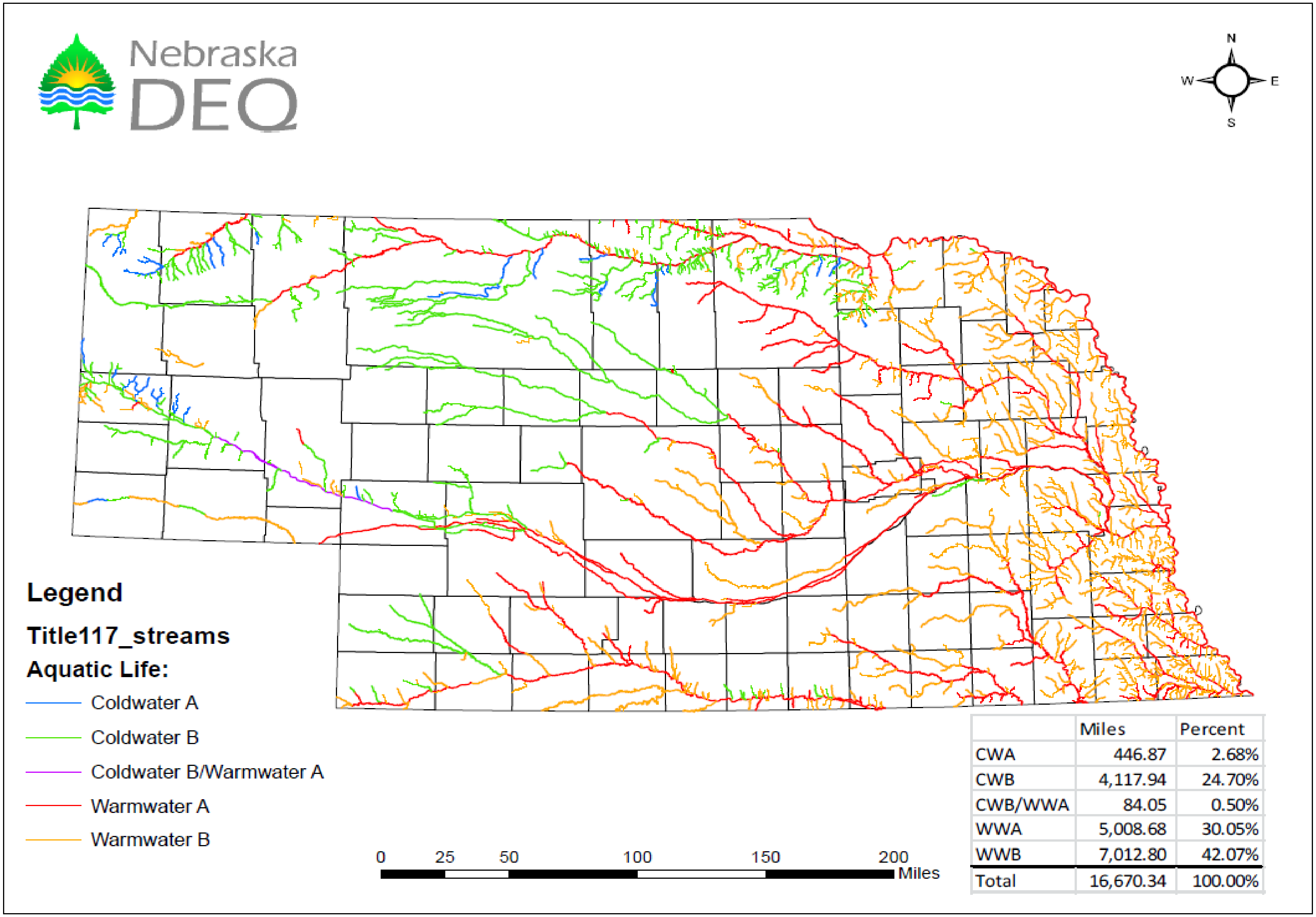
Researchers know fish have temperature preferences. Char (*Salvelinus sp.*) and salmon (*Oncorhynchus sp.* and *Salmo sp.*) prefer colder water; mosquitofish (*Gambusia sp.*) and catfish (*Ameiurus sp.*, *Ictalurus sp.*, *Noturus sp.* and *Pylodictis sp.*) prefer warmer water, and others are noted for preferences somewhere in between. Magnuson et al. (1979) stated that fish appear to fall into three thermal groups preferring cold, cool or warm water. However, there is no widely accepted definition as to which water temperature ranges define cold water, cool water or warm water. For example, North Carolina uses summer water temperatures and defines cold water as not exceeding 20 °C (68 °F) , cool water as not exceeding 25 °C (77 °F) and warm water as more than 25 °C (77 °F) (U.S. Army Corps of Engineers Wilmington District et al. 2003), while Michigan uses categories of cold at < 19 °C (66.2 °F), cool at 19-22 °C (66.2 – 71.6 °F) and warm at > 22 °C (71.6 °F) (Wehrly et al. 2003). They also add temperature fluctuation categories of stable [< 5 °C (41 °F)], moderate [5-10 °C (41 – 50 °F)] and extreme [> 10 °C (50 °F)] which expand their classification to nine categories (i.e., cold stable, cold moderate, cold extreme, cool stable, etc). Lyons et al. (2009) defined five classes of streams: coldwater, coolwater, cold transition, warm transition and warmwater, with the two transition classes being subdivisions of the coolwater class. Classes were based on a combination of mean water temperature from June through August, mean water temperature in July, and mean maximum daily temperature.

Regardless of the differences in temperature regimes used to define cold, cool and warm water streams, fish are cold-blooded and can tolerate temperatures outside of their preferred range for a certain period of time depending on their species, life-stage and body condition. As is especially evident in temperate North America, warm water fish can survive very cold water during the winter season by becoming inactive and relying on body reserves to maintain physiological processes. Cold water fish can tolerate warm water for short periods if they are in good body condition and the water has plentiful oxygen so their metabolic systems do not fail. Cool water fish also tolerate wide variations in thermal conditions using similar adaptations as either cold or warm water fish, depending on the species. A common misconception is that these classifications (cold, cool or warm) describe the condition a certain species can tolerate, when in actuality it describes a thermal regime in which a species tends to thrive.

NDEQ uses a decision matrix to classify reaches of streams according to their thermal properties and the stream biota present. A reach is classified as a cold water stream when maximum daily water temperatures do not exceed 25 °C (77 °F), which is slightly higher than other states' classification scales.

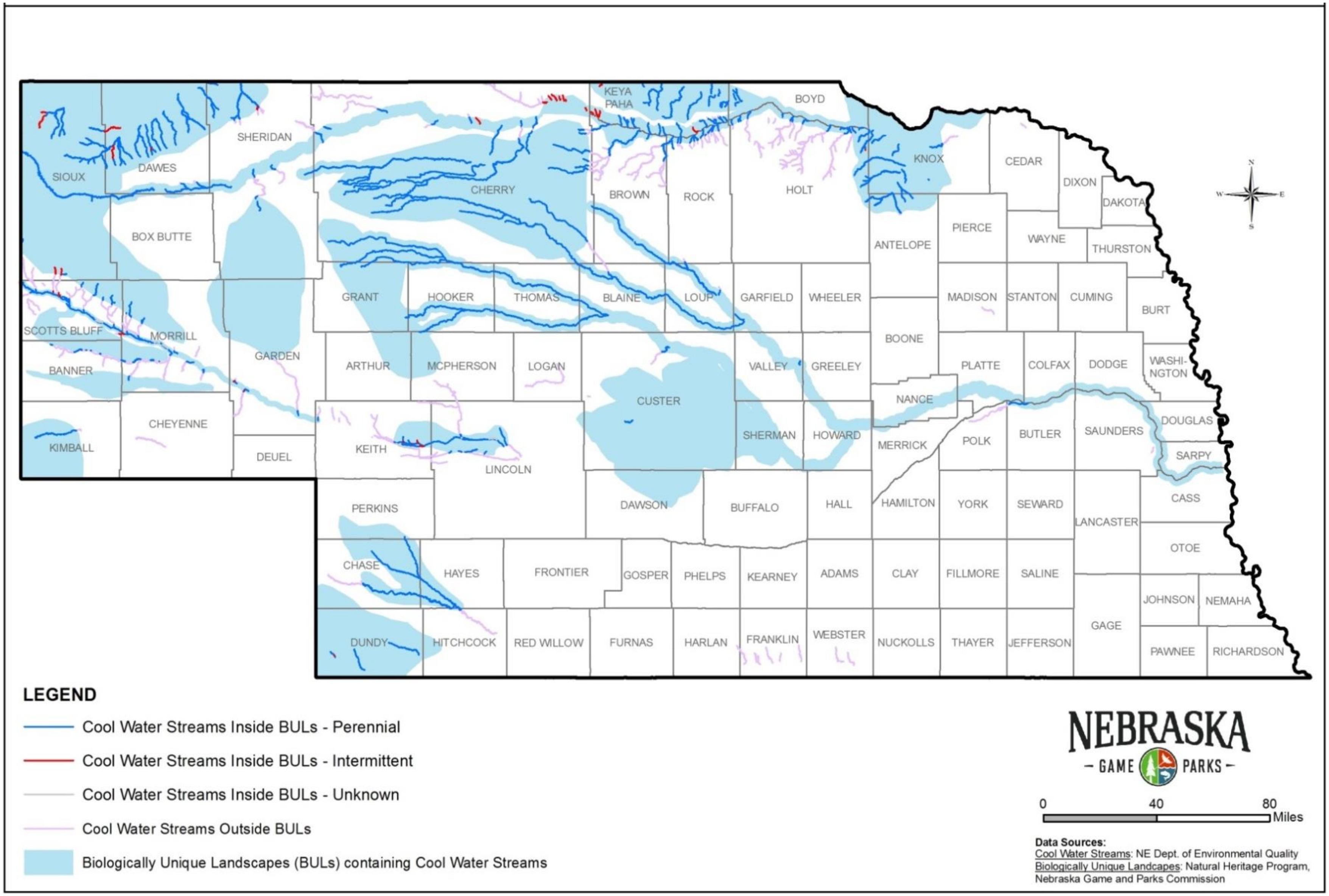
NDEQ assigns another designation depending on the ability of the stream reach to support salmonid (trout species) populations (Figure 2). If natural reproduction is occurring (there is documented juvenile presence) or the physical habitat (e.g., substrate, flow, cover) is capable of supporting trout reproduction, then a reach is designated by NDEQ as Coldwater "A." Streams supporting non-reproductive populations of trout (no juveniles or inadequate physical habitat) are designated by NDEQ as Coldwater "B." These coldwater streams also support important native fish species, such as Northern redbelly dace (*Chrosomus eos*), Northern pearl dace (*Margariscus nachtriebi*), Finescale dace (*Chrosomus neogaeus*), and Blacknose shiner (*Notropis heterolepis*), which are identified as "at-risk" species in the NNLP. All other flowing waters in Nebraska are classified by NDEQ as Warmwater "A" or "B." To avoid confusing classification styles across states and agencies, this planning document will collectively refer to the NDEQ Coldwater A and Coldwater B reaches, and associated species and habitats dependent on them, as "cool water" Nebraska streams. This does not include transitional streams (i.e., Coldwater B/Warmwater A). Based on this classification, there are 25 BULs collectively encompassing over 3,500 miles (5,6333 km) (approximately 78 percent) of cool water streams in Nebraska (Figure 3 and Appendix A).

Figure 2: Nebraska Department of Environmental Quality Stream Classifications



	Miles	Percent
CWA	446.87	2.68%
CWB	4,117.94	24.70%
CWB/WWA	84.05	0.50%
WWA	5,008.68	30.05%
WWB	7,012.80	42.07%
Total	16,670.34	100.00%

Figure 3: Biologically Unique Landscapes (BULs) Containing Cool Water Streams



Inventory

This section includes background information on native, introduced and exotic cool water stream fish species. It also provides information on trout stocking, cool water stream access areas, and regulations pertinent to these resources.

Nebraska Cool Water Stream Fish

The species of fish in Nebraska, as with all states, are a mixture of native, introduced and exotic species. Native species are those considered to have been present in the state's waterbodies before European settlement. Introduced species are those native to North America but their historical distribution did not include Nebraska; therefore they were either transported or have migrated to our state waters. Exotics species are those which are not native to North America; some were intentionally imported while others were carried unknowingly. A large number of Nebraskans can claim homesteaders in their heritage and many immigrants wished to bring reminders of their previous home. Therefore, many species of plants, livestock, birds and even fish eventually found their way to Nebraska.

One hundred and nine species of fish have been collected and documented in Nebraska streams since the 1890s. The U. S. and Nebraska fish commissions stocked over 20 species of fish in Nebraska by 1901. However, the first thorough fish survey was not completed in the state until the 1940's (Johnson 1949), making it difficult to determine which fish were native and which were introduced. Jones (1963) summarized the early years of fish collections and stockings within the state. His efforts resulted in an absolute list of fish collected from the state's waters, but did not completely resolve the question of which species were native and which were introduced. Exotic fish species were much easier to determine as their origins could be traced to other continents. Based on all available information and knowledge (both historic and current) it is presumed 78 of the 109 species are native, 25 are introduced and 6 are exotic.

All but five of the 109 total species collected in Nebraska have been recorded in both cool and warm water. There is overlap in the thermal regimes which fish can tolerate, explaining why some fish are caught in both cool and warm water. Warm water fish can tolerate colder water temperatures during the winter, and cool water fish can tolerate warmer water temperatures for short periods of time during the summer. Additionally, cool and warm water streams have not been equally sampled in Nebraska, and fish abundance varies by species, season and method of sampling. The combination of all these factors makes it difficult to determine which species are truly cool water dependent in Nebraska. Therefore, collection frequency data paired with common taxonomical classifications were used to classify 31 species as cool water fish in Nebraska (Table 1); however, these fish not necessarily cool water obligates or indicators of cool water streams.

Table 1: There are 31 species in Nebraska considered to be cool water fish based on a combination of the cool to warm water collection frequency ratio and known thermal tolerances in other states. These fish are not necessarily cool-water obligates or indicators of a cool water stream.

Common Name	**Scientific Name**	**Cool/Warm Collection Frequency**	**Native**	**Introduced**	**Exotic**	**Stocked**
Cutthroat trout	*Oncorhynchus clarkii*	*		X		X
Tiger trout	*Salmo trutta x Salvelinus fontinalis*	*		X		X
Brook trout	*Salvelinus fontinalis*	94.000		X		X
Brown trout	*Salmo trutta*	12.833			X	X
Longnose sucker	*Catostomus catostomus*	7.250	X			
Rainbow trout	*Oncorhynchus mykiss*	6.361		X		X
Finescale dace	*Chrosomus neogaeus*	3.800	X			
Northern pearl dace	*Margariscus nachtriebi*	3.632	X			
Blacknose shiner	*Notropis heterolepis*	3.333	X			
Northern redbelly dace	*Chrosomus eos*	2.393	X			
Longnose dace	*Rhinichthys cataractae*	2.176	X			
Orangethroat darter	*Etheostoma spectabile*	1.964	X			
Blacknose dace	*Rhinichthys atratulus*	1.836	X			
Plains topminnow	*Fundulus sciadicus*	1.134	X			
Brook stickleback	*Culaea inconstans*	1.129	X			
Iowa darter	*Etheostoma exile*	1.108	X			
White sucker	*Catastomus commersonii*	0.999	X			
Rock bass **	*Ambloplites rupestris*	0.892		X		X
Common shiner **	*Luxilus cornutus*	0.796	X			
Pumpkinseed **	*Lepomis gibbosus*	0.714		X		
Golden shiner ***	*Notemigonus crysoleucas*	0.634	X			X
Central stoneroller **	*Campostoma anomalum*	0.574	X			
Northern pike **	*Esox lucius*	0.551	X			X
Hornyhead chub **	*Nocomis biguttatus*	0.500	X			
Smallmouth bass **	*Micropterus dolomieu*	0.500		X		X
Creek chub **	*Semotilus atromaculatus*	0.496	X			
Brassy minnow **	*Hybognathus hankinsoni*	0.473	X			
Topeka shiner **	*Notropis topeka*	0.429	X			
Yellow perch **	*Perca flavescens*	0.254		X		X
Walleye **	*Sander vitreus*	0.130	X			X
Burbot **	*Lota lota*	0.000	X			

* Cutthroat trout and tiger trout have only been sampled in cool water streams. Therefore, a collection frequency ratio cannot be calculated because the number of cool water catches cannot mathematically be divided by zero.

** While frequently or more typically sampled in Nebraska's warm water, these are taxonomically recognized as cool water species, and are considered as such for the purposes of this document.

*** Golden shiners are generally considered a warm water species, but in Nebraska they are commonly sampled in cool water streams, and are therefore considered a cool water species in the state.

Historical, NGPC and NDEQ fish collection datasets were used to determine which fish species have been collected most frequently in Nebraska's cool water streams over the period of record. A "cool water to warm water" collection frequency ratio was generated from the dataset by dividing the number of cool water collections by the number of warm water collections in Nebraska for each species. The ratio indicates how likely any given species is to be sampled in cool versus warm water. For example, Brook trout (*Salvelinus fontinalis*), which are known to thrive in cold water, are 94 times more likely to be sampled in cool water streams versus warm water streams in Nebraska. They have the highest cool to warm water collection frequency and are considered a cool water species in Nebraska (Table 1). Conversely, Speckled chubs (*Macrhybopsis aestivalis*) a native species inhabiting big rivers, are 200 times more likely to be sampled in warm water than cool water. Therefore, they are not considered to be a cool water species.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 1: Brook trout (Salvelinus fontinalis)

However, in some cases, species collected more frequently in Nebraska's warm water, such as Walleye (*Sander vitreus*) and Burbot (*Lota lota*), have been thoroughly documented by researchers in other states as cool water species. Therefore, despite the collection frequency ratio in Nebraska of these two species (0.130 and 0.000 respectively), these have been included in the list of cool water fish for Nebraska. Species believed to be extirpated or are well documented as warm water fish are not classified as cool water fish in Nebraska.

At-risk Cool Water Stream Fish Species

Native fish occur throughout Nebraska waters, but few occur in cool water streams. Schainost (2015) identified 22 native fish species inhabiting cool water streams, nine of which are listed as at-risk species in the NNLP (Schneider et al. 2011) (Table 2). Blacknose shiner, Finescale dace, Northern redbelly dace, Plains topminnow (*Fundulus sciadicus*), and Topeka shiner (*Notropis topeka*) are listed as Tier 1 at-risk species (Schneider et al. 2011). Except for Plains topminnow, all of these Tier 1 at-risk species are listed as endangered or threatened at the state level under NESCA and/or the federal level under the Endangered Species Act (ESA). Blacknose dace (*Rhinichthys atratulus*), Burbot, Common shiner (*Luxilus cornutus*) and Northern pearl dace are Tier II at-risk species (Schneider et al. 2011) and/or species of concern in the NDEQ 2004-2008 fish sampling summary (Bazata 2011). All nine of these species are discussed further below.

Collectively, these nine at-risk species are either declining across their range and/or are disjunct populations in Nebraska which exist greater than 200 miles (322 km) from their current primary range. Although little is known about the life history and physiological tolerances of these species, declines are attributed to a variety of factors, including, but not limited to, channelization, siltation, water quality impairments, stream flow reduction and invasive, introduced, and exotic species, such as western mosquitofish (*Gambusia affinis*) and trout (Hrabik et al. 2015).

Table 2: Nebraska At-risk Fish Species Inhabiting Cool Water Streams

Common Name	Scientific Name	NNLP At-Risk Status	Endangered or Threatened
Blacknose dace	*Rhinichthys atratulus*	Tier II	not listed
Blacknose shiner	*Notropis heterolepis*	Tier I	state endangered
Burbot	*Lota lota*	Tier II	not listed
Common shiner	*Luxilus cornutus*	Tier II	not listed
Finescale dace	*Chrosomus neogaeus*	Tier I	state threatened
Northern pearl dace	*Margariscus nachtriebi*	Tier II	not listed
Northern redbelly dace	*Chrosomus eos*	Tier I	state threatened
Plains topminnow	*Fundulus sciadicus*	Tier I	not listed
Topeka shiner	*Notropis topeka*	Tier I	state and federal endangered

Note: The following species accounts were primarily taken from Hrabik et al. 2015 unless otherwise cited.

Blacknose Dace

In Nebraska, Blacknose dace are primarily found in the northeastern and north-central part of the state. Blacknose dace have one of the most specialized habitat requirements of all Nebraska fishes. They need clear, small streams with moderate to swift currents and hard (e.g., gravel) substrates. Spawning activity begins in May when water temperature reaches about 21 °C (70 °F) and can extend into July. They are intolerant of siltation, pollution and non-native predator fishes, especially trout.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 2: Blacknose dace (Rhinichthys atratulus)

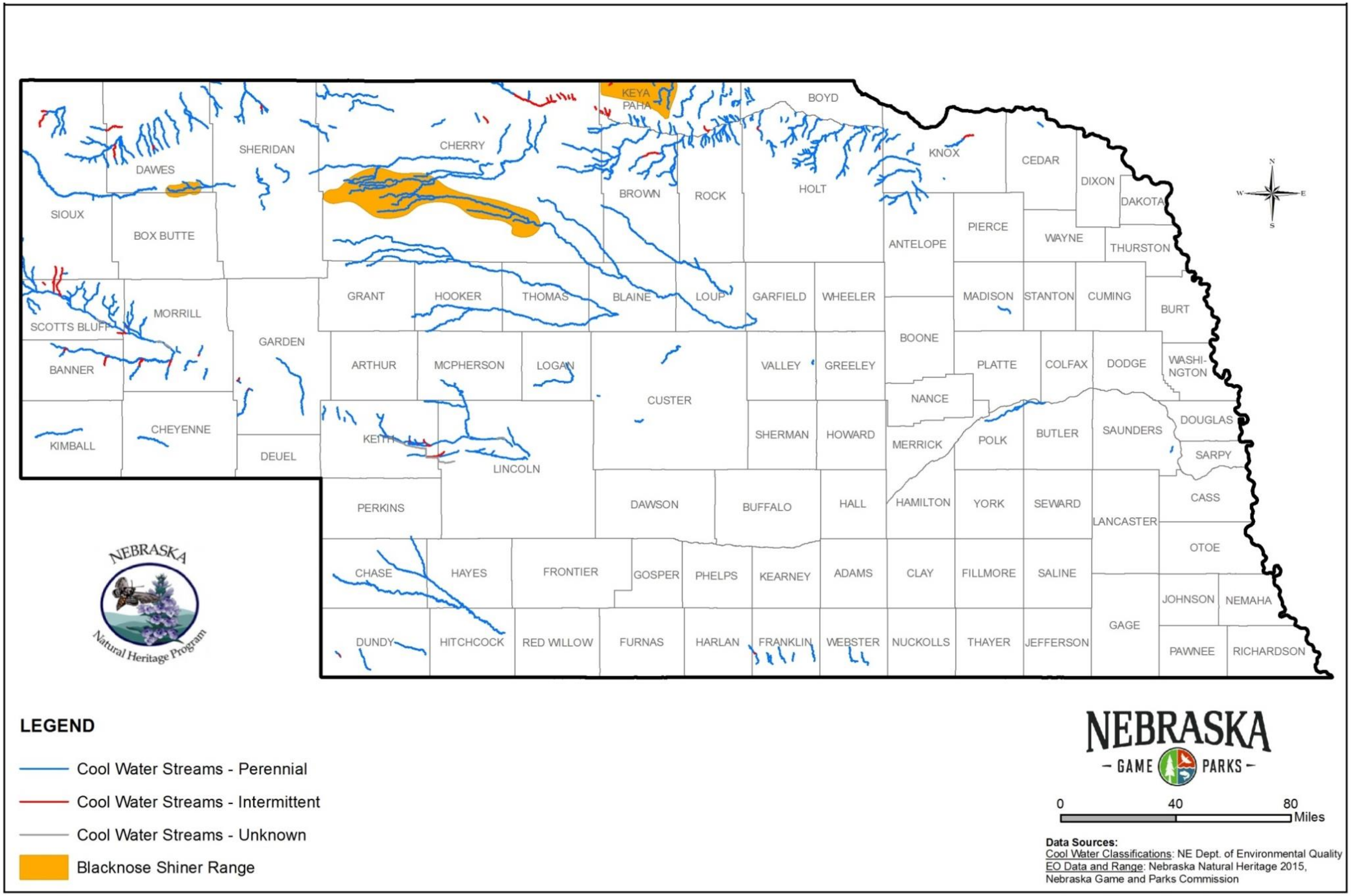
Blacknose Shiner

Blacknose shiner is listed as endangered under NESCA, and along with Topeka shiner (see below) it is one of the rarest fish in Nebraska with respect to distribution and abundance (Figure 4). In Nebraska, Blacknose shiners are found in pools in small, clear streams with sand or gravel substrates and permanent vegetation. They spawn from June through July over sandy substrates and feed on invertebrates, such as insects and snails. They are sensitive to turbidity and siltation, and their habitat has been greatly reduced due to sedimentation, dewatering and channel alteration. The presence of this species typically indicates good water quality.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 3: Blacknose shiner (Notropis heterolepis)

Figure 4: Estimated Current Range of Blacknose Shiner (Notropis heterolepis) in Nebraska



Burbot

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 4: Burbot (Lota lota)

Burbots look like a cross between a catfish and an eel, and are the lone representative of the Gadidae family in Nebraska waters. They are freshwater fish typically found north of 40° North Latitude (the Nebraska/Kansas border). In Nebraska, this fish has not been caught in cool water streams, but is commonly referred to as a cool water species in other states (Table 1). It has been found in the Missouri River downstream of Gavins Point Dam to Sioux City. Damming and channelization of the Missouri River have altered its habitat, range and distribution. Burbot spawn in mid-winter under the ice and eggs hatch in spring. Small burbot eat insects and crustaceans, while larger burbot prey on fish.

Common Shiner

Common shiners used to be present throughout Nebraska, but are now restricted to the western North Platte, Niobrara and Little Blue River systems. They inhabit small streams to medium-sized rivers with clear water and gravel substrate, and prefer rocky pools below riffles in permanent, spring-fed headwaters where there is little vegetation. They start spawning in late spring when water temperatures reach 16 °C (60 °F), and continue spawning through early summer. Fertilized eggs are adhesive and are buried in nests made of gravel. Eggs require a constant flow of well-oxygenated water, and are vulnerable to siltation and sedimentation. Common shiners feed on mayflies, caddisflies, midges and stoneflies.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 5: Common shiner (Luxilus cornutus)

Finescale Dace
Northern Pearl Dace
Northern Redbelly Dace

Finescale dace and Northern redbelly dace are listed as threatened under NESCA, and Northern pearl dace is a Tier II at-risk species. These small minnows occur in the central to northcentral and northwest part of the state (Figures 5 and 6) where they inhabit relatively small, clear, cool, spring-fed pools and headwaters of streams with slow to moderate current and sand or gravel bottoms. They also use spring-fed beaver ponds and marshes. These three species are found together with other small fish, such as Brook stickleback (*Culaea inconstans*), Fathead minnow (*Pimephales promelas*), Brassy minnow (*Hybognathus hankinsoni*), Iowa darter (*Etheostoma exile*), Common shiner, and Blacknose shiner. They are typically not present in areas stocked with minnow-eating sportfish. Finescale dace and Northern pearl dace spawn from late April to early May when the water temperature reaches approximately 16 °C (60 °F). Northern redbelly dace typically spawn from April through June, but spawning can extend into August. Eggs are deposited on aquatic vegetation, sunken logs, or submerged brush. These species of dace feed on algae, zooplankton and/or small invertebrates.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 6: Finescale dace (Chrosomus neogaeus)

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 7: Northern pearl dace (Margariscus nachtriebi)

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 8: Northern redbelly dace (Chrosomus eos)

Figure 5: Estimated Current Range of Finescale Dace (Chrosomus neogaeus) in Nebraska

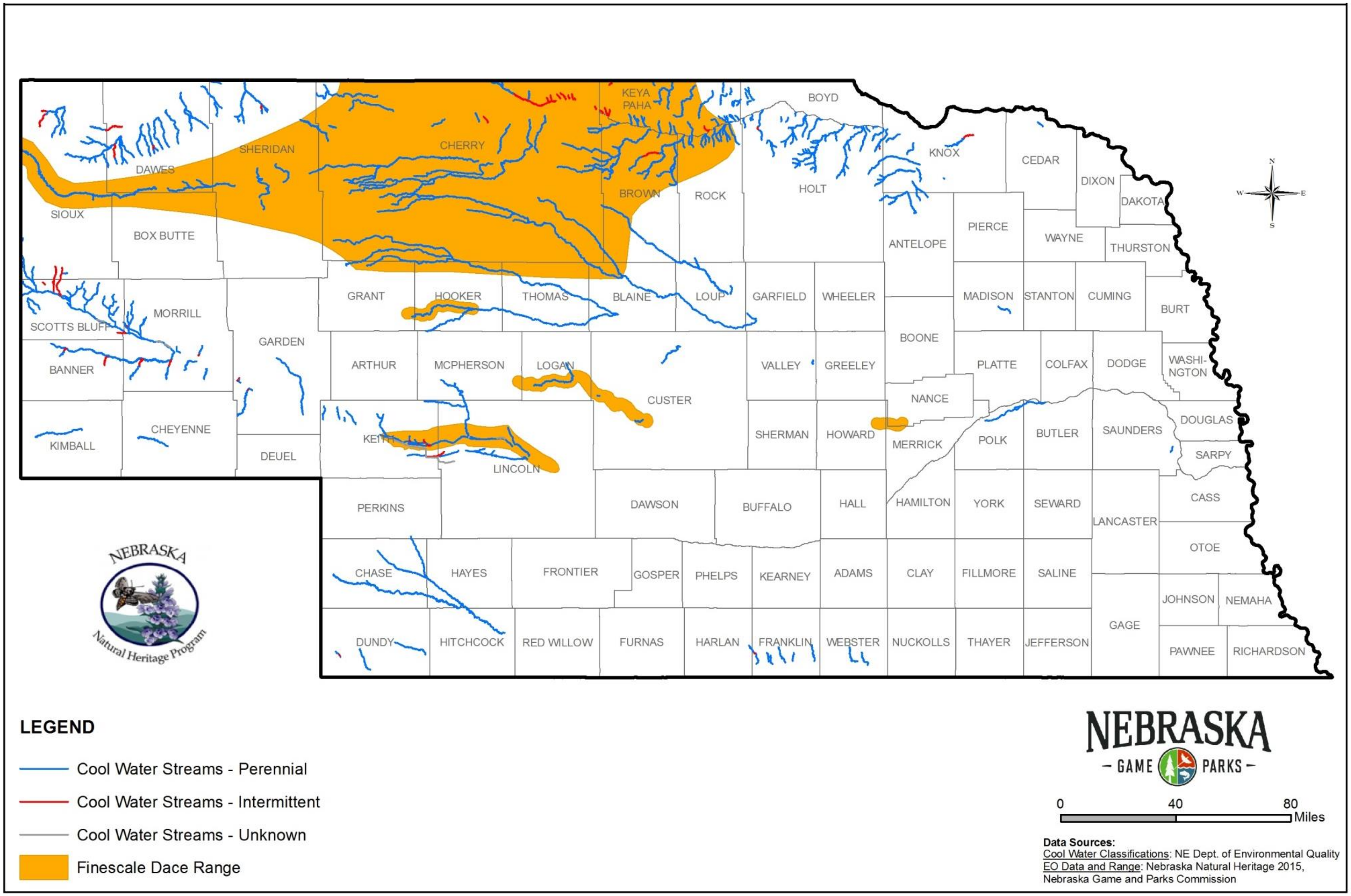
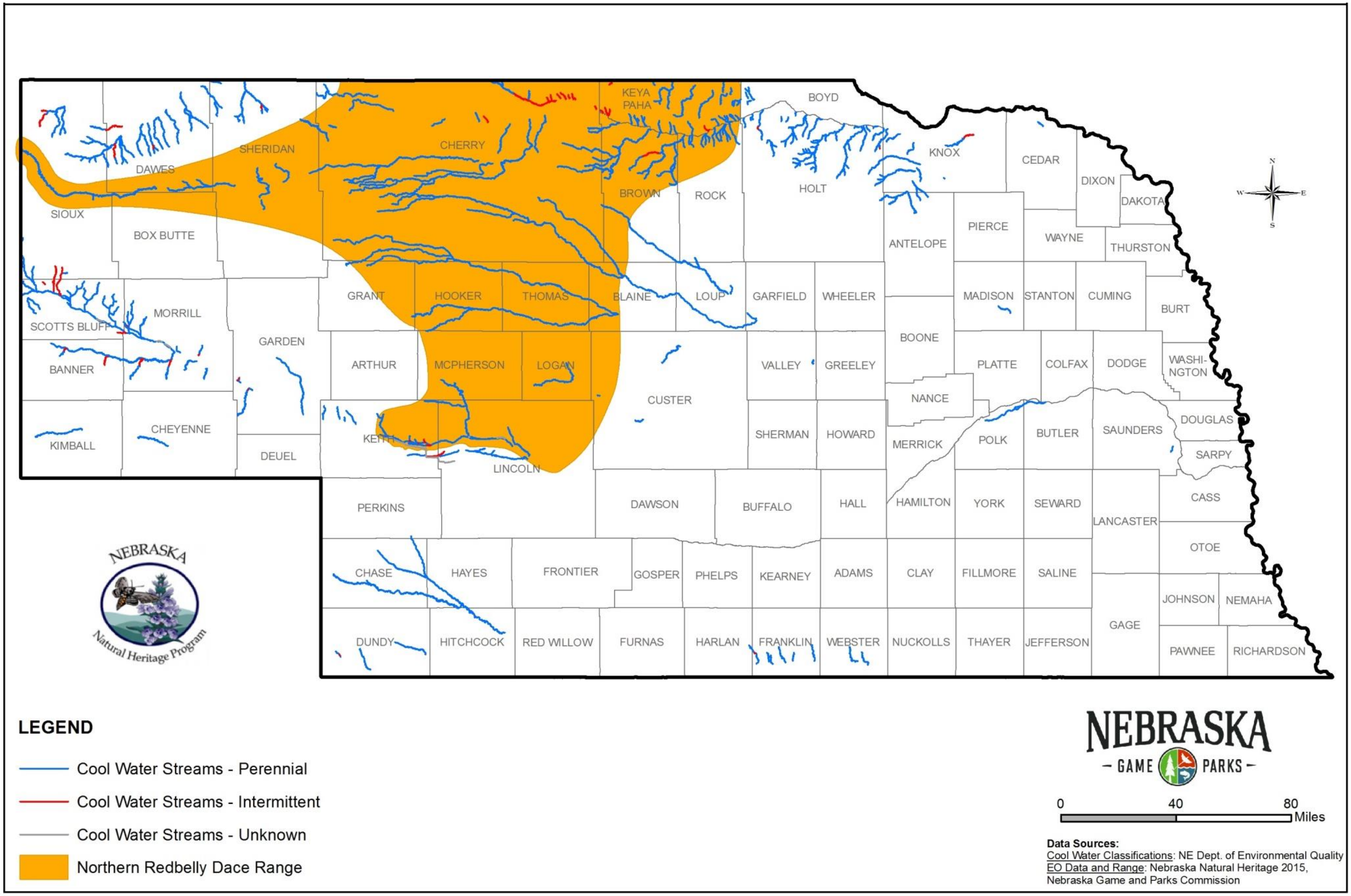


Figure 6: Estimated Current Range of Northern Redbelly Dace (Chrosomus eos) in Nebraska



Plains Topminnow


Photo by Ken Bouc, NEBRASKAland Magazine

Photo 9: Plains topminnow (Fundulus sciadicus)

Plains topminnow is considered to be nearly endemic to Nebraska, meaning that the species' distribution occurs primarily in Nebraska. They can be found throughout most of the state (Figure 7), but are most abundant in the Sandhills. They are most often found in small, clear, shallow streams with heavy vegetation and slow-moving water, such as headwaters, backwaters, pools in small creeks, overflow pools of larger streams, sloughs, and ditches adjacent to streams. Plains topminnows are most abundant in water that is 18 – 24 °C (65 – 75 °F), and they typically spawn from June through August. Plains topminnows are not as prolific as other fish. Females lay 50 – 90 eggs per year; eggs are sticky and are released into mats of filamentous algae or other vegetation. They eat small invertebrates, such as insects and snails. Populations are declining likely due to habitat degradation and competition with introduced fish species such as Western mosquitofish.

Topeka Shiner


Photo by Garold Sneegas, USFWS

Photo 10: Topeka shiner (Notropis topeka)

Topeka shiner is listed as endangered under ESA and NESCA. Other than Blacknose shiner (see above), it is one of the rarest fish in Nebraska, occurring only in southeast Madison County and southeast Cherry County (Figure 8). Similar to Blacknose shiners, Topeka shiners occupy riparian habitats or off-channel oxbows. In Nebraska, they select cool, weedy permanent pools in undisturbed small prairie streams with sand bottoms. They prefer perennial flowing streams, but can occur in intermittent streams where spring-fed pools occur. Aquatic vegetation consists of pondweed (*Potamogeton sp.*) and various forms of algae, such as muskgrass (*Chara sp.*). Stream banks are dominated by dense, overhanging vegetation, such as willows (*Salix sp.*), which shade and maintain cool stream temperatures. Topeka shiners can occur in association with Northern redbelly dace, Common shiner, and Brassy minnow. Spawning occurs from late spring through summer, and eggs are scattered over gravel. They eat midge larvae and other invertebrates, and are sensitive to a variety of stream disturbances (e.g., channelization, diversions, siltation, chemical run-off, introduced predatory fish, etc.)

Figure 7: Estimated Current Range of Plains Topminnow (Fundulus sciadicus) in Nebraska

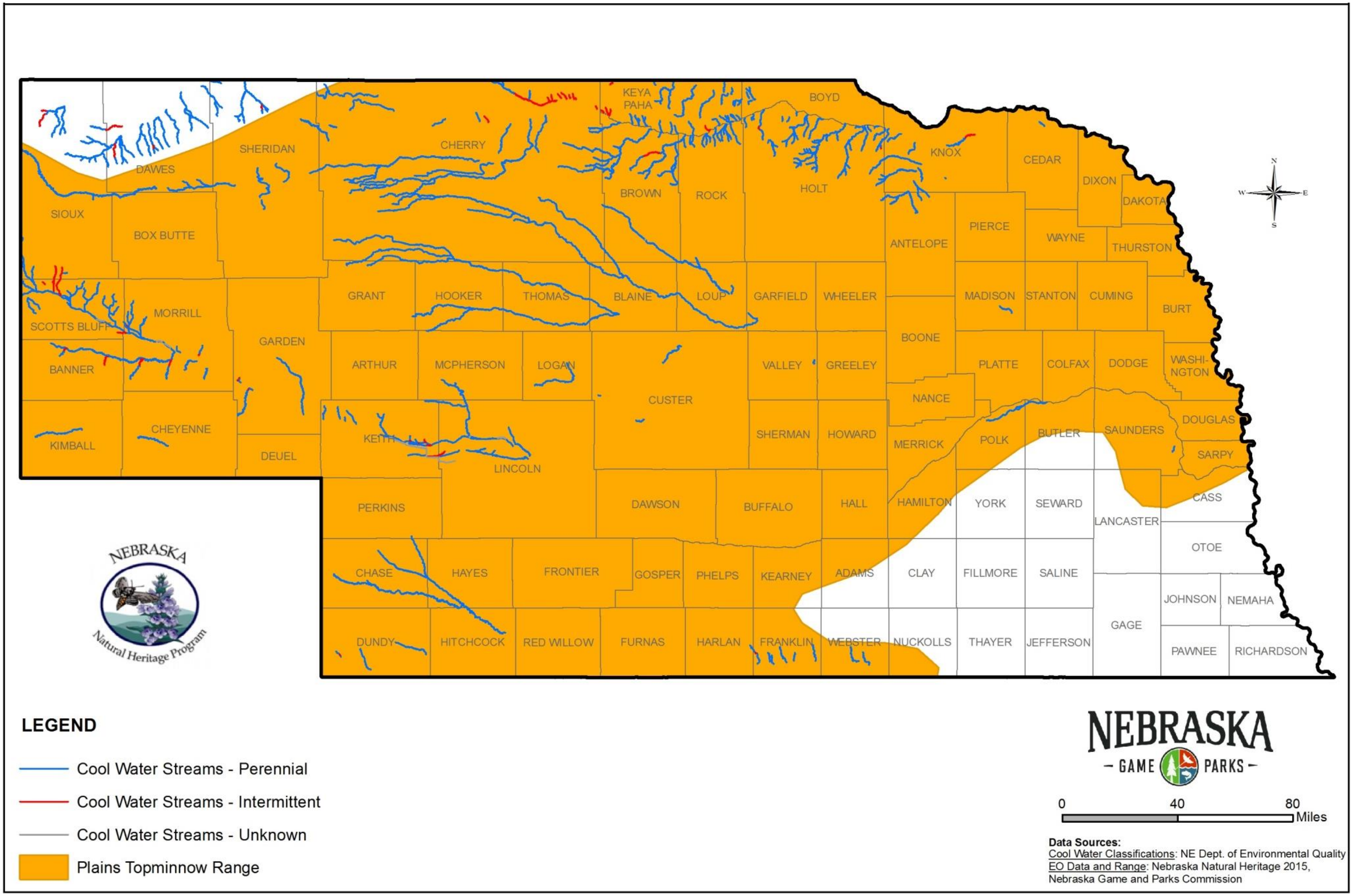
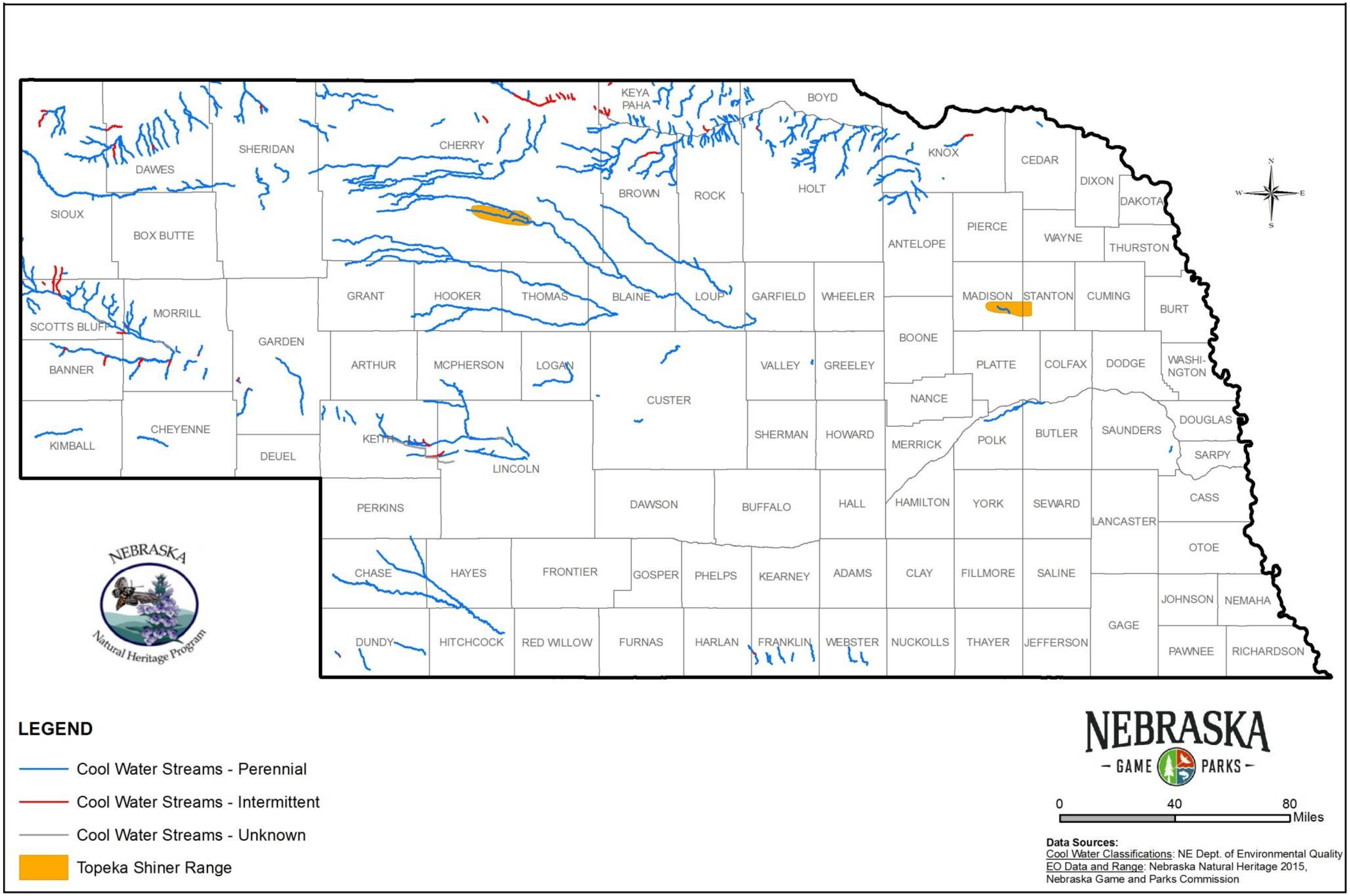


Figure 8: Estimated Current Range of Topeka Shiner (Notropis topeka) in Nebraska



At-risk Riparian Species

In addition to the aforementioned fish, there are other at-risk species inhabiting riparian zones associated with cool water streams. Two in particular deserve special attention: Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*) and Ute ladies'-tresses (*Spiranthes diluvialis*). These species are both listed as endangered or threatened under ESA and NESCA. In Nebraska, they only exist in riparian zones of cool water streams.

Colorado Butterfly Plant

Photo by Michael Fritz, NEBRASKAland Magazine

Photo 11: Colorado butterfly plant (Gaura neomexicana ssp. coloradensis)

Colorado butterfly plant is state-listed as endangered and federally-listed as threatened. In Nebraska, this species is only found along Lodgepole Creek in Kimball County (Figure 9). This plant prefers low meadows and stream edges. Germination occurs in late summer or fall. Then, in the following year, one or more upright stems grow up to three feet tall and produce flowers in mid to late summer. The flowers are less than an inch wide and open in the evening, suggesting a nocturnal pollinator. Unmanaged grazing, herbicides, permanent changes or alterations to stream flow and hydrology, and habitat destruction are all threats to this plant.

Ute Ladies'-tresses

Ute ladies'-tresses is a state and federally-listed threatened species. In Nebraska, they have only been found in western alkaline meadows along the Niobrara River in Sioux County (Figure 10). They have narrow leaves that can be up to ten inches long and less than an inch wide. Numerous small, white flowers form a spike, which can be up to six inches long. Reduced groundwater levels, invasive species, conversion of meadows to cropland, and annual haying of meadows have all contributed to the decline of this species.

Photo by Bekee Hotze, USFWS

Photo 12: Ute ladies'-tresses (Spiranthes diluvialis)

Figure 9: Estimated Range of Colorado Butterfly Plant (Gaura neomexicana ssp. coloradensis) in Nebraska

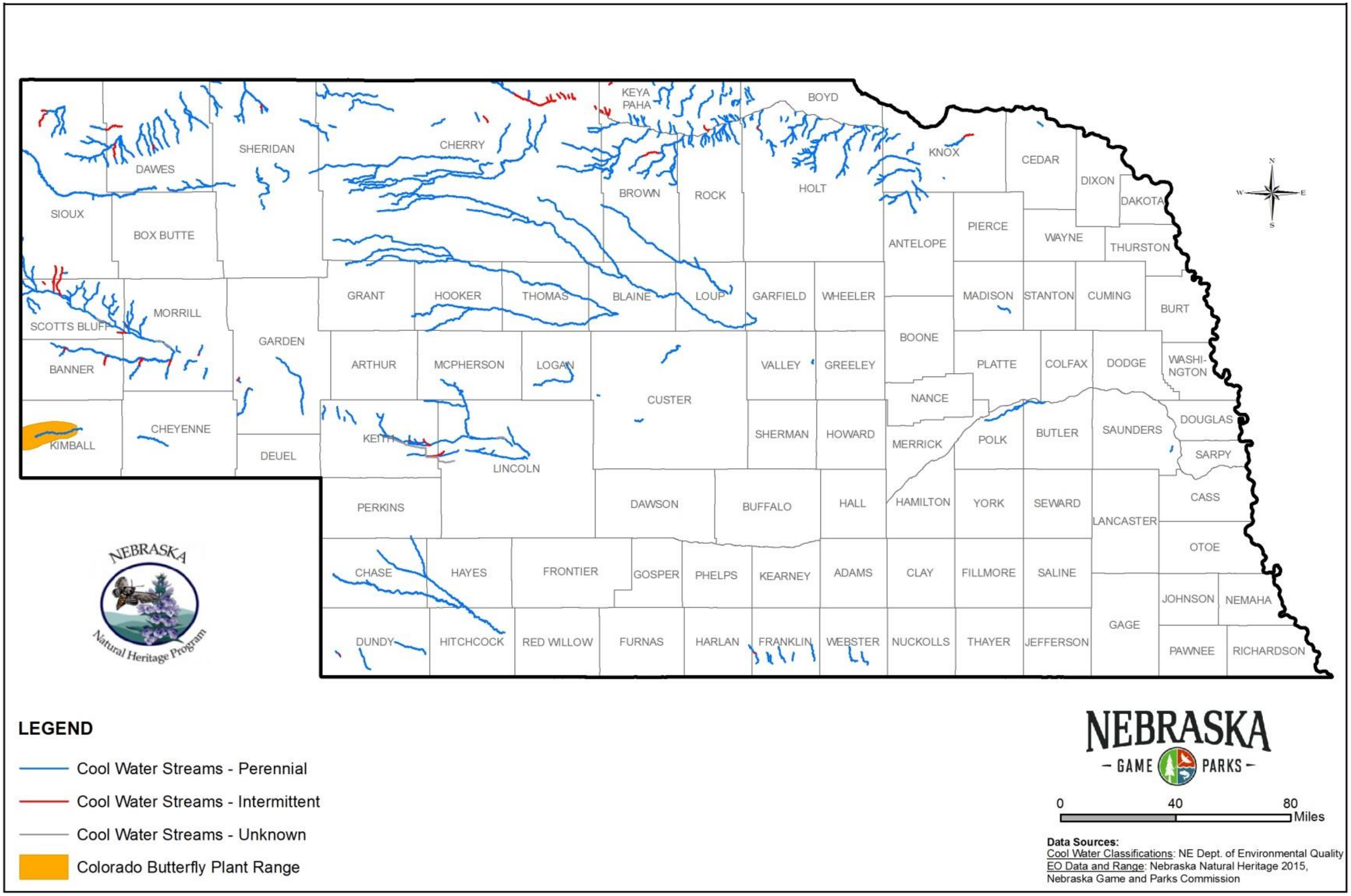
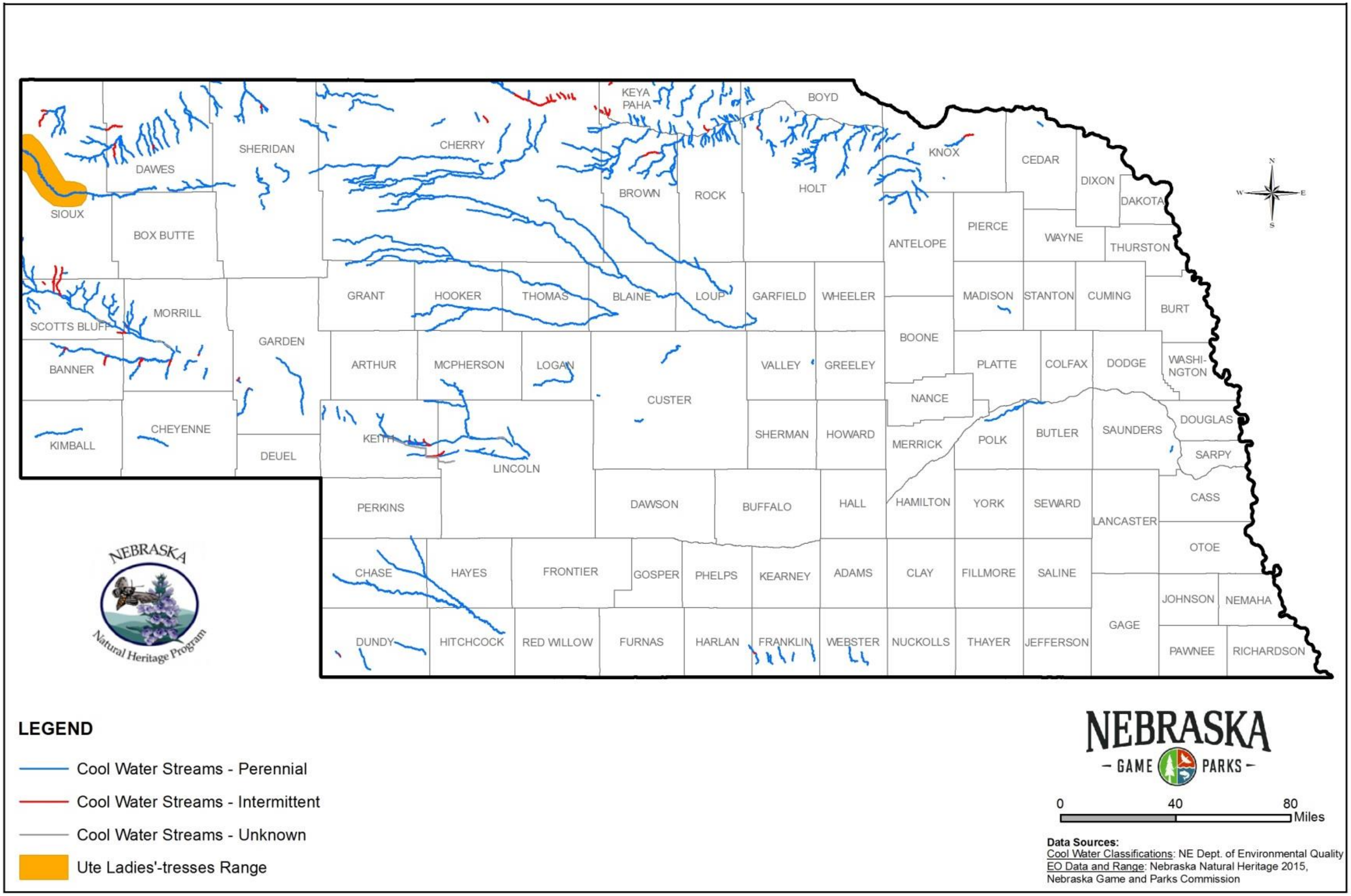


Figure 10: Estimated Range of Ute Ladies'-tresses (Spiranthes diluvialis) in Nebraska



Trout in Nebraska Cool Water Streams

Habitat Requirements

Five types of trout are present in Nebraska cool water streams: Brown trout (*Salmo trutta*), Rainbow trout, Brook trout, Cutthroat trout (*Oncorhynchus clarkii*) and Tiger trout (*Salmo trutta* X *Salvelinus fontinalis*). These trout species are all introduced or exotic (Table 1), but are highly sought by recreational anglers. All trout species need cool, clear water to survive and the appropriate proportion of nursery, rearing, feeding, and sheltering (protection) habitat to support a healthy population. Stream health and morphology play a critical role in trout reproduction. Specific stream habitat components (e.g., bank structure, substrate, flows, cover, etc.) are needed for successful incubation and hatching of trout eggs, survival and recruitment of juvenile stages, and to support an abundant diverse prey community (e.g., macroinvertebrates.) Wide, shallow streams with degraded banks and watersheds due to overgrazing and other detrimental land practices generally do not support trout, nor have habitat components or structure needed for successful trout reproduction.

Photo by Ken Bouc, NEBRASKAland Magazine

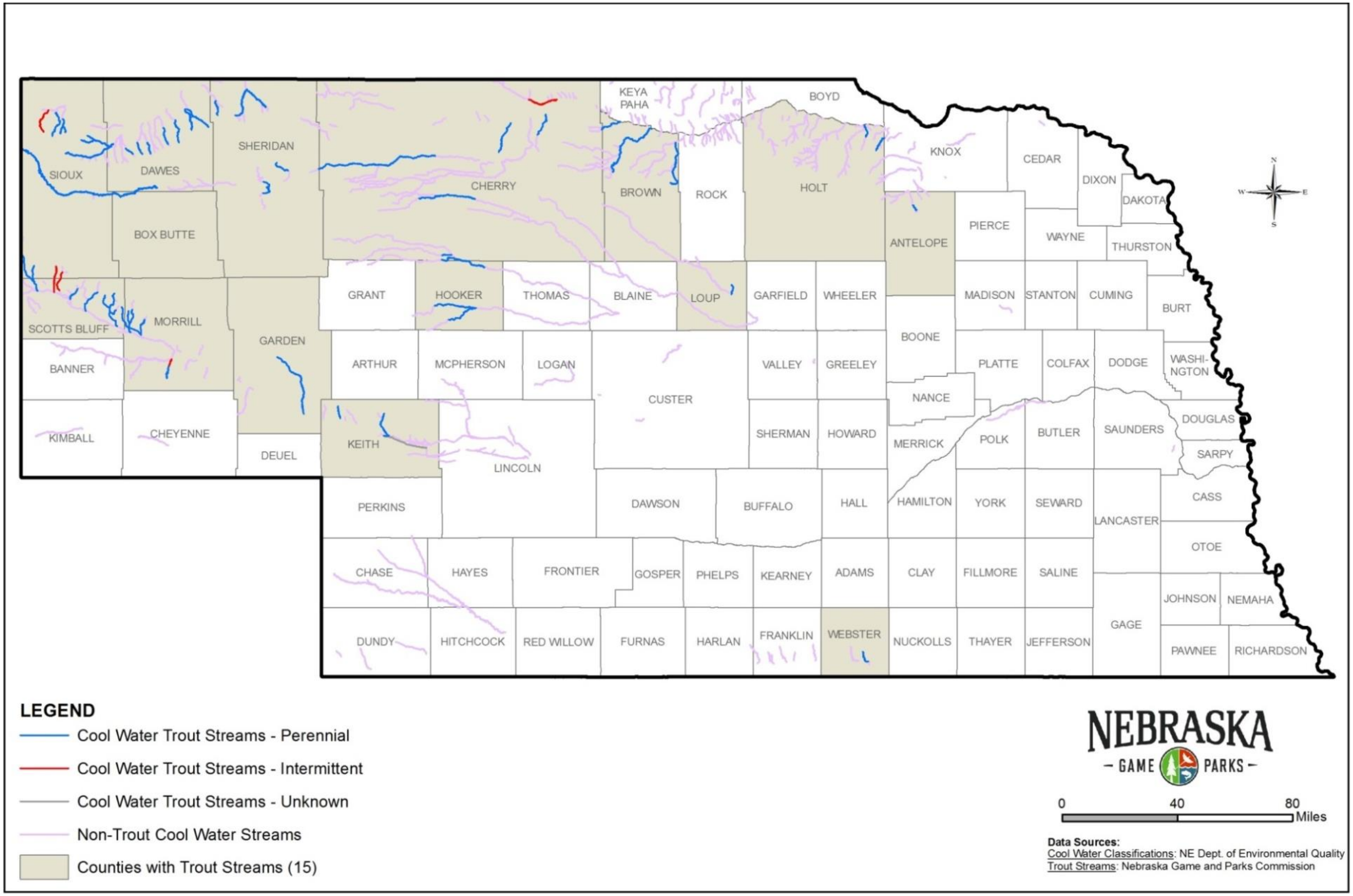
Photo 13: Brown trout (Salmo trutta)

In general, trout require stable gravel beds to create "redds" or spawning sites where reproduction occurs. Eggs are fertilized and deposited in these gravel beds where the eggs remain protected and aerated in the gravel until they hatch. Deposits of sand or silt rolling along the bottom of the stream will bury and suffocate the eggs thus resulting in failed reproduction. For this reason, many of Nebraska's "prairie" streams, even though they may contain the right water temperature regime, do not have natural trout reproduction due to sand substrate. In many instances, successful natural reproduction occurs only in the upper reaches of smaller rivers and streams where gravel is prevalent and sand transport and deposition is much lower. In Nebraska, these types of streams occur along the northern portions of the state, from the northeast/north central area to the panhandle and Pine Ridge, with an increase in such streams from east to west, and particularly towards the northwest (Figure 11).

Photo by Jenny Nguyen, NEBRASKAland Magazine

Photo 14: Cutthroat trout (Oncorhynchus clarkii)

Figure 11: Cool Water Streams with Trout



Trout Stocking

From 1927 to 1985, NGPC made 4,448 attempts to stock trout in both public and private reaches of cool water streams in an effort to establish or maintain fishable populations. One of the earliest, successful recorded stocking events was October 6, 1927 in the Niobrara River above what is now Box Butte Reservoir. However, despite multiple attempts and using multiple species, a large number of historical stockings from 1927 through 1985 failed or resulted in remnant populations which are occasionally sampled (Appendix B).

Natural trout reproduction and recruitment is sufficient in some streams to sustain adequate populations for angling without any level of stocking. Brown trout and Brook trout have the best success with natural reproduction in Nebraska. Both of these species reproduce in the fall (September to October) while Rainbow trout and Cutthroat trout spawn in the late winter to early spring. In other streams with lower levels of natural reproduction and recruitment, supplemental trout stocking is occasionally needed to enhance the population and improve the size structure necessary to maintain angler interest. Some streams may have appropriate water properties for trout to survive (e.g., temperature, flow), but may lack habitat for spawning and successful reproduction, resulting in zero or insufficient recruitment of fish. In these cases, NGPC or private individuals must consistently stock trout to maintain fishable populations. Appendix C includes a list of Nebraska streams with trout, and indicates which species are naturally reproducing and/or stocked in each stream.

Photo by Jeff Kurrus, NEBRASKAland Magazine

Photo 15: Rainbow trout (Oncorhynchus mykiss)

Stream fishing for trout is a small component of Nebraska's recreational angling opportunities. There are approximately 200,000 licensed anglers annually, and of these, only 5 percent preferred fishing for trout in 2012, and only 1.4 percent said they fish for trout in rivers and streams (Hurley 2012). Different scenarios exist dictating which streams will be stocked with trout, which species and size of trout will be stocked, and the frequency of stocking. Different species and strains of trout are stocked to stimulate angler interest, improve diversity in angler catch or to take advantage of environmental adaptations and conditions. For example, Brook trout are well adapted to smaller streams with very cold water, but they are stocked infrequently, and only when disease-free eggs are available from other states for culture. Rainbow trout are more easily cultured and grown to larger sizes compared to other trout species; therefore they are stocked more frequently and in more locations across the state.

In 2001, an angler creel survey found there was an average of 13 anglers per day fishing for trout in a small stretch (approximately two miles) of the East Branch of Verdigre Creek in Antelope County, Nebraska. Two hundred 10-inch (25 cm) Rainbow trout are stocked weekly, year-round to meet this demand. Streams with heavy fishing pressure, such as the East Branch of Verdigre Creek, will usually be stocked with "catchable" sized Rainbow trout. "Catchable" sized trout are 9-11 inches (23-28 cm) in length and provide an instant fishery. Streams with lower fishing pressure and a sufficient food supply are stocked with "sub-catchable" Brown trout or Rainbow trout. Sub-catchable sized trout are 3-6 inches (8-15 cm) in length and will grow to a catchable size within a year or two. Other streams may be stocked with "sub-catchable" trout because the naturally occurring rate of reproduction and recruitment is insufficient to maintain what is perceived to be an adequate standing crop (density) of fish.

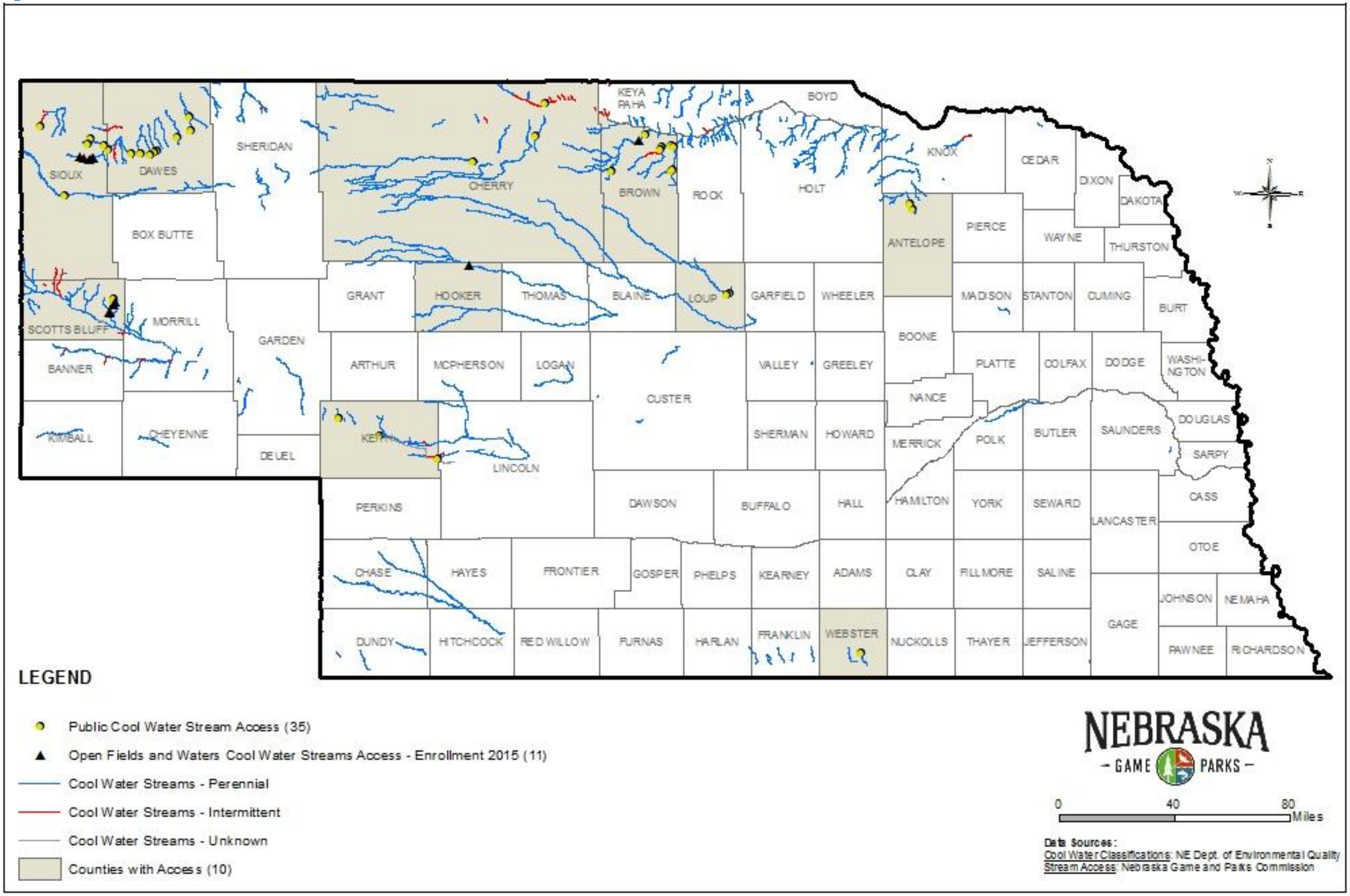
Available Access

Most of Nebraska's trout streams are located on private property in the northern and western areas of the state (Appendix D). In order for anglers to fish streams on private property, they must obtain landowner permission. However, there are almost 16 miles of cool water streams on private property which are open to public access made possible by lease agreements paid through the Open Fields and Waters (OFW) Access Program (Table 3). In addition to the 11 cool water stream public access areas made available through OFW, there are 35 access points to trout fishing streams on publicly owned property (Figure 12). *Trout Fishing in Nebraska's Streams* (NGPC 2002) provides anglers additional information regarding the location of trout streams, how to access them, and what species are present.

Table 3: Public Access to Cool Water Streams through the OFW Access Program (2015 Contracts)

Stream Name	**County**	**Miles (length)**	**Sides of Stream with Access**
Nine Mile Creek	Scotts Bluff	0.75	Both Sides
Nine Mile Creek	Scotts Bluff	0.5	Both Sides
Nine Mile Creek	Scotts Bluff	0.333	Both Sides
East Nine Mile Creek	Scotts Bluff	0.5	One Side
Plum Creek	Brown	1.5	Both Sides
Middle Loup River	Hooker	3.9	Both Sides
White River	Sioux	3.72	Both Sides
White River	Sioux	1.4	Both Sides
White River	Sioux	1.5	Both Sides
White River	Sioux	1.3	Both Sides
White River	Sioux	0.3	Both Sides
		15.703 total miles	

Figure 12: Nebraska Cool Water Streams Public Access



Current Regulations

There are several regulations governing various aspects of cool water streams and species inhabiting such streams. Brief descriptions of the most commonly encountered state and federal regulations are provided below.

Sport Fish

Sport fish regulations are administered by the NGPC and pertain directly to anglers. Under the current regulations, all anglers (age 16 and older) are required to be licensed and the statewide daily bag limit for trout is five and the possession limit is 12, regardless of species. In addition, only one fish greater than 16 inches long is allowed in the daily bag limit, except at Sutherland Canal. Special daily bag limits of two trout are established for Soldier Creek Wilderness Area, including the Wood Reserve Ponds, and the Middle and South Forks of Soldier Creek.

Baitfish Collection

Baitfish collection throughout the state is also regulated by the NGPC. The list of species which can be collected and used for baitfish is defined in state regulations (Title 163, Chapter 2, Section 009), and there is a possession limit of 100 baitfish. Collecting baitfish is prohibited in many cool water streams. Licensed anglers are allowed to collect legally designated baitfish species as indicated in the annual fishing guide. Legal minnow seines, dip nets and traps are allowed to take baitfish. However, it is illegal to possess a seine of any type on trout streams in Sioux, Scotts Bluff, Morrill, Garden and Keith Counties that are tributaries of the North Platte River and Lake McConaughy.

Aquatic Invasive Species

In order to protect streams from certain aquatic invasive species and diseases, the use of felt soled waders is prohibited in Nebraska waters. In addition, boats must be drained, dried and inspected when moving between certain bodies of water in order to avoid spread of invasive species. Similarly, the collection and subsequent transfer of aquatic organisms into public waters is prohibited.

Clean Water Act

The U.S. Army Corps of Engineers (USACE) administers the Section 404 permit of the Clean Water Act (CWA). A Section 404 permit is needed for projects which may affect waters of the U.S. Such projects could occur within a stream or on stream banks, and may include, but are not limited to, channel excavation, placing or removing fill (e.g., soil, structures), aquatic habitat restoration, watershed projects, dams, or water control structures.

Endangered and Threatened Species

Under the Nebraska Nongame and Endangered Species Conservation Act (NESCA), the NGPC has the authority and responsibility to protect species listed as endangered or threatened in Nebraska. NESCA prohibits "take" of all listed species and provides the ability for NGPC to penalize violators. Additionally, hundreds of projects are reviewed each year pursuant to NESCA to ensure actions authorized, funded, or carried out by state agencies do not result in jeopardizing the continued existence of listed species in Nebraska. One such action reviewed pursuant to NESCA is stocking trout. Some state-listed species are also federally listed. The federal Endangered Species Act (ESA) provides the legal framework for federally listed species and is enforced by the U.S. Fish and Wildlife Service (USFWS). Endangered and threatened species inhabiting cool water streams were discussed previously in this document.

NDEQ Assessment of Surface Water

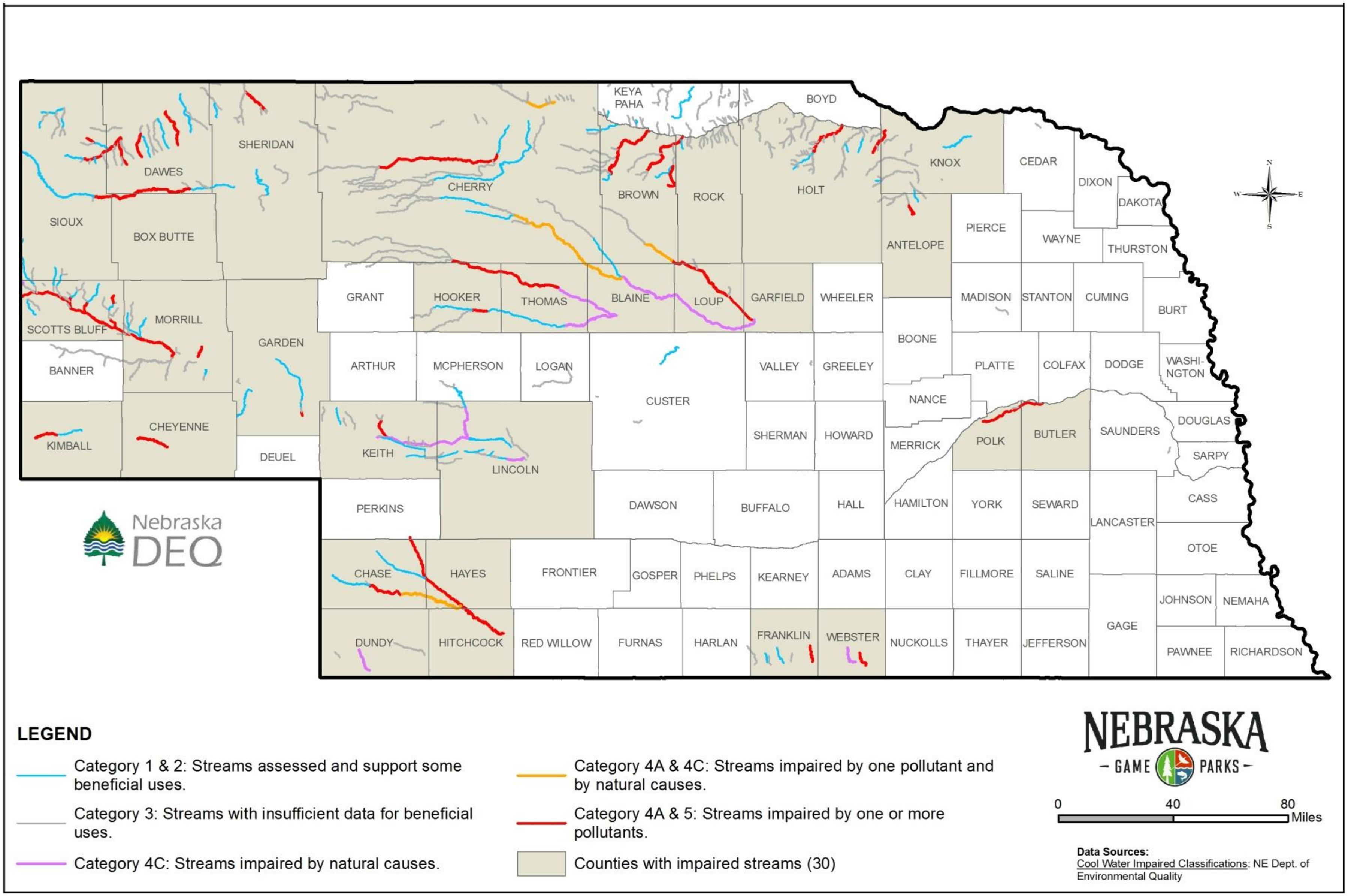
The Environmental Protection Agency (EPA) delegates responsibility to states to assess surface water quality pursuant to the CWA. In Nebraska, NDEQ is the primary agency responsible for conducting such assessments to determine if state and federal surface water quality objectives are being met. Programs used to collect data and make determinations about water quality are discussed later in this document.

Nebraska's water quality objectives are defined in *Title 117- Nebraska Surface Water Quality Standards* (NDEQ 2012). Title 117 defines beneficial uses that are to be supported by each of Nebraska's lakes and streams. It also includes numeric levels of pollutants such as *E. coli* bacteria and atrazine that can be present in a waterbody without impairing the assigned beneficial uses. Beneficial uses for Nebraska's waterbodies include: recreation (swimming, wading); aquatic life (health of aquatic macroinvertebrates, fish, and wildlife); water supply (public drinking water, agriculture and industrial) and aesthetics (NDEQ 2012).

Reporting Water Quality Conditions

Every two years the CWA requires states to develop an "Integrated Report" (NDEQ 2014) summarizing the water quality condition of all surface waterbodies in the state. For the 2014 Water Quality Integrated Report, NDEQ staff assessed 522 stream segments, equating to more than 9,745 miles of streams. Sampling was focused on streams used more widely by the public, and numerous streams still need to be assessed (Figure 13, Category 3). Based on stream sampling and assessment, NDEQ determines which waterbodies are or are not supporting their designated beneficial uses. Waters that do not fully support all of their assigned beneficial uses are considered "impaired" and placed on an impaired waterbodies list [303(d) list]. "Supporting" or "good quality waters" are those which fully support all assigned beneficial uses.

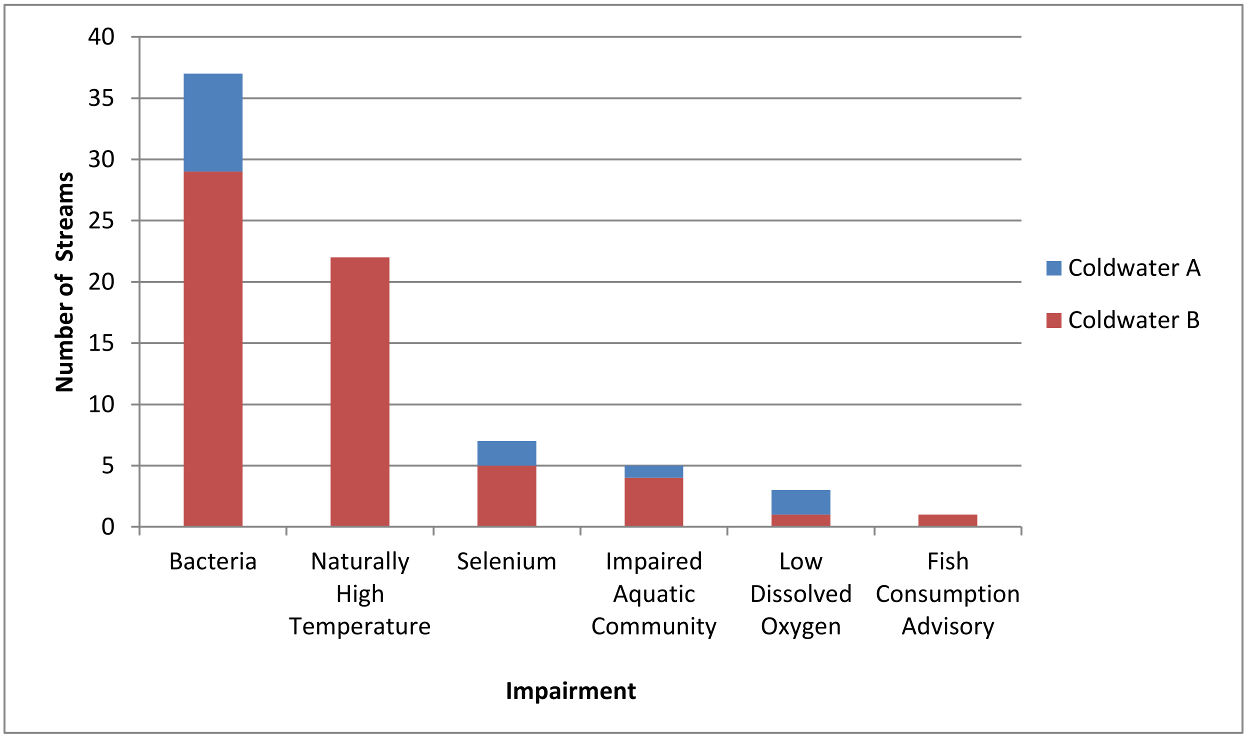
Figure 13: Water Quality Condition for Cool Water Streams



Impaired Cool Water Streams

Cool water streams are typically impaired for recreation and aquatic life beneficial uses, and are impaired by both natural causes and pollutants (Figure 13, Category 4). The most common causes of cool water stream impairments can be seen in Figure 14 below (NDEQ 2014). Some streams have multiple impairments. Bacteria (*E. coli*) is the leading impairment, followed by naturally high water temperatures. Selenium, impaired aquatic communities (with unknown causes), low dissolved oxygen, and fish consumption advisory are other impairments reported for cool water streams (NDEQ 2014). Appendix E lists the Coldwater A and B stream segments impaired for recreation and aquatic life beneficial uses, and the pollutant of concern, if known and applicable.

Figure 14: Cool Water Stream Impairments



Source: NDEQ 2014 Water Quality Integrated Report

E. coli bacteria are primarily associated with animal and human waste. Animal sources of *E. coli* bacteria commonly enter streams from livestock and wildlife wastes that runoff of the landscape during significant rainfall events. Human sources of contamination can include improperly maintained septic systems and wastewater facilities that discharge to streams (NDEQ 2016).

E. coli bacteria are monitored to provide an "indirect" indication of potentially harmful (pathogenic) bacteria. While not all *E. coli* bacteria are considered a threat to human health, some strains are. The larger the population of *E. coli* bacteria measured, the greater the odds are of having harmful pathogenic bacteria. Using this rationale, the value of 235 colonies of *E. coli* bacteria is the upper limit for allowing full body contact recreation. Ingesting water with higher levels of *E. coli* bacteria may cause symptoms to be exhibited within the intestinal tract (NDEQ 2016).

Although significantly fewer streams are impaired by low dissolved oxygen, selenium, mercury and other pollutants, these factors can degrade stream conditions for aquatic life and can also be harmful to people (NDEQ 2016). For example, heavy metals and other hazardous compounds can bioaccumulate in fish, which not only affects physiological processes of the fish, but also affects animals preying on those fish. In waterbodies where contaminant levels in fish are of concern to humans, a fish consumption advisory is issued. Such an advisory does not ban catching and eating fish, but instead provides guidelines for preparing fish and recommendations for limiting consumption of certain fish (NDEQ 2016).

Strategies to Resolve Water Quality Impairments

Cool water streams can be restored or at least have the pollutants or causes of impairments reduced. Once a waterbody is determined to be "impaired," NDEQ is required to develop a plan or method to reduce pollutant levels so that waterbody is able to support its designated uses. Three types of pollution control plans are commonly implemented. Point source pollution is managed by the National Pollutant Discharge and Elimination System (NPDES) permitting program, which is under authority of NDEQ in Nebraska. Nonpoint source pollution is managed by the development of Total Maximum Daily Loads (TMDLs) and Watershed Management Plans. Both of these nonpoint source pollution plans involve determining the cause and sources of the water quality impairment and working with stakeholders to develop and implement on-the-ground pollution control strategies. Continued water quality monitoring provides the needed data to determine if the plan is working or if modifications are required.

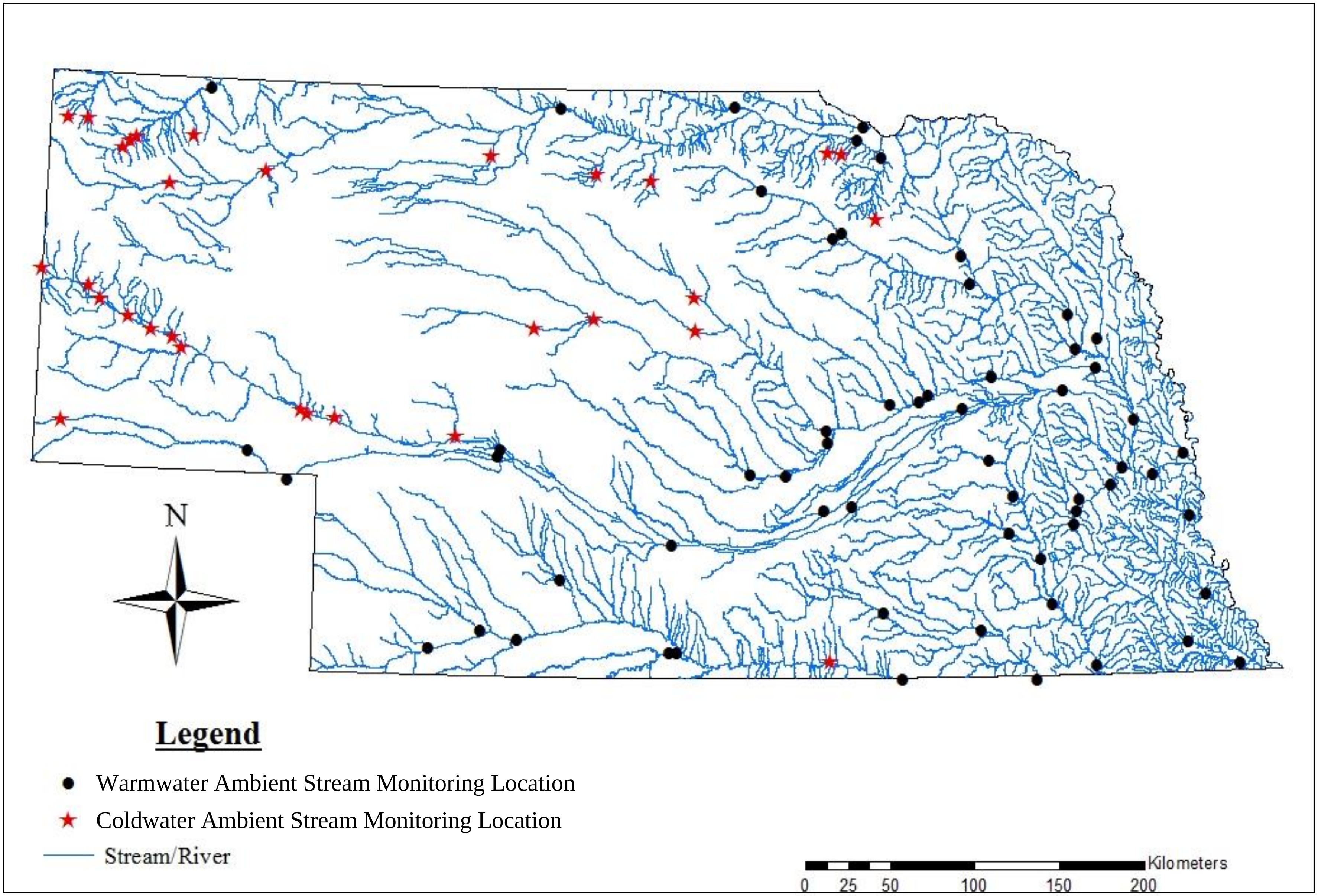
NDEQ Monitoring Programs

The NDEQ Surface Water Unit (SWU) coordinates various monitoring and assessment programs that: (1) collect physical, chemical and biological water quality samples from streams and lakes; (2) implement surface water improvement projects; and (3) prepare surface water quality reports. Some monitoring programs collect stream and lake samples throughout the state; however, most monitoring is focused on one to three major river basins each year in conjunction with a rotating basin monitoring strategy. For the purposes of this management plan, only those monitoring programs that are involved in the collection of data from cool water streams will be described here. Data collected through these monitoring and assessment programs are used to determine if a water body is impaired (as described above) and if CWA and Title 117 objectives are being achieved.

Ambient Stream Monitoring Program

The primary objectives of the Ambient Stream Monitoring Program (ASMP) are to provide information on the status and trends of water quality in streams within each of the state's 13 major river basins, and to link assessments of status and trends with natural and human factors affecting water quality. The ASMP has a network of 97 fixed stations located on streams across the state (Figure 15 and Appendix F). Ecoregion and land use considerations were used in selecting many of the monitoring sites. Fifty-eight of the 97 sites are located on main stem streams, while the remaining stations are located on tributaries of the main stem streams. Thirty-one of the sites are located on cool water streams as shown in Figure 15. Samples collected monthly are analyzed for chemical parameters including nutrients, total suspended solids, chlorides, certain pesticides and heavy metals. Field measurements are also taken, including water temperature, pH, dissolved oxygen, conductivity, turbidity and stream discharge.

Figure 15: Ambient Stream Monitoring Program Locations

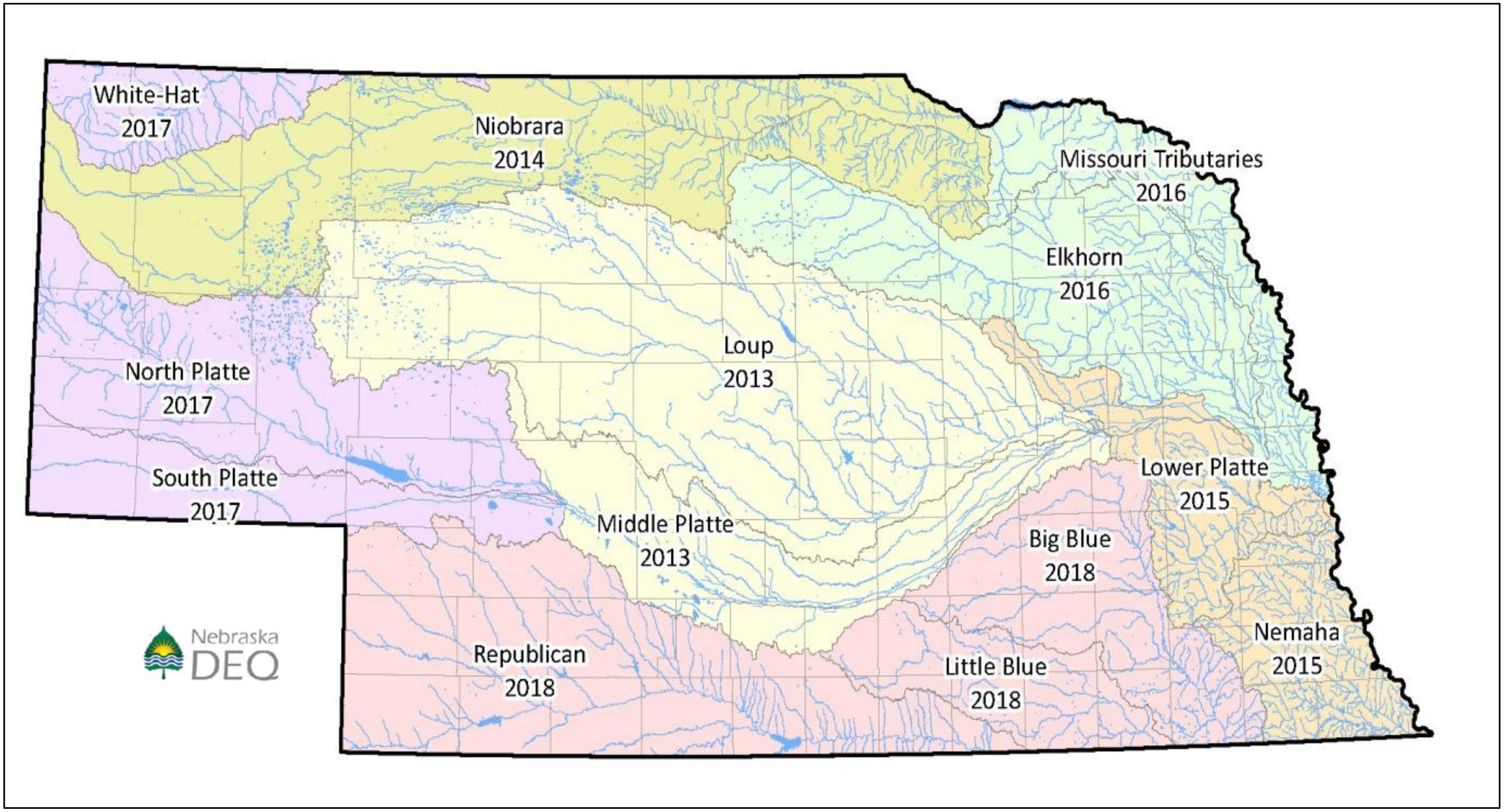


Basin Rotation Monitoring Program

The Basin Rotation Monitoring Program (BRMP) targets one to three river basins each year for intensive monitoring. Targeting resources in this manner improves NDEQ's ability to identify and remediate water quality problems and allows resources to be focused where they can produce the greatest environmental results. During a six-year cycle, all 13 major river basins in the state are intensively monitored. Figure 16 shows the basin rotation sampling schedule for 2013-2018. Some of the basins include cool water streams addressed by this plan. Monitoring data is used to document existing water quality conditions, assess the support of beneficial uses (such as aquatic life, recreation, and public drinking water supply) and prioritize water quality problems.

BRMP stream sites are sampled from May through September. The sites are sampled for *E. coli* bacteria, and are analyzed for physical/chemical parameters such as nutrients, total suspended solids, chlorides and select pesticides. Field measurements are also taken, including temperature, pH, oxygen, conductivity, turbidity and stream discharge. The data is used to document existing water quality conditions, identify water quality problems, identify pollutants of concern and their sources and estimate pollutant loadings. The data is made available and used by NGPC for management strategies on cool water streams.

Figure 16: Basin Rotation Monitoring Program Sampling Schedule 2013-2018



Stream Biological Monitoring Program

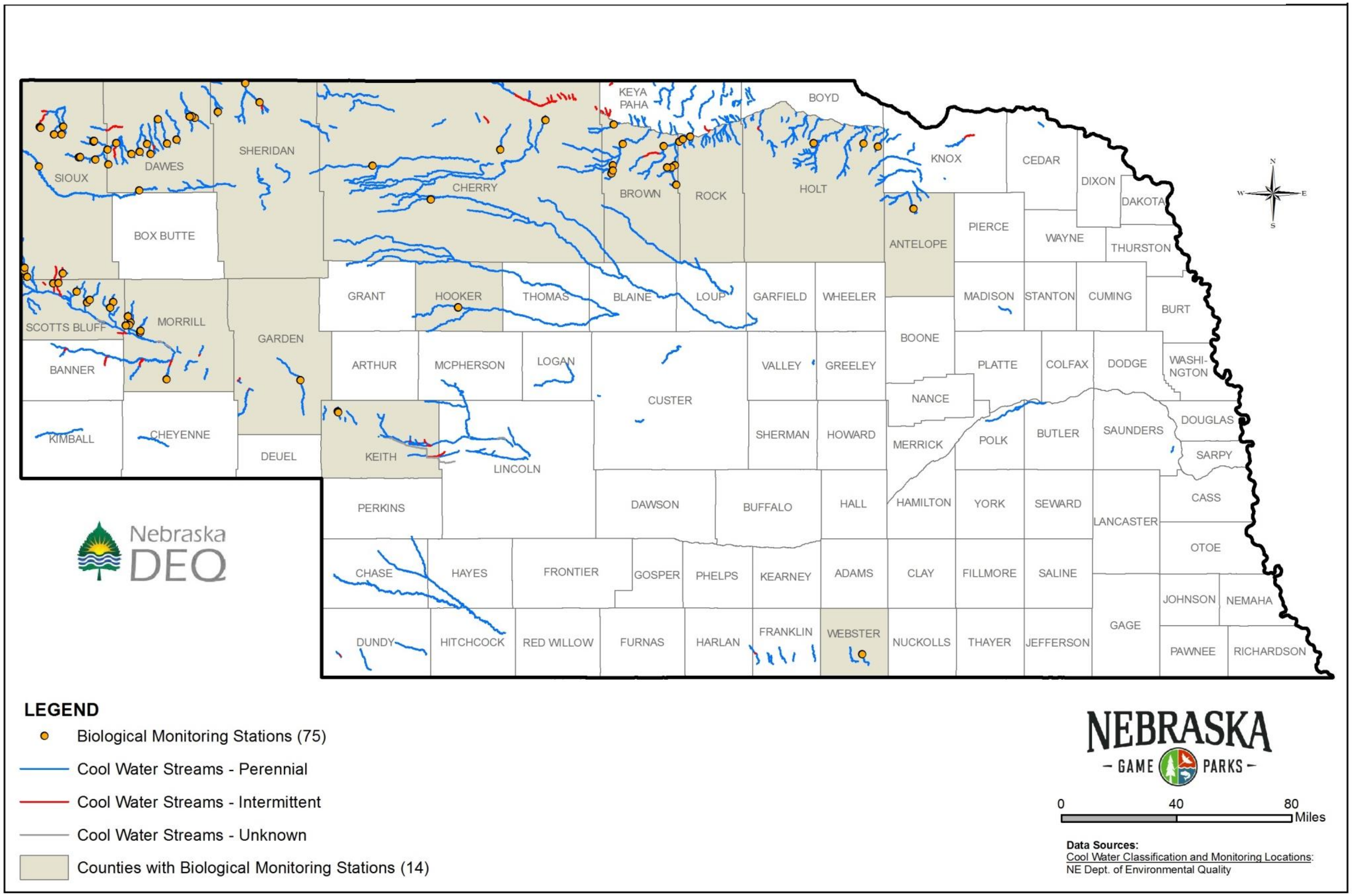
The Stream Biological Monitoring Program (SBMP) is used to evaluate the health of streams by evaluating the composition and numbers of resident aquatic macroinvertebrate and fish communities. These biological communities display varying habitat requirements and water quality tolerances making them excellent indicators of stream health. In 1997, NDEQ added a probabilistic monitoring design that involved sampling randomly selected sites in order to address statewide and regional questions about water quality. Assessments are made by comparing the biological communities of "reference condition" streams where there are no significant disturbances, to the communities collected from randomly selected stream sites.

Sampling is conducted in conjunction with the basin rotation monitoring strategy. Data are used to verify the biological criteria used in evaluating the health of aquatic life populations in Nebraska streams. The current approach allows evaluations of aquatic life health to be made with greater confidence even though fewer samples are collected. From 1998 to 2014, 103 samples of trout were taken from a total of 75 different stations as part of the SBMP (Figure 17). All 75 stations are not sampled every year. In some years, more than one sample was collected from an individual station.

Fish Tissue Monitoring Program

The NDEQ has been sampling and assessing toxins in fish tissue annually since 1978 from numerous streams and lakes across Nebraska. This information is used to assess pollutant trends, identify potential problem areas and to inform the public about health risk concerns identified through fish consumption advisories. These advisories do not ban the consumption of fish from a particular waterbody. Rather, advisories are designed to inform the public of how to safely prepare and eat what they catch, and provide suggested guidelines for limiting consumption. Nebraska began issuing fish consumption advisories in 1990. Since that time 28 cool water stream segments have been sampled for this program. Currently, a segment of the North Platte River (NP#-10000) is the only cool water stream in Nebraska under a fish consumption advisory (Appendix E).

Figure 17: Biological Monitoring Program Stations on Cool Water Streams 1998-2014



Threats to Cool Water Streams

There are many threats to cool water streams in Nebraska. The following section describes many of the current threats, including: climate change, habitat loss, land use practices, invasive species, surface and ground water development, and other physical and chemical stream alterations. The impaired status of cool water streams and strategies to resolve water quality impairments will also be identified.

Climate Change

The current and projected changes in climate will affect the quality, quantity (flow), and temperature of water in cool water streams and significantly impact the biota of these systems. Climate change will not only stress many aquatic species, but it will also exacerbate the effects of existing stressors such as habitat loss and fragmentation, pollution, invasive species, pests, and pathogens.

Water quality will likely be negatively impacted by projected climate change. Increases in the frequency of high intensity precipitation events, particularly in a landscape dominated by agriculture, will lead to increased runoff of sediments, fertilizers, and pesticides into streams, which will negatively impact aquatic biota. In addition, an increase in the frequency and magnitude of flood events will result in increased bank erosion and destabilization, impacting aquatic and riparian vegetation, and adding additional sediment to the stream system. In forested areas of the state, increases in the frequency and severity of wildfires due to climate change will result in increased amounts of ash sediment in streams. Increases in sedimentation will impact suitable spawning habitat for a number of fish species, as well as habitat for mollusks and other aquatic species.

Stream flow will be affected in two different ways by climate change, resulting in both decreases and increases in flow. An increase in the frequency and intensity of droughts will result in decreased stream flow during those times. This will result in stream segments being completely de-watered more often in the future. Average annual precipitation is projected to stay about the same in the state, but the increase in air temperatures means there will be an increase in evapotranspiration, so overall there will be less moisture available to recharge groundwater reservoirs that feed streams. In addition, increases in temperature and evapotranspiration, and decreases in soil moisture, will lead to increased water demand for agriculture and other human uses, further reducing groundwater and stream flows. Lower baseflows reduce available habitat for aquatic species, and streams with lower baseflows will be less buffered from the effects of increasing air temperature on water temperature.

The second major effect on stream flow will be an increase in the frequency and intensity of flooding events. Human flood control actions in the past have resulted in a flattening of the annual hydrograph for many streams and rivers, with negative consequences for many aquatic species. Thus, an increase in flooding may have some positive effects on stream systems, in addition to the negative effects mentioned above.

An increase in air temperature will result in an increase in water temperature and this may be the most significant climate change impact on cool water streams in the state. Changes in maximum water temperature of only a few degrees can result in major shifts in the occurrence, abundance, survival, growth, size distribution and reproduction of many species. Lyons et al. (2010) used a modeling approach to evaluate the effect of projected climate warming on the distribution of stream fish in Wisconsin. They found all cold and cool water species had significant declines in distribution under a moderate warming scenario while most warm water species increased their distribution. Brook trout, Burbot, Northern pearl dace, Blacknose shiner, and Northern redbelly dace were predicted to be completely eliminated from Wisconsin by 2050 under the major warming scenario (our current trajectory).

As waters warm, species will respond by shifting their distribution, when possible. Cool water species are expected to move higher in the watershed to find cooler water. In Nebraska, with little topographic relief, there will not be many places for these species to go, and those species already occupying headwater streams will have nowhere to go. Species' ability to respond to climate change in this way will be hampered by barriers to movement such as dams, diversions, and culverts. Cool water species will face an increase in competition and predation as warm water species move into stream reaches occupied by cool water species. Some of these new arrivals may be invasive species. However, spread of warm water species may also be limited by existing barriers to movement.

Another potential impact of climate change that is currently poorly understood for stream biota is the effect on phenology (the study of periodic plant and animal life cycle events and how these are influenced by seasonal and interannual variations). An earlier arrival of spring will affect the timing of snowmelt and peak runoff as well as the timing of annual warming of stream temperatures. These changes may alter the timing of life cycle events such as fish spawning or the hatching of insect species. A final concern is that warmer water temperatures will put cool water species under physiological stress and increase their susceptibility to toxins, parasites, and diseases.

Riparian Habitat Loss

Another threat to Nebraska's cool water streams is the loss of important riparian vegetation surrounding the stream. Native cool water stream riparian habitat in Nebraska varies; it can be dominated by sedges, grasses, shrubs, native trees or a combination of these. Riparian vegetation filters sediment, provides shade to help cool the stream, stabilizes banks, and provides structure for insects (food for the biota). Therefore, changes in habitat can change the chemistry and function of the stream. A switch from grassland to cropland in a riparian area could have a dramatic impact on the stream. If a significant buffer of perennial vegetation is not present near a stream, there could be more issues with sediment and chemicals from run off entering into the water. More subtle changes, like a change in the type of vegetation growing along the stream could also have impacts. A change from warm season grasses to cool season grasses along the banks of a stream might impact the amount of overhang and type of insects found in the vegetation at different times of the year.

Many streams have undergone human-induced alterations (i.e., channelized, stabilized, rerouted, etc.) or exist in highly disturbed/modified landscapes. In such situations, the stream and surrounding landscape are not able to adequately absorb impacts from high flow events and flooding as they were once capable of doing. Consequently, high flow events cause streams to become channelized or incised over time, resulting in head-cutting toward headwater portions of the stream. Deepening of the channel causes the water table to drop, which results in a change of hydrology and a corresponding shift from a wetland or wet meadow plant community to a mesic plant community.

Cool water streams have evolved with grazing from native and non-native ungulates. However, overgrazing a riparian area year after year could have negative impacts on the stream with the addition of sediment, bank destabilization, and lack of structure during hot times of the year. There has been significant research showing the negative impacts of unmanaged grazing (in general) on riparian areas throughout much of North American. However, there is a lack of specific information regarding impacts different grazing strategies (intensity, timing, and frequency) have on Nebraska cool water streams, specifically in Sandhills prairie streams.

Invasive Species

Invasive species can have negative impacts on cool water streams. An invasive species is "*…an alien* [non-native] *species whose introduction does, or is likely to cause economic or environmental harm, or harm to human health,*" (Executive Order No. 13112, 1999). Virtually any species can become invasive be it a mammal, reptile, amphibian, fish, crustacean, insect, mollusk, plant, or pathogen. Not all exotic or introduced species are invasive. What makes a species invasive is its ability to grow and reproduce quickly and spread aggressively, resulting in direct and/or indirect negative impacts on other species and/or humans.

For example, the Asian clam (*Corbicula fluminea)*, is a small invasive freshwater clam. They can grow up to one inch across though most will be half that size. They inhabit lakes and streams and can develop dense populations in only a few years. There is little evidence, at this time, that they cause problems for native species. Additionally, Asian clams do not directly impact humans; however they can have a large indirect impact. Asian clams clog power plant pipes (Global Invasive Species Database 2015), which increase maintenance costs at the plant. Those expenses are passed down to the consumer and are reflected in higher electric rates.

The impacts of invasive species can vary widely and are difficult to predict because the nature of every invasion is unique and depends on the resiliency of the habitat and properties of the invader. Despite uncertainty regarding the magnitude of impact, well-known species invading (or which could invade) cool water streams and riparian habitats are discussed below

Western Mosquitofish

Western mosquitofish use the same habitat preferred by the native Plains topminnow, a cool water species. The name "mosquitofish" is a misnomer, because although they were introduced as a mosquito-control agent, they are not effective predators of mosquito larvae. Unfortunately, they are effective predators of small fishes, and have caused native populations of Plains topminnow to disappear. Mosquitofish are native to the southern U.S., so it was assumed they would die out every winter. However, a small number developed cold tolerance and, combined with overwintering in warmer spring seep areas, enough survived to sustain the species. They are very prolific, so they quickly populate available, suitable habitat. The Plains topminnow is now a Tier I at-risk species due primarily to the western mosquitofish, and this invasive, introduced species could continue to have serious negative impacts on biodiversity of cool water streams.

Photo by Ken Bouc, NEBRASKAland Magazine

Photo 16: Western mosquitofish (Gambusia affinis)

Yellow Flag Iris

Yellow flag iris (*Iris pseudacorus*) is an ornamental plant which has escaped into the wild in the upper Niobrara River. It spreads by seed and rhizomes and forms dense, monotypic stands crowding out other plants. Along the Niobrara, it has narrowed the channel by forming dense stands on the margin of the stream. Consequently, the stream is forced to get deeper and faster to carry the same flow. The result is the loss of shallow, quiet water along the stream margin favored by many small, native cool water fish.

Eastern Red Cedar

Eastern red cedar (*Juniperus virginiana*) is a native tree species which has invaded prairies throughout the state (due to wildfire suppression) causing a dramatic change in land cover. Although commonly associated with impacts on prairies, this species also exists in thick stands on the banks of many cool water streams, choking out grass communities which hold and stabilize embankments and provide shade cover.

Viral Hemorrhagic Septicemia

Viral hemorrhagic septicemia (VHS) is a pathogen that can infect a wide range of freshwater fish, including salmonids. The disease is a national issue and has caused significant fish kills throughout wild fish populations, although impacts are usually temporary and seldom cause extirpation of a fish population. It could cause major problems in the confined ponds of a hatchery or bait vendor's tank through the collection of infected baitfish. There is an active monitoring program for VHS in Nebraska, but it is unknown how vectors are transported and how they may affect cool water streams.

Didymo

Didymo (*Gomphonema geminate*), also known as "rock snot", is a diatom that forms long stalks and creates dense mats covering the stream bed. While it is uncertain what community-level impacts this species may have, it will likely affect macroinvertebrates due to the way it covers the stream bed. It also has an indirect impact on humans in that it makes fishing almost impossible because hooks get snagged up in it. Present in surrounding states (Colorado, South Dakota and Wyoming) it has not been found in Nebraska yet, but it could occur in the future.

Water Usage in Nebraska

Groundwater and surface water development will continue to threaten stream flow in Nebraska, including flow in cool water streams. Many efforts are underway by Natural Resources Districts (NRDs), the Nebraska Department of Natural Resources (NDNR), municipalities, and other local, state and federal entities to address stream flow issues. These efforts include the Platte River Recovery Implementation Program (PRRIP), integrated management plans which conjunctively manage groundwater and surface water, groundwater management areas, and aquifer mapping, to name a few. However, the outcomes of such efforts may not be immediately detectable, so existing challenges will likely persist into the future.

Groundwater

In 2012, Nebraska ranked first nationally with about 8.2 million acres (3.3 million ha) of irrigated crop land (USDA National Agricultural Statistics Service 2016). Most of the acres are irrigated using groundwater, followed by acres receiving co-mingled ground and surface water. The number of irrigation wells installed per decade peaked in the 1970s. Since the seventies, about 10,000 wells have been installed each decade in Nebraska. According to the NDNR (2016), there are over 99,000 registered high capacity groundwater irrigation wells in Nebraska. The location of irrigation wells reflects the availability of groundwater, the suitability of the land for irrigation and the need for irrigation to meet crop water requirements.

Irrigation development has caused declines of groundwater levels (depth to groundwater from the soil surface) in some areas of the state. In many locations, the groundwater and surface water are hydrologically connected. An increase in pumping groundwater results in a decrease of surface water, which affects aquatic species, including those inhabiting cool water streams. The most severely affected areas are in Box Butte County, the western end of the Republican River Basin and parts of the Blue River Basin. NRDs have implemented management plans in these areas to regulate groundwater use.

Surface water

Nebraska has a significant amount of land [over 565,000 acres (over 228,647 hectares)] irrigated with surface water diverted from streams and rivers. There are approximately 60 federally and privately owned and operated irrigation and reclamation districts and water delivery companies in Nebraska (NDNR 2015). These districts and companies built networks of ditches, canals and pipes to transport and deliver surface water to irrigators in areas where groundwater is unavailable.

Irrigated crops generate billions of dollars for Nebraska’s economy every year. However, groundwater and surface water use (i.e., irrigation, industrial, municipal, etc.) have taken a toll on aquatic ecosystems, depleting stream flow and putting some species at-risk of becoming extirpated in the state. As previously state, many efforts are underway to seek sustainability of these resources, but reversing the downward trend in quality and quantity of some streams will be difficult and expensive.

Alteration of Natural Flows

Riverine ecosystems benefit in the long term when natural, annual cycles of high and low flows are allowed to occur unimpeded. Periods of high and low flows are needed for an array of habitat-forming processes to occur and to maintain community structure. Annual peak (high) flows influence channel morphology by constructing instream and floodplain habitat. A variety of species complete life cycle stages during periods of naturally occurring low flows. It is also easier for some species to move and/or migrate during periods of lower flows, as long as habitat connectivity is maintained. Therefore, long-term or permanent changes in timing, intensity, frequency and/or duration of high and low flow events can affect the overall functionality and species composition of a stream.

There are several factors which can permanently change natural flow patterns of Nebraska's cool water streams. These include agricultural uses (as discussed above), density of roads and dams, commercial and industrial discharges (e.g., wastewater or cooling water) (Eng et al. 2013), channelization and bank stabilization, constructing drainage ditches, and broad-scale land cover changes.

Factors Increasing Streamflow

Increasing average monthly streamflow or the frequency of high flow events over the long term is not always desirable. Such increases can result in streambank degradation, channel deepening and channel widening. As these components of a stream channel change, so will the community structure and species composition.

There are several human-induced factors which cause streamflow to increase. For example, high densities of impervious surfaces (i.e. roads), and urbanization increase run-off and consequently increase flows (Eng et al. 2013). Commercial and industrial water discharges increase flows, as do areas with a high percentage of agricultural cropland (Eng et al. 2013). A stream's flow may also be increased if additional water is pumped into the stream so it can be "naturally" transported for the purpose of augmenting flows elsewhere.

Barriers/Connectivity

Human-made barriers in streams, such as dams, culverts, and irrigation diversions, pose threats to cool water organisms by fragmenting stream habitat and preventing individuals from moving up-and-down the stream as needed. Fish purposefully moving downstream to overwinter cannot return upstream to spawn and rear their young if barriers are present. Dams not only prevent upstream movement, but large reservoirs behind dams can be barriers to downstream movement for some species as well. Barriers may also impede the ability of species to shift their distribution in the face of climate change. However, some barriers may be useful in preventing warm water species (predators, competitors, pathogens) from invading areas inhabited by cool water species.

Barriers also bisect species populations, preventing genetic exchange between the fragmented populations. Catastrophic events (e.g., drought, disease) could destroy upstream populations, and that stream segment could not be repopulated from downstream like systems without barriers. Freshwater mussel populations can be affected by barriers because they depend on host fish for reproduction. If movement of the host fish is stopped, the mussel population will likely die out.

In Nebraska, thousands of dams have been built primarily for agricultural purposes, flood control and hydropower, with a secondary benefit of recreation in many cases. Figure 18 shows locations of high, medium and low hazard dams in Nebraska's waterways which are in NDNR's database. The map does not show the thousands of farm ponds and watershed dams, most of which are on smaller waterways. There are also thousands of road culverts impeding movement of aquatic species, but there is no database with a comprehensive list of where all the culverts exist. Dams not only impede movement, but also reduce and alter streamflow.

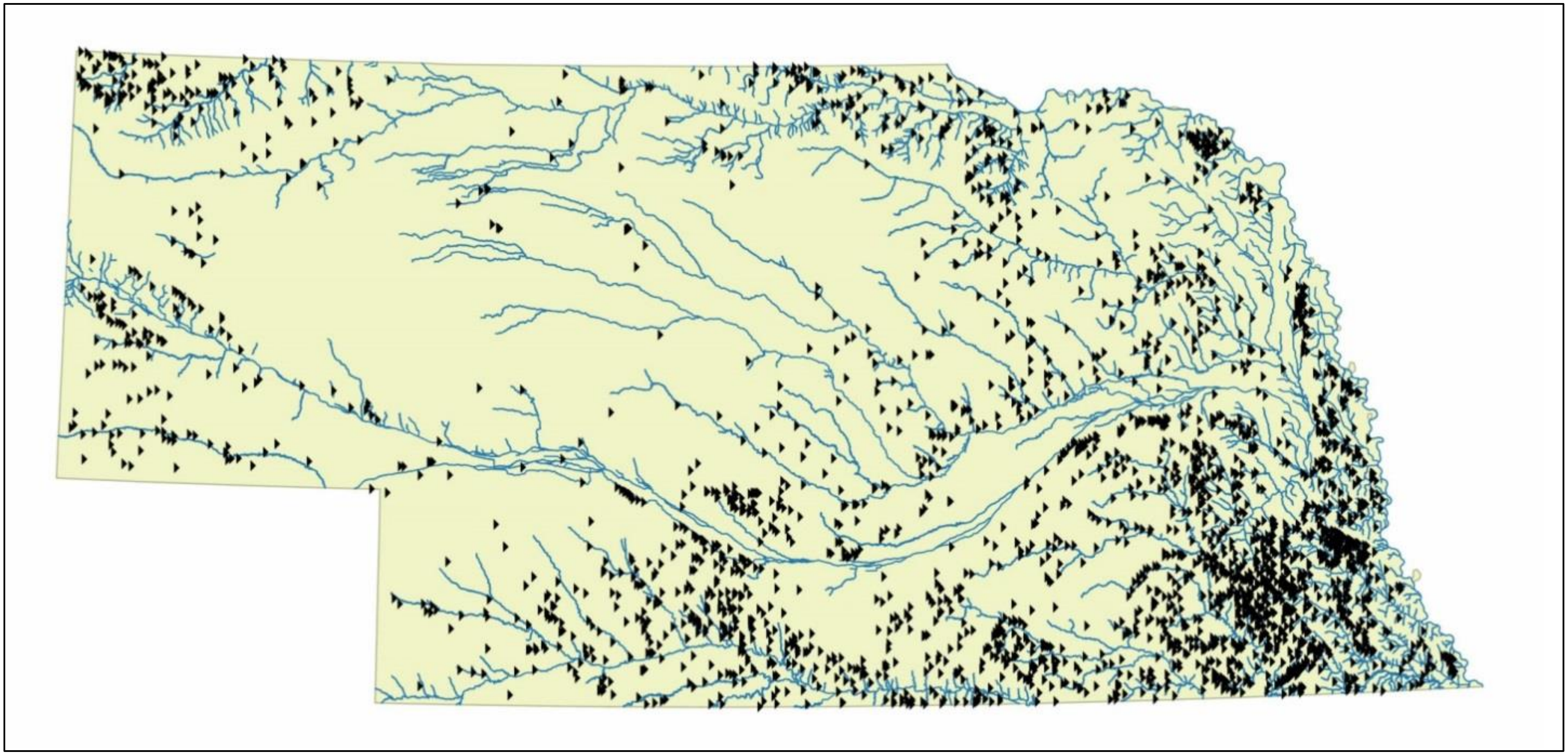
Alterations to Physical Characteristics

Altering physical characteristics of a stream (other than natural flows, which was discussed above) can impact its functionality and community composition. Cool water streams have a defined temperature regime as previously discussed in the document. The temperature regime strongly influences the existing aquatic community in any given stream. Removing shade trees, decreasing or increasing flows, loss of groundwater connectivity to surface water and inputs of warmer or cooler water from industrial discharges or irrigation return flows are all factors which may alter water temperature. Sustained changes (either increases or decreases) in water temperature will cause a shift in community composition of the stream.

Increased sedimentation, especially fine sediment, is a primary factor causing water quality impairment. In most cool water streams, sedimentation will have a negative effect on habitat quality for fish, mollusks, and other aquatic species. If sedimentation events occur during spawning season, fish reproduction could also be adversely impacted. As previously discussed, climate change is likely to increase the frequency and magnitude of flooding and fires, which will increase sedimentation (e.g., increased run-off, bank destabilization and erosion, ash, etc.)

Unmanaged livestock grazing in riparian zones and within the active channel also contributes to a variety of interconnected physical alterations to streams. Livestock trample streambanks and remove vegetation which has a direct effect on bank stability and the presence of streamside and instream cover. Channel width and depth can also be altered as banks destabilize, widening and shallowing the stream, and consequently, the temperature regime. Removing vegetation also affects shading provided by tree canopy or grassy bank vegetation.

Figure 18: High, Medium and Low Hazard Dams in Nebraska



Alterations to Chemical Characteristics

Altering chemical characteristics of water will impact cool water stream ecosystems and the species inhabiting them. It is difficult to correlate changes in aquatic chemistry to biotic response because the biotic response is often not immediate and occurs after a period of repeated exposure. Individuals can often tolerate some minor fluctuations in water chemistry, but eventually bioaccumulation will cause physiological or behavioral changes to occur. For example, artificial human hormones (e.g., estrogenic compounds) and detergents are present in municipal wastewater and feedlot run-off that discharge to river systems. Exposure to these pollutants over a period of time has been shown to cause endocrine disruption in some fish in Nebraska streams.

Diverse aquatic ecosystems are typically more resilient to certain levels of change, and are better able to neutralize or recover from temporary impacts. However, nutrients, pesticides, and other chemicals frequently reach critical levels, resulting in responses ranging from algal blooms and fish kills in local water bodies to dead zones in larger receiving water bodies (e.g. Gulf of Mexico). Water clarity, temperature, and dissolved oxygen levels are all affected in such situations, which in turn will either temporarily or permanently change the existing aquatic community.

Goals and Objectives

This section outlines NGPC's goals and objectives regarding cool water streams and associated riparian areas. Goals are focused on: (1) habitat management, (2) increasing knowledge, (3) angling opportunities, and (4) communication with stakeholders. The action items are those which could feasibly be started and/or completed during the five-year timeframe of this plan, depending on staffing and budgets. Therefore this is not a comprehensive list of everything which needs to be evaluated and accomplished pertaining to cool water streams, rather a starting point to build on in the future. The Cool Water Streams Initiative Development Team (see page 11) will evaluate the progress made toward achieving these goals over the next five years.

Goal 1: Protect, conserve, enhance and restore cool water aquatic habitats, fish communities and surrounding riparian areas so they are available for future generations.

Objective 1: Develop Habitat Improvement Guidelines

Action Item 1: Determine effective methods for improving cool water streams and associated riparian habitats.

Objective 2: Implement instream habitat rehabilitation projects

Action Item 1: Identify and prioritize public and private waters for instream habitat rehabilitation projects to benefit at-risk species and sportfish.

Action Item 2: Conduct instream habitat improvement projects for at-risk species and sportfish in several locations per year.

Strategy 1: Budget $100,000 within Fisheries Division's biennium budget (FY's 15/16 & 16/17) to manage the Cool Water Stream Program.

Strategy 2: Seek Nebraska Environmental Trust (NET) grant funding to develop five cool water stream demonstration sites. (See Appendix G for more information on developing demonstration sites and Appendix H for a list of demonstration sites.)

Objective 3: Implement riparian corridor management projects

Action Item 1: Evaluate riparian corridor management needs on public and private lands.

Strategy 1: Develop standard evaluation forms.

Strategy 2: Identify all public lands with cool water streams and evaluate 10 sites per year.

Strategy 3: Coordinate with NGPC, Natural Resources Conservation Service (NRCS), USFWS and other private lands biologists to identify landowners interested in cool water stream riparian corridor management and evaluate several sites per year.

Strategy 4: Develop management plans for evaluated sites.

Action Item 2: Prioritize and conduct riparian corridor management projects on at least two public lands and two private lands per year.

Objective 4: Enhance watershed conservation and management efforts

Action Item 1: Seek out and participate in local watershed programs and projects designed to improve cool water stream habitat.

Action Item 2: Identify highly erodible croplands adjacent to or near cool water streams and target those for restoration programs such as the Conservation Reserve Program (CRP).

Action Item 3: Identify potential sources of sediment in the watershed and deploy mechanisms to prevent or reduce sedimentation of cool water streams.

Action Item 4: Thin forests and use prescribed fire to reduce fuel loads in order to reestablish the historical system of low intensity fires in forested areas.

Objective 5: Enhance at-risk cool water stream species populations

Action Item 1: Develop a plan to propagate and stock at-risk cool water stream species.

Strategy 1: Evaluate existing facilities/capacity to identify potential limitations to propagating at-risk species by September 2016.

Strategy 2: Seek funding to construct/expand/rehabilitate facilities for the purpose of propagating at-risk species.

Strategy 3: Determine appropriate locations for stocking at-risk species based on existing aquatic communities in cool water streams.

Action Item 2: Establish a standard protocol for propagating and ranking criteria for stocking at-risk fish.

Objective 6: Address invasive species in cool water streams and riparian areas

Action Item 1: Determine which invasive species are currently being successfully controlled and continue such control efforts.

Action Item 2: Determine if there are any invasive species which are not currently being controlled and develop/implement a control plan as appropriate.

Action Item 3: Monitor the distribution/spread of invasive species which are currently not in Nebraska, but could be in the future.

Action Item 4: Take a pro-active approach in preventing other invasive species from establishing in Nebraska's cool water streams and riparian corridors

Goal 2: Increase knowledge of cool water stream resources and threats to such resources in order to prioritize and target restoration and management efforts.

Objective 1: Monitor and collect data on cool water streams.

Action Item 1: Coordinate with partners (NDNR, NDEQ, universities, Trout Unlimited, etc.) to prioritize stream monitoring locations, establish standard monitoring protocols, and determine which physical and chemical water properties will be monitored.

Strategy 1: Install temperature monitoring equipment on 15 cool water streams in North Central Nebraska by June 2016.

Action Item 2: Collect and organize information on Nebraska's cool water streams in a sharable format for current and future uses.

Strategy 1: Provide temperature logger data annually to NDEQ

Strategy 2: Produce an annual report beginning in 2017

Action Item 3: Continue to develop and maintain the Geographic Information System (GIS) and stream survey database.

Action Item 4: Define and identify reference standard sites and reference sites to establish a system for comparing habitat quality and determine target conditions.

Objective 2: Determine impacts and threats land cover and land use changes have or could have on cool water streams and aquatic organisms.

Action Item 1: Take on-site measurements of adjacent land cover (i.e., size of buffer strip, disturbed banks, vegetative community, etc.) and compare/correlate it to instream monitoring data.

Action Item 2: Review land cover data for the past 10 – 20 years to determine if there are trends in land use changes, and which areas are most likely to experience additional changes in the immediate future.

Action Item 3: Correlate changes in land cover and land use to changes in cool water stream qualities and communities.

Objective 3: Conduct research to address information gaps.

Action Item 1: Determine the effect of eastern red cedar on cool water streams.

Action Item 2: Assess impacts of grazing strategies (i.e., timing, duration, intensity) on sandhills prairie cool water streams.

Action Item 3: Study factors which may affect water temperature (i.e. return irrigation flows, removal of trees, decrease in stream flow due to groundwater and/or surface water pumping, industrial or municipal discharges, etc.)

Action Item 4: Analyze cool water streams in Nebraska to determine which are likely to be most or least resilient to climate change.

Action Item 5: Build on existing efforts to inventory at-risk species and better understand their life history requirements.

Action Item 6: Continue evaluating interactions between non-native sportfish (e.g., trout) and native at-risk species.

Objective 4: Evaluate completed cool water stream and riparian corridor restoration and management projects.

Action Item 1: Create an evaluation tool with standard parameters that can be used to assess all cool water stream and riparian corridor projects upon completion.

Action Item 2: Use results of restoration projects to refine and inform management techniques and identify management conflicts.

Goal 3: Provide and evaluate angling opportunities so an extensive range of experiences desired by anglers are available.

Objective 1: Identify streams suitable for establishing, enhancing, and/or maintaining trout fisheries, either by natural reproduction, stocking, or a combination of both.

Action Item 1: Develop criteria for where trout will be stocked as to avoid potential negative impacts on native and at-risk aquatic biota.

Action Item 2: Evaluate potential management conflicts with at-risk species.

Action Item 3: Define management objectives and set population and angler goals.

Strategy 1: Identify stream segments capable of supporting high quality populations. [High quality populations are defined as having a catch rate of more than one trout per meter (> 1/m) and a Relative Stock Density of Quality Length greater than 15 percent (RSD-Q >15). This means at least 15 percent of the stock size trout (250 mm or 8 inches) sampled are quality length (400 mm or 16 inches) or bigger.]

Strategy 2: Identify stream segments able to support large trout (RSD-Q > 15).

Strategy 3: Identify stream segments best suited for harvest of stocked trout.

Action Item 4: Propagate and maintain healthy stocks of brown, rainbow, cutthroat and brook trout for use in areas where it is determined trout can be stocked.

Strategy 1: Evaluate existing facilities/capacity for trout propagation.

Strategy 2: Seek funding to expand/rehabilitate facilities for the purpose of propagating trout.

Strategy 3: Propagate trout from certified disease free egg sources.

Strategy 4: Conduct health assessments of hatchery cohorts prior to stocking.

Objective 2: Evaluate and expand angler access.

Action Item 1: Assess and maintain current angler access opportunities and determine where more access is warranted given the other management objectives of NGPC.

Action Item 2: Create a list of Nebraska streams owned by government or quasi-government agencies to determine if there are opportunities for public access on such streams where access currently does not exist.

Action Item 3: Review land purchase protocol to assess ranking and priority of stream purchases.

Action Item 4: Increase angler access to cool water streams through corridor easement acquisition and other available programs.

Action Item 5: Fund and promote access to streams through the Open Fields and Waters (OFW) Program and investigate the need to expand the program to include watchable wildlife.

Objective 3: Assess angler use and angler attitudes.

Action Item 1: Evaluate fishing pressure and angling success in cool water streams.

Strategy 1: Set up trail cameras at one cool water stream access point per year to estimate angler use.

Action Item 2: Develop and conduct surveys of trout anglers to answer management questions and document trends in angler demographics and preferences over time.

Strategy 1: Work with Trout Unlimited Chapters to assess angler attitudes and develop management goals in 2017.

Action Item 3: Evaluate current fishing regulations to ensure they align with the goal of providing desirable angling opportunities.

Strategy 1: Assess current fishing regulations annually and conduct open houses to evaluate receptivity to regulation changes.

Goal 4: Increase communication and make information readily available to constituents, partners and fisheries and wildlife professionals.

Objective 1: Provide information to the public

Action Item 1: Educate and inform anglers, landowners and other clientele on current cool water stream management practices and programs in Nebraska.

Action Item 2: Distribute an annual status report to demonstrate progress in implementing this plan.

Action Item 3: Develop a publication for landowners called "Guide to Healthy Cool Water Streams."

Objective 2: Conduct tours of demonstration sites

Action Item 1: Conduct at least one tour of a cool water stream demonstration site in each of four regions in the state. (See Appendix H for Demonstration Sites.)

Objective 3: Evaluate effectiveness of communication/education efforts

Action Item 1: Determine baseline knowledge of cool water streams and management practices using a method that can be repeated in the future.

Recommendations for Management Strategies

Cool water streams are diverse, as are the issues revolving around their management. This section includes a variety of management practices and strategies which coincide with the goals, objectives, and action items in the previous section. Using the following recommendations and strategies will help achieve the vision set forth in this plan of creating productive and sustainable populations of cool water aquatic life, having healthy riparian zones and clean water, and improving watershed stability.

Implementing this plan will require much funding and extensive effort by NGPC staff, partners and stakeholders. Conservation resources (i.e., time, money and staff) are limited, so a triage approach could be taken, with most resources going to streams where management actions are needed and can be effective. Resources should also be devoted to protecting watersheds of climate resilient streams to ensure land use changes do not impair water quality or streamflow. Careful analysis and site specific input from stakeholders will be critical for ensuring the proper management tools and strategies are implemented. The interdivisional/interagency "Stream Team" (page 11) will coordinate efforts to develop such tools and strategies, incorporate them on the landscape, and evaluate their effectiveness.

Stream Prioritization

In order to prioritize work locations, biologists across the state were sent a list of the 400 identified cool water streams. Biologists ranked the top 20 most important cool water streams in Nebraska using the attributes listed below. See Appendix I for the top 63 streams ranked by the state's experts.

- **It is a perennial stream**
- **It supports trout**
- **It is a good representative of a cool water stream**
- **The stream needs management/protection**
- **It supports T&E species**
- **I know the private landowners are interested in doing work**
- **It is on public lands**
- **It is considered a Class A Cold Water stream**
- **It is considered a Class B Cold Water stream**
- **NDEQ considers this a stream in need of protection**
- **It is the headwaters of an important stream**
- **This stream needs monitoring**
- **There is public access available for fishing on the stream**

Instream Habitat Rehabilitation

Instream habitat rehabilitation projects help restore the function, hydrology and integrity of stream habitat in a variety of ways. Some projects are designed to create refugia for cool water species (i.e., deep pools and undercut banks) where temperatures remain cool during the summer. In other cases, eroded stream banks may be sloped back to reconnect the stream channel to the floodplain. This allows energy from floods and high flows to dissipate into the floodplain instead of further eroding the stream bank. Often times, there are multiple reasons for conducting instream restoration projects, and likewise, there are multiple benefits for physical, chemical and biological components of the stream.

The NGPC, USFWS, NRCS and Sandhills Task Force have worked with private landowners in Nebraska for over 20 years on cool water stream restoration projects. Some of the streams where these projects have occurred include Otter Creek, Gracie Creek, Gordon Creek, Elkhorn River headwaters, Holt Creek, Fairfield Creek and Sand Draw Creek. Where physically and financially possible, various types of habitat rehabilitation projects have also been conducted on small sections of streams under public ownership and of special concern.

Below is a tool box of instream practices and structures that have or can be used to restore instream habitat for a variety of fish species and improve the overall health of a stream. In general, when designing and installing structures, it is important to ensure aquatic organisms can still move up and down stream. Fish ladders or other similar structures can be built into projects to allow smaller species to navigate back upstream and maintain stream connectivity.

Weirs and Water Control Structures: These are often used for restoring streams which have been channelized, incised or are experiencing headcutting. These structures slow erosion and stream migration, raise the water table and can force water out into historic meandering channels in order to restore hydrology in the floodplain.

Photo 17: Weir structure on Sandhills stream

Photo 18: Water control structure

Root wads: When a tree has been uprooted, the lower trunk with the roots attached can be used as a root wad. The bole of the tree should be 6-10 feet (2 – 3 m) in length to enable trenching it into the stream bank to hold the structure in place. The roots can be placed at an upstream angle to redirect stream flow and deter erosion while providing increased overhead cover and bank cover for fish. A hole can also be dug under and/or around this type of structure to enhance fish use. While root wads are difficult to procure and place, they do provide some of the best stream bank stabilization and fisheries habitat improvements.

Boulder clusters: These habitat structures are exactly as named; clusters of boulders are placed in the stream bed to provide additional habitat where resting and feeding cover is lacking. They are generally used to benefit cold water fish species in very fast flowing and stable bank situations. They can be placed in shallow riffles and gravel enhanced areas, above and below vortex structures, boulder vanes and in the rear of pools.

Boulder vanes: These rock structures generally bisect the stream perpendicular to the stream banks and are similar to a rock dam. The top of the boulder vane is under the surface of the water and minimal water is pooled behind the structure. These structures are used where banks are stable or flooding does not occur. The boulders will create habitat and maintain a "hole" or pool above and/or below the structure. They are primarily used to provide a refuge in fast flowing streams devoid of slower water habitat and maintain a centered stream flow.

Vortex structures: These are hard structures designed to increase stream velocity and center water flow or direct it in a specific direction to lessen bank erosion, transport stream sediment and create and maintain a deep clean pool habitat.

Photo 19: Vortex structure

Photo 20: Vortex structure

Materials are generally rock; however a combination of rock and logs can be used. The basic design is a "wedge" of "V" shape of rock facing upstream with the side walls at a 30 degree angle to the bank. Tapering the height of the structure downward from the high water mark of the stream bank into the streambed enables this design to operate from flood stage to very low flows. Photos 19 through 22 are examples of vortex structures.

Photo 21: Vortex structure

Photo 22: Vortex structure

Spur logs: These structures are a combination of logs and rock that can be used for redirecting stream flows away from erodible banks while providing a small area of pool habitat along with some overhead cover. When properly placed they are very esthetic and function very well for all three of the purposes mentioned. Logs are anchored into the bank through an excavated trench, stabilized with some rock, and backfilled with soil. The stream bank is part of the structure so it may also need to be armored against erosion. Log placement should be angled upstream at 30 degrees as are the vortex structures. Water redirects over the logs at a 90 degree angle and is forced into the center of the stream. These structures divide stream flow to allow water to pass under the log as well as over the log, which results in redirecting the stream as desired.

Photo 23: Spur log structure

Spur logs can be placed individually, in pairs opposing one another, or angled into and buried in the center of the streambed. They also can be elevated just below the water surface if overhead cover is the desired habitat improvement needed. Single placement below a rock vortex structure or above or below a boulder vane also provides overhead cover. See photos 23 and 24 for examples of spur log structures.

Photo 24: Spur log structure

Gravel enhancement: Gravel can be added to a streambed to enhance fish spawning sites and provide additional invertebrate habitat. Gravel can be placed above and below a boulder vane to hold it in place, which will allow the stream to narrow, creating higher velocities to carry sediment. The creation and use of gravel enhancement is dependent upon stream flow, velocity and other factors that will keep the gravel in place. The diameter of the gravel used is dictated by these same variables.

Pool construction: Deep water pools can be constructed above and below some of the other structures discussed in this section to enhance the structure. If properly designed and placed, most of the structures will maintain a pool free of sediment and provide deeper, slower water habitat for the target stream species.

Hard point/wing deflectors: As the name implies, these hard structures are used to deflect stream flow away from the stream bank. Hard point deflectors can be different shapes and consist of different materials but are usually a rock wedge anchored into the bank or a log wedge trenched into the bank and backfilled with soil or rock. A trailing log on the downstream end can aid in deflecting current away from the bank as well as providing overhead cover for trout species. Hard point deflectors can also be used in conjunction with lunker structures by deflecting flow to the lunker structures along an opposing bank. A series of hard points can be used to increase stream sinuosity by deflecting stream flow back and forth between opposite banks. Usually a portion of the downstream end of a hard point will create pool habitat along with allowing sediment deposition to occur which will aid in constricting the stream, reducing stream width and increasing stream depth. Photos 25 and 26 are examples of hard point deflectors, and Photo 27 is an example of a wing deflector.

Photo 25: Hard point deflector

Photo 26: Hard point deflector

Channel reconstruction: In dire cases, total reconstruction of the stream channel could be undertaken. It is expensive and very limiting due to the tremendous amount of material that needs to be moved. In order to create a minimum amount of sinuosity for a stream, the general rule is to construct a meander every ten stream widths. If constructed properly, the stream should maintain pools, runs, riffles and point bars providing diverse and healthy stream habitats. A pool every five stream widths can maintain itself in streams with steeper gradients. This recommendation is based on observations at project sites in the upper North Platte River valley.

Photo 27: Wing deflector

Lunker structures: These structures are generally used in extreme reconstruction situations or where human traffic dictates the need for longer-lasting, durable hard structures to protect stream banks and create fish habitat. Installing lunker structures is more invasive and initially more destructive than installation of most other hard structures because of the extensive amount of excavation and stream bank shaping needed to place the structure and backfill over the top of it with soil. Once installed, lunker structures are perhaps the longest lasting and most maintenance-free of any hard habitat structures. In addition to preventing bank erosion, the added benefit of over-head cover is also realized. See photos 28 and 29 for examples of lunker structures.

Photo 28: Lunker structure

Photo 29: Lunker structure

Removing/modifying barriers: Human-made barriers including dams, diversions, and culverts may impede aquatic species movements in streams. Modifications to water control structures, low gradient emergency spillways, and diversions to side channels of streams must be made to accommodate their movement up and down stream. Targeting selected barriers for removal or modification will increase stream connectivity and allow species to more easily shift their range in response to changing water temperatures. As stated earlier in the document, some barriers may be useful in preventing warm water species (predators, competitors, pathogens) from invading areas inhabited by cool water species. Therefore, careful watershed analysis will be needed to determine which barriers would be most useful to remove or modify.

Riparian Corridor Management

Restoration and management of riparian zones will help address the predicted impacts of climate change, reduce erosion and sedimentation, protect streams from damage due to high flow events, and provide shade to maintain lower temperatures of streams and groundwater inputs. Lyons et al. (2000) evaluated effects of woody versus grassy riparian and stream bank vegetation. They concluded that for grassland/savannah regions, grassy riparian vegetation was more effective than woody vegetation in reducing bank erosion and trapping suspended sediments. Grassy vegetation contributes to bank stability, helps to narrow and deepen stream channels, and may provide shade on small streams, all of which contribute to maintaining lower water temperatures.

Fencing: Livestock grazing is a common practice for managing and maintaining functional grassland ecosystems and riparian areas in the Sandhills and northwest Nebraska. Most of these areas remain in good ecological condition, but grazing can be detrimental to grasslands and riparian areas when overstocked and consideration is not given to timing and distribution of livestock. Grazing strategies for livestock production may be different than those for managing riparian areas for fish production. Landowners must determine their goals and desired future conditions for the grasslands, riparian areas, and in-stream habitat and develop strategies to work towards those management goals. Stream Team members will work with landowners to assist with this process and encourage best management practices which protect or restore the integrity and functionality of cool water streams.

Many ranchers are moving away from season-long grazing systems (5-months during the summer growing season) towards rotational grazing systems. Season-long systems can be detrimental to riparian areas and streams as livestock concentrate along these areas during the summer producing poor habitat for fish communities. Cross fencing and alternate water sources are means of producing healthier plant communities, which is ultimately better for livestock production and fish production. If the goal is optimal fish production or protecting at-risk fish species, consideration should be given to fencing out the stream entirely.

Management of grazing around stream areas by appropriate fencing and controlling the duration of use can reverse and improve riparian habitat conditions in a relatively short period of time. Fencing is an effective, economical method of habitat enhancement. Refer to Photos 30 and 31 for a comparison of allowing managed versus unmanaged grazing in riparian zones.

Photo 30: Managed grazing allowed

Photo 31: Unmanaged grazing allowed

Watershed Management

Watershed management is a term used to describe the process of implementing land use and water management practices in a comprehensive manner to protect and improve the quality of water and other natural resources within a watershed.

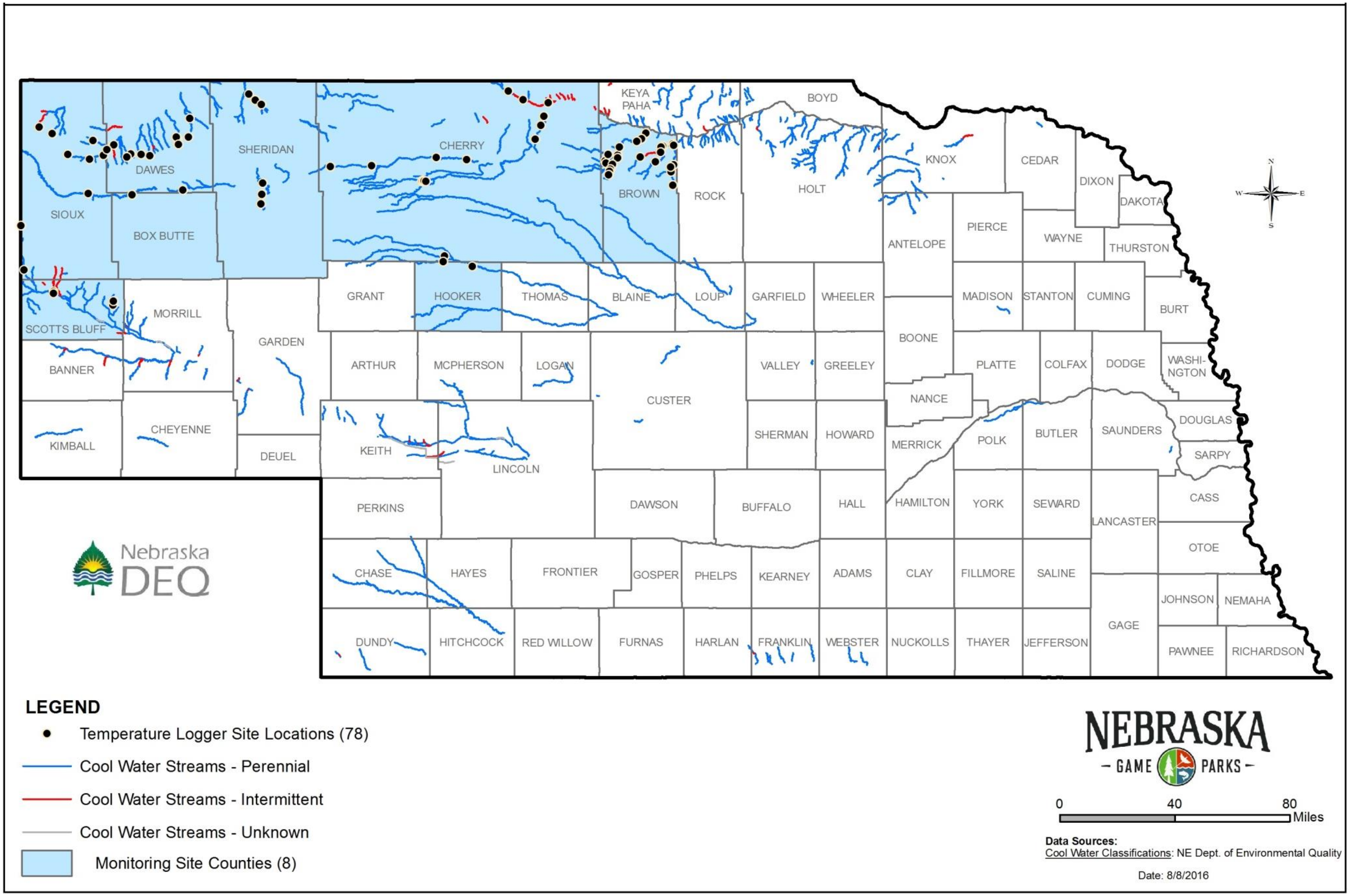
Cropland restoration: One watershed level approach is to identify areas within a priority watershed where there are highly erodible croplands and target those for restoration programs such as the Conservation Reserve Program (CRP). In a study in southwest Wisconsin, Marshall et al. (2008) documented positive effects of changes in agricultural land use on cold water stream communities. Areas with relatively high CRP participation (21% of land area) showed significant increases in scores of the cold water index of biotic integrity compared with areas of lower CRP participation (12% of land area). Higher levels of CRP resulted in decreased surface runoff and increased groundwater filtration, improving water quality and baseflows.

Resilience to wildfire: Another watershed approach is to increase the resilience of forests and woodlands to wildfires. Areas such as the Pine Ridge and Niobrara Valley historically had open woodlands maintained by frequent, low intensity groundfires. Relatively little ash was produced in these fires and vegetation recovery was fairly rapid, resulting in a limited amount of time that bare soil was exposed. Decades of fire suppression activities have resulted in forests with much higher tree density, which are susceptible to high intensity crown fires. In addition, climate change is resulting in hotter and drier conditions which also contribute to more intense wildfires. These more intense fires result in higher volumes of ash and a longer recovery time for vegetation, leading to the potential for more erosion of ash and sediments into streams. Practices including forest thinning and use of prescribed fire can reduce fuel loads and return the system to one of low intensity fires, thus reducing impacts on streams.

Stream Monitoring and Management Evaluations

The ability to monitor cool water stream conditions will be critical in devising appropriate management strategies, restoration projects and the evaluation of plan elements and actions. Management evaluations will focus on installed improvements or best management practices. The current thermal profiles consist of point data collections by NDEQ through standard monitoring protocols. However, diurnal and in some case seasonal trends don't accurately represent conditions experienced by the aquatic community, especially critical thresholds of sensitive species. Therefore, a more accurate characterization of continuous thermal information may reveal limiting conditions. Similarly, other important factors (e.g., flow, groundwater inputs, refuge frequency) may also be identified as needing further investigation. NGPC has placed data loggers at temperature monitoring sites (Figure 19 and Appendix J) to initially focus on thermal regimes as they relate to current classification, composition and segregation of fish communities.

Figure 19: Cool Water Stream Temperature Monitoring Sites



Fish Stocking

Stocking fish is used to achieve a variety of objectives including maintaining stream fish populations, improving sportfish populations, improving sportfish length frequency distribution, introducing fish species into a particular habitat and re-introduction of extirpated species. The stocking strategy which is employed depends on the specific management objective and matching a particular fish species to a stream and/or habitat type. When discussing fish stocking in Nebraska streams, thoughts generally turn to cool water species such as trout. However, strategies can be developed to propagate and stock at-risk stream species to maintain and enhance fragile populations. In addition, if habitat projects result in stream improvements and at-risk species need to be re-introduced into a particular stream system, stocking in the form of transferring wild adults and juvenile fish can be employed.

Stocking trout may negatively affect native fish and other aquatic biota through predation and/or competition. Streams selected for potential trout stocking should be evaluated to determine if there will be negative effects to at-risk species.

The following is a tool-box of stocking strategies for stream trout:

Trout species: Currently four species of trout and one hybrid are available for stocking in cold water streams by the NGPC. They are Rainbow trout, Brown trout, Brook trout, Cutthroat trout, and Tiger trout (brown X brook hybrid). The particular species stocked is dependent on a number of factors including, but not limited to, the size of the stream, (i.e., flow amount, width, depth, etc.), stream water temperature (e.g., brown trout can generally survive slightly warmer water than rainbows), food supply (i.e., invertebrates, other fish species present), stream habitat including substrate, over-winter stream habitat, and stream history (i.e., what has worked in the past). Regardless of the trout species selected for stocking, the following stocking strategies can apply. A table containing a list of streams stocked with trout is in Appendix B.

Juvenile or fingerling stocking (also known as put-grow-and-take): As the name implies, this stocking strategy involves stocking smaller sized fish and can be used for an initial introduction of trout to a stream system or as a supplemental or maintenance stocking to an existing trout population. In general, trout are hatched and reared in a fish production facility and stocked into streams as “sub-catchable,” 3-6 inch (8-15 cm) fish. This strategy can utilize higher numbers of fish for stocking as it is more economically feasible to move fish out of the production facility in a timely manner at a smaller size. This strategy is used if larger piscivorous fish are non-existent or found in low numbers in the target stream to insure adequate survival of the stocked fish. Obviously a high survival rate is critical to achieve the desired level of longevity and growth to larger sized fish for the angler.

Adult stocking (also known as put-and-take): This stocking strategy utilizes larger sized "catchable" fish that generally range from 9-11 inches (23-28 cm) in length depending on the species. Generally fewer adult size fish are stocked compared to the number of juvenile fish stocked, as the allowance for mortality associated with stocking smaller trout has been by-passed. Survival of larger, adult size fish is typically high if water quality, habitat and food availability are adequate. This stocking strategy is used to create an instant fishery for the angler. It is a highly successful strategy in high angler use situations such as in East Branch of Verdigre Creek on the Grove Lake Wildlife Management Area. It is also a strategy employed at Long Pine Creek (and other streams) to periodically supplement larger sized rainbow trout for the angler in the presence of a self-reproducing trout population.

Rainbow trout are usually selected to be used under this strategy because of the ease of rearing in a fish production facility. Rainbow trout easily convert to a dry pellet diet. Some strains of rainbow trout have been designated as "domestic strains" and are used for intensive culture. It is more expensive to raise trout to a "catchable" size but in many instances this is the only successful stocking strategy available.

Trap and transfer: This strategy involves the capture and transfer of juvenile and adult trout from a high density population to a stream with a low density or non-existent population. It is not used as often as stocking hatchery reared fish, but situations arise where a trout population benefits from the removal of excess trout to stimulate growth rates etc. Trout are collected with sampling gear and transported to a different stream for stocking. Time and expense for the trout stocking is lower than with hatchery reared fish as they do not have to go through the hatchery production regiment. A consideration that can add time and expense to trout transfer scenario is the need for disease sampling. Collected trout, or a surrogate species, from the host stream should be analyzed for the presence of certain diseases. Once this is completed, the stream fish can be freely moved to other streams and drainages.

At-Risk Native Species

Much research has been conducted on endangered and threatened species, but more is needed on at-risk species in general in order to better inform recovery and management decisions for these species. State recovery plans for endangered or threatened species identify, describe and schedule the actions necessary to restore populations of these animals and plants to a more secure status. Recovery plans have not been developed for most listed species. Plans are developed and implemented on a priority basis, dealing first with species in the most immediate danger of becoming extirpated from the state or extinct, whose life history requirements are best known, or those which offer the best opportunity for success. A variety of techniques are used in recovery efforts, including reintroduction, captive propagation, protection of habitat through various forms of acquisition or easements, habitat manipulation and restoration, public education, and strict legal protection.

The same strategies listed above can exist for at-risk species or native species of concern. At this time, little effort has been directed at culture activities for these species. Some research and production has been conducted with plains topminnow geared toward intensive culture that resulted in stocking efforts to re-introduce the species into suitable stream habitats.

Likely the most effective strategy for stocking native species of concern will involve the “trap and transfer” method. However, this will require identifying locations with abundant regional populations to allow for the removal of fish without having a negative impact on such populations. As with trout, sampling will need to be conducted to verify the presence or absence of certain diseases. Rather than sacrificing Tier 1 at-risk species for disease evaluation, more abundant surrogate species from the same stream or watershed can and should be used for this purpose.

Angler Access

Public access to cool water streams in Nebraska is most often sought by anglers for trout fishing. Currently, little or no demand exists for access to cool water streams for the purpose of “eco-tourism.” Future demand may include “watchable wildlife” opportunities along riparian corridors. At this time there is no NGPC lease program for this type of activity, but avenues do exist to gain public access for trout anglers and other stream users.

The NGPC can and occasionally does purchase land through fee title. The land thus becomes public property and is available for public access. Generally a large enough tract of land is purchased to be managed as a Wildlife Management Area (WMA) that accommodates hunting, fishing, bird watching, and/or other uses. A process and protocol is in place within NGPC for land (stream) purchase.

Another avenue for public access on streams is through access contracts that involve a trespass fee and lease agreement. Currently, this type of stream access is accomplished through the NGPC OFW Program. A process and protocol is in place that allows NGPC staff to enter into signed agreements with landowners for public access. A fee schedule is followed depending on the type of stream and the total amount of land designated in the agreement. Payment for access to cool water streams with trout fishing opportunity is currently $750 per mile if both sides of the stream are enrolled and $375 per mile if only one side on the stream is enrolled. In addition, many streams include valued riparian habitat. Additional riparian acres that include hunting opportunities can be enrolled at rates ranging from $6 to $15 per acre depending on the quality and location of the habitat. Adjacent areas designated as “roundout acres” can also be enrolled in an OFW contract at a rate of $0.50 to $1 per acre.

NGPC should explore the possibility of public access to streams on property owned or controlled by other government or non-government agencies (e.g., power companies, NRDs, etc.) if public access is currently not available. A contract or Memorandum of Understanding could be written between parties for public access to areas that are currently inaccessible.

Mitigating Climate Change

Management strategies can help to ameliorate the effects of climate change on cool water streams and their biota. The climate is changing and it is imperative that we assist species in adapting to this new reality. However, if climate change continues unabated, the projected rate and magnitude of change will make these management efforts increasingly more costly and less effective. Ultimately, to conserve cool water species in the state, we need to slow and halt anthropogenic climate change through reduction in greenhouse gas emissions and levels in the atmosphere. In the arena of climate change, these are referred to as climate change mitigation actions. There are a number of actions we can take as an agency to reduce our carbon footprint and increase carbon sequestration on the lands we manage. While these should be pursued, they will have a small effect relative to the scale of the problem. We can have a larger impact through education – developing and disseminating information on the impacts of climate change on cool water streams (and other habitats in the state) to the public and policy makers. We should also work to influence state policy and legislation to increase society's efforts at climate mitigation.

Several management activities included in the previous section can at least partially offset the negative impacts of climate change on cool water stream systems. These would include in-channel habitat modifications as well as riparian and watershed land management practices. These practices can help to maintain adequate groundwater inputs, cool water temperatures, and good water quality to counteract the effects of rising air temperatures and an increase in the frequency and magnitude of high intensity precipitation events, floods, and droughts.

Cool water streams in Nebraska should be analyzed to determine their resiliency to climate change in order to help prioritize where management efforts would be most effective. Highly resilient streams may maintain cool water temperatures and species for some time in the absence of intensive management. For streams with low resiliency, loss of cool water species is probably inevitable, and management efforts would provide minimal return for the investment. Therefore, management efforts should be directed towards streams where such efforts would allow for the persistence of cool water species that otherwise would decline with climate change.

Partnerships/Collaborations

Implementing this plan, which reaches across ownership and jurisdictional boundaries, will require careful collaboration with partners to ensure the delivery of quality products and services. The physical transition between aquatic and terrestrial communities as well as between riparian and upland plant communities is best described as zonation, a gradual transition in dominant features. However, land ownership boundaries are well-defined and such legally accepted lines cross the landscape regardless of the placement of these communities. The effective management, restoration and protection of these communities will stretch across these boundaries and require significant collaboration with existing land partners as well as developing relationships with new groups. The following list of potential collaborators is a starting point and is expected to grow over the course of the implementation of this plan.

- Bureau of Reclamation
- Business Leaders
- County Extension Offices
- Irrigation Districts
- Natural Resources Conservation Service
- Nebraska Association of Resources Districts and the following NRDs:
  Upper Niobrara-White, Middle Niobrara, Lower Niobrara, North Platte, South Platte, Twin Platte, Lower Platte North, Upper Republican, Middle Republican, Lower Republican, Upper Loup, Lower Loup, Upper Elkhorn, Lower Elkhorn, Papio-Missouri
- Nebraska Department of Environmental Quality
- Nebraska Department of Natural Resources
- Nebraska Environmental Trust
- Niobrara River Council
- Private landowners
- Sandhills Task Force
- Trout Unlimited
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Service
- Watershed communities

Funding

Funding to implement the plan will come from a variety of sources including NGPC's Game Cash Fund (funding derived from fishing and hunting license sales). NGPC has also received a three-year Nebraska Environmental Trust (NET) grant for approximately $650,000 for habitat enhancements, monitoring, and evaluation. Several key partners have also pledged money as match to the NET grant, and their money will be used in conjunction with the objectives established for the grant. See Table 4 for funding partners and allocation of these dollars. Seven cool water streams are listed on the second Aquatic Habitat Plan, and work to improve angler access and instream habitat on public reaches may be eligible for funding support.

Table 4: Nebraska Environmental Trust Grant Budget 2015-2017

2015	NGPC	NET	DEQ*	NRCS**	Sandhills Task Force*	USFWS- PFW *	Trout Unlimited	Total
Salary/benefits	$43,060.00							
Evaluation/Monitoring		$ 36,000.00	$17,000.00					
Habitat Enhancements	$51,040.00	$ 64,000.00			$ 2,000.00	$ 5,000.00	$ 1,000.00	
Equipment	$ 5,000.00							
	$99,100.00	$100,000.00	$17,000.00		$ 2,000.00	$ 5,000.00	$ 1,000.00	$ 224,100.00
2016								
Salary/benefits	$43,060.00							
Evaluation/Monitoring			$ 2,000.00					
Habitat Enhancements	$51,040.00	$100,000.00		$ 5,000.00	$ 2,000.00	$ 5,000.00	$ 1,000.00	
Equipment	$ 5,000.00							
	$99,100.00	$100,000.00	$ 2,000.00	$ 5,000.00	$ 2,000.00	$ 5,000.00	$ 1,000.00	$ 214,100.00
2017								
Salary/benefits	$43,060.00							
Evaluation/Monitoring			$ 2,000.00					
Habitat Enhancements	$51,040.00	$100,000.00		$ 5,000.00	$ 2,000.00	$ 5,000.00	$ 1,000.00	
Equipment	$ 5,000.00							
	$99,100.00	$100,000.00	$ 2,000.00	$ 5,000.00	$ 2,000.00	$ 5,000.00	$ 1,000.00	$ 214,100.00
							3 year total:	$ 652,300.00

*DEQ will spend $2,000/year in technical assistance, 2015 will include a $15,000 grant for evaluation and monitoring.

**NRCS, Sandhills Task Force, and USFWS-PFW will use their money on certain habitat contracts and will run their dollars through their normal funding channels (not NGPC).

Conclusion

The purpose of the Cool Water Streams Management Plan is to identify the goals for stewardship of these resources and develop action steps to achieve the goals. It also provides a vision for NGPC staff and partners to protect and maintain Nebraska's cool water streams, provide angling opportunities, promote recovery of at-risk species, and increase the public's awareness and appreciation of these resources.

This plan integrates science and partnerships to help protect and restore cool water streams. The conservation and enhancement of Nebraska's healthy cool water streams continues to evolve as NGPC moves forward to meet the challenges of the future. As such, the plan is dynamic, and as the need for revision arises, the plan will be modified accordingly. This document should be considered a five-year plan. When monitoring site information and demonstration sites are evaluated, priorities of the plan may be modified to help reach the overall goals. With appropriate management, the NGPC will help ensure that future generations will be able to enjoy Nebraska's cool water streams.

Appendices

Appendix A: Cool Water Streams in Biologically Unique Landscapes (BULs)

BUL Name	Total Cool Water Stream Miles in BUL	% of Total Cool Water Stream Miles in Nebraska*	Class A Cool Water Streams						Class B Cool Water Streams							
			Perennial		Intermittent		Total		Perennial		Intermittent		Unknown		Total	
			Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total
Central Loess Hills	4.73	0.10	0.00	0.00	0.00	0.00	0.00	0.00	4.73	100.00	0.00	0.00	0.00	0.00	4.73	100.00
Cherry County Wetlands	647.40	14.18	69.37	10.72	0.00	0.00	69.37	10.72	578.03	89.28	0.00	0.00	0.00	0.00	578.03	89.28
Dismal River Headwaters	63.97	1.40	0.00	0.00	0.00	0.00	0.00	0.00	63.97	100.00	0.00	0.00	0.00	0.00	63.97	100.00
Keya Paha	136.69	2.99	0.00	0.00	0.00	0.00	0.00	0.00	134.03	98.05	2.66	1.95	0.00	0.00	136.69	100.00
Kimball Grasslands	25.25	0.55	13.43	53.19	0.00	0.00	13.43	53.19	11.82	46.81	0.00	0.00	0.00	0.00	11.82	46.81
Lower Loup Rivers	2.11	0.05	0.00	0.00	0.00	0.00	0.00	0.00	2.11	100.00	0.00	0.00	0.00	0.00	2.11	100.00
Lower Niobrara River	60.90	1.33	6.58	10.80	0.00	0.00	6.58	10.80	54.32	89.20	0.00	0.00	0.00	0.00	54.32	89.20
Lower Platte River	7.02	0.15	0.00	0.00	0.00	0.00	0.00	0.00	7.02	100.00	0.00	0.00	0.00	0.00	7.02	100.00
Middle Niobrara River	190.79	4.18	38.04	19.94	0.00	0.00	38.04	19.94	122.89	64.41	29.86	15.65	0.00	0.00	152.75	80.06
North Platte River	124.25	2.72	2.11	1.70	0.00	0.00	2.11	1.70	107.13	86.22	6.85	5.51	8.16	6.57	122.14	98.3
Oglala Grasslands	198.81	4.36	39.05	19.64	6.23	3.13	45.28	22.78	139.27	70.05	14.26	7.17	0.00	0.00	153.53	77.22
Panhandle Prairies	154.16	3.38	34.35	22.28	0.49	0.32	34.84	22.60	113.84	73.85	5.48	3.55	0.00	0.00	119.32	77.40
Pine Ridge	240.27	5.26	82.44	34.31	2.07	0.86	84.51	35.17	144.95	60.33	10.81	4.50	0.00	0.00	155.76	64.83

*The total miles of Cool Water Streams (A & B) in Nebraska is 4,564.81 (Figure 2).

BUL Name	Total Cool Water Stream Miles in BUL	% of Total Cool Water Stream Miles in Nebraska*	Class A Cool Water Streams						Class B Cool Water Streams							
			Perennial		Intermittent		Total		Perennial		Intermittent		Unknown		Total	
			Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total	Miles	% of BUL total
Platte Confluence	95.14	2.08	0.00	0.00	0.00	0.00	0.00	0.00	82.58	86.80	3.83	4.02	8.73	9.18	95.14	100.00
Sandhills Alkaline Lakes	6.81	0.15	0.00	0.00	0.00	0.00	0.00	0.00	6.81	100.00	0.00	0.00	0.00	0.00	6.81	100.00
Sandsage Prairie North	178.62	3.91	0.00	0.00	0.00	0.00	0.00	0.00	178.62	100.00	0.00	0.00	0.00	0.00	178.62	100.00
Sandsage Prairie South	39.36	0.86	0.00	0.00	0.00	0.00	0.00	0.00	38.77	98.50	0.59	1.50	0.00	0.00	39.36	100.00
Snake River	96.34	2.11	0.00	0.00	0.00	0.00	0.00	0.00	96.34	100.00	0.00	0.00	0.00	0.00	96.34	100.00
Upper Loup Rivers – Calamus River	385.01	8.43	0.00	0.00	0.00	0.00	0.00	0.00	385.01	100.00	0.00	0.00	0.00	0.00	385.01	100.00
Upper Loup Rivers – Middle Loup River	244.97	5.37	0.00	0.00	0.00	0.00	0.00	0.00	244.97	100.00	0.00	0.00	0.00	0.00	244.97	100.00
Upper Loup Rivers – North Loup River	117.26	2.57	0.00	0.00	0.00	0.00	0.00	0.00	117.18	99.93	0.00	0.00	0.08	0.07	117.26	100.00
Upper Niobrara River	227.68	4.99	0.00	0.00	0.00	0.00	0.00	0.00	227.68	100.00	0.00	0.00	0.00	0.00	227.68	100.00
Verdigris-Bazile	194.38	4.26	22.60	11.63	0.00	0.00	22.60	11.63	171.51	88.23	0.27	0.14	0.00	0.00	171.78	88.37
Wildcat Hills North	24.72	0.54	0.00	0.00	0.00	0.00	0.00	0.00	24.72	100.00	0.00	0.00	0.00	0.00	24.72	100.00
Wildcat Hills South	1.68	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.68	100.00	0.00	0.00	0.00	0.00	1.68	100.00
TOTAL	3468.33	77.71	307.97		8.79		316.76		3059.98		74.61		16.97		3151.56	

*The total miles of Cool Water Streams (A & B) in Nebraska is 4,564.81 (Figure 2).

Appendix B: Failed Historical Trout Stocking

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Antelope	Antelope Creek	Rainbow trout	1/1/30	1.5	500	X	
Antelope	Big Springs Creek	Rainbow trout	1929-71	1.5-10.5	8922	X	
Antelope	Big Springs Creek	Brown trout	1964-79	1-8	10750	X	
Antelope	Big Springs Creek	Brook trout	5/18/54	3	500	X	
Antelope	Clearwater Creek	Rainbow trout	12/3/52	3 - 8	328	X	
Antelope	Clearwater Creek	Brown trout	1952-53	1.5-8	15131	X	
Antelope	Clearwater Creek	Brook trout	12/3/52	3 - 8	100	X	
Antelope	Pebble Creek	Rainbow trout	1934-63	3-12	6916	X	
Antelope	Pebble Creek	Brown trout	1950-55	1.5-12	12252	X	
Antelope	Pebble Creek	Brook trout	5/9/55	3	315	X	
Antelope	South Branch Verdigre Creek	Rainbow trout	5/18/54	3	1000	X	
Antelope	Unnamed to Bazile Creek	Brown trout	3/22/38	1.5	9000	X	
Boone	Beaver Creek	Rainbow trout	1951-52	3	4270	X	
Boone	Beaver Creek	Brown trout	1951-52	3	219392	X	
Boone	Beaver Creek	Brook trout	4/22/49	3	2000	X	
Boone	Skeedee Creek	Rainbow trout	2/23/35	3	400	X	
Box Butte	Niobrara River Upper Middle (Cornell Dam to Box Butte Dam)	Rainbow trout	1944-70	3-15	9107	X	
Box Butte	Niobrara River Upper Middle (Cornell Dam to Box Butte Dam)	Brown trout	1944-48	10-14	1550	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Boyd	Lamb Creek	Rainbow trout	4/7/36	3	1000	X	
Boyd	Lamb Creek	Brook trout	4/7/36	3	1000	X	
Boyd	Spring Creek	Brook trout	8/8/28	3	200	X	
Brown	Calamus River	Brown trout	1935-42	6-12	300	X	
Brown	Niobrara River Lower Middle (Spencer Dam to Cornell Dam)	Rainbow trout	5/17/58	3	1500	X	
Chase	Frenchman River	Rainbow trout	1929-53	0.5-12	36420		X
Chase	Frenchman River	Brown trout	1930-33	2-10	3636	X	
Chase	Frenchman River	Brook trout	1/1/31	2	1700	X	
Cherry	Bear Creek	Rainbow trout	1931-48	.5-12	22610	X	
Cherry	Bear Creek	Brown trout	1934-57	1.5-8	15340	X	
Cherry	Big Creek	Brown trout	1953-55	.5-2	7819	X	
Cherry	Brush Creek	Brown trout	4/23/53	0.5	2000	X	
Cherry	Cedar Creek (Rush Creek on County Map)	Rainbow trout	1932-53	0.5-12	35243	X	
Cherry	Cedar Creek (Rush Creek)	Brown trout	1939-54	1-12	20010	X	
Cherry	Cedar Creek (Rush Creek on County Map)	Brook trout	1947-51	2	3485	X	
Cherry	Goose Creek	Rainbow trout	1940-55	0.5-3	13500	X	
Cherry	Goose Creek	Brown trout	1948-55	0.5-3	35960	X	
Cherry	Gordon Creek	Rainbow trout	1935-39	6-12	490	X	
Cherry	Gordon Creek	Brown trout	2/2/52	1	5644	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Cherry	Hay Creek	Rainbow trout	2/3/33	2	250	X	
Cherry	Hay Creek	Brown trout	3/16/34	8	100	X	
Cherry	Merriman Creek	Rainbow trout	6/7/73	12	3566	X	
Cherry	Wright Creek	Rainbow trout	4/28/49	3	1000	X	
Cheyenne	Lawrence Fork	Rainbow trout	1929-61	2-4	13150	X**	
Cheyenne	Lawrence Fork	Brown trout	1931-83	2-12	16061	X**	
Colfax	Lost Creek	Rainbow trout	4/22/40	12	400	X	
Custer	Victoria Creek	Brown trout	1976-80	5-8	1300	X	
Dawes	Deep Creek	Rainbow Trout	1930-79	1-9	7498	X**	
Dawes	Deep Creek	Brown trout	8/8/30	1 - 2	4000	X**	
Dawes	Indian Creek	Rainbow trout	6/16/71	4	250	X	
Dawes	Licket Creek	Rainbow trout	4/12/49	3	1400	X	
Dawes	Rush Creek	Brook trout	7/10/79	3	3500	X	
Dawes	Spring Creek	Rainbow trout	9/20/77	5	500	X	
Dawes	Willow Creek	Brown trout	9/9/63	3	300	X	
Dawes	Willow Creek	Brook trout	4/16/56	3	300	X	
Dundy	Horse Creek	Rainbow trout	5/28/57	4	3000	X	
Dundy	Rock Creek	Rainbow trout	1929-70	1.5-12	34722	X	
Dundy	Rock Creek	Brown trout	8/1/29	8	380	X	
Franklin	Cottonwood Creek	Trout family	6/22/32	1-10	2250	X	
Franklin	Cottonwood Creek	Brown trout	1929-34	1-3	11865	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Franklin	Thompson Creek	Rainbow trout	1932-76	1-12	11733	X	
Franklin	Thompson Creek	Brown trout	1976-78	3-5	22050	X	
Franklin	Turkey Creek	Rainbow trout	1932-42	2-12	6180	X	
Frontier	Fox Creek	Trout family	1932	1-12	3400	X	
Frontier	Medicine Creek	Brook trout	8/8/30	3	5800	X	
Garden	Clear Creek	Rainbow trout	1929-81	1-12	107521	X**	
Garden	Clear Creek	Brown trout	1929-76	1.5	21850	X**	
Garden	Coldwater Creek	Rainbow trout	4/25/56	3	300	X	
Garden	Rush Creek	Rainbow trout	4/25/56	3	300	X	
Garfield	Calamus River	Brook trout	3/8/40	1-2	10000	X	
Garfield	Cedar River	Rainbow trout	7/21/51	2-3	4850	X	
Greeley	Cedar Creek	Brown trout	5/7/43	5-8	2600	X	
Harlan	Republican River above Harlan County Dam	Rainbow trout	4/15/59	12	4000	X	
Harlan	Turkey Creek	Brown trout	3/28/33	3	2500	X	
Holt	Ash Creek	Rainbow trout	8/5/30	1-2	6000	X	
Holt	Big Sandy Creek	Rainbow trout	1953-55	3	5034	X	
Holt	Big Sandy Creek	Brown trout	1953-56	3	4905	X	
Holt	Big Sandy Creek	Brook trout	6/16/53	3	500	X	
Holt	Brush Creek	Rainbow trout	1953-58	3	1200	X	
Holt	Brush Creek	Brown trout	2/28/70	7 - 8	700	X	
Holt	Eagle Creek	Rainbow trout	1928-58	1-12	30934	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Holt	Eagle Creek	Brown trout	1930-55	1-3	8704	X	
Holt	Eagle Creek	Brook trout	6/16/53	3	500	X	
Holt	Elkhorn River (Logan Creek to North Fork Elkhorn River)	Rainbow trout	3/29/40	10	800	X	
Holt	Middle Branch Eagle Creek	Brook trout	5/18/54	3	500	X	
Holt	Oak Creek	Rainbow trout	4/17/56	3	600	X	
Holt	Oak Creek	Brook trout	5/18/54	3	300	X	
Holt	Redbird Creek	Brown trout	5/18/54	3	2000	X	
Holt	Sand Creek	Rainbow trout	1933-58	2-3	6750	X	
Holt	Spring Creek	Brown trout	4/22/65	8-10	300	X	
Keith	Lonergan Creek	Rainbow trout	1945-82	1-4	290408		X
Keith	Lonergan Creek	Kokanee salmon	1958-59	1.5	34375	X**	
Keith	Lonergan Creek	Brown trout	1945-56	2-10	6720	X**	
Keith	Lonergan Creek	Brook trout	2/27/56	4-10	780	X**	
Keith	Sand Creek	Kokanee salmon	2/26/59	1.5	20250	X	
Keya Paha	Spring Creek	Brown trout	10/14/37	12	500	X	
Kimball	Lodgepole Creek	Rainbow trout	1928-71	1-14	77950	X**	
Kimball	Lodgepole Creek	Brown trout	1928-84	1-12	123920		X
Kimball	Lodgepole Creek	Brook trout	3/29/55	12	1450	X**	
Knox	Bazile Creek	Rainbow trout	3/13/48	12	334	X	
Knox	Howe Creek	Trout family	6/5/42	4-7	400	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Knox	Missouri River	Rainbow trout	5/1/57	10	5000	X	
Knox	Spring Creek	Rainbow trout	4/20/43	4-10	300	X	
Knox	Spring Creek	Brown trout	5/26/76	10	100	X	
Logan	South Loup River	Rainbow trout	1942-57	1-12	24389	X	
Logan	South Loup River	Brown trout	1/19/00	2-12	3461	X	
Logan	South Loup River	Brook trout	3/23/56	2	1050	X	
Loup	Calamus River	Rainbow trout	1936-48	1-12	51722	X	
Madison	Taylor Creek	Rainbow trout	1941-79	1.5-9	42070		?
Madison	Taylor Creek	Brown trout	1955-56	0.5-3	6217		?
Morrill	Browns Creek	Rainbow trout	4/22/38	2-4	500	X	
Morrill	Cedar Creek	Rainbow trout	1931-41	1-12	5570	X	
Morrill	Cedar Creek	Brook trout	9/9/80	4	2500	X	
Morrill	Indian Creek	Brown trout	3/8/76	1.5	18425	X	
Morrill	Pumpkin Creek	Rainbow trout	1928-67	2-14	17150	X**	
Morrill	Pumpkin Creek	Brown trout	4/25/56	2	2000	X**	
Pierce	Bazile Creek	Brown trout	10/13/37	10	150	X	
Pierce	Willow Creek	Rainbow trout	1928-43	2-12	6760	X	
Pierce	Willow Creek	Brook trout	2/22/37	1	4000	X	
Polk	Clear Creek	Rainbow trout	1930-43	1-12	49375	X	
Richardson	Easly Creek	Rainbow trout	4/18/42	5	500	X	
Rock	Ash Creek	Rainbow trout	5/18/67	2	250	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Rock	Ash Creek	Brown trout	1966-70	2-8	2750	X	
Rock	Coon Creek	Rainbow trout	1933-66	0.5-7	10550		X
Rock	Coon Creek	Brown trout	1952-84	2-9	10896		X
Rock	Coon Creek	Brook trout	1936-82	0.5-5	1750	X	
Rock	Elk Creek	Brook trout	11/4/66	5	800	X	
Rock	Oak Creek	Rainbow trout	1969-82	8-9	544		X
Rock	Oak Creek	Brown trout	1957-84	2-5	3050		X
Rock	Oak Creek	Brook trout	1930-83	0.5-5	5830	X	
Rock	Rock Creek	Rainbow trout	1934-61	1.5-3	17000	X	
Rock	Sand Creek	Rainbow trout	1/1/30	0.5	3000	X	
Rock	Short Pine Creek	Rainbow trout	3/13/34	0.5	2000	X	
Rock	Short Pine Creek	Brown trout	1934-53	0.5-2	8500		X
Rock	Short Pine Creek	Brook trout	6/13/53	2	500		X
Rock	Thomas Creek	Rainbow trout	6/6/52	2	150	X	
Scotts Bluff	Akers Draw	Rainbow trout	1938-55	4-12	4655	X**	
Scotts Bluff	Akers Draw	Brook trout	1947-55	3-12	500	X**	
Scotts Bluff	Hackberry Creek	Rainbow trout	1928-68	1.5-12	166280	X	
Scotts Bluff	Hackberry Creek	Brown trout	1930-79	3-12	63943	X	
Scotts Bluff	Hackberry Creek	Brook trout	1955-57	3-12	7044	X	
Scotts Bluff	Kiowa Creek	Brook trout	5/10/49	3	740	X	
Sheridan	Wounded Knee Creek (To South Dakota)	Brook trout	3/1/58	3	600	X	

* indicates presence of transitory or low sustainable populations

** indicates extirpation due to loss of flows

County Name	Stream Name	Species	Date or Year Range Stocked	Stocking Sizes (inches)	Total Stocked (#)	Failure	Remnant*
Sioux	Boggy Creek	Brook trout	4/21/51	2	280	X	
Sioux	Cottonwood Creek	Brook trout	1979-83	3-5	11000	X	
Sioux	Deep Creek	Brook trout	1943-80	2-4	14893	X	
Sioux	Little Cottonwood Creek	Brown trout	6/7/66	1-3	500	X	
Sioux	Little Cottonwood Creek	Brook trout	7/10/79	3	8000	X	
Sioux	Sand Creek	Brown trout	4/8/64	3	560	X	
Sioux	Warbonnet Creek	Rainbow trout	3/20/40	2	1120	X	
Thayer	Big Sandy Creek	Brook trout	2/3/37	0.5	6000	X	
Wheeler	Cedar Creek	Rainbow trout	1936-54	3-12	37550	X	
York	Beaver Creek	Trout family	8/8/30	3	125	X	
York	Beaver Creek	Brown trout	8/11/76	5	500	X	

* indicates presence of transitory or low sustainable populations
** indicates extirpation due to loss of flows

Appendix C: Nebraska Streams with Trout

Stream Name	Naturally Reproducing Trout Species	Stocked Trout Species (*)	NGPC District	County Name
East Branch Verdigre Creek	Brown trout, Rainbow trout	Rainbow trout (C)	Northeast	Antelope
Fairfield Creek	Brown trout		Northeast	Cherry, Brown
Gracie Creek		Rainbow trout (C)	Northeast	Garfield
Long Pine Creek	Brown trout, Rainbow trout	Rainbow trout (C)	Northeast	Brown
Louse Creek	Brown trout		Northeast	Holt
Plum Creek	Brown trout, Rainbow trout		Northeast	Brown
Steele Creek	Brown trout	Rainbow trout (C)	Northeast	Holt, Knox
Alliance Drain	Brown trout, Rainbow trout		Northwest	Scotts Bluff
Bayard Drain	Brown trout, Rainbow trout		Northwest	Scotts Bluff, Morrill
Beaver Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Sheridan
Big Bordeaux Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Dawes
Blue Creek	Brown trout	Brown trout (S)	Northwest	Garden
Chadron Creek	Brown trout, Brook trout		Northwest	Dawes
Dead Horse Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Dawes
Deer Creek	Brown trout		Northwest	Sheridan
Dismal River (North Fork)		Brown trout (S) Rainbow trout (S)	Northwest	Hooker
Dismal River (South Fork)		Brown trout (S)	Northwest	Hooker
Dry Sheep Creek	Brown trout, Rainbow trout		Northwest	Sioux
Dry Spotted Tail Creek	Brown trout, Rainbow trout		Northwest	Scotts Bluff, Sioux
East Ash Creek	Brown trout, Brook trout	Brown trout (S)	Northwest	Dawes
East Hat Creek	Brown trout		Northwest	Sioux
Greenwood Creek	Brown trout, Rainbow trout		Northwest	Morrill
Larabee Creek	Brown trout, Brook trout	Brown trout (S)	Northwest	Sheridan
Little Bordeaux Creek	Brown trout, Brook trout	Brown trout (S)	Northwest	Dawes

*C=catchable (9-11 inches), S=subcatchable (3-6 inches)

Stream Name	Naturally Reproducing Trout Species	Stocked Trout Species (*)	NGPC District	County Name
Middle Fork Soldier Creek	Brown trout, Brook trout		Northwest	Sioux
Middle Loup River		Brown trout (S)	Northwest	Cherry, Hooker
Middle Loup River (Middle Branch)		Brown trout (S)	Northwest	Hooker
Middle Loup River (South Branch)		Brown trout (S)	Northwest	Hooker
Minnechaduza Creek		Rainbow trout (C)	Northwest	Cherry
Mitchell Drain	Brown trout, Rainbow trout		Northwest	Scotts Bluff
Moffat Drain	Brown trout, Rainbow trout		Northwest	Scotts Bluff
Monroe Creek	Brown trout, Brook trout		Northwest	Sioux
Ninemile Creek	Brown trout, Rainbow trout		Northwest	Scotts Bluff
Niobrara River above Box Butte	Brown trout		Northwest	Sioux, Dawes, Box Butte
North Loup River		Brown trout (S)	Northwest	Cherry
Red Willow Creek	Brown trout, Rainbow trout		Northwest	Morrill
Schlagel Creek	Brown trout	Rainbow trout (S)	Northwest	Cherry
Sheep Creek	Brown trout, Rainbow trout		Northwest	Scotts Bluff, Sioux
Snake River (lower)		Brown trout (S) Rainbow trout (S)	Northwest	Cherry
Snake River (upper)	Brown trout, Rainbow trout	Brown trout (S) Rainbow trout (S)	Northwest	Cherry
Soldier Creek	Brown trout, Brook trout		Northwest	Dawes
South Fork Soldier Creek	Brown trout, brook trout		Northwest	Sioux
Sowbelly Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Sioux
Spotted Tail Creek	Brown trout, Rainbow trout		Northwest	Sioux
Squaw Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Dawes
Tub Springs Drain	Brown trout, Rainbow trout		Northwest	Scotts Bluff
West Ash Creek	Brown trout, Brook trout	Brook trout (S)	Northwest	Dawes
West Hat Creek	Brown trout, Brook trout		Northwest	Sioux

*C=catchable (9-11 inches), S=subcatchable (3-6 inches)

Stream Name	Naturally Reproducing Trout Species	Stocked Trout Species (*)	NGPC District	County Name
White Clay Creek	Brown trout		Northwest	Sheridan
White River	Brown trout	Brook trout (S)	Northwest	Sioux, Dawes
Wildhorse Creek	Brown trout, Rainbow trout, Brook trout		Northwest	Morrill
Winters Creek	Brown trout, Rainbow trout	Brook trout (S)	Northwest	Scotts Bluff
Elm Creek		Rainbow trout (C)	Southwest	Webster
Otter Creek	Brown trout, Rainbow trout		Southwest	Keith
Sutherland Supply Canal	Rainbow trout		Southwest	Keith
Whitetail Creek	Brown trout		Southwest	Keith

*C=catchable (9-11 inches), S=subcatchable (3-6 inches)

Appendix D: Trout Fishing Access on Cool Water Streams

Stream Name	County Name	Nearest Town	Trout species	Access*
Boardman Creek	Cherry	Valentine	Brown trout, Rainbow trout	PAPR
Big Bordeaux and Little Bordeaux Creeks	Dawes	Chadron	Brook trout, Brown trout	PAPR; except public on Big Bourdeaux WMA and U.S. Forest Service (USFS) Lands
Chadron Creek	Dawes	Chadron	Brook trout, Brown trout	PAPR; except public on Chadron State Park (SP
Sheep and Dry Sheep Creeks	Sioux, Scotts Bluff	Morrill	Brown trout, Rainbow trout	PAPR
Larabee Creek	Sheridan	Rushville	Brook trout, Brown trout	PAPR
Spotted Tail and Dry Spotted Tail Creeks	Scotts Bluff, Sioux	Mitchell	Brown trout, Rainbow trout	PAPR
Greenwood Creek	Morrill	Bridgeport	Brown trout, Rainbow trout	PAPR
Hat Creek, East and West Hat Creeks	Sioux	Harrison	Brook trout, Brown trout	PAPR
Minnechaduza Creek	Cherry	Valentine	Rainbow trout	Public on City Park and below Valentine State Fish Hatchery (SFH) water supply
Monroe Creek	Sioux	Harrison	Brook trout, Brown trout	PAPR; except public on Gilbert-Baker WMA
Nine Mile and East Nine Mile Creeks	Scotts Bluff	Minatare	Brown trout, Rainbow trout	PAPR; except public on Nine Mile Creek WMA and some segments with OFW Access
Niobrara River	Sioux, Dawes, Box Butte	Harrison to Box Butte Reservoir	Brown trout, Rainbow trout	PAPR; except public on Agate Fossil Beds National Monument
North Loup River	Cherry	Mullen	Brown trout, Rainbow trout	PAPR
Middle Loup River and North/ Middle/South Branches	Cherry, Hooker	Mullen	Brown trout, Rainbow trout	PAPR; except some segments of Middle Loup River with OFW access
Dismal River and North/South Forks	Hooker	Mullen	Brown trout, Rainbow trout	PAPR
Pine Creek	Sheridan	Rushville	Brown trout	PAPR
Red Willow Creek	Morrill	Bayard	Brown trout, Rainbow trout	PAPR
Schlagel Creek	Cherry	Valentine	Brown trout	PAPR; except public on Schlagel Creek WMA
Silvernail Drain	Morrill	Northport	Brown trout, Rainbow trout	PAPR

*PAPR = Private Access Permission Required; OFW = Open Fields and Waters Program

Stream Name	**County Name**	**Nearest Town**	**Trout species**	**Access***
Snake River (Upper and Lower)	Sheridan, Cherry	SE of Gordon to S of Cody; Below Merritt Res. to Niobrara River	Brown trout, Rainbow trout	PAPR
Soldier Creek and Middle/South Forks	Sioux, Dawes	Crawford	Brook trout, Brown trout, Rainbow trout	PAPR; except public on Fort Robinson SP, Soldier Creek WMA, and USFS lands
Sowbelly Creek	Sioux	Harrison	Brook trout, Brown trout	PAPR
Stuckenhole Creek (Bayard Drain)	Scotts Bluff, Morrill	Bayard	Brown trout, Rainbow trout	PAPR
Tub Springs Drain	Scotts Bluff	Scottsbluff	Brown trout, Rainbow trout	PAPR
White Clay Creek	Sheridan	Rushville	Brown trout	PAPR
White River	Sioux, Dawes	Fort Robinson	Brown trout, Cutthroat trout, Rainbow trout	PAPR; except public on Fort Robinson SP and some segments with OFW access
Wildhorse Creek	Morrill	Bayard	Brook trout, Brown trout, Rainbow trout	PAPR
Winters Creek	Scotts Bluff	Scottsbluff	Brown trout, Rainbow trout	PAPR
Squaw Creek	Dawes	Crawford	Brook trout, Brown trout	PAPR; except public on Ponderosa WMA
West and East Ash Creeks	Dawes	Crawford	Brook trout, Brown trout	PAPR; except public on USFS lands
Dead Horse Creek	Dawes	Chadron	Brown trout, Rainbow trout	PAPR
Beaver Creek	Sheridan	Hayes Springs	Brook trout, Brown trout	PAPR
Mitchell Drain	Scotts Bluff	Mitchell	Brown trout, Rainbow trout	PAPR
Alliance Drain	Scotts Bluff	Minatare	Brown trout, Rainbow trout	PAPR
Moffat Drain	Scotts Bluff	Minatare	Brown trout, Rainbow trout	PAPR
Blue Creek	Garden	Lewellen	Brown trout, Rainbow trout	PAPR
Deer Creek	Sheridan	Rushville	Brown trout, Rainbow trout	PAPR
Elm Creek	Webster	Red Cloud	Rainbow trout	PAPR; except public on Elm Creek WMA

*PAPR = Private Access Permission Required; OFW = Open Fields and Waters Program

Stream Name	County Name	Nearest Town	Trout species	Access*
North Platte River	Keith	Keystone	Brown trout, Rainbow trout	PAPR; except public below Nebraska Public Power District Diversion Dam (East end of Lake Ogallala)
Otter Creek	Keith	Lewellen	Brown trout, Rainbow trout	PAPR
Sutherland Supply Canal (Keystone Canal)	Keith, Lincoln	Keystone to Paxton	Brown trout, Rainbow trout	Public access road runs along most of the canal from Lake Ogallala to Sutherland Reservoir
Whitetail Creek	Keith	Ogallala	Brown trout	PAPR
Plum Creek	Brown	Johnstown	Brown trout, Rainbow trout	PAPR; except public on Bobcat WMA, Plum Creek Valley WMA, and some segments with OFW access
Long Pine Creek	Brown	Long Pine	Brown trout, Rainbow trout	PAPR; except public on Seven Springs (the wellfield for the town of Long Pine), Long Pine WMA and State Recreation Area (SRA), and Pine Glen WMA
East Branch Verdigre Creek	Antelope	Royal	Brown trout, Rainbow trout	PAPR; except public above Grove Lake as posted
Fairfield Creek	Cherry, Brown	Wood Lake	Brown trout	PAPR
Gracie Creek	Loup	Burwell	Rainbow trout	PAPR; except public 200 yards above Gracie Pond (north side of Calamus Reservoir)
Steele Creek	Holt, Knox	Lynch	Brown trout, Rainbow trout	PAPR
Louse Creek	Holt	Lynch	Brown trout	PAPR

*PAPR = Private Access Permission Required; OFW = Open Fields and Waters Program

Appendix E: Impaired Coldwater A & B Streams for Recreation and Aquatic Life Beneficial Uses (NDEQ 2014)

River Basin	Stream Segment	Stream	Recreation Impairment	Aquatic Life Impairment	Pollutant(s) of Concern
Loup	LO2-11300	Calamus River	Bacteria	Naturally high temperature	E. coli
Loup	LO2-11400	Calamus River	Bacteria	Naturally high temperature	E. coli
Loup	LO2-20000	North Loup River		Naturally high temperature	None
Loup	LO2-30000	North Loup River	Bacteria	Naturally high temperature	E. coli
Loup	LO2-40000	North Loup River	Bacteria	Naturally high temperature	E. coli
Loup	LO3-50100	Dismal River		Naturally high temperature	None
Loup	LO3-50300	Dismal River	Bacteria		E. coli
Loup	LO3-60000	Middle Loup River		Naturally high temperature	None
Loup	LO3-70000	Middle Loup River	Bacteria		E. coli
Middle Platte	MP1-10100	Clear Creek	Bacteria	Naturally high temperature	E. coli
Niobrara	NI2-10320	East Branch Verdigre Creek	Bacteria		E. coli
Niobrara	NI2-10800	Steel Creek	Bacteria		E. coli
Niobrara	NI2-11700	Eagle Creek	Bacteria		E. coli
Niobrara	NI3-12200	Long Pine Creek	Bacteria		E. coli
Niobrara	NI3-12220	Bone Creek	Bacteria	Naturally high temperature	E. coli
Niobrara	NI3-12400	Long Pine Creek	Bacteria		E. coli
Niobrara	NI3-13000	Plum Creek	Bacteria		E. coli
Niobrara	NI3-13100	Plum Creek	Bacteria		E. coli
Niobrara	NI3-21900	Minnechaduza Creek	Bacteria	Naturally high temperature	E. coli
Niobrara	NI3-22500	Snake River	Bacteria		E. coli
Niobrara	NI4-30000	Niobrara River	Bacteria		E. coli
Niobrara	NI4-40000	Niobrara River	Bacteria		E. coli
North Platte	NP1-20500	Birdwood Creek		Naturally high temperature	None
North Platte	NP1-30000	North Platte River		Naturally high temperature	None
North Platte	NP1-30900	Whitetail Creek	Bacteria	Naturally high temperature	E. coli
North Platte	NP1-40000	North Platte River		Naturally high temperature	None

River Basin	Stream Segment	Stream	Recreation Impairment	Aquatic Life Impairment	Pollutant(s) of Concern
North Platte	NP2-10800	Blue Creek		Selenium, Naturally high temperature	Selenium
North Platte	NP2-12100	Lower Dugout Creek		Impaired aquatic community	Unknown
North Platte	NP3-10000	North Platte River		Fish consumption advisory	Hazard index compounds*
North Platte	NP3-10100	Pumpkin Creek		Selenium, Low dissolved oxygen	Selenium, Unknown
North Platte	NP3-10900	Red Willow Creek	Bacteria		E. coli
North Platte	NP3-11700	Ninemile Creek	Bacteria		E. coli
North Platte	NP3-12000	Ninemile Creek		Low dissolved oxygen	Unknown
North Platte	NP3-12600	Winters Creek	Bacteria	Selenium	E. coli, Selenium
North Platte	NP3-13000	Tub Springs Drain	Bacteria		E. coli
North Platte	NP3-20000	North Platte River	Bacteria		E. coli
North Platte	NP3-30000	North Platte River	Bacteria		E. coli
North Platte	NP3-30600	Horse Creek	Bacteria		E. coli
North Platte	NP3-50000	North Platte River		Naturally high temperature	None
Republican	RE1-30100	Elm Creek		Impaired aquatic community	Unknown
Republican	RE1-30500	Crooked Creek		Naturally high temperature	None
Republican	RE1-31200	Thompson Creek	Bacteria	Naturally high temperature	E. coli
Republican	RE3-20200	Frenchman Creek	Bacteria	Selenium	E. coli, Selenium
Republican	RE3-20220	Stinking Water Creek	Bacteria	Selenium	E. coli, Selenium
Republican	RE3-20300	Frenchman Creek	Bacteria	Naturally high temperature	E. coli
Republican	RE3-20400	Frenchman Creek	Bacteria	Naturally high temperature	E. coli
Republican	RE3-40800	Rock Creek		Naturally high temperature	None
South Platte	SP1-10200	Fremont Slough		Naturally high temperature	None
South Platte	SP2-20000	Lodgepole Creek		Impaired aquatic community	Unknown

***Hazard index compounds-** Aroclor-1254 (PCB-1254), Lindane (g-BHC), cis-chlordane, Chlordane, trans-chlordane, DDT, Dieldrin, Heptachlor, Heptachlor Epoxide, Hexachlorobenzene, cis-nonachlor, trans-nonachlor, Oxychlordane, Pentachloroanisole, Trifluralin, Mercury, Cadmium, Selenium

River Basin	Stream Segment	Stream	Recreation Impairment	Aquatic Life Impairment	Pollutant(s) of Concern
South Platte	SP2-50000	Lodgepole Creek		Selenium, Low dissolved oxygen	Selenium, Unknown
White Hat	WH1-10420	Larabee Creek		Impaired aquatic community	Unknown
White Hat	WH1-11300	Chadron Creek	Bacteria		E. coli
White Hat	WH1-11820	West Ash Creek	Bacteria		E. coli
White Hat	WH1-20000	White River	Bacteria	Selenium	E. coli, Selenium
White Hat	WH1-20100	White Clay Creek	Bacteria		E. coli
White Hat	WH1-20310	Middle Fork Soldier Creek		Impaired aquatic community	Unknown
White Hat	WH1-30000	White River	Bacteria		E. coli

Appendix F: NDEQ's Ambient Stream Monitoring Program Sites

Station ID	Waterbody Name	Collection Date	Trout Species	Individuals (#)	Latitude (decimal degrees)	Longitude (decimal degrees)
009577	North Fork Dismal River	08-05-1998	Brown trout	1	41.86031	-101.13778
009582	Long Pine Creek	08-19-1998	Rainbow trout	1	42.69250	-99.66444
009582	Long Pine Creek	08-19-1998	Brown trout	1	42.69250	-99.66444
009594	Monroe Creek	07-15-1998	Brook trout	85	42.76724	-103.92753
009595	Middle Fork Soldiers Creek	07-16-1998	Brook trout	40	42.69819	-103.56799
009595	Middle Fork Soldiers Creek	07-16-1998	Brown trout	38	42.69819	-103.56799
009979	North Fork Dismal River	08-05-1998	Brown trout	1	41.86164	-101.13975
010158	Blue Creek	08-02-2006	Brown trout	1	41.49503	-102.19163
009702	Dry Spottedtail Creek	08-14-2001	Rainbow trout	50	41.98184	-103.83730
009977	North Loup River	08-06-1998	Rainbow trout	9	42.40369	-101.32189
009977	North Loup River	08-06-1998	Brown trout	7	42.40369	-101.32189
010163	Red Willow Creek	10-16-2001	Brown trout	111	41.73535	-103.25858
010163	Red Willow Creek	10-16-2001	Rainbow trout	9	41.73535	-103.25858
010164	Ninemile Creek	08-15-2001	Brown trout	180	41.88677	-103.43817
010164	Ninemile Creek	08-15-2001	Rainbow trout	37	41.88677	-103.43817
LP0005	Long Pine Creek	10-19-2000	Rainbow trout	157	42.57517	-99.69474
LP0005	Long Pine Creek	10-19-2000	Brown trout	111	42.57517	-99.69474
NI2057	Louse Creek	10-18-2000	Brown trout	37	42.68428	-98.43662
NI2426	East Verdigre Creek	10-17-2000	Rainbow trout	16	42.35714	-98.10315
NI2426	East Verdigre Creek	10-17-2000	Brown trout	174	42.35714	-98.10315
NI2496	Oak Creek	10-18-2000	Brown trout	57	42.68611	-98.76930

Station ID	Waterbody Name	Collection Date	Trout Species	Individuals (#)	Latitude (decimal degrees)	Longitude (decimal degrees)
NI2497	Steel Creek	10-17-2000	Brown trout	14	42.66897	-98.33975
NI3115	Sand Creek	10-18-2000	Brown trout	2	42.71869	-99.59344
NI3134A	Plum Creek	10-24-2000	Brown trout	13	42.57583	-100.10693
NI3140A	Fairfield Creek	07-30-2008	Brown trout	37	42.77940	-100.10332
NI3140A	Fairfield Creek	10-19-2000	Brown trout	50	42.77940	-100.10332
NI3263	Schlagel Creek	10-25-2000	Brown trout	107	42.80223	-100.55630
NI3263	Schlagel Creek	10-25-2000	Rainbow trout	3	42.80223	-100.55630
NI3268	Snake River	10-25-2000	Rainbow trout	10	42.65412	-100.85834
NI3498	Niobrara River	11-19-2002	Brown trout	66	42.44936	-103.26414
NI3503	South Fork Plum Creek	07-31-2008	Brown trout	8	42.53450	-100.11584
NI3506	Willow Creek	07-29-2008	Brown trout	12	42.56332	-99.71669
NI3507	Plum Creek	07-31-2008	Brown trout	37	42.68235	-100.04048
NI4516	Niobrara River	07-17-2008	Brown trout	2	42.56861	-103.93314
NP2015B	Otter Creek	11-02-2000	Rainbow trout	108	41.33708	-101.94056
NP2015B	Otter Creek	11-02-2000	Brown trout	3	41.33708	-101.94056
NP3029A	Greenwood Creek	11-20-2002	Brown trout	34	41.50028	-103.08171
NP3040	Wildhorse Canyon	11-09-2001	Rainbow trout	7	41.78457	-103.32414
NP3040	Wildhorse Canyon	11-09-2001	Brown trout	96	41.78457	-103.32414
NP3043A	Sheep Creek	11-08-2001	Rainbow trout	115	42.04532	-104.03342
NP3056	Tub Springs Drain	11-09-2001	Brown trout	140	41.94053	-103.68317
NP3059	Spottedtail Creek	11-08-2001	Rainbow trout	5	41.98389	-103.80484
NP3059	Spottedtail Creek	11-08-2001	Brown trout	237	41.98389	-103.80484

Station ID	Waterbody Name	Collection Date	Trout Species	Individuals (#)	Latitude (decimal degrees)	Longitude (decimal degrees)
NP3124	Red Willow Creek	09-19-2006	Rainbow trout	12	41.74487	-103.25619
NP3124	Red Willow Creek	09-19-2006	Brown trout	36	41.74487	-103.25619
NP3125	Wildhorse Drain	09-18-2006	Rainbow trout	11	41.77250	-103.33072
NP3125	Wildhorse Drain	09-18-2006	Brown trout	48	41.77250	-103.33072
NP3131	Sheep Creek	09-20-2006	Rainbow trout	141	42.01508	-104.01325
NP3132	Winters Creek	11-09-2001	Rainbow trout	82	41.88587	-103.61312
NP3132	Winters Creek	11-09-2001	Brown trout	22	41.88587	-103.61312
NP3133	Stuckenhole Drain	11-21-2002	Rainbow trout	214	41.77072	-103.35419
NP3133	Stuckenhole Drain	11-21-2002	Brown trout	46	41.77072	-103.35419
NP3134	Unamed Trib to Spottedtail Creek	11-20-2002	Rainbow trout	1	42.03105	-103.77477
NP3134	Unamed Trib to Spottedtail Creek	11-20-2002	Brown trout	1	42.03105	-103.77477
WH1006	White Clay Creek	10-24-2002	Brown trout	2	42.98776	-102.55888
WH1012A	East Ash Creek	10-22-2002	Brook trout	68	42.63243	-103.19032
WH1013A	West Ash Creek	10-22-2002	Brook trout	42	42.64265	-103.26128
WH1013A	West Ash Creek	07-09-2008	Brook trout	8	42.64265	-103.26128
WH1014B	Squaw Creek	10-22-2002	Brook trout	131	42.63192	-103.31651
WH1022	Chadron Creek	10-31-2000	Brook trout	1	42.70445	-103.01556
WH1022	Chadron Creek	10-31-2000	Brown trout	39	42.70445	-103.01556
WH1023	Dead Horse Creek	11-01-2000	Brook trout	3	42.80667	-103.14056
WH1037A	Soldiers Creek	11-01-2000	Brook trout	6	42.69389	-103.56889
WH1037A	Soldiers Creek	11-01-2000	Brown trout	124	42.69389	-103.56889
WH1038	White River	11-01-2001	Brown trout	7	42.61493	-103.66667

Station ID	Waterbody Name	Collection Date	Trout Species	Individuals (#)	Latitude (decimal degrees)	Longitude (decimal degrees)
WH1071	Beaver Creek	07-10-2008	Brook trout	5	42.84253	-102.74146
WH1071	Beaver Creek	10-31-2000	Brook trout	11	42.84253	-102.74146
WH1072	Little Bordeaux Creek	10-23-2002	Brown trout	3	42.81197	-102.89303
WH1073	Little Bordeaux Creek	10-23-2002	Brown trout	1	42.82101	-102.91396
WH1074	Big Bordeaux Creek	10-23-2002	Brown trout	72	42.82010	-102.92969
WH1074	Big Bordeaux Creek	07-10-2008	Brown trout	30	42.82010	-102.92969
WH1075	Larabee Creek	10-24-2002	Brook trout	2	42.89199	-102.46235
WH1077	White River	07-09-2008	Brown trout	31	42.68655	-103.41788
WH1078	White River	07-17-2008	Brown trout	27	42.61692	-103.65836
WH2041	West Hat Creek	11-01-2001	Brook trout	30	42.73100	-103.78333
WH2042	Sowbelly Creek	11-01-2001	Brook trout	2	42.73084	-103.83333
WH2042	Sowbelly Creek	11-01-2001	Brown trout	52	42.73084	-103.83333
WH2049	Monroe Creek	11-01-2001	Brook trout	136	42.76362	-103.92195
NP3147	Wildhorse Drain	06-14-2011	Rainbow trout	26	41.81672	-103.34043
NP3147	Wildhorse Drain	06-14-2011	Brown trout	5	41.81672	-103.34043
NP3148	Ninemile Creek	06-16-2011	Rainbow trout	96	41.85866	-103.46022
NP3148	Ninemile Creek	06-16-2011	Brown trout	147	41.85866	-103.46022
NP3149	Winters Creek	06-15-2011	Rainbow trout	106	41.89769	-103.59409
NP3149	Winters Creek	06-15-2011	Brown trout	16	41.89769	-103.59409
NP3151	Sheep Creek	06-15-2011	Rainbow trout	123	42.06020	-104.02977
WH1037	Middle Fork Soldier Creek	08-24-2011	Brown trout	50	42.69727	-103.56733
WH1037	Middle Fork Soldier Creek	08-24-2011	Brook trout	15	42.69727	-103.56733

Station ID	Waterbody Name	Collection Date	Trout Species	Individuals (#)	Latitude (decimal degrees)	Longitude (decimal degrees)
WH1081	Dead Horse Creek	08-23-2011	Brook trout	12	42.68449	-103.08101
WH1082	East Ash Creek	08-23-2011	Brook trout	2	42.68267	-103.21139
WH1083	White River	08-24-2011	Brown trout	26	42.65274	-103.47694
WH1084	Deep Creek	08-23-2011	Brown trout	2	42.60378	-103.55654
WH2085	Hat Creek	08-24-2011	Brown trout	82	42.76955	-103.77303
NP2137	Otter Creek	07-20-2011	Rainbow trout	33	41.33324	-101.93836
RE1227	Elm Creek	08-14-2012	Rainbow trout	1	40.11782	-98.44470
NI3410	Short Pine Creek	10-18-2000	Brown trout	2	42.70658	-99.64086
WH1060B	Dead Man's Creek	10-22-2002	Brook trout	32	42.57938	-103.47116
NI3547	South Fork Plum Creek	08-20-2014	Brown trout	26	42.53464	-100.11589
NI3523	Long Pine Creek	07-15-2014	Brown trout	71	42.47645	-99.68575
NI3523	Long Pine Creek	07-15-2014	Rainbow trout	62	42.47645	-99.68575
NI3546	Willow Creek	08-19-2014	Brown trout	22	42.56391	-99.74624
NI3526	Snake River	07-16-2014	Rainbow trout	5	42.57365	-101.71060
NI3530	Plum Creek	07-29-2014	Brown trout	4	42.54863	-100.10914
NI3449	Bone Creek	08-20-2014	Rainbow trout	1	42.67039	-99.76891

Appendix G: Developing Demonstration Sites on Nebraska's Cool Water Streams

The development of demonstration projects for best management practices (BMPs) on Nebraska's cool water streams will provide: 1) working examples of specific practices, 2) an opportunity to monitor these practices through time and assess their long-term value, 3) an active development of relationships with private landowners interested in cool water stream stewardship, and 4) improved habitat conditions for aquatic species dependent upon these systems. NGPC has been an active steward, and this plan consolidates and energizes those efforts to provide an effective and efficient manner by which to implement these projects cohesively with existing staff and partners.

Potential demonstration sites will arise through numerous avenues and current relationships with partners and private landowners. Sometimes this will occur incidentally (e.g., as a biologist is meeting with the cooperator/manager for other reasons) or purposefully (e.g., property or stream reach lies within an identified priority area). The objective in both instances is to gauge initial interest in having the stream reach further evaluated.

Establishing the core stream team

To establish the appropriate team and resources to develop a proposed demonstration site, a short summary of the project (e.g., initiation, location, suggested BMPs) from the initiator should be forwarded to the Cool Water Streams Administrative team (currently Alicia Hardin-Wildlife and Mark Porath-Fisheries) who will develop the core team for the project. While a proposed project may be located in an NGPC district and include the respective Wildlife and Fisheries staff, additional resource experts and partners may be specifically assigned depending on the project scope and objectives.

It is expected that the core team leaders will include Al Hanson (Fisheries Supervisor) and Matt Steffl (Private Lands Supervisor) for projects in the NW district, Jeff Schuckman (Fisheries Supervisor), and either Bill Vodehnal (Private Lands Biologist) or Scott Wessel (Private Lands Supervisor) depending on the project location, in the NE district. Additional core team members will include district fisheries biologists, Steve Schainost (Rivers & Streams Program Manager), and Jeff Blaser (Private Waters Program Manager).

Important resource experts may also be assigned to the core team as needed to develop and monitor a quality demonstration site. Depending on the project features, Dave Schumacher (Surface Water Unit Supervisor, DEQ), and Ritch Nelson (State Wildlife Biologist, NRCS), and NGPC staff including Gerry Steinauer (Botanist), Mike Fritz (Zoologist), Rick Schneider (Natural Heritage Program Manager), WMA Biologists (if working on a WMA), or SRA Superintendents (if working on an SRA) may be asked to participate on the project team.

Other potential partners may include: the Sandhills Task Force (Shelly Kelly), Partners for Fish and Wildlife (Kenny Dinan), NRCS (RC/DC or other representative in county), DEQ Non-Point Source Program (Elbert Traylor), Farm Bill or Coordinating Wildlife Biologist (depending on the project location), and Trout Unlimited (TU) (Mark Van Roogen is TU 710 President).

Initial stream evaluation site visit

If at all possible, the initial site visit should include all the core team leaders and as many of the core team and assigned resource experts as possible to ensure accurate information is presented to the property owner or manager. As a large gathering of state and federal employees can be an imposing group for many private landowners, the initiators summary should include this concern in the recommendation to the administrative team who will appropriately reduce the initial group size. Following the initial site evaluation additional members, resource experts and partners may be brought in to the project team to best fit the objectives and resource need. It is highly desired to have the landowner/tenant/manager involved in the project development to encourage ownership and adequate maintenance of the installed BMPs.

Project proposal and review

The core team subsequent to the initial evaluation site visit should determine if there is the potential for an effective demonstration project. A written proposal should be assembled outlining the objectives of the landowner, the features of the proposed project and estimated cost, and how the project will be maintained and evaluated. The proposal should be vetted by all members in attendance at the initial site visit with comments returned to the core team leaders.

The project proposal should include the following:

1) An aerial photo of the project area and general description of the surrounding landscape (e.g, BUL, stream name, county, stream category).
2) A description of the stream reach (e.g., order, flow, riparian corridor, current land use).
3) A description of the aquatic and riparian community if known (e.g., plant community assessments, fish sampling results, sensitive species present/absent).
4) Pictures of the project site indicating location, size and scale of proposed features.
5) Basic Budget table: Estimated cost of each installed practice/feature, percent cost-share to be provided by the landowner and/or partners.
6) Plans for sustaining the practice(s) being implemented.
7) Recommend a length of contract (minimum 5 years, maximum 10 years), depending on practice and features implemented and evaluation timeline.

8) A summary of the proposed project to meet the program goals, the urgency or uniqueness of the project to meet the objectives of the program.
9) Include your "thoughts" on the project and the feasibility of its success.

The draft proposal should be sent to the core team (including partners and assigned resource experts) and the Administrative team for input and review. A revised proposal can then be presented to the property owner or manager for their review to ensure we are all on the same page as to the types of practices being implemented for the project. Once concurrence is established a draft agreement will be assembled by the Administrative team and reviewed by the core team leaders prior to submitting to the property owner or manager for execution.

Appendix H: Confirmed or Potential Demonstration Sites

Stream Name	Status	County Name
Ash Creek	Potential	Rock
Coon Creek	Potential	Rock
Cub Creek	Potential	Keya Paha
Dry Spotted Tail Creek	Confirmed	Scotts Bluff
Gordon Creek	Confirmed	Cherry
Gracie Creek	Confirmed	Loup
Long Pine Creek	Confirmed	Brown
Louse Creek	Potential	Holt
Snake River (Below Merritt)	Potential	Cherry
Tributary N. Branch Verdigre Creek	Potential	Holt

Appendix I: Top 63 Cool Water Streams in Nebraska

Stream Name	County(s)	Segment	Type*	Trout Stocked	Trout Naturally Reproducing	NGPC Heritage E&T** or Tier 1	NDEQ E&T**	NDEQ Sensitive
Big Springs Creek	Antelope		CB, Perennial	No	No	Yes	No	Yes
Merriman Creek	Antelope, Knox	Headwaters to Verdigre Creek	CB, Perennial	No	No	Yes	No	Yes
Verdigre Creek	Antelope, Knox	North Branch in Knox County, East Branch headwaters to Grove Dam	CB, Perennial	No	No	No	No	Yes – North Branch
Pumpkin Creek	Banner, Morrill	Headwaters to North Platte River	CB, Perennial	No	No	No	No	Yes
Goose Creek	Blaine, Brown, Cherry	Headwaters to North Loup River	CB, Perennial	No	No	Yes	Yes	Yes
Dismal River	Blaine, Hooker, Thomas		CB, Perennial	No	No		No	No
Niobrara River	Box Butte, Dawes, Sioux	Above and below Box Butte Dam from WY border to Box Butte Creek	CB, Perennial	No	Yes – above Box Butte Dam	Yes	Yes – above Box Butte Dam	No
Bone Creek	Brown	Headwaters to Unnamed Creek to Long Pine Creek	CB, Perennial	No	No	Yes	Yes	Yes
Plum Creek	Brown	South Fork (all) to Evergreen Creek	CA, Perennial	No	Yes	No	No	Yes
Sand Draw	Brown		CB, Perennial	No	No	Yes	Yes	No

*CA = Class A Cool Water; CB = Class B Cool Water
**E&T = Endangered and Threatened

Stream Name	County(s)	Segment	Type*	Trout Stocked	Trout Naturally Reproducing	NGPC Heritage E&T** or Tier 1	NDEQ E&T**	NDEQ Sensitive
Dry Creek	Brown, Cherry		CB, Perennial	No	No		No	No
Long Pine Creek	Brown, Rock	Headwaters to Niobrara River	CA, CB, Perennial	Yes	Yes	Yes	No	Yes
Sand Draw	Chase		CB, Perennial	No	No	No	No	No
Arkansas Flats	Cherry		CB, Perennial	No	No	Yes	No	No
Betsy Creek	Cherry		CB, Perennial	No	No	Yes	Yes	No
Big Creek	Cherry		CB, Perennial	No	No	Yes	Yes	No
Boardman Creek	Cherry		CA, Perennial	No	No	No	Yes	Yes
Brush Creek	Cherry		CB, Perennial	No	No	Yes	Yes	No
Bull Creek	Cherry		CB, Perennial	No	No	No	Yes	Yes
Clifford Creek	Cherry		CB, Perennial	No	No	Yes	No	No
Dry Creek	Cherry		CB, Perennial	No	No	Yes	Yes	Yes
Evergreen Creek	Cherry		CB, Perennial	No	No	Yes	No	Yes
Fairfield Creek	Cherry		CA, Perennial	No	Yes	Yes	Yes	Yes
Gordon Creek	Cherry	Headwaters to Niobrara River	CB, Perennial	No	No	Yes	Yes	Yes
Leander Creek	Cherry		CB, Perennial	No	No	Yes	Yes	Yes
Minnechaduza Creek	Cherry		CB, Perennial	Yes	No	Yes	Yes	Yes
Mud Creek	Cherry		CB, Perennial	No	No	Yes	Yes	No
Sandy Richards Creek	Cherry		CB, Perennial	No	No	Yes	Yes	Yes
Schlagel Creek	Cherry		CA, Perennial	Yes	Yes	No	No	No

*CA = Class A Cool Water; CB = Class B Cool Water
**E&T = Endangered and Threatened

Stream Name	County(s)	Segment	Type*	Trout Stocked	Trout Naturally Reproducing	NGPC Heritage E&T** or Tier 1	NDEQ E&T**	NDEQ Sensitive
Snake River	Cherry	Cherry County above and below Merritt to Niobrara River	CA, CB (above Merritt), Perennial	Yes	Yes – below Merritt	Yes – above Merritt	Yes – above Merritt	Yes
Willow Creek	Cherry		CB, Perennial	No	No	Yes	Yes	No
Middle Loup River	Cherry, Grant, Hooker	North Branch & South Branch to Middle Loup River	CB, Perennial	Yes	No	Yes	Yes	Yes
Big Bordeaux Creek	Dawes		CB, Perennial	Yes	Yes	No	No	No
East Ash Creek	Dawes		CB, Perennial	Yes	Yes	No	No	No
Soldier Creek	Dawes, Sioux	Headwaters to White River, South Fork & Middle Fork	CA, Perennial	No	Yes	No	No	No
Frenchman Creek	Hayes, Hitchcock	Stinking Water Creek to Republican River	CB, Perennial	No	No	No	No	Yes
Brush Creek	Holt	Headwaters to Niobrara River	CB, Perennial	No	No	Yes	No	Yes
Camp Creek	Holt		CB, Perennial	No	No	No	Yes	Yes
Louse Creek	Holt	Headwaters to Niobrara River	CA, Perennial	No	Yes	No	No	Yes
North Platte River	Keith	Kingsley Dam to Whitetail Creek	CB, Perennial	No	No	Yes	No	No
Otter Creek	Keith	Headwaters to Lake C.W. McConaughy	CA, Perennial	No	Yes	Yes	No	No
Burton Creek	Keya Paha		CB, Perennial	No	No		No	No
Coon Creek	Keya Paha		CB, Perennial	No	No		No	No
East Branch Holt Creek	Keya Paha		CB, Perennial	No	No		Yes	No

*CA = Class A Cool Water; CB = Class B Cool Water
**E&T = Endangered and Threatened

Stream Name	County(s)	Segment	Type*	Trout Stocked	Trout Naturally Reproducing	NGPC Heritage E&T** or Tier 1	NDEQ E&T**	NDEQ Sensitive
Holt Creek	Keya Paha	Headwaters to NE-SD border	CB, Perennial	No	No	Yes	Yes	Yes
Shadley Creek	Keya Paha	Headwaters to NE-SD border	CB, Intermittent	No	No	Yes	Yes	No
Timber Creek	Keya Paha	Headwaters to NE-SD border	CB, Perennial	No	No	No	Yes	No
Lodgepole Creek	Kimball	Unnamed Creek (Sec 3-14N-58W) to Oliver Reservoir Dam	CA, Perennial	No	No	Yes	No	Yes
South Loup River	Logan	Headwaters to North Fork South Loup River	CB, Perennial	No	No	Yes	Yes	Yes
Gracie Creek	Loup		CB, Perennial	Yes	No	Yes	No	Yes
Bloody Creek	Loup, Rock		CB, Perennial	No	No		No	No
Taylor Creek	Madison		CB, Perennial	No	No	Yes	Yes	No
Red Willow Creek	Morrill	Headwaters to Wildhorse Drain	CA, Perennial	No	Yes	No	No	No
Clear Creek	Polk, Butler		CB, Perennial	No	No		No	No
Ash Creek	Rock		CB, Perennial	No	No	No	No	No
Short Pine Creek	Rock		CA, Perennial	No	No	No	No	Yes
Ninemile Creek	Scotts Bluff	Headwaters to Minatare Dam & Minatare Drain to North Platte River	CA, CB, Perennial	No	Yes	No	No	No
Sheep Creek	Scotts Bluff	Dry Sheep Creek to North Platte River	CB, Perennial	No	Yes	No	No	No
Spottedtail Creek	Scotts Bluff, Sioux	Unnamed Creek (Sec 23-24N-56W) to Tri- State Canal-	CA, Intermittent	No	Yes	No	No	Yes

*CA = Class A Cool Water; CB = Class B Cool Water
**E&T = Endangered and Threatened

Stream Name	County(s)	Segment	Type*	Trout Stocked	Trout Naturally Reproducing	NGPC Heritage E&T** or Tier 1	NDEQ E&T**	NDEQ Sensitive
Pine Creek	Sheridan	Headwaters to Niobrara River	CB, Perennial	No	No	Yes	Yes	Yes
Sheep Creek	Sioux	Headwaters to Unnamed Creek (Sec 15-24N-58W)	CA, Perennial	No	Yes	No	No	Yes
Monroe Creek	Sioux	Sec 33-33N-56W to Warbonnet Creek	CA, Perennial	No	Yes	No	No	No
Elm Creek	Webster		CB, Perennial	Yes	No	No	No	Yes

*CA = Class A Cool Water; CB = Class B Cool Water
**E&T = Endangered and Threatened

Appendix J: Cool Water Stream Temperature Monitoring Sites (2015-2016)

Monitoring Site Name	Stream Name	County Name	Public or Private	Monitoring Agency
AID 1	Alliance Irrigation Drain	Brown	Private	NGPC
Bordeaux Cliff	Big Bordeaux Creek	Dawes	USFS	NGPC
Bordeaux North	Big Bordeaux Creek	Dawes	Bordeaux WMA	NGPC
BN 1	Bone Creek	Brown	Private	NGPC
BN 2	Bone Creek	Brown	Keller Park SRA	NGPC
BN 3	Bone Creek	Brown	Keller Park SRA	NGPC
BN 4	Bone Creek	Brown	Private	NGPC
CD 1	Cedar Creek	Brown	Private	NGPC
Chadron Creek	Chadron Creek	Dawes	Chadron Creek Ranch WMA	NGPC
Chadron Creek- Above Discharge	Chadron Creek	Dawes	Chadron SP	NGPC
Chadron Creek- Below Discharge	Chadron Creek	Dawes	Chadron SP	NGPC
Chadron Creek Park Entrance	Chadron Creek	Dawes	Chadron SP	NGPC
Chadron Creek Park Exit	Chadron Creek	Dawes	Chadron SP	NGPC
Deadman Creek	Deadman's Creek	Sioux	Private	NGPC
DR 1	Dry Creek	Brown	Private	NGPC
Spottedtail-Hanson	Dry Spottedtail Creek	Scotts Bluff	PRBE	NGPC
Spottedtail-Steffl	Dry Spottedtail Creek	Scotts Bluff	PRBE	NGPC
East Ash	East Ash Creek	Dawes	USFS	NGPC
EG 1	Evergreen Creek	Brown	Private	NGPC
EG 2	Evergreen Creek	Brown	Private	NGPC
Gordon 1 (Station 1)	Gordon Creek	Cherry	Private	NGPC
Gordon 2 (Station 2)	Gordon Creek	Cherry	Private	NGPC
Gordon 3 (Station 3)	Gordon Creek	Cherry	Private	NGPC
Gordon 4 (Station 4)	Gordon Creek	Cherry	Private	NGPC
Forney's Pivot	Larabee Creek	Sheridan	Private	NGPC
Forney's	Larabee Creek	Sheridan	Private	NGPC
Dolezal's	Larabee Creek	Sheridan	Private	NGPC
LP 1	Long Pine Creek	Brown	Private	NGPC
LP 2	Long Pine Creek	Brown	Pine Glen WMA	NGPC
LP 3	Long Pine Creek	Brown	Long Pine SRA	NGPC
LP 4	Long Pine Creek	Brown	Private	NGPC
Middle Branch of Middle Loup	Middle Loup River, Middle Branch	Cherry	Private	NGPC
Middle Loup N. of Mullen	Middle Loup River	Hooker	Private	NGPC
South Branch Middle Loup	Middle Loup River, South Branch	Hooker	Private	NGPC
Middle Fork of Solider	Middle Fork Soldier Creek	Sioux	Fort Robinson SP	NGPC
Minnechaduza 1	Minnechaduza Creek	Cherry	Private	NGPC

Monitoring Site Name	Stream Name	County Name	Public or Private	Monitoring Agency
Minnechaduza 2	Minnechaduza Creek	Cherry	Private	NGPC
Minnechaduza 3	Minnechaduza Creek	Cherry	NGPC Fish Hatchery	NGPC
Monroe Creek	Monroe Creek	Sioux	Gilbert-Baker WMA	NGPC
9 Mile OFW	Nine Mile Creek	Scotts Bluff	OFW	NGPC
9 Mile WMA	Nine Mile Creek	Scotts Bluff	9 Mile WMA	NGPC
Niobrara River- HWY 71	Niobrara River	Box Butte	OFW	NGPC
Niobrara River- HWY 385	Niobrara River	Dawes	Private	NGPC
Niobrara River -Pink School House	Niobrara River	Sioux		NGPC
Pine Creek- North	Pine Creek	Sheridan	Private	NGPC
Pine Creek- Middle	Pine Creek	Sheridan	Private	NGPC
Pine Creek -South	Pine Creek	Sheridan	Private	NGPC
PL 1	Plum Creek	Brown	Bobcat WMA	NGPC
PL 2	Plum Creek	Brown	Private	NGPC
PL 3	Plum Creek	Brown	Private	NGPC
PL 4	Plum Creek	Brown	Private	NGPC
PL 5	Plum Creek	Brown	Private	NGPC
PL 6	Plum Creek	Brown	Private	NGPC
PL 7	Plum Creek	Brown	Plum Creek Valley WMA	NGPC
PL 8	Plum Creek	Brown	Private	NGPC
PL 9	Plum Creek, South Branch	Brown	Private	NGPC
SD 1	Sand Draw	Brown	Private	NGPC
SD 2	Sand Draw	Brown	Private	NGPC
Schlagel Creek 1	Schlagel Creek	Cherry	Schlagel Creek WMA	NGPC
Schlagel Creek 2	Schlagel Creek	Cherry	Private	NGPC
Schlagel Creek 3	Schlagel Creek	Cherry	Private	NGPC
Sandy Area N. of Henry	Sheep Creek	Sioux	Private	NGPC
WY NE State Area	Sheep Creek	Sioux	Private	NGPC
Snake River Above Merritt	Snake River	Cherry	Private	NGPC
Snake River East of Cherry Co.	Snake River	Cherry	Private	NGPC
Snake River HWY 61	Snake River	Cherry	Private	NGPC
Snake River- Schoolhouse Lake	Snake River	Cherry	Private	NGPC
Sowbelly	Sowbelly Creek	Sioux	Coffee Park	NGPC
Squaw Creek	Squaw Creek	Dawes	Ponderosa WMA	NGPC
West Ash Creek	West Ash Creek	Dawes	USFS	NGPC
White Clay Creek	White Clay Creek	Dawes	Private	NGPC
White River-Andrews	White River	Sioux	Private	NGPC
White River-Glen	White River	Sioux	Private	NGPC
White River- Swinging Bridge	White River	Sioux	Fort Robinson SP	NGPC
White River Golf Course	White River	Sioux	Fort Robinson SP	NGPC
WL 1	Willow Creek	Brown	Private	NGPC

References

Bazata, K. 2011. Nebraska Stream Biological Monitoring Program 2004-2008. Project report for the Nebraska Department of Environmental Quality, Lincoln, NE. Retrieved from: http://deq.ne.gov/Publica.nsf/pages/WAT170.

Eng, K., D.M. Wolock, D.M. Carlisle. 2013. River flow changes related to land and water management practices across the conterminous United States. Science of the Total Environment 463-464:414-422.

Exec. Order No. 13112, 3 C.F.R. 6183 (1999). Retrieved from: https://www.doi.gov/sites/doi.gov/files/uploads/EO%2013112_0.pdf.

Global Invasive Species Database (GISD). 2015. Species profile Corbicula fluminea. Retrieved from: http://www.iucngisd.org/gisd/species.php?sc=537.

Johnson, R.E. The Distribution of Nebraska Fish. Thesis. University of Michigan. 1942.

Jones, D.J. 1963. A History of Nebraska's Fishery Resources. Nebraska Game, Forestation and Parks Commission.

Hrabik, R.A., S.C. Schainost, R.H. Stasiak, E.J. Peters. The Fishes of Nebraska. Lincoln: Conservation & Survey Division, School of Natural Resources, University of Nebraska-Lincoln. 2015. Print.

Hurley, K. 2013. 2012 Statewide Licensed Angler Survey. Nebraska Game and Parks Commission Fisheries Division, Lincoln, Nebraska.

Lyons, J., J.S. Stewart, and M. Mitro. 2010. Predicted effects of climate warming on the distribution of 50 stream fish in Wisconsin. U.S.A. Journal of Fish Biology 77:1867-1898.

Lyons, J., T. Zorn, J. Stewart, P. Seelbach, K. Wehrly and L. Wang. 2009. Defining and characterizing coolwater streams and their fish assemblages in Michigan and Wisconsin, USA. North American Journal of Fisheries Management 29:1130-1151.

Lyons, J., S.W. Timble, and L.K. Paine. 2000. Grass versus trees: managing riparian areas to benefit streams of central North America. Journal of the American Water Resources Association 36:919-930.

Magnuson, J.J., L.B.Crowder and P.A.Medvick. 1979. Temperature as an ecological resource. American Zoologist 19(1):331-343.

Marshall, D.W., A.H. Fayram, J.C. Panuska, J. Baumann, J. Hennessy. 2008. Positive effects of Agricultural land use changes on coldwater fish communities in southwest Wisconsin streams. North American Journal of Fisheries Management 28(3):944-953.

NDEQ. 2016. 2015 Nebraska Water Monitoring Programs Report. Retrieved from: http://deq.ne.gov/Publica.nsf/pages/WAT233.

NDEQ. 2014. 2014 Water Quality Integrated Report. Retrieved from: http://deq.ne.gov/publica.nsf/pages/WAT214.

NDEQ. 2012. Title 117 – Nebraska Surface Water Quality Standards. Retrieved from: http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC.

NDNR. 2016. Summary of Non-abandoned Registered Wells on File After the Fourth Quarter, 2015. Retrieved from: http://dnr.nebraska.gov/gwr/fourth-quarter-by-county-and-use-non-abandoned-2.

NDNR. 2015. Irrigation and Reclamation Districts and Water Delivery Companies. Retrieved from: http://dnr.nebraska.gov/swr/irrigation-and-reclamation-districts-directory-2014.

NGPC. "Trout Fishing in Nebraska's Streams." NEBRASKAland January-February 2002: 1-20. Print.

Schainost, S. Personal Email Communication. March 17, 2016.

Schneider, R., K. Stoner, G. Steinauer, M. Panella, and M. Humpert. 2011. The Nebraska Natural Legacy Project: State Wildlife Action Plan, 2nd ed. The Nebraska Game and Parks Commission, Lincoln, NE.

U.S. Army Corps of Engineers Wilmington District, U.S. Environmental Protection Agency Region IV, North Carolina Wildlife Resources Commission, North Carolina Division of Water Quality, and Natural Resources Conservation Service. 2003. Stream Mitigation Guidelines. Retrieved from: https://www.scribd.com/document/32544031/S-O-P-Army-Corps-of-Engineers-Wilmington-Dist-Stream-Mitigation-Guidelines.

USDA National Agricultural Statistics Service. 2016. Nebraska Agriculture Fact Card. Nebraska Department of Agriculture, Lincoln, NE. Retrieved from: http://www.nda.nebraska.gov/facts.pdf.

Wehrly, K.E., M.J.Wiley and P.W.Seelbach. 2003. Classifying regional variation in thermal regime based on stream fish community patterns. Transactions of the American Fisheries Society 132: 18-38.