Donahoo Tract Restoration Plan

Dordt University Restoration Ecology Class (ENVR 325)
Spring 2019

Property Location: Peterson, IA (42.909620, -95.326878)

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Donahoo Restoration Plan

I. Project Introduction

a. Background and Site Summary

The Donahoo tract is located in Northwest Iowa along the Little Sioux River just south of the city of Peterson. The tract is 171.2 acres with 56.9 acres in Buena Vista County and 114.3 acres in Clay County. The location of the tract in two counties presents an interesting opportunity for collaboration between the Clay and Buena Vista County Conservation boards. A management plan for the property must balance the needs and resources of both counties and prioritize restoration goals based on ecological need.

The tract borders the Little Sioux River which is one of five protected waterways in Iowa. There is a wide range of habitats on the Donahoo tract including remnant prairie, oak savanna, upland forest, oxbows, floodplain forest, riparian grassland, and a pond. Remnant prairie and oak savanna have become rare in Iowa and the Midwest, which makes it important to preserve these endangered habitats.

The Spring 2019 Dordt University Restoration Ecology class saw great potential for the Donahoo tract as it provides a wide array of habitats and recreational opportunities. Furthermore, the collaboration of the Clay County Conservation Board and the Buena Vista County Conservation Board can provide more resources, funds, and available hands to implement the restoration plan.

b. Motivation

As students at a Christian university, we see restoration of the Donahoo tract as one small step towards the larger movement of restoring the whole creation. Recognizing that the creation does not belong to us, we seek, through this restoration plan, to enable all of creation (plants, animals, people, and other life forms) to flourish for generations to come.

c. Site History

The Iowa Natural Heritage Foundation purchased the Donahoo tract in 2017. The Donahoo family owned the property from 2016 to 2017 after buying it from the Croston family. The land was used by European settlers and modern-day farmers for cattle grazing, although it has been many years since it was last grazed. Centuries prior to the arrival of European settlers, the area was occupied by Native Americans of Mill Creek Culture who farmed the land and hunted large herbivores such as bison and elk.

i. Cultural

Iowa's archaeological past is divided into five distinct eras: the Paleoindian, Archaic, Woodland, Prehistoric, and Historic periods (Alex, 2000). The Paleoindian, Archaic, and Woodland eras combined lasted from 11,500 B.C.E. to 900 C.E. Due to age of these cultures and the climate of Northwest Iowa there is limited knowledge about these

ancient native peoples and few artifacts are typically found. During the late Prehistoric era Northwest Iowa became home to the people belonging to Mill Creek Culture. Remnants of this culture are centered around the Big and Little Sioux Rivers and their tributaries. As a horticultural society, Mill Creek peoples chose their village sites in relation to water availability, tillable soil, proximity to large game, and timber sources (Alex, 2000). A clear indicator of Mill Creek Culture sites are large mounds 10 to 12 feet high. These mounds were created as native peoples buried their trash and old buildings and rebuilt on the tops of these mounds (Fishel, 1996). The Mill Creek people traded extensively with other native groups to the south and appeared to be a peaceful group, although some villages were fortified with ditches on three sides. It is not understood why the Mill Creek people left the area, but by the end of the 13th century they had left Iowa and groups such as the Ioway, Omaha, Chippewa, and Sioux moved into the area (Mill...c1996-2019).

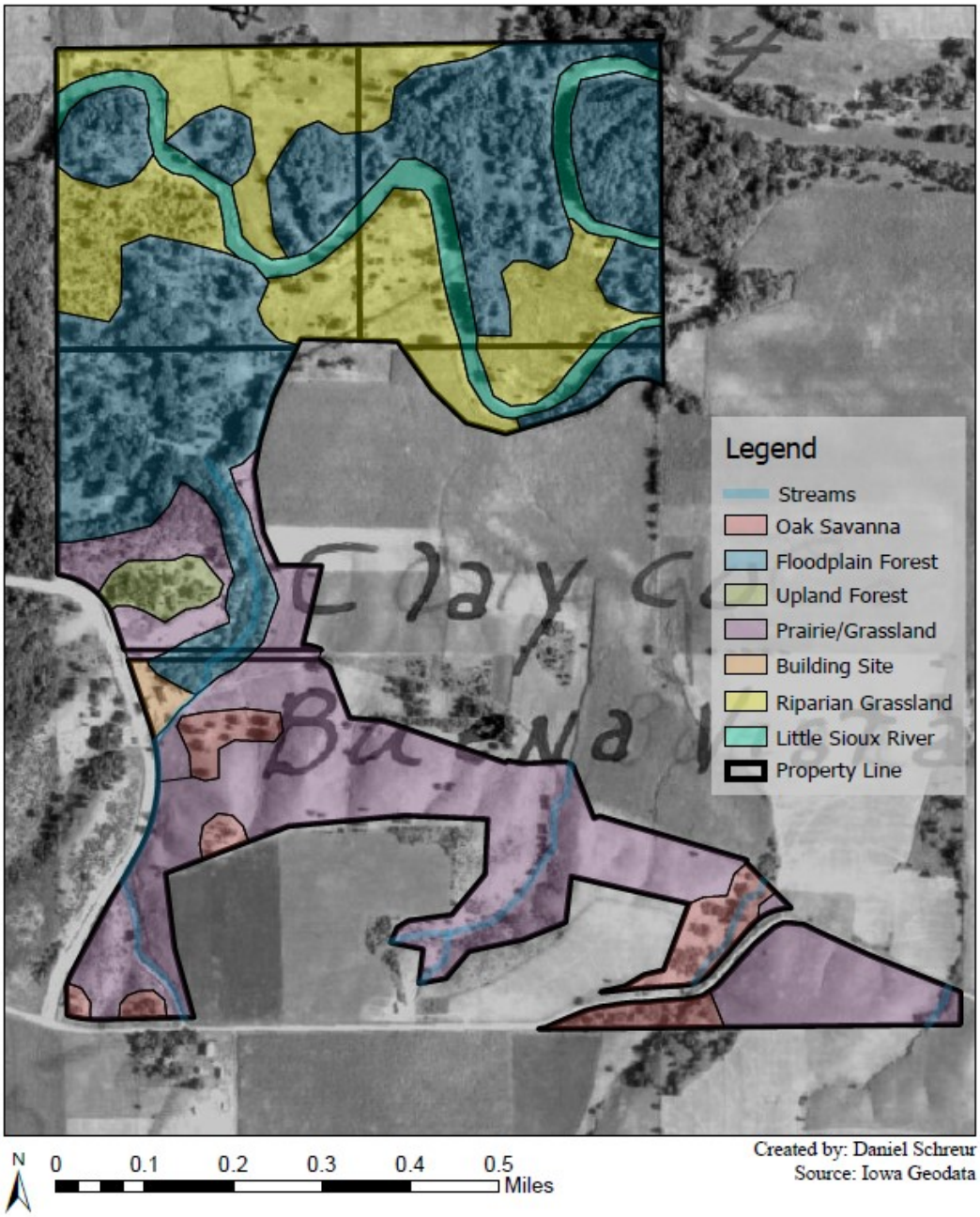
The Donahoo tract has the potential to contain archaeological sites belonging to Mill Creek Culture. Archaeologist Megan Stroh Messerole at the Sanford Museum and Planetarium in Cherokee, Iowa, pointed out the topographical features that would have appealed to this people group for building villages, farming, and burying their dead. Although there are no known sites on or directly surrounding the Donahoo tract, it is an opportune place to do future archaeological investigations and digs.

ii. Ecological

The Donahoo Tract was historically composed of the following ecosystems: tall grass prairie, oak savanna, upland forest, floodplain forest, riparian grassland, and the Little Sioux River and its associated oxbows. Each ecosystem would have been composed of native species, utilized by wildlife in unique ways, and experienced natural disturbances at various times. The tall grass prairie was incredibly diverse and resilient and provided habitat for many animal species. Because of the rich, fertile soil created by the tall grass prairie's deep root system, the majority of the tall grass prairie was converted to agricultural land by early settlers. Less than 1% of Iowa's tall grass prairies are left today (Houseal). There are several fragments of high-quality remnant prairie left on the Donahoo tract. Within the tract there are also pieces of degraded oak savanna. Historically, the oak savanna would have consisted of large oak trees widely distributed with a diverse herbaceous plant understory. Oak savanna depended on heavy grazing and frequent fire to suppress woody growth. Oak savannas were severely compromised with the arrival of Europeans, who did not recognize the uniqueness of this ecosystem, and who removed the necessary disturbances needed to keep oak savannas healthy. The little Sioux River and its associated floodplains and oxbows create a dynamic system in which the ecosystems composition varied widely over time. This is due to frequent flooding or lack of flooding throughout the years. The river has changed its course and has left behind several oxbows which have been filled in with sediment during flooding and which provide wetland habitat for many species of birds and fish.

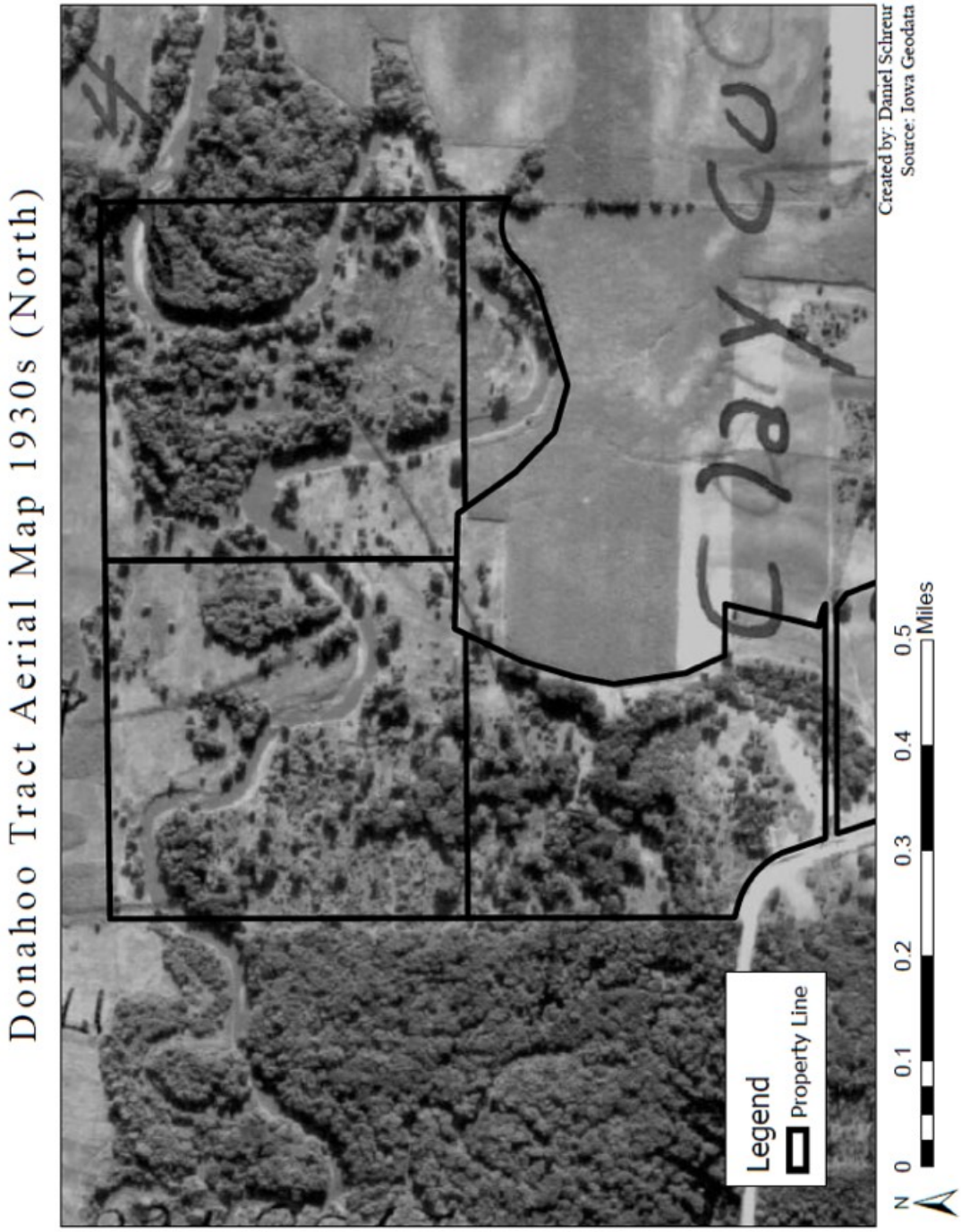
d. Historical Ecosystems Maps

Donahoo Tract Historical Ecosystems Map (1930s imagery)



Created by: Daniel Schreur
Source: Iowa Geodata

1930s Aerial Photos

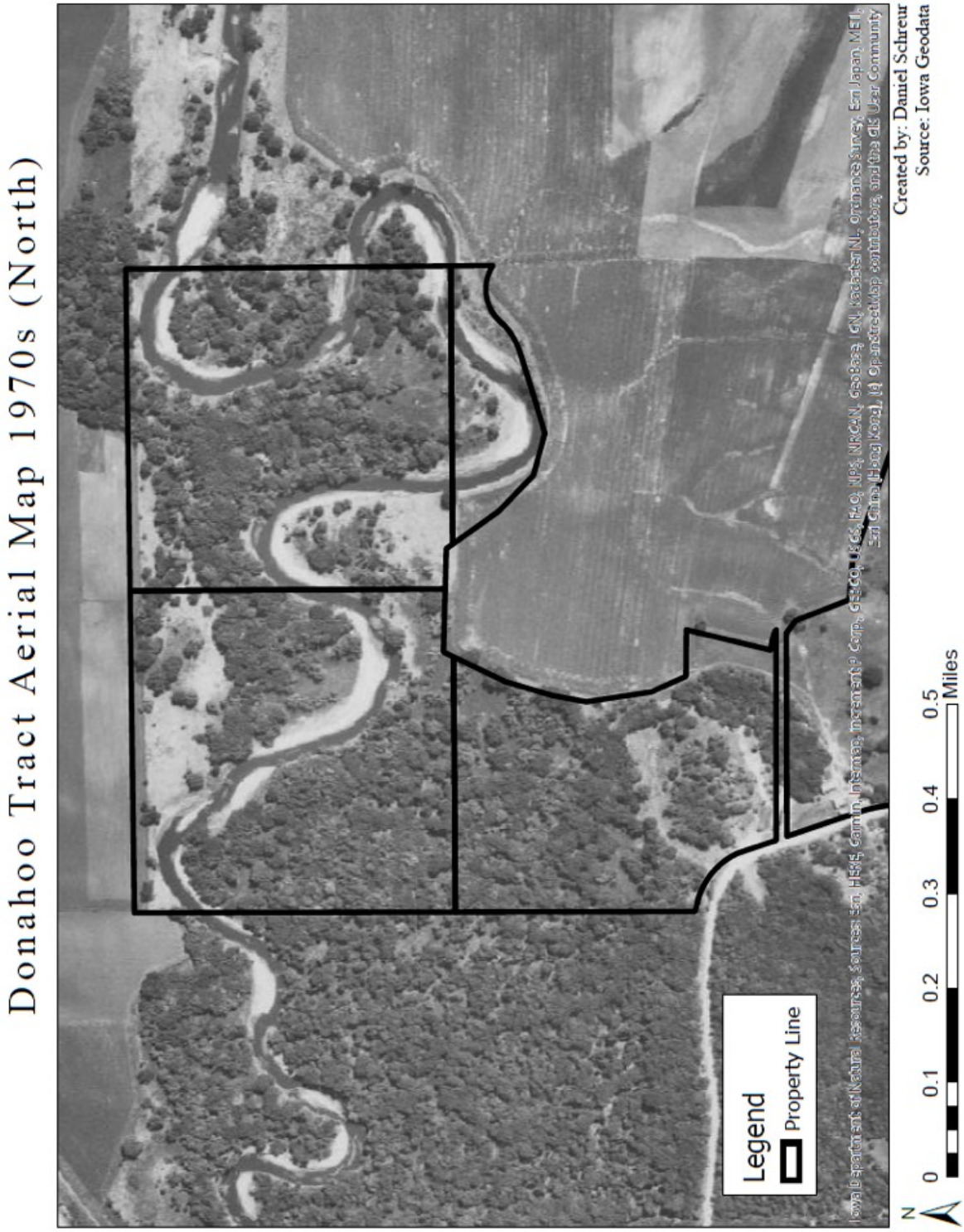


Donahoo Tract Aerial Map 1930s (South)

N 0 0.1 0.2 0.3 0.4 0.5 Miles

Created by: Daniel Schreur
Source: Iowa Geodata

1970s Aerial Maps



Donahoo Tract Aerial Map 1970s (South)

N

0 0.1 0.2 0.3 0.4 0.5 Miles

Created by: Daniel Schreur
Source: Iowa Geodata

e. Current Conditions and Site Usage

For the restoration to be successful it is helpful to understand the current use and conditions of the site. Starting restoration work without understanding the current conditions can lead to taking unnecessary steps and ignoring needed work. In short, the current conditions dictate what work is necessary for the ecosystem to be restored. Thus, the restoration begins with an understanding of the current state of the ecosystems.

The current native prairie is located in 1o, 2J and 2L (Map 1-2 Pages 22-23). It contains some problem areas such as invasive species which are colonizing and encroaching upon prairie remnants and surrounding grasslands. Lack of plant diversity in remnants and surrounding grasslands is also troubling. Prairie remnants cover a small area compared to the historical range on the property. The native prairie has also been overrun by smooth bromegrass, which was likely seeded to support grazing by domestic livestock.

The existing condition of the upland forest presents various opportunities and challenges. One problem is the encroaching red cedar population. Another problem is the erosion that occurs in many of the ravines that the upland forest inhabits. In some of the upland forest there are other invasive species in the understory. There are also areas of dumping and other rubbish which need to be taken care of. The 1930 photo shows that only section 1n (map 1 page 22) is true upland forest and the rest of the forest areas could potentially be removed and turned back into prairie.

The existing condition of the oak savanna ecosystem presents several opportunities and challenges. Oak savanna remnants on the Donahoo tract are very split up. They can be found in sections 2d, 2e,2g,2h,2m and 2o of map 1 (page 23). These remnant sections of oak savanna are prime candidates for restoration. Some of the existing problems are invasive species and a lack of fire and grazing (disturbance). The understory in the oak savannas has been overgrown by smooth bromegrass in most areas. The brome grass was likely planted to support the cattle that historically grazed the property.

The pond was created by an earthen dam that blocked the flow of a small stream. The pond is 24,000 square feet (.56 acres) and has a maximum depth of 14 feet. The pond is inhabited by green sunfish, *Lepomis cyanellus* and largemouth bass *Micropterus salmoides.* The berm itself has experienced erosion at the site of the spillway and the back side seems to be undergoing some sliding which could compromise the pond.

The floodplain forest is comprised mostly of older silver maples and cottonwood with a few green ashes. The trees are widely spaced with little understory growth. The areas where the trees do not create shade are dominated by reed canary grass. Judging from the fact that there are few younger trees it seems that there is little new growth. The Little Sioux River also runs through the property with flooding being a frequent occurrence leaving behind sediment when the river recedes. There is significant channelization causing steep riverbanks and erosion along the path of the river.

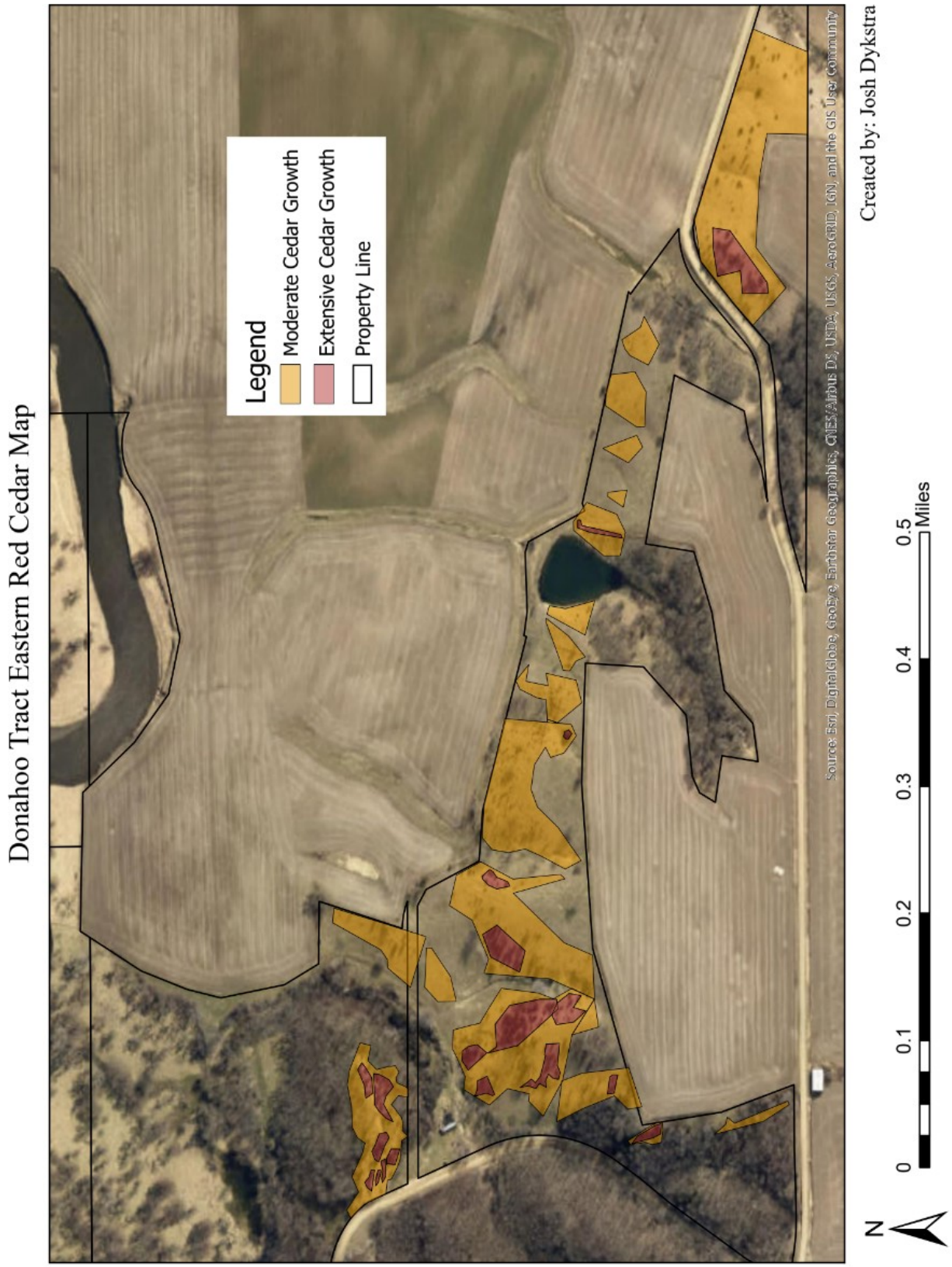
There is evidence of at least 4 oxbows, three of which appear to be partially functional and hold at least some water after the river floods. The oxbows vary in size and depth with increased sedimentation in some. In a few of the oxbows there is standing vegetation, mostly reed canary grass. Two of the oxbows have been completely filled in with sediment and no longer hold water. The other oxbows have partial sedimentation which has reduced their capacity to hold water after flooding events.

The building site is located in 2a (Map 2 Page 23) this site contains an old cattle shed and other structures that are in serious disrepair, as well as other rubbish that poses a danger to

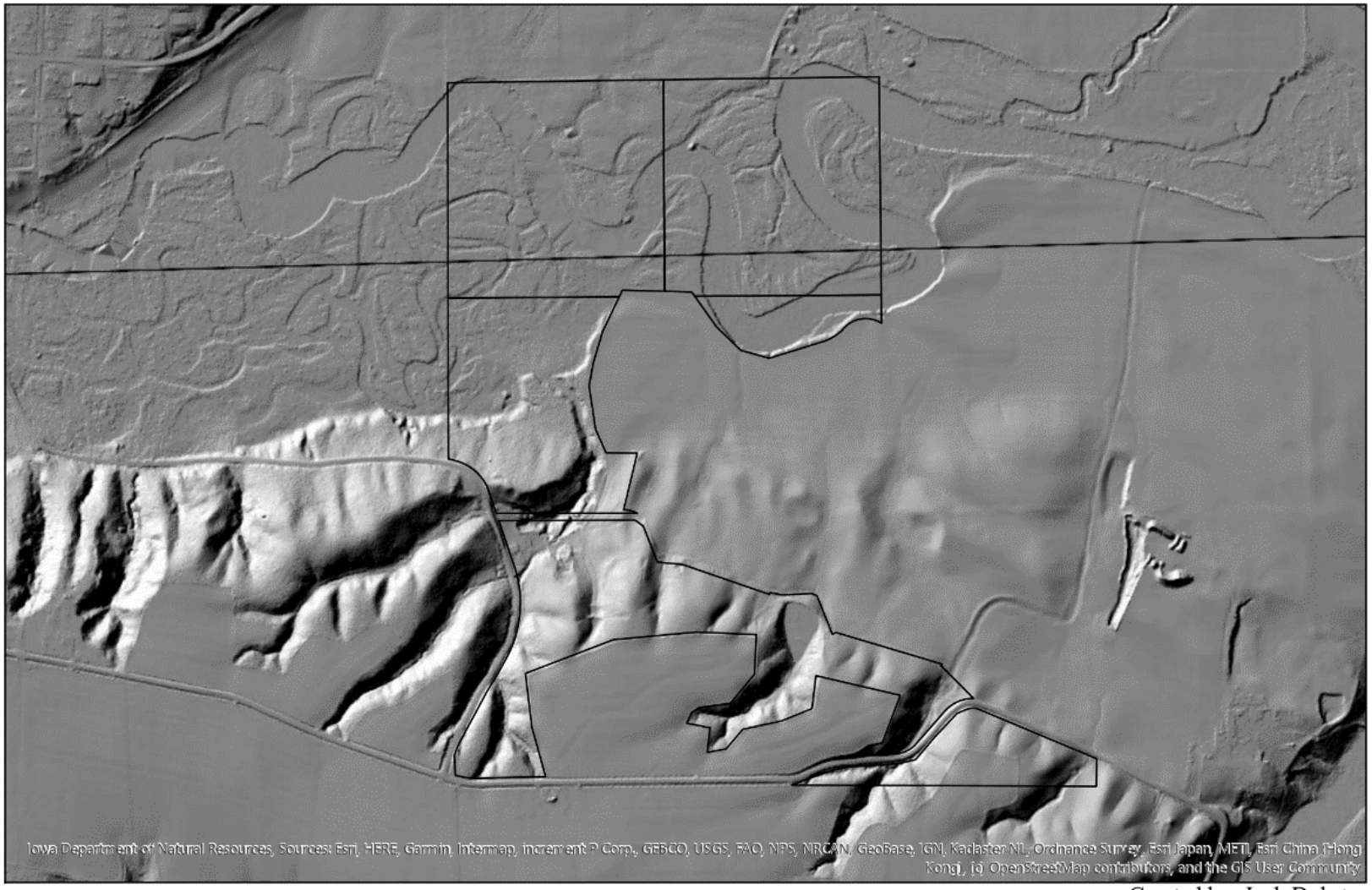
people and potentially wildlife if not removed. There are also three uncapped wells that need to be taken care of immediately. The site is primarily vegetated by woody species and has experienced high levels of disturbance. There is also extensive, ongoing soil erosion due to culvert failure.

The Donahoo tract has not been used for agriculture for an estimated four to five years. Cropland has been left fallow which has allowed for the establishment of weedy and invasive plant species. Invasive species have been introduced to almost every ecosystem due to human activities as well as the lack of grazing and fire. Red cedars are threatening the prairie, oak savannas, and upland forest ecosystems. The pond on the tract has been stocked in the past with green sunfish, (***Lepomis cyanellus)*** and there was a large population of these fish still in pond as of April 16, 2019.

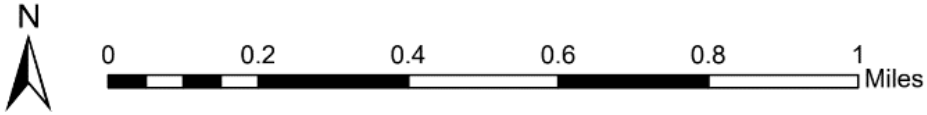
i. Maps


Donahoo Tract Eastern Red Cedar Map
Legend
Moderate Cedar Growth
Extensive Cedar Growth
Property Line
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Created by: Josh Dykstra
N
0
0.1
0.2
0.3
0.4
0.5
Miles

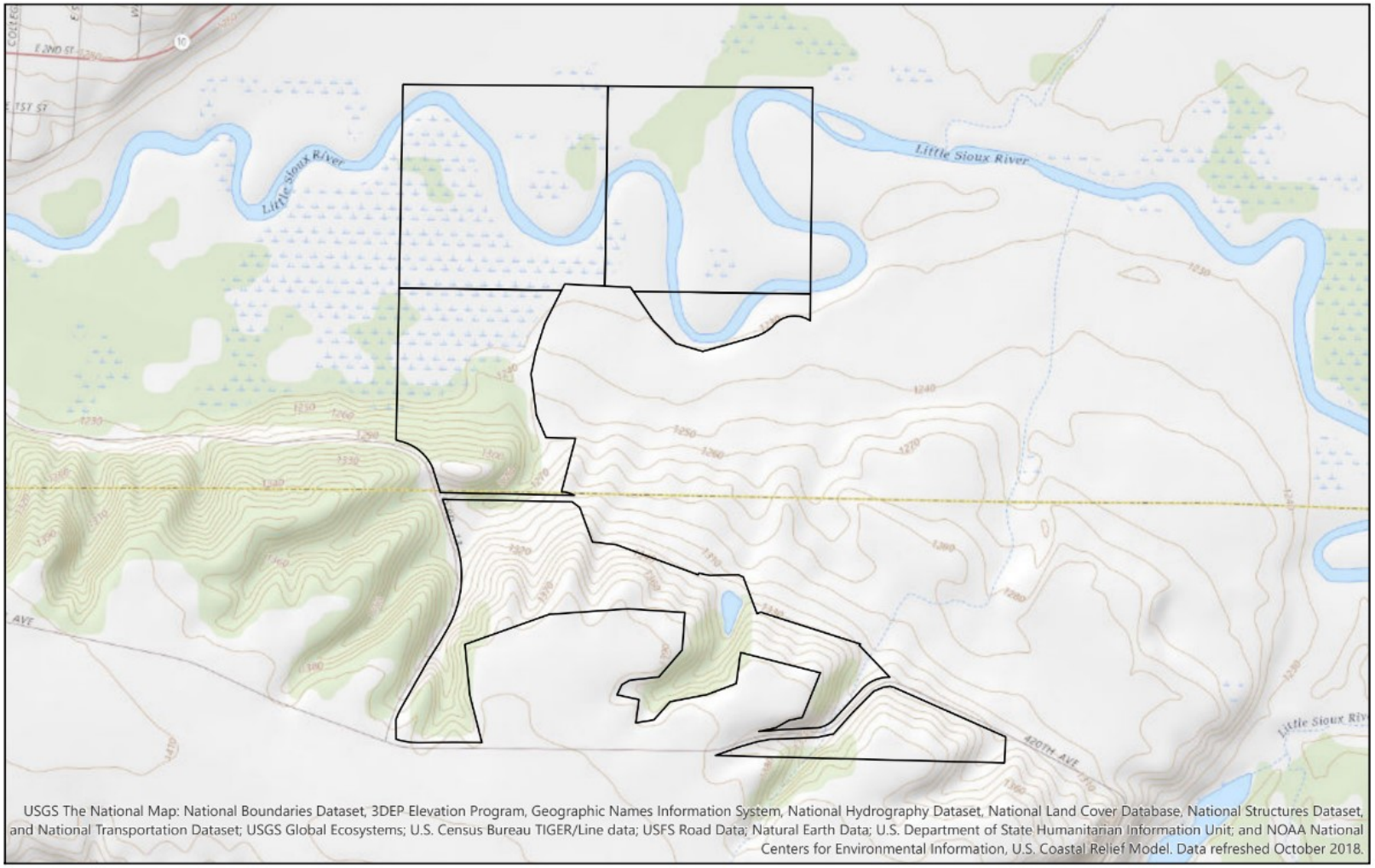
Donahoo Tract LiDar Map



Created by: Josh Dykstra
Source: Iowa Geodata



Donahoo Tract Topographic Map



Created by: Josh Dykstra

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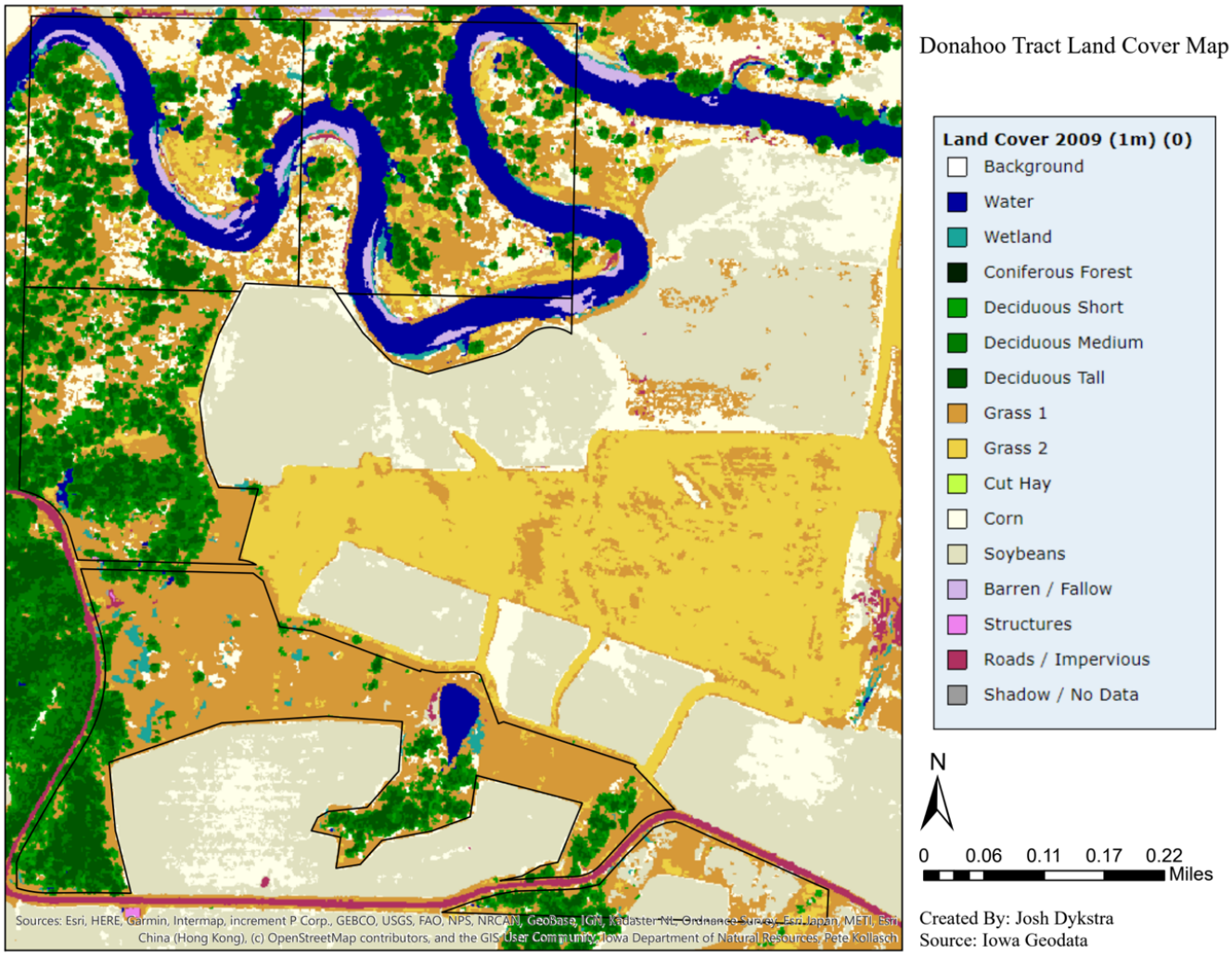
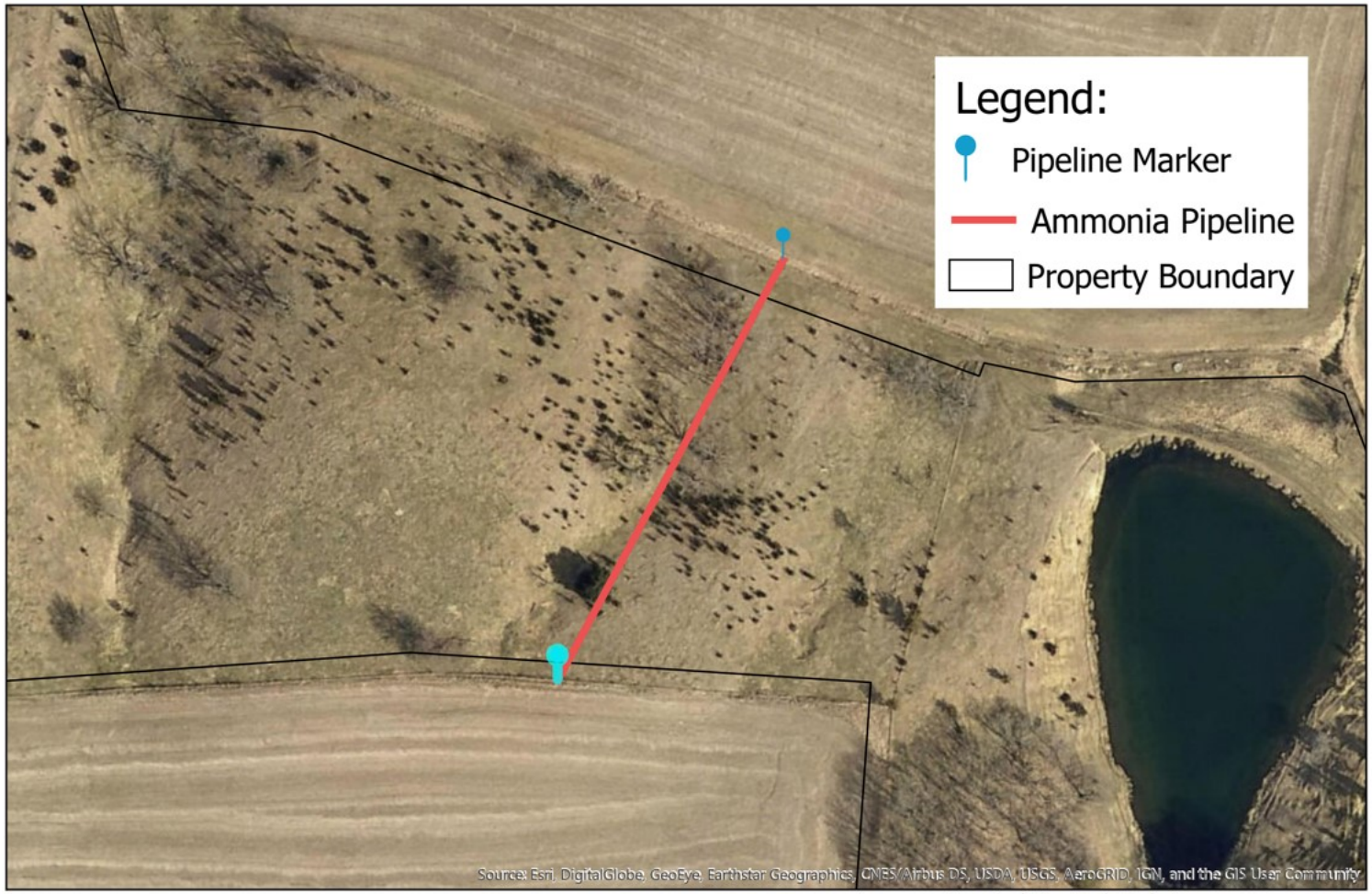
0 0.15 0.3 0.45 0.6 0.75 Miles


Donahoo Tract Land Cover Map
Land Cover 2009 (1m) (0)
Background
Water
Wetland
Coniferous Forest
Deciduous Short
Deciduous Medium
Deciduous Tall
Grass 1
Grass 2
Cut Hay
Corn
Soybeans
Barren / Fallow
Structures
Roads / Impervious
Shadow / No Data
N
0 0.06 0.11 0.17 0.22
Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community, Iowa Department of Natural Resources, Pete Kollasch
Created By: Josh Dykstra
Source: Iowa Geodata

Donahoo Tract Ammonia Pipeline Map



N

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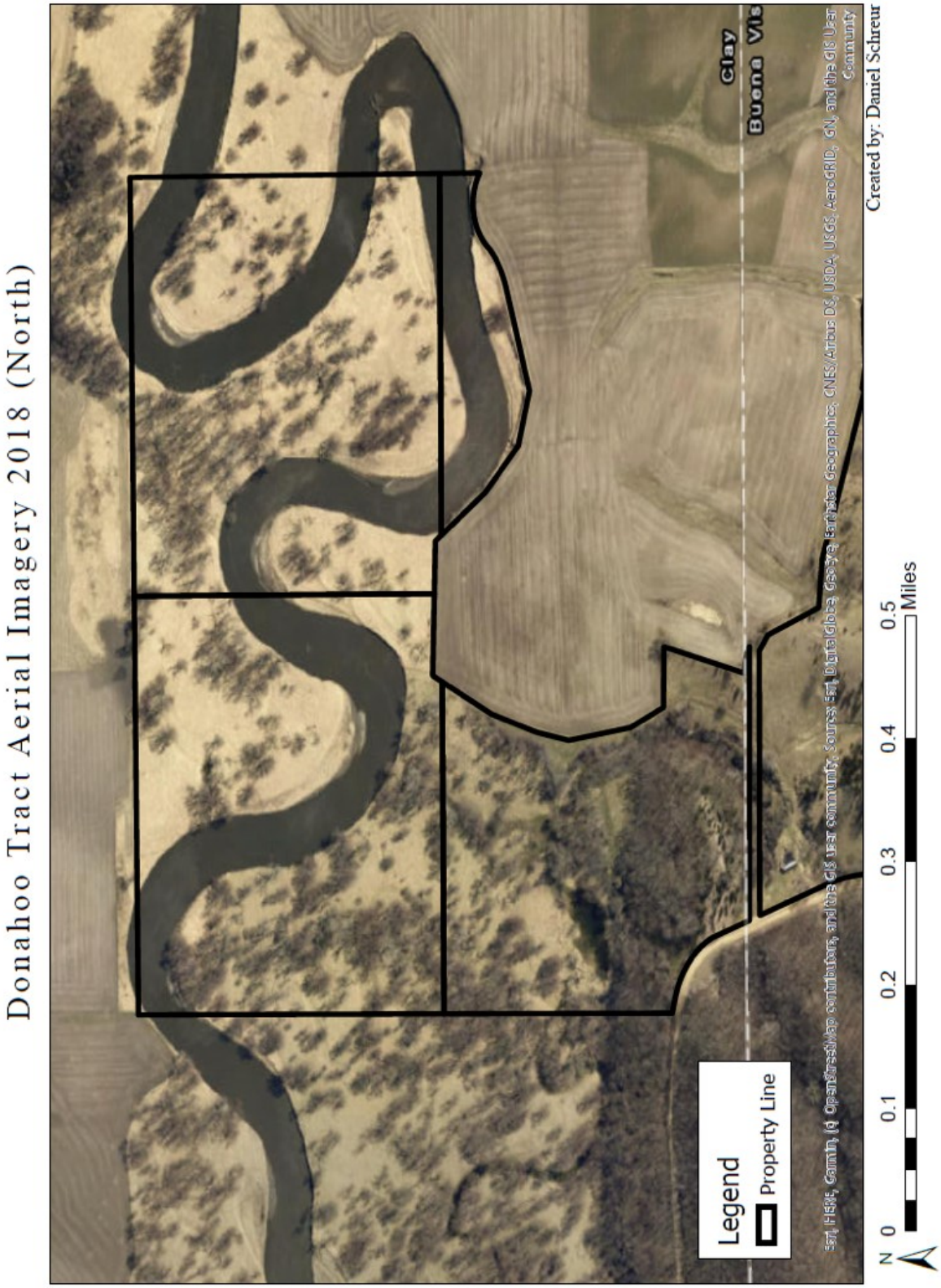
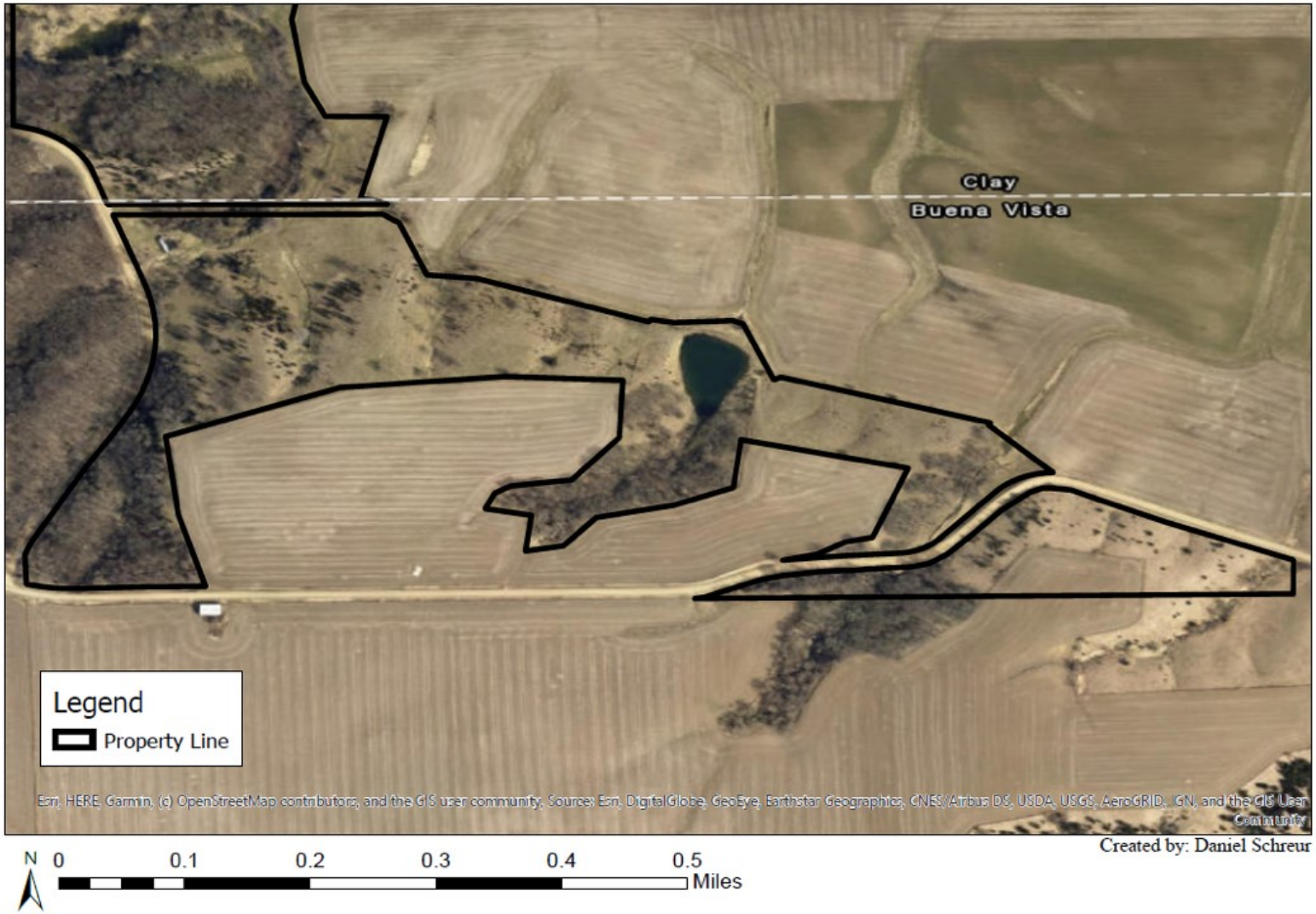
Created By: Josh Dykstra
Source: National Pipeline Mapping System

2018 Aerial Map

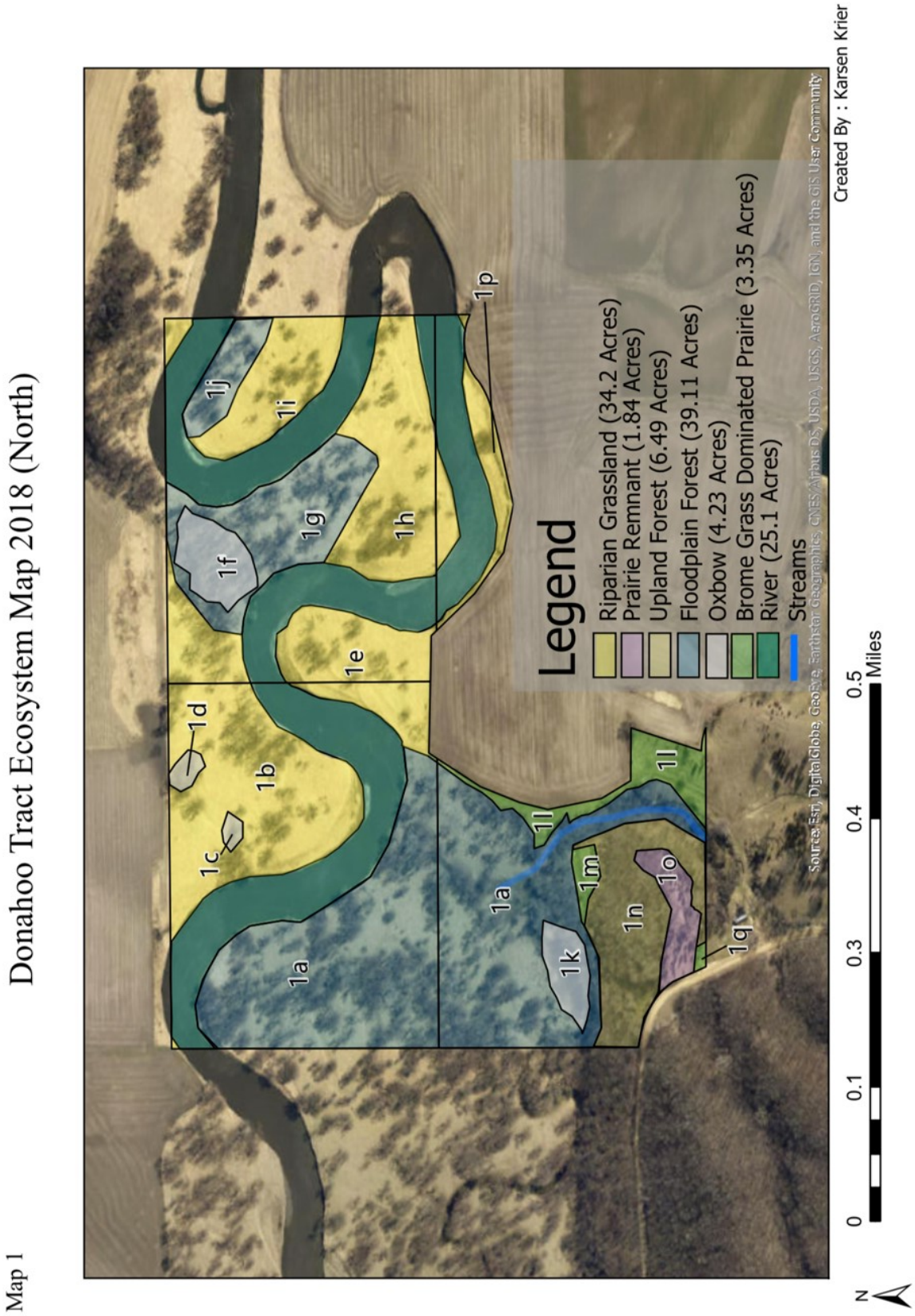


Donahoo Tract Aerial Imagery 2018 (South)



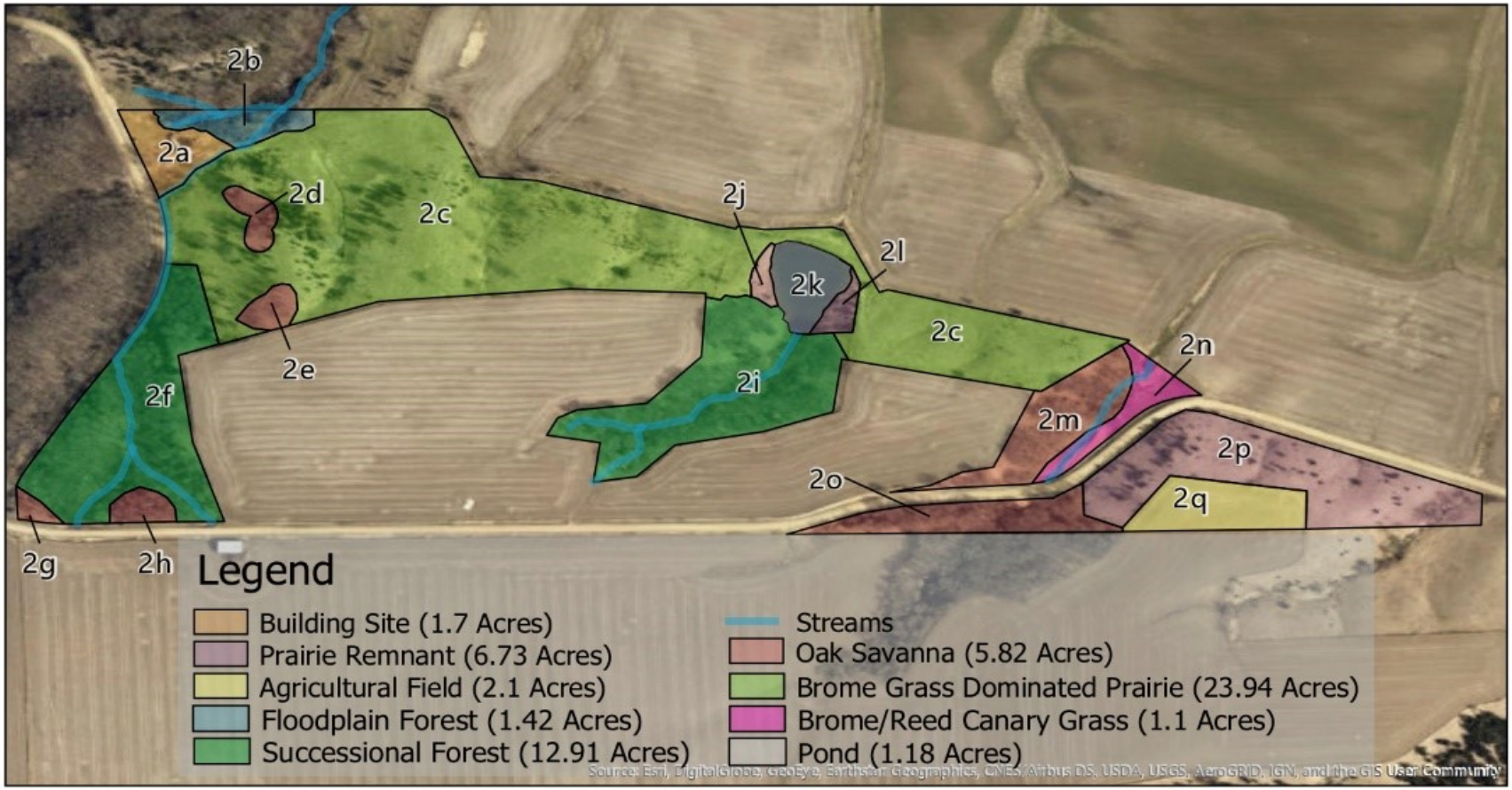
Created by: Daniel Schreur

Ecosystem Maps



Map 2

Donahoo Tract Ecosystem Map 2018 (South)



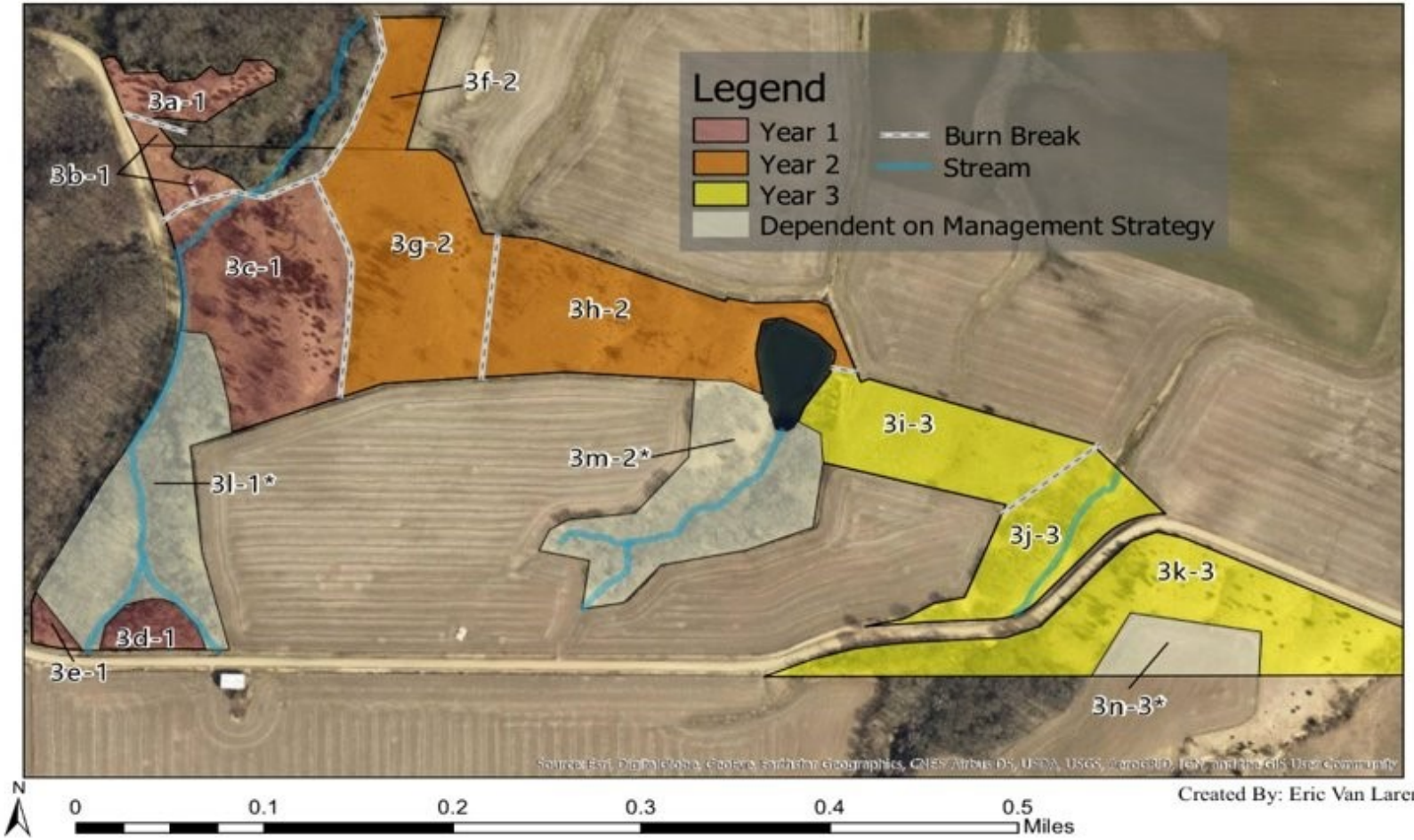
N

0 0.1 0.2 0.3 0.4 0.5 Miles

Created By: Eric Van Laren

Map 3

Donahoo Tract Burn Regime (3 Year Rotation)

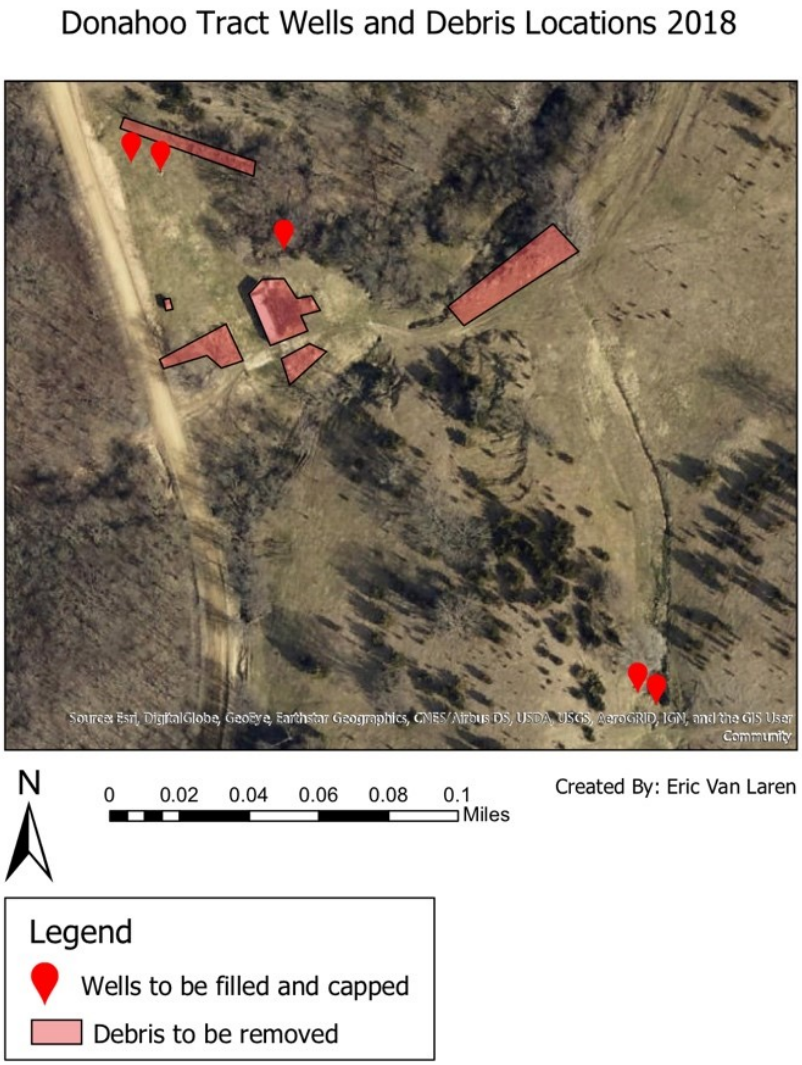


N

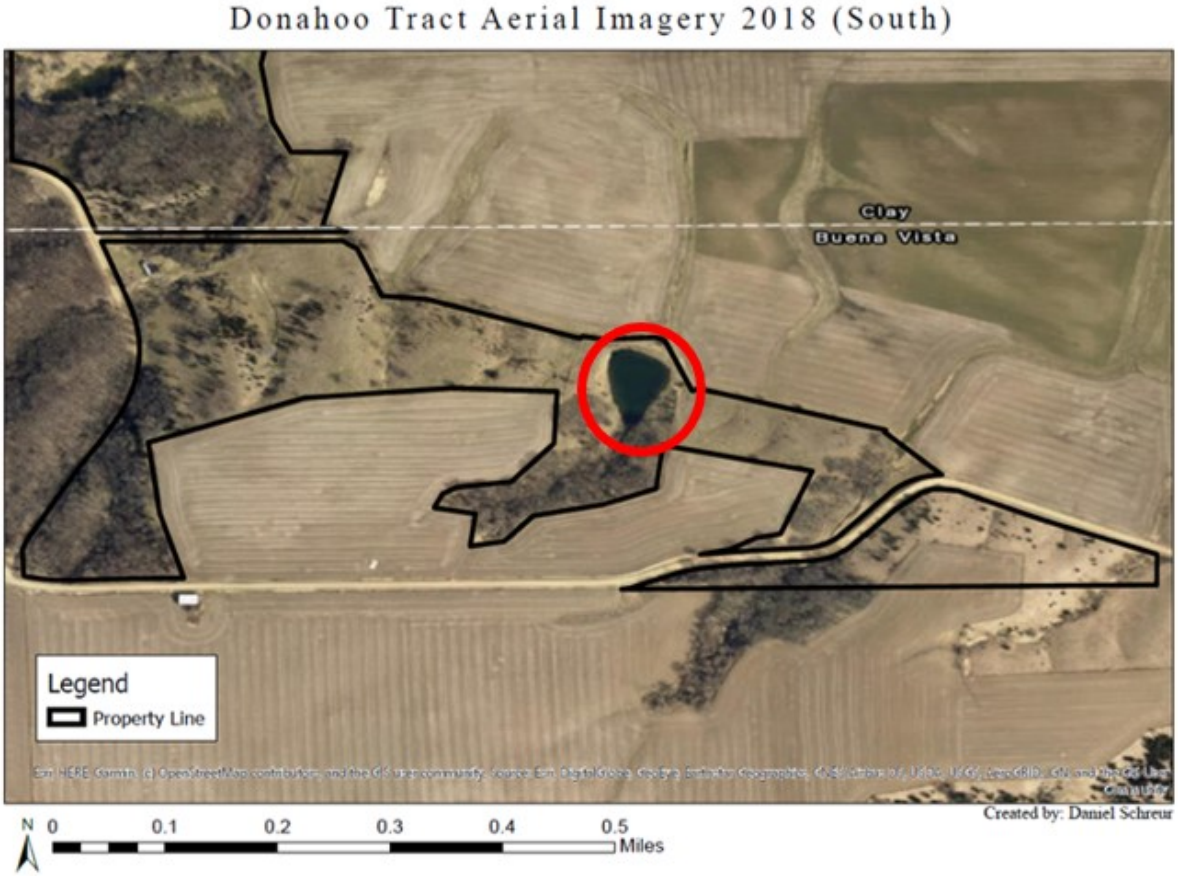
0 0.1 0.2 0.3 0.4 0.5 Miles

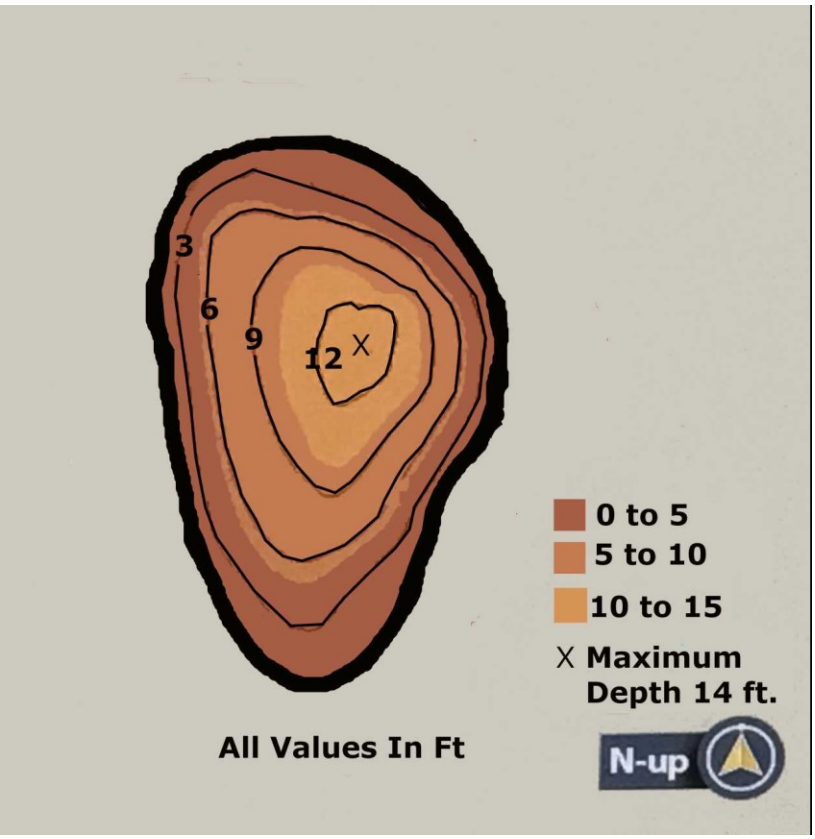
Created By: Eric Van Laren

Donahoo Tract Wells and Debris Locations 2018



Pond Contour Map





II. Project Summary

a. Problem Statement

Like most of Iowa's landscape, the Donahoo tract has been heavily impacted by agricultural activities. In places where there was once prairie, full of different species of grasses and forbs, smooth bromegrass and eastern red cedars now cover the hills. Cedars have surrounded large oak trees in parts of the savannahs and suppress the undergrowth which is vital to the ecosystem. Upland forests found throughout the property are now home to invasive species which displace native species and make movement for people and animal species difficult. Oxbows have been filled with sediment due to the constant flooding which is common for areas near the Little Sioux River. Floodplain forests have become overrun by reed canary grass - making it difficult for younger trees to become established. However, there are a few places in which prairie ecosystems have survived and oak savannahs have remained free of the invasive cedars. These remnants give us hope for the future of the property and its restoration.

b. Mission Statement

Preserve, restore, and increase the resilience of remnant and degraded ecosystems to promote wildlife habitat, community partnerships, and opportunities for recreation and education.

c. Stakeholder Desires

The Iowa Natural Heritage Foundation funded the acquisition of the Donahoo tract with the help and support of several public and private organizations who hope to utilize the site in different ways. A unique aspect of the tract is its location in two counties. The opportunity for collaboration and shared objectives/goals between the Clay County and Buena Vista County Conservation Boards will be beneficial in management of this site. A meeting with stakeholders allowed us to determine the different desired outcomes for the tract. Stakeholders want management activities that will involve the reduction of invasive species, restoration of habitat, and increased opportunities for hunting and recreation. The priority invasive species to remove are eastern red cedars and reed canary grass. There was a desire for a fire regime, grazing, and other activities to promote native species. Several stakeholders also expressed the importance of recreational and educational activities to encourage public usage of the tract. Restoration of all ecosystems will increase wildlife populations allowing hunting, fishing, and education to occur. They would also like to limit the number of trails and instead use firebreaks as trails. It was also expressed that two parking lots (one on the east side and another on the west) would be useful for public access and for maintenance purposes.

d. Permits and Easements

An ammonia pipeline runs through the property in a north-south direction just west of the pond (map, p. 18). Because the line is within 100 feet of the pond, it may be necessary to obtain a permit in order to reconstruct the dam for the pond. Permits may also be necessary in the process of excavating and restoring oxbows.

Easements may be needed to access the north side of the property as there is currently no good access point.

e. Leitbild Model

Planning a restoration project begins with visualizing the ideal outcome for the restoration site. The Lietbild model is a tool that analyzes the current ecological conditions and stakeholder desires to suggest the idyllic outcome for the site if there were no limitations or constraints. The Leitbild model can then be used to guide and inform realistic goal setting.

The ideal condition for this property is the complete removal of all invasive species to promote native species richness and diversity. Eastern red cedar, reed canary grass, Japanese Barberry and smooth bromegrass are the major invasive species present on this property. Removal of these species will promote the reestablishment of diverse native plant communities and improve wildlife habitat. Improvement of ecosystem quality and functioning should be the management priority, but these improvements should increase opportunities for human recreation. This property is best suited for hunting, hiking, fishing and birdwatching activities and can also be utilized for education.

The Leitbild model envisions restoring the majority of the habitats on the property to their dynamic, pre-European or original states. Contained within the property are exceptional remnant prairie and oak savanna. Both of these habitats are incredibly threatened due to habitat destruction and land conversion. Promoting oak savanna would involve woodland thinning, improving herbaceous undergrowth, and reintroducing disturbance. Promoting native prairie would involve reintroducing disturbances such as fire and grazing to promote native species.

Additionally, each habitat would benefit from seeding and planting of native species which would increase plant diversity and increase the amount of pollinator habitat available.

Floodplain forests were scarce in pre-European times and instead consisted of a mix of prairie and oak savanna ecosystems. Due to more frequent flooding the ideal restored condition of the floodplain forest would consist of buffer systems with trees, shrubs, and grasses that would promote wildlife habitats as well as regulate water temperatures. Planting seedlings in the floodplain would provide successional species to take the place of older trees. Structures would be placed in certain locations to protect seedlings from recurrent floods. Excavation and removal of sediment would allow the reformation of previous oxbows providing wildlife habitat and reducing nutrient flow into the river.

The ideal condition envisioned for the building site combines an ecological and human perspective. In terms of an ecological perspective the ideal restored condition would involve the complete removal of all modern human artifacts, planting and seeding native species after the invasive species have been removed, and permanent erosion control. From a human perspective the ideal condition for this area would include removal of hazardous materials, capping of wells and pipe access points, installation of a parking lot and other infrastructure, and the creation of firebreaks to provide access to the rest of the property.

Public involvement and educational and recreational activities including hunting, fishing, and hiking would be possible using trails that would cause little disturbance to the land. The pond would provide an ideal habitat for a variety of fish species as well as aquatic vegetation to promote fishing by the public. The restored ecosystems and habitats would promote wildlife activity, which would be attractive to hunters, bird watchers, hikers, and photographers. Several points of access with parking lots would increase the ease of entering the property and give access to the different ecosystems present on the land. A boat ramp on the Little Sioux River would provide access for recreational activities.

III. Implementation by Habitat

a. Prairie Remnants

i. Habitat Description

Prairie remnants are fragments of the original prairie that used to dominate Iowa's landscape. Prairie remnants have not been tilled or altered in a significant way and contain native prairie plant communities. Today, less than 1% of Iowa's native prairies are left intact. Because this ecosystem is so rare, it is vital that we protect and restore it (Houseal). Iowa's prairies are being threatened by invasive species encroachment throughout the state.

Prairie plant communities typically consist of about 60% grasses, 35% forbs, and 5% shrubs, by to biomass. Some of the common prairie plants found in these remnants include big and little bluestem, Indian grass, switch grass, common milkweed, leadplant, gray-headed coneflower, and hoary vervain (Tallgrass Prairie).

Prairie remnants are valuable biological, cultural, and ecological areas. They can contain rare and threatened species with unusual genetic traits or adaptations. The prairies of Iowa provide areas for recreation for many people with different interests. Invasive species, primarily smooth bromegrass and eastern red cedar, are making their way into

the prairie remnants and taking over the small area that the native species have left. This is a common problem for many prairies in the region and it must be addressed before more of our remnant prairie is gone forever.

The high-quality prairie remnants on this property are located on a hill north of the building site (1o, map 1 pg. 22), along the steep edges of the pond (2j, 2l, map 2 pg. 23), and across the road in the SE corner of the property (2p, map 2 pg. 23). The high-quality remnants make up a very small percentage of the historical range of prairie on the property. There are approximately 8.6 acres of remnant prairie. There are several prairie areas that are extensively colonized by smooth bromegrass but still have many native species present. If the invasive species are controlled, these sections have a good chance of coming back as quality prairie.

ii. Reference Site

Christiansen Area/Vaudt Property (4653-4601 Martin Access Rd, Cherokee, IA 51012, 42°51'08.8"N 95°27'20.7"W)

The tallgrass prairie located on this site provides a good reference site for the remnant prairie located on the Donahoo Tract. These sites are near each other and therefore would have had similar historical disturbances and similar plant species composition.

[The Bertram reservation would be a good reference site, but there is not a species list compiled for the property. If this site is ever assessed and a species list is made, then it could be used as a reference site.]

iii. Objectives and Procedures

Objective 1: Establish a regular prescribed fire regime.

> **Procedures:** Divide the prairie/brome grassland into 3 manageable burn parcels and begin a rotational burning pattern. Firebreaks must be established and mown to separate the prairie into smaller, easily manageable burn units. See map 3 (pg 24) for a visual of the burn regime and firebreaks. Burning should occur every 3 years alternating between parcels and seasons to encourage diversity. For the first several years, the burn should take place in the late spring to help control smooth brome. No more than 1/3 of the prairie remnants on the property should be burned in one year. (Shirley).
>
> **Justification:** Regular burns are a natural part of the prairie ecosystem. Smaller burn parcels are easier to manage with a small crew and are safer. Only burning a certain percent of the remnant prairie is essential so that rare or sensitive insects and other invertebrates do not lose all their habitat at one time (Shirley). Late spring burns have historically been used to suppress cool season grasses such as smooth brome.

Objective 2: Remove most of the eastern red cedars to allow prairie remnants to reestablish themselves.

Procedures: Mechanically remove cedars that do not burn in prescribed burns. Cedars in and around remnant prairies should be identified and removed in the first couple years so that the prairie has more area to expand into. This task should begin in areas that have recently been burned but can be carried out in other areas as well. There will need to be continued monitoring for regrowth after an area is clear of most cedars. Cedars were historically present in this area so not all of them must be removed. A small percentage can be left to provide habitat.

Justification: Removal of cedars removes the suppressive canopy and allows prairie plants to become established. This also prepares the area for a more successful prescribed burn.

Objective 3: Grazing.

Procedures: Use cattle to establish a historical grazing disturbance on the prairie. Exterior barbed or electric wire fence would have to be repaired or replaced in many areas. If a regular burn regime is in place, internal fencing may not be needed as the cattle will graze most heavily on the most recently burned areas (Fuhlendorf, et al. 2004). This objective should be implemented once objectives 1-3 have had significant progress made on them. Evaluate species composition every 3 years to determine the effect grazing is having on the plant community.

Justification: Grazing disturbance by large herbivores is a natural part of a healthy prairie. Grazing has a similar effect as mowing and would be more effective on the steep slopes found on this property. This natural disturbance would promote greater diversity and resilience of native prairie species.

iv. Aftercare

Adaptive management will be needed. Data will need to be collected and analyzed to determine what steps to take next. Regular rotational burning will be needed to reduce the impact of invasive species. Species counts or other data should be collected after 3 to 5 years to determine how successful the management practices have been, and if changes need to be made.

b. Smooth Brome Dominated Grassland

i. Habitat Description

Smooth bromegrass (*Bromus inermis*) is a cool season perennial grass native to much of Europe. Brought to the United States in the late 1800s, smooth brome has become naturalized across North America. Smooth brome was introduced as a candidate for livestock feed on rangeland and farmland, and eventually displaced native grasses in many prairie remnants. The grass is considered an invasive species by restoration

ecologists. The grass is drought tolerant and tends to establish quickly in new habitats preventing other more desirable species from flourishing (Salesman). The Donahoo tract has 27.29 acres of smooth brome dominated grasslands making it a definite concern. This ecosystem can be located on map 1 (points 1m and 1l, pg. 22) and map 2 (point 2c, pg. 23).

Eastern red cedars are also becoming too numerous in the grassland. Younger trees can be found that stand 3 ft. tall and older ones are up to 25 ft tall. Specific locations in which the eastern red cedars are exceptionally dense are noted on the eastern red cedar density map (pg. 15). It is notable that the Eastern Red Cedar is a native species to Iowa. Therefore, complete eradication is not a specific goal. However, the population should be contained in designated areas.

ii. Reference Site

Christiansen Area/Vaudt Property
(4653-4601 Martin Access Rd, Cherokee, IA 51012,
42°51'08.8"N 95°27'20.7"W)

[See 'Prairie Remnant' for more information concerning the reference site.]

iii. Objectives and Procedures

Objective 1: Use prescribed burns to suppress invasive species currently competing with native prairie species.

> **Procedure:** The most recent prescribed burn on the Donahoo Tract, relative to the creation of this plan, was conducted on April 9, 2019. See map 3 (pg. 23) for visual description of the burn area. Prescribed burns, with the goal of suppressing smooth brome grass, should be conducted in mid to late spring. As seen on map 3 (pg. 23), the property has been divided into three parts which should be burned in a three year rotation. As the smooth brome plant transfers resources from its roots to the upper parts of the plant in the spring, it becomes vulnerable to fire damage. By burning in the spring, native prairie plants are given the competitive advantage and have the chance to get ahead of the smooth bromegrass (Salesman).
>
> **Justification:** Fire was an important disturbance event in North American prairies before the land was converted to agricultural use. Native plants have had the opportunity to evolve with fire, while smooth brome has not evolved with fire in the same way (Salesman). It is important to burn in late spring, however, as a burn that occurs too early may not remove the growth point of smooth brome allowing for rapid resurgence after a burn. Professionals suggest burning smooth brome when it is at boot height to help get rid of the tillers and the growth point (Bahm).

Objective 2: Use herbicides to manage invasive species that aren't responding to prescribed fire.

Procedure: If there are no desirable species present in a portion of the grassland, a mixture of sulfosulfuron and glyphosate should be used to suppress smooth brome. Some areas dominated by smooth brome may contain pockets of desired native forbs which would be best treated with clethodim, a grass selective herbicide.

In order to effectively prep the site for the reintroduction of native species, there will need to be several herbicide treatments. In June following a mid to late Spring burn, the first herbicide treatment should be applied. In October of the same year, a second herbicide treatment should be applied. (Bahm; Williams 2018)

Justification: A 2011 study showed that these chemicals were effective for this task (Bahm). It was also shown that native plant response to pesticide application varied, but a planting 2 to 3 weeks after application usually allowed for successful native plant establishment (Bahm).

Objective 3: Greatly reduce Eastern Red Cedar population to allow native prairie species to flourish.

Procedure: Eastern red cedars are present in many areas throughout the grassland. The height of these can range from 3 ft to approximately 25 ft. The recommendation for these is to first observe the effects of grassland burning on them and then go through and remove the remaining cedars using chainsaws or perhaps a branch clipper for the smaller trees. (Verbal recommendation from Dr. Yari Johnson of the University of Wisconsin-Platteville.)

Justification: Eastern red cedar has spread aggressively in poorly managed rangeland due to the lack of prescribed burning. The shade the trees create prevents the growth of native prairie grass and forbs. Additionally, research has shown that red cedar is a dominant factor in displacing grassland birds and songbirds from native prairie and as few as three red cedar per acre will displace some birds (prairie chickens) from their habitat. Red cedars can provide some value to wildlife but the value is generally not unique and can often be fulfilled by other vegetation (Natural).

Objective 4: Reintroduction of native prairie plants.

Procedure: A no-till drill designed for native prairie seed is recommended for the reintroduction of prairie plant. These drills plant seed in rows by opening a shallow groove in the soil, which causes only minimal soil disturbance. Seeds should be planted at a depth between 1/8 and 1/4 inch below the soil surface. (Shirley 1994, p. 152)

The "Mixed Height Prairie Seed Mix" from Prairie Moon Nursery is recommended. This mix contains 28 wildflower species which make up 51% of the mix and 7 grass species which make up 49% of the mix. This mix is perfect for the hills on the Donahoo tract as they remain dry being higher in elevation and

being exposed to Iowa's strong winds. If a different mix is desired, Prairie Moon Nursery has custom mix options available. However, a mix similar to the one mentioned above or one which includes species native to Iowa grasslands is recommended (What).

Justification: Prairies which once covered Iowa consisted of 60 percent grass, 35 percent forbs, and 5 percent shrubs on average. Within these percentages, there is a great diversity of species. For example, 72 different species of grasses can be seen in Iowa prairies (Thompson 1992, p. 10).

iv. Monitoring Progress

The property should be assessed at least twice during the summer (June and August) in order to accurately determine floral composition. We recommend that the Iowa Roadside Managers from Clay and Buena Vista counties conduct this assessment.

v. Aftercare

A three year rotation (as described in map 3) of prescribed burning will be necessary to suppress competitive invasive grass species and woody species. The success of the reintroduction of native prairie species should be determined by site assessment conducted by the Iowa Roadside Managers from Clay and Buena Vista counties.

c. Upland Forest

i. Habitat Description

Upland forest is characterized as a forest that has fifty to one-hundred percent canopy cover and includes key upland forest species. Some examples of these species are oak, basswood, elm, ash, walnut, and maple species. Upland forest is an important ecosystem in that it creates healthy soil and water. Healthy soil and water benefits living and non-living components of the upland forest and neighboring ecosystems. Upland forests tend to occur on relatively moist, yet well-drained upland. They are also more likely to occur on north and east facing slopes and on upper terrace levels in stream valleys (Thompson, Apfelbaum).

Often healthy upland forests contain multiple levels of canopy cover. The hardwood species such as oak and basswood often make up the upper canopy of upland forest. Understory trees that grow beneath the canopy may include ironwood, maple saplings, and elm. Ground-layer vegetation may include sedges, jack-in-the-pulpit, and wildflowers (Thompson, Apfelbaum).

At the Donahoo property, there is one parcel of upland forest. It on the north side of the ridge that runs east/west just north of the building site. This parcel can be clearly distinguished on the 1930's imagery map (pg. 9-10).

ii. Reference Site

Wanata State Park (125th Ave, Peterson, IA 51047, 42°54'40.5"N 95°20'18.2"W) is very close to the Donahoo property and is a great reference for what a healthy upland forest in this part of Iowa should look like. The southern edge of the park contains the best example of upland forest. The canopy, understory and ground level vegetation are all a good reference for a native upland forest ecosystem.

iii. Objectives and Procedures

Objective 1: Remove cedars.

Procedure: Remove cedars using mechanical methods.

Justification: Clearing out the cedar trees will clear out the understory of the upland forests. This will allow for more sunlight to get through the canopy to the ground and provide more water for vegetation in the area.

Objective 2: Remove nonnative shrubs and woody vines.

Procedure: Cut down nonnative and invasive shrubs and woody vines such as Japanese barberry (*Berberis thunbergii*). The best way to remove Japanese barberry is by cutting or trimming down the growth and then applying herbicide. Glyphosate can be used but must be used carefully around desired foliage. Other herbicide application options are Dicamba, triclopyr, and 2-4,D. The most effective time to treat Japanese barberry is in late August or early September. The estimated cost to have a crew come and remove the Japanese barberry is about $4000 (Abbey).

Justification: Nonnative shrubs and woody vines often have shallow root systems. Introducing natives back to the upland forest will allow for a deeper root structure that will reduce erosion.

Objective 3: Reestablish native understory and ground level vegetation.

Procedure: Native plants can be seeded in late fall (November) by broadcasting seed throughout the forest floor. There are some native species remaining in the upland forest on the Donahoo tract, but they are not as abundant as they should be. Native species that remain include: white trout lily, bloodroot, Virginia waterleaf, Dutchman's britches, Jacob's ladder, sweet cicely, and bedstraw. There are cool season grasses starting to grow in some places. Intentional seeding of native woodland species may limit the spread of these grasses. The shady woodland seed mix from Prairie Moon Nursery costs about $1400 per acre. At 4 acres of upland forest this amounts to $5600.

Justification: Without an increased presence of native species at the ground and understory level, the dynamics of the upland forest will begin to shift. Thick understory growth could interfere with the recruitment of overstory trees such as red oak. The loss of ground level vegetation to cool season grasses could substantially decrease plant diversity.

iv. Aftercare

Upland forest should be monitored to prevent the introduction of other invasive species. Monitoring tree stand health is also important for detecting diseases or pests that may be affecting the health of the forests.

d. Successional Forest

i. Habitat Description

Successional Forest at the Donahoo tract is characterized as the growth of tree stands post European settlement. Successional forest in this area will function similarly to upland forest. Trees may have been allowed to grow because of the absence of fire or the introduction of more species to the area through European contact. Common tree species in this area include black walnut, ash, and other post-settlement introduced species (Nelson).

The ravine above the pond can be identified as successional forest. There is also a large patch of trees that is growing in the Southwest corner of the property. These two sites are not forest ecosystems on the 1930 map (pg. 9-10), but the early growth of these stands is visible.

ii. Reference Site

See Upland Forest Reference Site

iii. Objectives and Procedures

Since successional forest is not the natural or original ecosystem for this property we suggest three different options for restoration.

Option 1: Treat as Upland Forest

Procedure: Leave successional forest in place. The successional forest has similar problems as the upland forest areas. The same procedures should be used in the successional forest as the upland forest as they also share the same issues.

Justification: Climate change and other factors may have altered the environmental conditions, making upland forest the preferred ecosystem on these sites.

Option 2: Restore to historical condition

Procedure: Remove successional forest. Restoring to historical condition would require the removal of trees from these areas. There is a total of about 13.5 acres of successional forest in the ravine above the pond and the SW corner of the property. Clearing land would cost $3,000 to $6,000 dollars per acre, if the work was done by a hired crew.

Justification: This course of action is consistent with a full restoration of the ecosystems on the Donahoo property.

Option 3: Clear trees near remnant oak savanna parcels

Procedure: Clear areas of successional forest near oak savanna growth.

Justification: There are areas of successional forest that are encroaching on areas of oak savanna. Mechanical removal near oaks would be prescribed to allow maximum sunlight and water availability for the native oak savanna ecosystems.

iii. Aftercare

See Upland Forest aftercare

e. Oak Savanna

i. Habitat Description

Bur Oak Savanna is a unique ecosystem and is typically found where land has not been farmed but has been used for grazing or been left untouched. On a large scale, Oak savanna can be defined as a large area of either white or bur oak trees which are sparsely placed and whose understory consists of native forbs and grasses (US. Fish and Wildlife). On the Donahoo tract, the native species in this ecosystem include Bur Oak, Big Bluestem, Indian Grass, and many native forbs.

According to the U.S Fish and Wildlife Service, Oak savannas are a fire dependent ecosystem. Historically fires were started by either lighting or human activity. Fire is crucial for this habited because it keeps out invasive woody species as well as returning nutrients to the soil.

ii. Reference Site

For the Oak Savanna reference site, we have selected the Little Sioux Wildlife Area in Clay County(Little Sioux Wildlife Management Area, Greenville, IA 51343 43°02'38.5"N 95°03'34.9"W) . This site is located northeast of the Donahoo property. Restoration of this site was started in 2011 and is ongoing. Unfortunately, this site does have a complete species list yet.

iii. Objectives and Procedures

The desired conditions for the oak savannah would be to completely remove existing invasive species as well as setting in place a burn plan to help manage them for the long term. Prescribed fire will protect the savanna from invasive species and stimulate the growth of native plants (U.S Fish and Wild life).

Objective 1: Remove all unwanted woody species (Completed year 1)

> **Procedure/Justification:** Removing all invasive woody species in the Oak savanna section should be the top priority for this ecosystem. This includes, but is not limited to, the Eastern red cedar. Cedars can be removed mechanically (chain saw) as well as with prescribed burns for smaller cedars (U.S Fish and Wildlife).

Objective 2: Removing of nonnative plants/grasses (Completed year 2)

> **Procedure/Justification:** Removing nonnative plants can be done by hand, or using other methods such as heavy machinery. This should be accomplished every summer where there is an abundance of nonnative plants in the Oak Savanna areas (Belwin Conservancy).

Objective 3: Prescribed fire for Oak Savannas

> **Procedure/Justification:** An Oak Savanna should be burned every 2-5 years. By following the burn plan on Map 3 (Page 23) this will be accomplished. With the introduction of fire, invasive woody species will be kept at bay. The oaks, with their thick bark, will be able to withstand the fire.

Objective 4: Reseeding of the Oak Savannas understory (Complete in Year 2)

> **Procedure/Justification:** A healthy Oak Savanna understory should contain a diverse set of native plants. Currently, however, the understory is dominated by smooth bromegrass. The savanna understory should be seeded to a mixture of wildflowers (forbs) and native grasses (NRCS Missouri). Savanna seed mixes can be obtained from Prairie Moon Nursery, Ion Exchange, and other suppliers.

iv. Aftercare

The oak savanna should be monitored for invasive species infestation. If an invasive species is spotted, it should be removed as soon as possible. Continue to follow the burn plan with the Oak Savannas as shown in Map 3 to prevent woody species (mainly eastern red cedars) from returning (U.S Fish and Wildlife).

f. Pond

i. Habitat Description

The Donahoo tract pond is a man-made aquascape, likely constructed for recreational purposes. Man-made ponds are difficult to define as they vary greatly in their value to nature. Small ponds quickly disappear due to rapid vegetation growth and debris filling them in. Ponds with shallow vernal pools and gradual banks possess natural aquatic value for native species, hosting amphibians and dragonflies, which support populations of predatory fish. The pond on the Donahoo tract has great potential, given its maximum depth of 14 ft, along with several wetland grasses inhabiting the ponds edge. This site could prove valuable for recreation, encouraging people who like to fish to visit the site.

ii. Reference Site

As this is a man-made pond, there is no reference site needed to guide reconstruction of the pond. However, it is important to take into account the surrounding vegetation and wildlife when considering what actions should be taken. Generally, providing more shelter for small fish and reducing predatory fish numbers will result in enhanced native species biodiversity.

Due to the pond's shallow nature and surrounding agriculture, the pond has the potential to be high in nitrogen and phosphorus. Our sampling showed low levels of ammonia in the pond, but significant inputs of nitrate-nitrogen entering the pond from the west inlet stream (Appendix, p. 69). Turbid, brown water that is easily stirred up exists along the shoreline and may induce algal growth.

iii. Objectives and Procedures

Objective 1: Prevent Erosion

Procedure/Justification: To meet this objective, native wetland grasses could be used to stabilize shorelines. Biodegradable coconut fiber can be used to initially prevent erosion before the grasses become established. This would help with the aesthetics, serve as an additional habitat, and require little further maintenance.

Objective 2: Install an Aerator

Procedure/Justification: Because of the desire for recreation, aeration may be considered to add oxygen to the water column. This will also prevent fish kills during the winter, reducing the need for constant stocking, as well as increasing decomposition, further reducing sedimentation and the threat of the pond filling in.

Objective 3: Aquatic Plant Control

Procedure/Justification: Aquatic plant growth can be regulated by seasonal changes in water levels. With good management, plant growth can reduce overall nutrient levels within the pond.

Objective 4: Reconstruct the Berm

Procedure/Justification: The collapse of this berm would mean that there would be no more pond, and the remaining water and fish would wash out into the agricultural fields below. Therefore, it is of the utmost importance to reconstruct this berm with solid materials, add at least one outlet pipe that will assist in regulating the water levels, and add an overflow structure that can safely route flood waters around the dam. There are several options to reconstruct and reinforce the pond, and with research and possibly the assistance of a civil engineer, should be completed quickly and effectively.

iv. Aftercare

Aftercare is necessary for man-made ponds, as they were not created naturally. The aftercare necessary is the maintenance of the berm, removal of sediments, stocking of fish, and removal of invasive plant and animal species. Long-term, rerouting the inlet streams through a wood chip bioreactor would reduce nitrate inputs into the pond, and improve water quality.

g. Floodplains

i. Description

The floodplains make up a dynamic system that consists of two main ecosystems: floodplain forest and riparian grassland. Over time, recurring floods can change the size and composition of these ecosystems. Flexibility is crucial and necessary in the floodplains. In order to account for this characteristic, smaller areas in each ecosystem will be the primary focus. This provides a starting point for restoration with potential for expansion. It also reduces the risk of setbacks with flooding events and allows for natural change within the floodplains.

h. Floodplain Forest

i. Habitat Description

Floodplain forests are the flat, broad, and low-lying areas that cover the bottom of river valleys. These pieces of land typically flood when a river or stream flows over its banks, which is usually in the spring when the snow melts or during periods of heavy rainfall. With flooding waters, sediment and silt deposits occur as the floodwaters subside and, because of this, it's important to establish a permanent cover of trees to help

stabilize banks and prevent excessive erosion. Species of trees that are tall with extensive, shallow root systems that hold tightly to the soil are most desirable to stabilize river banks. Examples of these are cottonwood, silver maple, box elder, and black willow. The Donahoo tract mostly consists of floodplain forests near the Little Sioux River on the northern end of the tract.

ii. Reference Site

The TNC Swamp White Oak Preserve (1620 231st St, Muscatine, IA at 41°24'23.8"N 91°18'16.8"W) is a reference that would prove useful in restoring the floodplain to a pre-European lowland oak savanna. This is located on the Cedar River in Muscatine County. The current species composition of the floodplain forest for the Donahoo tract is typical for many sites along the river and is acceptable for this area.

iii. Objectives and Procedures

Objective 1: Large woody debris should be left in the riparian floodplain to promote habitat and establishment of other floodplain trees (Aquatic Restoration).

Objective 2: Establish seedlings

Procedure: Large woody debris provides some shelter for species; however, other structures may be necessary for additional successional tree establishment. Flooding events with moving debris can remove younger seedlings and prevent a younger forest from establishing. Natural seeding/regeneration is the main goal for the floodplain forest, however, planting seedlings is an option that can be used if needed.

Justification: Structures are needed to enable young seedlings to establish and allow the development of younger forests. Large woody debris provides this naturally. Moving in additional structures would increase the opportunity for successful seedling regeneration.

iv. Aftercare

Little maintenance is needed unless it is determined that additional seedling establishment is needed.

i. Riparian Grassland

i. Habitat Description

Reed canary grass is a dominant, invasive species within the floodplain forest which is of high concern. Currently it is the primary species present on the floodplain

outcompeting native species. There are also deposits of sediment present from recent flooding.

ii. Reference Site

The Nature Conservancy's Brown Preserve (Peterson, IA, 42°52'02.1"N 95°19'24.8"W) in northwestern Buena Vista County has nearly unaltered streambanks that can be used as a reference in species composition and function for this property. A complete species list should be available from TNC in 2020.

iii. Objectives and Procedures

Objective 1: Eliminate Reed Canary Grass.

Procedure: Reed Canary Grass is an invasive that is often found in wetlands and riverbanks in addition to other areas. Several mechanisms of control are available for eradication of this species: mechanical, chemical, and prescribed burning. Mechanical removal using machinery may be necessary to remove all the rhizomes and seeds produced by the reed canary grass. This should be done in the early spring to prevent the growth of the species. An area must be determined to deposit the removed soil and debris (Wold 2019). Due to the potential difficulty of importing machinery to the floodplain other techniques would likely provide a more ideal solution. Chemical spraying in addition to burning is the most effective control. In the spring, when reed canary grass growth from the rhizome or seed is evident, a glyphosate solution mixed with a surfactant approved for aquatic sites should be applied. In the late spring, the area should be burned. If there is additional growth in the summer another herbicide application and/or burn may be necessary in the fall (Chmielewski 2011).

Glyphosate provides a good chemical control option along with an aquatic approved surfactant for use in wetland areas. To begin, this control should be applied to the 5-acre area in section 1e (Ecosystems Map 1, pg. 21). This area will provide a starting point from which further reed canary grass removal can occur. The south side is easier to access and should be treated first in increments determined by personnel from each county. Reed canary grass removal should begin in 2020, however, due to unpredictable flooding the timeline will need to be flexible. Ideally the treatment would take around 5 years for complete removal (Wisconsin). Glyphosate 5.4 Aquatic Herbicide surfactant costs $65/gallon or $795/ 30-gallon drum according to Pest and Lawn Solutions. One gallon will treat about 0.75 acres. (https://www.solutionsstores.com/glyphosate-5-4-aquatic-herbicide?CAWELAID=120308880000000021&gclid=EAIaIQobChMI9bX_s-KF4gIVlozICh0tVwBcEAkYASABEgLYfPD_BwE). With 34.2 acres of land to treat, roughly 45 gallons of glyphosate is needed to treat the entire riparian grassland. However, the land area should be divided into smaller segments for treatment to reduce risk.

Justification: Eradicating reed canary grass promotes the growth of native species and promotes diversity in the floodplain.

Objective 2: Reestablish native grassland species

Procedure: Seeding should be carried out very soon after removal of reed canary grass (Wold 2019). Bare ground should be seeded with 7 to 10 pounds/acre. This should be done with a seed mix containing a variety of native species (Wisconsin 2009). Some good replacements for reed canary grass include Canada Bluejoint and Dropping Sedge (Chmielewski 2011). Plugs and grasses should be seeded in the spring and forbs and sedges in the fall or winter (Wisconsin 2009).

Section 1e on the south side of the river (Ecosystems Map 1, pg. 21) provides an area with relatively easy access for reed canary grass removal. This area is about 5 acres. The CP23 Flood prone/wet 30/10 seed mix from Allendan Seed Company priced at $108/acre is a good option for reseeding (https://www.allendanseed.com/). It has a variety of grasses, sedges, and other plants. Other seed companies like Prairie Moon Nursery could also provide additional options, however, are more expensive. Because of the risk of flooding and set backs in reed canary grass removal, a cheaper seed mix is preferred.

Justification: Replacing reed canary grass promotes native species and diversity within the floodplain. A seed mix will encourage diversity and replace the current reed canary grass monoculture.

iv. Aftercare

Reed canary grass should be monitored and sprayed if there is evidence of new growth. Spraying and burning must occur every year for up to three to five years or more. Due to recurrent flooding, the control of this species will be difficult, thus maintenance is crucial to reduce the prevalence of the species.

j. River

i. Habitat Description

Rivers are naturally flowing watercourses that flow towards, and eventually empty into, an ocean, sea, lake, or another body of water. In more unusual cases, rivers flow into the ground and dry out before reaching a body of water. With recurrent flooding, it's imperative that restoration methods be practiced within the floodplain forests to prevent erosion and stabilize the river banks. The Little Sioux River runs through the Clay County portion of the Donahoo tract.

ii. Objectives and Procedures

Objective 1: Reduce runoff entering the river.

Agricultural operations can easily contribute to nutrient pollution when not properly managed. Fertilizers and manure are the main sources, and when these pollutants interact with water, it can have a negative impact on the water quality.

> **Procedure:** Collaborating with all of the people and organizations who have a direct effect on the entire watershed is vital to reducing runoff. The most significant method for controlling nutrient pollution is applying fertilizers in the proper amount, at the right time of year, and with the right method (The Sources and Solutions: Agriculture). Using controlled-release fertilizers delays the availability of nutrients for plant uptake after application and controls nutrient release over time which is one option for controlled fertilizer methods (Buechel). The Donahoo tract is surrounded by agricultural operations and includes known runoff locations. The main source of runoff comes from a highly eroded bank on the river on the south-eastern end of the tract.
>
> Establishing cover crops and buffer zones also helps reduce runoff that enters the river by acting as a flexible wall between fields and bodies of water (The Sources and Solutions: Agriculture). However, this might not be a desirable method for farmers who aim to use all available land for strictly agricultural uses. If this route is chosen by farmers, cover crops need to be established between the fields and river to ensure little to no pollution enters the river.

Objective 2: Reduce erosion and stabilize riverbanks

> **Procedure:** Soil samples should be taken along the riverbank in order to determine soil composition. A reliable method for collecting soil samples is the soil-coring device or an auger. Things like total metals, total organic carbon, percent moisture, and grain size can be determined from these samples (MacDonald 2013). This should be done before seedling establishment efforts. This will provide more information for the possibility of vegetative species establishment along the river bank as frequent flooding changes soil composition.
>
> Seedlings can then be planted and established according to soil composition. To make this process manageable, areas where the river curves and causes the most erosion will be focused on. This includes areas 1g and 1b on the north riverbanks and areas 1e and 1a on the south riverbanks (Ecosystems Map 1, pg. 21). Establishment of root systems once the seedlings mature will reduce erosion and prevent the river from channelizing further. Section 1a on the south side of the river has steep banks and may provide the best option for initial erosion control as several trees are already present in this area (Ecosystems Map 1, pg. 21).
>
> Excavation of riverbanks to reduce the channelization of the river may be necessary to allow the river to reach the floodplain more easily and reduce channelization (Why We Need to Restore Floodplains). Because this is more

expensive, it should not be utilized right away, however, it is still mentioned as an option.

Objective 3: Establish riparian buffer zones

Procedure: Two zones should be established for a buffer system. Zone 1 should be at least 12 meters or about one third of the distance of the whole buffer. Trees and shrubs should make up this zone beginning at the river channel. Tree and shrub species already present on the property could comprise these buffers. Tree species could include silver maple, green ash, willow, cottonwood, and oaks most of which are already present. Shrubs could include wild plum, chokecherry, and red osier dogwood. These species are not present on the current species list, however, flexibility in shrubs would be possible. Zone 2 should start at the edge of Zone 1 and have a composition of warm season grasses and forbs. It should be anywhere from 6 to around 40 meters wide. Stiff stemmed grasses like switchgrass or cordgrass are useful for capturing and slowing down runoff from agricultural fields (Lee 2003).

A well-developed buffer zone would be most helpful along the north side of the river in area 1b (refer to map on page 21) where agricultural fields are in close proximity to the river. An acre of land could be converted to this buffer system as a research opportunity.

Justification: Excavation of riverbanks can reduce channelization and steep riverbanks. Riparian buffer zones will reduce sedimentation and nutrients from entering the river. This will simultaneously reduce erosion along the riverbank with the development of root systems in trees in Zone 1.

Objective 4: Survey mussels and other aquatic species in river

Procedure: Conduct a mussel survey in this part of the river by 2021 to get a complete species list. Work with Mike Hawkins, a fishery biologist with the DNR, to see what mussel species are in the river. Install 2-3 riffles or other fish habitat in the river by 2023 to increase mussel populations (Iowa DNR).

Justification: Part of the mussel lifecycle is dependent on certain fish species. Once the species of mussel are identified, additional habitat can be created for the fish species that these mussels depend on to reproduce and grow successfully.

iv. Aftercare

Water quality of the Little Sioux river should be monitored monthly to ensure no additional and/or previous agricultural runoff contributes to the river. In the event that water quality shows a significant amount of nutrient pollution, the source of runoff needs

to be identified in order to converse with the responsible agricultural field owner. Soil samples will be taken every year or after flooding before vegetative establishment efforts. Tree species, shrubs, forbs, and grasses may need to be planted to maintain good buffer systems.

k. Oxbows

i. Habitat Description

An oxbow is a remnant of a river or stream curve/meander. Over time the river cuts off the meander leaving a long narrow wetland. A healthy oxbow provides critical habitat for many kinds of aquatic and avian creatures. The health of an oxbow depends on the amount of sediments it holds. If there is too much sediment, then it begins to dry up more frequently and no longer provides the necessary habitat for certain animals. Ideally oxbows would have few trees around their edges to prevent leaves from accelerating sediment deposits.

Currently there are several oxbows on the Donahoo tract that contain water for at least part of the year. These oxbows have a range of depths and sizes. Some are present for only a short time following a flood and thus need restoration. Others have at least a small part that holds water for an extended time following a flood, though whether they hold water all year has yet to be determined and would depend on the frequency of rainfall and flooding.

ii. Reference Site

Bev and Dwight Rutter's property near Spencer, IA provides a good reference site (http://theprairieflower.com/). In addition, Karen Wilke with the Nature Conservancy is aware of a potential site in the Boone River Watershed. Even though the site might be a little far away The Nature Conservancy has done a lot of successful restoration work on oxbows in the area

.

iii. Objectives and Procedures

Objective 1: Excavate soil to historic riverbed depth

Procedure: By the end of 2022, excavate oxbow 1k on the south side of the property (see map on page 21). This will be roughly 2000 cubic meters of soil. The total estimate for the removal of the soil is about $10,000. The excess soil can be placed on surrounding farmland with the permission of the farmers. (TNC)

By the end of 2023 oxbow 1c on the north side of the property (see map on page 21) should be excavated. This will be done in the same manner as the previous oxbow. This will remove roughly 300 cubic meters of soil. The cost will be about $1,500 dollars. (TNC)

Justification: Sediment has filled in the original stream channel reducing the amount of water the area can hold. By excavating the soil the oxbow will have the potential to hold up to 250,000 gallons of floodwater.

Objective 2: Re-slope and reseed banks

Procedure: To help stabilize the new banks native plants can be seeded. The plants would have to be resilient with the amount of flooding that takes place in the area. The addition of the native plants will help to replace the reed canary grass growing in the area. (TNC)

iv. Aftercare

Oxbows require very little care once they are restored. Monitoring of the sites would be needed to make sure water quality stays within the acceptable range. It would also be beneficial to make sure that the banks are staying intact without encroachment from reed canary grass.

l. Building Site

i. Site Description

The building site is a unique area on the Donahoo property that does not clearly fall into an ecological habitat. It is located on the east side of County Road 13/125th Avenue. Historically, this site was used for cattle. It appears there may have been a house standing on the site at some point (prior to its use as a corral for cattle). The site sits in a valley with hills to the north and south. The habitats surrounding the site are predominantly prairie and upland woods. There are two buildings still standing; both are in serious disrepair and should be removed in light of public safety. In addition to the old buildings, much of the site is covered in various forms of rubbish (Donahoo Tract Well and Debris Locations 2018 Map, page 24). There are pieces of metal, plastic, and wood with exposed nails scattered throughout the area. The majority of this rubbish has been grown over by reed canary grass and other grasses making it difficult to see.

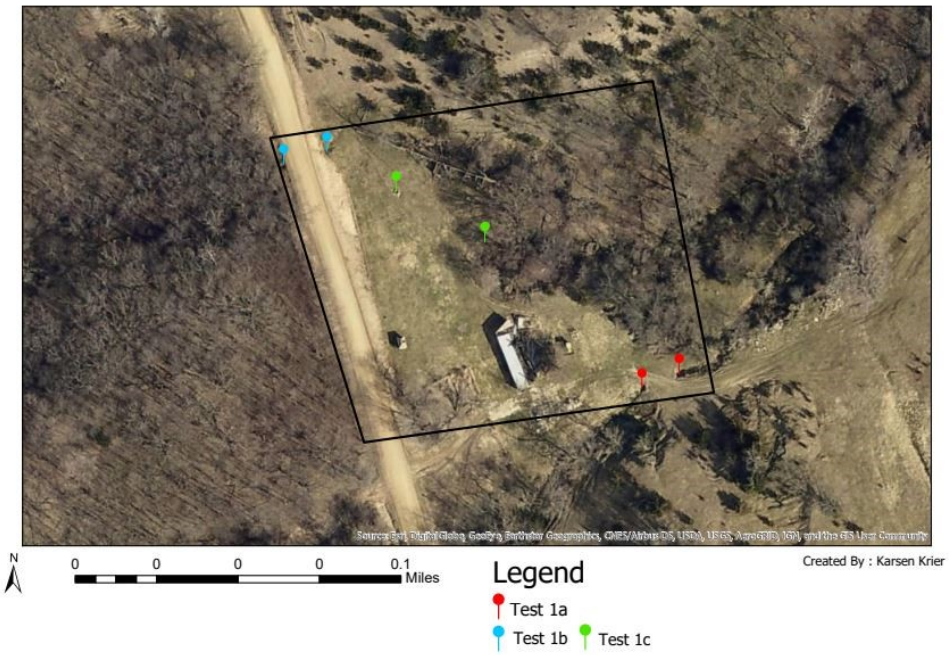
Multiple streams run from the west side of the road, under the road, and through this part of the property. At some point in the site's history culverts were installed that directed the water under the road and to a stream. At present drainage issues have led to significant erosion on the east side of the site. This site provides valuable access to the west side of the property and would be a prime location for a parking lot.

ii. Problems

The building site has four main issues that will need to be addressed to increase the value of the area for wildlife and human recreation. The first issue that will need to be addressed is the proper capping and marking of the uncapped well and the two pipe access points. The second issue that will need to be resolved is the removal of hazardous

buildings and containment or removal of human rubbish that is scattered throughout the site. Not all the buildings or rubbish need be removed, but the most unsightly and dangerous items should be removed. The third issue that must be addressed is controlling the erosion that is being caused by the tile drainage pipe and groundwater seepage. Cole-Parmer Fluorescent Yellow/Green Dye Tracer was used to try and understand the source of the water flow, but our testing did not provide any conclusive results. Approximately 7 mL were applied in three separate places as demonstrated on the map below. At Site 1 the dye was applied in the stream right before a culvert. After application the dye ran directly through the culvert. At Site 2 the dye was applied on the west site of the road at the culvert opening and it flowed through the culvert to the east side of the road where it leached into the ground. At Site 3 dye was applied into the well. After approximately 8 minutes the dye was seen coming out of the tile drain pipe. Although the dye tracer tests were helpful, they were not conclusive. Since the source of the problem was not identified steps should be taken to mitigate the problem. The fourth issue to be addressed is the invasive species that have overtaken the site due to human activities.

Dye Tracer Map



iii. Objectives and Procedures

Objective 1: Cap wells and remove hazardous buildings or rubbish.

Procedure: The well should be capped by an Iowa DNR certified well contractor by the end of 2019. The other two pipe access points should be clearly marked during 2019 and evaluated by the proper Clay County authorities to determine their purpose and the proper infrastructure that can be installed to provide functionality and safety by 2020. The danger that buildings and rubbish may pose to human users and environmental health should be evaluated. Removal of buildings could be contracted out or done by county employees and accomplished

with large machinery, while most of the rubbish removal would have to be done manually.

Justification: As public land, proper safety procedures should be followed in order to minimize possibility of injury to human users. There is also the aesthetic value that public land should provide which is inhibited by these aspects of the property.

Objective 2: Control erosion.

Procedure: The severity of the erosion and the inability to identify a clear source of the problem makes correcting this problem difficult. We recommend that a contractor be hired to determine and resolve the underlying cause of the erosion by 2020. Once the erosion is controlled native wetland plants should be seeded in the ravine that has been carved out to stabilize soils and reduce the amount of soil being washed into the Little Sioux River. The erosion should be monitored in case more drastic measures need to be taken in the future such as installing gabions or use of erosion blankets.

Justification: Decreasing soil erosion improves water quality and limits the amount of highly disturbed areas where invasive species can thrive.

Objective 3: Install parking lot and driveway.

Procedure: Improve the current pull-off by adding gravel to the driveway and create a larger parking lot by grading the area and adding gravel by 2022. Crushed-concrete driveway gravel costs approximately $30/ton and in order to cover the desired area 25-30 tons of gravel would be needed. It would cost approximately $900 to get the necessary materials and additional funds for labor and equipment.

Justification: This would improve access to the property for public recreation.

Objective 4: Control reed canary grass and reintroduce native species.

Procedure: After a parking lot is installed and the erosion is controlled the reed canary grass on the building site should be controlled, this process could begin in 2023 or 2024. Apply glyphosate herbicide to entire site in the fall for three to five years in a row. In between glyphosate application a cover crop of oats should be seeded in order to hold soils in place. After the last herbicide application, we recommend seeding the area with Prairie Moon Nursery's *Pretty Darn Quick* seed mix which would cost approximately $902/acre as of 2019. The building site is just over one acre, which would mean not including labor or machinery it would cost just over $900 to seed the site. Each year after seeding the area should be mown or burned to reduce the likelihood of reed canary grass re-establishment (Wisconsin DNR).

Justification: Controlling invasive species improves the ecological quality of the area and decreases the threat to adjacent endangered habitats such remnant prairie and oak savanna.

m. Agricultural Field

i. Site Description

There is an approximately 2-acre row crop field on the SE end of the property (2q, map 2 pg. 23). This field was presumably planted in corn and soybeans for the past many decades. Because this site has been intensively farmed for many years, it can be viewed as a blank slate for our restoration purposes. The land can be used one of two ways depending on whether ecological restoration or public recreation is valued more.

ii. Objectives and Procedures

Objective 1A: Convert the field to a tall grass prairie.

Procedures: Multiple rounds of secondary tillage or judicious use of herbicides can deplete the weed seed bank before seeding. A broadcast seeder can be used to conveniently seed the area in autumn or after frost. If planting takes place in the spring, a prairie seed drill may be the best choice, to avoid losing seed to birds and wildlife. To control weeds, the prairie should be mowed once the plants reach about one foot in height. The mower should be set at 6 inches. Mowing should take place at least three times the first year if weed pressure is high. The second year, one mowing will probably suffice, but if weed pressure is still high more mowing may need to take place. This parcel of land can be added to the prairie burn regime on its third or fourth year (Iowa State University). The "Mixed Height Prairie Seed Mix" from Prairie Moon Nursery is recommended for this area. This mix contains 28 wildflower species which make up 51% of the mix and 7 grass species which makes up 49% of the mix. This mix costs $1,675/acre so the total seed cost would be about $3,350 (Prairie Moon Nursery).

Justification: From a restoration viewpoint, this objective makes the most sense. This land historically would have been tallgrass prairie and it would be appropriate to restore this land to its pre-European state. It should be easy to convert because it is not colonized extensively by cedar or smooth brome.

Objective 1B: Utilize the field as a sorghum food plot.

Procedures: Tillage or judicious use of herbicides to remove weeds would be needed before seeding. Sorghum does best when soil temperatures warm to about 60-70 degrees Fahrenheit. Sorghum can be broadcast at a rate of 10-15 lbs./acre

or drilled at a rate of 5 lbs./acre. A pull-behind planter for corn could also be used. Soil will need to be assessed to determine if fertilizer needs to be applied (Westerfield). Wild Game Food Plot Sorghum sells for $75 for 50 lbs. (Hancock Seed Company).

Justification: This objective aims to achieve a greater recreational value from the property. People will use this property for public hunting and a food plot will provide food/shelter for popular game bird species such as pheasant and turkey. The food plot may also provide food/shelter for non-game native species.

IV. Summary/Overall Follow-Up Monitoring Plan

Data should be collected, monitored, and evaluated throughout the implementation of this project. Continuing to carry out these actions will change the way management is carried out. This is called adaptive management. Adaptive management allows us to change the system as well as learn from it. The data collected from this project can be used as a guide for future restoration projects with similar ecosystems.

The prairie, grassland, upland forest and oak savannas will change after the cedar and smooth brome removal. Adaptive management will be necessary in this process. After these major invasive species are removed, the growth of native species should be assessed. This list should be compared with the species lists from the reference sites to assess progress. A new species list should be made every 4 years to determine whether these ecosystems have the desired diversity. If the desired diversity is not present, native seeding should be implemented. If the desired diversity is found to be present, prescribed burns should continue to be conducted on a regular schedule.

The aquatic ecosystems such as oxbows, floodplain forest, and the pond are all variable ecosystems as they are affected by flooding, drought, and runoff. Monitoring the effects that these variables have on these ecosystems will be crucial to successful restoration and management. Specific attention should be given to sedimentation in all the aquatic habitats. Measurements of sediment depths can be determined by inserting a metal pole into the mud, down to the original pond bottom. (Fairchild, Robinson. 2011) In both the pond and the oxbows, the original bottom is likely to have rocks and gravel in it. By pressing down until contact with gravel/small rocks is felt and then measuring the length of pole that entered the mud, the amount of sediment can be recorded. By comparing new readings to old ones, a rate of sedimentation may be deduced. If excessive sedimentation occurs steps should be taken to reduce the sedimentation rate and remove excess sediments.

Encroachment of reed canary grass should also be closely monitored to reduce competition with native species that will be established. The berm for the pond will have to be monitored for erosion to ensure that it remains stable. Additionally, the riverbank will require monitoring to ensure that bank erosion is within acceptable levels. Monitoring for these will be as simple as taking pictures and comparing them each year.

a. Priorities

1) The first priority is to protect and conserve the remaining sections of remnant prairie and oak savanna through cedar removal, burning, and mowing. Both of these

ecosystems are endangered and should first be protected in order to enhance them later.

2) The second priority is to reintroduce a burning regime and seed smooth brome grasslands with native prairie species in order to increase plant diversity.
3) The third priority is to clean up the rubbish in the building site to make the area safer for public use.

b. Public Outreach/Education

1) Public outreach can be maintained through the different social media outlets that the conservation boards use. It would be important to keep it updated with all the different restoration efforts taking place on the property. This will allow the public to understand what is taking place. It also may be beneficial to post pictures of the staff and other workers conducting the different restoration practices on the tract.
2) Getting the public involved with the implementation of the restoration plan is beneficial as it not only increases the available hands to do the work, but it also teaches the public how to care for the world hands-on. This can be accomplished through volunteer opportunities in which citizens are given the opportunity to be involved with accomplishing the objectives and procedures listed above. Donations are always appreciated, so setting up a way for citizens to contribute financially is a great way to get the public involved as well.
3) The naturalists have also talked about creating different programs that can be conducted on the tract. Talking with Bri Bloom there would be a potential to create a forest program focusing on tree identification of the different trees on the tract. The tract would also be a great place to conduct different birding programs. There would be the potential to even incorporate the active Bald Eagle *(Haliaeetus leucocephalus)* nest on the north side of the property.

d. Gantt Chart

Objective	Area	Season	2019	2020	2021	2022	2023	2024	2025-2030
Cedar Removal	Prairie, Smooth Brome, Upland Forest, Oak Savanna	Any	—	—	—	—	—	—	—
Assess Pond Structure, Fix Berm	Pond	Spring, Summer, Fall	—	—	—	—	—	—	—
Cap Wells	Building Site, Smooth Brome Grassland	Any, before public use	—						
Building Removal	Building Site	Any, before public use	—						
Establish/ Maintain Firebreaks	Prairie, Smooth Brome, Oak Savanna	Spring, Summer, Fall	—						
Burn Regime on Prairie	Remnant Prairie and Smooth Brome Grassland	Spring		—	—	—	—	—	—
Remove Reed Canary Grass	Floodplain Forest			—	—	—	—	—	—
Build Parking Lot	Building Site	Any			—	—			
Riverbank and Oxbow Excavation	River	Summer, Fall			—	—	—	—	—
Riparian Buffer System	Floodplains	Any				—	—	—	—
Remove nonnative shrubs and woody vines	Upland Forest, Successional Forest	Spring					—	—	—
Reseed Native Vegetation	Smooth Brome Grassland and Floodplain Forest	Spring						—	—
Exterior Fencing, Grazing Plan	Prairie, Smooth Brome Grassland	Any							—

e. Budget

See the table below for an estimate of expenses for the first five years of the project, as well as longer term financial inputs. Having the property jointly owned and managed by two different counties may be an advantage, since both counties can apply for grants and other funds. For example, both Clay County and Buena Vista County have access to a wide variety of REAP grants provided by the Iowa Department of Natural Resources; specifically, Open Space Grants, County Conservation Grants, the Conservation Education Program, and others.

Preliminary Budget:

Budget - Donahoo Tract - May, 2019		Year					
Ecosystem	**Description of Work**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024+**
Remnant Prairie	Cedar Removal (Conservation Corps team 1 week)	2500					
	Burn - $60/acre	120	60	360	120	60	360
	Grazing						TBD
Smooth Brome Grasslands	Cedar Removal (Conervation Corps team 1 week)	2500					
	Prairie Seed - $750 per acre				20467		
	Herbicide (glyphosate + sulfosulfuron) - $75-100 per acre (2 Applications)		2729				
	Burn - $60 per acre	631	948	946	631	948	946
Oak Savanna	Burn $60 per acre (C.R.P reimbursement rate)		116	116	116	116	116
	Savanna seed mix - $750 per acre		4350				
	Cedar removal (Conservation Corps team for 1 week)	2500					
Upland Forest	Cedar Removal - (117 hours)					5600	
	Native Seeding - Shady Woodland Mix - $1400/acre				4000		
	Remove Japanese Barberry with hired crew			TBD			
Succession -al Forest	Clear successional forest (if chosen): $3000-6000 per acre						
Floodplain	Burning/chemical application - $795/30 gallon drum (get 2)		1590				

	Seed mix - $108/acre (34 acres)		3672				
River	Excavation- if needed			10000			
Oxbows	Excavating accumulated sediments			10000		10000	
Pond	Windmill Aerator- Prevents algal blooms, fish kills in the winter; has a low initial cost as well as long life expectancy.	1500	150	150	150	150	150
	Fish Restock- Hybrid Bluegill and Largemouth Bass	250	250	250	250	250	250
	Native Wetland Grasses- 1-3 Acres, 3-7 native wetland grass species needed	2100		1000			1000
	Berm- 3 ft high 5 ft wide	4000					
Building Site	Parking lot				900		
	Pollinator Seed mix to replace reed canary grass				1000		
	Contract out erosion control	TBD					
Agricultura l Ground	Convert to Prairie -Seeding	3350					
	Convert to Prairie			60			60
	Convert to Food Plot - Sorghum Seed	75	75	75	75	75	75
Expenses by Year		13,311	13,635	22,292	27,344	16,894	2,292
Cumulative Expenses		13,311	26,946	49,238	76,582	93,476	95,768

V. Appendices

a. Site Analysis

Existing Condition	Desired Restored Condition	Possible Action Required
UPLAND FOREST		
The existing condition of the Upland Forest presents various opportunities and challenges. One problem is the encroaching red cedar population. This likely has killed many deciduous trees. Another problem is the erosion that occurs in many of the ravines. There are also other invasive species such as Japanese barberry. Some areas of dumping and other rubbish are present.	One desired condition is maintaining valuable tree species that add historical or ecological value. Another desired condition is a clear understory for native undergrowth. Stable runoff of the streams and ravines that run through these areas will be ideal. Clearing out trash and other debris that has been left behind would also be ideal. Overall, a clean understory and healthy native and ecologically beneficial growth is the desired condition.	Removal of cedars and other threatening undergrowth. Another action is finding a solution to the eroding soil in the ravines. If there are any invasive species, they will have to be removed and tree plantings could be implemented to promote native and ecologically beneficial growth. Rubbish and other dump sites will have to be cleaned and restored.
OAK SAVANNA		
This ecosystem is in danger and is disappearing from the landscapes of the Midwest. This section of Oak Savanna is a prime specimen for being restored. It is being impacted by invasive species and the absence of fire.	The desired conditions are to have the Oak Savanna completely rid of invasive species, and successfully implement an appropriate burn plan.	Removal of encroaching invasive species (i.e. cedars) and reintroduction of fire to encourage oak growth. Plant more oak trees to increase size and quality of existing oak savanna.
NATIVE PRAIRIE		
Invasive species are colonizing and encroaching upon prairie remnants and surrounding grasslands	Invasive species do not have a significant impact on native species and have a minor role in terms of biomass and cover	Herbicide application; manual removal; native species establishment; regular burn regime established; historically similar grazing pressure implemented
Lack of plant diversity in remnants and surrounding grasslands	Prairie remnants and surrounding grasslands would have more forbs and potentially more grasses; greater diversity in plant species present	Removal of invasive species; seeding using native mixes or seed from nearby prairie remnants; regular disturbances that promote the growth and spread of native prairie species

Prairie remnants cover a small area compared to their historical range on the property	Prairie composed of historically native species would cover a similar area as it would have pre-European settlement on the property	Mechanical removal of woody species and invasive herbaceous species that have taken over historically prairie areas; seeding and establishment of new prairies; maintenance and care of established prairies.
BROMEGRASS dominated grasslands		
Brome grass, *Bromus Inermus,* has been planted in the native prairie areas and has completely overgrown most native prairie species. Smooth brome grass was likely planted to support the cattle that historically grazed the property.	The stretch goal would be to eradicate the brome grass and allow native species to take its place. A more realistic goal would be to stop the brome from moving into any additional areas. The removal of smooth brome is something that will take many years following practices in the next box over.	**Grazing** - In small patches where the goal is to eliminate smooth brome grass as much as possible, the patch should be grazed early (when the stem begins to elongate, usually in early May), allowed to rest for a short time (usually less than 20 days) and then grazed again. It is important that the smooth brome grass is not fall grazed.
		Burning - The best time to burn is when smooth brome grass is in the boot stage (usually late May). This will result in less seed being produced as compared with dormant season burning. It is also important to note that in order for prescribed burning to be effective, subsequent burns have to take place (ensure that sufficient litter has accumulated so the fire has enough fuel to burn).
Brome grass fact sheet https://d10k7k7mywg42z.cloudfront.net/assets/50ad04e8dabe9d4a8500738c/SmoothBrome.pdf	Prairie seedling guide https://secure.iowadot.gov/lrtf/docs/PrairieSeedlingGuide.pdf	**Mowing** - A single cutting of smooth brome grass while in the boot stage (flowering heads still enclosed within the sheath) is the most effective method for preventing seed set. It is especially practical for

		preventing seed production in small areas or patches of smooth brome grass. The best conditions for damaging smooth brome grass are hot, moist weather at the time of cutting followed by a dry period.
BUILDING SITE		
Site contains old cattle shed and other structures that are in serious disrepair as well as various rubbish that pose a danger to people and potentially wildlife if not removed.	Installation of a parking lot/access point on the southern part of this portion of the property, the complete removal of hazardous materials, and installation of firebreaks.	Manually pull out and properly dispose of all hazardous waste (i.e. metal, boards with exposed nails, old machinery) and take buildings down. Determine where to place firebreaks and then mow these areas.
Site primarily vegetated by weedy species and has experienced high levels of disturbance.	Decreased abundance of invasive species and complete removal of hazardous rubbish.	Mow area and apply herbicides to decrease amount of invasive species and seed native prairie plants that can grow quickly and compete with the weed species.
Extensive erosion due to culvert failure.	Functioning culvert and stabilized surface that is populated by native species and that resists future erosion	Install a new culvert or other structure to divert water down to the Little Sioux River. Stabilize surface first using gabions and eventually using naïve species that are capable of holding soil in place.
AGRICULTURAL GROUND		
Site is currently unplanted and left alone the past year to become colonized by common agricultural weeds	Restore the field to a prairie as it was historically before being farmed	Herbicide application; seeding using native mixes or seed from nearby prairie remnants; regular disturbances that promote the growth and spread of native prairie species
Site is currently unplanted and left alone the past year to become colonized by common agricultural weeds	Turn the field into a food plot to increase the recreational opportunities the property supports	Herbicide application; light tilling/disking; planting of cover crops (such as corn, sunflowers, etc.) providing

		food and shelter for game species
FLOODPLAIN FOREST		
Site has open understory with very few young trees.	More young trees growing to replace the old trees as they die.	Tree plantings or seeding. desired trees including silver maple, cottonwood, and basswood.
Much of the understory is covered with invasive reed canary grass.	Native grasses or riparian understory plants.	Application of herbicides, regular burning, or mowing. A denser over story would also shade out the grass and promote other floodplain plant species.
Some bank erosion along parts of the river bank. The bank is steep and has some undercutting.	Stabilized bank with natural levels of erosion.	Planting native trees, shrubs, and grasses to hold the bank in place. Addition of rock may be necessary in places.
OXBOWS		
Relatively shallow, some do not hold water for very long.	A diversity of oxbow depths with some holding water for much of the year.	Digging down to the original bottom (removing sediment).
Many have some standing vegetation, mostly reed canary grass.	Diverse plant community with a variety of native wetland plants.	Seeding and planting of wetland species.
POND		
Unstable dirt spillway.	Stable spillway capable of handling large amounts of water without further erosion.	Adding rock/concrete to stabilize eroding areas as well as adding a culvert or concrete for a spillway.
Dike possibly unstable (serious erosion/shifting soil near base and side of dike).	Stable dike that will not give way due to the weight of the pond.	Inspection by a professional to determine the extent of the problem as well as suggest possible solutions.
Deposition of mud sediments, especially near the inlet.	Minimal sedimentation to promote a sandy/gravelly bottom.	Creation of a sediment trap and removal of current sediments.
Pond Structure/fish habitat undetermined.	Structure, such as rocks and submerged trees, to provide cover for fish.	Adding some large rocks or submerging trees to establish structure if needed.
Two streams converging into one inlet leading to the pond. Undetermined water source and water quality.	Improved water quality that supports a wide variety of fish and aquatic flora.	Decrease agriculture runoff by installing wetlands or routing water through wood chip bioreactor

b. SWOT-C

Strengths	Habitat diversity, remnant prairie species, roads to property, wildlife habitat, location
Weaknesses	Access, flooding, E. coli in nearby lagoons, available labor, management cost, erosion, funding, access, fences, man-made structures
Opportunities	Recreation, education, wildlife diversity, collaboration of 2 counties, tree planting
Threats	Invasive species, flooding
Constraints	Funding, lack of equipment, collaboration of 2 counties

c. Species Lists

Birds	**Scientific Name**
Family: Podicipedidae	
Pied-Billed Grebe	*Podilymbus podiceps*
Family: Pelecanidae	
American White Pelican	*Pelecanus erythrorhynchos*
Family: Acrocoracidae	
Double-crested Cormorant	*Phalacrocorax auritus*
Family: Ardeidae	
Least Bittern	*Ixobrychus exilis*
American Bittern	*Botaurus lentiginosus*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Green-backed Heron	*Butorides striatus*
Cattle Egret	*Bubulcus ibis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea Herodias*
Family: Anatidae	
Canada Goose	*Branta Canadensis*
Snow Goose	*Chen caerulescens*
Ross' Goose	*Chen rossii*
Greater White-fronted Goose	*Anser albifrons*
Cackling Gooae	
Trumpeter Swan	*Cygnus buccinator*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Green-winged Teal	*Anas crecca*
American Widgeon	*Anas Americana*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Blue-winged teal	*Anas discors*
Wood Duck	*Aix sponsa*
Ruddy Duck	*Oxyura jamaicensis*

Canvasback	*Aythya valisineria*
Redhead Duck	*Aythya Americana*
Ring-necked Duck	*Aythya collaris*
Lesser Scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Hooded Merganser	*Lophodytes cucullatus*
Red-breasted Merganser	*Mergus serrator*
Family: Laridae	
Franklin's Gull	*Larus pipixcan*
Ring-billed Gull	*Larus delawarensis*
Family: Rallidae	
Virginia Rail	*Rallus limicola*
Sora Rail	*Porzana Carolina*
American Coot	*Fulica Americana*
Family: Charadriidae	
Killdeer	*Charadrius vociferous*
Black-bellied Plover	*Pluvialis dominica*
Semipalmated Plover	*Charadrius semipalmatus*
American Golden Plover	*Pluvialis dominica*
Family: Scolopacidae	
Hudsonian Godwit	*Limosa haemastica*
Marbled Godwit	*Limosa fedoa*
Willet	*Catoptrophorus semipalmatus*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Spotted Sandpiper	*Actitis macularia*
Solitary Sandpiper	*Tringa solitaria*
Wilson's Phalarope	*Phalaropus tricolor*
Short-billied Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Stilt Sandpiper	*Calidris himantopus*
Semipalmated Sandpiper	*Calidris pusilla*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Upland Sandpiper	*Bartramia longicauda*
Dunlin	*Calidris alpina*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Family: Cathartidae	
Turkey Vulture	*Cathartes aura*
Family: Accipitridae	

Bald Eagle	*Haliaeetus leucocephalus*
Golden Eagle	*Aquila chrysaetos*
Osprey	*Pandion haliaetus*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Swainson's Hawk	*Buteo swainsoni*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
Rough-legged Hawk	*Buteo lagopus*
Family: Falconidae	
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
American Kestrel	*Falco sparverius*
Family: Phasianidae	
Gray Partridge	*Perdix perdix*
Ring-necked Pheasant	*Phasianus colchicus*
Wild Turkey	*Meleagris gallopavo*
Family: Columbidae	
Rock Dove	*Columba livia*
Eurasian Collared-dove	*Streptopelia decaocto*
Mourning Dove	*Zenaida macroura*
Family: Cuculidae	
Yellow-billed Cuckoo	*Coccyzus minor*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Family: Strigidae	
Short-eared Owl	*Asio flammeus*
Long-eared Owl	*Asio otus*
Great Horned Owl	*Bubo virginianus*
Eastern Screech Owl	*Otus asio*
Barred Owl	*Strix varia*
Northern Saw-whet Owl	*Aegolius acadicus*
Family: Caprimulgidae	
Common Nighthawk	*Chordeiles minor*
Whip-poor-will	*Caprimulgus vociferus*
Family: Apodidae	
Chimney Swift	*Chaetura pelagica*
Family: Trochilidae	
Ruby-throated Hummingbird	*Archilochus colubris*
Family: Alcedinidae	
Belted Kingfisher	*Ceryle alcyon*
Family: Picidae	
Red-bellied Woodpecker	*Melanerpes carolinus*
Northern Flicker	*Colaptes auratus*

Red-headed Woodpecker	*Melanerpes erythrocephalus*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Pileated Woodpecker	*Dryocopus pileatus*
Family: Tyrannidae	
Eastern Kingbird	*Tyrannus tyrannus*
Great Crested Flycatcher	*Myiarchus crinitus*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Acadian Flycatcher	*Empidonax virescens*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Eastern Wood-Pewee	*Contopus virens*
Eastern Phoebe	*Sayornis phoebe*
Family: Laniidae	
Loggerhead Shrike	*Lanius ludovicianus*
Northern Shrike	*Lanius excubitor*
Family: Alaudidae	
Horned Lark	*Eremophila alpestris*
Family: Hirundinidae	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Tree Swallow	*Tachycineta bicolor*
Purple Martin	*Progne subis*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Family: Corvidae	
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Family: Paridae	
Black-capped Chickadee	*Parus atricapillus*
Family: Certhiidae	
Brown Creeper	*Certhia Americana*
Family: Sittidae	
White-brested Nuthatch	*Sitta carolinebsis*
Red-brested Nuthatch	*Sitta Canadensis*
Family: Troglodytidae	
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Family: Sylviidae	
Blue-gray Gnatcatcher	*Polioptila caerulea*
Family: Motacillidae	
American Pipit	*Anthus rubescens*
Family: Regulidae	

Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Family: Turdidae	
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichia mustelina*
American Robin	*Turdus migratorius*
Familt: Mimidae	
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Northern Mockingbird	*Mimus polyglottos*
Familt: Bombycillidae	
Cedar Waxwing	*Bombycilla cedrorum*
Family: Sturnidae	
European Starling	*Sturnus vulgaris*
Family: Vireonidae	
Yellow-throated Vireo	*Vireo flavifrons*
Red-eyed Vireo	*Vireo olivaceus*
Blue-headed Vireo	*Vireo solitaries*
Warbling Vireo	*Vireo gilvus*
Philadelphia Vireo	*Vireo philadelphicus*
Family: Parulidae	
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrine*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Northern Parula	*Parula Americana*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronate*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Blackpoll Warbler	*Dendroica striata*
Black and White Warbler	*Mniotilta varia*
Prothonotary Warbler	*Protonotaria citrea*
Yellow Warbler	*Dendroica petechial*
Northern Waterthrush	*Seiurus noveboracensis*
Kentucky Warbler	*Oporornis formosus*

Connecticut Warbler	*Oporornis agilis*
Mourning Warbler	*Oporornis Philadelphia*
Wilson's Warbler	*Wilsonia pusilla*
Canada Warbler	*Wilsonia canadensis*
Oven Bird	*Seiurus aurocapillus*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Icteria virens*
American Redstart	*Setophaga ruticilla*
Family: Cardinalidae	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Northern Cardinal	*Cardinalis cardinalis*
Diskcissel	*Spiza americana*
Blue Grosbeak	*Guiraca caerulea*
Indigo Bunting	*Passerina cyanea*
Family: Emberizidae	
Eastern Towhee	*Pipilo erythrophthalmus*
Spotted Towhee	*Pipilo maculatus*
Clay-colored Sparrow	*Spizella pallida*
Lark Sparrow	*Chondestes grammacus*
Vesper Sparrow	*Pooecetes gramineus*
Henslow's Sparrow	*Ammodramus savannarum*
Le Conte's Sparrow	*Ammodramus leconteii*
Fox Sparrow	*Passerella iliaca*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Harris's Sparrow	*Zonotrichia querula*
Nelson's Sharp-tailed Sparrow	*Ammodramus caudacutus*
Grasshopper Sparrow	*Ammodramus savannarum*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
American Tree Sparrow	*Spizella arborea*
Field Sparrow	*Spizella pusilla*
Chipping Sparrow	*Spizella passerine*
Dark-eyed Junco	*Junco hyemalis*
Family: Icteridae	
Bobolink	*Dolichonyx oryzivorus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Red-winged Blackbird	*Agelaius phoeniceus*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Rusty Blackbird	*Euphagus carolinus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*

Northern Oriole	*Icterus galbula*
Family: Thraupidae	
Summer Tanager	*Piranga rubra*
Scarlet tanager	*Piranga olivacea*
Family: Passeridae	
House Sparrow	*Passer domesticus*
Family: Fringillidae	
Pine Siskin	*Carduelis pinus*
Common Redpoll	*Carduelis flammea*
House Finch	*Carpodacus mexicanus*
Red Crossbill	*Loxia curvirostra*
American Goldfinch	*Carduelis tristis*
Purple Finch	*Carpodacus purpureus*
Evening Grosbeak	*Coccothraustes vespertinus*

Mammals

*Designates a threatened, or an endangered species for Iowa, or federally listed species.

Name	**Scientific Name**
Family: Didelphidae	
Virginia opossum	*Didelphis virginiana*
Family: Soricidae	
Masked Shrew	*Sorex cinereus*
*Hayden's Shrew	*Sorex haydeni*
Eastern Mole	*Scalopus aquaticus*
Family Vespertilionidae	
Little Brown Bat	*Myotis lucifugus*
Silver-haired Bat	*Lasionycteris noctivagans*
Big Brown Bat	*Eptesicus fuscus*
Hoary Bat	*Lasiurus cinereus*
Family: Leporidae	
Eastern Cottontail	*Sylvilagus floridanus*
White-tailed Jackrabbit	*Lepus townsendii*
Family Sciuridae	
*Franklin's Ground Squirrel	*Spermophilus franklinii*
Flying Squirrel	*Glaucomys Volans*
Eastern Chipmunk	*Tamias striatus*
Woodchuck	*Marmota monax*
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*
Fox Squirrel	*Sciurus niger*
Family: Geomyidae	
Plains Pocket Gopher	*Geomys bursarius*
Family: Castoridae	
Beaver	*Castor Canadensis*
Family: Muridae	
White-footed mouse	*Peromyscus leucopus*
Deer Mouse	*Peromyscus maniculatus*

*Northern Grasshopper Mouse	*Onychomys leucogaster*
*Western Harvest Mouse	*Reithrodontomys megalotis*
Prairie Vole	*Microtus ochrogaster*
Meadow Vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
House mouse	*Mus musculus*
Norway Rat	*Rattus norvegicus*
Family: Canidae	
Coyote	Canis latrans
Red Fox	*Vulpes vulpes*
Family: Procyonidae	
Raccoon	*Procyon lotor*
Family: Mustelidae	
Ermine	*Mustela ermine*
*Long-tailed Weasel	*Mustela frenata*
*Least Weasel	*Mustela nivalis*
Mink	*Mustela vison*
Badger	*Taxidea taxus*
*Spotted Skunk	*Spilogale putorius*
Striped Skunk	*Mephitis mephitis*
River Otter	*Lutra Canadensis*
Family: Felidae	
Bobcat	*Lynx rufus*
Family: Cervidae	
White-tailed Deer	*Odocoileus virginianus*

<u>Plant Species</u>

Indicates Non-native Species. *

Grass Species

Name	**Scientific Name**
Big Bluestem	*Andropogon gerardii*
Blue Grama	*Bouteloua gracilis*
Side-oats Grama	*Bouteloua curtipendula*
*Kentucky Bluegrass	*Poa pratensis*
Indian Grass	*Sorhastrum nutans*
Little Bluestem	*Schizachyrium scoparium*
Switch Grass	*Panicum virgatum*
*Smooth Brome	*Bromus inermis*
Canada Wildrye	*Elymus Canadensis*
Virginia Wildrye	*Elymus virginicus*
Common Foxtail	*Alopecurus carolinianus*
Prairie Cordgrass	*Spartina pectinate*

Rough Dropseed	*Sporobolus compositus*
Sand Dropseed	*Sporobolus cryptandrus*
Tall Dropseed	*Sporobolus compositus*
*Giant Green Foxtail	*Setaria viridis*
Porcupine Grass	*Hesperostipa spartea*
Purple Top	*Tridens flavus*
*Orchard Grass	*Dactylis glomerata*
*Reed Canary Grass	*Phalaris arundinacea*
*Timothy	*Phleum pretense*
Forbs	
Butterfly Milkweed	*Asclepias tuberosa*
Swamp Milkweed	*Asclepias incarnate*
Pale Purple Coneflower	*Echinacea pallida*
Rough Blazing Star	*Liatris aspera*
Leadplant	*Amorpha canescens*
Wild Bergamont	*Monarda fistulosa*
Gray-headed Coneflower	*Ratibida pinnata*
Black-eyed Susan	*Rudbeckia hirta*
Stiff Goldenrod	*Solidago rigida*
Canada Goldenrod	*Solidago Canadensis*
Prairie Goldenrod	*Solidago missouriensis*
Showy Goldenrod	*Solidago speciosa*
Spiderwort	*Tradescantia ohioensis*
Compass Plant	*Silphium laciniatum*
Purple Prairie Clover	*Dalea purpurea*
White Prairie Clover	*Dalea candida*
Round-headed Bushclover	*Lespdeza capitate*
Rattlesnake Master	*Eryngium yuccafolium*
Hoary Puccoon	*Lithospermum canescens*
Prairie Phlox	*Phlox pilosa*
Heath Aster	*Aster ericoides*
Jack-in-the-pulpit	*Arisaema triphyllum*
Solomon's Seal	*Polygonatum biflorum*
Yarrow	*Achillea millefolium*
Prairie Larkspur	*Delphinium virescens*
Catnip	*Nepeta cataria*
Indian Plantain	*Cacalia plantaginea*
Ground Plum	*Astragalus crassicarpus*
Wild Onion	*Allium canadense*
Wild Rose	*Rosa arkansana*
Hoary Vervain	*Verbena stricta*
Common Milkweed	*Asclepias syriaca*
Wild Bergamot	*Monarda fistulosa*
Ironweed	*Vernonia fasciculate*
Dense Blazingstar	*Liatris pycnostachya*
Dotted Blazingstar	*Liatris punctate*

Blue-eyed Grass	*Sisyrinchium montanum*
Scurf Pea	*Psoralea argophylla*
Blue Lobelia	*Lobelia siphilitica*
White False Indigo	*Baptisia lactea*
Noxious Plants	
Canada Thistle	*Cirsium arvense*
Common Burdock	*Arctium minus*
Bull Thistle	*Cirsium vulgare*
Musk Thistle	*Carduus nutans*
Wild Carrot	*Daucus carota*
Common Cocklebur	*Xanthium strumarium*
Velvetleaf	*Abutilon atheophrasti*
Trees	
American Basswood	*Tilia Americana*
Black Walnut	*Juglans nigra*
Bur Oak	*Quercus macrocarpa*
Red Oak	*Quercus rubra*
Cottonwood	*Populus deltoids*
Eastern Red Cedar	*Juniperus virginiana*
Elderberry	*Sambucus Canadensis*
Green Ash	*Fraxinus pennsylvanica*
Honey Locust	*Gleditsia triacanthos*
Prickly Ash	*Zanthoxylum americanum*
Mulberry	*Morus rubra*
Silver Maple	*Acer saccharinum*
Smooth Sumac	*Rhus glabra*
Wild Plum	*Prunus Americana*
American Bittersweet	*Calastrus scandens*

<u>Lizards, Turtles, Salamanders, and Snakes Species List</u>

Name	**Scientific Name**
Family: Ranidae	
Northern Leopard Frog	*Rana pipiens*
Bullfrog	*Rana catesbeiana*
Family: Hylidae	
Gray treefrog	*Hyla versicolor*
Western Chorus Frog	*Pseudacris triseriata*
Cricket Frog	*Acris crepitans*
Family: Bufonidae	
American Toad	*Bufo americanus*
Family: Ambystomatidae	
Tiger salamander	*Ambystoma tigrinum*
Family: Scincidae	
Northern Prairie Skink	*Eumeces septentrionalis*
Family: Emydidae	

Painted Turtle	*Chrysemys picta*
Family: Chelydridae	
Snapping Turtle	*Chelydra serpentine*
Family: Trionychidae	
Spiny Softshell Turtle	*Apalone spinifera*
Family: Colubridae	
Northern Redbelly Snake	*Storeria occipitomaculata*
Redside Garter Snake	*Thamnophis sirtalis*
Plains Garter Snake	*Thamnophis radix*
Milk Snake	*Lampropeltis Triangulum*
Bullsnake	*Pituophis melanoleucus*
Fox Snake	*Elpahe vulpina*

<u>Fish Species in spring 2019</u>

Name	**Scientific Name**
Largemouth Bass	*Micropterus salmoides*
Green sunfish	*Lepomis cyanellus*

d. Water Analysis – Spring, 2019 Data

Water quality is an important issue in Iowa. Improving water quality should be something we strive for in this project. The EPA has set the maximum contaminant level goal (MCLG) for nitrate at 10 mg/L. The MCLG for nitrite is set at 1 mg/L. The National Academy of Science recommends a drinking water standard of 0.5 mg/L for ammonia.

Nitrate- maximum contaminant level goal (MCLG):10 mg/L Nitrite- MCLG: 1 mg/L

(https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations)

"Ammonia is rarely found in unpolluted surface water or well water, but water contaminated with sewage, animal wastes or fertilizer runoff may contain elevated levels. The US Environmental Protection Agency (USEPA) has not established a maximum contaminant level (MCL) for ammonia in drinking water. Environmental limits for ammonia in surface water in the US range from 0.25 to 32.5 mg/l (ppm). The National Academy of Science recommends, and many European nations have adopted, a drinking water standard of 0.5 mg/l (ppm). In 1990 the US EPA issued a lifetime exposure advisory of 30 mg/l (ppm) for ammonia." (https://www.oregon.gov/oha/PH/HealthyEnvironments/DrinkingWater/Monitoring/Documents/health/ammonia.pdf)

	Nitrates	Phosphorus	Ammonia	Bacteria
Pond North	1.7 mg/L	2.2 mg/L	1.11 mg/L	121 count
Pond South	2.45 mg/L	.98 mg/L	2.4 mg/L	130 count
Oxbow #1	1.3 mg/L	2.6 mg/L	Under Range	198 count
Oxbow #2	1.6 mg/L	2.2 mg/L	Under Range	212 count
Oxbow #4	1.3 mg/L	.78 mg/L	Under Range	76 count
West Inlet Stream	12.1 mg/L	1.8 mg/L	Under Range	
East Inlet Stream	5.9 mg/L	3.3 mg/L	Under Range	
River #1	7.7 mg/L	1.2 mg/L	Under Range	274 count
River #2	7.2	1.4 mg/L	Under Range	321 count

Raw Data – Samples taken in March and in April

	Nitrates #1	**Nitrates #2**	**Nitrites #1**	**Phosphorus #1**	**Phosphorus #2**	**Ammonia #1**	**Ammonia #2**
Pond N	1.87 mg/L	2.34 mg/L	Under range	1.2 mg/L	2.8 mg/L	.87 mg/L	1.33 mg/L
Oxbow #1	.40 mg/L	1.76 mg/L	Under range	2.2 mg/L	2.6 mg/L	Undetectable	Undetectable
Pond S	.99 mg/L	2.65 mg/L	Under range	.86 mg/L	1.4 mg/L	1.5 mg/L	2.8 mg/L
River W	1.56 mg/L	.79 mg/L	Under range	1.8 mg/L	1.64 mg/L	Undetectable	Undetectable
E Inlet Stream	3.9 mg/L	3.8 mg/L	Under range	1.96 mg/L	1.56 mg/L	Under range	Under range
W Inlet Stream	13.5 mg/L	13.4 mg/L	Under range	2.3 mg/L	1.44 mg/L	Under range	Under range
Oxbow #2 E	1.2 mg/L	0.9 mg/L	Under range	.88 mg/L	.77 mg/L	Under range	Under range

Oxbow #2 W	1.1 mg/L	0.7 mg/L	Under range	.91 mg/L	2.08 mg/L	Under range	Under range
W Inlet Stream WHITE	12.5 mg/L	12.4 mg/L	Under range	2.06 mg/L	1.91mg/L	Under range	Under range
Oxbow #4	1.2 mg/L	1.2mg/L	Under range	1.84 mg/L	1.45 mg/L	Under range	Under range

	Nitrates #1	**Nitrates #2**	**Nitrates #12**	**Ammonia**	**Phosphorus #1**	**Phosphorus #2**	**Bacteria**
West Inlet Stream - White Pipe	11	11.1	Under Range	Under Range	2.22	2.33	
East Inlet Stream	5.9	5.8	Under Range	Under Range	2.91	3.31	
River #1	7.9		Under	Under	2.1		274
River #2	7.2		Under	Under	1.29		321
Pond #1	1.7		Under	Under	1.48		121
Pond #2	2.4		Under	Under	1.47		130
Oxbow #4	1.3	1.33	Under	Under	0.77	0.79	76
Oxbow #2A	1.6	1	Under	Under	0.87	1.3	227
Oxbow #2B	2.2	1.3	Under	Under	2.02	2.08	212
Oxbow #1	0.77	1.6	Under	Under	2.6	2.5	8

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